# Model WW5064 / WW1074 / WW2074

## 50 / 100 / 200 MS/s Four Channel Arbitrary Waveform Generator

## User Manual

## Rev. 1.1

Distribution in the UK & Ireland

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

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

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

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

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

Before operation this instrument:

1. Ensure the instrument is configured to operate on the voltage at the power source. See Installation Section.

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

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

If the instrument:

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

Do not operate until performance is checked by qualified personnel.

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# Document Revision History

| Revision | Date | Description | Author |
|---|---|---|---|
| 1.1 | 20-Oct-2020 | • New formatting with improved document navigation. | Jakob Apelblat |
| 1.0 | 15-Jul-2015 | • Original release. | Jonathan Netzer |

# Acronyms & Abbreviations

Table Acronyms & Abbreviations

| Acronym | Description |
|---|---|
| µs or us | Microseconds |
| ADC | Analog to Digital Converter |
| AM | Amplitude Modulation |
| ASIC | Application-Specific Integrated Circuit |
| ATE | Automatic Test Equipment |
| AWG | Arbitrary Waveform Generators |
| AWT | Arbitrary Waveform Transceiver |
| BNC | Bayonet Neill–Concelm (coax connector) |
| BW | Bandwidth |
| CW | Carrier Wave |
| DAC | Digital to Analog Converter |
| dBc | dB/carrier. The power ratio of a signal to a carrier signal, expressed in decibels |
| dBm | Decibel-Milliwatts. E.g., 0 dBm equals 1.0 mW. |
| DDC | Digital Down-Converter |
| DHCP | Dynamic Host Configuration Protocol |
| DSO | Digital Storage Oscilloscope |
| DUC | Digital Up-Converter |
| ENoB | Effective Number of Bits |
| ESD | Electrostatic Discharge |
| EVM | Error Vector Magnitude |
| FPGA | Field-Programmable Gate Arrays |
| GHz | Gigahertz |
| GPIB | General Purpose Interface Bus |
| GS/s | Giga Samples per Second |
| GUI | Graphical User Interface |
| HDMI | High-Definition Multimedia Interface |
| HP | Horizontal Pitch (PXIe module horizontal width, 1 HP = 5.08mm) |
| Hz | Hertz |

| Acronym | Description |
|---|---|
| IF | Intermediate Frequency |
| I/O | Input / Output |
| IP | Internet Protocol |
| IQ | In-phase Quadrature |
| IVI | Interchangeable Virtual Instrument |
| JSON | JavaScript Object Notation |
| kHz | Kilohertz |
| LCD | Liquid Crystal Display |
| LO | Local Oscillator |
| MAC | Media Access Control (address) |
| MDR | Mini D Ribbon (connector) |
| MHz | Megahertz |
| ms | Milliseconds |
| NCO | Numerically Controlled Oscillator |
| ns | Nanoseconds |
| PC | Personal Computer |
| PCAP | Projected Capacitive Touch Panel |
| PCB | Printed Circuit Board |
| PCI | Peripheral Component Interconnect |
| PRBS | Pseudorandom Binary Sequence |
| PRI | Pulse Repetition Interval |
| PXI | PCI eXtension for Instrumentation |
| PXIe | PCI Express eXtension for Instrumentation |
| QC | Quantum Computing |
| Qubits | Quantum bits |
| RADAR | Radio Detection And Ranging |
| R&D | Research & Development |
| RF | Radio Frequency |
| RT-DSO | Real-Time Digital Oscilloscope |
| s | Seconds |
| SA | Spectrum Analyzer |

| Acronym | Description |
|---|---|
| SCPI | Standard Commands for Programmable Instruments |
| SFDR | Spurious Free Dynamic Range |
| SFP | Small Form-Factor Pluggable |
| SFP | Software Front Panel |
| SMA | Subminiature version A connector |
| SMP | Subminiature Push-on connector |
| SPI | Serial Peripheral Interface |
| SRAM | Static Random-Access Memory |
| TCXO | Temperature Controlled Crystal Oscillator |
| TFT | Thin Film Transistor |
| T&M | Test and Measurement |
| TPS | Test Program Sets |
| UART | Universal Asynchronous Receiver-Transmitter |
| USB | Universal Serial Bus |
| VCP | Virtual COM Port |
| Vdc | Volts, Direct Current |
| V p-p | Volts, Peak-to-Peak |
| VSA | Vector Signal Analyzer |
| VSG | Vector Signal Generator |
| WDS | Wave Design Studio |

# 1 Getting Started

## 1.1 What's in This Chapter

This chapter contains a general description of the Model 2074 Waveform Generator and an overall functional description of the instrument. It also describes the front and rear panel connectors and indicators.

**NOTE**

- This manual is common to Models 5064, Model 1074 and Model 2074. Features and functions are described for the Model 2074 and the variations are described in 8 Appendix A Specifications, page 293. The main differences are related to the highest sampling clock rate and the output frequency. If you purchased either Model 5064 or Model 1074, refer to the specifications and ignore references to frequency and sample clock limits that exceed those which are listed in Appendix A.

## 1.2 Introduction

Model 2074 is a four-channel, Universal Waveform Generator. It is a high performance waveform generator that combines four separate and powerful channels in one small package. Supplied free with the instrument is ArbConnection software utility, which is used for controlling the 2074 and for generating, editing and downloading waveforms from a remote computer. The following highlights the 2074 features.

## 1.3 2074 Feature Highlights

- Four output configuration with Independent waveform control
- Tight phase offset control between channels (1 point resolution)
- 16-bit vertical resolution
- Generates signals up to 20 Vp-p (into high impedance load)
- 16-bit LVDS level digital pattern output
- 2 M memory depth for each channel
- 200 MS/s sample clock frequency
- 80 MHz output bandwidth
- 1 ppm clock stability
- Extremely low phase noise carrier
- PSK and QAM modulation
- Built-in standard waveforms; half-cycle waveforms
- Separate sequence generators for each channel
- Multiple instrument synchronization, jitter-free and phase control
- Remote calibration without removing case covers
- Auxiliary pulse generator and counter/timer functions
- GPIB, USB and Ethernet interfaces

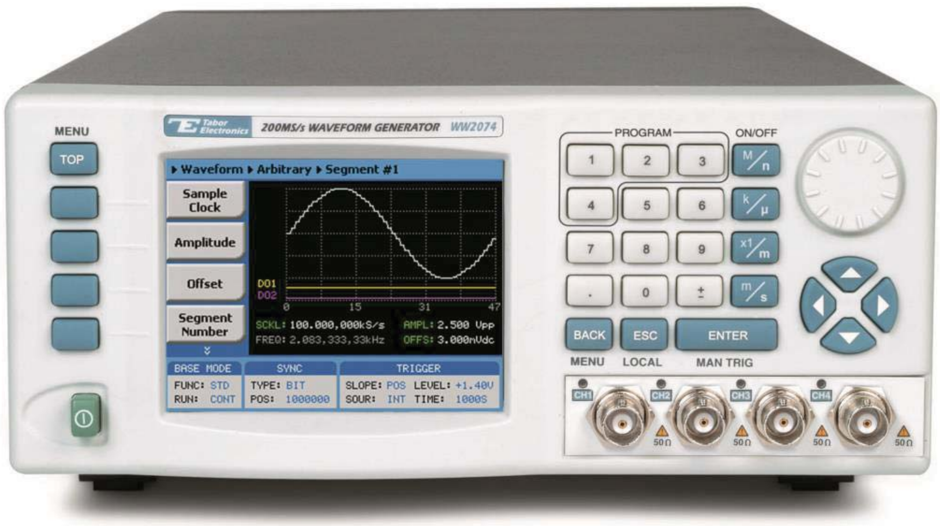


Figure 1.1, Model 2074

## 1.4 ArbConnection Feature Highlights

- Three powerful tools in one software package: Complete instrument control, as well as, waveform and pulse composers
- Detailed virtual front panels control all 2074 functions and modes
- Wave composer generates, edits and downloads complex waveforms
- Easy, on-screen generation of complex pulses using the pulse composer
- 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

Various screens of the ArbConnection program are shown in Figures 1-2 through 1-4.


Figure 1-2, ArbConnection – The Control Panels

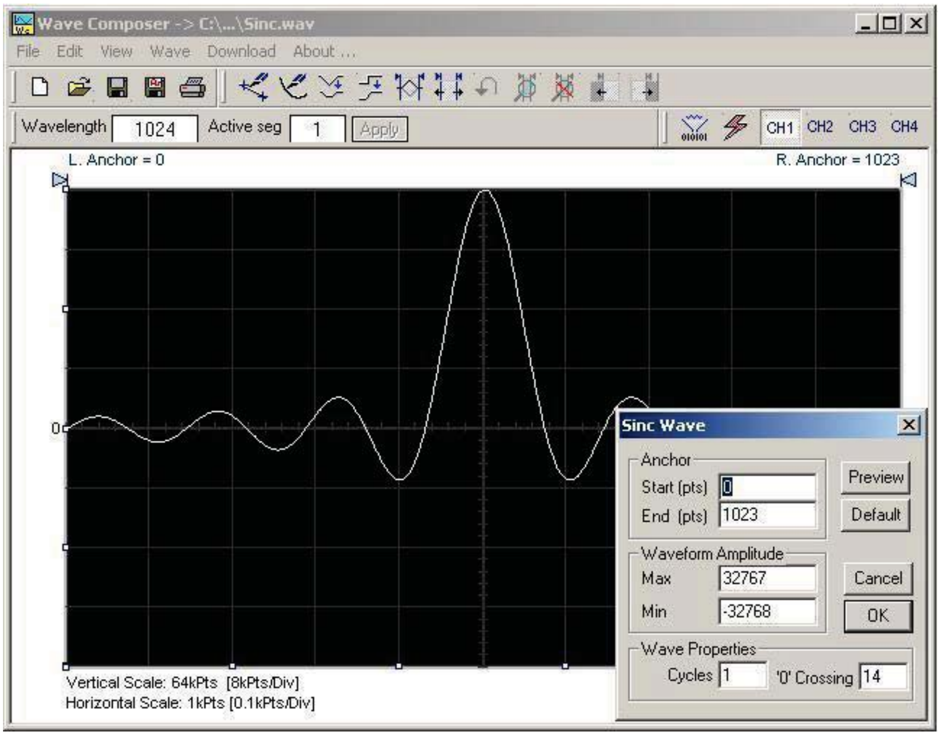


Figure 1-3, ArbConnection – The Wave Composer

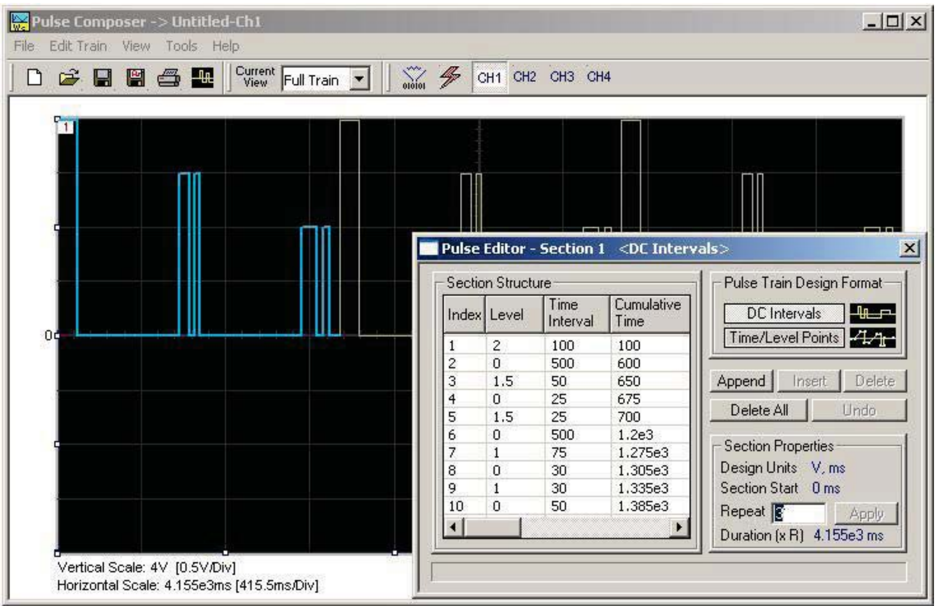


Figure 1-4, ArbConnection – The Pulse Composer

## 1.5 Introduction

A detailed functional description is given following the general description of the features, functions, and options available with the Model 2074.

The Model 2074 is a bench-top, 2U high, half rack wide, four-channel synthesized Waveform Generator, a high performance instrument that provides multiple and powerful functions in one small package. The 2074 generates an array of standard waveforms from a built-in waveform library as well as arbitrary, sequenced and modulated waveforms. The generator outputs 16-bit waveforms from two channels at up to 200 MS/s with different waveform properties. The unique design provides increased dynamic range and lower "noise floor" making it ideal for the generation of multi-tone signals and I&Q modulation.

Sample rates up to 200 MS/s are available with memory size up to 2 Meg. All channels are synchronized to the same sampling clock however, each channel can output a different waveform shape and length and by designing waveforms with different length, each channel can output different frequencies that are synchronized to the same sample clock source.

Based entirely on digital design, the 2074 has no analog functions resident in its hardware circuits and therefore, data has to be downloaded to the instrument for it to start generating waveforms. The instrument can compute and generate a number of standard functions such as sine, square, triangle and others. Complex waveforms can be computed in external utilities, converted to an appropriate format and downloaded to the 2074 as waveform coordinates. Dedicated waveform memory stores waveforms in memory segments and allows playback of a selected waveform, when required. The waveforms are backed up by batteries or can be stored in a flash memory for use at a later time.

Frequency accuracy of the output waveform is determined by the clock reference. Using the internal TCXO the reference oscillator provides 1 ppm accuracy and stability over time and temperature. If higher accuracy and/or stability are required, one may connect an external reference oscillator to the rear panel input and use this input as the reference for the 2074. Frequency may be is programmed from the front panel with 11 digits of resolution and with up to 14 digits from an external controller, so using an external reference is recommended, if you intend to utilize the full resolution provided by the instrument.

Output amplitude for each of the channels may be programmed separately from 20 mV to 20 Vp-p into an open circuit, and 20 mV to 10 V into 50 Ω loads. Amplitude and offsets are completely independent to each other and can be programmed with 4 digits of resolution as long as the +5 V and the -5 V rail limitations (double into open circuit) are not exceeded. The amplitude display is calibrated to the load source, which is normally 50 Ω. In cases where the load difference is different, you can customize the instrument to display the correct amplitude reading that matches your load impedance.

Besides its normal continuous mode, the Model 2074 responds to a variety of trigger sources. The output waveform may be gated, triggered, or may generate a counted burst of waveforms. A built-in re-trigger generator with a programmable period can be used as a replacement of an external trigger source. Triggers can be delayed to a specific interval by a built-in trigger delay generator that has a range of 200 ns to over 20 seconds.

The arbitrary waveform memory is comprised of a bank of 16-bit words. Each word represents a point on the horizontal waveform scale. Each word has a horizontal address that can range from 0 to 2 Meg and a vertical address that can range from -32767 to +32768 (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.

There is no need to use the complete memory bank every time an arbitrary waveform is generated. Waveform memory can be divided into up to many 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 and loop up to multiple segments in user defined order. Each channel has its own sequence generator.

The Tabor Model 2074 can be controlled from either GPIB, USB, or LAN interfaces. The product is supplied with IVI.COM driver and ArbConnection software. ArbConnection simulates an array of mechanical front panels with the necessary push buttons, displays and dials to operate the Model 2074 from a remote interface as if it is a bench-top instrument. ArbConnection also allows on-screen creation and editing of complex waveforms and patterns to drive the 2074 various outputs.

It is highly recommended that the user become familiar with the 2074 front panel, its basic features, functions and programming concepts as described in this and the following chapters.

## 1.6 Options

Several options are available for the 2074. These are listed below. Note that all options are factory installed and therefore, they must be ordered with the product.

1. Option 1 - 2 Meg Waveform Memory – increases the memory capacity from 1 Meg to 2 Meg. The 2 Meg waveform memory option is not field installable and therefore, it must be ordered with the product. Compare the option number below with the number printed on your instrument to check if the 2 Meg waveform memory option is installed in your equipment.

### 1.6.1 Identifying Installed Options

Options must be specified at the time of your purchase. If you place an order for an option, you may interrogate the instrument if the option is indeed installed on your unit. The Installed Options field in the System display shows which of the options is installed in your instrument. Information how to operate the menus and how to access the System menu is given in Chapter 3.

## 1.7 Manual Changes

Technical corrections to this manual (if any) are listed in the back of this manual on an enclosed MANUAL CHANGES sheet.

## 1.8 Safety Considerations

The Model 2074 has been manufactured according to international safety standards. The instrument meets EN61010-1 and UL1244 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**

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

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

## 1.9 Supplied Accessories

The instrument is supplied with a power cord and a CD which contains ArbConnection, manual, IVI driver and supporting files. USB, LAN and synchronization cables and a service manual are available upon request.

## 1.10 Specifications

Instrument specifications are listed in 8 Appendix A Specifications, page 293. These specifications are the performance standards or limits against which the instrument is tested. Specifications apply under the following conditions: output terminated into 50Ω after 30 minutes of warm up time, and within a temperature range of 20°C to 30°C. Specifications outside this range are degraded by 0.1 % per °C.

## 1.11 Functional Description

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

### 1.11.1 Front Panel Connectors and Indicators

The Model 2074 has 4 BNC connectors on its front panel: four main outputs. Each connector on the front panel has an LED associated with it, indicating when the output is active (LED on), or when inactive (LED off). The function of each of the front panel connectors is described in the following paragraphs.

#### 1.11.1.1 Main Output – CH1, CH2, CH3 and CH4

The main output connectors generate fixed (standard) waveforms to 80 MHz, user (arbitrary), sequenced and modulated waveforms. The arbitrary and sequenced waveforms are sampled with sampling clock rate to up 200 MS/s. Output source impedance is 50 Ω, hence the cable connected to this output should be terminated with 50 Ω load resistance. If the output is connected to a different load resistance, determine the actual amplitude from the following equation:

$$V_{out} = 2V_{prog}\left(\frac{R_L}{50+R_L}\right)$$

#### 1.11.1.2

The output amplitude is doubled when the output impedance is above roughly 10 kΩ.

#### 1.11.1.3 SYNC Output

The SYNC output generates a single or multiple TTL pulses 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 pulse sync along the waveform is programmable. The SYNC output is used as marker output when the 2074 is programmed to one of the modulation functions. The source of the sync can be programmed to source from channel 1 or channel 2.

### 1.11.2 Front Panel Controls

Front panel controls and keys are grouped in logical order to provide efficient and quick access to instrument functions and parameters. Refer to Figure 1-5 throughout the following description to learn the purpose and effect of each front panel control.

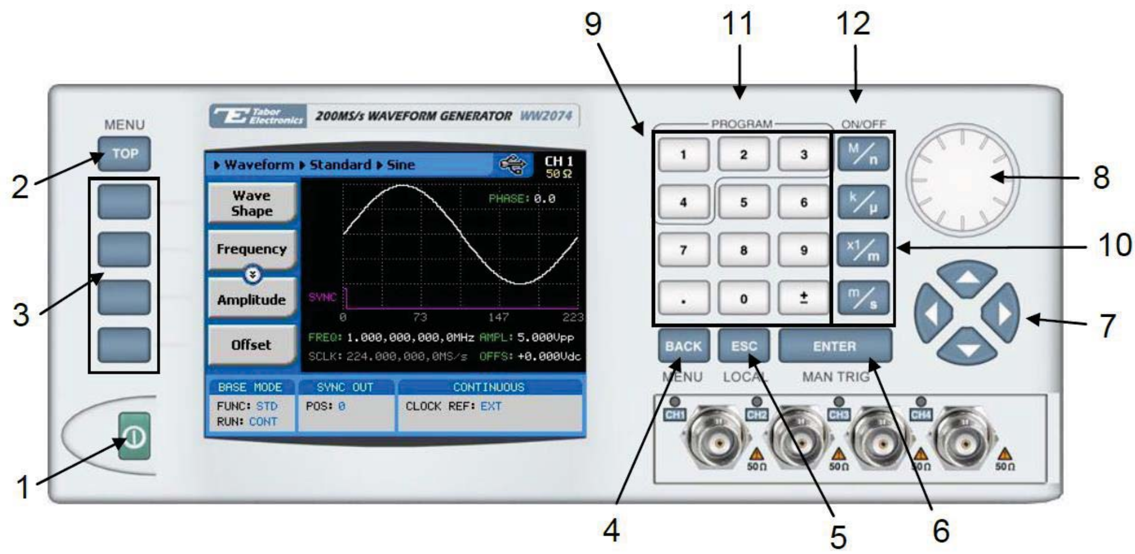


Figure 1-5, 2074 Front Panel Controls

**Note**

- The index in the following paragraphs point to the numbered arrows in above figure.

1. *Power Switch* – Toggles 2074 power ON and OFF
2. *Menu Top* – Selects the root menu. This button is disabled during parameter editing
3. *Menu Soft Keys* – Soft keys have two functions:
   1) Selects output function shape or operating mode,
   2) Selects parameter to be audited

These buttons are disabled during parameter editing

4. *Menu Back* – Backs up one menu position. This button is disabled during parameter editing
5. *Cancel (Local)* – Has two functions:
   1) When in edit mode, cancels edit operation and restore last value
   2) When operating the 2074 from a remote interface, none of the front panel buttons are active. The Local button moves control back from remote to front panel buttons
6. *Enter (Man Trig)* – Has two functions:
   1) When multiple parameters are displayed on the screen, the cursor and the dial scroll through the parameters. Pressing Enter selects the parameter for edit. After the parameter has been modified, the Enter button locks in the new variable and releases the buttons for other operations
   2) When the 2074 is placed in "Triggered" run mode, the Man Trig button can be used to manually trigger the 2074
7. *Cursor UP, Down, Left and Right* – Has two functions:
   1) When multiple parameters are displayed on the screen, the cursor and the dial scroll through the parameters
   2) When parameter is selected for editing, cursor buttons right or left move the cursor accordingly. Cursor buttons up or down modify parameter value accordingly
8. *Dial* – Has similar functionality as the cursor UP and Down keys
9. *Numeral keypad* – These keys are used for modifying an edited parameter value
10. *Parameter Suffixes (M, k, x1 and m)* – These keys are used to place suffix at the end of the parameter. They are also used for terminating an edit operation
11. *Program* – Use keypads 1 through 4 to modify the screen to display channels 1, 2, 3 and 4, respectively. These keys can be used only when the 2074 is not in edit mode
12. *ON/OFF* – This key can be used only when the 2074 is not in edit mode. The ON/OFF toggles output waveform, at the output connector, on and off.

### 1.11.3 Rear Panel Input & Output Connectors

The 2074 has a number of connectors on its rear panel. These connectors are described below. Figure 1-6 shows rear panel plugs, indicators, connectors and other parts.

### 1.11.3.1 TRIG IN

In general, the trigger input is used for stimulating output waveforms at the main output connector(s). The trigger input is inactive when the generator is in continuous operating mode. When placed in trigger, gated or burst mode, the trigger input is made active and waits for the right condition to trigger the instrument. The trigger input is edge sensitive, i.e., it senses transitions from high to low or from low to high.

Trigger level and edge sensitivity are programmable for the trigger input. For example, if your trigger signal rides on a dc level, you can offset the trigger level to the same level as your trigger signal, thus assuring correct threshold for the trigger signal. The trigger level is adjustable from -5 V to +5 V.

The trigger input is common to all channels. Therefore, if the 2074 is placed in trigger mode, all channels share the same mode and the trigger input causes all channels to start generating waveforms at the same time. Phase relationship between channels is tightly controlled in trigger mode and therefore, you should expect the channels to start generating waves with exactly the same start phase. Further control of leading edge offset between channels is also provided.

### 1.11.3.2 REF IN

This SMB connector accepts 10 MHz reference signal. The reference input is available for those applications requiring better accuracy and stability than what is provided by the 2074. The reference input is active only after selecting the external reference source mode. The reference input, by default, accepts TTL level signals and the input impedance is 10 kΩ however, the input can be modified to accept 0 dBm sine waveforms and its impedance modified to 50 Ω. The modification is done by moving jumpers internally. Information on the modification is provided to the user upon request.


Figure 1-6, 2074 Rear Panel

### 1.11.3.3 SYNC1, 2, 3 and 4

These BNC connectors generate synchronization signals, one for each channel. The sync outputs are active at all times, regardless if the front panel  main outputs were turned on or not and therefore, if you leave cables hooked on these connectors, make sure they do not damage your equipment when you turn on the 2074.

### 1.11.3.4 LAN

This RG45 connector accepts standard Ethernet cable. Correct setting of the IP address is required to avoid conflicts with other instruments or equipment on the network. Information how to change IP address and load instrument drivers to the computer is provided in the Installation chapter of this manual.

### 1.11.3.5 USB

This connector accepts standard USB-1 cable. The connection to the host computer is automatic and does not require any address setting from within the 2074. The first time the 2074 is connected to the computer, it will request the driver file. This file is located on the CD which is supplied with the instrument. Information how to install the driver is provided in the Installation chapter of this manual.

### 1.11.3.6 GPIB

This 24-pin connector accepts standard GPIB cable. The GPIB address is configured using the front panel utility menu. The 2074 conforms to the IEEE-488.2 standard. Programming protocol is SCPI version 1993.0. GPIB cables are available separately from your Tabor dealer.

### 1.11.3.7 AC LINE

This 3-prong AC LINE connector accepts ac line voltage. The 2074 senses the line voltage and sets the appropriate range automatically. Therefore, the traditional line voltage selector is not available on the rear panel. To avoid potentially hazardous situations, always connect the center pin to mains ground using the line cord that is supplied with the instrument.

### 1.11.3.8 AC FUSE

The AC fuse protects the 2074 from excessive current. Always replace the fuse with the exact type and rating as printed on the rear panel. If the fuse blows again after replacement, we recommend that you refer your instrument immediately to the nearest Tabor service center.

### 1.11.3.9 X-INST SYNC

The X_INST SYNC (Multi-Instrument Synchronization) group of is comprised of four SMB connectors, designated as SCLK OUT/IN, and COUPLE OUT/IN. Theses connectors are installed in your instrument only if you ordered the multi-instrument synchronization option. Besides the rear panel connectors, you should receive a few other cables. Information how to connect and synchronize between two or more instrument is given later in this manual.

***SCLK OUT***

This SMB connector outputs the programmed sample clock frequency. Output level is 400mVp-p, terminated into 50Ω. Note that correct termination is necessary for this output otherwise you will not see this signal at all. This output generates sample clock waveforms continuously, regardless if the 2074 is operating in continuous, trigger, or gated modes.

The sample clock output is used for multiple-instruments synchronization. In master mode, connect this output with an SMB to SMB cable to the SCLK IN on the adjacent slave instrument. You may also use this output to synchronize other components in your system to one master clock.

***SCLK IN***

This SMB connector accepts 300mVp-p to 1Vp-p into 50Ω level signal. Normally, this input is disabled. When enabled, the clock at this input replaces the internal clock generator and the 2074 generates waveforms having the external sample clock rate.

When synchronizing you 2074 as a slave unit, an SMB to SMB cable is connected from the Master SCLK OUT connector to this SCLK IN connector.

***COUPLE OUT***

This SMB connector outputs the coupling signals to the slave unit. Output level is LVPECL, terminated into 50Ω to 1.3V. For multi-instrument synchronization, connect this output to the COUPLE IN connector on the slave unit.

***COUPLE IN***

This SMB connector accepts coupling signals from the master unit. Input level is LVPECL, terminated into 50Ω to 1.3V. For multi-instrument synchronization, connect this input to the COUPLE OUT connector on the master unit.

## 1.12 Run Modes

The 2074 can be programmed to operate in one of four run modes: Continuous, Triggered, Gated and counted Burst. There are two other modes that can operate in conjunction with the basic four run modes, these are: Delayed Trigger and Re-Trigger. The run modes are common to all of the 2074 waveform output

Summary of run modes and optional trigger sources are listed in Table 1-1. Information in this table also identifies legal run modes and lists possible setting conflicts.

### 1.12.1 Continuous

In normal continuous mode, the selected waveform is generated continuously at the selected frequency, amplitude and offset. Only when operated from a remote interface, the output can be toggled on and off using a trigger command.

### 1.12.2 Triggered

In triggered mode, the Model 2074 circuits are armed to generate one output waveform. The trigger circuit is sensitive to transitions at the trigger input. Select between positive or negative transitions to trigger the instrument. You may also program the trigger level to the desired threshold level. When triggered, the generator outputs one waveform cycle and remains idle at the last point of the waveform.

The Model 2074 can be triggered from a number of sources:

1) Rear panel connector, designated as TRIG IN,
2) Front panel button marked as MAN TRIG (second function to the Enter button), and
3) Bus commands that are applied to the instrument from any interface, LAN, USB or GPIB.

Description of the various trigger source options is given in the following paragraphs.

The trigger signal, whether it comes from an external source or from an interface command, is routed through some electrical circuits. These circuits cause some small delay known as system delay. System delay cannot be eliminated completely. The system delay is a factor that must be considered when applying a trigger signal. It defines the time that will lapse from a valid trigger edge or software command to the instant that the output reacts.

### 1.12.3 Burst

The burst mode is an extension of the triggered mode where the Model 2074 can be programmed to output a pre-determined number of waveforms. Note that the burst run mode cannot be applied to sequenced waveform because the two functions share the same circuit and therefore, whenever counted burst is selected for sequenced waveforms, the generator will issue a setting conflict error.

Table 1-1, Run Modes and Trigger Source Options Summary

| ***Run Mode*** | ***Trigger Option*** | ***Status*** |
|---|---|---|
| *Continuous* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger*<br>*(*) Output signal is toggled on and off using interface triggers* | *Disabled*<br>*Active(*)*<br>*Disabled*<br>*Active*<br>*Disabled* |
| *Triggered* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Active*<br>*Active*<br>*Active* |
| *Counted Burst* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger*<br>*(*) Not in conjunction with Re-Trigger*<br>*(**) Not in conjunction with Mixed* | *Active*<br>*Active*<br>*Active(*)*<br>*Active*<br>*Active(**)* |
| *Gated* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Disabled*<br>*Active*<br>*Disabled* |

### 1.12.4 Gated

In gated mode, the 2074 generates output waveforms between two gating signal. Only hardware triggers can be used to open and close the gate. The gate opens on the first trigger transition and closes on the second transition. Trigger level and trigger slope are programmable. Trigger delay and re-trigger do not apply to the gated run mode.

## 1.13 Delayed Trigger

The delayed trigger function is exactly the same as the trigger mode except a programmable delay inhibits signal output for a pre-determined period after a valid trigger. The delay time defines the time that will lapse from a valid trigger (hardware or software) to output. The delay is programmable in steps of 20 ns from 200 ns to 20 s. The trigger delay can be applied to all run modes: continuous, trigger and burst.

## 1.14 Re-Trigger

The Re-trigger run mode requires only one trigger command to start a sequence of triggered or counted burst of signals. The re-trigger delay defines the time that will lapse from the end of a signal to the start of the next signal. Re-trigger delay is programmable in steps of 20 ns from 200 ns to 20 seconds.

## 1.15 Trigger Source

The Model 2074 can be triggered from a number of sources:

1) Rear panel connector, designated as TRIG IN;

2) Front panel button marked as MAN TRIG (second function to the Enter button); and

3) Bus commands that are applied to the instrument from any interface, LAN, USB or GPIB.

Description of the various trigger source options is given in the following paragraphs. Summary of trigger options and optional trigger sources are listed in Table 1-2, identifying legal operating modes and listing possible setting conflicts.

### 1.15.1 External

When selecting the External trigger source, the rear panel TRIG IN connector becomes active and every legal signal that is applied to this input is causing the 2074 to trigger. Alternately, if an external signal is not available, the front panel MAN TRIG button may also be used to trigger the instrument. When EXT is selected, triggers commands from a remote interface are ignored. EXT is the default trigger source.

### 1.15.2 Bus

When selecting the Bus as a trigger source, the rear panel TRIG IN connector and the front panel MAN TRIG button are disabled and only trigger commands from a remote interface are accepted by the instrument. Make sure that the appropriate trigger source is selected if you mix remote and local operation.

### 1.15.3 Mixed

Mixed trigger advance source defines special trigger behavior where the 2074 expects to first receive remote bus trigger and only then accept hardware triggers. The first time that the 2074 is placed in this mode, all EXT (rear and front panel hardware) triggers are ignored until a remote *TRG is issued. Following the first software trigger, subsequent triggers from the remote interface (software) are ignored and only rear and front panel triggers are accepted by the instrument.

Table 1-2, Trigger Source Options Summary

| ***Trigger Option*** | ***Source/ Description*** | ***Status*** |
|---|---|---|
| *External* | *Interface trigger commands*<br>*Rear panel TRIG IN connector*<br>*Front panel MAN TRIG button* | *Disabled*<br>*Active*<br>*Active* |
| *Bus* | *Interface trigger commands*<br>*Rear panel TRIG IN connector*<br>*Front panel MAN TRIG button* | *Active*<br>*Disabled*<br>*Disabled* |
| *Mixed* | *Interface trigger commands*<br>*Rear panel TRIG IN connector*<br>*Front panel MAN TRIG button*<br>*(*) First trigger from BUS only, subsequent triggers from EXT only* | *Active(*)*<br>*Active(*)*<br>*Active(*)* |

## 1.16 Output Type

The Model 2074 can output five types of waveforms: Standard, Arbitrary, Sequenced and Modulated waveforms. The various output types are described in the following paragraphs.

### 1.16.1 Standard Waveforms

The 2074 can generate an array of standard waveforms. The waveforms are generated mathematically from standard equations and converted to waveform coordinates that are downloaded to the working memory. Unlike analog function generators that use electrical circuits to produce the wave shapes, the 2074 must compute the waveform coordinates every time a new function is selected or every time the parameters of the function change.

The 2074 can produce 11 standard waveforms: sine, triangle, square, ramp and pulse, sinc, gaussian and exponential pulses, dc and Pseudo-random noise. Some of the waveforms parameters can be modified such as start phase for sine and triangle, duty cycle for square, rise and fall times for pulses etc. The standard waveforms are the most commonly used wave shapes and therefore were collected to a library of standard waveforms that can be used without the need to compute and download waveform coordinates.

The repetition rate of the standard waveforms is given in units of Hz. Both channels share the same clock source and therefore, when a standard function shape is selected for re-play, the frequency of the waveforms is the same at the output connectors of both channels. Also, when standard waveforms are used, both channels share the same run mode, as well as delayed trigger and re-trigger settings. On the other hand, each channel can have a unique set of waveform, amplitude, offset and waveform parameters without interference between the channels.

When both channels are programmed for standard waveforms, the skew between the channels is minimal. Refer to Appendix A for the skew between channels specification.

Figure 1-7 shows typical front panel for the standard waveform display and Figure 1-8 shows typical standard waveform panel as displayed when ArbConnection is used for remote programming.

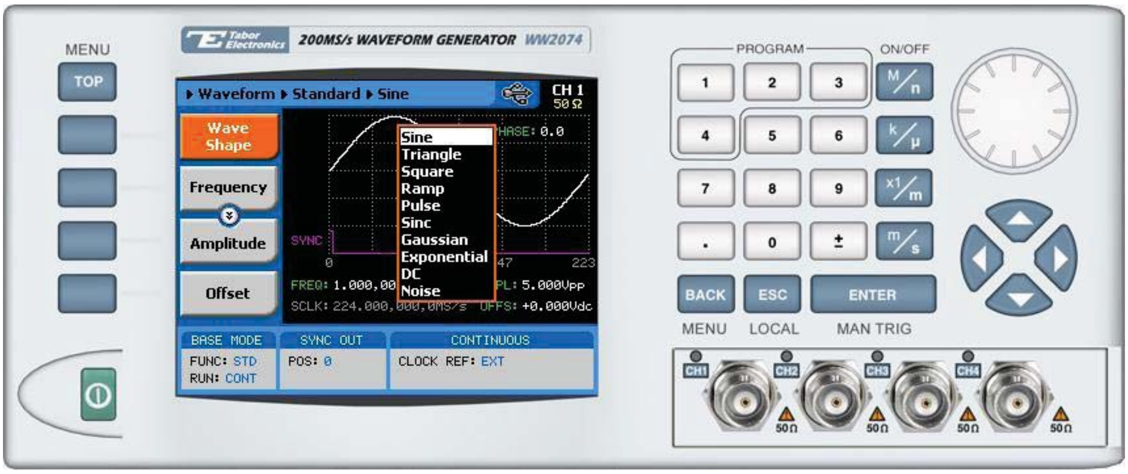


Figure 1-7, Typical 2074 Standard Waveforms Display


Figure 1-8, ArbConnection Example - Typical Standard Waveforms Panel

## 1.16.2 Half Cycle Waveforms

As a subset of the standard waveforms, the 2074 can generate some of the waveforms, split into two half cycle. When generated continuously, the second half cycle is delayed by a programmed interval. In triggered mode, each trigger stimulates half cycle of the selected function.

Three half cycle waveform shapes are available for generation: Sine, triangle and square. Note when the half cycle function is selected, both channels are placed in this mode automatically.

The repetition rate of the half cycle waveforms is given in units of Hz. Both channels share the same clock source and therefore, when a standard function shape is selected for re-play, the frequency of the half cycle waveforms is the same at the output connectors of both channels. Also, when half cycle waveforms are selected, both channels share the same run mode, as well as delayed trigger and re-trigger settings.

Figure 1-7 shows typical front panel for the standard waveform display and Figure 1-8 shows typical standard waveform panel as displayed when ArbConnection is used for remote programming. Figure 1-9 shows typical front panel for the half cycle waveforms display.

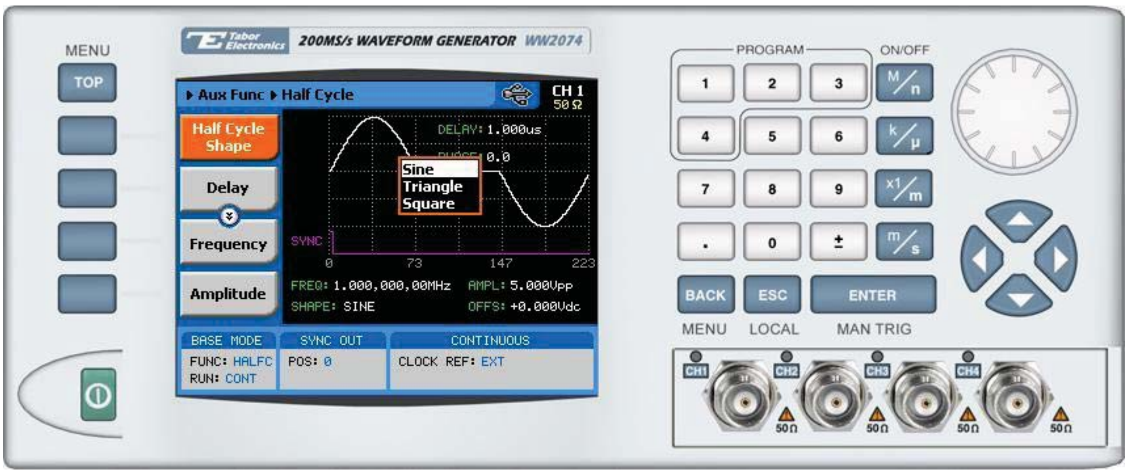


*Figure 1-9, Typical Half Cycle Display*

### 1.16.3 Arbitrary Waveforms

One of the main functions of the Racal model 2074 is generating real-life waveforms. These are normally not sinewaves and squares but user specific waveforms. Generating such waveforms require external utilities such as MATLAB or even spreadsheets but having the program alone is not enough for the 2074; Once the waveform is computed and defined, it must be converted to a format which the instrument can accept and coordinates downloaded to the generator memory for re-play.

Arbitrary waveforms are stored as digital XY coordinates in a special memory, normally referred to as working memory. Each coordinate is referred to as waveform point, or waveform sample. The waveform is better defined if it has many waveform points. For example, with only 8 point, sine waveform will hardly resemble the shape of a sinewave and will look more like an up-down staircase, but with 100 points, the same sine waveform will look almost perfect.

The final shape of the waveform is produced by a DAC (Digital to Analog Converter) The waveform samples are clocked to the DAC at a rate defined by the sample clock frequency. The output of the DAC converts the digital data to analog levels and passes on the signal to the output amplifier. The shape of the function is more or less the same as it comes out of the DAC except it could be amplified or attenuated, depending on the require amplitude level.

The size of the working memory is limited to the way the hardware was designed. The 2074 has 1Meg points available as standard (2 Meg point optional) to build one or more waveforms. There is no need to use the entire memory for only one waveform; The memory can be divided into smaller segments loaded with different waveforms while the instrument can be programmed to output one segment at a time.

The Model 2074 has separate arbitrary waveform memories for each channel and each channel can be loaded with different waveforms. Channels are not limited by the number of segments and by the shape of the waveforms.

Figure 1-10 shows typical front panel for the arbitrary waveform display and Figure 1-11 shows typical ArbConnection panel as displayed when ArbConnection is used for remote programming.

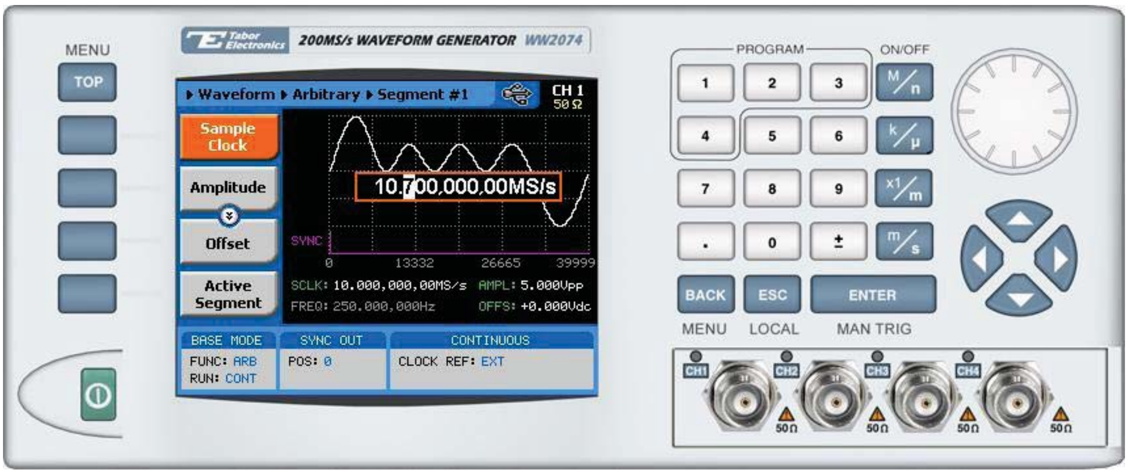


Figure 1-10, Typical 2074 Arbitrary Waveforms Display

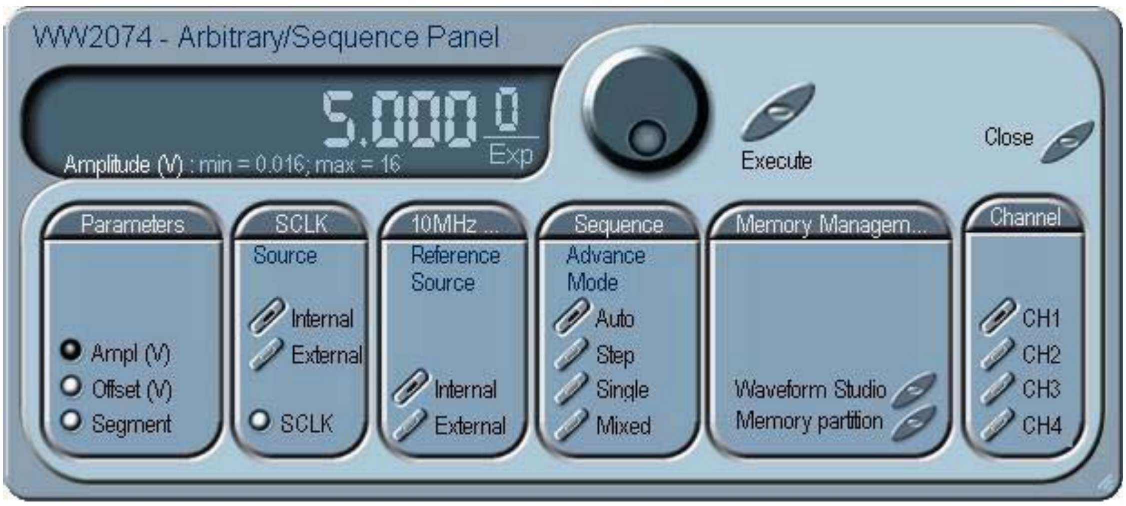


Figure 1-11, ArbConnection Example – Typical Arbitrary & Sequenced Waveforms Panel

### 1.16.4 Sequenced Waveforms

The sequence generator is a very powerful tool that lets you link and loop segments in any way you desire. The Model 2074 has two separate sequence generators – one for each channel. Each sequence generator is dedicated to its own channel.

The sequence circuit is useful for generating long waveforms with repeated sections. The repeated waveform has to be programmed once and the repeater will loop on this segment as many times as selected.  When in sequenced mode, there is no time gap between linked or looped segments. Sequence tables must be loaded to the generator before sequenced waveforms can be generated. The data for the sequence table is first prepared on an external platform, then downloaded to the generator.

As a simple example of a sequenced waveform, look at Figures 1-12 through 1-14. 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 1-15.

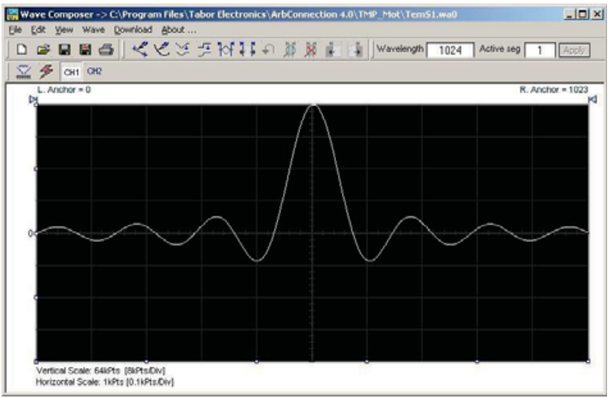

*Figure 1-12, Segment 1 Waveform – Sinc*

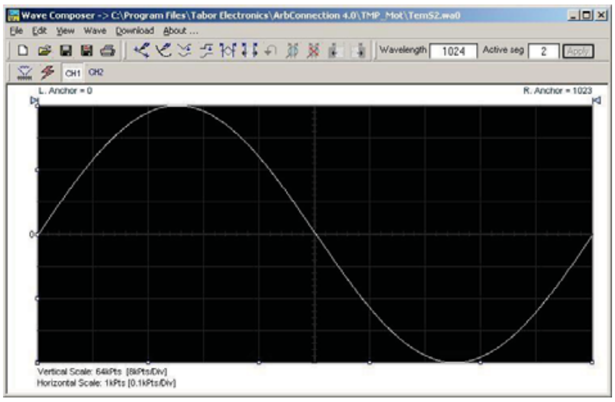

*Figure 1-13, Segment 2 Waveform - Sine*

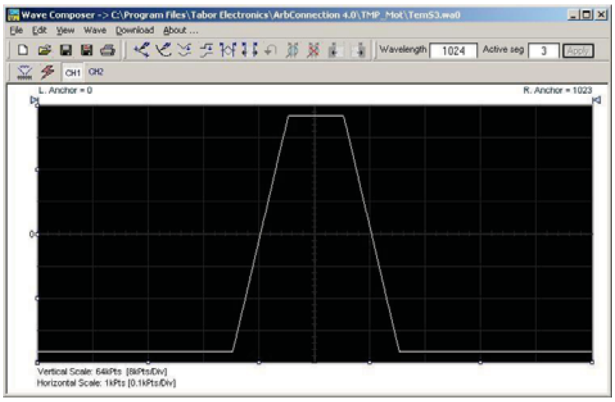


*Figure 1-14, Segment 3 Waveform - Pulse*

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

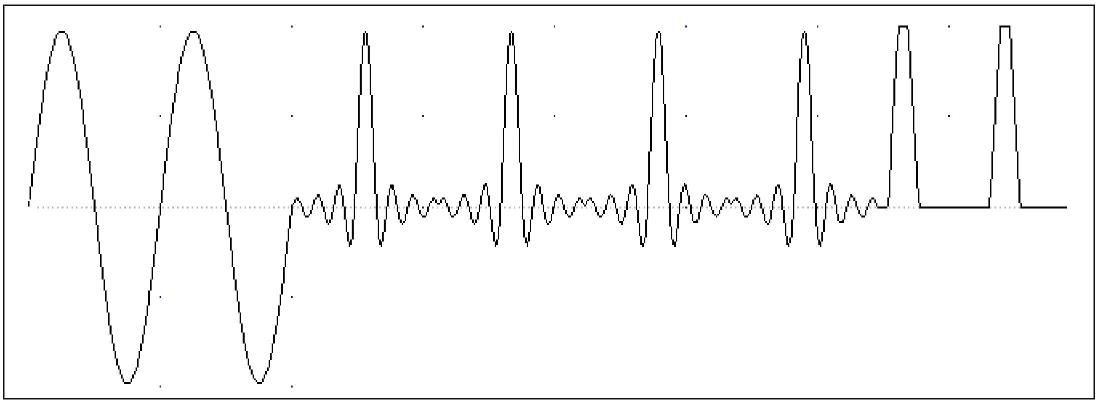

Figure 1-15, Sequenced Waveform

Figure 1-16 shows typical front panel entry for the above sequence and Figure 1-17 shows the waveform studio as is typically being used for building and generating the sequence table from remote.

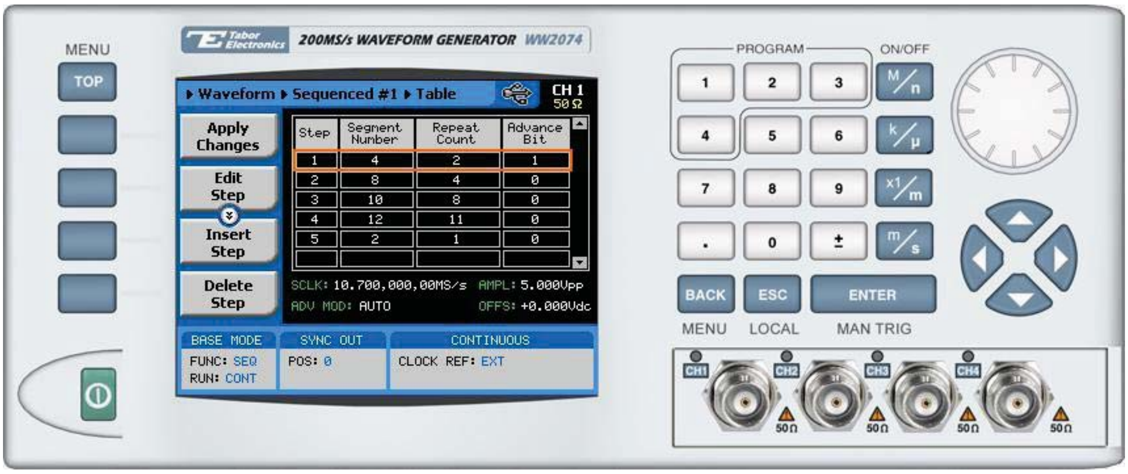


Figure 1-16, Typical Front Panel Programming of a Sequence Table

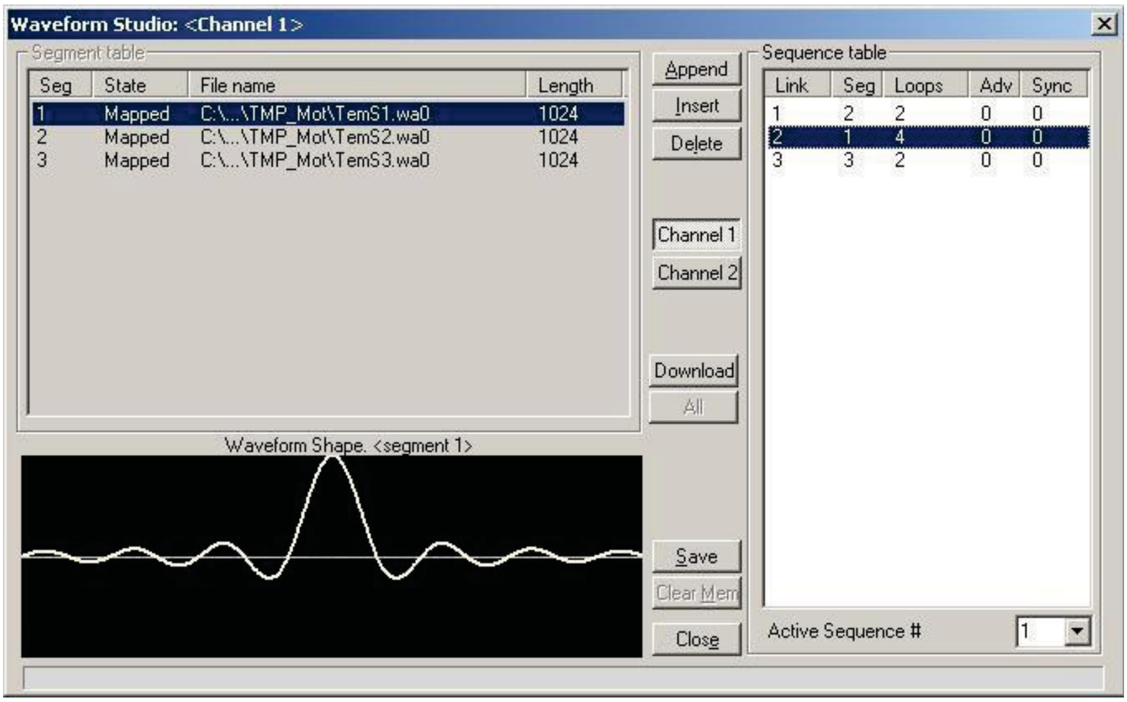


Figure 1-17, ArbConnection Sequence Table Studio

### 1.16.4.1 Sequence Advance Modes

As shown above, sequences are built as simple table of which define link, segment, loops and advance bits. When placed in sequenced mode, the output is changing from link to link in an ascending order. The term Sequence Advance Modes defines what is causing the instrument to step from link to link. There are four basic advance modes that can be selected for the sequence mode: Auto, Stepped, Single and Mixed. These modes are explained in the following paragraphs. Also note that there are some limitations that should be observed while using the various sequenced advance modes. These limitations are summarized in Table 1-3.

***Auto***

Auto advance sequence is the mode that you want to use when the sequence is expected to run continuously from the first step in the table to the last, and then resume from the first step. There are no interrupts between steps and between the last and the first step of the sequence. When auto mode is selected, the 2074 can also be placed in triggered and gated run modes. The various run mode options that are available for the auto advance mode are summarized in Table 1-3.

***Stepped***

Stepped advance sequence is the mode that you want to use when the sequence is expected to advance on triggers only. The trigger source is selectable from either external or bus commands. The step will run continuously until a trigger advances the sequence to the next step. When the last step is reached, the next trigger will advance to the first step in the sequence and this sequence will repeat itself as long as triggers are applied to the generator. Note that the generator operates in continuous run mode; Trying to place it in trigger or gated run mode will issue a settings conflict error message. The various run mode options that are available for the step advance mode are summarized in Table 1-3.

***Single***

Single sequence advance is the mode that you want to use when the sequence is expected to advance on triggers only. The trigger source is selectable from either external or bus commands. The step will run once until a trigger advances the sequence to the next step. When the last step is reached, the next trigger will advance to the first step in the sequence and this sequence will repeat itself as long as triggers are applied to the generator. Note that the generator operates in triggered run mode; Trying to place it in continuous or gated run mode will issue a settings conflict error message. The various run mode options that are available for the single advance mode are summarized in Table 1-3.

***Mixed***

Mixed advance sequence is the mode that you want to use when some steps of the sequence are expected to run as if in Auto advance mode while some steps that are flagged should wait and operate as if in Stepped sequence mode. The base run mode of the instrument is continuous. The sequence will step through segments of the table that are marked as continuous and will stop and wait for a trigger on sequence steps that are marked with a special flag. Note that the generator operates in continuous run mode; Trying to place it in trigger or gated run mode will issue a settings conflict error message. The various run mode options that are available for the step advance mode are summarized in Table 1-3.

Table 1-3, Sequence Advance and Trigger Options Summary

| ***Run Mode*** | ***Run Mode*** | ***Status*** | ***Trigger Option*** | ***Status*** |
|---|---|---|---|---|
| *Auto* | *Continuous*<br>*Triggered*<br>*Gated*<br>*Burst* | *Active*<br>*Active*<br>*Active*<br>*Disabled* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Disabled*<br>*Active*<br>*Disabled* |
| *Step* | *Continuous*<br>*Triggered*<br>*Gated*<br>*Burst* | *Active*<br>*Disabled*<br>*Disabled*<br>*Disabled* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Disabled*<br>*Active*<br>*Disabled* |
| *Single* | *Continuous*<br>*Triggered*<br>*Gated*<br>*Burst* | *Disabled*<br>*Active*<br>*Disabled*<br>*Disabled* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Disabled*<br>*Active*<br>*Disabled* |
| *Mixed* | *Continuous*<br>*Triggered*<br>*Gated*<br>*Burst* | *Active*<br>*Disabled*<br>*Disabled*<br>*Disabled* | *External*<br>*Bus*<br>*Mixed*<br>*Delayed Trigger*<br>*Re-Trigger* | *Active*<br>*Active*<br>*Disabled*<br>*Active*<br>*Disabled* |

### 1.16.5 Modulated Waveforms

I & Q modulation is one of the fastest growing requirements for digital waveform generation applications. The 2074 can generate phase modulation and QAM modulation on all four channels where each pair generates a separate modulation scheme. Having two pairs of modulation channels is specifically helpful for speeding up tests on parts in production.

Figure 1-18 shows a typical front panel entry for modulated waveform and Figure 1-19 shows an ArbConnection example of a modulation panel.

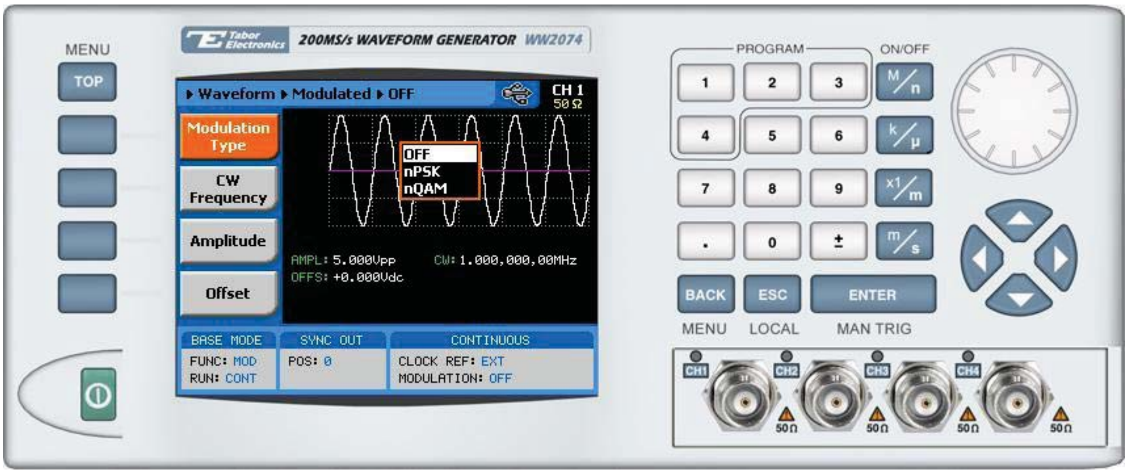


Figure 1-18, Typical Modulated waveform Display


Figure 1-19, ArbConnection Example – FM Modulation Panel

## 1.16.5.1 Modulation Off

In modulation OFF, the output generates continuous Carrier Waveform frequency. The carrier waveform is sinewave and its frequency can be programmed using the CW Frequency menu. The value programmed for the CW Frequency parameter, is used for all other modulation functions.

#### 1.16.5.2 (n)PSK

The (n)PSK function allows shifts through multiple phase and amplitude positions to form phase shift constellations. There are 6 different types of phase shift keying that the 2074 can generate: BPSK, QPSK, OQPSK, pi/4DQPSK, 8PSK and 16PSK. The User PSK can be used for generating non-standard phase shifts. Programming the user PSK is easily done using very simple table entries which define symbol and phase value. In this function, the amplitude remains constant throughout the entire phase entries.

#### 1.16.5.3 (n)QAM

The (n)QAM function is similar to the standard ASK function except the output can shift to multiple amplitudes and phase positions to form an amplitude/phase shift constellations. There are 4 different types of Quadrature Amplitude Modulation that the 2074 can generate: 16QAM, 64QAM and 256QAM. If another constellation scheme is required, one can use the User QAM to design his/her own symbol list and constellation.

## 1.17 Modulation Run Modes

Run modes are shared by all waveforms that are generated by the 2074, including modulation. However, there are some limitations that apply to the modulation functions. The modulation functions will not operate in gated or burst mode, all other features that apply to trigger are available for the user, including re-trigger and trigger delay.

## 1.18 Auxiliary Functions

The 2074, besides its standard waveform generation functions, has two additional auxiliary functions that can transform the instrument to one of two, stand-alone, full-featured, instruments: Digital Pulse Generator and Counter/Timer. Operating instructions for the auxiliary functions are given in Chapter 3. The following describes these two auxiliary functions in general.

### 1.18.1 Digital Pulse Generator

The digital pulse generator auxiliary function transforms the 2074 into a four-channel pulse generator with the capability to generate pulses exactly as they would be generated by a stand-alone pulse generator instrument. When using this function one could program all pulse parameters in timing units. All pulse parameters are programmable including period, pulse width, rise and fall times, delay, polarity and more. Operating instructions for the digital pulse generator are given in Chapter 3. Model 2074 front panel and ArbConnection control panel examples for the digital pulse generator function are shown in figures 1-20 and 1-21, respectively.

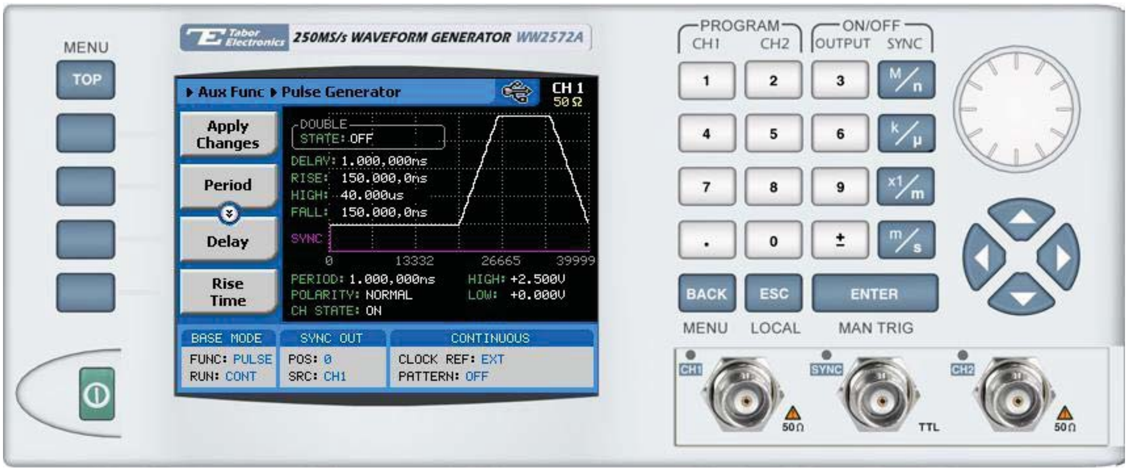


*Figure 1-20, 2074 Digital Pulse Generator Menu Example*


*Figure 1-21, ArbConnection Digital Pulse Generator Panel Example*

## 1.18.2 Counter / Timer

The counter/timer auxiliary function transforms the 2074 into a counter/timer instrument with the capability to measure parameters exactly as they would be measured by a stand-alone counter/timer instrument. When using this function one could select the measurement function, gate time trigger level and hold the measurement till condition requires a reading. The readings are taken and displayed on the LCD display, or passed on the remote interface to the host computer for further processing. Operating instructions for the counter/timer are given in Chapter 3. 2074 front panel and ArbConnection control panel examples for the counter/timer are shown in figures 1-22 and 1-23, respectively.

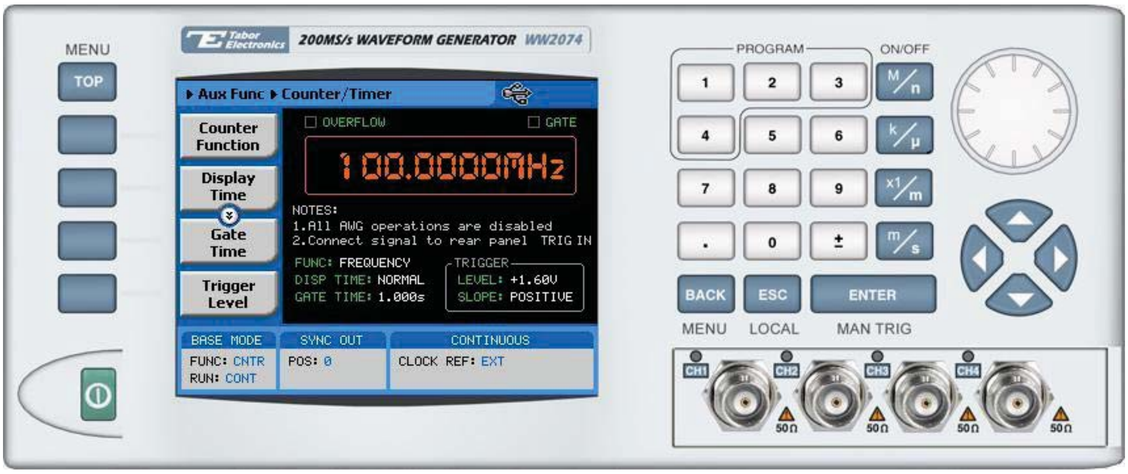


*Figure 1-22, 2074 Counter/Timer Menu Example*


*Figure 1-23, ArbConnection Counter/Timer Panel Example*

## 1.19 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.

## 1.20 Customizing the Output Units

There are some parameters that could be customized for easier fit of the output; These are: horizontal time units, load impedance, 10 MHz reference source and sample clock source. Information on the customization options is given in chapter 3.

## 1.21 Programming the Model 2074

The Model 2074 has no controls on its front panel. Instrument functions, parameters, and modes can only be accessed through VXIbus commands. There are a number of ways to "talk" to the instrument. They all require that an appropriate software driver be installed in the Resource Manager (slot 0). The rest is a matter of practice and knowledge of the language in use. There are other system considerations like address selection that have to be settled before programming the instrument. These topics are discussed in later chapters.

Low level programming of the Model 2074 is done using SCPI commands. Programming aspects are covered in Chapters 4. High level drivers like IVI drivers are beyond the scope of this manual. Contact your Tabor representative for more information about high level drivers for the Model 2074.

# 2 Configuring the Instrument

## 2.1 Installation Overview

This chapter contains information and instructions necessary to prepare the Model 2074 for operation. Details are provided for initial inspection, grounding safety requirements, repackaging instructions for storage or shipment, installation information and Ethernet address configuration.

## 2.2 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.

## 2.3 Safety Precautions

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

**CAUTION**

- 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. Read the operating information carefully before using the product.

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

**WARNING**

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

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

When using test fixtures, keep the lid closed while power is applied to the device under test. Carefully read the Safety Precautions instructions that are supplied with your test fixtures.

Before performing any maintenance, disconnect the line cord and all test cables. Only qualified service personnel should perform maintenance.

## 2.4 Performance Checks

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

## 2.5 Power Requirements

The function generator may be operated from a wide range of mains voltage 85 to 265 Vac. Voltage selection is automatic and does not require switch setting. The instrument operates over the power mains frequency range of 48 to 63Hz. Always verify that the operating power mains voltage is the same as that specified on the rear panel.

The 2074 should be operated from a power source with its neutral at or near ground (earth potential). The instrument is not intended for operation from two phases of a multi-phase ac system or across the legs of a single-phase, three-wire AC power system. Crest factor (ratio of peak voltage to rms.) should be typically within the range of 1.3 to 1.6 at 10% of the nominal rms. mains voltage.

## 2.6 Grounding Requirements

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

**WARNING**

- Do not attempt to float the output from ground as it may damage the Model 2074 and your equipment.

## 2.7 Long Term Storage or Repackaging for Shipment

If the instrument is to be stored for a long period of time or shipped to a service center, proceed as directed below. If repacking procedures are not clear to you or, if you have questions, contact your nearest 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 RMA (Returned Materials Authorization) order as well as the date and method of shipment. ALWAYS OBTAIN AN RMA NUMBER FROM THE FACTORY BEFORE SHIPPING THE 2074 TO TABOR ELECTRONICS.

## 2.8 Preparation for Use

Preparation for use includes removing the instrument from the container box, installing the software and connecting the cables to its input and output connectors.

## 2.9 Installation

If this instrument is intended to be installed in a rack, it must be installed in a way that clears air passage to its cooling fans. For inspection and normal bench operation, place the instrument on the bench in such a way that will clear any obstructions to its rear fan to ensure proper airflow.

**CAUTION**

- Using the 2074 without proper airflow will result in damage to the instrument.

## 2.10 Installing Software Utilities

The 2074 is supplied with a CD that contains the following programs: IVI Driver, ArbConnection, USB driver and some other utilities to aid you with the operation of the instrument. For bench operation, all that you need from the CD is this manual however, it is recommended that you stow away the CD in a safe place in case you'll want to use the 2074 from a host computer or in a system.

The *IVI driver* is a useful utility that provides standard communication and commands structure to control the 2074 from remote. Programming examples are also available to expedite your software development. The IVI driver comes free with the 2074 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 2074 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 2074 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 *USB* driver is required if you intend to connect the 2074 to a host computer on a USB bus. Information how to connect the USB cable and how to load the software is given in this chapter.

## 2.11 Controlling the Instrument from Remote

In general, the 2074 can be controlled from remote using one of the following interfaces: USB, Ethernet and GPIB. Remote interface cables are not supplied with the instrument so if you plan on using one of the remote programming option, make sure you have a suitable cable to connect to your host computer. The following paragraphs describe how to connect and configure the 2074 to operate from remote. The description is given for computers fitted with Windows XP but little changes will show while installing software on different Windows versions.

## 2.12 Connecting to a Remote interface

You can connect your Tabor 2074 to GPIB, USB, or LAN adapters, depending on your application and requirements from your system. Installing interface adapters in your computer will not be described in this manual since the installation procedures for these adapters change frequently. You must follow the instructions supplied with your particular adapter. Before proceed with the remote interface installation, install an adapter card and follow the instructions in the following paragraphs.

***GPIB Connection***

Direct connection between a host computer and a single device with GPIB is not recommended since GPIB adapter is usually expensive and is not really required for direct connection. Use GPIB connection in cases where download speed is critical to the system or when you already have GPIB system in place and you are adding the 2074 as a GPIB device. The GPIB port is connected with a special 24-wire cable. Refer interconnection issues to your GPIB supplier. After you connect the 2074 to the GPIB port, proceed to the GPIB Configuration section in this chapter for instructions how to select a GPIB address.

***USB Connection***

Direct connection between a single host computer and a single device with USB is most recommended as this does not require any specific considerations and device configuration. Just connect your Tabor 2074 to your PC using a standard USB cable and the interface will self-configure. After you connect the 2074 to the USB port, proceed to the USB Configuration section in this chapter for instructions how to install the USB driver.

***LAN Connection***

Direct connection between a single host computer and a single device with 10/100 BaseT is possible, but you must use a special cable that has its transmit and receive lines crossed. If your site is already wired connect the 2074 via twisted pair Ethernet cable. Take care that you use twisted pair wires designed for 10/100 BaseT network use (phone cables will not work). Refer interconnection issues to your network administrator. After you connect the 2074 to the LAN port, proceed to the LAN Configuration section in this chapter for instructions how to set up LAN parameters.

## 2.13 Selecting a Remote interface

The 2074 is supplied by the factory with the active remote interface set to USB. If you intend to use USB connection, then all you need to do is connect your USB cable and proceed with the USB Configuration instructions as given in this chapter to install the USB driver and to configure the USB port (first connection only). If you already used your instrument in various platforms and want to re-select your interface

To select an active Interface, you need to access the Select Interface screen as shown in Figure 2-1. To access this screen press the TOP menu button, then select the Utility soft key and scroll down with the dial to the Remote Setup option and press the Enter key. The Select Interface soft key will update the display with the interface parameters.

Use the curser keys left and right to point to the required interface option then press Enter. The new interface will Initialize and the icon at the top will be updated and will flag the active interface option.

The interface icon is always displayed at the top of the screen so if you are not sure which of the interfaces is selected, compare the following icons to what you have on the screen:


Designates GPIB interface is selected and active. GPIB configuration is required to communicate with your PC.

Designates USB interface is selected and active. First connection requires USB configuration and software driver installation to communicate with your PC.

Designates LAN interface is selected and active. LAN configuration is required to communicate with your PC.

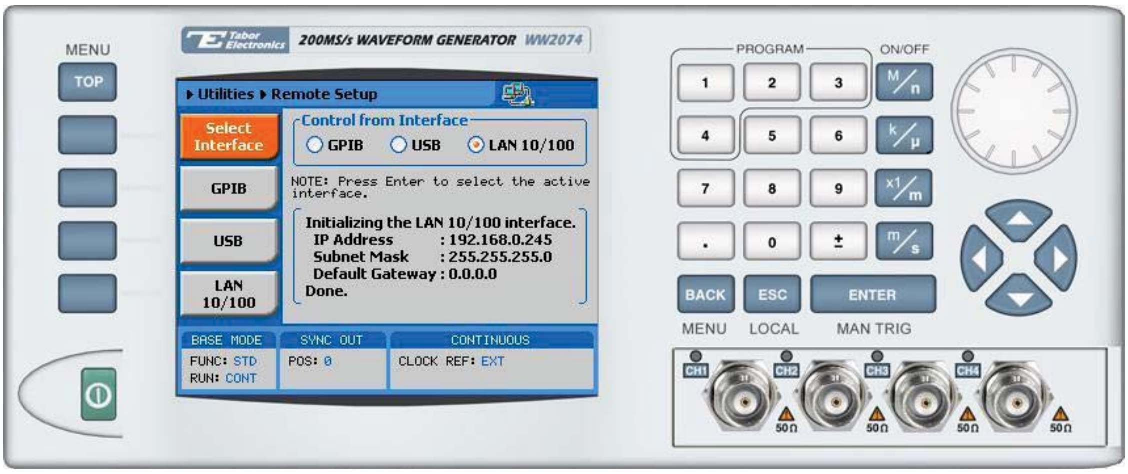


Figure 2-1, Selecting a Remote interface

## 2.13.1 GPIB Configuration

GPIB configuration requires an address setting only. If you intend to use more than one instrument on the bus, you have to make sure each device has a unique address setting. GPIB address is programmed from the front panel Utility menu as shown in Figure 2-2. To access this screen press the TOP menu button, then select the Utility soft key and scroll down with the dial to the Remote Setup option and press the Enter key. The GPIB soft key will update the display with the GPIB address parameter. The default address is 4. To modify the address, press the Enter key and use the dial or keypad to select the new address. Press Enter for the 2074 to accept the new address setting.

**Note**

- Configuring your GPIB address setting does not automatically select the GPIB as your active remote interface. Setting a remote interface is done from the Select interface menu. Information how to select and Interface is given hereinbefore.

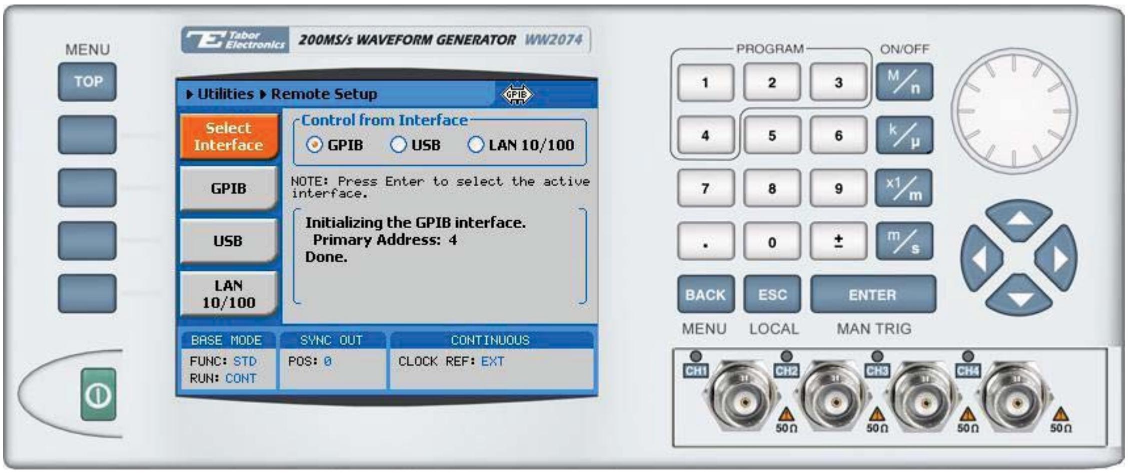


Figure 2-2, GPIB Configuration Screen

## 2.13.2 USB Configuration

The USB requires no front panel configuration parameters. Following simple installation steps as shown later, just connect your Tabor 2074 to your PC using a standard USB cable and the interface will self-configure. The first time you connect the generator to your PC, the new hardware will be detected and the message as shown in Figure 2-3 will appear:


Figure 2-3, USB Device Detected

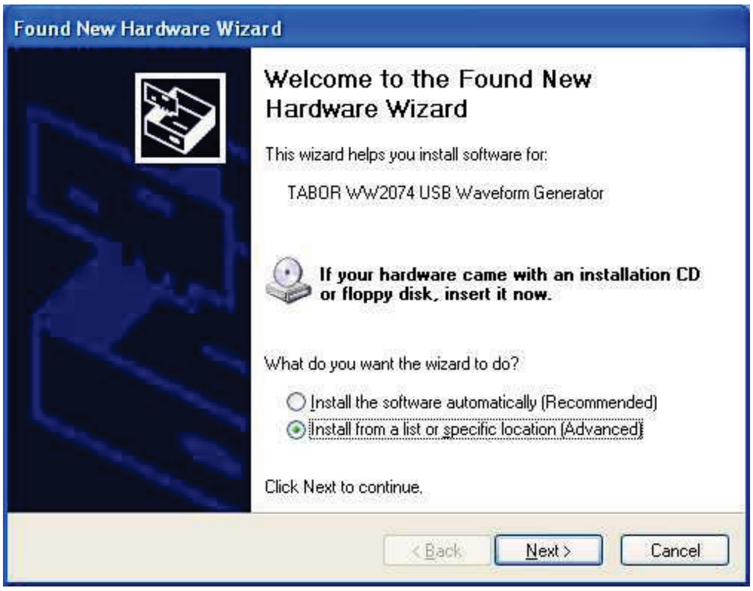


Figure 2-4, Found New Hardware Wizard

Immediately thereafter, the Found New Hardware Wizard will open, as shown in Figure 2-4. Select the Install from a list or specific Location option and click on next. At this time insert the installation CD into your CD driver. If you know the logical letter for your CD drive, type in the information in the path field. If you are not sure where this driver is, click on the Browse button and look for the path. Check the appropriate controls as shown in Figure 2-5 and then click on Next. With Service Pack 2 only, you'll be prompted with a Windows Logo Warning message, as shown in figure 2-6, advising you that the software has not been verified for its compatibility with Windows XP. Click on Continue Anyway. To complete the process press on Finish, as shown in Figure 2-7.

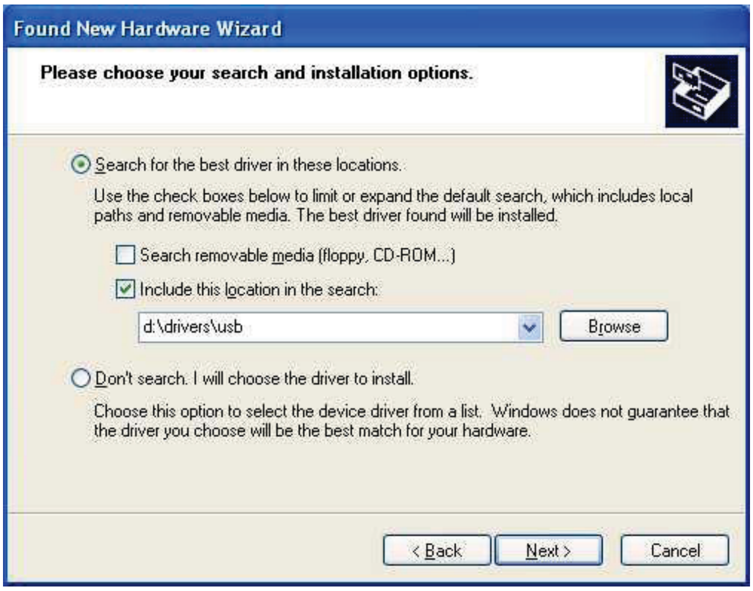


Figure 2-5, Choose Your Search and installation Options

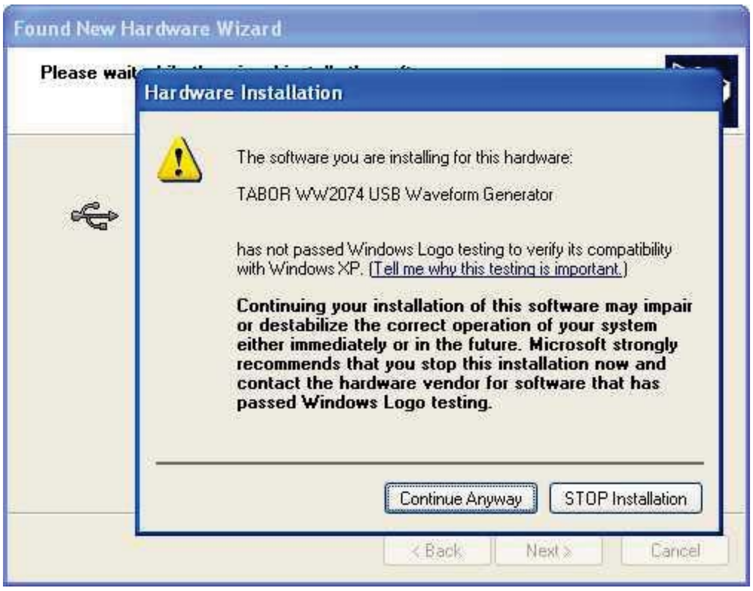


*Figure 2-6, Windows Logo Warning Message*


Figure 2-7, New Hardware Found and Software installed

Figure 2-7 shows that the Tabor 2074 USB Waveform Generator has been found and software driver installed. However, the process does not end at this point but continues to assign a logical port address to the USB driver. After you click on Finish, the Found New Hardware message appears however, this time it has found a USB serial port, as shown in Figure 2-8.


Figure 2-8, Found New Hardware - USB Serial Port

Proceed with the installation till a logical drive is assigned to the USB port. The process is very similar to what you have done before, just select the path and options in the next dialog box and click on Next as shown in Figure 2-9. With Service Pack 2 only, you'll be prompted with a Windows Logo Warning message, as shown in figure 2-10, advising you that the software has not been verified for its compatibility with Windows XP. Click on Continue Anyway. To complete the process click on Finish, as shown in Figure 2-11.

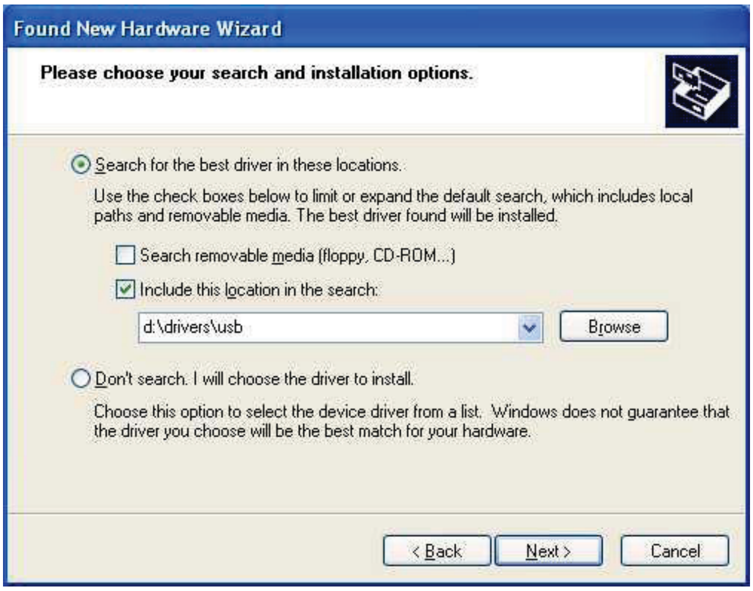


Figure 2-9, Choose Your Search and installation Options


*Figure 3-10, Windows Logo Warning Message*

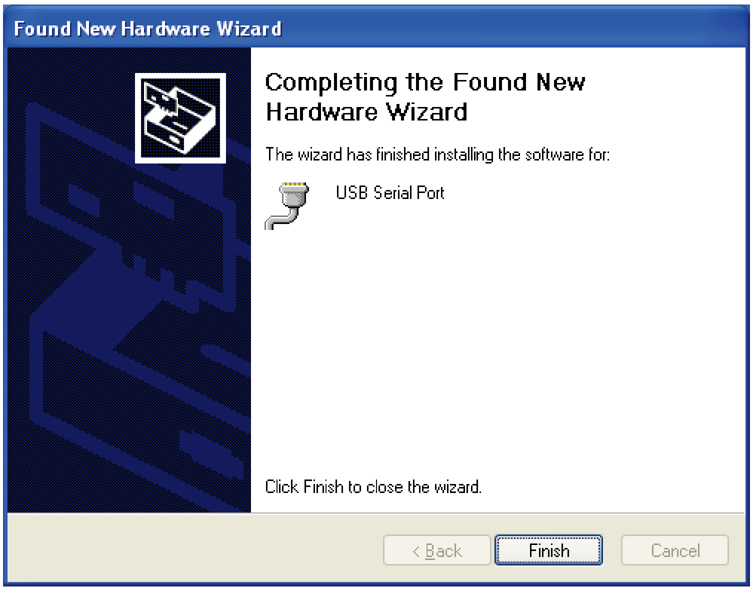


Figure 2-11, New Hardware Found and Software installed

The process above detected a USB device and installed the software for it, then it has assigned a Serial Port address to the USB post. In fact, this ends the process unless you want to verify that the drivers and the port are correctly assigned on your PC.

To make sure your USB port and the Tabor 2074 configured correctly, compare your Device Manager to the example in Figure 2-12.

**Note**

- Configuring your USB setting does not automatically select the USB as your active remote interface. Setting a remote interface is done from the Select interface menu. Information how to select and Interface is given hereinbefore.


Figure 2-12, Model 2074 Configured for USB Operation

### 2.13.3 LAN Configuration

There are several parameters that you may have to set to establish network communications using the LAN interface. Primarily you'll need to establish an IP address. You may need to contact your network administrator for help in establishing communications with the LAN interface. To change LAN configuration, you need to access the LAN 10/100 screen as shown in Figure 2-13. To access this screen press the TOP menu button, then select the Utility soft key and scroll down with the dial to the Remote Setup option and press the Enter key. The LAN 10/100 soft key will update the display with the LAN parameters.

Note there are some parameters that are shown on the display that cannot be accessed or modified; These are: Physical Address and Host Name. These parameters are set in the factory and are unique for product. The only parameters that can be modified are the IP Address, the Subnet mask and the Default gateway. Correct setting of these parameters is essential for correct interfacing with the LAN network. Description of the LAN settings and information how to change them is given in the following.

**Note**

- Configuring your LAN setting does not automatically select the LAN as your active remote interface. Setting a remote interface is done from the Select interface menu. Information how to select and Interface is given herinbefore.

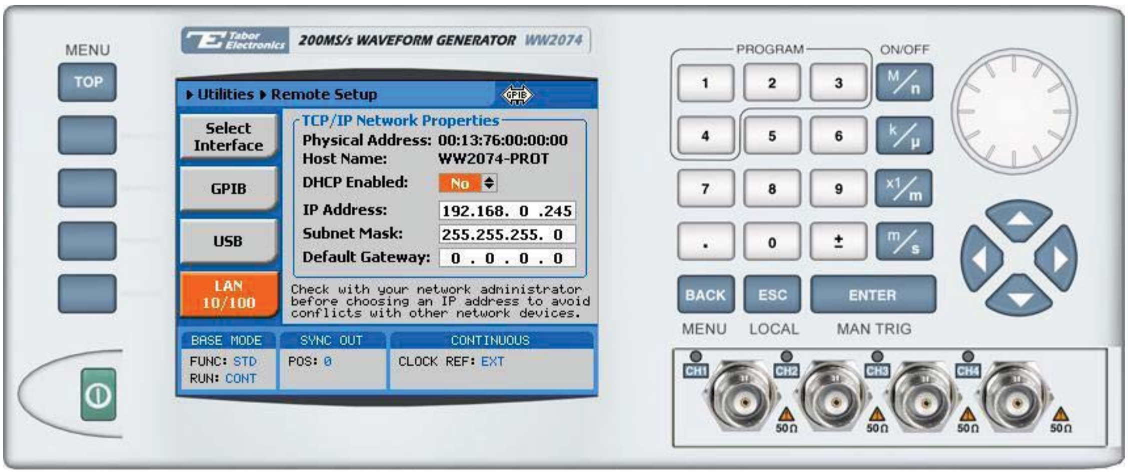


Figure 2-13, LAN Configuration Screen

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

ddress - The unique, computer-readable address of a device on your vork. An IP address typically is represented as four decimal numbers ırated by periods (for example, 192.160.0.233). Refer to the next section - ɔsing a Static IP Address.

**ıet mask** - A code that helps the network device determine whether :her device is on the same network or a different network.

**:way IP** - The IP address of a device that acts as a gateway, which is a ıection between two networks. If your network does not have a gateway, his parameter to 0.0.0.0.

#### 2.13.3.1 Choosing a Static IP Address

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

**For a Network without a Network Administrator**
If you are assembling your own small Ethernet network, you can choose your own IP addresses. The format of the IP addresses is determined by the subnet mask. You should use the same subnet mask as the computer you are using with your Ethernet device. If your subnet mask is 255.255.255.0, the first three numbers in every IP address on the network must be the same. If your subnet mask is 255.255.0.0, only the first two numbers in the IP addresses on the network must match.

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

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

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

| IP Address | Comment |
|---|---|
| 123.234.45.211 | Valid. |
| 123.234.45.213 | Valid. The first three numbers match the previous IP address. The fourth number must be a unique number in the range of 1 to 254. |

| | |
|---|---|
| 123.202.45.214 | Invalid. Second number does not match the previous IP addresses. The first three numbers must match on all IP addresses with subnet mask 255.255.255.0. |
| 123.234.45.0 | Invalid. The first three numbers are valid but the fourth number cannot be 0. |
| 123.234.45.255 | Invalid. The first three numbers are valid but the fourth number cannot be 255. |

**TIP**

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

- **For Windows 98/Me/2000/XP**
    1. **Open a DOS prompt.**
    2. **Type IPCONFIG.**
    3. **Press <Enter>.**

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

- **For Windows 95**
    1. **Open a DOS prompt.**
    2. **Type WINIPCFG.**
    3. **Press <Enter>.**

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

# 3 Using the Instrument

## 3.1 Overview

This chapter contains information about how to operate the Tabor 2074. Operation is divided into two general categories: basic bench operation, and remote operation (GPIB, USB and ENET). Basic bench operation, which is covered in this section, describes how to operate the arbitrary waveform generator using front panel sequences. The 2074 is supplied with ArbConnection, a PC based software package with a graphical user interface to allow users to program all of the functions directly. LabView drivers and a set of SCPI commands are available for more experienced programmers.

The following paragraphs describe the various modes of operation and give examples of how to program the Model 2074. The manual is organized by instrument function and instructions are given in each paragraph on how to use the function from both the front panel and ArbConnection.

**NOTE**

- This manual is common to Models 5064, Model 1074 and Model 2074. Features and functions are described for the Model 2074 and the variations are described in Appendix A. The main differences are related to the highest sampling clock rate and the output frequency. If you purchased either Model 5064 or Model 1074, refer to the specification list and ignore references to frequency and sample clock limits that exceed those which are listed in Appendix A.

## 3.2 Inter-Channel Dependency

The 2074 has four output channels. Although this is a four-channel instrument, many of the commands that set parameters and functions are shared by all other channels. For example, sample clock and run modes cannot be set separately for each channel. On the other hand, you may program each channel to have different function shape, amplitude and offset. Table 3-1 lists the function and parameters and their related Inter-channel dependency.

### 3.2.1 Inter-Channel Phase Dependency

The 2074 has only one sample clock source, which means that waveform samples are clocked simultaneously on both channels. Therefore, if you are looking to have completely separated channels, with no correlation between the two signals, this is not the right instrument for you. However, most applications for multiple channels generator require phase correlation between the outputs and this is the way the 2074 is constructed. Shared sample clock source assures that both channels start generating signals exactly on the same phase and, in addition, there is an assurance that there is no jitter between the channels. Inter-channel phase control is described later in this chapter, in the Using the Auxiliary Functions section.

## 3.3 Output Termination

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

Note that the display reading of the amplitude level is calibrated to show the actual level on the load when the load impedance is exactly 50 Ω. There are cases however, where the load has different impedance so, in that case, the display reading will indicate a different reading than the actual amplitude level on the load. The 2074 provides a customization menu where the load impedance can be changed from 50 Ω to other values. Information how to customize the 2074 is given later in this chapter.

## 3.4 Input / Output Protection

The Model 2074 provides protection for internal circuitry connected to input and output connectors. Refer to the specifications in Appendix A to determine the level of protection associated with each input or output connector.

**WARNING**

- The outputs can only be connected to resistive loads. Connecting the 2074 to inductive or capacitive load may damage the output and void the warranty on the instrument.

## 3.5 Power On/Reset Defaults

The 2074 utilizes non-volatile memory backup that automatically stores the last setup before the generator has been turned off. Every time you turn on the instrument, the non-volatile memory updates the front panel setting with modes, parameters and waveforms from its last setting with only one exception, for safety reasons, the outputs remain off even if they were turned on before powering down the 2074.

After power on, the instrument displays information messages and updates the display with the last setup information. The 2074 can always be reset to its default values; Information on how to restore default parameters is given below.

**NOTE**

- The non-volatile memory is backed up by a set of rechargeable batteries. The batteries are being charged only when the instrument is plugged into the mains outlet and the power is turned on. Minimum charge time that will assure reasonable back up power is 48 hours. After charging the batteries, you may expect that front panel settings will remain unaffected for a period of roughly 4 hours. Longer backup periods are not guaranteed so if you need to keep your settings without interruptions, make sure the instrument is always connected to the mains power and the power to the 2074 is left on.

## 3.6 Resetting the 2074

If you are not yet fully familiar with front panel operation of the 2074, you may find yourself locked into a "dead-end" situation where nothing operates the way it should. The fastest way to restore the generator to a known state is by resetting the instrument to factory defaults.

Observe Figure 3-1 and reset parameters to factory defaults as follows:

1. Press the Utilities soft key
2. Scroll down to the, or
3. Press button 3 to restore factory defaults

Table 3-1 summarizes factory defaults for the most common parameters. A complete list of all parameters, their defaults, as well as their maximum and minimum values is given in Chapter 4.

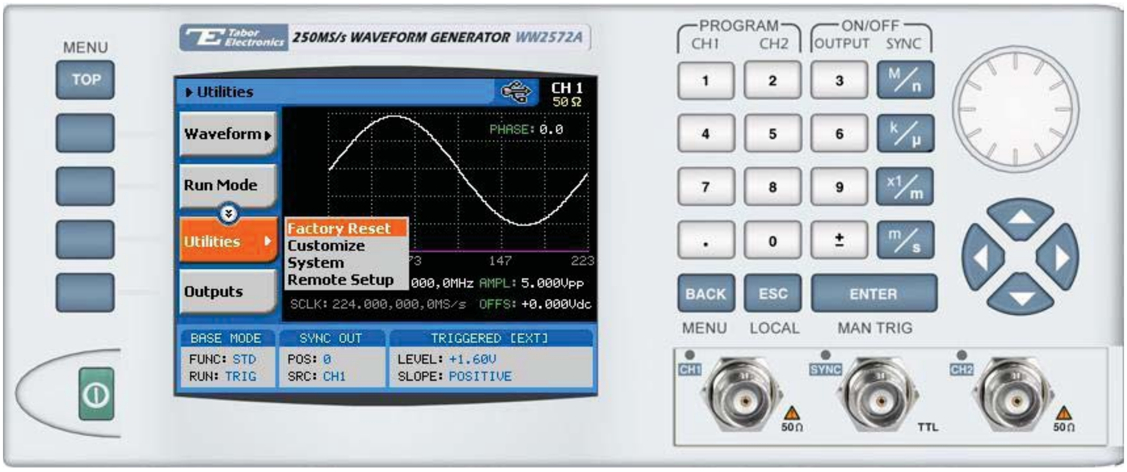


*Figure 3-1, Reset 2074 to Factory Defaults*

Table 3-4, Default Conditions After Reset

| Function / Parameter | Default | Inter-Channel Dependency |
|---|---|---|
| Outputs State: | Off | Separate |
| SYNC State: | Off | Common |
| Operating Mode: | Continuous | Common |
| Active Channel: | 1 | Separate |
| Digital Pattern State: | Off | Separate |
| Output Function: | Standard | Separate |
| Output Function Shape: | Sine | Separate |
| Standard Wave Frequency: | 1 MHz | Common |
| User Wave Sample Clock: | 10 MS/s | Common |
| Sample Clock Source & Reference: | Internal | Common |
| Amplitude: | 5 V | Separate |
| Offset: | 0 V | Separate |
| Filter State: | Off | Separate |
| Filter Type: | Auto | Separate |
| Trigger Slope: | Positive | Common |
| Trigger Level: | 1.6 V | Common |
| Trigger Source: | External | Common |
| Trigger Delay: | Off | Common |
| Re-Trigger: | Off | Common |
| Modulation State: | Off | Common |

## 3.7 Controlling the 2074

Controlling 2074 function, modes and parameters is simply a matter of pressing once or twice the appropriate button as described in the following paragraphs. Refer to Figure 3-2 throughout this description.

13. ***Power Switch*** – Toggles 2074 power ON and OFF
14. ***Menu Top*** – Selects the root menu. This button is disabled during parameter editing
15. ***Menu Soft Keys*** – Soft keys have two functions:
    1) Selects output function shape or operating mode,
    2) Selects parameter to be audited

    These buttons are disabled during parameter editing
16. ***Menu Back*** – Backs up one menu position. This button is disabled during parameter editing
17. ***Cancel (Local)*** – Has two functions:
    1) When in edit mode, cancels edit operation and restore last value
    2) When operating the 2074 from a remote interface, none of the front panel buttons are active. The Local button moves control back from remote to front panel buttons

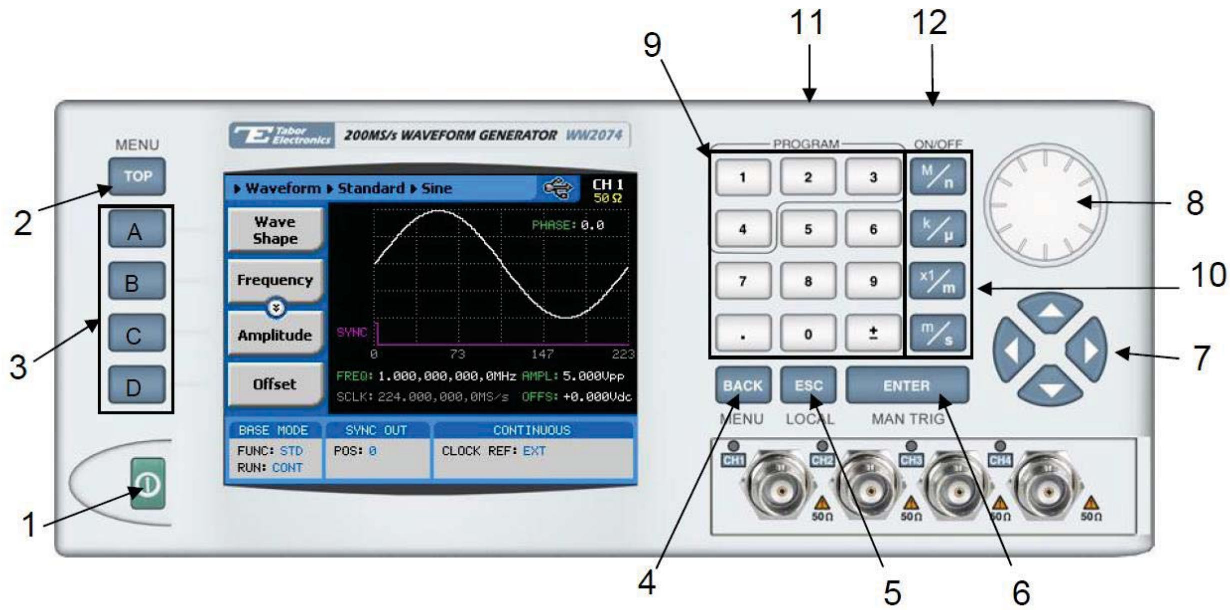


*Figure 3-2, 2074 Front Panel Operation*

18. ***Enter (MAN TRIG)*** – Has two functions:
    1) When multiple parameters are displayed on the screen, the cursor and the dial scroll through the parameters. Pressing Enter selects the parameter for edit. After the parameter has been modified, the Enter button locks in the new variable and

releases the buttons for other operations

2) When the 2074 is placed in "Triggered" run mode, the Man Trig button can be used to manually trigger the 2074

19. **Cursor *UP, Down, Left and Right*** – Has two functions:
    1) When multiple parameters are displayed on the screen, the cursor and the dial scroll through the parameters
    2) When parameter is selected for editing, cursor buttons right or left move the cursor accordingly. Cursor buttons up or down modify parameter value accordingly
20. ***Dial*** – Has similar functionality as the cursor UP and Down keys
21. **Numeral *keypad*** – These keys are used for modifying an edited parameter value
22. ***Parameter Suffixes (M, k, x1 and m)*** – These keys are used to place suffix at the end of the parameter. They are also used for terminating an edit operation
23. ***Program*** – Use the Program keys to modify the screen to display parameters from channel 1, 2, 3 or 4. These keys can be used only when the 2074 is not in edit mode
24. ***ON/OFF*** – This key can be used only when the 2074 is not in edit mode. The ON/OFF toggles output waveform on and off at the output connector.

## 3.8 2074 Front Panel Menus

The 2074 has over 300 parameters that control functions, modes, waveforms and auxiliary functions. Due to the complexity of the product, the functions were divided to logical groups and sub-groups and access to these groups is provided using the soft key menus. There are five main menus, of which can be accessed after pressing the TOP soft key; These are shown in Figure 3-1 and are mark as item 3 (A, B, C and D). The main menus are Waveform, Run Mode, Utility, Outputs and Auxiliary. Each main menu provides access to sub-menus as summarized in Tables 3-2 to 3-5. Note that the description in these tables is given for general understanding of what is available in terms of operating the instrument. For detailed instructions, check the appropriate section of the manual.

Table 3-5, Front Panel Waveform Menus

| Soft Key | TOP Menu | 2nd Level Menu | 3rd Level Menu | Notes |
|---|---|---|---|---|
| A | Waveform | | | Provides access to initial selection of the waveform type. Selects from Standard, Arbitrary, Sequenced and Modulated |
| A | | Standard | | |
| A | | | Wave Shape | Select from a wave shapes list |

| | | | | |
|---|---|---|---|---|
| B | | | Frequency | Programs standard waveform frequency |
| C | | | Amplitude | Programs output amplitude |
| D | | | Offset | Programs output amplitude offset |
| ↓D (*) | | | Phase | Parameters depend on selected shape |
| ↓D | | | Reset Parameters | Resets parameters for this waveform only |
| B | | Arbitrary | | |
| A | | | Sample Clock | Programs sample clock frequency |
| B | | | Amplitude | Programs output amplitude |
| C | | | Offset | Programs output amplitude offset |
| D | | | Active Segment | Selects the active arbitrary waveform segment |
| ↓D | | | Wave Composer | Provides access to the waveform composer |
| ↓D | | | Delete Segments | Deletes a specific segment |

(*) ↓D denotes you have to scroll down to access the menu. Scroll using the arrows up or down or the dial.

Table 33-2, Front Panel Waveform Menus (continued)

| Soft Key | TOP Menu | 2nd Level Menu | 3rd Level Menu | Notes |
|---|---|---|---|---|
| C | | Sequenced | | |
| A | | | View Table | Provides access to the sequence table |
| B | | | Advance Mode | Programs the sequence advance mode |
| C | | | Advance Source | Selects the sequence advance source |
| D | | | Sample Clock | Programs the sample clock frequency |
| ↓D | | | Amplitude | Programs output amplitude |
| ↓D | | | Offset | Programs output amplitude offset |
| ↓D | | | Active Sequence | Selects the active sequence for the output |
| | **Modulation Option** | | | |
| D | | Modulated | | |
| A | Off | | Modulation Type | Selects from Off, PSK and QAM |
| B | Off | | CW Frequency | Programs the carrier waveform frequency |
| C | Off | | Amplitude | Programs the CW Amplitude |
| D | Off | | Offset | Programs the CW amplitude offset |
| B | (n)PSK | | PSK Type | Programs the PSK type: PSK, BPSK, QPSK, OQPSK, pi/4DQPSK, 8PSK and 16PSK |
| C | (n)PSK | | PSK Data | Displays and edits (n)PSK data table. Also, provides access to demonstration data symbols |
| D | (n)PSK | | CW Control | Turns CW on and off |
| ↓D | (n)PSK | | CW Frequency | Programs the carrier waveform frequency |
| ↓D | (n)PSK | | Symbol Rate | Programs the symbol transition rate |
| ↓D | (n)PSK | | Marker | Programs the marker position |
| ↓D | (n)PSK | | Amplitude | Programs the CW Amplitude |
| ↓D | (n)PSK | | Offset | Programs the CW amplitude offset |

| | | | | |
|---|---|---|---|---|
| B | (n)QAM | | QAM Type | Programs the QAM type: 16QAM, 64QAM, 256QAM and User QAM |
| C | (n)QAM | | QAM Data | Displays and edits (n)QAM data table. Also, provides access to demonstration data symbols |
| D | (n)QAM | | CW Control | Turns CW on and off |
| ↓D | (n)QAM | | CW Frequency | Programs the carrier waveform frequency |
| ↓D | (n)QAM | | Symbol Rate | Programs the symbol transition rate |
| ↓D | (n)QAM | | Marker | Programs the marker position |
| ↓D | (n)QAM | | Amplitude | Programs the CW Amplitude |
| ↓D | (n)QAM | | Offset | Programs the CW amplitude offset |

Table 3-6, Front Panel Run Mode Menus

| Soft Key | TOP Menu | 2nd Level Menu | 3rd Level Menu | Notes |
|---|---|---|---|---|
| B | Run Mode | | | Provides access to 2074 Run Mode options: Continuous, Triggered, Gated and Counted Burst |
| A | | Continuous | | Selects the continuous run mode |
| B | | Triggered | | Selects the triggered run mode. Provides access to trigger parameters, re-trigger on/off and re-trigger parameters |
| C | | Gated | | Selects the gated run mode. Provides access to gating parameters |
| D | | Burst | | Selects the triggered run mode. Provides access to counted burst parameters, re-trigger on/off and re-trigger parameters |

(*) ↓D denotes you have to scroll down to access the menu. Scroll using the arrows up or down or the dial.

Table 3-7, Front Panel Utility and Output Menus

| Soft Key | TOP Menu | 2nd Level Menu | 3rd Level Menu | Notes |
|---|---|---|---|---|
| C | Utility | | | Provides access to factory reset, display customization, remote setup and system parameters |
| | | Factory Reset | | Allows reset of all 2074 parameters to factory default values |
| | | Customize | | Provides access to display customization: horizontal units, clock sources, load impedance, dial direction and display brightness |
| | | System | | Displays all 2074 system parameters, including serial number, installed option, last calibration date. Also monitors internal temperature rise. |
| | | Remote Setup | | Provides access to selecting the remote interface. Available interfaces are LAN, USB and GPIB |
| A | | | Select interface | Selects between GPIB, USB and LAN |

| | | | | |
|---|---|---|---|---|
| B | | | GPIB | Programs GPIB address |
| C | | | USB | Display information on the USB ID |
| D | | | LAN | Programs LAN IP address |
| D | Outputs | | | Provides access to output on/off control, filter on/off and type, SYNC output on/off control and properties, and start phase offset between channels. |

Table 3-8, Front Panel Auxiliary Menus

| Soft Key | TOP Menu | Auxiliary Function | 2nd Level Menu | Notes |
|---|---|---|---|---|
| ↓D | Auxiliary | | | Provides access to the following auxiliary functions: Digital Pulse Generator, Counter/Timer, Half Cycle waveforms, Multi-instrument synchronization and Digital Patterns. |
| A | | Pulse Generator | Apply Changes | Press this button to accept modifications of pulse parameters. |
| B | | | Period | Programs the period of the pulse |
| C | | | Delay | Programs the delay from the start of the pulse |
| D | | | Rise Time | Programs the pulse rise time parameter |
| ↓D | | | High Time | Programs the pulse high time parameter |
| ↓D | | | Fall Time | Programs the pulse fall time parameter |
| ↓D | | | High Level | Programs the pulse high level parameter |
| ↓D | | | Low Level | Programs the pulse low level parameter |
| ↓D | | | Polarity | Programs the pulse polarity parameter |
| ↓D | | | Double State | Toggles double pulse state on and off |
| ↓D | | | Channel State | Programs the channel programmability state |
| ↓D | | | Sync Position | Programs the sync pulse position parameter |
| A | | Counter/Timer | Counter Function | Selects the counter/timer measurement function |
| B | | | Display Time | Selects between continuous and single measurement cycles |
| C | | | Gate Time | Programs the counter gate time |
| D | | | Trigger Level | Programs the trigger level for the counter input |
| ↓D | | | Trigger Slope | Programs the trigger slope for the counter input |
| ↓D | | | Reset/Arm | Resets the counter display and arms the counter for the next measurement cycle |
| A | | Half Cycle | Half Cycle Shape | Selects the half cycle waveform shape. Select between sine, triangle or square waveforms |
| B | | | Delay | Programs the delay between the half cycles |
| C | | | Frequency | Programs the delay from the start of the pulse |
| D | | | Amplitude | Programs the half cycle Amplitude |
| ↓D | | | Offset | Programs the half cycle amplitude offset |
| ↓D | | | | Programs the start phase of the sine and triangular waveforms |
| ↓D | | | Phase | Programs the half cycle start phase angle |

| | | | | |
|---|---|---|---|---|
| A | | X-Inst Sync, | Couple State | Toggles master/slave mode on and off |
| B | | | Properties | Provide access to selection of the master and delay between adjacent instruments |
| C | | | Slaves IP Address | Allows addition of slave units. Every added IP address is automatically added as slave |

(*) ↓D denotes you have to scroll down to access the menu. Scroll using the arrows up or down or the dial.

## 3.9 Enabling the Outputs

For safety reasons, main outputs default setting is OFF. The outputs can be turned on and off using either the hot keys, or the Output Menu. Observe Figure 3-3 and disable or enable the main outputs using the procedure below. The same procedure can be used for enabling and disabling the SYNC output. The numbers on Figure 3-3 correspond to the procedure steps in the following description.

1. While not editing any parameter, select the channel you want to turn on using one of the keys that are circled with the PROGRAM label
2. Press ON/OFF to toggle main output on and off. Notice when you turn on the output, the LED which is associated with the programmed output is turned on as well.

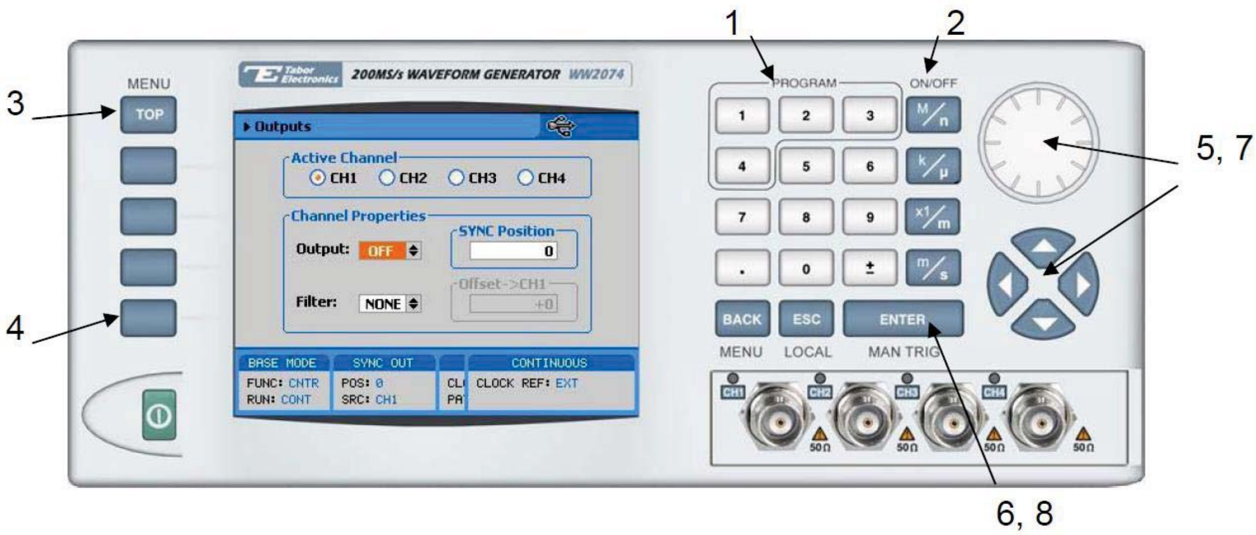


*Figure 3-3, Enabling and Disabling the Outputs*

Alternately, the outputs can be turned on and off from the Outputs sub menu. Use the following procedure to open the Outputs dialog box press to toggle output state:

3. Press TOP to display the root menu
4. Press Outputs to open the Outputs dialog box as shown in Figure 3-3

5. Use the dial or arrow keys to access the required field. Focus is on a field that is painted orange.
6. To edit the field press Enter. The edited field will turn white with orange borders
7. Use the dial or arrow keys to change the field
8. Press Enter again to lock in the setting

## 3.10 Selecting a Waveform Type

There are four main types of waveforms that the 2074 can produce: Standard, Arbitrary, Sequenced and Modulated waveforms. Standard and modulated waveforms are computed from equations and tables that are built into the program. The instrument can output arbitrary and sequenced waveforms however, only after waveform data has been downloaded into its memory.

Digital patterns can also be generated from a rear-panel connector in conjunction with the arbitrary waveform output. The digital patterns, however, will be described and discussed separately in this chapter.

Refer to Figure 3-4 and use the following procedure to select an output waveform type.

Note that there are sub-menus associated with each output type menu. Accessing and using these sub-menus is described later in this chapter. The numbers on Figure 3-4 correspond to the procedure steps in the following description.

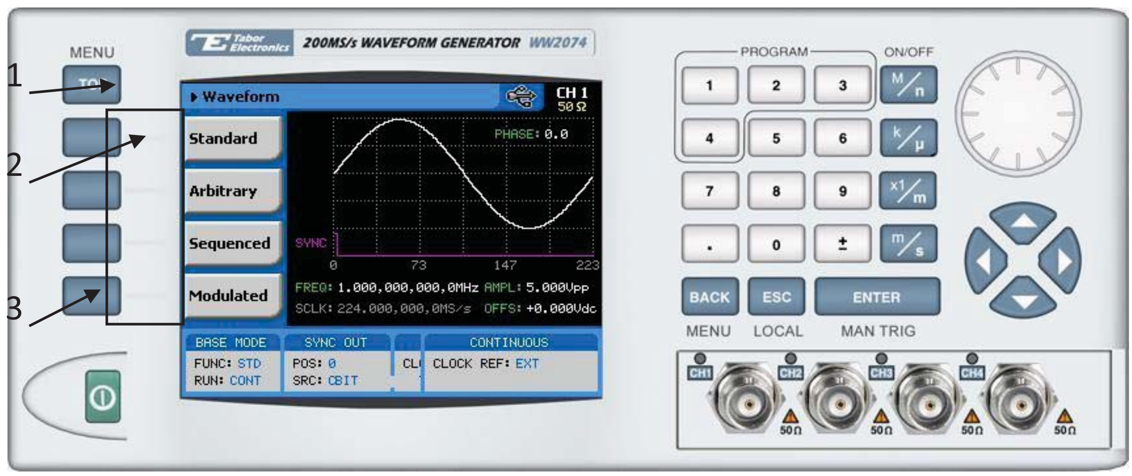


*Figure 3-4, Selecting an Output Waveform Type*

Alternately, the outputs can be turned on and off from the Outputs sub menu. Use the following procedure to open the Outputs dialog box press to toggle output state:

1. Press TOP to display the root menu
2. Press Waveforms, the display as shown in Figure 3-4 will open.
3. Press one of the soft keys to select the required waveform.

Note the waveform screen shows a sine waveform. The sine is the default waveform. After you select a different waveform type, the screen will be updated with a new symbol, which is associated with the new type.

**Note**

- The picture in the 2074 LCD display is an icon only. The actual output waveform may look entirely different.

## 3.11 Changing the Output Frequency

You should be careful not to confuse waveform frequency with sample clock frequency. The waveform frequency parameter is valid for standard waveforms only and controls waveform frequency at the output connector; The sample clock frequency parameter is valid for arbitrary and sequenced waveforms only and defines the frequency of which the generator clocks data points.

Standard waveform frequency is measured in units of Hz. Arbitrary waveform sample clock frequency is measured in units of S/s (samples per second). The frequency of a given arbitrary waveform at the output connector is dependent on sample clock frequency, the number of data points, and other specific waveform definitions.

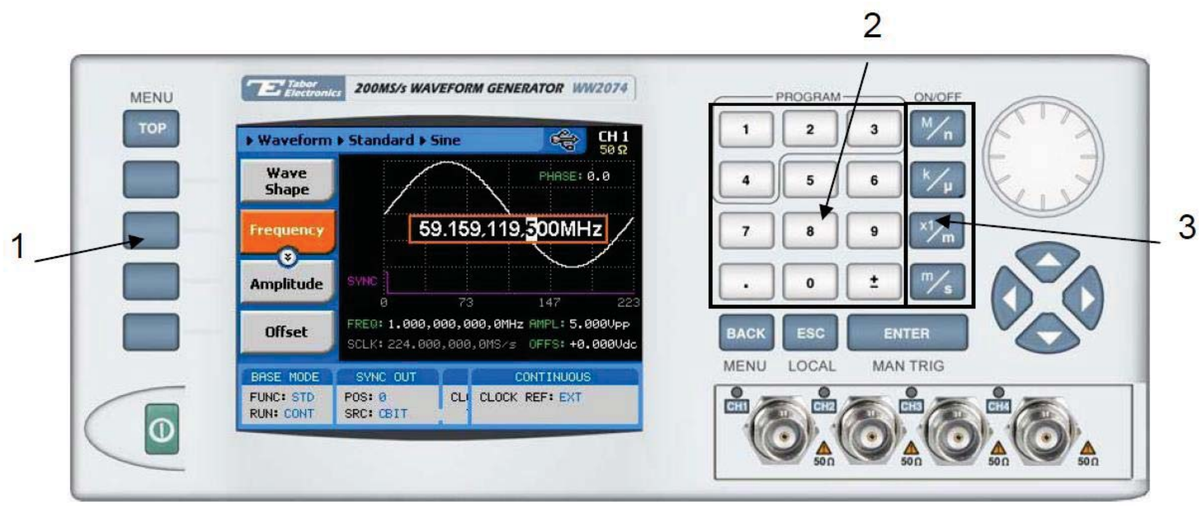


*Figure 3-5, Modifying Output Frequency*

The frequency of the output waveform will change only if a standard waveform is generated. First select a standard waveform as described earlier and then proceed with frequency modification.

Observe Figure 3-5 and modify frequency using the following procedure. The index numbers in Figure 3-5 correspond to the procedure steps in the following description.

1. Press the Frequency soft key to select the frequency parameter
2. Use the numeric keypad to program the new frequency value
3. Press M, k, x1 or m to terminate the modification process

Alternately, you can modify the frequency value with the dial and arrow keys but then the termination of the process is by pressing Enter only.

**Note**

- If you use the dial or arrow keys to modify the frequency parameter, the output is updated immediately as soon as you modify the parameter. The final value will be locked in as soon as you press Enter. If you choose to leave the old value, press Cancel to terminate the process and to discard of any change made to this parameter

## 3.12 Changing the Sample Clock Frequency

The frequency of the sample clock will affect the output waveform only if arbitrary or sequenced waveforms are generated. First select an arbitrary waveform as described earlier and then proceed with sample clock frequency modification.

Observe Figure 3-6 and modify the sample clock using the following procedure. The index numbers in Figure 3-6 correspond to the procedure steps in the following description.

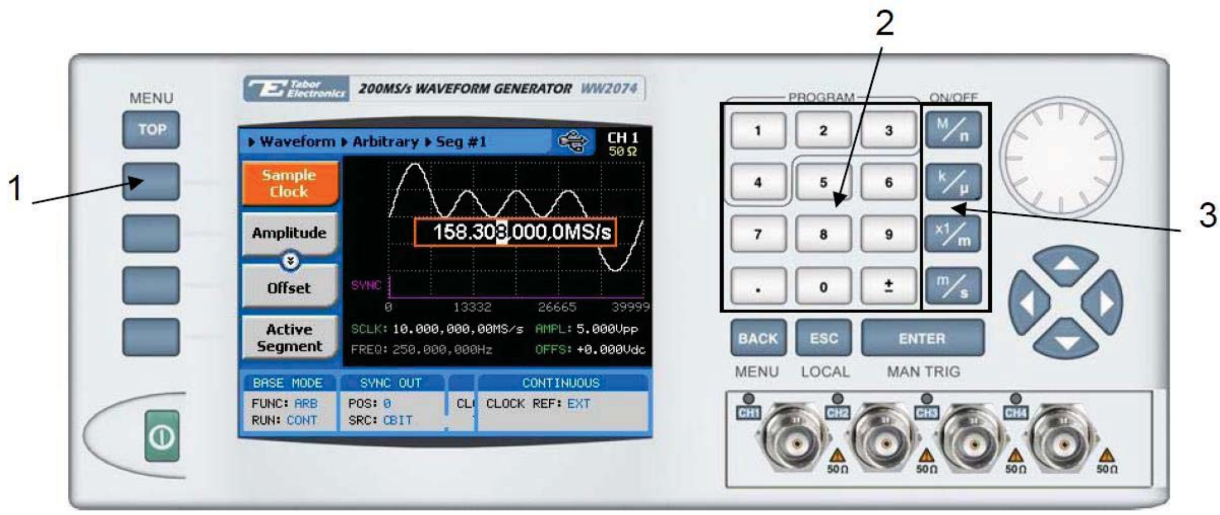


*Figure 3-6, Modifying Sample Clock Frequency*

1. Press the Sample Clock soft key to select the sample clock parameter
2. Use the numeric keypad to dial the new sample clock frequency value
3. Press “M” for MS/s, “k” for kS/s, “x1” for S/s, or “m” for mS/s to terminate the modification process

Alternately, you can modify the sample clock frequency value with the dial and arrow keys but then the termination of the process is by pressing Enter only.

**Note**

- If you use the dial or arrow keys to modify the sample clock frequency parameter, the output is updated immediately as soon as you modify the parameter. The final value will be locked in as soon as you press Enter. If you choose to leave the old value, press Cancel to terminate the process and to discard of any change made to this parameter

## 3.13 Programming the Amplitude and Offset

Output amplitude and offset can be programmed independently and separately for each channel. Amplitude and offset are set within windows, so before you select values for these parameters, make sure you do not exceed the limits.

Amplitude and offset can be programmed independently as long as the following relationship between the two values is not exceeded:

$$Window \geq \frac{Amplitude}{2} + |Offset|$$

The first thing you do before you program amplitude and offset setting is define which of the channels is being programmed. The active channel is displayed at the upper right corner of the LCD display.

When the display shows CH 1 at the upper right corner, you are currently programming channel 1 parameters. Keypads "1" and "2" are used as hot keys for channel selection. While not editing any parameter, press key "2" to program channel 2 parameters.

When the display shows CH 2 at the upper right corner, you can proceed with channel 2 programming. Use the same procedure to modify the parameters for channels 3 and 4.

The amplitude and offset parameters are duplicated in multiple screens however, when changed for a specific function shape, the new value is updated on all screens for all other function shapes. Refer to Figure 3-7 and modify amplitude and offset using the procedure as described below. The index numbers in Figure 3-7 correspond to the procedure steps in the following description.

1. Press the Amplitude soft key button
2. Press Enter to edit the Amplitude value
3. Use the numeric keypad to program the new value
4. Press "m" for mV, or "x1" for volts to select the suffix letter.
5. Press Enter to lock in the value

Alternately, you can modify the amplitude value with the dial and arrow keys but then the termination of the process is by pressing Enter.

Offset is programmed the same way as amplitude except select Offset from the soft key menus to access the offset parameter.

**Note**

- If you use the dial or arrow keys to modify the amplitude or offset parameters, the output is updated immediately as soon as you modify the parameter. The final value will be locked in as soon as you press Enter. If you choose to leave the old value, press Cancel to terminate the process and to discard of any change made to this parameter

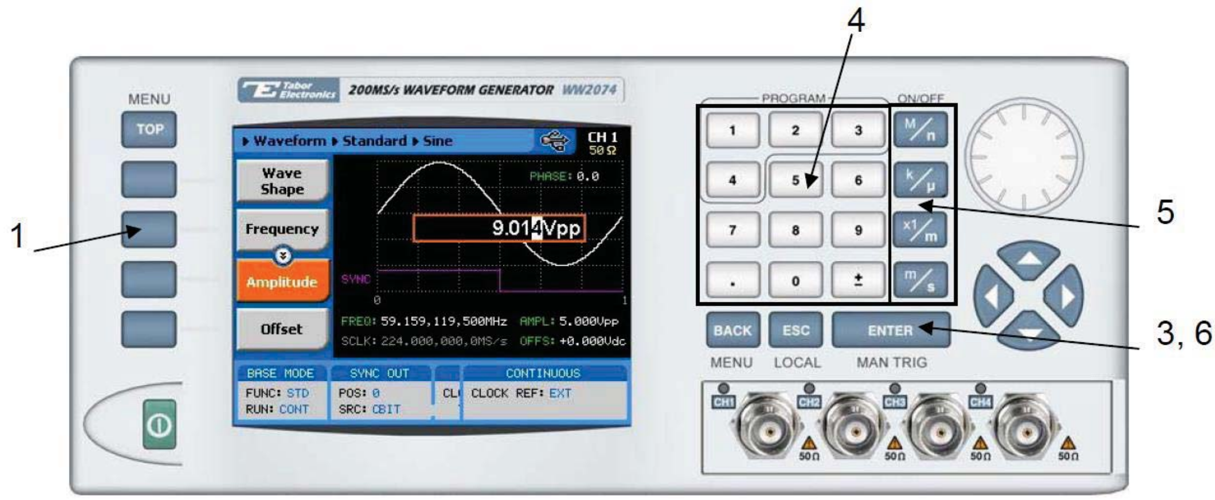


*Figure 3-7, Programming Amplitude and Offset*

## 3.14 Selecting a Run Mode

The Model 2074 offers four run modes: Continuous, Triggered, Gated and Burst.

The selected waveform is repeated continuously when the instrument is set to operate in Continuous mode. The continuous output can be turned on and off from a remote interface, and thus controlling the start and stop of the waveform from an external source. The operating mode defaults to continuous after reset.

Triggered, Gated, and Burst modes require an external signal to initiate output cycles. In some case, an internal trigger generator is available to generate the required trigger stimuli without the need to connect to external devices. Figure 3-8 show the run mode options. Press one of the soft keys in the left to select the required run mode.

Description of the various runs modes and the parameters that are associated with each run mode is given in the following paragraphs.

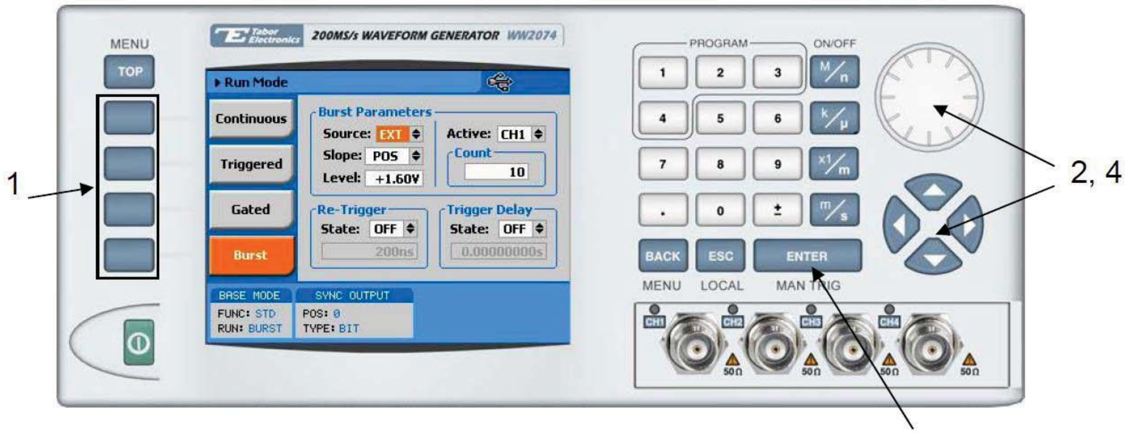


*Figure 3-8, Run Mode Options*

**Note**

- Burst run mode is shown in Figure 3-8 as an example however, the following description applies to all Run Mode menus.

In general, a specific run mode is selected from the Run Mode soft key menu. The screen as shown in Figure 3-8 is displayed. Proceed to select the run mode and to program parameters as follows:

1. Press one of the soft keys to select from: Continuous, Triggered, Gated or burst. The output will immediately be updated with the selected run mode
2. Use the arrow keys or the dial to scroll down to the parameter field you want to modify
3. Press Enter to edit the field value
4. Use the arrow keys or the dial to modify the parameter
5. Press Enter to lock in the value

### 3.14.1 Triggered Mode

In Triggered mode, the output remains at a DC level as long as a valid trigger signal has not occurred. Each time a trigger occurs, the 2074 generates one complete output waveform. At the end of the output cycle, the output resumes position at a DC level that is equal to the amplitude of the last point of the waveform.

The instrument may be triggered from one of the following sources: A rear panel input, designated as TRIG IN, front panel button, marked MAN TRIG and a remote command such as *TRG. When placed in EXT (external) trigger source, remote commands are ignored and the instrument monitors the TRIG IN connector or the MAN TRIG control. When in BUS, the hardware inputs are ignored and only remote commands can trigger the instrument. The MIX is a special trigger advance mode that senses the first remote trigger and only then enables the hardware sources.

There are four parameters you can adjust for this mode:

***Source*** – defines the trigger source. EXT enables the rear panel trigger input, BUS enables remote commands and MIX enables remote command and after the first trigger enables the EXT source.

***Slope*** – defines edge sensitivity for the trigger input

***Level*** – sets the trigger level crossing point for the rear panel TRIG IN connector. Signal transition to above the trigger level will trigger the instrument. When the slope is set to negative, transitions to below the trigger level will trigger the instrument. Trigger level sensitivity and maximum level should be observed to avoid damaging the input

***Trigger Delay*** – defines the state of the delayed trigger function.

***Re-Trigger*** – defines the state of the re-trigger function

You may use the triggered mode to trigger standard, arbitrary sequenced and modulated waveforms. The Trigger run mode parameters are shown in Figure 3-9.


*Figure 3-9, Trigger Run Mode Parameters*

### 3.14.2 Delayed Trigger

The delayed trigger function operates in conjunction with the triggered and counted burst modes. When enabled, it inhibits the output signal for a pre-determined period after a valid trigger. The delay time defines the time that will lapse from a valid trigger (hardware or software) to output. To enable the delayed trigger feature, scroll down to the Trigger Delay State field and press Enter. Use the down key to change the state to ON and press enter again to lock in the state position. The delay field then becomes active. Scroll down to the delay field and press enter. Modify the delay to match your delay requirement and press Enter again.

Note that the minimum delay is 200 ns and can be increased to over 20 seconds with 20 ns resolution.

### 3.14.3 Re-Trigger

The re-trigger function operates in conjunction with the triggered and counted burst modes. When enabled, it does not modify the output except when a valid trigger is received. It then starts an automatic sequence of internal triggers that generate repeated output cycles or bursts. The time in the re-trigger group defines the time that will lapse from the end of the signal to the start of the next signal.

To enable the re-trigger feature, scroll down to the Re-Trigger State field and press Enter. Use the down key to change the state to ON and press enter again to lock in the state position. The re-trigger time field then becomes active. Scroll down to the re-trigger time field and press enter. Modify the time to match your requirement and press Enter again.

Note that the minimum re-trigger interval is 200 ns and can be increased to over 20 seconds with 20 ns resolution.

### 3.14.4 Gated Mode

When set to gated mode, the 2074 output remains at a DC level as long as the rear-panel TRIG IN signal remains inactive. The output gates on and off between two transitions, either positive or negative, depending on the slope setting. Only the rear panel TRIG IN connector can be used for operating the gated mode.

When placed in gated mode, the generator idles on a DC level until the first gate on transition. The signal will complete after the gate off transition and the generator will once again resume DC level equal to the last point of the waveform.

There are two parameters you can adjust for the gated mode:

***Source*** – defines the gating signal source. Since the gated run mode relies on hardware transitions, only EXT is a valid source for the gated mode.

***Slope*** – defines if the generator is gating on and off on positive or negative transitions.

***Level*** – sets the trigger level crossing point for the rear panel TRIG IN connector. Signal transition to above the trigger level will gate the instrument. When the slope is set to negative, transitions to below the trigger level will gate the instrument. Trigger level sensitivity and maximum level should be observed to avoid damaging the input

You may use the gated mode to gate standard, arbitrary, sequenced and modulated waveforms. The gated run mode parameters are shown in Figure 3-10.


*Figure 3-10, Gated Mode Parameters*

### 3.14.5 Burst Mode

Burst mode is similar to Triggered mode with the exception that only one trigger signal is needed to generate a counted number of output waveforms. In Burst mode, the output remains at a DC level as long as a valid trigger signal has not occurred. Each time a trigger occurs, the 2074 generates a counted number of burst of waveforms. At the end of the output burst, the output resumes position at a DC level that is equal to the amplitude of the last point of the waveform.

The instrument may be triggered from one of the following sources: A rear panel input, designated as TRIG IN, front panel button, marked MAN TRIG and a remote command such as *TRG. When placed in EXT (external) trigger source, remote commands are ignored and the instrument monitors the TRIG IN connector or the MAN TRIG control. When in BUS, the hardware inputs are ignored and only remote commands can trigger the instrument. The MIX is a special trigger advance mode that senses the first remote trigger and only then enables the hardware sources.

There are four parameters you can adjust for this mode:

***Source*** – defines the trigger source. EXT enables the rear panel trigger input, BUS enables remote commands and MIX enables remote command and after the first trigger enables the EXT source.

***Slope*** – defines edge sensitivity for the trigger input

***Level*** – sets the trigger level crossing point for the rear panel TRIG IN connector. Signal transition to above the trigger level will trigger the instrument. When the slope is set to negative, transitions to below the trigger level will trigger the instrument. Trigger level sensitivity and maximum level should be observed to avoid damaging the input

***Burst*** – Defines the number of cycles the generator will output after a trigger signal. Each channel can be programmed to have a unique burst counter.

***Trigger Delay*** – defines the state of the delayed trigger function.

***Re-Trigger*** – defines the state of the re-trigger function

You may use the counted burst mode in conjunction with standard, arbitrary and modulated waveforms only. Sequenced waveforms cannot be used in burst mode. The Burst run mode parameters are shown in Figure 3-11.


*Figure 3-11, Burst Run Mode Parameters*

## 3.15 Using the Manual Trigger

The manual trigger allows you to trigger or gate the 2074 directly from the front panel. This button is active only when the generator is placed in external trigger only. The MAN TRIG button is a second function to the Enter button and can be used only when the display is not in editing mode.

## 3.16 Using the SYNC Output

The 2074 has four sync outputs, one for every channel, located on the rear panel. The outputs are always active, regardless if the main output is turned on or off and therefore, for safety reasons, if you are not sure if the output can damage your devices, disconnect the sync outputs from your test gear immediately after you turn off the generator. Each sync pulse can be programmed to have a different position along the waveform length. The SYNC parameters are shown in Figure 3-12. The Menu is accessible by selecting the Outputs soft key as shown in Figure 3-3.


*Figure 3-12, SYNC and Filter Parameters*

There are four parameters you can adjust for the SYNC output:

***Active Channel*** – When you select CH1, CH2, CH3 or CH4, subsequent programming will apply to the selected channel only. For example, if you want to program the sync position for channel 3, press key number 3 on the keypad and observe that the CH3 option is checked. You can then move forward to program the sync position for channel 3. Note that when you exit this menu, the display will still be associated with channel 3 programming so if you intend to program another channel, select the required channel, as explained in the above.

***Position*** – Lets you place the sync start at any point along the length of the waveform. Placement resolution is 4 points. As default, the sync signal is positioned at the beginning of the waveform. Position is unique for each channel so if you change from channel to channel, you can see that the field is updated with the correct position, as was programmed for the specific channel.

## 3.17 Applying Filters

Four filters are available for each channel. These filters have fixed cutoff frequencies of which their properties are specified in Appendix A. The built-in filters are switched in after the DAC circuit and are used for reducing the noise, harmonics and spurious signals above the cutoff frequency.

The built-in filters are available for the user in standard, arbitrary, sequenced and modulated modes. The only function where the Model 2074 does not allow external control is when standard sinusoidal waveform is selected.

**Note**

- The default output function of the generator is the sine waveform. The instrument is using filters to reconstruct this waveform and therefore, the state of the filters cannot be changed until another output function is selected. A setting conflict error will occur if one attempts to change the filter state before changing to another output function.

If you do not plan on using the filters, make sure that you leave the selection OFF. This will eliminate confusing setting conflicts.

Modification of the filter state and range is done from the Outputs menu. To access this menu select the Outputs screen as shown in Figure 3-12.

## 3.18 Selecting the SCLK Source and Reference

In cases where synchronization to other instruments in a system is needed, you have two options: Use an external clock source for the 10 MHz reference clock or replace the internal sample clock generator entirely with an external clock source. Either way, this is a major twist in the 2074 basic operation because if, for any reason, you leave one or both source options on external and do not apply the necessary signal to the input, the operation of the generator will be impeded without visual references that something is wrong.

The SCLK and the 10MHz reference source menu were placed in the Customize menu, as shown in Figure 3-13. Change these settings only if you are absolutely sure that another reference source is available at the appropriate inputs.

The SCLK input is located on the rear panel. Use this input to replace the internal sample clock generator. The external sample clock input accepts ECL level signals, terminated to –2V into 50Ω.

The 10 MHz reference input is also located on the rear panel. It accepts TTL level signals only. Note that the 2074 internal reference is accurate to within 1 ppm.

To display and modify the SCLK or the 10 MHz clock source, press TOP, then Utility and scroll down to the Customize option.


*Figure 3-13, Modifying the SCLK and 10 MHz Clock Source*

## 3.19 Generating Standard Waveforms

The majority of applications require the use of common waveforms such as sinusoidal, triangular and square. In fact, these are the only waveforms that function generators can produce and therefore, one should expect that these waveforms be available even in a complex generator such as this. The 2074, being a completely digital instrument, has a library of built-in waveforms that allow generation of these basic waveforms plus many more.

By default, the 2074 is programmed to generate one of the common waveforms in the market – sine waveform. Figure 3-14 shows a list of all other waveforms that the instrument can generate however, one must not forget that the waveforms are generated digitally from either lookup tables or formulated from standard equations and therefore, each time a new waveform is selected, one should expect to have a slight delay between the time the waveform was selected to when it is being generated at the output connector.

The waveforms that reside in the built- in library are referred to as Standard Waveforms. The meaning of this term is that these waveforms have standard characteristics that is commonly known and or associated with these waveforms. For example, sine waveform has known spectral and power distribution that could be compared to published mathematical equations. The quality of the generator determines how closeness of the waveform generation to its pure mathematical properties.

The 2074 has a library of 10 standard waveforms: Sine, Triangle, Square, Ramp, pulse, sinc, Gaussian, Exponential, DC and Noise. Some of the parameters for these waveforms can be modified to fine tune the waveforms for specific applications. For example, changing the sine start phase on channels 2 and 3 create a three-phase sine system. The standard waveforms and their parameters that can be modified are summarized in the following paragraphs.

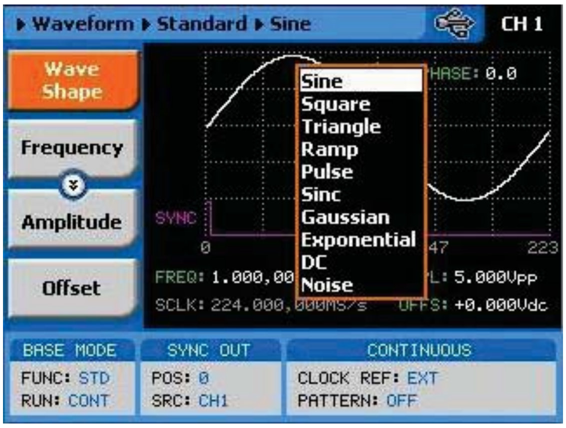


*Figure 3-14, Built-in Standard Waveforms Menu*

## 3.20 Sine Wave

The sine waveform is the most commonly used waveform. The waveform is generated from a lookup table that has 1000 points and therefore, the sine waveform is generated with 1000-points accuracy up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically up to a point where filters are being switched in to reconstruct the waveform. The technique of generating sine waves above certain frequency is not within the scope of this manual however, one should remember that above certain frequency the waveform is losing purity and quality because the number of points that are available to construct the waveform are inversely proportional to the output frequency. This statement is true for all standard waveforms and this is the reason for limiting the upper frequency of certain waveforms.

There are certain menus that provide access to sine waveform parameters; These are:

***Frequency*** – programs the frequency of the sine waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Phase*** – sets the start phase of the output waveform. You will not be able to see any change in the waveform if you generate a continuous sine waveform however, if you place the generator in triggered run mode, the output will start the sine wave generation from a point defined by the Phase parameter. The start phase is programmed in units of degree.

***Reset Parameters*** – Resets the sine wave parameters to their original factory defaults.

## 3.21 Square Wave

The square waveform is a commonly used waveform. The waveform is generated from a lookup table that has 1000 points and therefore, the square waveform is generated with 1000-points accuracy up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically.

There are certain menus that provide access to square waveform parameters; These are:

***Frequency*** – programs the frequency of the square waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Duty Cycle*** – programs the square wave duty cycle (pulse width to period ratio). The duty cycle is programmed as percent of the period. The default value is 50 %.

***Reset Parameters*** – Resets the square wave parameters to their original factory defaults.

## 3.22 Triangle Wave

The triangle waveform is a commonly used waveform. The waveform is generated from a lookup table that has 1000 points and therefore, the triangle waveform is generated with 1000-points accuracy up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The triangular waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the shape becomes distorted to a point where it is not usable anymore.

There are certain menus that provide access to triangle waveform parameters; These are:

***Frequency*** – programs the frequency of the triangle waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Phase*** – sets the start phase of the output waveform. You will not be able to see any change in the waveform if you generate a continuous triangular waveform however, if you place the generator in triggered run mode, the output will start the triangle wave generation from a point defined by the Phase parameter. The start phase is programmed in units of degree.

***Reset Parameters*** – Resets the triangular wave parameters to their original factory defaults.

## 3.23 Ramp Wave

The ramp waveform is a special case of the triangular waveform with a slight difference, the ramp can be adjusted for its rise and fall times. The ramp waveform is a very common waveform and is required for numerous applications however, not being a true ramp generator, the ramp parameters are computed and programmed as percent of the ramp period. The waveform is computed every time a parameter is modified. 1000 points are allocated for the ramp shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The ramp waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the resolution of the parameters is lost to a point where it is not usable anymore.

There are certain menus that provide access to ramp waveform parameters; These are:

***Frequency*** – programs the frequency of the ramp waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Delay*** – sets the delay time for the ramp start. The delay is programmed as percent of the ramp period.

***Rise*** – programs the ramp rise time. The rise time is programmed as percent of the ramp period.

***Fall*** – programs the ramp fall time. The fall time is programmed as percent of the ramp period.

Note that the sum of the delay, rise and fall times cannot exceed 100 %. If the sum is less than 100 %, the end of the ramp will remain at a dc level to the completion of the period.

***Reset Parameters*** – Resets the ramp wave parameters to their original factory defaults.

## 3.24 Pulse Wave

The pulse waveform is a very common waveform and is need for the majority of the applications however, not being a true pulse generator, the pulse parameters are computed and programmed as percent of the pulse period. The waveform is computed every time a parameter is modified. 1000 points are allocated for the pulse shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The pulse waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the resolution of the parameters is lost to a point where it is not usable anymore.

There are certain menus that provide access to pulse waveform parameters; These are:

***Frequency*** – programs the frequency of the pulse waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Delay*** – sets the delay time for the ramp start. The delay is programmed as percent of the ramp period.

***Rise*** – programs the ramp rise time. The rise time is programmed as percent of the ramp period.

***Fall*** – programs the ramp fall time. The fall time is programmed as percent of the ramp period.

Note that the sum of the delay, rise, high and fall times cannot exceed 100 %. If the sum is less than 100 %, the end of the pulse will remain at a dc level to the completion of the period.

***Reset Parameters*** – Resets the pulse wave parameters to their original factory defaults.

## 3.25 Sinc Wave

The sinc pulse (sine x/x) waveform is a very common waveform and is required in many applications however, not being a true pulse generator, the sinc pulse parameters are re-computed every time a parameter is changed. 1000 points are allocated for the sinc pulse shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The sinc pulse waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the shape of the pulse is deteriorated to a point where it is not usable anymore.

There are certain menus that provide access to sinc pulse waveform parameters; These are:

***Frequency*** – programs the frequency of the sinc waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***#Cycles*** – sets the number of “0” crossing cycles for the sinc function. Note that the default value is 4. Changing the value to a different number requires re-calculation of the waveform and may take a few seconds until the waveform is computed and generated at the output connector.

***Reset Parameters*** – Resets the sinc pulse wave parameters to their original factory defaults.

## 3.26 Gaussian Wave

The gaussian pulse waveform is useful in many applications. The gaussian pulse parameters are re-computed every time a parameter is changed. 1000 points are allocated for the gaussian pulse shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The gaussian pulse waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the shape of the pulse is deteriorated to a point where it is not usable anymore.

There are certain menus that provide access to gaussian pulse waveform parameters; These are:

***Frequency*** – programs the frequency of the sinc waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Exponent*** – sets the exponent factor for the gaussian function. Changing the default exponent value to a different number requires re-calculation of the waveform and may take a few seconds until the waveform is computed and generated at the output connector.

***Reset Parameters*** – Resets the gaussian pulse wave parameters to their original factory defaults.

## 3.27 Exponential Wave

The exponential pulse waveform is useful in applications simulating capacitor charge or discharge. Not being a true pulse generator, the exponential pulse parameters are re-computed every time a parameter is changed. 1000 points are allocated for the exponential pulse shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The exponential pulse waveform is reasonable up to about 20 MHz where 10 points are available to generate its shape. As the number of points decrease further, the shape of the pulse is deteriorated to a point where it is not usable anymore.

There are certain menus that provide access to sinc pulse waveform parameters; These are:

***Frequency*** – programs the frequency of the sinc waveform. Note that at low frequencies (up to about 200 kHz), when you modify the frequency parameter, the output responds with coherent change however, at higher frequencies, the waveform has to be re-computed every time and therefore, when you modify the frequency, the output wanders until the waveform is being re-computed and then restored to full accuracy.

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Exponent*** – sets the exponent factor for the exponential function. Setting the exponent to a negative value inverts the exponential function. Changing the default exponent value to a different number requires re-calculation of the waveform and may take a few seconds until the waveform is computed and generated at the output connector.

***Reset Parameters*** – Resets the exponential pulse wave parameters to their original factory defaults.

# 3.28 DC Wave

The DC waveform is useful for applications requiring simply and accurate DC level.  There are certain menus that provide access to the DC waveform parameters; These are:

***DC Level*** – programs the level of the DC output function. The amplitude is programmed in units of volts and generated continuously at the output connector in a similar way as a power supply generates its output. Note however, that the amplitude is calibrated when the output is terminated into 50 Ω load impedance.

***Reset Parameters*** – Resets the DC amplitude parameter to its original factory default.

## 3.29 Noise Wave

The noise waveform is useful in applications requiring generation of simple noise. The spectral spread of the noise is pseudo-random and is limited in its bandwidth by the bandwidth parameter. The noise parameters are re-computed every time a parameter is changed. 1000 points are allocated for the noise shape up to about frequency setting of 200 kHz (output frequency = sample clock frequency / number of points). As frequency is increased above 200 kHz the number of points is being reduced automatically. The noise waveform is reasonable up to about 2 MHz where 100 points are available to generate its shape. As the number of points decrease further, the shape of the noise is deteriorated to a point where it is not usable anymore.

There are certain menus that provide access to noise waveform parameters; These are:

***Amplitude*** – programs the amplitude of the output waveform. Note that amplitude and offsets can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the amplitude parameter in this menu overrides amplitude setting in all other menus.

***Offset*** – programs the offset of the output waveform. Note that offset and amplitude can be programmed freely within the specified amplitude window, as explained in the Programming Amplitude and Offset section in this chapter. Note that setting the offset parameter in this menu overrides offset setting in all other menus.

***Bandwidth*** – sets the sample clock rate which generates the noise. It also serves as a simple tool to limit the bandwidth of the noise to a known value.

Note that while generating noise, bear in mind that the noise is generated in a certain memory size and it is being repeated over and over until the function is disabled. Therefore, the noise is not really random as is the pure translation of the word.

***Reset Parameters*** – Resets the gaussian pulse wave parameters to their original factory defaults.

## 3.30 Generating Arbitrary Waveforms

In general, the Model 2074 cannot by itself create arbitrary waveforms. If you want to use arbitrary waveforms, you must first load them into the instrument. The 2074 is supplied with waveform creation and editing, called – ArbConnection. Besides waveform generation, ArbConnection has instrument control features, sequence table generator, pulse composer and many other features that will be described separately. Figure 3-15 shows an example of a waveform that was created with the ArbConnection. Once the waveform is created on the screen, downloading it to the 2074 is just a click of a mouse away.

Detailed information on the structure of the arbitrary waveform and the commands that are needed to download arbitrary waveforms to the 2074 is given in Chapter 5. Information in this Chapter will give you some general idea what arbitrary waveforms are all about.

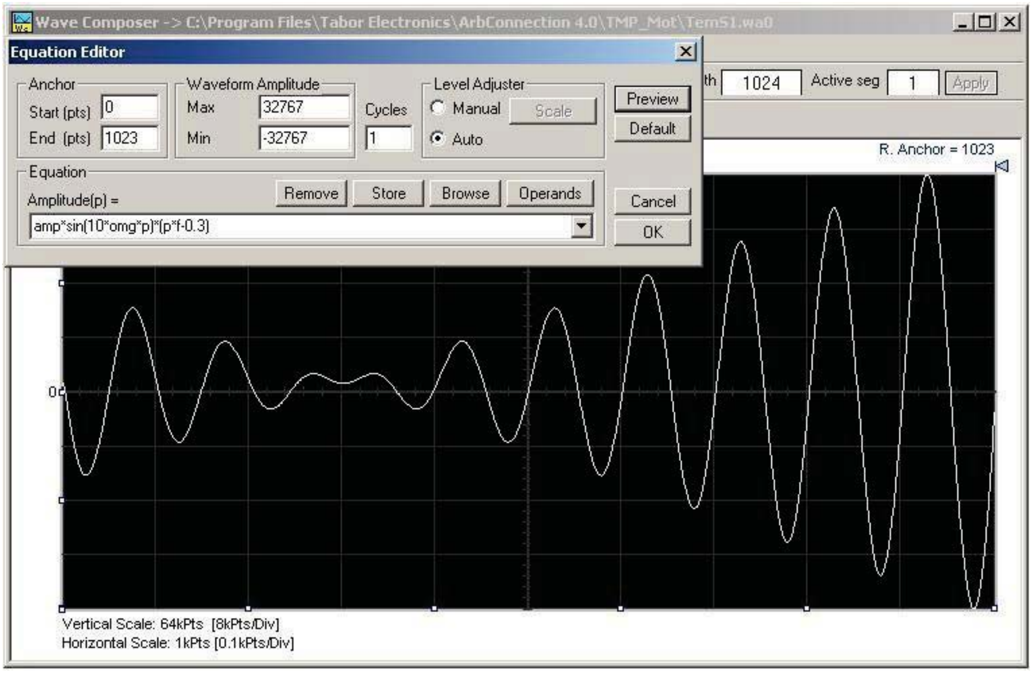


*Figure 3-15, the Wave Composer Tool for Generating Arbitrary Waveforms*

### 3.30.1 What are Arbitrary Waveforms?

Arbitrary waveforms are generated from digital data points, which are stored in a working memory. The working memory is connected to a digital to analog converter (DAC) and a sample clock generator is clocking the data points, one at a time, to the output circuit. In slow motion, the output generates a waveform that resembles the look of a staircase. In reality, the DAC is generating amplitude hops that depend on bit arrangement and sample clock speed.

The working memory has two major properties: vertical resolution and memory depth.

***Vertical Resolution*** – This term defines the precision along the vertical axis of which data points can be placed and generated by the DAC. The 2074 is using 16-bit DAC’s to generate arbitrary waveforms. Converting 16 bits to precision shows that each data point can be placed along the vertical axis with a precision of 1/65,536.

***Memory Depth*** – Defines how many data points can be stored for a single waveform cycle. The 2074 has 1 M waveform memory capacity and 2 M waveform memory as an option.

Having such large memory capacity is an advantage. Modern applications in the telecommunications industry require simulation of long waveforms without repeatable segments. The only way to create such waveforms is having sufficient memory depth. On the other hand, if you do not need to use very long waveforms but must have many other waveforms stored in your working memory, the 2074 lets you divide the memory bank to smaller segments and load different waveforms into each segment.

### 3.30.2 Generating Arbitrary Waveforms

Downloading waveforms to the 2074 and managing arbitrary memory are explained in the programming section of this manual. This section assumes that you have already downloaded waveforms and want the instrument to output these waveforms.

Refer to Figure 3-16 and use the following description to learn how to output arbitrary waveforms and how to program arbitrary waveform parameters. To select Arbitrary waveforms as the output waveform type press Waveforms, then Arbitrary. The screen as shown in Figure 3-16 will display and the output will already generate arbitrary waveforms. Note the channel you are currently program and make sure the icon at the upper right corner agrees with your required programming sequence. Use the following procedure to modify the parameters that are associated with the arbitrary waveform function:

1. Press the soft key next to the required parameter to display the edit field
2. Punch in the value using the numeric keypad. Be careful not to exceed parameter limits while you key the numbers
3. Select and press a suffix
4. Press Enter to lock in the new value

Alternately, after you display the edit field, you may use the dial and/or the arrow keys to modify the field then, press Enter to lock in the new value. If you did not make programming errors and did not make any mistake while downloading your waveform segment(s), then the output should generate your desired waveform.

There are four parameters that are available for programming in this window:

***Sample Clock*** – Defines the sample clock frequency for the arbitrary waveform. Information how to modify the sample clock is given in this chapter.

***Amplitude*** – Defines the amplitude of the arbitrary waveform. Note that regardless of the amplitude setting, the vertical resolution of which the waveform is generated is always 14 bits.

***Offset*** – Defines the offset value of the arbitrary waveform. The offset and the amplitude can be freely programmed within a 10V window (+5V to -5V rails).

***Active Segment***– Defines which of the segments in the working memory is currently active at the output connector. As was discussed earlier, the working memory can be divided to 2k segments and different waveforms loaded in each segment. Any segment is available at the output connector only if it has been selected to be the active segment. The segment selection field lets you select any segment from 1 to n regardless if it contains waveform data or not so be careful when you select a segment number as it may be empty and no output will be generated.

***Delete Segments*** – Allows distractive removal of all segments from the memory. In fact, this command does not erase the memory but only removes the table that defines start and stop for each segment location. If you have recorded your segment sizes you can always re-define the segment table, which will restore the original waveforms in each segment. There is however, no way back if you perform a download action after you delete the segment table.

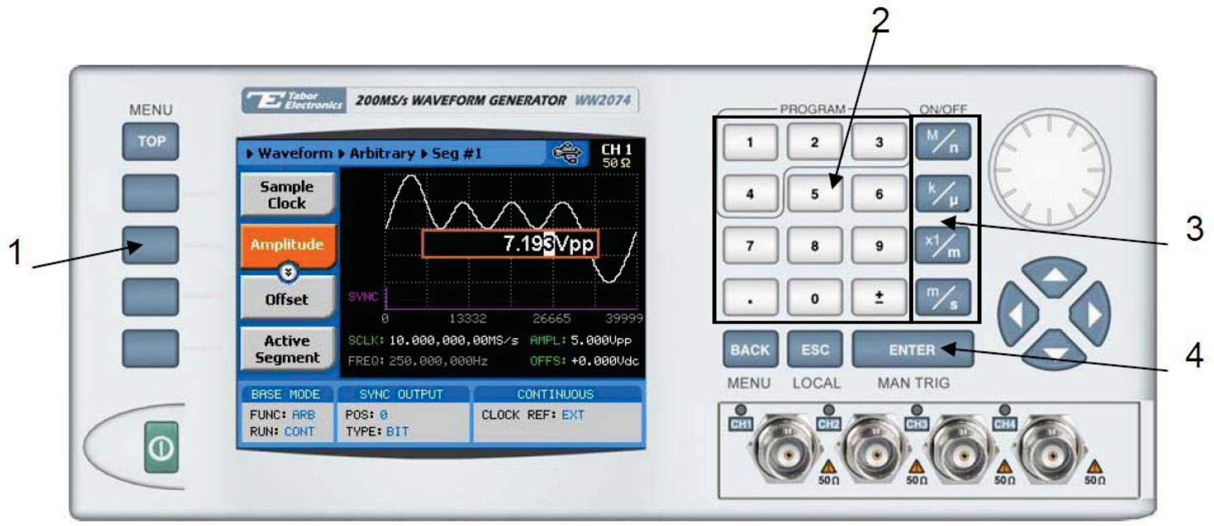


*Figure 3-16, Programming Arbitrary Waveform Parameters*

## 3.31 Generating Sequenced Waveforms

In general, the Model 2074 cannot by itself create sequenced waveforms. If you want to use sequenced waveforms, you must first load them into the instrument. The 2074 is supplied with waveform creation and editing, called – ArbConnection. Besides waveform creation, ArbConnection has instrument control features, sequence table generator and many other features that will be described separately. To generate a sequence you must first download waveforms to the instrument, generate a sequence table and download the sequence table to the instrument. Sequences are generated easily using the waveform Studio as demonstrated in Figure 3-17. Note that different sequences can be generated for each channel.

Detailed information on the structure of the arbitrary waveform and the commands that are needed to download arbitrary waveforms to the 2074 is given in Chapter 5. There, you can also find information how to create and download sequence tables using SCPI programming commands. Information in this chapter will give you some general idea what sequenced waveforms are all about.

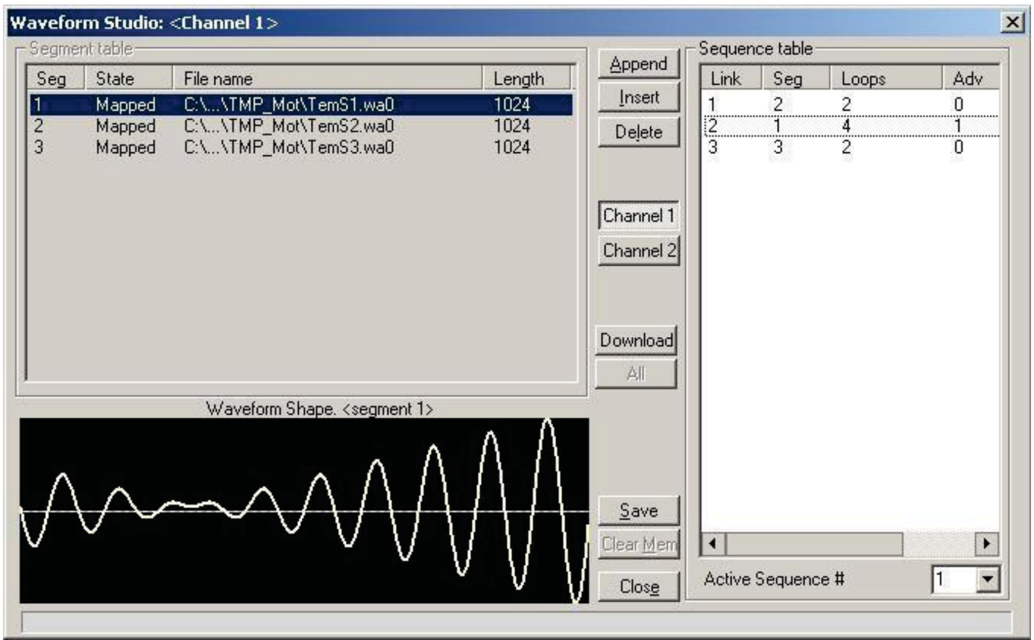


*Figure 3-17, Using ArbConnection to Generate Sequences*

### 3.31.1 What Are Sequenced Waveforms?

Sequenced waveforms are constructed from two or more arbitrary waveforms, which are linked and looped in any way you can imagine, as long as you observe the limitations set forth in the specification section of this manual.

The first thing to do before you can generate sequenced waveforms is download waveforms to the 2074. You may use ArbConnection or any other application to create waveform segments. Then, you can build your sequence table. An example of how sequenced waveforms work with three different waveforms is demonstrated in Chapter 1, Figures 1-12 through 1-15.

The sequence table, as shown in Figure 3-17, specifies: Link, Seg, Loops and Adv. Description of the various elements within the sequence table is given below.

***Link*** - This parameter defines an index array for the sequence generator. When generating sequences, the instrument steps though the link # 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 field is a special code that is used in conjunction with the mixed advance mode. This bit flags the 2074 if the selected link is continuous or stepped. Information on the Mixed sequence advance mode is given later. “0” flags continuous, “1” flags stepped.

Assuming that you already downloaded waveforms, created and downloaded sequence table, you can proceed now with the following description how to set the 2074 to output sequenced waveforms.

Refer to Figure 3-18 and use the following description to learn how to output sequenced waveforms and how to program sequence parameters. To select Sequenced waveforms as the output waveform type press Waveforms, then Sequenced. The screen as shown in Figure 3-18 will display and the output will already generate arbitrary waveforms. Note the channel you are currently program and make sure the icon at the upper right corner agrees with your required programming sequence.

Use the following procedure to modify the parameters that are associated with the Sequenced waveforms function:

1. Press the soft key next to the required parameter to display the edit field
2. Punch in the value using the numeric keypad. Be careful not to exceed parameter limits while you key the numbers
3. Select and press a suffix
4. Press Enter to lock in the new value

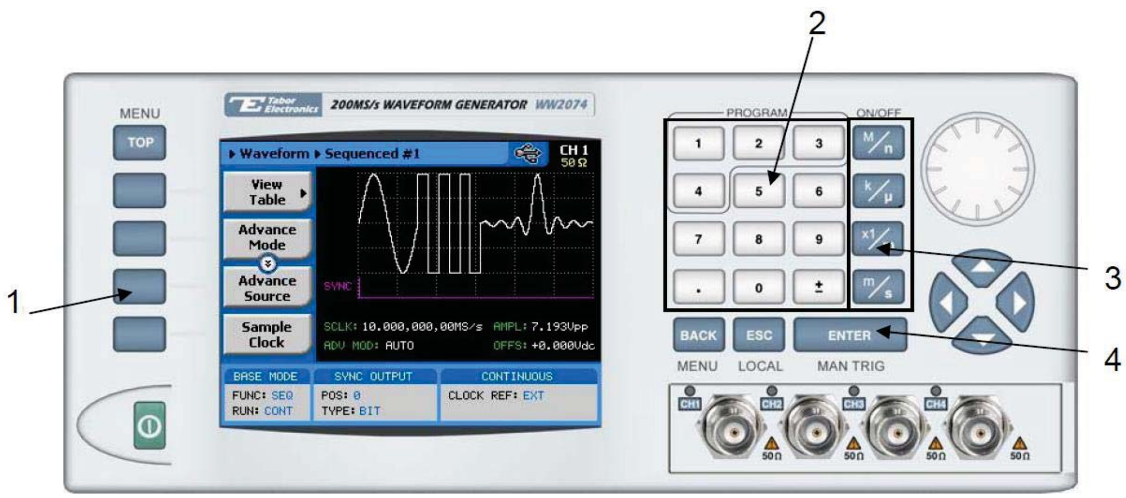


*Figure 3-18, Sequence Parameters*

Alternately, after you display the edit field, you may use the dial and/or the arrow keys to modify the field then, press Enter to lock in the new value. If you did not make programming errors and did not make any mistake while downloading your waveform segment(s), then the output should generate your desired waveform. There are seven parameters that are available for programming in this window:

***View Table*** – Provides access to a sequence table. If no table was yet defined, you can define the sequence table from this menu. You can also edit an existing sequence table from this command. Information on editing the sequence table is given later.

***Advance Mode*** – Defines the advance mode for the sequence. There are four advance mode options you can select from: Automatic, Stepped, Single and Mixed. A description of the various advance modes is given later. Note that advance mode depends on run mode and therefore, if you selected continuous run mode for the 2074, you will not see the Single advance mode in the advance mode options list. Similarly, if you selected triggered run mode, Stepped and Mixed will be omitted from the list.

***Advance Source*** – Defines which of the triggers inputs will advance the sequence. The advance source has no effect on Automatic advance source.

***Sample Clock*** – Programs the sample clock frequency for the sequenced waveform. The final period of the complete sequence can be extracted from the following relationship:

Sequence Duration = 1 / (SCLK / n)

n = the number of waveform points in the sequence, including looped waveforms.

***Amplitude*** – Defines the amplitude of the sequenced waveform.

***Offset*** – Defines the offset of the sequenced waveform.

***Active segment*** – Programs the active segment in a sequence. The SYNC will be placed on the active segment. There is no other purpose for this parameter in the sequence.

**Tip**

- Use the arrow keys or the dial to scroll through the sequence parameters. The View Table will remain at the top while the others may be accessed selectively.

### 3.31.2 Editing the Sequence Table

If you select the View option as was described above, the sequence table will display as shown in Figure 3-19. If you already have a sequence table in place, you can edit the steps and modify the table per your new requirements. If you do not have a sequence table, you can construct the table from this screen however, you must make sure first that the segments you intend to use are loaded with waveforms.

Observe Figure 3-19 and note the commands that are available for editing and creating a sequence table.

***Apply Changes*** – After you make modifications to the sequence table, you must use this command to update the internal registers with the new table settings and output updated immediately with the new settings. Changes, if made, in the table will be updated automatically when you exit the Edit Table screen however, the output will change to the new settings only after you re-enter the sequence function.

***Edit Step*** – Provides entry point to the table. You may scroll between the fields using the arrow keys. If you want to edit a specific step, place the cursor on the step and press Enter. Edit the field as required and press Enter again to lock in the new value.

***Insert Step*** – Allows adding another step to the sequence table. You have a choice of adding the step above or below the cursor line or at the end of the sequence table.

***Go to Step*** – Provides entry point to the sequence table at a specific step number. Continue editing the step as described above.

***Delete Step*** – Use this command to delete a specific step from the sequence. You'll be asked to confirm if you really want to delete the step before the final execution.

***Delete Table*** – Use this command to delete the entire sequence table. You'll be asked to confirm if you really want to delete the step before the final execution.

**Tip**

- Use the arrow keys or the dial to scroll through the edit parameters. The Apply Changes will remain at the top while the others may be accessed selectively.

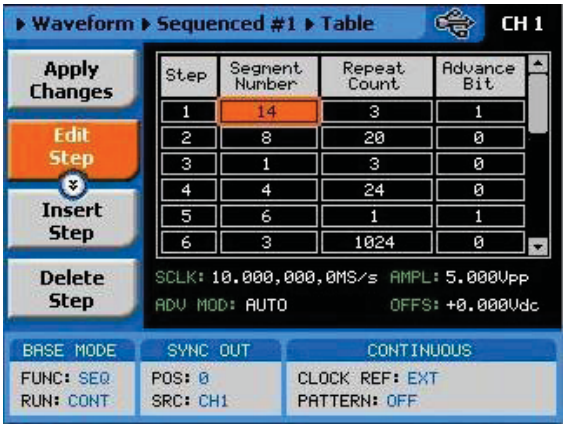


*Figure 3-19, Editing the Sequence Table*

### 3.31.3 Selecting Sequence Advance Modes

As was explained above, the 2074 steps through an index of links; It may loop a few times on a designated link and eventually, after the last link, the process repeats itself. Stepping from link to link through the sequence table is done automatically by the instrument. However, there are applications requiring control when and how the link is stepped. The 2074 has a number of sequence advance options: Auto, Stepped, Single and Mixed. These advance modes are described in the following.

***Automatic*** – specifies continuous advance where the generator steps continuously and automatically through the links to the end of the sequence table and then repeats the sequence from the start. For example, if a sequence is made of three segments – 1, 2, and 3, and AUTO mode is used, 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. AUTO is the default sequence advance mode. Note, to use this mode, the 2074 must be in *continuous* operating mode.

***Stepped*** – Using this advance mode, the sequence is advanced to the next link only when a valid trigger is received. The output of the 2074 generates the first segment continuously until a trigger signal advances the sequence to the next link. If repeats were selected for a segment, the loop counter is executed automatically. Note, although the trigger input controls advanced steps, to use this mode, the 2074 must be in *continuous* operating mode.

***Single*** – Using this advance mode, the 2074 idles between steps until a valid trigger signal is sensed. The single advance mode requires that the 2074 be in trigger operating mode only. An attempt to select the Single advance mode when the instrument is in continuous operating mode cannot be done. When triggered, 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 were programmed, the output will repeat this segment for n times automatically. Only after executing all of the programmed loops will the sequence step to the next assigned link.

**Note**

- To use the single advance mode, the 2074 must be in programmed first to *triggered* run mode.

***Mixed*** – This sequence advance mode allows combination of automatic and stepped links in one sequence table. To use this mode, in the sequence table, mark the Adv field “1” to flag stepped link or “0” for continuous link. Then, download the sequence table to the 2074. Note, to use this mode, the 2074 must be in *continuous* operating mode. Step with a “0” bit assigned to a step 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 then, will wait for the next trigger to advance to the next step.

1. Refer to Figure 3-20 and select the Advance Mode with the appropriate soft key. The advance mode options, as shown in Figure 3-20 will display. Use the dial or arrow keys to scroll down to the required mode and press Enter to lock in the selected mode.

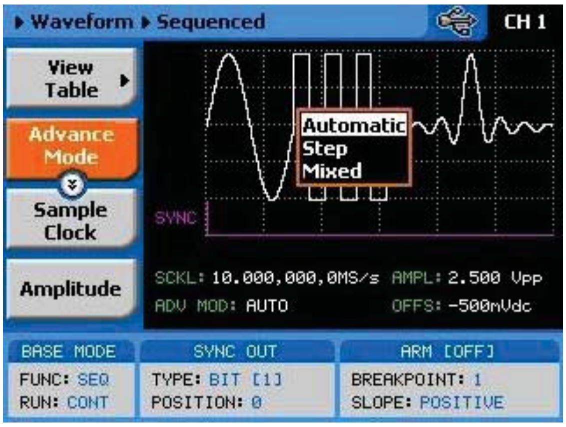


*Figure 3-20, Sequence Advance Options*

**Note**

- The operating mode of the instrument, as selected from the Run Modes menu, affects the way that the 2074 lets you access the sequence advance mode parameter. If you are in continuous mode, as shown in Figure 3-20, you can select one of: AUTO, STEP, or MIXED. If you already selected the triggered run mode, you'll be able to select from AUTO, or SINGLE only as advance modes.

## 3.32 Generating Modulated Waveforms

I & Q modulation is one of the fastest growing requirements for digital waveform generation applications. The 2074 can generate phase modulation and QAM modulation on all four channels where each pair generates a separate modulation scheme. Having two pairs of modulation channels is specifically helpful for speeding up tests on parts in production.

Modulated waveforms are selected from the waveforms menu. Figure 3-21 shows how to select the modulation type. To access this menu, press TOP, then waveforms and select the Modulated waveforms option.

Modulation type is selected from the Modulation Type menu. Refer to Figure 3-21 and use the following procedure to select the modulation type.

1. Press on the Modulation Type soft key. The following options will display: Off, (n)PSK and (n)QAM
2. Using the dial or the up and down arrow keypad, scroll down to the desired option
3. Press Enter to lock in the selected modulation type. The output will be updated immediately after you press the Enter button.

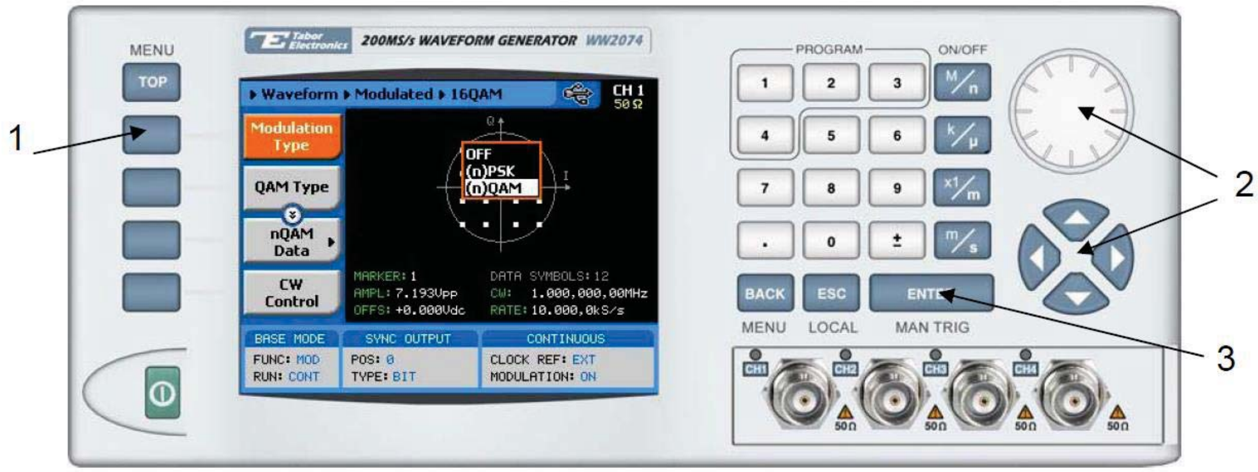


*Figure 3-21, Selecting a modulated Waveform*

## 3.32.1 Off

The Modulation Off is a special case of the modulation function where the output is not modulated but generates carrier waveform (CW) frequency only. CW is the sine waveform that is being modulated. When placed in Modulation Off, the sine waveform is generated from the main outputs continuously. Figure 3-22 shows the Modulation Off menus.

While in the Off option, there are some parameters that can be programmed for the carrier waveform:

**CW Frequency** – defines the frequency of the carrier waveform. Using this standard AM function, the shape of the carrier waveform is always sine. The CW parameter, as programmed in this menu is shared by all other modulation options.

**Amplitude** – defines the carrier amplitude level. The same level is used throughout the instrument when you move from waveform shape to another. The Amplitude parameter, as programmed in this menu is shared by all other waveform options.

**Offset** – defines the offset level for the carrier waveforms. The same level is used throughout the instrument when you move from waveform shape to another. The Offset parameter, as programmed in this menu is shared by all other waveform options.

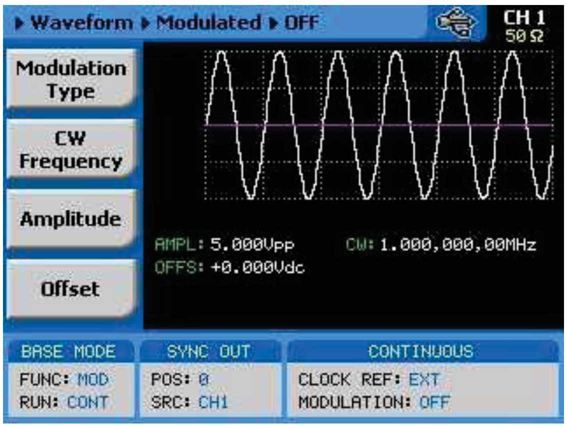


*Figure 3-22, Modulation OFF Parameters*

### 3.32.1.1 (n)PSK

There are 6 different types of phase shift keying that the 2074 can generate: BPSK, QPSK, OQPSK, pi/4DQPSK, 8PSK and 16PSK. If another constellation scheme is required, one can use the User PSK to design his/her own symbol list and constellation. An example of a QPSK display is shown in Figure 3-23.

There are other parameters that control the (n)PSK function, these are:

**PSK Type** – selects from one of BPSK, QPSK, OQPSK, pi/4DQPSK, 8PSK and 16PSK. Once a type is selected the associated parameters are automatically available on the display for adjustments.

**PSK Data** – provides access to the PSK data symbols. By default the table is empty so the symbols must be loaded into the table before the (n)PSK function can be used. For testing and/or demonstration purpose, a default table is available to download from the front panel however, this table must be converted for different applications. An example of the QPSK data entry table is given in figure 3-24.

**CW Control** – can turn the carrier waveform on and off. Use the carrier off position when directly driving vector generators.

**CW Frequency** – defines the frequency of the carrier waveform. Using this PSK function, the shape of the carrier waveform is always sine. CW frequency is programmable from 10 Hz to 50 MHz.

**Symbol rate** – programs the rate of which symbols step through. The rates can be programmed from 1 symbol/s to 1e6 symbols/s.

**Marker** – defines an index point where the SYNC output generates a synchronization pulse. The marker can be programmed within the range of the symbol list.

**Amplitude** – defines the carrier amplitude level. The same level is used throughout the instrument when you move from waveform shape to another.

**Offset** – defines the offset level for the carrier waveforms.  The same level is used throughout the instrument when you move from waveform shape to another.

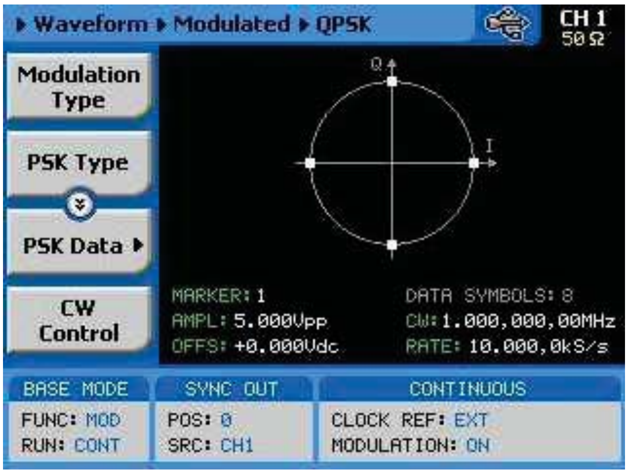


*Figure 3-23, QPSK Modulation Display Example*

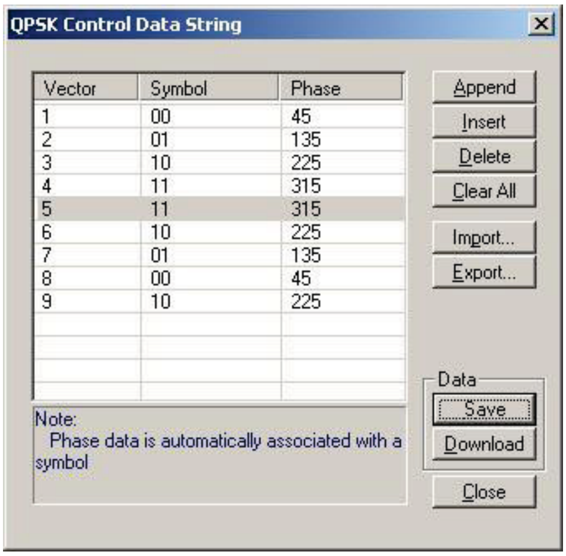


*Figure 3-24, QPSK Data Entry Table Example*

## 3.32.1.2 User PSK

The User PSK function is similar to the (n)PSK function except the symbols and their associated vector positions can be freely designed at locations that are non-standard. The user PSK display is shown in figure 3-25. The symbols can be designed on the 2074 display, or on the User PSK Control Data String dialog box as shown in figure 3-26.

After you design the symbols and generate the control data string, the definition and the modification of the other parameters are done exactly as you would do for the other PSK functions.

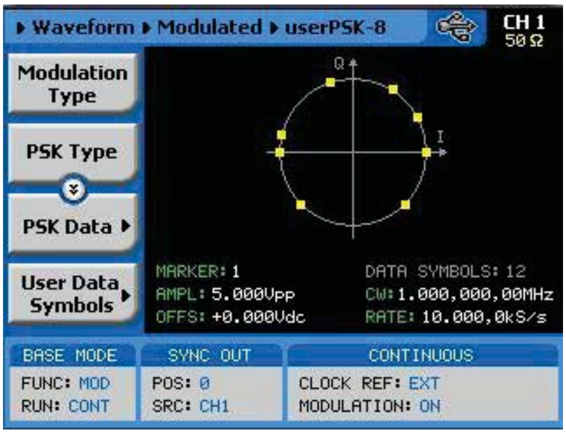


*Figure 3-25, User PSK Display*

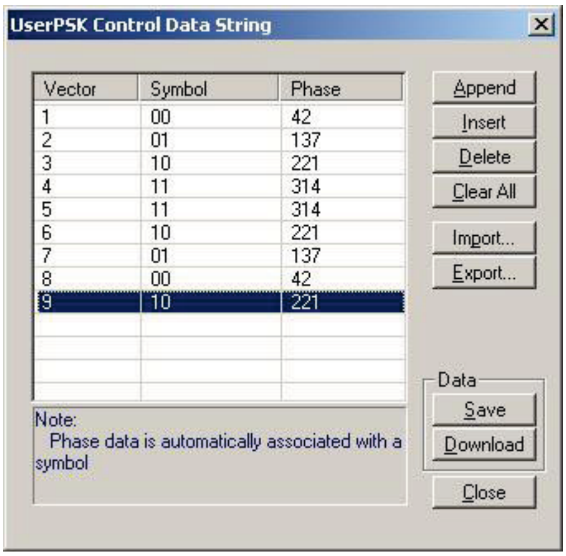


*Figure 3-26, User PSK Data Entry Table Example*

### 3.32.1.3 (n)QAM

There are 4 different types of Quadrature Amplitude Modulation that the 2074 can generate: 16QAM, 64QAM and 256QAM. If another constellation scheme is required, one can use the User QAM to design his/her own symbol list and constellation. An example of a 64QAM display is shown in Figure 3-27.

There are other parameters that control the (n)QAM function, these are:

**QAM Type** – selects from one of 16QAM, 64QAM, 256QAM and User QAM. Once a type is selected the associated parameters are automatically available on the display for adjustments.

**QAM Data** – provides access to the QAM data symbols. By default the table is empty so the symbols must be loaded into the table before the (n)QAM function can be used. For testing and/or demonstration purpose, a default table is available to download from the front panel however, this table must be converted for different applications. An example of the 64QAM data entry table is shown in figure 3-28.

**CW Control** – can turn the carrier waveform on and off. Use the carrier off position when directly driving vector generators.

**CW Frequency** – defines the frequency of the carrier waveform. Using this QAM function, the shape of the carrier waveform is always sine. CW frequency is programmable from 10 Hz to 50 MHz.

**Symbol rate** – programs the rate of which symbols step through. The rates can be programmed from 1 symbol/s to 1e6 symbols/s.

**Marker** – defines an index point where the SYNC output generates a synchronization pulse. The marker can be programmed within the range of the symbol list.

**Amplitude** – defines the carrier amplitude level. The same level is used throughout the instrument when you move from waveform shape to another.

**Offset** – defines the offset level for the carrier waveforms.  The same level is used throughout the instrument when you move from waveform shape to another.

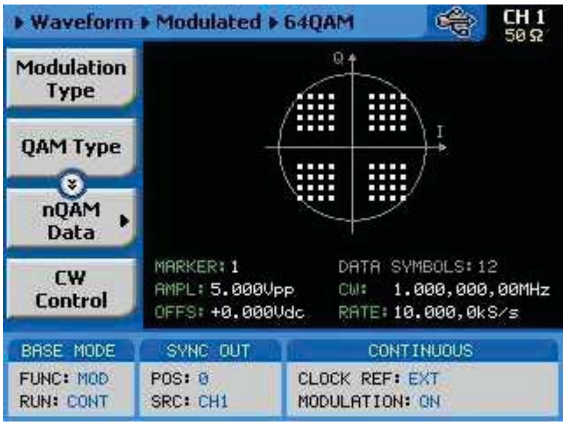


*Figure 3-27, 64QAM Display Example*

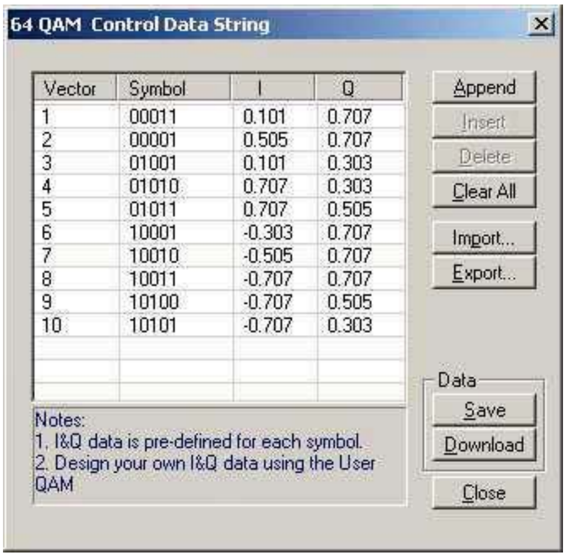


*Figure 3-28, 64QAM Data Entry Table Example*

### 3.32.1.4 User QAM

The User QAM function is similar to the (n)QAM function except the symbols and their associated vector positions can be freely designed at locations that are non-standard. The user QAM display is shown in figure 3-29. The symbols can be designed on the 2074 display, or on the User QAM Control Data String dialog box as shown in figure 3-30.

After you design the symbols and generate the control data string, the definition and the modification of the other parameters are done exactly as you would do for the other QAM functions.

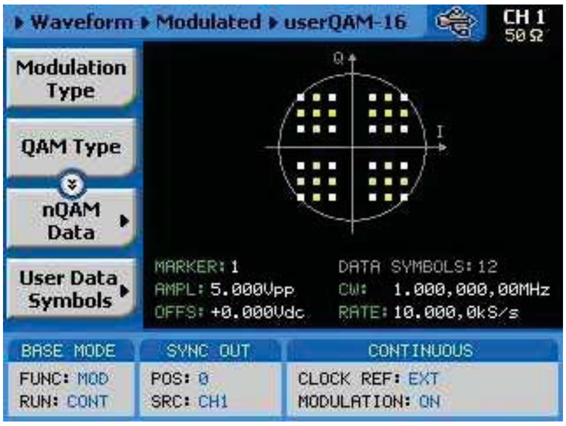


*Figure 3-29, User Display*

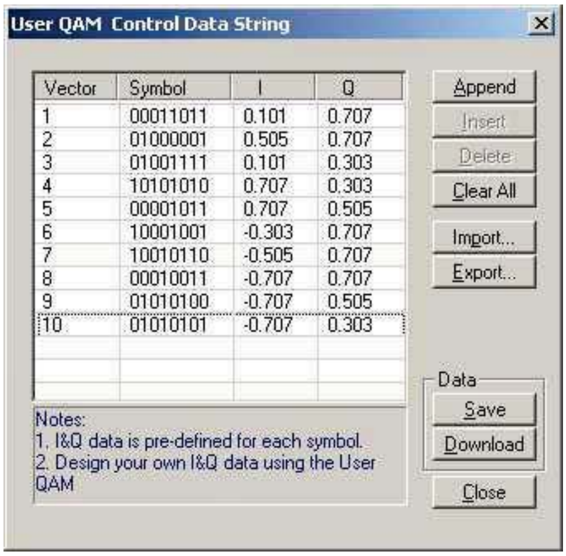


*Figure 3-30, User QAM Data Entry Table Example*

## 3.33 Using the Auxiliary Functions

The 2074, besides its standard waveform generation functions, has two additional auxiliary functions that can transform the instrument to one of two, stand-alone, full-featured, instruments: Digital Pulse Generator and Counter/Timer. In addition, the 2074 can generate half cycle waveforms with programmable delays between the halves and the rear panel multi-instrument synchronization connector can transform multiple the 2074 units to multi-channel system with full synchronization, jitter and phase control between channels. Detailed operating instructions for the auxiliary functions are given in the following paragraphs.

### 3.33.1 Using the Digital Pulse Generator

The digital pulse generator function provides means of designing pulses and their associated parameters in units of time, exactly as would be done on a stand-alone, bench-type, analog pulse generator. Note however, that the pulse is built in the same memory as the arbitrary waveforms are being stored and therefore, changing from arbitrary to digital pulse modes and reverse, may overwrite waveforms that were downloaded to the memory. Use the instructions below to access and program the pulse menus.

1. Press TOP to display the root menu.
2. Press the arrow down key once and observe that the Auxiliary Functions menu appears.
3. Press Auxiliary Functions soft key and notice that the Pulse Generator option is highlighted, as shown in Figure 3-31.
4. Press the Enter button to select the digital pulse generator function Figure 3-32 shows the Pulse Generator panel and menus.

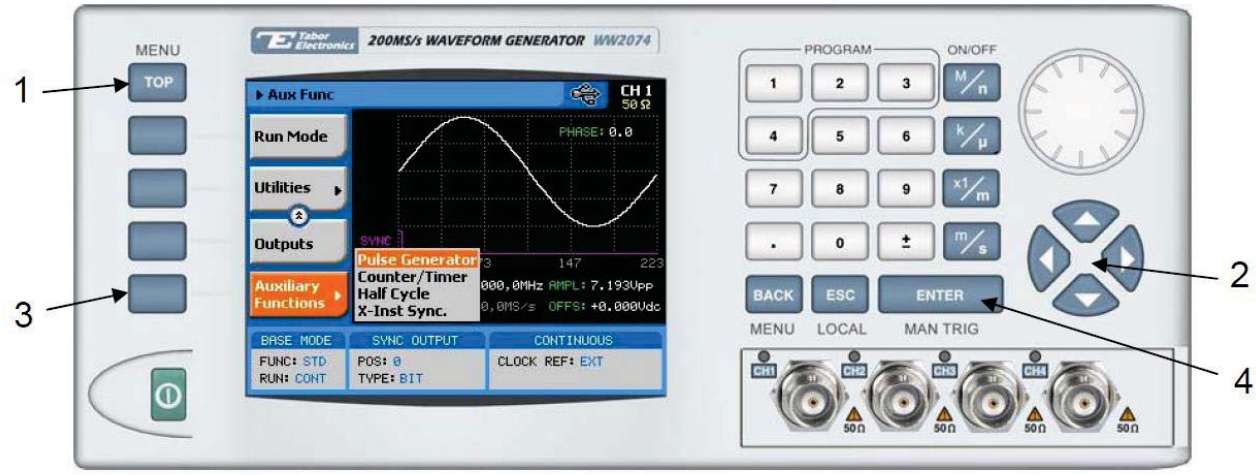


*Figure 3-31, Accessing the Pulse Generator Menus*

**Note**

- The pulse shape on the 2074 LCD display is an icon only. The actual output waveform may look entirely different.

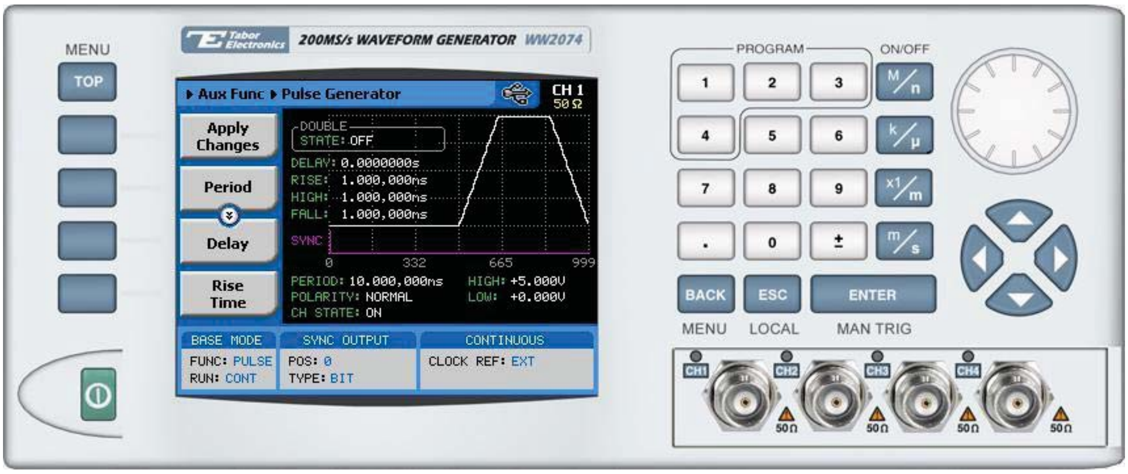


*Figure 3-32, the Digital Pulse Generator Menus*

The digital pulse generator menus provide access to all pulse parameters just as they would be programmed on an analog pulse generator.

To access the pulse parameters, use one of the soft keys. If you do not see a required parameter on the screen, press the key up or down to scroll through the menus.

The technique of changing parameter values is exactly the same as you are using to modify standard waveform parameters. Simply press the soft key that is associated with the parameter, then punch in the numbers using the numeric keyboard and complete the modification by assigning a suffix and pressing the Enter button. Figure 3-33 shows the screen after the Period soft key has been depressed.


*Figure 3-33, Programming the Pulse Period Parameter*

The final step before the modified pulse shape will be available at the output connector is pressing the Apply Changes soft key.

**NOTE**

- No change will be made on the pulse shape and at the output connector before the Apply Changes button has been pressed, except when the High and Low Level buttons are exercised. This was done to let the internal computing circuit do the calculation of the pulse parameters only once every time one or more parameters have been modified.

Adjusting the pulse shape with the required characteristics can only be done if all of its parameters can be adjusted both in the time and amplitude domain. The Model 2074 provides all the necessary controls to do just that. However, always bear in mind that the pulse is being generated digitally and therefore there are some limitations that would have to be observed. These limitations will be discussed later in this chapter. Below you will find a list of all pulse parameters that you'll be able to access though the soft key menus.

#### 3.33.1.1 Pulse Generator Menus

***Apply Changes***
This, by far, is the most important key to understanding the pulse generation process. The 2074 is actually an arbitrary waveform generator, not a pulse generator however, with some firmware changes, the same memory that is being used by the arbitrary waveform function can be converted to design pulse shapes. In this case, every change of pulse period, parameter or transition, requires re-computation of the pulse shape and download sequence to the arbitrary waveform memory. The process is critical to assure that the pulse design was done within the legal boundaries and generation capabilities of the model 2074. To avoid multiple design conflicts and tedious exploration of why a pulse cannot be designed with this or that parameter, the Apply Changes button makes the choice only once at the end of the pulse design. Therefore, always make sure that after you complete the design of your pulse, press the Apply Changes soft key button to end the design process and to route the new pulse design to the output terminal.

***Period***
The period defines the repetition rate of the pulse. The period is programmable from 80 ns.

***Delay***
The delay defines the time the pulse is delayed from its start to the first transition. The delay times is computed as part of the pulse period and therefore, if you do not plan to have a delayed pulse, change its value to 0 s.

***Rise Time***
The rise time defines the time it takes for the pulse to transition from its low level to its high level settings. Do not confuse this parameter with the industry-standard interpretations of rise time such 10% to 90% of amplitude. The rise times is computed as part of the pulse period and therefore, if you do not plan to have linear transitions, change its value to 0 s.

***High Time***
The high time defines the time idles on its high level setting. Do not confuse this parameter with the industry-standard interpretations of pulse width that is normally measured at 50% of amplitude level.

***Fall Time***
The fall time defines the time it takes for the pulse to transition from its high level to its low level settings. Do not confuse this parameter with the industry-standard interpretations of fall time such 90% to 10% of amplitude. The fall times is computed as part of the pulse period and therefore, if you do not plan to have linear transitions, change its value to 0 s.

***High Level***

The high level parameter defines the top amplitude level of the pulse. Any value is acceptable as long as it is larger than the low level setting and does not exceed +10 V and does not fall short of the 50 mV minimum high to low level setting.

***Low Level***
The low level parameter defines the lower amplitude level of the pulse. Any value is acceptable as long as it is smaller than the high level setting and does not exceed -10 V and does not fall short of the 50 mV minimum high to low level setting.

***Polarity***
The polarity parameter provides access to selecting the polarity of the pulse. Three options are available: Normal, Inverted and Complemented. These options are defined below.

Normal – The pulse is generated with the parameters as programmed for the pulse

Inverted – The pulse is inverted about the 0V base line setting

Complemented – The pulse is inverted about its mid-amplitude base line setting

Note that except for Normal output, inverted and complemented replace high and low levels and rise and fall times.

***Double State***
The Double State toggles between single and double pulse modes. When double pulse state is turned on, the screen is replaced by an icon that shows that the double pulse mode is on, as shown in Figure 3-34. In this case, the Double Delay button is made available enabling access to the double pulse delay parameter.

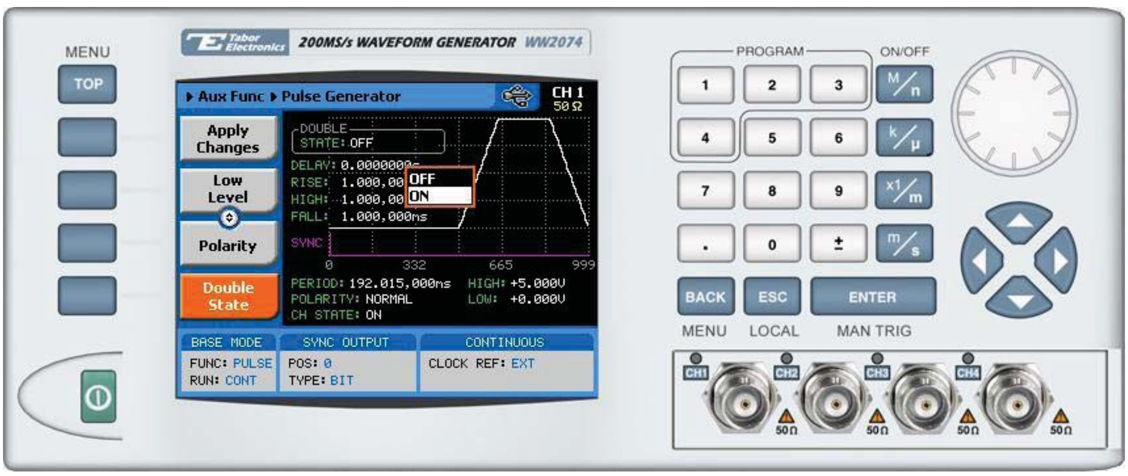


*Figure 3-34, Double Pulse Mode*

***Double Delay***
The Double Delay parameter programs the delay between the two adjacent pulses. This parameter is active only when the double pulse mode is turned on.

***Sync Position***
The Sync Position parameter programs the position of the sync output along the pulse cycle. The position is the only parameter that is programmed in units of waveform points. The location of the sync is visible on the screen below the pulse icon and the number of points that are used for building the pulse shape is shown below the horizontal axis.

***Channel State***
The channel state comes in handy when programming pulse parameters for one channel only. This option is specifically useful because you may want to program one channel while the other channel was already programmed before and its parameters may collide with the new parameters that you are programming on another channel. When you select the Channel State OFF option, you may freely program all parameters on the other channel and the OFF channel will not be computed but will generate a dc level at its output terminal.

## 3.34 Pulse Design Limitations

Keeping in mind that the pulse is created digitally, using memory points, one should understand there are limitations of creating such pulses that evolve from this system. These limitations are summarized below.

1. *Step increment defines resolution and period*

The pulse is being created digitally using a sample clock generator that clocks memory points. The rate of the sample clock defines the incremental resolution. Consider that you want to generate 100 ms pulse rates with 1 ms high time pulse and the rest of the period low. In this case, the generator can select the 1 kS/s to 10 kS/s clock rate because this is enough for generating a high signal of 1 ms using just 100 to 1000 memory points. However, when you want to define much smaller pulse widths at larger rep rates, the number of points that are used for the generation increases as a function of the period. The limitation is set by the number of memory points; with the basic model 2074, the incremental resolution is 1 in 1 million. This increases to 1 in 2 million if you purchased the Model 2074 with option 1 (2 M memory expansion) installed.

2. *Sum of pulse parameters cannot exceed the period*

While designing a pulse shape, bear in mind that the generator will detect automatically if you are trying to mess with the mathematics. Therefore, remember, the sum of all parameters cannot exceed the period. Always start your pulse design by assigning the correct pulse period and only then work your way down the parameters list.

3. *Only single and double pulse can be designed*

Just as a stand-alone pulse generator, the capability that is built into the digital pulse generator allows generation of these two waveforms. This allows generation of single or double pulse patterns having a fixed high and low amplitude values. In case you need to design complex trains of pulse waveforms, you can always do it using the Pulse Composer in ArbConnection. The pulse composer allows creation of complex pulse trains without limiting amplitude, shape and number of pulses in one pulse train.

4. *Inter-channel parameter dependency*

As explained in 1 above, the pulse is created digitally using a sample clock generator that clocks memory points. The 2074 has only one sample clock generator and therefore, most of the pulse parameters that are associated with time interval are shared across the channels. When designing a pulse on one channel, bear in mind that some parameters will be exactly the same on the other channel. These are: Period, rise, high and fall times, double state and double state delay. The rest of the parameters are not inter-channel dependent and can be designed within the limitation of the pulse generator, as specified in Appendix A.

### 3.34.1 Using the Counter/Timer

The counter/timer auxiliary function transforms the 2074 into a counter/timer instrument with the capability to measure parameters exactly as they would be measured by a stand-alone counter/timer instrument. When using this function one could select the measurement function, gate time trigger level and hold the measurement till condition requires a reading. The readings are taken and displayed on the LCD display, or passed on the remote interface to the host computer for further processing. 2074 front panel example for the counter/timer is shown in figures 3-35.

Because the 2074 cannot measure and generate waveforms at the same time, when placed in the counter/timer mode, all waveform generation are purged and the 2074 can be used for measurements only.

### 3.34.2 Accessing the Counter/Timer Menus

The digital counter/timer function provides means of measuring timing characteristics of external signals, exactly as would be done on a stand-alone, bench-type, counter/timer. Use the instructions below to access and select the counter/timer mode and any of its measurement functions.

1. Press TOP to display the root menu.
2. Press the arrow down key once and observe that the Auxiliary Functions menu appears.
3. Press Auxiliary Functions soft key and notice that the Counter/Timer option is highlighted, as shown in Figure 3-35.
4. Press the Enter button to select the counter/timer function Figure 3-36 shows the counter/timer panel and menus.

**NOTE**

- After you select the counter/timer function, the front-panel Counter On LED illuminates, designating the counter/timer function is enabled and all other 2074 waveform generation functions are disabled.

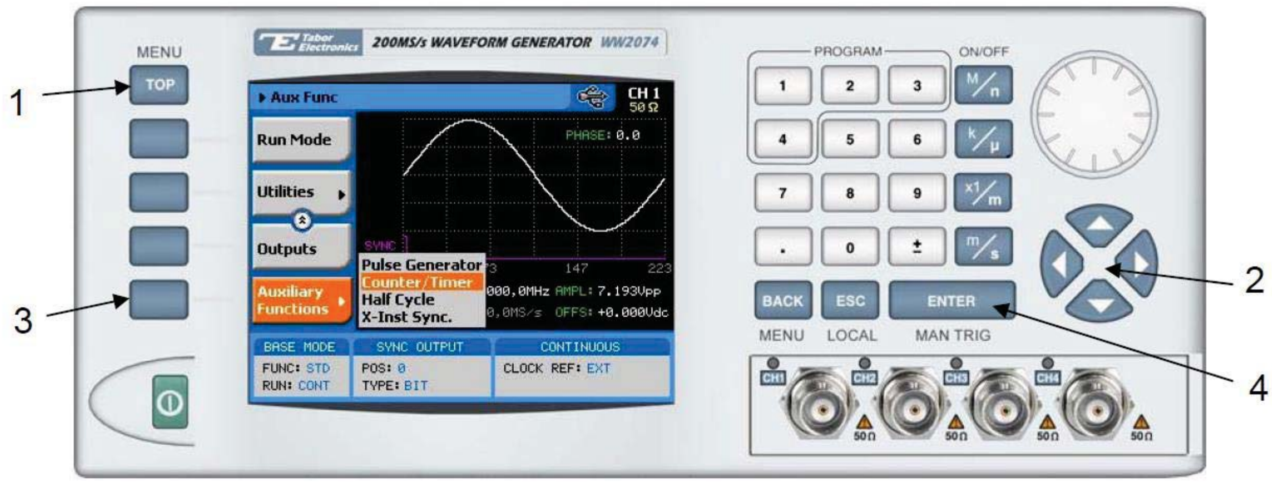


*Figure 3-35, Accessing the Counter/Timer Menus*

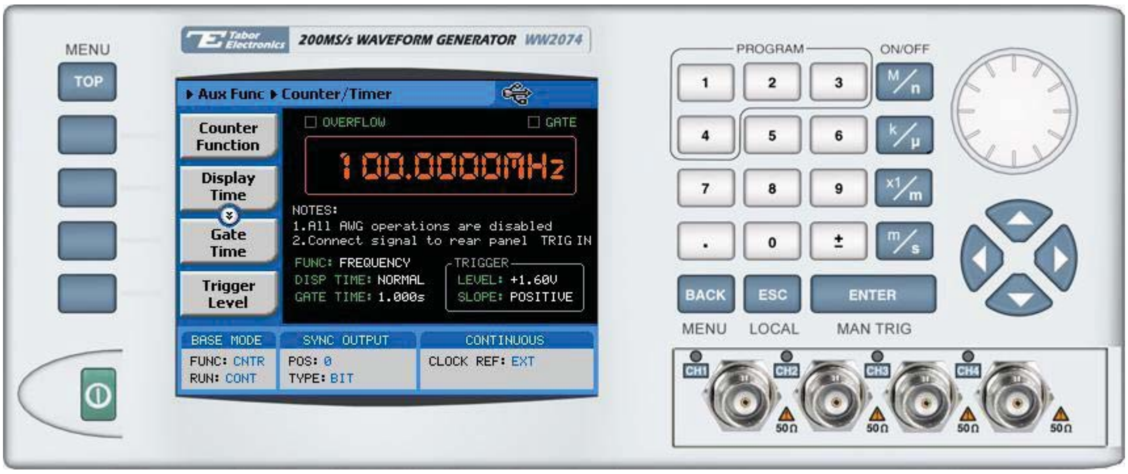


*Figure 3-36, the Digital Counter/Timer Menus*

## 3.34.3 Selecting a Counter/Timer Function

The digital counter/timer can measure one of the following functions: Frequency, Period, Period Averaged, Pulse Width and Totalize, either within a specified gate time or infinitely. Observe Figure 3-37 and use the instructions below to access and select one of the counter/timer measurement functions.

1. Press the Counter Function soft key button to display the measurements list.

2. Use the dial or the up and down keys to scroll through the list. Select the required function.

3. Press Enter to execute the selected function.

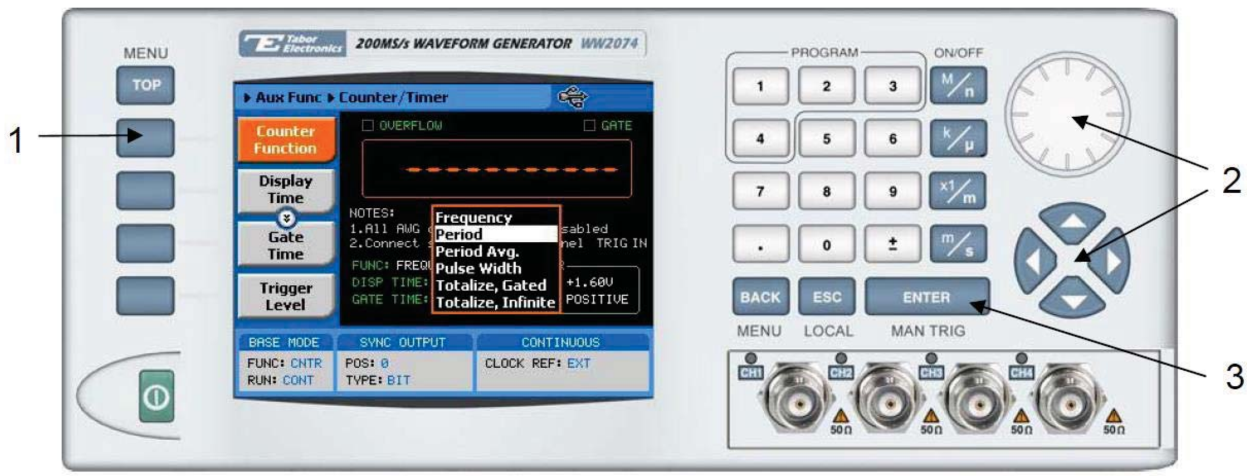


*Figure 3-37, Selecting a Counter/Timer Measurement Function*

### 3.34.3.1 Counter/Timer Menus

There are various counter/timer settings that define how the instrument will perform the measurement. For example, the period of the gate time must always be larger than the period of the measured signal. The counter/timer menus are described below.

***Display Time***
There are two display times available with the 2074: Normal and Hold.

*Normal* – defines continuous measurement taken at an interval equal to about gate time period plus 300 ms. This mode of operation assures that reading are taken and displayed long enough for the eye to see the result.

*Hold* – defines single reading taken and held on the display until cleared and armed for the next measurement. This mode is especially useful for systems applications where reading must be prepared only once and taken at a specific time.

***Gate Time***
The gate time defines how long the gate will open and allow signal to enter the measurement bin. The gate time value is important because it must be larger than the period of the signal. It also, indirectly, controls the number of digits that can be displayed. At a gate time of 1 second, the counter can display eight digits. As the gate time is reduced, the number of displayable digits is reduced proportionally. Also note that the gate opens only after a valid signal is available at the counter input (TRIG IN connector) and therefore, make sure you arm the counter for measurement only when you expect the signal to appear at the input otherwise, you may lock out the remote interface until a signal triggers the input and the measurement has been completed.

***Trigger Level***
The trigger level parameter defines the vertical cross point where the signal will trigger a measurement. Trigger level range is from -5 V to +5 V and the default threshold level is set to 1.6 V, which is very convenient for TTL level signals. To change the default level, select the Trigger Level menu and modify the level using direct keyboard entry. Press Enter to lock in the new value.

***Trigger Slope***
The Trigger Slope defines on which transition the counter input will trigger. There are two options: Positive and Negative. The default option is positive, which means that the counter will trigger on positive transitions at the counter input. The trigger slope parameter is also used for defining the measured portion of a pulse. When in pulse width measurements, the counter will measure the width when transitioning from low level to high level and when the negative slope is selected, the counter will measure the high to low level transitions.

***Reset/Arm***

The Rest/Arm button has two functions: Reset removes the last reading from the display and zeroes the reading. At the same time, the counter is armed for the next measurement. Use this button to clear the display reading when the display time is set to hold.

### 3.34.3.2 Counter/Timer Limitations

Keeping in mind that the counter/timer is a by-product of the AWG, one should understand there are limitations to what this product can do. Summary of the counter/timer limitations is given below.

1. *Measurement speed*

What is expected from a full-featured counter/timer is measurement speed. The rate of which the counter performs its measurements depends on the display mode setting. The Normal setting is normally used for bench reading, where the user expects to see the result after each measurement. The display time is roughly 300 ms allowing enough time to see the result after each gate time cycle. In this case, the maximum rate is 3 measurements in one second when using low period gate times. The Hold display mode allows one reading at a time. The reading starts when the input senses a valid trigger signal and ends after the gate has closed. Processing time for the reading and the display is roughly 100 ms and therefore, in this mode, the counter can take 10 readings maximum in one second. Regardless of the display mode, the readings are also available for collection from a remote interface.

2. *Gate time period must be higher than the signal period*

In Fact, this limitation is true for every counter. The gate must open for an interval that allows enough transitions to pass through the counter gate. If the gate time is too short to measure a signal, the gate will open but no results can be obtained and displayed.

3. *Auxiliary functions disables waveform generation*

When the auxiliary counter/timer function is selected, all operations of the waveform generator are purged. Do not expect from the 2074 to make counter measurements and at the same time have signals at output connectors.

## 3.35 Using the Half Cycle Waveforms

Half Cycles is a special case of the standard waveforms except the waveforms are generated half cycle at a time, displaced by a delay time that is user programmable. In continuous mode, the half cycles are generated continuously. In triggered mode, each half cycle is generated only after a valid trigger signal is sensed at the trigger input connector. The half cycle waveforms can also be triggered from remote.

### 3.35.1 Accessing the half Cycle Menus

1. There are three half cycle waveforms that can be generated: Sine, Triangle and Square. Use the instructions below to access and select the digital patter mode and its associated data source.

2. Press TOP to display the root menu.

3. Press the arrow down key once and observe that the Auxiliary Functions menu appears.

4. Press the Auxiliary Functions soft key and scroll down to highlight the Half Cycle option, as shown in Figure 3-38.

5. Press the Enter button to select the half cycle function Figure 3-39 shows the half cycle panel and menus.

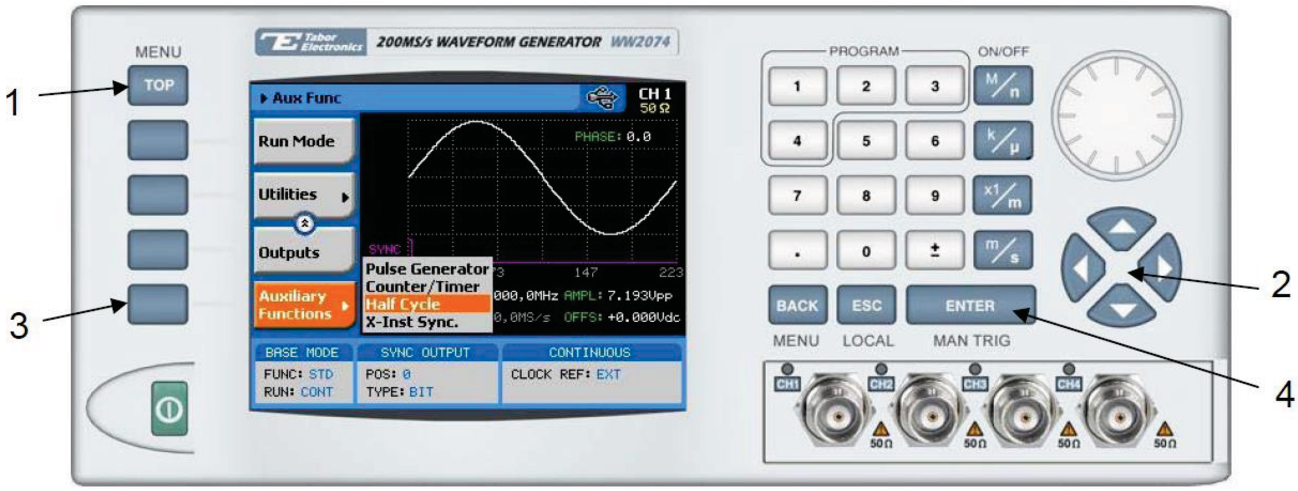


*Figure 3-38, Accessing the Digital Pattern Menus*

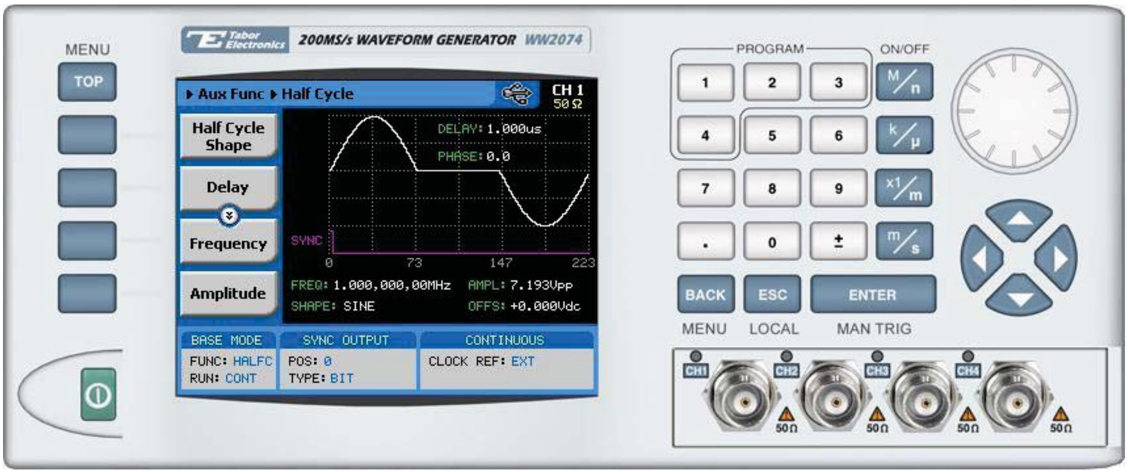


*Figure 3-39, the Digital Pattern Menus*

## 3.35.1.1 Half Cycle Menus

There are various settings that define how the instrument will generate half cycles. For example, spacing between the halves can be programmed to any length between 200 ns to 20 s. The half cycle menus are described below.

***Half Cycle Shape*** – defines the shape of the half cycle waveform. There are three types of waveforms that can be halved: sine triangle and square.

***Delay*** – defines the delay between the halves. The delay can be programmed from 200 ns to 20 s with increments of 20 ns.

***Frequency*** – defines the frequency of the half cycle waveforms as if they were combined to a single cycle waveform. Actually, if you want to calculate the period of the half cycle use the following relationship:

Half Cycle Period = 2 / frequency

***Amplitude*** – defines the amplitude level of the half cycle waveform. The same level is used throughout the instrument when you move from waveform shape to another.

***Offset*** – defines the offset level of the half cycle waveform. The same level is used throughout the instrument when you move from waveform shape to another.

***Phase*** – defines the start phase of the half cycle waveform. The first cycle starts with this phase offset setting and the second half starts 180° later.

### 3.35.2 Synchronizing Multiple Instruments

The 2074 waveform generator has two output channels. These outputs are just about everything you'll ever need for generating your signals however, some applications require multiple of synchronized channels, which can only be available if you purchase a much more expensive waveform generator or, by combining two separate instruments into one.

As you probably know, having two separate instruments will not do the job because each has its own clock source. Also, driving one generator from the clock of the other will not work because of the nature of memory-driven digital waveform generators that must have definite and clear signals when to start clocking the samples of the waveform.

The two instrument synchronization technique that is utilized by the 2074 provides complete control over waveform run mode, start point, phase offset between adjacent units while maintaining jitter-free and skew-free synchronized outputs. Before or after multiple instruments are synchronized, each instrument can be programmed to have different waveform shape and amplitude however, in this mode, both units share the same run mode, i.e., continuous, triggered, etc.

To achieve synchronization, you must have special inter-connection cables and, in addition, LAN cables that either connect to a LAN network or, in case you do not use a network, two adjacent instruments can be connected together by a cross-wired LAN cable, with no connection to a LAN network. In any case, before you commence with your connections, make sure you get the synchronization cables from your Tabor dealer and get yourself familiar with the information below.

The interconnection cables are proprietary and must be bought from Tabor Electronics Ltd. In case you require such cables, contact your nearest dealer or the Tabor customer service department for price and delivery information. The purpose of these cables is to link the necessary signals from instrument to instrument. These signals will assure that the clock is the same, the reference is the same and that both units share start and stop signals for careful and complete control over waveform start phase.

Hardware synchronization is only part of the deal. The two 2074's must be set up so that one becomes master and the other(s) slave. Information how to connect the two instruments with the synchronization cable, how to select the master unit and how to proceed with synchronized operation is given in the following paragraphs.

### 3.35.2.1 Connecting the instruments

There is a difference if you wish to synchronize two or more instruments because, for two instruments you do not need to have a LAN network however, if you need more than 4 channels, the only way to do it is by connecting each instrument, separately, to the LAN network. For two instruments only, you can either connect to the LAN network or connect between the two instrument using a cross-wired LAN cable. In addition to the LAN cable(s) you need to connect the sample clock and the trigger signals between instruments. If you look at figure 3-40 below, you'll notice the X-INST SYNC group of connectors. These are SMB type connectors. They are connected as follows: The SCLK OUT and the COUPLE OUT connectors on the master module are connected to the SCLK IN and the COUPLE IN on adjacent slave unit. Additional units are connected in a daisy chain manner.

As a general note, if you do not intend to use the 1281A's in Master/Slave mode, it is highly recommended to remove the cable from one of the instrument because signals that are routed from one instrument to the other may interfere during normal operation.

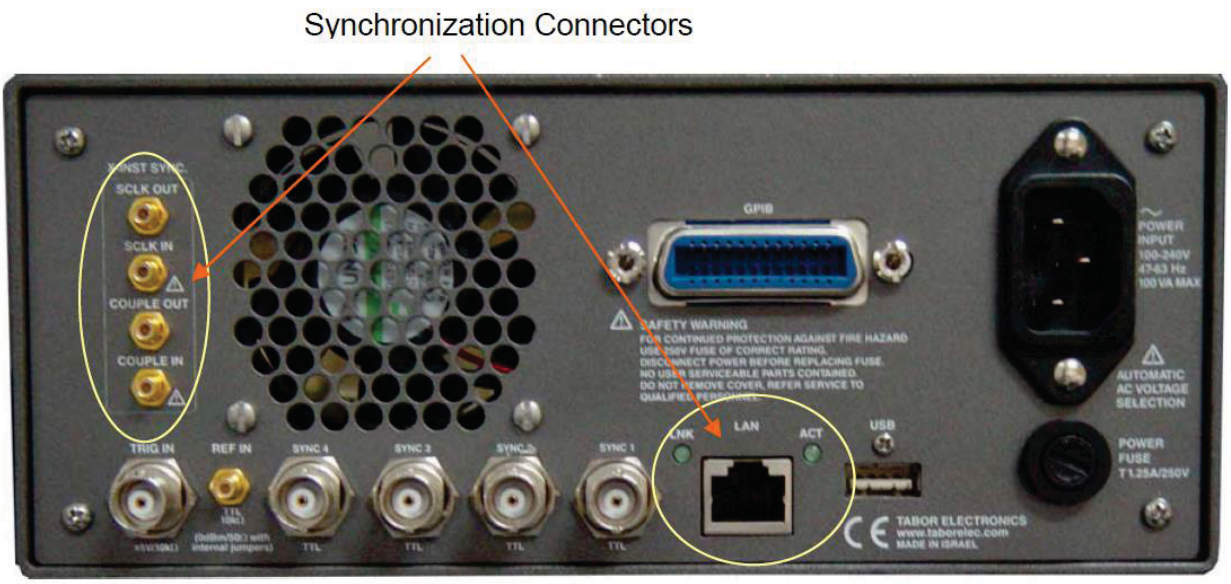


*Figure 3-40, Connecting the 2074 Synchronization Cables*

### 3.35.2.2 Selecting a Master

Connecting the cables between the instruments is just the first step. The next is to select one instrument as master and the others as slave. Use the following procedure:

1. On the master unit, press the TOP Menu button to select the root menus
2. Press the down key button
3. Press the Auxiliary Functions soft key button
4. Use the dial or the up/down keys to scroll down to the X-Inst Sync option, as shown in figure 3-65
5. Press Enter. The display will change to show the multi-instruments synchronization menus
6. Press the Properties soft key button and select the role of the instrument as mater, as shown in figure 3-66. You may select from this menu if the instrument will be master or slave. If you select as slave, you will be able to program the start phase offset for the slave instrument as well.

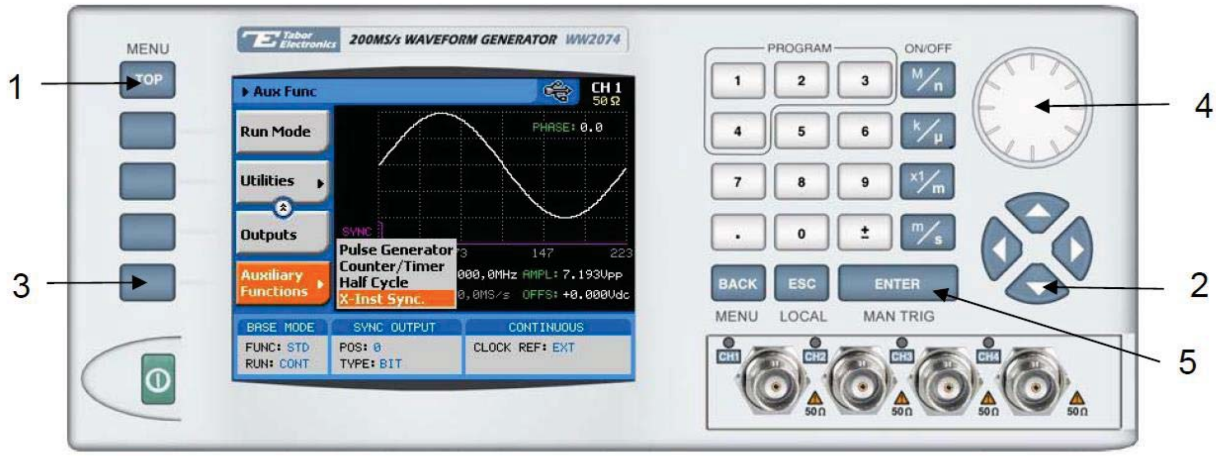


*Figure 3-41, Selecting the Multi-Instruments Synchronization Menus*

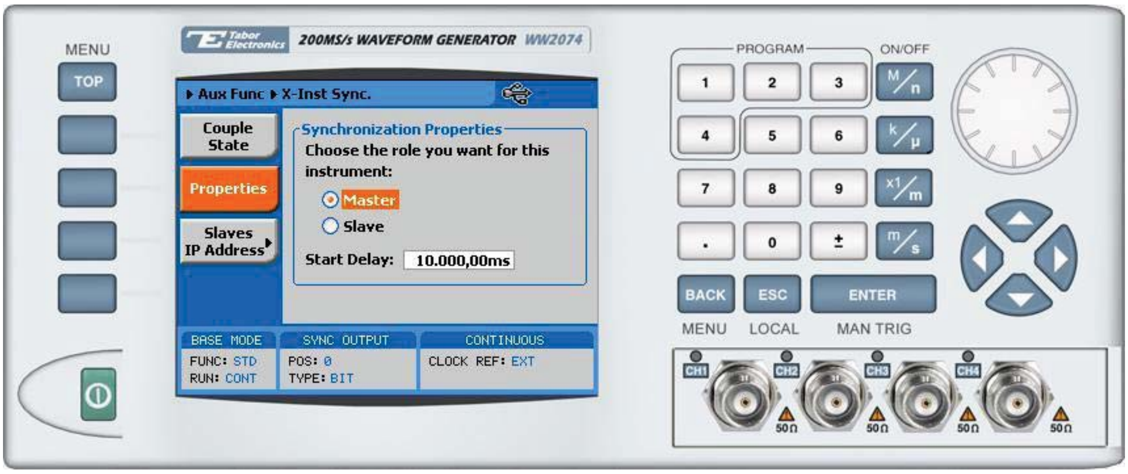


*Figure 3-42, Selecting the Couple State*

The next step is to tell the master instrument that will become slave instrument. Remember that the 2074 can synchronize more than two instruments and that each one must be connected to a LAN network for communications and synchronization signals and therefore, all instruments must be set up to operate from a LAN interface and each instrument must have a unique LAN address for identification.

Slave units are identified by their LAN address. Press the Slaves IP Address soft key button to access the identification menu as shown in Figure 3-43.

There are two additional soft key commands added as you enter the Slaves IP Address menu: Insert Slave and Delete Slave. Use these buttons to add or remove salve identifications from your synchronization list. Every IP address that will be added to this table will automatically become part of the synchronization scheme.

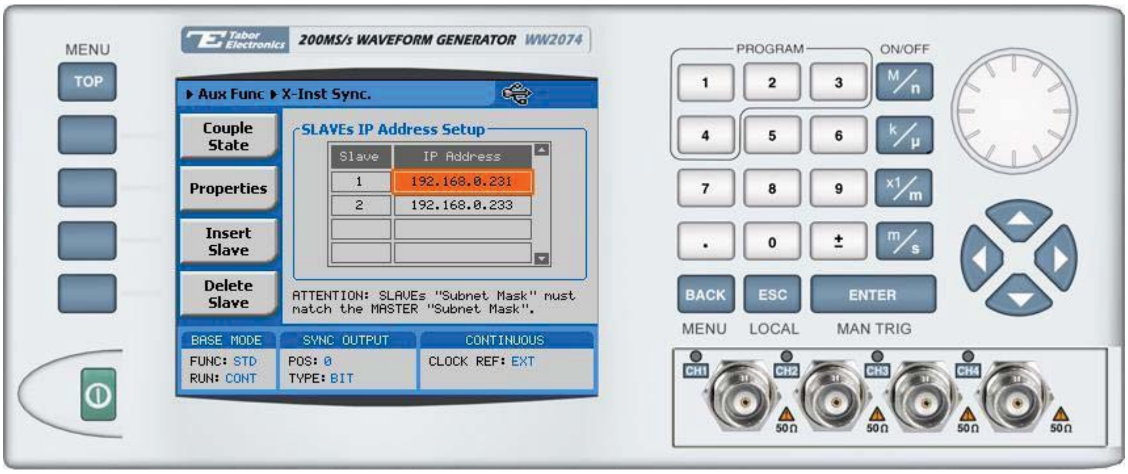


*Figure 3-43, Programming Slaves IP Address*

The final step to synchronize all instruments is the Couple State button as shown in figure 3-44. Select the Active state and press Enter to synchronize the instruments.


*Figure 3-44, Activating the Synchronization Process*

### 3.35.2.3 Operating Synchronized Instruments

Operating synchronized instruments is best achieved if some ground-rules are learned and adhered to.

1. Connecting the synchronization cables is pre-requisite however, additional steps must be performed to set one unit in master mode the others as slave.

2. Make sure you activate the synchronization sequence from the Master unit only

3. Sample clock and output frequency can only be controlled from the master unit

4. Both master and slave units must be placed in the same run mode to operate synchronously. For example, units in burst mode will synchronize however, one set to continuous and the another to burst will not synchronize

5. Both master and slave units must be placed in the same waveform mode to operate synchronously. For example, both units in sequence mode will synchronize however, one set to Arbitrary and the other to sequence will not synchronize

6. Two instrument synchronization does not operate in modulated waveform mode

7. Trigger signal is applied to the master input and is common to both master and slave units

8. Each instrument can have a unique set of waveforms, active segment, sequence, amplitude and offset parameters

9. Slave channels can be delayed in reference to the master channels by a pre-defined number of sample clocks. Observe Figure 3-42 and access the Start Phase field in the Synchronization Properties group. The start phase defines the delay time that the instrument will hold off before it will start generating the output waveform. Setting resolution is 20 ns and the delay can be programmed from 200 ns to 20 s.

10. There is always some skew between adjacent instruments, which is due to circuit delays and cable length. Always consider the initial skew in your inter-instrument delay calculations. The initial waveform skew on the slave unit is roughly 25 ns.

#### 3.35.2.4 Understanding the Basics of Phase Offset Between Channels

The 2074 has two output channels that can generate various and numerous waveforms. Although the control over waveform parameters is separate for each channel, the sample clock is derived from a single source. Having a single source for both channels is of great advantage because of two main reasons: 1) There is no jitter between the two channels and 2) If we ignore the initial skew, both waveforms start at exactly the same phase.

Understanding the initial skew term is very important. If you set both channels to output square waveforms and then connect these signals to an oscilloscope; If you then set the oscilloscope to its fastest time base setting, you'll see the two rising edges of the 2074 signals. They do not overlap exactly because the instrument has a skew spec of ±1 ns.

Skew is caused as a result of many factors. Although the two channels were designed exactly the same, small variations in printed circuit board layout or component values are enough to cause skew. These factors were known during the design phase and were minimized as practical. On the other hand, skew can also be generated from external factors that are controlled by the user alone. Examples for these factors are variation in cable length and quality, as well as, non-symmetrical end termination. Therefore, if you want to eliminate skew between channels, you have to use exactly the same cable type, the same cable length and the same termination on both channels.

There are times, however, that you do need to offset phase between channels. In that case, the 2074 lets you adjust phase-offset variations with resolution of one point. When you do, just keep in mind that the initial skew will escort your programmed phase offset throughout the entire phase offset range.

### 3.35.2.5 Adjusting Phase Offset for Standard Waveforms

The 2074 can generate an array of standard waveforms however, one should bear in mind that the 2074 is a digital instrument and that standard waveforms are created from lookup tables or computed from equations; The lookup tables or equations are converted to waveform coordinates, placed in the arbitrary waveform memory and then clocked to the DAC with the sample clock generator. The frequency of the output waveform is computed from the relationship of two parameters: sample clock frequency and number of points.

Output Frequency = SCLK / number of waveform points

As you probably already realize, the sample clock has a finite frequency, 200 MS/s in the case of the 2074. And therefore, to reach high frequencies, the number of points is reduced proportionally. For example, consider output frequency of 20 MHz, there are only 10 points available to create the shape of the waveform.

With the above information on hand, we can deduct that if we want to phase offset one channel in reference to another, the number of waveform points determine the resolution of the phase steps. For example, for a 200 kHz sine wave, the number of points that are required to generate the waveform is 1000. So, phase offset can be programmed with resolution of 360°/1000=0.36°. On the other hand, at 20 MHz, the number of points that are required to generate the waveform is 10. So, phase offset can be programmed with resolution of 360°/10=36°.

So how do you figure out how many waveform points are used and what is the best resolution you may get? Simply look at the display of the standard waveform. You may not control the sample clock frequency when you use standard waveforms however, the display provides information on the internal SCLK setting and you may find out how many waveform points are used by looking at the SYNC line below the waveform icon. With this information, you can now compute your phase offset resolution.

Now, navigate to the Outputs menu, as shown in figure 3-45, you can see the Offset->CH1 field. The delay is programmed in units of waveform points. Use the examples above to compute how many degrees are represented by each waveform point and enter the phase offset you wish to program. If you program any value besides 0, the start of channel 2 output will be delayed for an interval set by the following relationship:

Offset [Channel 2] = n x 1/sclk

Or, if you prefer to use phase offset in degrees, compute your phase offset resolution from the following relationship:

Phase Offset Resolution = 360° / n (where n = wave points)

And then multiply n by the value you program in the Offset ->CH1 field.

Note that offset values can be enter as positive or negative values. For example, in case you want channel 3 to lag channel 1 signal, enter a negative value, as shown in Figure 3-45.


*Figure 3-45, Programming Phase Offset between Channels*

Contrary to what was discussed in the above, there are two waveforms that behave differently; these are sine and triangular waveforms. You can still use the phase offset method as was described in the above however, the two functions are different in a way that you can change the start phase on each waveform in increments of 0.2° regardless of how many waveform points are being used for generating the shape. This is true even if the number of waveform points do not allow such resolution however, it is also limited to 50MHz maximum. The phase offset for sine and triangle are changed from the Standard Sine and Standard Triangle menus and not from the Outputs menu. When you change start phase on one channel, you automatically generate a phase offset between the two channels, provided that both channels generate the same waveform shape. The phase adjustment for the sine and triangle waveforms is accessed from the Waveform->Standard->Phase menu, as shown in figure 3-46.

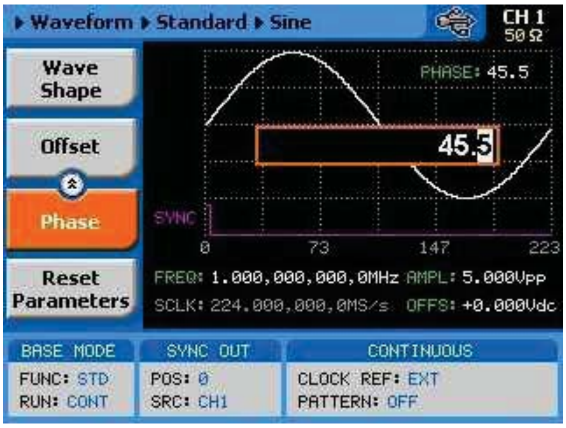


*Figure 3-46, Changing the Start Phase on the Sine Waveform*

### 3.35.2.6 Adjusting Phase Offset for Arbitrary Waveforms

The method of setting phase offset between channels when the 2074 is programmed to generate arbitrary or sequenced waveforms is simpler because you already know how many waveform points you used for generating your waveform and what is the programmed sample clock and therefore, as discussed before, the delay is computed from the following relationship:

Offset [Channel 2] = n x 1/sclk

Or, if you prefer to use phase offset in degrees, compute your phase offset resolution from the following relationship:

Phase Offset Resolution = 360° / n (where n = wave points)

And then multiply n by the value you program in the Offset ->CH1 field. Navigate to the Outputs menu, as shown in figure 3-45, and modify the Offset [Channel 2] field as required.

### 3.35.2.7 Adjusting Phase Offset for Modulated Waveforms

Modulated waveforms are generated digitally and therefore the phase offset between channels cannot be modified. Using the modulated waveforms, there is a constant phase offset between the channels; this phase offset is always 90°. The constant phase offset for the modulated waveform is especially valuable for generating I & Q vectors.

## 3.36 Customizing the Output Units

There are two parameters that could be customized for easier fit of the output parameters; These are: the Horizontal Units, the Load Impedance, Dial Direction, Clock Source and Display Brightness. Figure 3-47 shows the customization panel. Navigate to the customization display from the Utility menu. Adjust the brightness and the dial direction for your preferences and select the clock source as required by your system management. Information on the how to adjust the horizontal units and how to adjust the display for your load impedance is given in the following paragraphs.

### 3.36.1 Selecting the Horizontal Units

Normally, frequency units – Hertz are used when specifying waveform frequency however, at times and as part of global system considerations, it makes it more convenient to work with time units – seconds. The horizontal scale of the 2074 can be modified to operate either in the frequency domain or time domain. The default setting for the generator is frequency units.


*Figure 3-47, Customizing the Model 2074*

## 3.36.2 Adjusting Load Impedance

As specified in Appendix A, the display of the output amplitude is valid when the load impedance is exactly 50 Ω. Such impedance is absolutely necessary when operating at high frequencies where unmatched output impedance can cause reflections and standing waves. It is therefore recommended to terminate the output with 50 Ω loads only. In certain applications where the load impedance is of no consequence, it may range from 50 Ω to open circuit however, since the source impedance is 50 Ω, the displayed amplitude will be different than the actual level on the load. If you know your load impedance, you can adjust the display to show the exact level on your load. The adjustment, as you can see in Figure 3-47 can be made separately for each channel. The default load impedance setting is 50 Ω.

## 3.37 Monitoring the Internal Temperature

The 2074 has an internal temperature sensor that allows monitoring of the internal temperature. In cases where you suspect that the instrument is getting too warm, or malfunction occurs, you can monitor the internal temperature to see if the cause is excessive heat inside the unit. The temperature information is also available to read from a remote interface, so constant control over system temperature can be maintained.

Temperature reading is automatically read and displayed every time you select the System display from the Utility menus. Figure 3-48 is an example of the System menu, showing the temperature inside the unit as 35°C. To update the reading press the numeric "0" button.

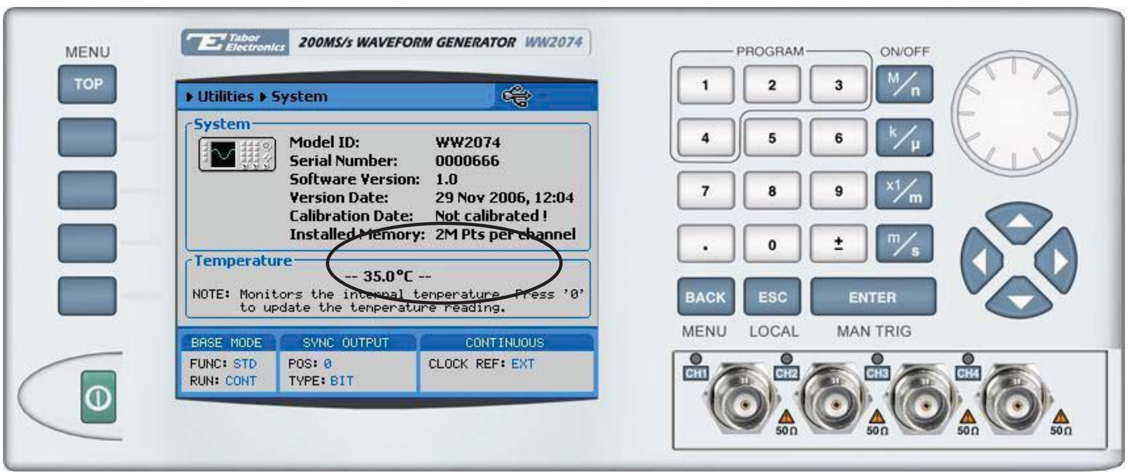


*Figure 3-48, Reading the 2074 Internal Temperature*

# 4 ArbConnection

ArbConnection is a PC-based utility program that serves as an aid for programming the Model 2074. ArbConnection has many functions and features of which all of them share a common purpose – controlling 2074 functions from remote. Refer to the ArbConnection 4.x User Manual that that can be downloaded from www.taborelec.com/downloads .

**Note**

- ArbConnection version 4.3.207 provides support for WW2074.

# 5 Remote Programming Reference

## 5.1 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 2074. 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 2074 is given in Table 5-1.

## 5.2 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.

## 5.2.1 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.

## 5.2.2 Command Separator

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

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

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

```
TRIG:SLOP NEG;COUN 10;TIM 5e-3
```

is the same as sending the following three commands:

:TRIG:SLOP NEG
:TRIG:COUN 10
:TRIG:TIM 5e-3

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

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

### 5.2.3 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.

### 5.2.4 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?
```

### 5.2.5 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.

### 5.2.6 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.

### 5.2.7 IEEE-STD-488.2 Common Commands

The IEEE-STD-488.2 standard defines a set of common commands that perform functions like reset, trigger and status operations. Common commands begin with an asterisk ( * ), are four to five characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space. Use a semicolon ( ; ) to separate multiple commands as shown below:

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

### 5.2.8 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.

#### 5.2.8.1 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>
```

## 5.3 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}
```

## 5.4 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 }
```

## 5.5 Arbitrary Block Parameters

Arbitrary block parameters are used for loading waveforms into the generator's memory. Depending on which option is installed, the Model 2074 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>
```

## 5.6 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.

## 5.7 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 2074 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 5-1, Model 2074 SCPI Commands List Summary

| Keyword | Parameter Form | Default |
|---|---|---|
| *Instrument Control Commands* | | |
| :INSTrument | | |
| [:SELect] | 1 \| 2 \| 3 \| 4 \| n… | 1 |
| :COUPle | | |
| :MODE | MASTer \| SLAVe | MAST |
| :DELay | 0 to 20 | 0 |
| :SLAVe | | |
| :DELete | <LAN_IP_address> | |
| :INSert | <LAN_IP_address> | |
| :STATe | OFF \| ON \| 0 \| 1 | 0 |
| :OUTPut | | |
| :LOAD | 50 to 1e6 | 50 |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :FILTer | | |
| [:LPASs] | NONE \| 25M \| 50M \| 60M \| 120M | NONE |
| :SYNC | | |
| :POSition | 0 to 1e6-1 (0 to 2e6-1 with option 2M) | 0 |
| [:SOURce] | | |
| :ROSCillator | | |
| :SOURce | INTernal \| EXTernal | INT |
| :FREQuency | | |
| [:CW] | 10e-3 to 80e6 \| MINimum \| MAXimum | 1e6 |
| :RASTer | 1.5 to 200e6 \| MINimum \| MAXimum | 1e7 |
| :SOURce | INTernal \| EXTernal | INT |
| :VOLTage | | |
| [:LEVel] | | |
| [:AMPLitude] | 10e-3 to 10 \| MINimum \| MAXimum | 5 |
| :OFFSet | -4.992 to 4.992 | 0 |
| :PHASe | | |
| [:OFFSet] | 0 to $\pm$1e6-1 (0 to $\pm$2e6-1 with option 2) | 0 |
| :FUNCtion | | |
| :MODE | FIXed \| USER \| SEQuence \| MODulation \| COUNter \| PULSe \| HALFcycle | FIX |
| :SHAPe | SINusoid \| TRIangle \| SQUare \| PULSe \| RAMP \| SINC \| GAUSsian \| EXPonential \| NOISe \| DC | SIN |

## Table 5-1, Model 2074 SCPI Commands List Summary (continued)

| Keyword | Parameter Form | Default |
|---|---|---|
| *Standard Waveforms Commands* | | |
| :SINusoid | | |
| :PHASe | 0 to 360 | 0 |
| :TRIangle | | |
| :PHASe | 0 to 360 | 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 |
| *Arbitrary Waveforms Commands* | | |
| :TRACe | | |
| [:DATA] | <data_array> | |
| :DEFine | <1 to 10k>,<16 to 1(2)e6> (<segment_#>,<size>) | 1 |
| :DELete | | |
| [:NAME] | 1 to 10k | |
| :ALL | | |
| :SELect | 1 to 10k | 1 |
| :SEGMent | | |
| [:DATA] | <data_array> | |

Table 55-1, Model 2074 SCPI Commands List Summary (continued)

| Keyword | Parameter Form | Default |
|---|---|---|
| *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 |
| *Modulated Waveforms Commands* | | |
| [:SOURce] | | |
| :MODulation | | |
| :TYPE | OFF \| PSK \| QAM | OFF |
| :CARRier | | |
| [:FREQuency] | 10 to 50e6 | 1e6 |
| :LOAD | | |
| :DEMO | | |
| *Modulated Waveforms Commands (continued)* | | |
| :PSK | | |
| :TYPE | BPSK \| QPSK \| OQPSK \| DQPSK \| 8PSK \| 16PSK \| USER | BPSK |
| :DATA | <data_array> | |
| :MARKer | 1 to 4000 | 1 |
| :BAUD | 1 to 10e6 | 10e3 |
| :CARRier | | |
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :USER | | |
| :DATA | <data_array> | |
| :QAM | | |
| :TYPE | 16QAM \| 64QAM \| 256QAM \| USER | 16QAM |
| :CARRier | | |
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :BAUD | 1 to 10e6 | 10e3 |
| :DATA | <data_array> | |
| :MARKer | 1 to 4000 | 1 |

| | | |
|---|---|---|
| :USER | | |
| :DATA | <data_array> | |

Table 5-1, Model 2074 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 | EXT |
| :SLOPe | POSitive \| NEGative | POS |
| :RETRigger | | |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :TIMe | 200e-9 to 20 | 200e-9 |
| | *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 5-1, Model 2074 SCPI Commands List Summary (continued)

| Keyword | Parameter Form | Default |
|---|---|---|
| *Auxiliary Functions Commands (continued)* | | |
| :AUXiliary | | |
| :PULSe | | |
| :DELay | 0 to 10 | 0 |
| :DOUBle | | |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :DELay | 0 to 1e3 | 1e-3 |
| :LEVel | | |
| :HIGH | -7.990 to 8 | 5 |
| :LOW | -8 to 7.990 | 0 |
| :HIGH | 0 to 1e3 | 1e-3 |
| :POLarity | NORMal \| COMPlement \| INVerted | NORM |
| :PERiod | 64e-9 to 1e6 (64e-9 to 2e6 with option 2) | 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? | | |
| :LOCal | | |
| :VERSion? | | |
| :INFOrmation | | |
| :CALibration? | | |
| :MODel? | | |
| :SERial? | | |
| :IP | | |
| [:ADDRess] | <IP_address> | |
| :MASK | <mask> | |
| :GATeway | <gate_way> | |
| :BOOTp | OFF \| ON \| 0 \| 1 | 0 |
| HOSTname: | <host_name> | |
| :KEEPalive | | |
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :TIMEout | 2 to 300 | 45 |
| :PROBes | 2 to 10 | 2 |

| | | |
|---|---|---|
| :TEMPerature? | | |

Table 5-1, Model 2074 SCPI Commands List Summary (continued)

| Keyword | Parameter Form | Default |
|---|---|---|
| *System Commands (continued)* | | |
| *CLS | | |
| *ESE | 1 to 255 | 1 |
| *OPC | | |
| *RST | | |
| *SRE | 1 to 255 | 1 |
| *TRG | | |
| *ESR? | | |
| *IDN? | | |
| *OPT? | | |
| *STB? | | |

## 5.8 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 5-2, Instrument Control Commands Summary

| Keyword | Parameter Range | Default |
|---|---|---|
| :INSTrument | | |
| [:SELect] | 1 \| 2 \| 3 \| 4 \|...n | 1 |
| :COUPle | | |
| :MODE | MASTer \| SLAVe | MAST |
| :DELay | 0 to 20 | 0 |
| :SLAVe | | |
| :DELete | <LAN_IP_address> | |
| :INSert | <LAN_IP_address> | |
| :STATe | OFF \| ON \| 0 \| 1 | 0 |
| :OUTPut | | |
| :LOAD | 50 to 1e6 | 50 |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :FILTer | | |
| [:LPASs] | NONE \| 25M \| 50M \| 60M \| 120M | NONE |
| :SYNC | | |
| :POSition | 0 to 1e6-1 (0 to 2e6-1 with option 2M) | 0 |
| [: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] | 10e-3 to 10 \| MINimum \| MAXimum | 5 |
| :OFFSet | -4.995 to 4.995 | 0 |
| :PHASe | | |
| [:OFFSet] | 0 to ±1e6-1 (0 to ±2e6-1 with option 2) | 0 |
| :FUNCtion | | |
| :MODE | FIXed \| USER \| SEQuence \| MODulation \| COUNter \| PULSe \| HALFcycle | FIX |

## INSTrument{1|2|3|4|..n}(?)

### *Description*

This command will set the active channel for future programming sequences. Subsequent commands affect the selected channel only.

### *Parameters*

| Range | Type | Default | Description |
|---|---|---|---|
| 1-4 (5 - n) | Discrete | 1 | Sets the active channel for programming from remote. Channels 1, 2, 3 and 4 are associated with the 2074. Channels 5 and subsequent channels are available only when the 2074 operate in master/slave mode and was coupled to other instruments. The channel designator is automatically adjusted to the number of channels that are joined to form the multi-channel system, regardless if 2074 or 2571A/2A units are used in this system |

### *Response*

The 2074 will return 1, 2, 3, 4, or n depending on the present active channel setting

## INSTrument:COUPle:MODE{MASTer|SLAVe}(?)

### *Description*

This command will assign master or slave properties to the instrument. If the assignment is slave, most of the instrument operational functions will be controlled from the master instrument however, waveforms, amplitudes and offsets can be controlled individually for each slave unit.

### *Parameters*

| Name | Type | Default | Description |
|---|---|---|---|
| MASTer | Discrete | MAST | Programs a specific 2074, in a multi-instruments system, as master instrument. Note that only one instrument can be designated as master while all other instruments must be programmed as slaves. |
| SLAVe | Discrete | | Programs 2074's, in a multi-instruments system, as slave instrument. Note that multiple instruments can be designated as slaves but only one instrument can be designated as master. |

### *Response*

The 2074 will return MAST or SLAV depending on current instrument couple mode assignment.

## INSTrument:COUPle:DELay<delay>(?)

### *Description*

This command will assign master or slave properties to the instrument. If the assignment is slave, most of the instrument operational functions will be controlled from the master instrument however, waveforms, amplitudes and offsets can be controlled individually for each slave unit.

***Parameters***

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <delay> | 0 to 20 | Numeric | 0 | Will set the waveform start delay between channels in units of seconds. Channel 1 is always the reference channel. Channels 2 to "n" are delayed in reference to channel 1. Note that this parameter is operating in conjunction with the continuous run mode and only when multiple instruments are synchronized. |

***Response***

The 2074 will return the present delay value in units of seconds.

## INSTrument:COUPle:SLAVe:DELete<LAN_address>

***Description***

This command will delete a designated slave unit from a synchronized multi-instruments system list.

***Parameters***

| Name | Type | Default | Description |
|---|---|---|---|
| <LAN_address> | String | | Will remove a designated instrument, which is specified through its IP address, from a synchronized multi-instruments system list. Contact your computer administrator, if you are not sure how to specify LAN address. |

## INSTrument:COUPle:SLAVe:INSert<LAN_address>

***Description***

This command will add a designated slave unit to a synchronized multi-instruments system list.

***Parameters***

| Name | Type | Default | Description |
|---|---|---|---|
| <LAN_address> | String | | Will add a designated instrument, which is specified through its IP address, from a synchronized multi-instruments system list. Contact your computer administrator, if you are not sure how to specify LAN address. |

## INSTrument:COUPle:STATe{OFF|ON|0|1}(?)

***Description***

This command will turn the 2074 couple state on and off.

***Parameters***

| Range | Type | Default | Description |
|---|---|---|---|
| 0-1 | Discrete | 0 | Sets the couple mode on and off. Note that this command must be applied to the master instrument only otherwise, the couple state will not be affected. To select the master instrument use the INST:SEL 1 command. |

***Response***

The 2074 will return 1 if the couple state is on, or 0 if the couple state is off.

## OUTPut:LOAD<load>

***Description***

This command will specify the load impedance that will be applied to the 2074 output.

***Parameters***

| Name | Type | Default | Description |
|---|---|---|---|
| <load> | Numeric (integer only) | 50 | Will specify the load impedance that will be applied to the 2074 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 2074 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 2074 will return 1 if the output is on, or 0 if the output is off.

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

### *Description*

This command will select which filter is connected to the 2074 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 2074 will return NONE, 25M, 50M, 60M, or 120M depending on the type of filter presently connected to the output.

## OUTPut:SYNC:POSition<position>(?)

### *Description*

This command will program the 2074 SYNC position. This command is active in arbitrary (USER) mode only.

### *Parameters*

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <position> | 0 to 1e6-1 | Numeric (Integer only) | 0 | Will set the SYNC position in waveform points. The sync position can be programmed in increments of 4 points minimum. The range is extended to 2e6-1 when option 2 is installed. 1M memory size is standard. |

### *Response*

The 2074 will return the present SYNC position value

## 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 2074 for it to continue normal operation |

### *Response*
The 2074 will return INT, or EXT depending on the present 2074 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 80e6 | 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 (80e6). |

### *Response*
The 2074 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 200e6 | 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 (200e6). |

### *Response*
The 2074 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 2074, 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 2074 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> | 10e-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 (10mV). |
| MAXimum> | | Discrete | | Will set the amplitude to the highest possible level (10V). |

***Response***

The 2074 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> | -4.995 to 4.995 | 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 2074 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).

## PHASe:OFFSet<phase_offs>(?)

***Description***

This command programs the start phase offset between channels 1 and 2 in units of waveform points. Phase offset resolution when using this command is 1 point.

***Parameters***

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <phase_offs> | 0 to ±1e6-1 | Numeric (Integer only) | 0 | Will set the phase offset in reference to channel 1. The range is extended to ±2e6-1 when option 2 is installed. 1M is standard. |

### *Response*
The 2074 will return the present phase offset value.

## 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 2074 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 2074 are purged and the 2074 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 2074 are purged and the 2074 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 2074 are |

purged and the 2074 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 2074 will return FIX, USER, SEQ, MOD, COUN, PULS or HALF depending on the present 2074 setting.

## 5.9 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 5-3, 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 |
| :TRIangle | | |
| :PHASe | 0 to 360 | 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 2074 will return SIN, TRI, SQU, PULS, RAMP, SINC, EXP, GAUS, NOIS, or DC depending on the present 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 will return the present DC amplitude value.

## 5.10 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 2074 has the following waveform memory capacity:

1M – standard memory configuration
2M – optional memory expansion

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

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

Unlike the built-in standard waveforms, arbitrary waveforms must first 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 2074 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 2074 is given in the following paragraphs.

Table 5-4, Arbitrary Waveforms Commands Summary

| Keyword | Parameter Range | Default |
|---|---|---|
| :TRACe | | |
| [:DATA] | <data_array> | |
| :DEFine | <1 to 10k>,<16 to 1(2)e6> (<segment_#>,<size>) | 1 |
| :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 2074 memory. Waveform data is loaded to the 2074 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 5-1.

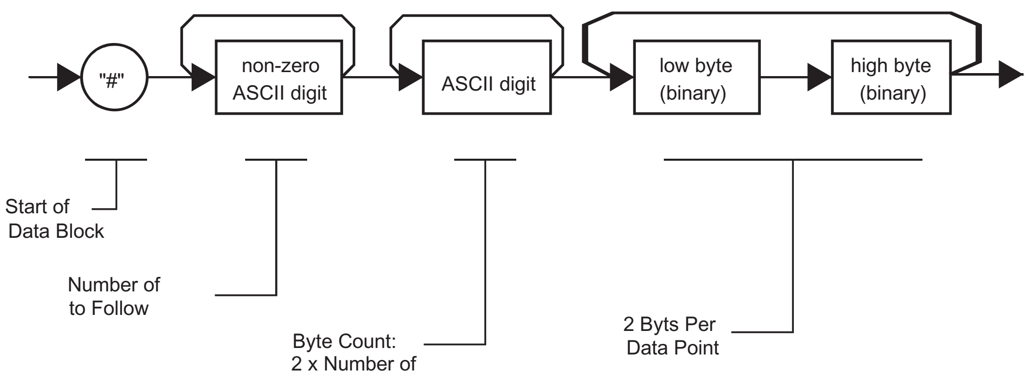


Figure 5-1, Definite Length Arbitrary Block Data Format

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 2074 as waveform data points. The following description shows you how to prepare the data for downloading to the 2074. 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 5-2 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.

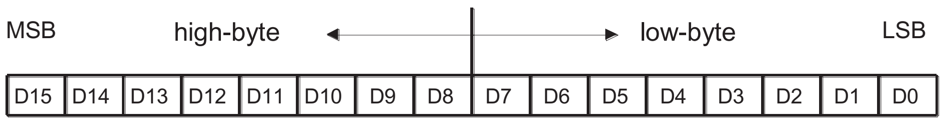


Figure 5-2, 16-bit Initial Waveform Data Point Representation

Figure 5-3 shows the same 16-bit word as in Figure 5-2, except the high and low bytes are swapped. This is the correct format that the 2074 expects as waveform point data. The first byte to be sent to the generator is the low-byte and then high-byte.

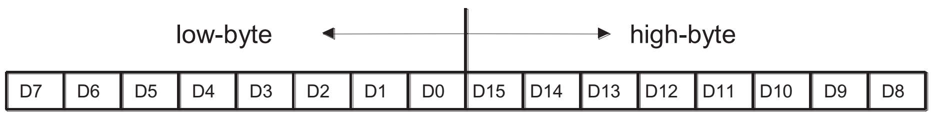


Figure 5-3, 16-bit Waveform Data Point Representation

### *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 2074 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 1(2)M | Numeric (integer only) | | Programs the size of the selected segment. Minimum segment length is 16 points, the maximum is limited by the memory option that is installed in your instrument either 1M or 2M |

## 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 2074 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 2074 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 2074 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:

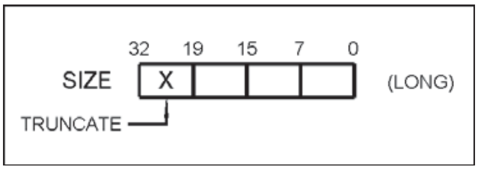


Figure 5-4, Segment Address and Size Example

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 2074 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 2074 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. |

## 5.11 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 2074 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 5-5, 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 2074 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 5-1. The transfer of definite length arbitrary block data must terminate with the EOI bit set. This way, carriage-return (CR – 0dH) and line feed (LF – 0aH) characters can be used as sequence data and will not cause unexpected termination of the arbitrary block data. Figure 5-5 shows how to prepare the 64-bit word for the sequence step, repeat, mixed mode and sync bit.

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 2074 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 2074 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

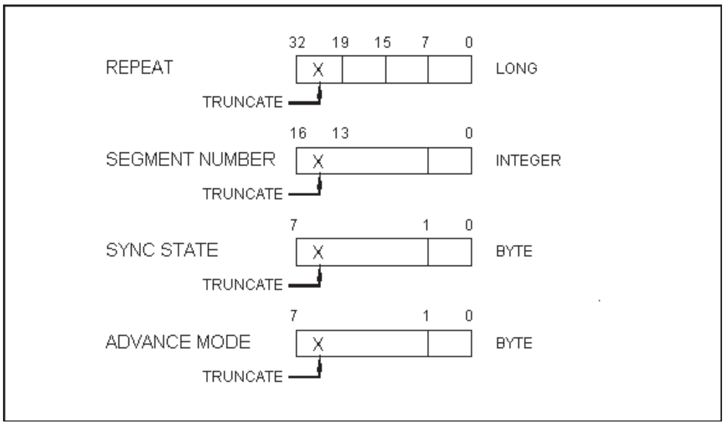


Figure 5-5, 64-bit Sequence Table Download Format

### *Parameters*

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

## SEQuence:ADVance{AUTOmatic|STEP|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 2074 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 2074 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:<br>1) The 2074 must be set to operate in continuous mode<br>2) Select the MIX sequence advance mode<br>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 2074 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_ | 1 to 10 | Numeric (integer | 1 | Selects the active sequence number |

| | | | |
|---|---|---|---|
| number> | | only) | |

### *Response*

The 2074 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 2074 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 2074 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 2074 will return BIT or LCOM depending on the present SYNC mode

# 5.12 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: PSK and QAM. The modulation commands are summarized in Table 5-6. Factory defaults after *RST are shown in the Default column. Parameter range and low and high limits are listed, where applicable.

Table 5-6, Modulated Waveforms Commands

| Keyword | Parameter Form | Default |
|---|---|---|
| [:SOURce] | | |
| :MODulation | | |
| :TYPE | OFF \| PSK \| QAM | OFF |
| :CARRier | | |
| [:FREQuency] | 10 to 50e6 | 1e6 |
| :LOAD | | |
| :DEMO | | |
| :PSK | | |
| :TYPE | BPSK \| QPSK \| OQPSK \| DQPSK \| 8PSK \| 16PSK \| USER | BPSK |
| :DATA | <data_array> | |
| :MARKer | 1 to 4000 | 1 |
| :BAUD | 1 to 10e6 | 10e3 |
| :CARRier | | |
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :USER | | |
| :DATA | <data_array> | |
| :QAM | | |
| :TYPE | 16QAM \| 64QAM \| 256QAM \| USER | 16QAM |
| :CARRier | | |

| | | |
|---|---|---|
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :BAUD | 1 to 10e6 | 10e3 |
| :DATA | <data_array> | |
| :MARKer | 1 to 4000 | 1 |
| :USER | | |
| :DATA | <data_array> | |

## MODulation:TYPE{OFF|PSK|QAM}(?)

### *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). |
| PSK | Discrete | | This turns on the PSK function. Program the PSK parameters to fine tune the function for your application. |
| QAM | Discrete | | This turns on the QAM function. Program the QAM parameters to fine tune the function for your application. |

### *Response*
The 2074 will return OFF, PSK, or QAM 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> | 10e-3 to 50e6 | 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 2074 will return the current carrier frequency value.

## 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.

## 5.12.1 PSK Modulation Programming

Use the following command for programming the PSK parameters. The PSK functions use pre-defined table settings. In case the standard table do not suit the application you can design your own (n)PSK data using the User PSK data table entry option. Note that the carrier waveform frequency (CW) setting is common to all modulation schemes.

### PSK:TYPE{BPSK|QPSK|OQPSK|8PSK|16PSK|USER}(?)

***Description***

This selects between the various (n)PSK modulation schemes.

***Parameters***

| Name | Type | Default | Description |
|---|---|---|---|
| BPSK | Discrete | BPSK | Selects the Binary Phase Shift Keying (BPSK) modulation type. In this mode, the instrument shifts from 0° to 180° at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| QPSK | Discrete | | Selects the Quadrature Phase Shift Keying (QPSK) modulation type. In this mode, the instrument responds to 2 input bits that correspond to four phases of the carrier wave. The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| OQPSK | Discrete | | Selects the Offset Phase Shift Keying (OPSK) modulation type. The mapping is the same as for the QPSK except the element of I is moved first and then the element of Q is moved if the status changes from one to another. These two steps are carried out within the time of one step of QPSK. By shifting the movement of the Q element, the status can be changed without going through the origin even if a change of 180° occurs. Because one symbol period is calculated in two steps, an even value must be used for oversampling. The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| DQPSK | Discrete | | Selects the $\Pi$/4-shifted Differentially encoded QPSK modulation type. In this mode, the symbol is located at the position where the phase is shifted from the current symbol position by 45° from the value of the next data symbol. The first symbol position is defined by QPSK. pre-defined values. |

| | | |
|---|---|---|
| | | $\Pi$/4DQPSK uses both the QPSK and another four-point table rotated by 45°.The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| 8PSK | Discrete | Selects the 8-phase Shift Keying (8PSK) modulation type. In this mode, the instrument shifts through eight symbols with 3 bits. The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| 16PSK | Discrete | Selects the 16-phase Shift Keying (16PSK) modulation type. In this mode, the instrument shifts through sixteen symbols with 4 bits. The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |
| USER | Discrete | Selects the User PSK modulation type. There are no pre-assigned symbols for this mode and therefore, the symbols must first be designed using the PSK:USER:DATA table. The number of bits are user definable. The symbols are shifts at a rate determined by the PSK:BAUD command and in a sequence as programmed by the PSK:DATA table. |

### *Response*

The 2074 will return BPSK, QPSK, OPSK, DPSK, 8PSK, 16PSK, or USER on the selected PSK type setting.

## PSK:DATA<psk_data>

### *Description*

Loads the data stream that will cause the 2074 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 2074 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 2074 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 2074 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 2074 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).

## PSK:CARRier:STATe{OFF|ON|0|1}(?)

### *Description*

This command will toggle the carrier waveform (CW) on and off. This command affects all (n)PSK function and has no effect on the PSK function. The carrier off function is especially useful as direct input for I & Q vector generators that need the digital information only and supply the carrier information separately.

### *Parameters*

| Range | Type | Default | Description |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 0-1 | Discrete | 1 | Sets the carrier output on and off |

### *Response*
The 2074 will return 1 if the output is on, or 0 if the output is off.

## PSK:USER:DATA<user_data>

### *Description*
Loads the user phase data for the (n)PSK modulation function. The data contains a list of phase values within the range of 0° to 360°. The user data table is associated with the User PSK function only where symbols can be freely designed as non-standard vectors. After you enter the symbol data in this table, you must generate the symbol sequence using the PSK:DATA command, as shown earlier in this section.

Below you can see an example of the User PSK data table. The symbol index is automatically incremented from 0 to n so there is no need to provide index numbers in this table.

### *Sample User PSK Symbols Data Array*

5.5 50 95 120 150 190.4 210 225.8 265 280 307 90.7 180.2

### *Parameters*

| Name | Type | Description |
|---|---|---|
| <user_data> | Binary | Block of binary data that contains phase information for the (n)PSK modulation function. |

### 5.12.2 QAM Modulation Programming

Use the following command for programming the QAM parameters. The QAM commands allow selection of the (n)QAM type, programming the QAM baud, placing the marker position, turning the carrier waveform (CW) on and off function and designing data symbols.

## QAM:TYPE{16QAM|64QAM|256QAM|USER}(?)

***Description***

This selects between the various (n)QAM modulation schemes. The 16QAM, 64QAM and 256QAM types have standard symbol configuration. In case you need non-standard symbol constellations, use the User QAM to design your own symbol data.

***Parameters***

| Name | Type | Default | Description |
|---|---|---|---|
| 16QAM | Discrete | 16QAM | Selects the 16 Quadrature Amplitude Modulation (16QAM) modulation type. 16QAM is a 4-level modulation method that uses 16 phases/amplitude symbols. The first two bits define at which event of the IQ plane the phase exists (00: upper right, 01: upper left, 10: lower left, 11: lower right) and the rest of the 2 bits defines the position of the symbol in each event.<br>The instrument steps through these events in a sequence as listed in the QAM:DATA table and at a frequency which is programmed using the QAM:BAUD parameter. |
| 64QAM | Discrete | | Selects the 64 Quadrature Amplitude Modulation (64QAM) modulation type. 64QAM is a 6-level modulation method that uses 64 phases/amplitude symbols. The first two bits define at which event of the IQ plane the phase exists (00: upper right, 01: upper left, 10: lower left, 11: lower right) and the rest of the 4 bits defines the position of the symbol in each event.<br>The instrument steps through these events in a sequence as listed in the QAM:DATA table and at a frequency which is programmed using the QAM:BAUD parameter. |
| 256QAM | Discrete | | Selects the 256 Quadrature Amplitude Modulation (256QAM) modulation type. 64QAM is a 8-level modulation method that uses 256 phases/amplitude symbols. The first two bits define at which event of the IQ plane the phase exists (00: upper right, 01: upper left, 10: lower left, 11: lower right) and the rest of the 6 bits defines the position of the symbol in each event.<br>The instrument steps through these events in a sequence as listed in the QAM:DATA table and at a frequency which is |

| | | |
|---|---|---|
| | | programmed using the QAM:BAUD parameter. |
| USER | Discrete | Selects the User QAM modulation type. There are no pre-assigned symbols for this mode and therefore, the symbols must first be designed using the QAM:USER:DATA table. The instrument will then step through the programmed symbols in a sequence as listed in the QAM:DATA table and at a frequency which is programmed using the QAM:BAUD parameter. |

***Response***

The 2074 will return 16QAM, 64QAM, 256QAM, or USER depending on the selected QAM type setting.

## QAM:BAUD<baud>(?)

***Description***

This allows the user to select (n)QAM baud. The baud is the interval of which the symbols stream in the (n)QAM data array as they are clocked with the baud generator.

***Parameters***

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <baud> | 1 to 10e6 | Numeric | 10e3 | Programs the baud of which the symbols stream in the (n)QAM data table. Baud is programmed in units of Hz. |

***Response***

The 2074 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).

## QAM:CARRier:STATe{OFF|ON|0|1}(?)

***Description***

This command will toggle the carrier waveform (CW) on and off. The carrier off function is especially useful as direct input for I & Q vector generators that need the digital information only and supply the carrier information separately.

***Parameters***

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

***Response***

The 2074 will return 1 if the output is on, or 0 if the output is off.

## QAM:DATA<qam_data>

***Description***

Loads the data stream that will cause the 2074 to hop from vector to vector. Data format is a string of "0’s" and "1’s" which define when the output generates the various vectors. The size of the data word depends on the QAM type. For 16QAM there are only four bits and for 256QAM there are 8 bits. 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 a 16QAM data table is constructed. The 16QAM data table sample below shows a list of 10 shifts. The 2074 will step through this list, outputting the various vectors in a sequence as defined by the data list.

### *Sample 16QAM Data Array*

0000 0100 1010 0111 1111 0001 0010 0111 0101 1111

### *Parameters*

| Name | Type | Description |
|---|---|---|
| <qam_data> | ASCII | Block of ASCII data that contains information for the generator when to step from one vector setting to another. |

## QAM:MARKer<index>(?)

### *Description*

Programs where on the data stream the 2074 will generate a pulse, designated as QAM 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 QAM data list. The QAM:MARK command is common to all QAM modulation types.

### *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 2074 will return the present marker position.

## 5.13 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 2074. 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. Additional information on the run mode options and how the 2074 behaves in the various run mode options is given in Chapter 3. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

Table 5-7, 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 | EXT |
| :SLOPe | POSitive \| NEGative | POS |
| :RETRigger | | |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :TIMe | 200e-9 to 20 | 200e-9 |

## 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 2074 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 2074 to operate in triggered, gated, or counted burst run modes. |

***Response***

The 2074 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 2074 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 2074 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 only) | 1 | Programs the burst count. |

***Response***

The 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 will return the present burst count value.

## TRIGger:SOURce:ADVance{EXTernal|BUS|MIXed}(?)

### *Description*

This selects the source from where the 2074 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 2074 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 2074 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. |

### *Response*

The 2074 will return EXT, BUS, or MIX 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 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 2074 will return the present re-trigger period value.

## 5.14 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 2074. These commands can transform the 2074 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 5-8. Factory defaults after *RST are shown in bold typeface. Parameter low and high limits are given where applicable.

Table 5-8, Auxiliary Commands

| Keyword | Parameter Form | Default |
|---|---|---|
| *Digital Pulse Commands* | | |
| :AUXiliary | | |
| :PULSe | | |
| :DELay | 0 to 10 | 0 |
| :DOUBle | | |
| [:STATe] | OFF \| ON \| 0 \| 1 | 0 |
| :DELay | 0 to 1e3 | 1e-3 |
| :HIGH | 0 to 1e3 | 1e-3 |
| :LEVel | | |
| :HIGH | -7.990 to 8 | 5 |
| :LOW | -8 to 7.990 | 0 |
| :PERiod | 64e-9 to 1e6 (64e-9 to 2e6 with the 2 M option) | 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 |

## 5.14.1 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 10 | 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 2074 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 2074 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 2074 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 2074 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> | -4.990 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 10 mV. |

### *Response*
The 2074 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 4.990 | 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 10 mV. |

### *Response*
The 2074 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 1e6 | Numeric | 10e-3 | Will program the period of the pulse waveform in units of seconds. The maximum period is extended to 2e6 when the 2 Meg memory option is installed. |

### *Response*
The 2074 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 2074 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 2074 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 2074 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 2074 will return the present fall time value in units of seconds.

## 5.14.2 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: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 2074 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 2074 will return the present gate time value in units of seconds.

## 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 2074 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 period measurements resolution 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 2074 will return FREQ, PER, APER, PULS, GTOT or ITOT depending on the present measurement function setting.

## 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 2074 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.

### 5.14.3 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 2074 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 2074 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 2074 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 2074 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 2074 will return SIN, TRI, or SQU depending on the present 2074 setting

## 5.14.4 System Commands

The system-related commands are not related directly to waveform generation but are an important part of operating the 2074. These commands can reset or test the instrument, or query the instrument for system information.

Table 5-9, System Commands Summary

| Keyword | Parameter Form | Default |
|---|---|---|
| :RESet (*RST) | | |
| :SYSTem | | |
| :ERRor? | | |
| :LOCal | | |
| :VERSion? | | |
| :INFOrmation | | |
| :CALibration? | | |
| :MODel? | | |
| :SERial? | | |
| :IP | | |
| [:ADDRess] | <IP_address> | |
| :MASK | <mask> | |
| :GATeway | <gate_way> | |
| :BOOTp | OFF \| ON \| 0 \| 1 | 0 |
| HOSTname: | <host_name> | |
| :KEEPalive | | |
| :STATe | OFF \| ON \| 0 \| 1 | 1 |
| :TIMEout | 2 to 300 | 45 |
| PROBes | 2 to 10 | 2 |
| :TEMPerature? | | |

## RESet, or *RST

### *Description*

This command will reset the 2074 to its factory defaults.

## SYSTem:ERRor?

### *Description*

Query only. This query will interrogate the 2074 for programming errors.

### *Response*

The 2074 will return error code. Error messages are listed later in this manual.

## SYSTem:LOCal

### *Description*
This command will deactivate the active interface and will restore the 2074 to local (front panel) operation.

## SYSTem:VERSion?

### *Description*
Query only. This query will interrogate the 2074 for its current firmware version. The firmware version is automatically programmed to a secure location in the flash memory and cannot be modified by the user except when performing firmware update.

### *Response*
The 2074 will return the current firmware version code in a format similar to the following: 1.02

## 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: 2074. 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 2074.

## 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).

## SYSTem:IP<ip_adrs>(?)

### *Description*
This command programs the IP address for LAN operation. The programming must be performed from either USB or GPIB controllers.

### *Parameters*

| Name | Range | Type | Description |
|---|---|---|---|
| <ip_adrs> | 0 to 255 | String | Programs the IP address for LAN operation. Programming must be performed from USB or GPIB interfaces. Current IP address can be observed on LAN Properties front panel display. |

### *Response*
The 2074 will return the present IP address value similar to the following: 192.168.0.6

## SYSTem:IP:MASK<mask_adrs>(?)

### *Description*
This command programs the subnet mask address for LAN operation. The programming must be performed from either USB or GPIB controllers.

### *Parameters*

| Name | Range | Type | Description |
|---|---|---|---|
| <mask_adrs> | 0 to 255 | String | Programs the subnet mask address for LAN operation. Programming must be performed from USB or GPIB interfaces. Current subnet mask address can be observed on LAN Properties front panel display. |

### *Response*
The 2074 will return the present IP address value similar to the following: 255.255.255.0

## SYSTem:IP:BOOTp{OFF|ON|0|1}(?)

### *Description*
Use this command to toggle BOOTP mode on and off.

### *Parameters*

| Range | Type | Default | Description |
|---|---|---|---|
| 0-1 | Discrete | 0 | Toggles BOOTP mode on and off. When on, the IP address is administrated automatically by the system |

### *Response*
The 2074 will return 0, or 1 depending on the present BOOTP setting.

## SYSTem:IP:GATeway<gate_adrs>(?)

### *Description*

This command programs the gateway address for LAN operation. The programming must be performed from either USB or GPIB controllers.

### *Parameters*

| Name | Range | Type | Description |
|---|---|---|---|
| <gate_adrs> | 0 to 255 | String | Programs the gateway address for LAN operation. Programming must be performed from USB or GPIB interfaces. Current gateway address can be observed on LAN Properties front panel display. |

### *Response*

The 2074 will return the present IP address value similar to the following: 0.0.0.0

## SYSTem:IP:HOSTname<name>(?)

### *Description*

This command programs the host name address for LAN operation. The programming is performed in the factory and it is highly suggested that users do not change the host name without first consulting a Tabor customer service person.

### *Parameters*

| Name | Type | Description |
|---|---|---|
| <name> | String | Programs the host name for LAN operation. |

### *Response*

The 2074 will return a string containing the host name. String length is 16 characters.

## SYSTem:KEEPalive:STATe{OFF|ON|0|1}(?)

### *Description*

Use this command to toggle the keep alive mode on and off. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

### *Parameters*

| Range | Type | Default | Description |
|---|---|---|---|
| 0-1 | Discrete | 1 | Toggles the keep alive mode on and off. When on, the 2074 constantly checks for smooth LAN connection at intervals programmed by the syst:keep:time command. The LAN will be probed as many times as programmed by syst:keep:prob parameter to check if there is an interruption in the LAN communication. When communication fails, the 2074 reverts automatically to local (front panel) operation. |

### *Response*

The 2074 will return 0, or 1 depending on the present keep alive setting.

## SYSTem:KEEPalive:TIMEout<time_out>(?)

### *Description*
This command programs the keep alive time out. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

### *Parameters*

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <time_out> | 2 to 300 | Numeric | 45 | Programs the keep alive time out in units of seconds. The time out period is initiated when the LAN is idle for more than the time out period. The LAN will be probed as many times as programmed by syst:keep:prob parameter to check if there is an interruption in the LAN communication. When communication fails, the 2074 reverts automatically to local (front panel) operation. |

### *Response*
The 2074 will return the present keep alive time out value.

## SYSTem:KEEPalive:PROBes<probs>(?)

### *Description*
This command programs the number of probes that are used by the keep alive sequence. The keep alive mode assures that LAN connection remains uninterrupted throughout the duration of the LAN interfacing.

### *Parameters*

| Name | Range | Type | Default | Description |
|---|---|---|---|---|
| <time_out> | 2 to 10 | Numeric | 2 | Programs the number of probes that are used by the keep alive sequence. The time out period is initiated when the LAN is idle for more than the time out period and the LAN will be probed as many times as programmed by this parameter to check if there is an interruption in the LAN communication. When communication fails, the 2074 reverts automatically to local (front panel) operation. |

### *Response*
The 2074 will return the present keep alive number of probes.

## SYSTem:TEMPerature?

### *Description*
Query only. This query will interrogate the 2074 for its internal temperature reading.

### *Response*
The 2074 will return the current internal temperature value in units of degrees C, similar to the following: 40.00

## 5.15 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 2074

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

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

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

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

***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 2074 response to *IDN? is:

**Tabor,2074,0,1.01**

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

***OPC?** - Returns "1" to the output buffer after all the previous commands have been executed. *OPC? is used for synchronization between a controller and the instrument using the MAV bit in the Status Byte or a read of the Output Queue. The *OPC? query does not affect the OPC Event bit in the Standard Event Status Register (ESR). Reading the response to the ***OPC?** query has the advantage of removing the complication of dealing with service requests and multiple polls to the instrument. However, both the system bus and the controller handshake are in a temporary hold-off state while the controller is waiting to read the *OPC? query response.

***OPT?** - Returns the value "0" for a 2074 with no options.

***RST** - Resets the generator to its default state. Default values are listed in

Table 5-1.

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

***SRE?** - Query the Status Byte enable register. The generator returns a decimal value in the range of 0 to 63 or 128 to 191 since bit 6 (RSQ) cannot be set. The binary-weighted sum of the number represents the value of the bits of the Service Request enable register.

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

***TRG** - Triggers the 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".

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

### 5.15.1 The SCPI Status Registers

The Model 2074 uses the Status Byte register group and the Standard Event register group to record various instrument conditions. Figure 5-1 shows the SCPI status system.

An Event Register is a read-only register that reports defined conditions within the generator. Bits in an event register are latched. When an event bit is set, subsequent state changes are ignored. Bits in an event register are automatically cleared by a query of that register or by sending the *CLS command. The *RST command or device clear does not clear bits in an event register. Querying an event register returns a decimal value, which corresponds to the binary-weighted sum of all bits, set in the register.

An Event Register defines which bits in the corresponding event register are logically ORed together to form a single summary bit. The user can read from and write to an Enable Register. Querying an Enable Register will not clear it. The *CLS command does not clear Enable Registers but it does clear bits in the event registers. To enable bits in an enable register, write a decimal value that corresponds to the binary-weighted sum of the bits required to enable in the register.

### 5.15.2 The Status Byte Register (STB)

The Status Byte summary register contains conditions from the other registers. Query data waiting in the generator's output buffer is immediately reported through the Message Available bit (bit 4). Bits in the summary register are not latched. Clearing an event register will clear the corresponding bits in the Status Byte summary register. Description of the various bits within the Status Byte summary register is given in the following:

**Bit 0** - Decimal value 1. Not used, always set to 0.

**Bit 1** - Decimal value 2. Not used, always set to 0.

**Bit 2** - Decimal value 4. Not used, always set to 0.

**Bit 3** - Decimal value 8. Not used, always set to 0.

**Bit 4** - Decimal value 16. Message Available Queue Summary Message (MAV). The state of this bit indicates whether or not the output queue is empty. The MAV summary message is true when the output queue is not empty. This message is used to synchronize information exchange with the controller. The controller can, for example, send a query command to the device and then wait for MAV to become true. If an application program begins a read operation of the output queue without first checking for MAV, all system bus activity is held up until the device responds.

**Bit 5** - Decimal value 32. Standard Event Status Bit (ESB) Summary Message. This bit indicates whether or not one or more of the enabled ESB events have occurred since the last reading or clearing of the Standard Event Status Register.

**Bit 6** - Decimal value 64. Master Summary Status (MSS)/Request Service (RQS) Bit. This bit indicates if the device has at least one condition to request service. The MSS bit is not part of the IEEE-STD-488.1 status byte and will not be sent in response to a serial poll. However, the RQS bit, if set, will be sent in response to a serial poll.
Bit 7 - Decimal value 128. Not used, always set to 0.

### 5.15.2.1 Reading the Status Byte Register

The Status Byte summary register can be read with the *STB? common query. The *STB? common query causes the generator to send the contents of the Status Byte register and the MSS (Master Summary Status) summary message as a single <NR1 Numeric Response Message> element. The response represents the sum of the binary-weighted values of the Status Byte Register. The *STB? common query does not alter the status byte.

### 5.15.2.2 Clearing the Status Byte Register

Removing the reasons for service from Auxiliary Status registers can clear the entire Status Byte register. Sending the *CLS command to the device after a SCPI command terminator and before a Query clears the Standard Event Status Register and clears the output queue of any unread messages. With the output queue empty, the MAV summary message is set to FALSE. Methods of clearing other auxiliary status registers are discussed in the following paragraphs.

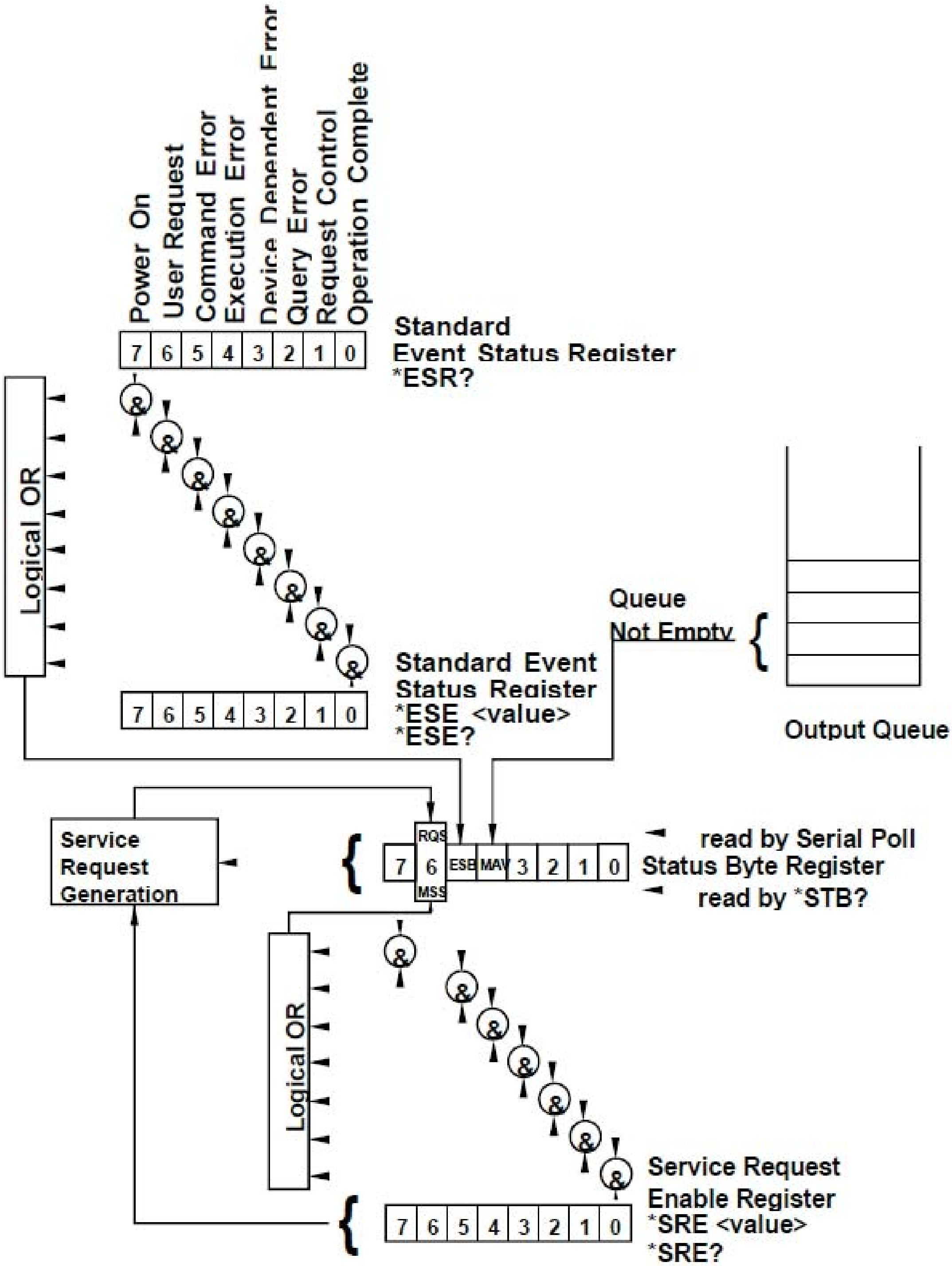


Figure 5-6. SCPI Status Registers

### 5.15.2.3 Service Request Enable Register (SRE)

The Service Request enable register is an 8-bit register that enables corresponding summary messages in the Status Byte Register. Thus, the application programmer can select reasons for the generator to issue a service request by altering the contents of the Service Request Enable Register.

The Service Request Enable Register is read with the *SRE? common query. The response to this query is a number that represents the sum of the binary-weighted value of the Service Request Enable Register. The value of the unused bit 6 is always zero.

The Service Request Enable Register is written using the *SRE command followed by a decimal value representing the bit values of the Register. A bit value of 1 indicates an enabled condition. Consequently, a bit value of zero indicates a disabled condition. The Service Request Enable Register is cleared by sending *SRE0. The generator always ignores the value of bit 6. Summary of *SRE commands is given in the following.

***SRE0** - Clears all bits in the register.

***SRE1** - Not used.

***SRE2** - Not used.

***SRE4** - Not used.

***SRE8** - Not used.

***SRE16** - Service request on MAV.

***SRE32** - Service request on ESB summary bit.

***SRE128** - Not used.

#### 5.15.2.4 Standard Event Status Register (ESR)

The Standard Event Status Register reports status for special applications. The 8 bits of the ESR have been defined by the IEEE-STD-488.2 as specific conditions, which can be monitored and reported back to the user upon request. The Standard Event Status Register is destructively read with the *ESR? common query. The Standard Event Status Register is cleared with a *CLS common command, with a power-on and when read by *ESR?.

The arrangement of the various bits within the register is firm and is required by all GPIB instruments that implement the IEEE-STD-488.2. Description of the various bits is given in the following:

**Bit 0** - Operation Complete. Generated in response to the *OPC command. It indicates that the device has completed all selected and pending operations and is ready for a new command.

**Bit 1** - Request Control. This bit operation is disabled on the Model 2074.

**Bit 2** - Query Error. This bit indicates that an attempt is being made to read data from the output queue when no output is either present or pending.

**Bit 3** - Device Dependent Error. This bit is set when an error in a device function occurs. For example, the following command will cause a DDE error:

```
VOLTage 5;:VOLTage:OFFSet 2
```

Both of the above parameters are legal and within the specified limits, however, the generator is unable to generate such an amplitude and offset combination.

**Bit 4** - Execution Error. This bit is generated if the parameter following the command is outside of the legal input range of the generator.

**Bit 5** – Command Error. This bit indicates the generator received a command that was a syntax error or a command that the device does not implement.

**Bit 6** - User Request. This event bit indicates that one of a set of local controls had been activated. This event bit occurs regardless of the remote or local state of the device.

**Bit 7** - Power On. This bit indicates that the device's power source was cycled since the last time the register was read.

### 5.15.2.5 Standard Event Status Enable Register (ESE)

The Standard Event Status Enable Register allows one or more events in the Standard Event Status Register to be reflected in the ESB summary message bit. The Standard Event Status Enable Register is an 8-bit register that enables corresponding summary messages in the Standard Event Status Register. Thus, the application programmer can select reasons for the generator to issue an ESB summary message bit by altering the contents of the ESE Register.

The Standard Event Status Enable Register is read with the *ESE? Common query. The response to this query is a number that represents the sum of the binary-weighted value of the Standard Event Status Enable Register.

The Standard Event Status Enable Register is written using the *ESE command followed by a decimal value representing the bit values of the Register. A bit value one indicates an enabled condition. Consequently, a bit value of zero indicates a disabled condition. The Standard Event Status Enable Register is cleared by setting *ESE0. Summary of *ESE messages is given in the following.

***ESE0** – No mask. Clears all bits in the register.
***ESE1** – ESB on Operation Complete.
***ESE2** – ESB on Request Control.
***ESE4** – ESB on Query Error.
***ESE8** – ESB on Device Dependent Error.
***ESE16** – ESB on Execution Error.
***ESE32** – ESB on Command Error.
***ESE64** – ESB on User Request.
***ESE128** – ESB Power on.

## 5.16 Error Messages

In general, whenever the 2074 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 2074 is set to output the built-in sine waveform, or activating the built-in sine waveform when one of the 2074 filters is turned on. Corrective action: If in sine, select another function and activate the filter(s).

4. Activating burst mode when the 2074 is set to sequence mode, or activating sequence mode when the 2074 is set to burst mode. Corrective action: Remove the 2074 from burst or sequence and then selected the desired mode.

5. Changing operating mode from triggered to continuous when the 2074 is set to single sequence advance, or changing the operating mode from continuous to triggered when the 2074 is set to automatic sequence advance mode. Corrective action: Observe the 2074 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.

# 6 Performance Checks

## 6.1 What's in This Chapter

This chapter provides performance tests necessary to troubleshoot the Model 2074 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.

## 6.2 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.

## 6.3 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

### 6.3.1 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 2074 and allow it to warm-up for at least 30 minutes before beginning the performance test procedure.

### 6.3.2 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 2074 to factory defaults, use the Factory Rest option in the Utility menu.

## 6.4 Recommended Test Equipment

Recommended test equipment for troubleshooting, calibration and performance checking is listed in Table 6-1 below. Test instruments other than those listed may be used only if their specifications equal or exceed the required characteristics.

Table 6-1, Recommended Test Equipment

| Equipment | Model No. | Manufacturer |
|---|---|---|
| (with jitter package) | LT342 | LeCroy |
| | 6900B | Krohn Hite |
| | 2000 | Keithley |
| | 6020R | Tabor Electronics |
| Spectrum Analyzer | E4411 | HP |
| Pulse Generator (with manual trigger) | 8500 | Tabor Electronics |

## 6.5 Test Procedures

Use the following procedures to check the Model 2074 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.

## 6.5.1 Frequency Accuracy

Frequency accuracy checks tests the accuracy of the internal oscillators. All channels share the same output frequency and the same reference oscillators and therefore, the accuracy is tested on channel 1 only.

### 6.5.1.1 Frequency Accuracy, Internal Reference

Equipment: Counter

Preparation:

1. Configure the counter as follows:
   Termination: 50Ω, DC coupled
2. Connect the 2074 Channel 1 output to the counter input – channel A
3. Configure the 2074, channel 1 as follows:
   Waveform: Squarewave
   Amplitude: 2V
   Output: On
   Frequency: As specified in Table 6-2

Test Procedure:

1. Perform frequency Accuracy tests using Table 6-2

Table 6-2, Frequency Accuracy

| 2074 Setting | Error Limits | Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 10.000000000Hz | ±10μHz | | | |
| 1.0000000000kHz | ±1mHz | | | |
| 100.00000000kHz | ±100mHz | | | |
| 1.0000000000MHz | ±1Hz | | | |
| 80.000000000MHz | ±80Hz | | | |

### 6.5.1.2 Frequency Accuracy, External 10MHz Reference

Equipment: 10MHz reference (at least 0.1ppm), Counter

Preparation:

1. Leave counter setting and 2074 connections as in last test
2. Connect the 10MHz reference oscillator to the 2074 rear panel input
3. Configure the 2074 channel 1 as follows:
   10 MHz Ref: External
   Waveform: Squarewave
   Amplitude: 2V
   Output: On
   Frequency: As specified in Table 6-3

Test Procedure

1. Perform frequency Accuracy tests using Table 6-3

Table 6-3, Frequency Accuracy Using External 10MHz Reference

| 2074 Setting | Error Limits | Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 10.000000000MHz | ±1Hz | | | |

| | | | | |
|---|---|---|---|---|
| 50.000000000MHz | ±5Hz | | | |

## 6.5.2 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.

### 6.5.2.1 Amplitude Accuracy

Equipment**:** DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: ACV
2. Connect 2074 Channel outputs to the DMM input
3. Configure the 2074 as follows:
   Frequency: 1 kHz
   Output: On
   Amplitude: As specified in Table 6-4

Test Procedure

1. Perform amplitude Accuracy tests on all channels using Table 6-4

Table 6-4, Amplitude Accuracy, DAC output

| **2074 Amplitude Setting** | **Error Limits** | **DMM Reading** | | | | **Pass** | **Fail** |
|---|---|---|---|---|---|---|---|
| | | **CH1** | **CH2** | **CH3** | **CH4** | | |
| 10.00 V | 3.534 V, ±60 mV | | | | | | |
| 5.000 V | 1.767 V, ±42 mV | | | | | | |
| 500 mV | 176.7 mV, ± 5.3 mV | | | | | | |
| 50.00 mV | 17.67 mV, ± 1.9 mV | | | | | | |

## 6.5.3 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.

#### 6.5.3.1 Offset Accuracy

Equipment: DMM

Preparation:

1. Configure the DMM as follows:
   Termination: 50 Ω feedthrough at the DMM input
   Function: DCV
2. Connect 2074 Channel outputs to the DMM input
3. Configure the 2074 as follows:
   Frequency: 1 MHz
   Amplitude: 20 mV
   Output: On
   Offset: As specified in Table 6-5

Test Procedure

1. Perform Offset Accuracy tests on all channels using Table 6-5

Table 6-5, Offset Accuracy

| 2074 Offset Setting | Error Limits | DMM Reading | | | | Pass | Fail |
|---|---|---|---|---|---|---|---|
| | | CH1 | CH2 | CH3 | CH4 | | |
| +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 | | | | | | |

### 6.5.4 Squarewave Characteristics

This tests the characteristics of the square waveform. It includes transition times, aberrations and skew between channels. Each channel has its own set of amplifiers and attenuators and therefore, the characteristics are tested on each channel separately.

#### 6.5.4.1 Squarewave Checks

Equipment: Oscilloscope, 50 Ω, 20dB feedthrough attenuator

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 2074 Channel outputs to the oscilloscope input
   Configure the 2074 as follows:
   - Frequency: 1 MHz
   - Waveform: Squarewave
   - Amplitude: 5 V
   - Output: On

Test Procedure

1. Perform Squarewave Characteristics tests on all channels using Table 6-6

Table 6-6, Square wave Characteristics

| Parameter Tested | Error Limits | Oscilloscope Reading | | | | Pass | Fail |
|---|---|---|---|---|---|---|---|
| | | CH1 | CH2 | CH3 | CH4 | | |
| Rise/Fall Time | <4.5 ns | | | | | | |
| Ringing | <6 % + 10 mV | | | | | | |
| Over/undershoot | <6 % + 10 mV | | | | | | |

### 6.5.4.2 Skew Between Channels

Equipment: Oscilloscope, 50 Ω, 20dB feedthrough attenuator

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 50 Ω, 20 dB attenuator feed through at the oscilloscope. Use identical cables to connect the channels to the oscilloscope.
   Setup: As required for the test
2. Connect 2074 Channel outputs to the oscilloscope input
3. Configure the 2074 as follows:
   Waveform: Arbitrary
   SCLK: 200 MS/s
   Amplitude: 6 V
   Output: On

Test Procedure

1. Using ArbConnection prepare and download the following waveform (all channels):
   Wavelength: 1024
   Waveform: Square
2. Measure the skew between channels 1 and 2 to be less than 2 ns.
3. Measure the skew between channels 3 and 4 to be less than 2 ns.
4. Measure the skew between channels 1 and 3 to be less than 7 ns.
5. Modify the phase offset parameters on channels 2, 3 and 4 from -10 to 10 and check that the phase offset between channels is increased by 5 ns with every phase offset step.

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

## 6.5.5 Sinewave Characteristics

This tests the characteristics of the sine waveform. It includes distortions, spectral purity and flatness. Each channel has its own set of amplifiers and attenuators and therefore, the characteristics are tested on each channel separately.

### 6.5.5.1 Sinewave Distortions

Equipment: Distortion Analyzer, Spectrum Analyzer, and ArbConnection

Preparation:

1. Connect 2074 Channel outputs to the distortion analyzer input.
2. Configure the 2074 as follows:
   - SCLK: As required by the test
   - Waveform: Arbitrary
   - Amplitude: 5 V
   - Output: On
3. Using ArbConnection prepare and download the following waveform:
   - Wavelength: As required by the test
   - Waveform: Sinewave

Test Procedure

1. Perform Sinewave distortion tests on all channels using Table 6-7

Table 6-7, Sinewave Distortion

| 2074 SCLK Settings | Sinewave Points | 2074 Frequency | Reading Limits | Distortion Reading | | | | Pass | Fail |
|---|---|---|---|---|---|---|---|---|---|
| | | | | CH1 | CH2 | CH3 | CH4 | | |
| 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% | | | | | | |

### 6.5.5.2 Sinewave Spectral Purity

Equipment: Spectrum Analyzer

Preparation:

1. Connect 2074 Channel outputs to the spectrum analyzer input. Use 50 Ω, 20 dB feedthrough termination at the spectrum analyzer input.
2. Configure the 2074 as follows:
   - Amplitude: 5 V
   - Output: On
   - Frequency: As required by the test

Test Procedure

1. Perform sinewave spectral purity tests using Table 6-8.

Table 6-8, Sinewave Spectral Purity

| 2074 Freq Settings | Reading Limits | Spectrum Analyzer, Settings & Results | | | | | | Pass | Fail |
|---|---|---|---|---|---|---|---|---|---|
| | | Start | Stop | CH1 | CH2 | CH3 | CH4 | | |
| 10 MHz | >45 dBc | 1 MHz | 100 MHz | | | | | | |
| 50 MHz | >30 dBc | 10 MHz | 200 MHz | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 80 MHz | >25 dBc | 10 MHz | 200 MHz | | | | | | |

#### 6.5.5.3 Sinewave Flatness

Equipment: Oscilloscope

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect 2074 Channel outputs to the oscilloscope input
3. Configure the 2074 as follows:
   Amplitude: 6 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 tests on all channels using Table 6-9

Table 6-9, Sinewave Flatness

| 2074 Sine Frequency | Error Limits | Oscilloscope Reading | | | | Pass | Fail |
|---|---|---|---|---|---|---|---|
| | | CH1 | CH2 | CH3 | CH4 | | |
| 1 MHz | 6 Divisions | Reference | | | | X | X |
| 10 MHz | 6 ±0.3 Divisions | | | | | | |
| 50 MHz | 6 ±0.4 Divisions | | | | | | |
| 80 MHz | 6 ±0.4 Divisions | | | | | | |

### 6.5.6 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. The run modes are common to all channels however, each channel has its own trigger circuit and therefore, each channel must be tested separately.

#### 6.5.6.1 Trigger, Gate, and Burst Characteristics

Equipment: Oscilloscope, function generator, counter

Preparation:

1. Configure the Oscilloscope follows:
   - Termination: 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input
   - Setup: As required for the test
2. Connect 2074 Channel outputs to the oscilloscope input
3. Configure the function generator as follows:
   - Frequency 1 MHz
   - Run Mode: As required by the test
   - Wave: TTL Square
4. Connect the function generator output to the 2074 TRIG IN connector
5. Configure the 2074 as follows:
   - Frequency: 25 MHz
   - Waveform: Sinewave
   - Burst Count: 1e6 counts, each channel
   - Amplitude: 1 V
   - Trigger Source: External
   - Output: On

Test Procedure

1. Perform trigger and gate tests using Tables 6-10
2. Configure the counter to TOTB Measurements and perform burst tests using Tables 6-10. Set counter trigger level to 100mV.

Table 6-10, Trigger, gate, and burst Characteristics.

| 2074 Run Mode | External Trigger Pulse | Oscilloscope Reading CH1, CH2, CH3, CH4 | Pass | Fail |
|---|---|---|---|---|
| Triggered | 1 MHz, Continuous | Triggered waveform | | |
| Gated | 1 MHz, Continuous | Gated Waveform | | |
| Burst | Single shot | Burst, 1e6 waveforms | | |

### 6.5.6.2 Mixed Trigger Advance Test

Equipment: Oscilloscope, function generator, ArbConnection

Preparation:

1. Configure the Oscilloscope follows:

| | |
|---|---|
| Termination: | 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input |
| Setup: | As required for the test |
| Run Mode: | Single |

2. Connect 2074 Channel 1 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 2074 TRIG IN connector
5. Configure the 2074, channel 1 only, as follows:

| | |
|---|---|
| Frequency: | 25 MHz |
| Waveform: | Sinewave |
| Run Mode: | Burst |
| Burst Count: | 5 counts, each channel |
| 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 10 μs intervals

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

### 6.5.6.3 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.
   Waveform: Squarewave
2. Place the "T" connector on the output terminal of the function generator. Connect one side of the "T" to the 2074 TRIG IN connector and the other side of the "T" to the channel A input of the counter
3. Connect the 2074 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 2074, 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 6-11

Table 6-11, Trigger Delay Tests

| 2074 Delay Setting | Error Limits | Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 1 μs | 1 μs ±230 ns | | | |
| 1 ms | 1 ms ±50 μs | | | |
| 1 s | 1 s ±50 ms | | | |

### 6.5.6.4 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 2074 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 2074, channel 1 only, 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
   Re-trigger Source: BUS
   Output: On

Test Procedure

1. Using ArbConnection, manually trigger the instrument
2. Perform trigger delay tests using Tables 6-12.

Table 6-12, Re-Trigger Delay Tests

| 2074 Delay Setting | Error Limits | Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 1μs | 1 μs ±85 ns | | | |
| 1ms | 1 ms ±50 μs | | | |
| 1s | 1 s ±50 ms | | | |

#### 6.5.6.5 Trigger Slope

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope follows:
   Termination: 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
   Trigger Source: External
2. Connect 2074 Channel 1 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 2074 TRIG IN connector
5. Connect the function generator main output to the 2nd channel of the oscilloscope
6. Configure the 2074 as follows:
   Frequency: 1 MHz
   Waveform: Sine wave
   Run Mode: Triggered
   Output: On

Test Procedure

1. Toggle 2074 trigger slope from positive to negative visa versa
2. Verify on the oscilloscope that the 2074 transitions are synchronized with the slope of the trigger

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.6.6 Trigger Level

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:
   Termination: 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input
   Setup: As required for the test
2. Connect 2074 Channel 1 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 2074 TRIG IN connector
5. Configure the 2074 as follows:
   Frequency: 1 MHz
   Waveform: Sine wave
   Run Mode: Triggered
   Trigger level: 0 V
   Ch1 Output: On

Test Procedure

1. Verify that the 2074 outputs triggered waveforms spaced at 0.1 ms
2. Modify the function generator offset to +2 V and change the 2074 trigger level to +4 V. Verify that the 2074 outputs triggered waveforms spaced at 0.1 ms
3. Modify the function generator offset to -2 V and change the 2074 trigger level to -4 V. Verify that the 2074 outputs triggered waveforms spaced at 0.1 ms

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.7 Sequence operation

This tests the operation of the sequence generators. Each channel has its own sequence generator and therefore operation is tested on each channel separately. This also checks the sequence advance options.

### 6.5.7.1 Automatic Advance

Equipment: Counter

Preparation:

1. Configure the Counter as follows:
   Function: TOTB Measurement
2. Connect the counter channel B to the 2074 output
3. Configure the 2074 as follows (all channels):
   SCLK 200 MS/s
   Waveform: Sequence
   Run Mode: Trigger
   Amplitude: 2 V
   Output: On
4. Using ArbConnection prepare and download the following waveform to all channels:
   Segments: 1 to 5
   Wavelength: 128 points
   Waveform: 1 cycle square
   Trigger Source: BUS
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 | |
|---|---|---|---|---|

2. Remove the cable from 2074 channel 1
3. Repeat the test procedure as above for channels 2, 3 and 4

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.7.2 Step Advance

Equipment: Oscilloscope, function generator

Preparation:

1. Configure the Oscilloscope as follows:

   | | |
   |---|---|
   | Termination: | 20 dB, 50 Ω feedthrough attenuator at the oscilloscope input |
   | Setup: | As required for the test |

2. Connect 2074 Channel 1 output to the oscilloscope input
3. Configure the function generator as follows:

   | | |
   |---|---|
   | Frequency | 10 kHz |
   | Run Mode: | Triggered |
   | Waveform: | TTL level square |

4. Connect the function generator output to the 2074 TRIG IN connector
5. Connect 2074 Channel 1 to the Oscilloscope input
6. Configure the 2074 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 to all channels:

   | | |
   |---|---|
   | 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. Press the manual trigger button on the function generator and observe that the waveforms advance through the sequence table repeatedly

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

2. Remove the cable from 2074 channel 1
3. Repeat the test procedure as above for channel 2, 3 and 4

| Test Results | Pass | | Fail | |
|---|---|---|---|---|

**Note**

- Leave the same setup for the next test

### 6.5.7.3 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. Press the manual trigger button on the function generator and 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 | |
|---|---|---|---|---|

2. Remove the cable from 2074 channel 1
3. Repeat the test procedure as above for channel 2, 3 and 4

| Test Results | Pass | | Fail | |
|---|---|---|---|---|

## 6.5.8 Modulated Waveforms Characteristics

This tests the operation of the modulation circuits. It includes tests for the (n)PSK and for the (n)QAM modulation functions. When in this mode, each two channels 1-2 and 3-4 are generate in parallel the same modulation function however, each couple can be programmed to generate a different modulation type.

### 6.5.8.1 (n)PSK

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: 200 μs
   Sampling Rate: 50 MS/s at least.
   Trace View: X-Y
   Amplitude: 1 V/div
2. Connect 2074 Channel 1 output to the oscilloscope input, channel 1
3. Connect the 2074 Channel 2 output to the oscilloscope input, channel 2
4. Configure model 2074 controls on channels 1 and 2 as follows:
   Waveform: Modulated
   Modulation: nPSK
   PSK Type: 8PSK
   CW Control: Off
   CH1 Output: On
   CH2 Output: On

Test Procedure:

1. Load Demo table to the 8PSK Data Table
2. Set oscilloscope and verify 8PSK constellation trace on the oscilloscope

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

3. Modify 2074 PSK Type to 16PSK
4. Load Demo table to the 16PSK Data Table
5. Verify 16PSK constellation trace on the oscilloscope

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

#### 6.5.8.2 (n)QAM

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:

   Time Base: 1 ms
   Sampling Rate: 50 MS/s at least.
   Trace View: X-Y
   Amplitude: 1 V/div

2. Connect 2074 Channel 1 output to the oscilloscope input, channel 1
3. Connect the 2074 Channel 2 output to the oscilloscope input, channel 2
4. Configure model 2074 controls on channels 1 and 2 as follows:

   Waveform: Modulated
   Modulation: nQAM
   QAM Type: 16QAM
   CW Control: Off
   CH1 Output: On
   CH2 Output: On

Test Procedure:

1. Load Demo table to the 16QAM Data Table
2. Set oscilloscope and verify 16QAM constellation trace on the oscilloscope

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

6. Modify 2074 QAM Type to 64QAM
7. Load Demo table to the 64QAM Data Table
8. Verify 64QAM constellation trace on the oscilloscope

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

### 6.5.9 SYNC Output operation

This tests the operation of the SYNC output. There are four separate synchronization outputs, which are located on the rear panel. There are two parameters being tested, the sync qualifier and the sync position. The sync output has TTL level amplitude.

### 6.5.9.1 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 2074 SYNC output CH1 to the oscilloscope input
3. Configure model 2074 as follows:
   Ch1 Output: On

Test Procedure:

1. Verify trace on the oscilloscope shows synchronization pulses at 1 μs intervals.

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

2. Remove the cable from channel 1 and repeat the test on channels 2, 3, and 4, using the appropriate sync output connection on the rear panel for each channel

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

#### 6.5.9.2 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 2074 CH1 output to the oscilloscope input (1)
3. Connect the 2074 rear panel CH1 SYNC output to the oscilloscope input (2)
4. Configure model 2074 channel as follows:
   Waveform: Sine
   Run Mode: Burst
   Burst Count: 10
   Re-trigger On
   Re-trig period: 10 μs
   CH1 Output: On

Test Procedure:

1. Manually trigger the 2074
2. Verify trace on the oscilloscope shows synchronization pulse having 9 μs pulse width. Verify the SYNC is high for the duration of the burst.

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

3. Remove the cable from channel 1 and repeat the test on channels 2, 3, and 4, using the appropriate sync output connection on the rear panel for each channel

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

#### 6.5.9.3 SYNC Position

Equipment: Oscilloscope

Preparation:

1. Configure the oscilloscope as follows:
   Time Base: As required by the test
   Amplitude: 2 V/div
2. Connect the 2074 CH1 output to the oscilloscope input (1)
3. Connect 2074 SYNC output CH1 to the oscilloscope input (2)
4. Configure model 2074 as follows:
   Ch1 Output: On

Test Procedure:

1. Verify trace on the oscilloscope shows synchronization pulses at 1 μs intervals. Verify that the synchronization pulse coincides with the start of the waveform
2. Modify the SYNC Position parameters and observe that the synchronization pulse position moves in reference to the channel 1 output

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

3. Remove the cable from channel 1 and repeat the test on channels 2, 3, and 4, using the appropriate sync output connection on the rear panel for each channel

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.10 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. Each channel has its own working memory and therefore each channel is tested separately.

#### 6.5.10.1 Waveform memory

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Connect 2074 Channel outputs to the distortion analyzer input. Configure the 2074 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: 1 M points (2 M with an option installed)
   - 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 | |
|---|---|---|---|---|

### 6.5.11 Remote Interfaces

This tests the communication with the 2074 using the various interface options. Connecting and setting up the 2074 for operation with the various interface options is described in Chapter 2. Before you proceed with and of the following tests, make sure first that the 2074 is configured to operate with the selected test. GPIB operation requires setting of the GPIB address, LAN operation requires correct setting of the LAN parameters and USB operation requires that the USB port is configured correctly and USB driver installed on the host computer.

### 6.5.11.1 GPIB Control

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Set up the 2074 for GPIB operation and connect the instrument to a host controller
2. Connect 2074 CH1 output to the distortion analyzer input.
3. Configure the 2074 as follows:
   SCLK: 200 MS/s
   Waveform: Arbitrary
   Output: On
4. Using ArbConnection prepare and download the following waveform:
   Wavelength: 1 M points (2 M with an option installed)
   Waveform: Sine wave

Test Procedure

1. Check the resulting trace on the oscilloscope
2. Perform Sine wave distortion. It should be less than 0.1 %

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.11.2 USB Control

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Set up the 2074 for USB operation and connect the instrument to a host controller
2. Connect 2074 CH1 output to the distortion analyzer input.
3. Configure the 2074 as follows:
   SCLK: 200 MS/s
   Waveform: Arbitrary
   Output: On
4. Using ArbConnection prepare and download the following waveform:
   Wavelength: 1 M points (2 M with an option installed)
   Waveform: Sine wave

Test Procedure

1. Check the resulting trace on the oscilloscope
2. Perform Sine wave distortion. It should be less than 0. 1 %

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.11.3 LAN Control

Equipment: Distortion Analyzer, ArbConnection

Preparation:

1. Set up the 2074 for LAN operation and connect the instrument to a host controller
2. Connect 2074 CH1 output to the distortion analyzer input.
3. Configure the 2074 as follows:

   SCLK: 200 MS/s
   Waveform: Arbitrary
   Output: On
4. Using ArbConnection prepare and download the following waveform:

   Wavelength: 1 M points (2 M with an option installed)
   Waveform: Sine wave

Test Procedure

1. Check the resulting trace on the oscilloscope
2. Perform Sine wave distortion. It should be less than 0.1 %

| **Test Results** | Pass | | Fail | |
|---|---|---|---|---|

## 6.5.12 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 2074 waveform generation are automatically purged and the instrument is transformed to a stand-alone counter/timer. Waveform generation is resumed as soon as the counter/timer function is turned off.

### 6.5.12.1 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 2074 TRIG IN connector
3. Configure the 2074, as follows:

   Auxiliary Function: Counter/Timer
   Function: Frequency
   Trigger Level: 0 V

Test Procedure:

1. Perform Frequency Measurement Accuracy tests using Table 6-13

Table 6-13, Frequency Measurement Accuracy

| Function Generator Setting | Error Limits | 2074 Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 1.000000 MHz | ±2 Hz | | | |
| 100.0000 MHz | ±200 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 120.00000 MHz, ±200 Hz

| Test Results | Pass | | Fail | |
|---|---|---|---|---|

## 6.5.12.2 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 2074 TRIG IN connector
3. Configure the 2074, as follows:
   Auxiliary Function: Counter/Timer
   Function: Period
   Trigger Level: 0 V

Test Procedure:

1. Perform Period Accuracy tests using Table 6-14

Table 6-14, Period Measurement Accuracy

| Function Generator Setting | Error Limits | 2074 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 6-14, verify that the period reading is 1.000000 μs ±10 ps

| Test Results | Pass | | Fail | |
|---|---|---|---|---|

### 6.5.12.3 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 2074 TRIG IN connector
3. Configure the 2074, as follows:
   Auxiliary Function: Counter/Timer
   Function: Pulse Width
   Trigger Level: 0 V

Test Procedure:

1. Perform Pulse Width Accuracy tests using Table 6-15

Table 6-15, Pulse Width Measurement Accuracy

| Function Generator Setting | | Error Limits | 2074 Counter Reading | Pass | Fail |
|---|---|---|---|---|---|
| **Frequency** | **Duty Cycle** | | | | |
| 10 kHz | 50 % | 50.00 μs ±100 ns | | | |
| 100 kHz | 50 % | 5.000 μs ±100 ns | | | |
| 1 MHz | 70 % | 700.0 ns ±100 ns | | | |

2. Change the counter/timer slope to Negative
3. With the last function generator setting in Table 6-15
4. Verify that the pulse width reading is 300 ns ±100 ns

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

### 6.5.12.4 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
2. Connect the function generator to the 2074 TRIG IN connector
3. Configure the 2074, as follows:
   Auxiliary Function: Counter/Timer
   Function: Totalize, Gated
   Gate Time: As required by the test
   Trigger Level: 0 V

Test Procedure:

1. Press the Reset/Arm button
2. Perform Totalize, Gated Accuracy tests using Table 6-16

Table 6-16, Totalize, Gate Measurement Accuracy

| 2074 Gate Time Setting | Error Limits | 2074 Counter Reading | Pass | Fail |
|---|---|---|---|---|
| 1.000 s | 1000000 ±30 | | | |
| 100.0 ms | 100000 ±30 | | | |

3. Change the function generator run mode to Burst and set Burst Count to 100
4. Press the Reset/Arm button on the 2074 to reset and arm the totalize function
5. Manually trigger the function generator and verify that the 2074 counter reading is 100 ±1

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

### 6.5.12.5 Totalize, Infinite

Equipment: Function Generator with at least 1 ppm accuracy

Preparation:

1. Configure the function generator as follows:
   Frequency: 150 MHz
   Wave: Square
   Amplitude 500 mV
2. Connect the function generator to the 2074 TRIG IN connector
3. Configure the 2074, 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 1’000’000
4. Press the Reset/Arm button on the 2074 to reset and arm the totalize function
5. Manually trigger the function generator and verify that the 2074 counter reading is 1000000 $\pm 2$

| | | | | |
|---|---|---|---|---|
| **Test Results** | Pass | | Fail | |

# 7 Adjustments and Firmware Update

## 7.1 What's in This Chapter

This chapter provides adjustment information for the 2074 dual channel 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.**

## 7.2 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 2074, perform a complete performance checks as given in Chapter 6 to verify proper operation of the instrument.

## 7.3 Environmental Conditions

The 2074 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 2074 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.

### 7.3.1 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 2074 and allow it to warm-up for at least 30 minutes before beginning the performance test procedure.

## 7.4 Recommended Test Equipment

Recommended equipment for adjustments is listed in Table 7-1. 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 7-1, Recommended Calibration for Adjustments

| Equipment | Model No. | Manufacturer |
|---|---|---|
| (with jitter package) | LC684 | LeCroy |
| | 2000 | Keithley |
| Frequency Counter (Rubidium reference) | 6020R | Tabor Electronics |
| Function Generator (with manual trigger) | 8020 | Tabor Electronics |
| Accessories | BNC to BNC cables | |
| | 50Ω Feedthrough termination | |
| | Dual banana to BNC adapter | |

## 7.5 Adjustment Procedures

Use the following procedures to calibrate the Model 2074. The following paragraphs show how to set up the instrument for calibration and what the acceptable calibration limits are.

Calibration is done with the covers closed and the 2074 connected through an interface to a host computer. Any interface can be used from the following: USB, LAN, or GPIB. 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 7-1, Calibration Password

4. Type your User Name Password and click on OK. The Calibration Panel as shown in Figure 7-2 will appear.

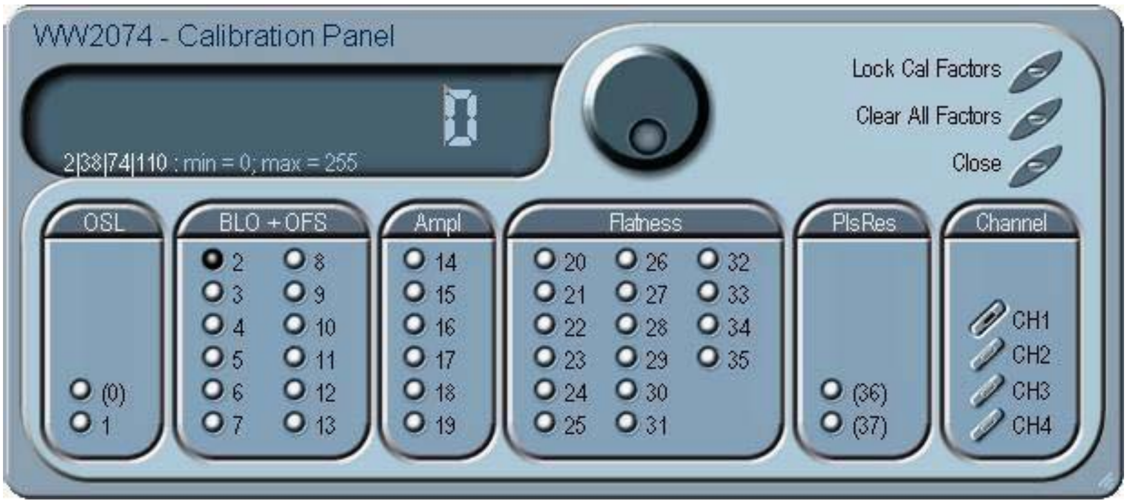


Figure 7-2, Calibration Panel

**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 50 and, except the (50M) and 10M adjustments in the Selection group, should be carried out exactly in the order as numbered on the panel. There are separate adjustments for Channels 1, 2, 3 and 4 so make sure that the output cables are connected to the appropriate channel during the adjustments.

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 2074 is done automatically, some of the configuration is shown for reference. There is no requirement to change configuration of the 2074 during the remote adjustment procedure except in places where specifically noted.

## 7.6 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

#### 7.6.1.1 (Setup 0)

**50 MHz Gated Oscillator Adjustment**

Equipment: Counter, Function Generator, BNC to BNC cables,

Preparation:

4. Configure the counter as follows:
   Termination: 50 Ω DC
   Function: TI A -> B
   Slope B: Negative
5. Connect the 2074 Channel 1 output to the oscilloscope input
6. Connect an external function generator to the rear panel TRIG IN connector
7. Configure the 2074 as follows:
   CAL:NUM 0
8. Using an external function generator, manually trigger the 2074

Adjustment:

9. Adjust C18 for an interval from pulse end to pulse start of 20 μs, ±5 %

#### 7.6.1.2 Setup 1

**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 2074 Channel 1 output to the counter input.
3. Configure the 2074 as follows:
   CAL:NUM 1

Adjustment:

4. Adjust CAL:VAL for counter reading of 10 MHz, ±2 Hz

## 7.7 Channels 1, 2, 3 & 4 Adjustments

The following adjustment procedures are common to all four channels. Complete the adjustments for channel 1 first and then return to the beginning to commence with channel 2 adjustments and then repeat the sequence for channels 3 and 4. Adjustments in the following procedure refer to Channel 1 output only however, after you complete the adjustments for channel 1, remove the cable from CH1 output and connect to CH2 output and so on until you complete the adjustments for all channel

### 7.7.1 Base Line Offset Adjustments

The base line offset adjustments assure that the AC signal is symmetrical around the 0 V line. Use this procedure if you suspect that there is a base line accuracy issue.

#### 7.7.1.1 CH1 – Setup 2

#### 7.7.1.2 CH2 – Setup 38

#### 7.7.1.3 CH3 – Setup 74

#### 7.7.1.4 CH4 – Setup 110

**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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feedthrough termination
3. Configure the 2074 as follows:
   CAL:NUM 2, 38, 74 and 110 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 0 V, ±20 mV

#### 7.7.1.5 CH1 – Setup 3

#### 7.7.1.6 CH2 – Setup 39

#### 7.7.1.7 CH3 – Setup 75

#### 7.7.1.8 CH4 – Setup 111

**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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 3, 39, 75 and 111 – respectively

Adjustment

4. Adjust CAL:VAL for DMM reading of 0 V, ±5 mV

#### 7.7.1.9 CH1 – Setup 4

#### 7.7.1.10 CH2 – Setup 40

#### 7.7.1.11 CH3 – Setup 76

#### 7.7.1.12 CH4 – Setup 112

**Base Line Offset, 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: 100 mV
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 4, 40, 76 and 112 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 0 V, ±20 mV

#### 7.7.1.13 CH1 – Setup 5

#### 7.7.1.14 CH2 – Setup 41

#### 7.7.1.15 CH3 – Setup 77

#### 7.7.1.16 CH4 – Setup 113

**Base Line Offset, 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: 100 mV
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 5, 41, 77 and 113 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 0 V, ±5 mV

### 7.7.2 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.

#### 7.7.2.1 CH1 – Setup 6

#### 7.7.2.2 CH2 – Setup 42

#### 7.7.2.3 CH3 – Setup 78

#### 7.7.2.4 CH4 – Setup 114

**+1 V Offset 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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 6, 42, 78 and 114 – respectively

Adjustment:

4. CAL:VAL for DMM reading of +1 V, ± 5 mV

#### 7.7.2.5 CH1 – Setup 7

#### 7.7.2.6 CH2 – Setup 43

#### 7.7.2.7 CH3 – Setup 79

#### 7.7.2.8 CH4 – Setup 115

**+3 V Offset Output, Amplifier In**

Equipment: DMM, BNC to BNC cable, 50Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 7, 43, 79 and 115 – respectively

Adjustment:

4. CAL:VAL for DMM reading of +3 V, ± 15 mV

#### 7.7.2.9 CH1 – Setup 8

#### 7.7.2.10 CH2 – Setup 44

#### 7.7.2.11 CH3 – Setup 80

#### 7.7.2.12 CH4 – Setup 116

**+4 V Offset Output, Amplifier In**

Equipment: DMM, BNC to BNC cable, 50Ω Feed through termination, Dual banana to BNC adapter

Preparation:

1. Configure the DMM as follows:
   Function: DCV
   Range: 10 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 8, 44, 80 and 116 – respectively

Adjustment:

4. CAL:VAL for DMM reading of +4 V, ± 25 mV

#### 7.7.2.13 CH1 – Setup 9

#### 7.7.2.14 CH2 – Setup 45

#### 7.7.2.15 CH3 – Setup 81

#### 7.7.2.16 CH4 – Setup 117

**-1 V Offset 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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 9, 45, 81 and 117 – respectively

Adjustment:

4. CAL:VAL for DMM reading of -1 V, ± 5 mV

#### 7.7.2.17 CH1 – Setup 10

#### 7.7.2.18 CH2 – Setup 46

#### 7.7.2.19 CH3 – Setup 82

#### 7.7.2.20 CH4 – Setup 118

**-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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 10, 46, 82 and 118 – respectively

Adjustment:

4. CAL:VAL for DMM reading of -3 V, ± 15 mV

#### 7.7.2.21 CH1 – Setup 11

#### 7.7.2.22 CH2 – Setup 47

#### 7.7.2.23 CH3 – Setup 83

#### 7.7.2.24 CH4 – Setup 119

**-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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 11, 47, 83 and 119 – respectively

Adjustment:

4. CAL:VAL for DMM reading of -4 V, ± 25 mV

### 7.7.2.25 CH1 – Setup 12
### 7.7.2.26 CH2 – Setup 48
### 7.7.2.27 CH3 – Setup 84
### 7.7.2.28 CH4 – Setup 120

**(+) 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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 12, 48, 84 and 120 – respectively

Adjustment:

4. CAL:VAL for DMM reading of +500 mV, ±5 mV; Note reading

### 7.7.2.29 CH1 – Setup 13
### 7.7.2.30 CH2 – Setup 49
### 7.7.2.31 CH3 – Setup 85
### 7.7.2.32 CH4 – Setup 121

**(-) 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 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 13, 49, 85 and 121 – respectively

Adjustment:

4. CAL:VAL for DMM reading of -500 mV, ±5 mV

## 7.7.3 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.

### 7.7.3.1 CH1 – Setup 14

### 7.7.3.2 CH2 – Setup 50

### 7.7.3.3 CH3 – Setup 86

### 7.7.3.4 CH4 – Setup 122

**9 V Amplitude, 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: ACV
   Range: 10 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 14, 50, 86 and 122 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 3.182 V ±30 mV

### 7.7.3.5 CH1 – Setup 15

### 7.7.3.6 CH2 – Setup 51

### 7.7.3.7 CH3 – Setup 87

### 7.7.3.8 CH4 – Setup 123

**7 V Amplitude, 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: ACV
   Range: 10 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 15, 51, 87 and 123 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 2.475 V ±25 mV

#### 7.7.3.9 CH1 – Setup 16
#### 7.7.3.10 CH2 – Setup 52
#### 7.7.3.11 CH3 – Setup 88
#### 7.7.3.12 CH4 – Setup 124

**5 V Amplitude, 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: ACV
   Range: 1 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 16, 52, 88 and 124 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 1.767 V ±20 mV

#### 7.7.3.13 CH1 – Setup 17
#### 7.7.3.14 CH2 – Setup 53
#### 7.7.3.15 CH3 – Setup 89
#### 7.7.3.16 CH4 – Setup 125

**3 V Amplitude, 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: ACV
   Range: 1 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 17, 53, 89 and 125 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 1.060 V ±10 mV

#### 7.7.3.17 CH1 – Setup 18

#### 7.7.3.18 CH2 – Setup 54

#### 7.7.3.19 CH3 – Setup 90

#### 7.7.3.20 CH4 – Setup 126

**1.1 V Amplitude, 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: ACV
   Range: 1V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 18, 54, 90 and 126 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 388.9 mV ±3 mV

#### 7.7.3.21 CH1 – Setup 19

#### 7.7.3.22 CH2 – Setup 55

#### 7.7.3.23 CH3 – Setup 91

#### 7.7.3.24 CH4 – Setup 127

**1 V Amplitude, 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: ACV
   Range: 1 V
2. Connect the 2074 Channel 1 output to the DMM input. Terminate the 2074 output at the DMM input with the, 50 Ω Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 19, 55, 91 and 127 – respectively

Adjustment:

4. Adjust CAL:VAL for DMM reading of 353.5 mV ±3 mV

### 7.7.4 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.

#### 7.7.4.1 CH1 – Setup 20
#### 7.7.4.2 CH2 – Setup 56
#### 7.7.4.3 CH3 – Setup 92
#### 7.7.4.4 CH4 – Setup 128

**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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 20, 56, 92 and 128 – respectively

Adjustment:

4. Adjust the Fine Amplitude of the Oscilloscope to get the signal of 6 divisions on the screen.

#### 7.7.4.5 CH1 – Setup 21
#### 7.7.4.6 CH2 – Setup 57
#### 7.7.4.7 CH3 – Setup 93
#### 7.7.4.8 CH4 – Setup 129

**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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 21, 57, 93 and 129 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.9 CH1 – Setup 22
#### 7.7.4.10 CH2 – Setup 58
#### 7.7.4.11 CH3 – Setup 94
#### 7.7.4.12 CH4 – Setup 130

**35 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:

   CAL:NUM 22, 58, 94 and 130 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.13 CH1 – Setup 23
#### 7.7.4.14 CH2 – Setup 59
#### 7.7.4.15 CH3 – Setup 95
#### 7.7.4.16 CH4 – Setup 131

**50 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:

   CAL:NUM 23, 59, 95 and 131 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.17 CH1 – Setup 24
#### 7.7.4.18 CH2 – Setup 60
#### 7.7.4.19 CH3 – Setup 96
#### 7.7.4.20 CH4 – Setup 132

**50.00001 MHz Amplitude**

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100mV
2. Connect the 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 24, 60, 96 and 132 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.21 CH1 – Setup 25
#### 7.7.4.22 CH2 – Setup 61
#### 7.7.4.23 CH3 – Setup 97
#### 7.7.4.24 CH4 – Setup 133

**60 MHz Amplitude**

Equipment: 50 Ω, 20 dB Feed through termination, Oscilloscope

Preparation:

1. Configure the Oscilloscope as follows:
   Input Impedance: 50 Ω
   Range: 100mV
2. Connect the 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 25, 61, 97 and 133 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.25 CH1 – Setup 26
#### 7.7.4.26 CH2 – Setup 62
#### 7.7.4.27 CH3 – Setup 98
#### 7.7.4.28 CH4 – Setup 134

**70 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 26, 62, 98 and 134 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.29 CH1 – Setup 27

#### 7.7.4.30 CH2 – Setup 63

#### 7.7.4.31 CH3 – Setup 99

#### 7.7.4.32 CH4 – Setup 135

**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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 27, 63, 99 and 135 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.33 CH1 – Setup 28

#### 7.7.4.34 CH2 – Setup 64

#### 7.7.4.35 CH3 – Setup 100

#### 7.7.4.36 CH4 – Setup 136

**1 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 28, 64, 100 and 136 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.4.37 CH1 – Setup 29
### 7.7.4.38 CH2 – Setup 65
### 7.7.4.39 CH3 – Setup 101
### 7.7.4.40 CH4 – Setup 137

**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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 29, 65, 101 and 137 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.4.41 CH1 – Setup 30
### 7.7.4.42 CH2 – Setup 66
### 7.7.4.43 CH3 – Setup 102
### 7.7.4.44 CH4 – Setup 138

**35 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 30, 66, 102 and 138 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.4.45 CH1 – Setup 31
### 7.7.4.46 CH2 – Setup 67
### 7.7.4.47 CH3 – Setup 103
### 7.7.4.48 CH4 – Setup 139

**50 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 31, 67, 103 and 139 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.4.49 CH1 – Setup 32
### 7.7.4.50 CH2 – Setup 68
### 7.7.4.51 CH3 – Setup 104
### 7.7.4.52 CH4 – Setup 140

**50.00001 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 32, 68, 104 and 140 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.4.53 CH1 – Setup 33
### 7.7.4.54 CH2 – Setup 69
### 7.7.4.55 CH3 – Setup 105
### 7.7.4.56 CH4 – Setup 141

**60 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20d B Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 33, 69, 105 and 141 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.57 CH1 – Setup 34
#### 7.7.4.58 CH2 – Setup 70
#### 7.7.4.59 CH3 – Setup 106
#### 7.7.4.60 CH4 – Setup 142

**70M Hz 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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 34, 70, 106 and 142 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

#### 7.7.4.61 CH1 – Setup 35
#### 7.7.4.62 CH2 – Setup 71
#### 7.7.4.63 CH3 – Setup 107
#### 7.7.4.64 CH4 – Setup 143

**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 2074 Channel 1 output to the Oscilloscope input. Terminate the 2074 output at the Oscilloscope input with the, 50 Ω, 20 dB Feed through termination
3. Configure the 2074 as follows:
   CAL:NUM 35, 71, 107 and 143 – respectively

Adjustment:

4. Adjust CAL:VAL to get the signal of 6 divisions on the screen.

### 7.7.5 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.

#### 7.7.5.1 (CH1 – Setup 36)

#### 7.7.5.2 (CH2 – Setup 72)

#### 7.7.5.3 (CH3 – Setup 108)

#### 7.7.5.4 (CH4 – Setup 144)

**Pulse Response, Amplifier Out**

Equipment: Oscilloscope, BNC to BNC cable, 20dB Feedthrough attenuator

Preparation:

1. Configure the 2074 as follows:
   CAL:NUM 36, 72, 108 and 144 – respectively
2. Connect the 2074 Channel 1 output to the oscilloscope input. Set oscilloscope input impedance to 50 Ω
3. Set oscilloscope vertical sensitivity to 20 mV

Adjustment:

4. Adjust vertical trace to 6 divisions
5. Adjust RV3 (CH1), RV4 (CH2), RV1 (CH3) and RV2 (CH4) for best pulse response (4 ns type, 5% aberrations)

#### 7.7.5.5 (CH1 – Setup 37)

#### 7.7.5.6 (CH2 – Setup 73)

#### 7.7.5.7 (CH3 – Setup 109)

#### 7.7.5.8 (CH4 – Setup 145)

**Pulse Response, Amplifier In**

Equipment: Oscilloscope, BNC to BNC cable, 20 dB Feedthrough attenuator

Preparation:

1. Configure the 2074 as follows:
   CAL:NUM 37, 73, 109 and 145 – respectively
2. Connect the 2074 Channel 1 output to the oscilloscope input. Use 20dB Feedthrough attenuator at the oscilloscope input
3. Set oscilloscope input impedance to 50 Ω
4. Set oscilloscope vertical sensitivity to 0.1 V

Adjustment:

5. Adjust vertical trace to 6 divisions
6. Adjust C1036 (CH1), C1073 (CH2), C13 (CH3) and C25 (CH4) for best pulse response (4 ns type, 5% aberrations)

## 7.8 Updating 2074 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 on 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 2074, check the revision level which is installed in your instrument. 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. The revision level of your firmware can be displayed as shown in Figure 7-3. To access this screen, select the TOP menu, then select the Utility soft key and scroll down to the System option. Press Enter and the screen will show with the system information. Check both the Software Version and the Version Date as both should match with the latest release.

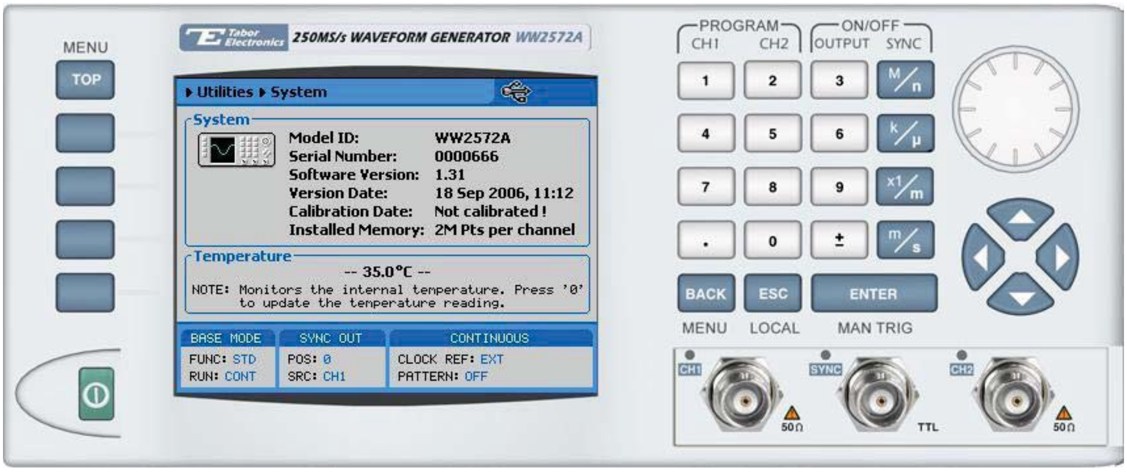


Figure 7-3, Software Version Screen

**NOTE**

**Firmware updates are performed with the LAN set as the active interface and with the 2074 communicating with the PC through the network.**

To update the 2074 firmware, you will have to run the **NETConfig** utility. If you do not have this utility installed on your computer, run the installation procedure from the enclosed CD. You will not be able to update firmware without the NETConfig utility. To invoke this utility, complete the following steps:

1. Turn power **OFF** on your 2074
2. Click on NETConfig shortcut on the desktop or select Start »Programs» Tabor Electronics» NETConfig» NETConfig 1.0

The NETConfig window lists Tabor devices found on your subnet. Figure 7-4 shows an example of this display.

3. Click on the "Use wait message" to select this option as shown in Figure 7-4.


Figure 7-4, The NETConfig Utility

4. Turn power **ON** on your 2074 and observe that the progress bar, as shown in Figure 7-5, is advancing from left to right. Do not do anything on the 2074 until the progress bar completes its travel to the right end.

**Tips**

**If the progress bar is not moving check the following for possible problems:**

**1. If you are connecting to a LAN network, make sure your device is connected with standard LAN wire to your wall plug**

**2. If you use direct connection from your PC to the 2074, your cable should be cross wired. You can get such cable from any computer store near your area**

**3. If your network is using a managed switch, it is possible that it is configure to break the package with broadcast address and therefore, the only way to use NetConfig is to connect the instrument directly to the PC with a cross wired cable**


Figure 7-5, Check for Progress Bar Movement

5. As soon as the progress bar reached the far right hand of the bar, click on the Refresh button. If your device was connected and booted correctly, the device address will appear in the device list, as shown in Figure 7-6.

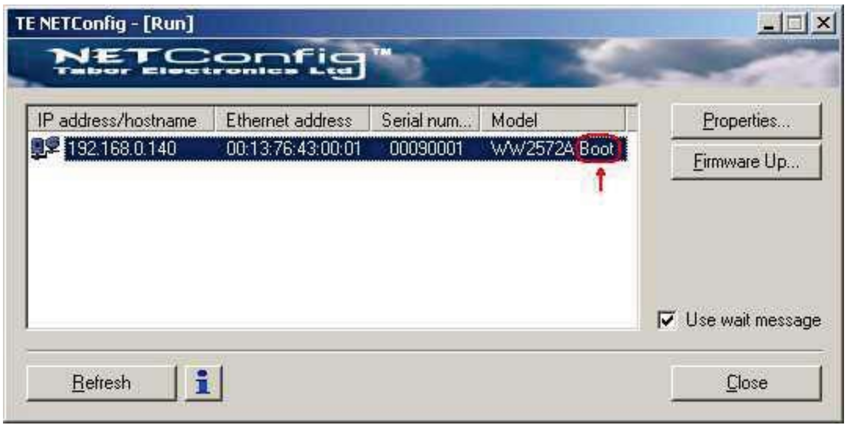


Figure 7-6, WW2074 has been Detected on the LAN Network

**NOTES**

- Click Refresh again if you do not see your device in the list of Ethernet devices. If you cannot detect your device after a few attempts check that you have not lost the connection as described in previous paragraphs.
- You can only update instrument(s) that appear in the NETConfig window.

Point and click on the device you want to update. The selected device will now have blue background. Click on the Firmware Up... button. The firmware Update dialog box as shown in Figure 6-7 appears.


Figure 7-7, The Firmware Update Dialog Box

In the TE NETConfig [Firmware Update] dialog box click on the  button to browse and locate the upgrade file. After you select the file its complete path will be displayed in the Flash binary image filename field as shown in Figure 7-8. Make sure the file in the path agrees with that specified by your supervisor. To complete the update process, click on Update and observe the File Transfer Progress bar. The update will complete with a Firmware Update d Successfully message, as shown in Figure 7-9.

Click on Back to close NETConfig Firmware Update dialog box and turn off the power to the 2074. The next time you power up the instrument, the device automatically reboots with the new firmware in effect.


Figure 7-8, Firmware Update Path


Figure 7-9, Firmware Update Completed

# 8 Appendix A Specifications

**Note**

- Except where noted, the specifications are the same for models WW5064, WW1074 and 2074.

## 8.1 Waveform Parameters

Table 8.1 Waveform Parameters

| | |
|---|---|
| **Configuration** | |
| Output Channels | 4, semi-independent |
| **Inter-Channel Dependency** | |
| Separate Controls | Output on/off, amplitude, offset, filters, standard waveforms, user waveforms and size, sequence table. |
| Common Controls | Sample clock, frequency, reference source, run modes and SYNC output. |
| **Leading Edge Offset** | |
| Description | Channel 1 waveform used as start reference, channels 2, 3 and 4 can be offset by a programmable number of points. Channels 3 and 4 must have the same duration in one of the following run modes: Triggered, Burst, or gated. |
| Jitter Between Channels | 0 ps |
| Offset Units | Waveform points |
| Range | 0 to ±2 M points, each channel in reference to channel 1 |
| Resolution and Accuracy | 1 point, channel 1/2; 4 points, channels ¾ |
| Skew | ±(1 SCLK +1 ns) (50Ω cables, equal length) between channels; 1 ns between channels 3 and 4. |
| **Multiple Instruments Synchronization** | |
| Description | Multiple instruments can be connected together and synchronized to provide multi-channel synchronization. Phase (leading edge) offset between master and slave units is programmable. |

| **Leading Edge Offset** | |
|---|---|
| Description | Leading edge is programmable in reference to an adjacent unit. |
| Offset Units | Seconds |
| Range | 200 ns to 20 s |
| Resolution and Accuracy | 20 ns |
| Initial Skew | <±(15 ns + 1 sample clock cycle) between adjacent instruments, depending on cable length and quality, typically with 1 meter coax cables. |
| **Sample Clock** | |
| Range | 1.1 S/s to 200 MS/s, Model 2074;<br>1.5 S/s to 100 MS/s, Model 1074;<br>1.5 S/s to 50 MS/s, Model 5064 |
| Resolution | 10 digits |
| Accuracy and Stability | Same as reference |
| 10MHz Reference Clock | |
| Standard | ≥0.0001% (1 ppm TCXO) initial tolerance over a 19 °C to 29 °C temperature range; 1ppm/°C below 19 °C and above 29 °C; 1ppm/year aging rate |
| External | |
| Frequency | 10 MHz |
| Connector | Rear Panel SMB |
| Impedance/Level | 10 kΩ ±5 %, TTL, 50 % ±2 % duty cycle (factory default); or, 50 Ω ±5 %, 0 dBm sinewave (Internal jumper setting) |
| **Amplitude Characteristics** | |
| Amplitude | 20 mV to 20 Vp-p, output open circuit<br>10 mV to 10 Vp-p, into 50Ω |
| Resolution | 4 digits |
| Accuracy (measured at 1 kHz into 50Ω) | |
| 10mV to 99 mVp-p | ±(1% of setting + 5 mV) |
| 100mV to 999 mVp-p | ±(1% of setting +10 mV) |
| 1 V to 10 Vp-p | ±(1% of setting + 70 mV) |
| DC Offset Range | 0 to ±4.995 V |

| | |
|---|---|
| Accuracy | ±(1% +1% of amplitude setting +5 mV) |
| Resolution | 1 mV |
| **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. Each channel has its own set of filters. |
| Type | 25 MHz Bessel<br>50 MHz Bessel<br>60 MHz Elliptic<br>120 MHz Elliptic |
| **Run Modes** | |
| Description | Define how waveforms start and stop. Run modes description applies to all waveform types and function, except where noted. Continuous operation is specified across the entire sample clock frequency range. |
| Continuous | Continuously free-run output of a waveform. Output 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 numbers of waveform cycles. (Does not apply to Sequence Mode). Burst is programmable from 1 through 1 M 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 | Rear panel BNC, or front panel manual |

| | |
|---|---|
| | trigger button. |
| BUS | Trigger commands from a remote controller only. |
| Mixed | Senses an external trigger first, consecutive triggers are expected from remote commands only. |
| 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 5 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 |
| **Standard Waveforms** | |
| Frequency Range | |
| Sine, Square | 10 mHz to 80 MHz, Model 2074;<br>10 mHz to 40 MHz, Model 1074;<br>10 mHz to 20 MHz, Model 5064 |
| All other waveforms | 10 mHz to 20 MHz, some are usable above 20 MHz |
| Frequency Resolution | 11 digits |
| Accuracy & Stability | Same as frequency standard. |

| | |
|---|---|
| Sine | |
| Start Phase Range | 0 to 360.0° |
| Start Phase Resolution | 0.1° |
| Triangle | |
| Start Phase Range | 0 to 360.0° |
| Start Phase Resolution | 0.1° |
| Square | |
| Duty Cycle Range | 0% to 99.9% |
| Pulse and Ramp Functions | |
| 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 |
| Sine Wave Performance | |
| Description | Sine wave performance is measure at 5 Vp-p. Sine Wave Performance applies to STD and ARB. |
| THD | 0.1% to 100 kHz |
| Flatness | 5 % to 10 MHz<br>7 % to 80 MHz |
| Harmonics | -25 dBc, <80 MHz<br>-30 dBc, <50 MHz<br>-45 dBc, <10 MHz |
| Non-harmonics | -60dBc, <80 MHz<br>-65dBc, < 50 MHz |
| Phase Noise | |
| 100 Hz Offset | -70dBc/Hz |
| 1 kHz Offset | -85dBc/Hz |
| 10 kHz Offset | -92dBc/Hz |
| 100 kHz Offset | -112dBc/Hz |
| 1 MHz Offset | -140dBc/Hz |

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|---|---|
| Square Wave, Pulse Performance | |
| Rise/Fall Time (10%-90%) | <4.5 ns |
| Aberration | <(6% +10 mV) |
| **Half-Cycle Waveforms** | |
| Function Shape | Sine, Triangle, Square (All channels share the same mode, function shape may be programmed separately for each channel) |
| 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) |
| Delay Resolution | 20 ns |
| **Arbitrary Waveforms** | |
| Vertical Resolution | 16 bits |
| Waveform Segmentation | Permits division of 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 1 M points (2 M optional). |
| Custom Waveform Creation Software | ArbConnection software allows instrument control and creation of custom waveforms either freehand, with equations or built-in functions or with imported waveforms |
| **Sequenced Waveforms** | |
| Operation | Segments may be linked and repeated in a user-selectable fashion to generate extremely long waveforms. Segments are advanced using either a command or a trigger. |
| Sequences | 10 |
| Sequencer Steps | 1 to 4096 |

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|---|---|
| Segment Loops | 1 to 1 M |
| Minimum Segment Duration | 500 ns |
| Minimum Segment Size in a Sequence | 16 points |
| 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). |
| **Modulated Waveforms** | |
| Operation | The instrument can output two separate I & Q signals using channels 1/2 and 3/4. Carrier waveform may be turned on and off to directly drive vector generator inputs. |
| Modulation Schemes | (n)PSK and (n)QAM |
| (n)PSK and (n)QAM | |
| Carrier Waveform | Sine wave |
| Carrier Control | On or Off, programmable |
| Carrier Frequency | 10 Hz to 50 MHz, Model 2074;<br>10 Hz to 25 MHz, Model 1074;<br>10 Hz to 12.5 MHz, Model 5064; |
| Modulation Type | |
| (n)PSK | BPSK, QPSK, OQPSK, □/4 DQPSK, 8PSK, 16PSK and User Defined |
| (n)QAM | 16QAM, 64QAM, 256QAM and User |

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|---|---|---|---|
| | Defined | | |
| Symbol Rate Range | 1 symbol/s to 1e6 symbols/s | | |
| Symbol Period Accuracy | ±(500 ns + Carrier Period) | | |
| Table Size | 2 to 4096 | | |
| **Wireless Signal Generation Characteristics** | | | |
| Description | Wireless signals are generated using Modular software. These signals are downloaded to the 2074 through GPIB, LAN or USB interface. The output was characterized using the following test conditions: Sample Clock = External; Sample Clock Frequency = as specified; Modulation = QPSK; Baseband Filter = Raised Cosine; Alfa = 0.35. ACLR was characterized using the following test conditions: BW = Symbol Rate; Offset = 1.35 x Symbol Rate | | |
| EVM | 0.1 MSym/s | 1 MSym/s | 5 MSym/s |
| 10 MHz | 0.15% (1) | 0.30% (1) | 1.40% (1) |
| 80 MHz | 0.25% (2) | 0.50% (2) | 1.20% (2) |
| ACPR | 0.1 MSym/s | 1 MSym/s | 5 MSym/s |
| 10 MHz | 73 dB (1) | 73 dB (1) | 65 dB (1) |
| 80 MHz | 64 dB (2) | 64 dB (2) | 60 dB (2) |
| | (1) Sample Clock Frequency = 100 MS/s | | |
| | (2) Sample Clock Frequency = 200 MS/s | | |
| **Counter/Timer** | | | |
| Operation | The instrument 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 | | |

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| | times |
| Period, Pulse Width | |
| Range | 1 µs to 50 ms |
| Resolution | 100 ns |
| Totalize | |
| Frequency Range | 20 Hz to 100 MHz |
| Accumulation Range | $2^{32}$-1 |
| Overflow Indication | LED, turns on when capacity is exceeded |
| General | |
| Input | Rear Panel TRIG IN, BNC connector |
| Trigger Level Range | ±5 V |
| Sensitivity | 500 mVp-p |
| Damage Level | ±12 V |
| Minimum Pulse Width | ≥5 ns |
| Slope | Positive/Negative transitions, selectable |
| Gate Time | 100 µs to 1 s |
| Display 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 |
| **Digital Pulse Generator** | |
| Operation | The generator 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. |

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| 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.<br>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.<br>3. The sum of all pulse parameters must not exceed the pulse period setting. |
| Channel Dependency | All channels share pulse parameters except level, polarity, delay and state. |
| Pulse State | On or Off. On generates pulse output; Off generates 0 Vdc. |
| Pulse Mode | Single or double, programmable |
| Polarity | Normal, inverted or complemented |
| Minimum Period | 16 / SCLK |
| Minimum increment | 1.4 / SCLK |
| Delay | 0 ns min; 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 +4.990 V |
| High Level | -4.990 V to +5 V |

## 8.2 Outputs

Table 8.2 Outputs

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|---|---|
| **Main Outputs** | |
| Connector | Front panel BNC, each channel<br>Impedance: 50Ω ±1% |
| Protection | Short Circuit to Case Ground, 10 s max |
| Standby | Output On or Off (Output Disconnected) |
| **SYNC Outputs** | |
| Connectors | Rear panel BNC connectors, separate for each channel |
| Level | TTL |
| Sync Type | Pulse with Arbitrary and Standard Waves; LCOM in Sequence and Burst Modes. |

## 8.1 General

Table 8.3 General

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|---|---|
| **General** | |
| **GPIB Information** | |
| Connector | Rear panel 25-pin D connector |
| GPIB Revision | IEEE-488.2 |
| SCPI Revision | 1993.0 |
| Logical Address Settings | 1 - 31, configured via front panel programming |
| DMA | Downloads arbitrary waveform data, arbitrary FM waveform data and sequence table data. DMA support is required by the controller. |
| **Ethernet** | |
| Connector | Rear panel RJ-45, female |
| Physical Layer | 10/100Base-T |
| IP address | Programmed from the front panel or through the USB port |
| Baud Rate | 10/100Mbit/sec, auto negotiated |
| Protocol | SCPI commands over TCP/IP. |

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| **USB** | |
| Connector | Type A receptacle |
| Specifications | Version 1.0/version 2.0 |
| Protocol | SCPI commands over USB |
| **Front Panel Display** | |
| | Color LCD, 3.8" reflective, 320 x 240 pixels, back-lit. |
| **Front Panel Indicator LEDs** | |
| Output On | Green – Output on / off (each channel) |
| **Power Requirements** | |
| Mains Input Range | 100 to 240Vac, nominal, 47-63 Hz |
| Maximum Total Module Power | 60 W |
| Current Rating | 0.5 A |
| **Mechanical** | |
| Dimensions | 212 x 88 x 415 mm (W x H x D) |
| Weight | Approximately 3.5 kg |
| **Environmental & Certification** | |
| Operating temperature | 0°C - 40°C, RH 85% to 45%, respectively. 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. |
| EMC Certification | CE marked |
| Safety | EN61010-1, 2nd revision |