



588 Series Pulse Generator
Operating Manual

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Introduction

Introduction

This manual is a reference designed to familiarize you with the Berkeley Nucleonics 588 series pulse generator and is arranged so that you can easily find the information you're looking for. Generally, each topic has its own section and no section assumes that you've read anything else in the manual.

Technical Support

For questions or comments about operating the 588 -- our technical staff can be reached via one of the following methods:

- Phone - (415) 453-9955
- Fax - (415) 453-9956
- Internet - www.berkeleynucleonics.com

Warranty

In addition to a 30-day money back guarantee, the 588 has a two-year limited warranty from the date of delivery. This warranty covers defects in materials and workmanship. Berkeley Nucleonics will repair or replace any defective unit. Contact us for information on obtaining warranty service.

Package Contents

The box you receive should contain the following:

- 588 Pulse Generator
- AC Power Cord
- User's Manual on Disk

Contact Berkeley Nucleonics (415) 453-9955 if any parts are missing.

Safety Issues

Normal use of test equipment presents a certain amount of danger from electrical shock because testing must be performed where exposed voltage is present.

An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 VDC or RMS AC should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltages pose an even greater threat because such voltage can easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

- If possible, familiarize yourself with the equipment being tested and the location of its high-voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
- Do not expose high voltage needlessly. Remove housing and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after shutting down power.
- When testing AC powered equipment, remember that AC line voltage is usually present on power input circuits, such as the on-off switch, fuses, power transformer, etc.
- Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment. Make certain such surfaces are not damp or wet.
- Use the time-proven “one hand in the pocket” technique while handling an instrument probe. Be particularly careful to avoid contact with metal objects that could provide a good ground return path.
- Never work alone. Someone should always be nearby to render aid if necessary. Training in CPR first aid is highly recommended.

Front Panel Overview

Front Panel Overview

588 Front Panels

Display Layout and Indicators

A 4 line x 20 character vacuum fluorescent display module displays parameters and status information. The status information is located in the upper-left corner of the display, between the two brackets. There are four enunciators:

- Vertical Arrow Indicates there are additional pages to the current menu.
- Blinking Light Indicates the unit is actively generating pulses, or armed and waiting for an external trigger.
- Musical Note Indicates the function key has been pressed.
- Question Mark In external oscillator operation, indicates the internal pll is not yet locked with the external clock signal.

The upper-right side of the display contains the title of the currently displayed menu. The rest of the display is used for system parameters. The display brightness may be adjusted, allowing the instrument to be used under various lighting conditions.

Description of Front-Panel Area

Keypads

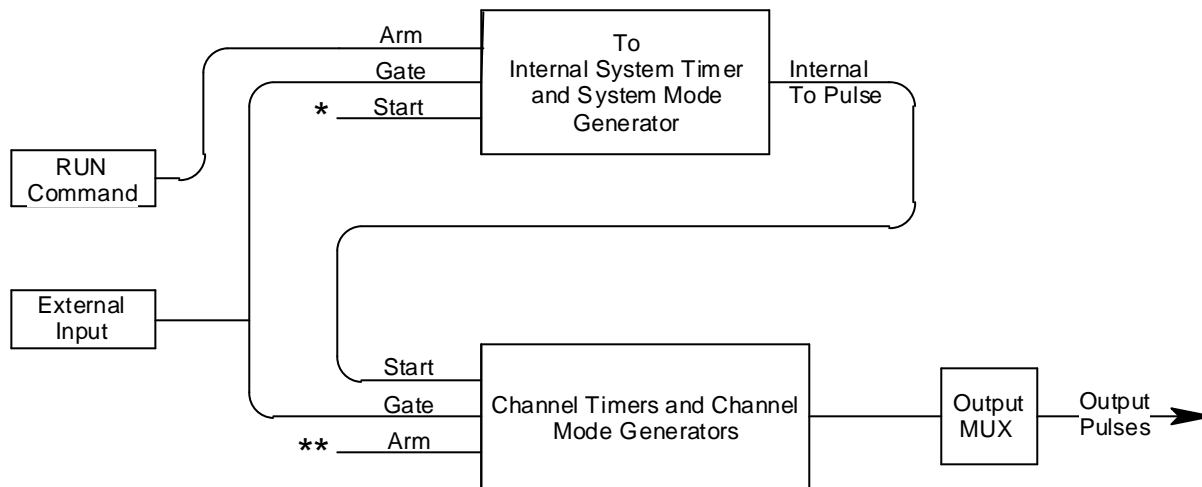
Three keypad areas provide fast access to various menus and easy editing of system parameters.

- Menu Keypad Provides one touch access to the channel, trigger, gate and system menus for setting up the appropriate parameters. The Page button will allow you to page through the multiple levels of a menu, if multiple levels exist.
- Arrow Keypad The up/down arrows are used to increment/decrement the current parameter (indicated by the blinking cursor). The position of the cursor controls the step size for each increment. The right/left arrow moves the cursor to different positions within the current parameter. The **NEXT** key selects the next parameter in the currently displayed menu.

**Pulse Concepts and
Pulse Generator Operations**

Pulse Concepts and Pulse Generator Operation

Counter Architecture Overview



*Start source is: RUN button in Internal Modes
External input in External Trigger modes
*TRG command via Serial/GPIB access

**Channels are armed by the RUN button. In single shot and burst modes channels may be rearmed by pressing the RUN button.

System Timer Functions

The System Timer functions as a non-retriggerable, multi-vibrator pulse generator. This means that once started, depending on the mode, the timer will produce pulses continuously. Before pulses can be generated, the timer must be armed and then receive a start pulse. Arming the counter is done by pressing the **RUN/STOP** key. With external trigger disabled, the **RUN/STOP** key also generates the start command for the counter. With external trigger enabled, the external trigger provides the start pulse. In either case, once started, the counter operation is determined by the System Mode Generator. Standard modes include:

- Continuous Once started T_0 pulses are generated continuously.
- Single Shot One T_0 pulse is generated for each start command.
- Burst 'n' T_0 pulses are generated for each start command.
- Duty Cycle Once started T_0 pulses cycle on and off continuously.

The T_0 pulses are distributed to all of the start inputs of the Channel Timers and Mode Generators

Channel Timer Functions

The Channel Timer functions as a non-retriggerable, delayed, one shot pulse generator. This means that the timer will only generate one delayed pulse for every start pulse received. Once the channel timer has started counting, additional start pulses will be ignored until the pulse has been completed (non-retriggerable). The start pulse for each channel is provided by the internal T_0 pulse generated by the Internal System Timer. Whether or not a pulse is generated for each T_0 pulse is determined by the Channel Mode Generator. Standard modes include:

- Normal A pulse is generated for each T_0 pulse.
- Single Shot One pulse is generated at the first T_0 pulse, after which output is inhibited.
- Burst A pulse is generated for each T_0 pulse, 'n' times, after which output is inhibited.
- Duty Cycle 'n' pulses are generated for each T_0 pulse after which the output is inhibited for 'm' times. The cycle is then repeated.

Different modes may be selected for each output, allowing a wide variety of output combinations. Each output may also be independently disabled or gated (using the external gate input).

Digital Output Multiplexer

The output of the Channel Timers are routed to a set of multiplexers. This allows routing of any or all Channel Timers to any or all of the unit outputs. In the normal mode of operation, the output of the nth Channel Timer is routed to the Tnth output connector. As an example, if a double pulse is required on Channel A output, one can multiplex the Channel A timer with the Channel B timer adjusting each timer to provide the necessary pulses.

Dependent & Independent Timing Events

The 588 allows the user to control the relationship between the Channel Timers by setting the sync source for each timer. Independent events are all timed relative to the internal T_0 start pulse. Dependent events may be linked together by setting the sync source to the controlling event. This allows the instrument to match the timed events and adjustments can be made in one event without detuning the timing between it and a dependent event.

Navigating the 588 Front Panel

Selecting Menus

Parameters are grouped in menus, selectable using the function keys. To select the output channel parameters press the letter key corresponding to the desired channel. Menus may include a number of different pages, each page containing up to four parameters. The status block in the upper-left corner of the display shows a vertical arrow if the current menu contains additional pages.

Press the Page button to select the next page. There may be multiple channel menus depending on the model. Secondary menu can be accessed by pressing the letter key of that channel a second time.

There are also individual menu keys for the gate (GATE), trigger (TRIG), and system (MENU) menus. Depending on the model, each of these menus may have multiple pages, accessed by the Page button, or secondary menu, accessed by pressing that particular function key a second time.

Selecting Menu Items

Within a menu, the blinking cursor indicates the current menu item for editing. The **NEXT** key will select a different menu item.

Numeric Input Mode

When the current item is numeric, the system enters the Numeric Input Mode. In this mode data may be edited using the arrow keypad. The Left and Right arrow keys are used to select a digit to edit. The selected digit blinks to identify itself as the active digit. The Up and Down arrow keys are then used to increment or decrement this digit.

Entering Non-Numeric Parameters

When the current item is non-numeric, the Up and Down arrow keys are used to select among different options for the parameter. If the item is an on-off toggle, the Up arrow enables the item and the Down arrow disables the item.

Enabling System Output

The RUN/STOP key is used to arm the system. With external trigger disabled, the key will arm and start pulse output. With external trigger enabled, the key will arm the pulse generator. Pulse output then starts after the first valid trigger input. Pressing the RUN/STOP key a second time disables the pulse generator.

Enable/Disable Channel Output

At the top of each channel menu page is a parameter to enable or disable the output of the channel. Each channel may be individually enabled or disabled.

Rearming the Channel Timers

If there are channels currently running in normal mode, single shot and burst channels can be re-armed without affecting the timing on normal mode channels. The rearming page is located under the System Menu. Once on the rearming page, pressing the up arrow rearms the channel timers.

Setting Pulse Timing Parameters

Pulses are defined by a delay, from their sync or start pulse to the active edge, and a width.

Wid: Sets the width of the active portion of the pulse.
 Dly: Sets the delay from the sync source to the start of the pulse.

NOTE: If $Wid + Dly + 75ns$ (hardware reset time) $> T_o$ Period, the correct pulse width will be generated but at a slower rate.

Setting Pulse Output Parameters

There are three basic types of outputs available on the 588: (a) TTL/CMOS compatible outputs; (b) adjustable amplitude outputs.

Out: Selects between TTL/CMOS Mode and Adjustable mode when both are available on a single output.
 Pol: Sets the voltage polarity of the pulse, active high or active low. Note: All outputs are positive - negative voltages are not supported.
 Ampl: In adjustable mode, the unloaded output voltage is set. The actual output voltage will depend on the load impedance. For example: If the load is 50 ohms, the output will be 50% of the stated voltage.

Using the Output Multiplexer

Each output channel includes a multiplexer which allows routing any or all of the timer outputs to the physical output. This allows double pulses and other complex pulse trains to be generated.

MUX: -HGFEDCBA-
 -00000101-

The multiplexer is represented by a “n” bit binary number as shown above. “n” is the number of channels. Each bit represents a channel timer, which is enabled by setting the bit to one. In the above example, timers A and C are combined on the current output.

Setting System Internal Rate Parameters

The internal T_o period controls the fundamental output frequency of the system. Each channel may operate at submultiples of the fundamental frequency using their duty cycle mode.

Source: Sets the reference source for the internal T_o Period.
 Per: Sets the internal T_o Period.

To set the system Internal Rate, press the Menu key and then use the arrow keys to specify the T_o Period.

588 Menus

588 Menu Structure

System MODE Menus

To Mode	To Mode	To Mode	To Mode
MODE: Continuous	MODE: Single Shot	MODE: Burst	MODE: Duty Cycle
		# / Burst	# / On
			# / Off

CHANNEL Menus

Timing Parameters	Pulse Configuration	Pulse Configuration
Channel Enable	Channel Enable	Channel Enable
Sync Source	Polarity	Polarity
Pulsewidth	Output Type: TTL, Optical	Output Type: Adjustable
Delay		Output Level

Channel Mode	Channel Mode	Channel Mode	Channel Mode	Wait Menu
Channel Enable	Channel Enable	Channel Enable	Channel Enable	
Mode: Normal	Mode: Single Shot	Mode: Burst	Mode: Duty Cycle	
			# / On	
		# / Burst	# / Off	Wait Count

Advanced CHANNEL Menus

Multiplexer Menu	Channel Gated Operation	Channel Gated Operation
Channel Enable	Channel Enable	Channel Enable
Mux	Gate Enable	Gate Enable: <method>
Help Line		Logic

CLOCKS/RATE Menu

Rate	Rate Source	Reference Out
Source	Source	Ref Out
T ₀ Period		

TRIG Menu

Trig Mode	Trig Mode
Trig Disabled	Trig: Triggered
	Level
	Edge

GATE Menu

Gate Mode	Gate Mode
Gate Disabled	Gate: Mode
	Level
	Logic

SYSTEM Menus

Comm. Parameters	Comm. Parameters	Comm. Parameters	Keypad Parameters	Misc. Parameters
Interface: RS232	Interface: USB	Interface: GPIB/Ethernet	Key Repeat Rate	Auto Start
Baud Rate		Address	Key Volume	Decimal Mark
Echo Enable			Knob Volume	LCD Brightness

STORE Menu

Store Menu
Configuration #
Name
Help Line

COUNTER Menu

Counter Menu
Enabled/Disabled
T Counts
Help Line

RECALL Menu

Recall Menu
Configuration #
Name
Help Line

INFORMATION Menu

Information Menu
Model Number
Serial Number
Firmware Version
FPGA Version

System Mode Menu

To Mode	To Mode	To Mode	To Mode
MODE: Continuous	MODE: Single Shot	MODE: Burst	MODE: Duty Cycle
			# / On
		# / Burst	# / Off

Setting System Mode of Operation

The MODE menu sets the T_o system timer mode. The menu will show the extra set parameters (Burst, On & Off) only when they are appropriate.

- Mode: Selects the T_o mode: Continuous, Single Shot, Burst or Duty Cycle mode.
- Burst: Sets the number of pulses to be generated when in Burst mode.
- On: Sets the number of pulses to be generated during each on cycle.
- Off: Sets the number of pulses to skip each during off cycle when in the Duty Cycle mode.

**NOTE: Any mode may be started by either the RUN/STOP key in the internal trigger mode or armed by the RUN/STOP key and started by an external trigger in the external trigger mode. In the single shot and burst modes, (internally triggered) the unit disarms itself at the end of the pulse train. Pressing the RUN/STOP key after the unit has been disarmed will generate a new pulse train.*

Channel Menus

Timing Parameters	Pulse Configuration	Pulse Configuration
Channel Enable	Channel Enable	Channel Enable
Sync Source	Polarity	Polarity
Pulsewidth	Output Type: TTL	Output Type: Adjustable
Delay		Output Level

Channel Mode	Channel Mode	Channel Mode	Channel Mode	Wait Menu
Channel Enable	Channel Enable	Channel Enable	Channel Enable	
Mode: Normal	Mode: Single Shot	Mode: Burst	Mode: Duty Cycle	
			# / On	
		# / Burst	# / Off	Wait Count

Enabling Channel Output

At the top of each of the channel menu pages is a parameter to enable or disable the channel. Each channel may be individually controlled.

Setting the Channel Timing Parameters

To define a pulse requires two parameters: the delay to the active edge and the width of the pulse.

Wid:	Sets the channel pulse width.
Dly:	Sets the channel delay until the active edge.

Setting Pulse Output Configuration

The 588 supports two types of outputs: a high speed TTL/CMOS compatible output and for applications which require different voltage levels or higher current, an adjustable voltage output. The pulses can also be defined to be active high or active low.

Pol:	Sets the pulse polarity, active high or active low.
Out:	Selects the output mode, TTL/CMOS or Adjustable
Ampl:	Sets the output voltage level when in the Adjustable mode.

Setting Channel of Operation

Each channel may be set independently to operate in one of four modes: normal, single shot, burst, or duty cycle (within the **CHANNEL** menus):

Mode:	Selects the mode for the current channel. Additional parameters are provided for the burst mode and the duty cycle mode.
Brst:	Sets the number of pulses in the burst mode to generate before inhibiting output.
On:	Sets the number of pulses to generate before inhibiting output in Duty Cycle Mode.
Off:	Sets the number of pulses to inhibit before repeating the On Cycle in Duty Cycle Mode.

Delaying the Start of Channel Output

Within any channel mode, the output of the channel can be delayed using the wait parameter (within the **CHANNEL** menu):

Wait:	Sets the number of T_o pulses to wait until enabling the channel output.
-------	--

Configuring the Channel Multiplexer

To define which channels are fed into the channel multiplexer, the corresponding bit for the desired channel to add should be set to 1.

All desired omitted channels should have the corresponding bit set to 0.

Mux: Enable/disable bitfield.

Advanced Channel Menus

Advanced Timing Parameters	Channel Gated Operation	Channel Gated Operation
Channel Enable	Channel Enable	Channel Enable
SyncSource	Gate Enable: Disabled	Gate Enable: <method>
		Gate Polarity

Setting the Sync Source

Although each channel receives its start pulse from the internal T_0 pulse, logically the start pulse can be assigned such that the delay entered is relative to the T_0 pulse or any other channel pulse. This allows dependent events to link. The unit will not allow a circular chain of sync sources that would result in a channel triggering itself. The delay entered is relative to the selected sync source.

Sync Source: Selects the channel sync source.

Setting Channel Gate Control

When the global gate is set (Chan Menu), the channel can then use the gate input with independent behavior from other channels.

Gate: Enables the **GATE** input for the channel by setting the method of output control used with the gating function.
 Logic: Sets the logic level used with the gating function, either active high or active low.

“Pulse Inhibit” method - the gate prevents the channel from being triggered by the channel’s trigger source pulse. If a pulse has already started when the gate disables the channel, the pulse will continue normal output but will not restart on the next trigger pulse.

“Output Inhibit” method - the gate leaves the base triggering alone and enables/disables the output directly.

Gate Menu

Gate Mode	Gate Mode
Gate: Disabled	Gate: <method>
	Level
	Logic

Enabling System Gate

Enables the use of the GATE input as a trigger inhibit or output control for all channels simultaneously, or on a per channel basis.

- Mode: Selects between disabling the **GATE** inputs and method of output control
- Level: Sets the gating threshold.
- Logic: Sets the active logic level.

Trig Menu

Trig Mode	Trig Mode
Trig: Disabled	Trig: <trig mode>
	Level
	Edge

Enabling System Trigger

Enable the use of the **TRIG** input by the system timer as a trigger source.

- Mode: Selects between disabling/enabling the trigger mode(s).
- Level: Sets the trigger threshold.
- Edge: Selects between rising edge / falling edge as the trigger source when a trigger mode is enabled.

Rate Menu

Rate Source	Reference Out
Source	Ref Out
To Period	

Setting the Clock Source and Internal Rate

- Source: Selects the internal or external clock source from which the unit will operate.
- Per: Sets the T_o period which determines the fundamental output frequency of the unit.

Setting the Output Reference

- Ref Out: Selects the frequency of the output reference for synchronizing with external system components.

System Menu

Comm. Parameters	Comm. Parameters	Comm. Parameters	Keypad Parameters	Misc. Parameters
Interface: RS232	Interface: USB	Interface: GPIB/Ethernet	Key Repeat Rate	Auto Start
Baud Rate		Address	Key Volume	Decimal Mark
Echo Enable			Knob Volume	LCD Brightness

Setting System Communication Parameters

The 588 comes with a standard RS232 serial port and USB port. The unit will not respond to computer commands unless these ports are properly configured.

Interface:	RS232, USB, Ethernet
Baud Rate:	Selects the baud rate for the selected interface.
Echo:	Selects whether to echo characters back to the host computer or not.
Address:	Sets the GPIB address.

Setting Keypad Parameters

The rate at which a key will repeat itself when held down may be set. This can be used to provide a controlled rate at which a parameter is incremented. In addition, the volume of the beep can be controlled for both the keypad and the adjustable knob.

Key Rate:	Sets the rate at which the keys will repeat when held down.
Key Vol:	Sets the beep volume for the keypad.
Knob Vol:	Sets the beep volume for the Rotary Knob.

Setting the Auto Start Mode

The unit may be configured to automatically start generating pulses after power up.

Setting the Display Decimal Mark

Mark:	Selects the format of the decimal mark, "." or ",".
-------	---

Setting the Display Brightness

LCD	Adjusts display brightness.
-----	-----------------------------

Store Menu

Store Menu
Configuration #
Name
Help Line

Storing a Configuration

Use the following procedure to store a complete system configuration:

- Set all parameters to the desired value.
- Select a configuration number.

**NOTE: You cannot store to the zero location, as that contains the factory default values.*

- Label the configuration as desired.
- From the Store menu, press the store button sequence (FUNC + store).

Recall Menu

Recall Menu
Configuration #
Name
Help Line

Recalling System Configurations

Use the following procedure to recall a stored or default system configuration:

- Enter the Recall Menu (FUNC + recall).
- Select a configuration number.
- From the Recall Menu, press the recall key sequence (function + recall).

**Note: Configuration 0 is the factory default setting.*

Counter Menu

Counter Menu
Enable/Disable
T Counts
Help Line

Using the Counter Function

The Counter function counts the number of T_o pulses output by the system clock. When the unit is operated in system single shot mode, the T_o count reflects the number of incoming trigger pulses.

Information Menu

Information Menu
Model Number
Serial Number
Firmware Version
FPGA Version

The Information Menu provides all of the pertinent version numbers and serial numbers for the unit. This information should be readily available when contacting customer service for troubleshooting help.

Operating the 588

Quick Start - Normal Internal Rate Generator Operation

The 588 has a powerful set of functions providing a number of modes of operation for the internal or “System” rate generator (T_o). Most of these functions can be ignored if a simple continuous stream of pulses is required. Starting from the default settings, which can be restored by recalling configuration 0, the following parameters need to be set:

Pulse Width, Delay	Enter the Channel menus by pressing the letter key. Enter the required pulse width and delay. Repeat for each output channel.
T_o Period	Enter the Rate menu by pressing the FUNC key and then the RATE key. Set the desired pulse period. Note that in general, the pulse delay plus the pulse width, plus a 75ns hardware reset constant, for any channel must be less than the T_o period.
Start	Press the RUN/STOP key to start generating pulses.
Stop	Press the RUN/STOP key a second time to stop generating pulses.

Quick Start - Normal External Trigger Operation

To generate a single pulse for every external trigger event, based on the default configuration 0, the following parameters need to be set:

System Mode	Enter the MODE menu by pressing the FUNC key and then the MODE key. Select Single Shot mode.
Trig	Enter the TRIG menu by pressing the TRIG key. Select Triggered.
Level	Press the NEXT key until the Level parameter is highlighted. Set the trigger threshold voltage to approximately 50% of the trigger signal amplitude.

Edge	Press the NEXT key until the Edge parameter is highlighted. Set the instrument to trigger off the rising edge or falling edge as desired.
Pulse Width, Delay	Enter the Channel menus by pressing the letter key. Enter the required pulse width and delay. Repeat for each output channel.
Start	Press the RUN/STOP key to start/arm the instrument. The 588 will now generate a pulse for every valid trigger.
Stop	Press the RUN/STOP key a second time to stop/disarm the instrument (i.e. to stop generating pulses).

System Timer Overview

For internal operation, the 588 contains a timer and mode generator which generates an internal T_0 clock that is used to trigger all the channel timers. System modes are controlled via the **MODE** menu.

To Use Continuous Mode

The **RUN/STOP** button starts and stops a continuous pulse stream at the rate specified by the Rate menu. This corresponds to the normal output mode for most pulse generators. To generate a continuous stream of pulses:

To generate a continuous stream of pulses:

- within the system **Mode** menu

Mode Select Continuous for the system mode.

- within the **Rate** menu

Source Select the system oscillator or the external clock in frequency.

Period Set the desired period.

Pressing the **RUN/STOP** key will now generate a stream of T_0 pulses, at a rate specified by the period parameter.

To Use Single Shot Mode

To generate a single pulse with every press of the **RUN/STOP** key:

- within the system **Mode** menu

Mode Select Single Shot for the system mode.

Pressing the **RUN/STOP** key will now generate a single pulse.

To Use System Burst Mode Function

The **RUN/STOP** button generates a stream of “n” T_o pulses, where “n” is specified by the Burst parameter. The rate is specified in the Rate menu. Pressing the **RUN/STOP** button while the burst is in process will stop the output. After the burst has been completed, pressing the **RUN/STOP** button will generate another burst. To generate a burst of pulses:

- within the system **Mode** menu

- Mode: Select the Burst mode.
- Burst: Set the number of pulses to produce in the burst.

To Use System Duty Cycle Function

The **RUN/STOP** button starts a continuous pulse stream which oscillates on for the “n” pulses and off for “m” pulses, where “n” and “m” are specified by the On and Off parameters, respectively. The rate is specified in the Rate Menu. To generate a stream of pulses which oscillates on for ‘n’ pulses and off for ‘m’ pulses:

- within the system **Mode** menu

- Mode: Select the Duty Cycle mode.
- On: Set the number of pulses to produce during the on cycle.
- Off: Set the number of pulses to skip during the off cycle.

-within the **Rate** menu

- Source Select the system oscillator or the external clock in frequency.
- Period: Set desired Period.

Channel Timer Overview

The output of each channel is controlled by two timers to generate the delay timing and the pulse width. All channels are simultaneously triggered, depending on the system mode, by either the internal T_o pulse, the external trigger, or a trigger provided by a cpu. A given channel may or may not generate a pulse depending on its own channel mode as described below.

To Use Channel Normal Mode Function

The Normal mode generates a continuous stream of pulses at a rate determined by the system timer:

- within the **Channel** menus

- Enable: Select Enable to enable channel output.
- Dly: Set the desired delay.
- Wid: Set the desired pulse width.
- Mode: Select the Normal mode.

Pressing the **RUN/STOP** key will now generate a continuous stream of pulses.

To Use Channel Single Shot Function

The Single Shot mode generates a single pulse every time the **RUN/STOP** key is pressed. To use the Single Shot mode:

- within the **Channel** menus

Enable	Select Enable to enable channel output.
Delay	Set the desired delay.
Width	Set the desired pulse width.
Mode	Select the Single shot mode.

To Use Channel Burst Mode Function

The Burst mode generates a burst of pulses every time the **RUN/STOP** key is pressed. To use the Burst mode:

-within the **Channel** menus

Enable	Select Enable to enable channel output.
Delay	Set the desired delay.
Width	Set the desired pulse width.
Mode	Select the Burst mode.
#/Burst	Set the number of pulses to produce in the burst.

To Use the Channel Duty Cycle Function

To generate a stream of pulses which oscillates on for 'n'pulses and off for 'm' pulses:

- within the **Channel** menus

Enable	Select Enable to enable channel output.
Delay	Set the desired delay.
Width	Set the desired pulse width.
Mode	Select the Duty Cycle mode.
On Cycle	Set the number of pulses to produce during the on cycle.
Off Cycle	Set the number of pulses to skip during the off cycle.

Note: Older Berkeley Nucleonics pulse generators had a divide-by-n function. The duty cycle mode is a more general case. To reproduce the divide-by-n function, set the on cycle to 1 and set the off cycle to (n-1), where "n" is the divide-by-n factor.

To Use the Channel Gating Function

Each channel may use the external input to gate or control its output. The gate controls the triggering of the channel. To use the gate, set the following parameters

- within the **Channel** menu

Mode: In Gate Menu must be set to Channel Menu.
Channel Gate: Select Pulse Inh or Output Inh.
Logic: Select active high or active low.

In “Pulse” inhibit method, the gate prevents the channel from being triggered by the channel’s trigger source pulse. If a pulse has already started when the gate disables the channel, the pulse will continue normal output but will not restart on the next pulse. In “Output” inhibit method, the gate leaves the base triggering alone and enables/disables the output directly. Output pulses will immediately cease when the gate signal is removed

External Input Overview

The external inputs may be used to trigger the unit or to gate the system or channel timers. When using a trigger input, the external input acts as a system start pulse. Depending on the system mode, the result of a trigger input can be either a single pulse, a burst of pulses or the start of a stream of pulses.

To Generate a Pulse on Every Trigger Input

To generate a pulse on every external trigger received, set the following parameters:

- within the **Mode** menu

Mode: Select the Single Shot mode.

- within the **Trigger** menu

Mode: Select Triggered mode.
Level: Set the trigger threshold level.
Edge: Select which edge, rising or falling, to trigger on.

Pressing the **RUN/STOP** key will arm the unit. Once the unit is armed, it will generate a T_0 pulse for every external trigger received. Pressing the **RUN/STOP** key will disarm the unit. This mode corresponds to the normal external trigger mode found on most other pulse generators.

To Generate a Burst of Pulses on Every Trigger Input

To generate a burst of pulses for every external trigger received set the following parameters:

-within the **Mode** menu

Mode: Select the Burst mode.

Burst: Set the number of pulses to generate in each burst.-
within the Rate menu

T_o : Set the period between pulses.

- within the **Rate** menu

Source: Select the system oscillator or an external clock in frequency.

T_o : Set the period between pulses.

- within the **Trigger** menu

Mode: Select Triggered mode.

Level: Set the trigger threshold level.

Edge: Select which edge, rising or falling, to trigger on.

Pressing the **RUN/STOP** key will arm the unit. Once the unit is armed, it will generate a set of pulses for every external trigger received. The unit is reset at the end of a burst and will generate another set of pulses upon receiving a new trigger. Triggers that occur in the middle of a burst are ignored. Pressing the **RUN/STOP** key will disarm the unit.

To Start a Continuous Stream of Pulses Using the External Trigger

The external trigger may be used to start the unit generating pulses:

- within the **Mode** menu

Mode: Select the Continuous mode.

- within the **Rate** menu

Source: Select the system oscillator or an external clock in frequency.

T_o : Set the period between pulses.

- within the **Trigger** menu

Mode: Select the Trigger mode.

Level: Set the trigger threshold level.

Edge: Select which edge, rising or falling, to trigger on.

Pressing the **RUN/STOP** key will arm the unit. Once the unit is armed, it will begin generating pulses after an external trigger is received. Triggers that occur after the pulses start are ignored. Pressing the **RUN/STOP** key a second time will disarm the unit.

To use the External Gate to Control the System

The external gate may be used to control the output of the unit. To gate the system timer:

Gate: Select active high or active low.

Level: Set the threshold voltage for the external input.

Method (advanced): Select Pulse or output (press Function Key and then hit Channel Key; repeat to cycle through Advanced Channel Menu.

- within the **Mode** menu

Mode: Select the desired mode.

- within the **Rate** menu

Source: Select the system oscillator or an external clock in frequency..

Per: Set the period between pulses.

- within the **Gate** menu

Mode: Select Pulse Inh or Output Inh.

Level: Set the gate threshold level.

Logic: Select active high or active low.

Pressing the **RUN/STOP** key will arm the unit. Once the unit is armed, it will begin generating pulses whenever the external gate input is in the active state. Pressing the **RUN/STOP** key a second time will disarm the unit.

Programming the 588

Personal Computer to Pulse Generator Communication

The 588 comes standard with an RS232 serial and USB interface. An Ethernet interface is standard on the 588. All menu settings can be set and retrieved over the computer interface using a simple command language. The command set is structured to be consistent with the Standard Commands for Programmable Instruments. Although due to the high number of special features found in the 588, many of the commands are not included in the specification. The syntax is the same for all interfaces.

RS232 Interface Overview

The serial port is located on the back of the 588 and uses a 9-pin D-type connector with the following pinout (as viewed from the back of the unit):

1	No Connection
2	Tx - Transmit (to computer)
3	Rx - Receive (from computer)
4	DTR - Connected to pin 6
5	Ground
6	DSR - Connected to pin 4
7	RTS - Connected to pin 8
8	CTS - Connected to pin 7
9	No Connection

The serial port parameters should be set as follows:

Baud Rate	4800, 9600 19200, 38400, 57600, 115200*
Data Bits	8
Parity	None
Stop Bits	1

*The default baud rate for the RS232 is 115200.

USB Interface Overview

The USB interface is standard on the 588. Before this type of communication can be used, the appropriate drivers must be installed on the personal computer (pc). These drivers are included on the CD that was shipped with your unit. Please contact Berkeley Nucleonics or visit www.quantumcomposers.com for updated installation files and instructions.

USB communication is achieved by using a mapped (virtual) COM port on the PC. The driver installation executable will obtain an unused COM port number,

install the USB drivers, and make that COM port number available for typical RS232 communication to the pulse generator. Hyperterminal or other common software may be used.

When communicating through the mapped COM port over USB, the baud rate for the communication port used by the USB chip must match the baud rate for the COM port on the PC. Access to the USB port baud rate is done using the SCPI command “:SYSTem:COMMunicate:SERial:USB n” command, where ‘n’ is the desired communication speed. This parameter can be accessed via any communication method. The default baud rate for USB is 38400.

USB communication notes:

- The correct drivers must be installed on the personal computer before communication can be accomplished via USB.
- The BAUD rates on the PC and on the pulse generator must match for successful communication.
- The USB port’s BAUD rate on the pulse generator can be set using the SCPI command “:SYSTem:COMMunicate:SERial:USB n” where ‘n’ can be:
 - o 4800
 - o 9600
 - o 19200
 - o 38400 (default)
 - o 57600
 - o 115200
- USB 1.0 specification is used. The USB cable can be removed without “unplugging” the device in the operating system environment.
- Echo functionality is not available on the USB port.

Ethernet Interface Overview

An Ethernet interface is standard on the 588. Refer to Appendix C included at the end of this manual for more information about the Ethernet Interface and Operation.

Programming Command Types and Format

The 588 Pulse Generator uses two types of programming commands: IEEE 488.2 Common Commands and Standard Commands for Programmable Instruments (SCPI). The format is the same for all interfaces. Hyperterminal (in Windows) or any other generic terminal program may be used to interactively test the commands using the RS232 interface. The format of each type is described in the following paragraphs.

Line Termination

The pulse generator uses text-style line terminations. When a command is sent to the unit, the firmware is programmed to read characters from a communication port until it reads the line termination sequence.

The command string is parsed and executed after reading these characters. These characters are the “carriage return” and “linefeed”. They are ASCII character set values 13 and 10 respectively (hex 0x0D and 0x0A). All command strings need to have these characters appended.

When the pulse generator responds to a command, whether it is a query or a parameter change, it also appends its return strings with these characters. Coded applications could use this behavior to know when to stop reading from the unit. However, if the “echo” parameter is enabled, there will be two sets of line terminators, one following the echoed command string, and one following the pulse generator’s response.

Note: The pulse generator will echo commands on the DB9 serial port only.

The pulse generator responds to every communication string. If the communication string is a query, the unit responds with the queried response (or error code) followed by the line terminators. If the communication string is a parameter change, the response is “ok” (or error code) followed by the line terminators. For this reason, it is not recommended that multiple commands be stacked together into single strings as is common with some other types of instruments. It is recommended that the coded application send a single command in a string and follow immediately by reading the response from the unit. Repeat this sequence for multiple commands.

IEEE 488.2 Common Command Format

The IEEE 488.2 Common Commands control and manage generic system functions such as reset, configuration storage and identification. Common commands always begin with the asterisk (*) character and may include parameters. The parameters are separated from the command mnemonic by a space character. For Example:

```
*RST      <cr> <lf>
*RCL 1    <cr> <lf>
*IDN?     <cr> <lf>
```

SCPI Command Keywords

The commands are shown as a mixture of upper and lower case letters. The upper case letters indicate the abbreviated spelling for the command. You may send either the abbreviated version or the entire keyword. Upper and/or lower case characters are acceptable.

For example, if the command keyword is given as POLarity, then POL and POLARITY are both acceptable forms; truncated forms such as POLAR will generate an error; polarity, pol, and PolAriTy are all acceptable as the pulse generator is not case sensitive.

SCPI Command Format

SCPI commands control and set instrument specific functions such as setting the pulse width, delay and period. SCPI commands have a hierarchical structure composed of functional elements that include a header or keywords separated with a colon, data parameters, and terminators. For example:

SCPI Format

```
:PULSE1:STATE ON           <cr> <lf>
:PULSe1:WIDTh 0.000120     <cr> <lf>
:PULSe:POL NORMal         <cr> <lf>
```

Any parameter may be queried by sending the command with a question mark appended. For example:

- QUERY FORMAT

```
:PULSE1:STATE?
Will return:           <cr><lf>

:PULSE1:WIDT?
Will return:           0.000120000 <cr><lf>

:PULSE1:POL?
Will return:           NORM <cr><lf>
```

SCPI Keyword Separator

A colon (:) must always separate one keyword from the next lower-level keyword. A space must be used to separate the keyword header from the first parameter. If more than one parameter is used, you must separate subsequent parameters with a comma.

SCPI Optional Keywords

Optional keywords and/or parameters appear in square brackets ([]) in the command syntax. Note that the brackets are not part of the command and should not be sent to the pulse generator. When sending a second level keyword without the optional keyword, the pulse generator assumes that you intend to use the optional keyword and responds as if it had been sent.

SCPI Specific and Implied Channel

Some commands, such as PULSe, allow specifying a channel with an optional numeric keyword suffix. The suffix will be shown in square brackets [1 / 2]. The brackets are not part of command and are not to be sent to the pulse generator. The numeric parameters correspond to the following channels: 0 = To, 1 = ChA, 2 = ChB, etc. Only one channel may be specified at a time.

If you do not specify the channel number, the implied channel is specified by the :INSTrument:SELEct command or the last referenced channel.

After power-up or reset (*RST) The instrument default is channel #1.

SCPI Parameter Types

The following parameter types are used:

<numeric value>	Accepts all commonly used decimal representation of numbers including optional signs, decimal points, and scientific notation: 123, 123e2, -123, -1.23e2, .123, 1.23e-2, 1.2300E-01.
<boolean value>	Represents a single binary condition that is either true or false. True is represented by a 1 or ON; false is represented by a 0 or OFF. Queries return 1 or 0.
<identifier>	Selects from a finite number of predefined strings.

Error Codes

The unit responds to all commands with either:
ok <cr><lf> or ?n <cr><lf>

Where "n" is one of the following error codes:

- 1 Incorrect prefix, i.e. no colon or * to start command.
- 2 Missing command keyword.
- 3 Invalid command keyword.
- 4 Missing parameter.
- 5 Invalid parameter.
- 6 Query only, command needs a question mark.
- 7 Invalid query, command does not have a query form.
- 8 Command unavailable in current system state.

Programming Examples

Example 1) 20 ms pulse width, 2.3 ms delay, 10 Hz, internal trigger, continuous operation.

:PULSE1:STATE ON <cr> <lf>	enables channel A
:PULSE1:POL NORM <cr> <lf>	sets polarity to active high
:PULSE:WIDT 0.020 <cr> <lf>	sets pulse width to 20 ms
:PULSE1:DELAY 0.0023 <cr> <lf>	sets delay to 2.3 ms
:PULSE0:MODE NORM <cr> <lf>	sets system mode to continuous
:PULSE0:PER 0.1 <cr> <lf>	sets period to 100 ms (10 Hz)
:PULSE0:TRIG:MODE DIS <cr> <lf>	disables the external trigger

To start the pulses use either of the following commands:

:PULSE0:STATE ON <cr> <lf>	starts the pulses
:INST:STATE ON <cr> <lf>	alternate form to start pulses

Example 2) 25 μ s pulse width, 0 delay, external trigger, one pulse for every trigger.

:PULSE1:STATE ON <cr> <lf>	enables channel A
:PULSE1:POL NORM <cr> <lf>	sets polarity to active high
:PULSE:WIDT 0.000025 <cr> <lf>	sets pulse width to 25 μ s
:PULSE1:DELAY 0 <cr> <lf>	sets delay to 0
:PULSE0:MODE SING <cr> <lf>	sets system mode to single shot
:PULSE:TRIG:MODE TRIG <cr> <lf>	sets system to external trigger
:PULS:TRIG:LEV 2.5 <cr> <lf>	sets trigger level to 2.5 v
:PULS:TRIG:EDGE RIS <cr> <lf>	set to trigger on rising edge

To arm the instrument in external gate mode, use either of the following commands:

:PULSE0:STATE ON <cr> <lf>	arms the instrument
:INST:STATE ON <cr> <lf>	alternate form if T ₀ is currently selected

A software generated external trigger can be generated by using the following command:

*TRG <cr> <lf>	generates a software external trigger
----------------	---------------------------------------

588 SCPI Command Summary

Keyword	Parameter	Std/ New	Comments
:INSTrument		Std	Subsystem. Supports treating each channel as a logical instrument.
:CATalog?		Std	Query only. Returns a comma-separated list of the names of all channels. A two channel instrument would return: T ₀ , CHA, CHB.
:FULL?		Std	Query only. Returns a comma-separated list of the names of all channels and their associated number. A two channel instrument would return: T ₀ , 0, CHA, 1, CHB, 2.
:COMMands?		New	Query only. Returns an indented list of all SCPI commands.
:NSElect	<numeric value>	Std	Selects a channel using the channel's numeric value. All channel specific commands will refer to the selected channel.
:SElect	<identifier>	Std	Selects a channel using the channel's identifier string. All subsequent channel specific commands will refer to the selected channel.
:STATe	<boolean value>	Std	Enables/Disables the selected channel output. If T ₀ is selected all output is affected. Enabling T ₀ is the same as pressing the RUN button.

588 SCPI Command Summary

Keyword	Parameter	Std/ New	Comments
:PULSe[0]		Std	Subsystem. Contains commands to control the output pulse generation. Commands without suffix refer to the currently selected logical instrument. See INSTrument subsystem.
:COUNter		New	Subsystem. Contains commands to define the Counter function.
:STATe	<boolean value>	New	Enables/Disables the counter function.
:CLear	TCNTS/GCNTS	New	Clears the designated counter. Standard units only have the Trigger counter.
:COUNter?	TCNTS/GCNTS	New	Queries the number of counts for the specified input. Standard units only have the Trigger counter.

588 SCPI Command Summary

Keyword	Parameter	Std/ New	Comments
:STATe	<boolean value>	Std	Enables / Disables the output for all channels. Command is the same as pressing the RUN/STOP button.
:PERiod	<numeric value>	Std	Sets the To period.
:MODE	NORMAL / SINGLE / BURSt / DCYClE	New	Sets the To mode.
:BCOunter	<numeric value>	New	Burst Counter. Number of pulses to generate in the Burst mode.
:PCOunter	<numeric value>	New	Pulse Counter. Number of pulses to generate during on cycle of the Duty Cycle mode.
:OCOunter	<numeric value>	New	Off Counter. Number of pulses to inhibit output during the off cycle of the Duty Cycle mode.
:ICLock	SYS/ EXT10/ EXT20/ EXT25/ EXT40/ EXT50/ EXT80/ EXT100	New	Sets Source for the internal rate generator. System Clock or External Source ranging from 10MHz to 100MHz.
:OCLock	To 5Mhz, 10Mhz 20Mhz, 40Mhz Chan, Rate	New	Sets external clock output. To Pulse or 50% duty cycle TTL output.
:GATe		New	Subsystem. Contains the commands to define the Gate function.
:MODE	DIS/PULS/OUTP/ CHAN	New	Sets Global Gate Mode. Disable, pulse inhibit, output inhibit, channel.
:LOGic	LOW / HIGH	New	Sets Channel Gate logic level. Active low or active high.
:LEVel	<numeric value>	New	Sets the gate threshold. Value is in volts with a range of .20 to 15 Volts.
:TRIGger		New	Subsystem. Contains the commands to define the Trigger function.
:MODE	DIS / TRIG	New	Sets Trigger Mode. Disable or TRIG (enable).
:EDGE	RISing / FALLing	New	Selects which edge (rising or falling) to use as the trigger signal.
:LEVel	<numeric value>	New	Sets the Trigger Threshold. Value is in volts, with a a range of .20 to 15 Volts.

588 SCPI Command Summary

Keyword	Parameter	Std/ New	Comments
:PULSe [1 / 2 / n]		Std	Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA = 1, ChB = 2, etc). Command without suffix refers to the currently selected logical instrument. See INSTRUMENT subsystem.
:STATe	<boolean value>	Std	Enables/Disables the output pulse for selected channel.
:WIDTh	<numeric value>	Std	Sets the width or duration of the output pulse.
:DELay	<numeric value>	Std	Sets the time from the start of the To period to the first edge of the pulse.
:SYNC	TO, CHA, CHB, CHC, CHD, etc.	New	Selects the Sync source.
:MUX	<numeric value>	New	Selects which timers are enabled as output for the current channel.
:POLarity	NORMAL / COMPLEMENT / INVERTed	Std	Sets the polarity of the pulse. For NORMAL operation the second nominal state is more positive than the first. COMPLEMENT and INVERTed are aliases. For both, the second state is more negative than the first.
:OUTPut		New	Subsystem. Contains command to control output mode.
:MODE	TTL / ADJUSTable /	New	Selects output AMPLitude mode: TTL/CMOS, ADJUSTable.
:AMP	<numeric value>	New	Sets adjustable output level.
:CMODE	NORMAL / SINGLE / BURSt / DCYCLE	New	Channel Mode. Sets the channel pulse series output mode.
:BCOUNTER	<numeric value>	New	Burst Counter. Sets the number of pulses to generate when channel is in the BURST mode.
:PCOUNTER	<numeric value>	New	Pulse Counter. Sets the number of pulses to generate during the on cycle of the Duty Cycle Mode.
:OCOUNTER	<numeric value>	New	Off Counter. Number of pulses to inhibit output during the off cycle of the Duty Cycle mode.
:WCOUNTER	<numeric value>	New	Sets the number of To pulses to delay until enabling output.
:CGATE	DIS / PULS / OUTP	New	Sets Channel Gate Mode. Disable, pulse inhibit, output inhibit. (Global Gate Mode must be set to CHAN for this command to be available).
:CLOGic	LOW / HIGH	New	Sets Channel Gate Logic level. Active low or active high. (Global Gate Mode must be set to CHAN for this command to be available).

588 SCPI Command Summary

Keyword	Parameter	Std/ New	Comments
:SYSTem		Std	
:STATe?		New	Query only. Returns the state of the machine: returns "1" if the machine is armed and/or generating pulses or "0" if the machine has been disarmed.
:BEEPer		Std	Subsystem. Controls the audible beeper.
:STATe	<boolean value>	Std	Enables/disables the beeper.
:VOLume	<numeric value>	Std	Sets the volume of the beeper. Range is 0 to 100, where 0 is off and 100 is maximum volume.
:COMMunicate		Std	Subsystem. Controls the RS232 and GPIB interfaces.
:GPIB		Std	Subsystem. Controls the physical configuration of the GPIB port.
:ADDRes	<numeric value>	Std	Sets the GPIB of the instrument.
:SERial		Std	Subsystem. Controls the physical configuration of the RS232 port.
:BAUD	4800 / 9600 / 19200 / 38400 / 57600 / 115200 /	Std	Sets the baud rate for both receiving and transmitting using the DB9 RS232 port.
:USB	4800 / 9600 / 19200 / 38400 / 57600 / 115200 /	New	Sets the baud rate for communication when using mapped comports for USB and Ethernet communication. Must be set to the default value (115200) for raw TCP/IP communication (i.e. Labview).
:ECHO	<boolean value>	New	Enables/Disables transmission of characters received on the DB9 serial port.
:KLOCK	<boolean value>	New	Locks the keypad.
:AUTorun	<boolean value>	New	After power-up, unit will start generating pulses automatically.
:VERSion?		Std	Query only. Returns SCPI version number in the form: YYYY.V ex. 1999.0
:SERN?		New	Query only. Returns the serial number.
:INFORmation?		New	Query only. Returns model, serial number, firmware version, and FPGA version numbers.
:NSID?		New	Query only. Returns firmware and FPGA identification numbers.
:CAPS	<boolean value>	New	Forces unit to recognize commands only sent in capital letters. 1 turns on the feature - 0 disables the feature.

Keyword	Parameter	Std/ New	Comments
:DISPlay		Std	Subsystem. Contains commands to control the display.
:MODE	<boolean value>	New	Enables/Disables automatic display update. When true, front panel display is updated with serial command parameter changes. Setting to false decreases response time.
:UPDate?		New	Query only. Forces update of display. Use when mode is false.
:BRiGhtness	<numeric value>	New	Controls intensity of display. Range is 0 to 4, where 0 is off and 4 is full intensity.
:ENABle	<boolean value>	New	Enables/Disables the display and front panel lights. When Disabled the keylock is enabled to prevent parameter changes from the front panel.

IEEE 488.2 Common Commands

Mnemonic	Command Name	Parameters	Comments
*IDN?	Identification Query		Queries the Pulse Generator Identification. The ID will be in the following format: model#-#channels-option#-version#
*RCL	Recall Command	<numeric value>	Restores the state of the Pulse Generator from a copy stored in local nonvolatile memory (0 through 12 are valid memory blocks).
*RST	Reset Command		Resets the Pulse Generator to the default state.
*SAV	Save Command	<numeric value>	Stores the current state of the Pulse Generator in local nonvolatile memory (1 through 12 are valid memory blocks).
*TRG	Trigger		Generates a software trigger pulse. Operation is the same as receiving an external trigger pulse.
*LBL	Setup Label	<string value>	Query Form returns the label of the last saved or recalled configuration. Command Form sets the label string for the next "**sav" command. String must be in double quotes, 14 characters max.
*ARM	Channel Trigger Reset		Resets channel triggers when channels are set to single shot or burst mode. Functions like pressing the function then run/stop button.

Appendix

Appendix A - Specifications

588 Specifications

PULSE GENERATION

RANGE	
DELAY	0 - 1000s
WIDTH	10ns - 1000s
RESOLUTION	250ps
TIMEBASE	50MHz
TIMEBASE ACCURACY	25PPM

INTERNAL RATE GENERATOR

RATE (T_o period)	0.0002Hz to 10.000MHz
RESOLUTION	10ns
ACCURACY	Same as timebase
JITTER	50ps
BURST MODE	1 to 9,999,999

TTL/ADJUSTABLE OUTPUTS

NUMBER	2, 4 or 8 Channel Output
LOAD	50 ohm
RISE TIME (10% - 90%)	3ns typ TTL 15ns typ @ 20V (high imp) Adj 25ns typ @ 10V (50 ohms) Adj
SLEW RATE	>0.5V/ns TTL >0.1V/ns Adj
OVERSHOOT	<100mV + 10% of pulse amplitude
LEVELS	TTL 0 to 4 VDC high imp 2.0 to 20.0 VDC high imp 1.0 to 10.0 VDC into 50 ohm
RESOLUTION	10mV
ACCURACY	1ns + .0001 x Setpoint

EXTERNAL INPUTS

TRIGGER INPUTS

NUMBER	0, 2 or 4
RATE	DC to 1/ (200ns + longest delay)
THRESHOLD	0.2 to 15VDC
MAXIMUM INPUT VOLT.	60V Peak
RESOLUTION	10mV
IMPEDANCE	1000 ohm
SLOPE	Rising or Falling
IMPEDANCE	1000 ohm
JITTER	800ps RMS
INSERTION DELAY	<180ns
MINIMUM PULSE WIDTH	2ns

GATE INPUTS

THRESHOLD	0.2 to 15 VDC
MAXIMUM INPUT VOLT.	60V Peak
RESOLUTION	10mV
POLARITY	Active High/Active Low
FUNCTION	Pulse Inhibit or Output Inhibit
CHANNEL BEHAVIOR	Global w/Individual Channel
PULSE INHIBIT DELAY	120ns
OUTPUT INHIBIT DELAY	50ns

STANDARD FEATURES/FUNCTIONS

COMMUNICATIONS	USB/RS232
GLOBAL GATES/TRIGGERS	2 Global Gate/Trigger Inputs
CHANNEL GATES/TRIGGERS	Optical/Electrical Available (5ns Jitter)
EXTERNAL CLOCK IN	10MHZ - 100MHZ in 1MHz increments 0.02V
EXTERNAL CLOCK OUT	To, Rate, Chan, 2X ExtPLL, 1X ExtPLL, 1/2x ExtPLL, 1/2 Ext, 40MHz, 20MHz, 10MHz, 5MHz, Disabled
COMMAND SET COMPATIBILITY	Backwards Compatible

OPTIONS

COM	Extended Communications (Ethernet, GPIB)
-----	--

MODULES

Standard Quad TTL/Adjustable








Appendix B - Safety Symbols

Safety Marking Symbols

Technical specifications including electrical ratings and weight are included within the manual. See the Table of Contents to locate the specifications and other product information. The following classifications are standard across all BNC products:

- Indoor use only
- Ordinary Protection: This product is NOT protected against the harmful ingress of moisture.
- Class 1 Equipment (grounded type)
- Main supply voltage fluctuations are not to exceed +/-10% of the nominal supply voltage.
- Pollution Degree 2
- Installation (overvoltage) Category II for transient overvoltages
- Maximum Relative Humidity: <80% RH, non-condensing
- Operating temperature range of 0° C to 40° C
- Storage and transportation temperature of -40° C to 70° C
- Maximum altitude: 3000 m (9843 ft.)
- This equipment is suitable for continuous operation.

This section provides a description of the safety marking symbols that appear on the instrument. These symbols provide information about potentially dangerous situations which can result in death, injury, or damage to the instrument and other components.

Symbols	Publications; Descriptions & Comments
	IEC 417, No. 5031 Direct current - Vdc may be used on rating labels.
	IEC 417, No. 5032 Alternating current - For rating labels, the symbol is typically replaced by V and Hz as in 230V, 50Hz. DO NOT USE Vac.
	IEC 417, No. 5033 Both direct and alternating current.
	IEC 617-2 No. 02-02-06 Three-phase alternating current.
	IEC 417, No. 5017 Earth (ground) terminal - Primarily used for functional earth terminals which are generally associated with test and measurement circuits. These terminals are not for safety earthing purposes but provide an earth reference point.
	IEC 417, No. 5019 Protective conductor terminal - This symbol is specifically reserved for the protective conductor terminal and no other. It is placed at the equipment earthing point and is mandatory for all grounded equipment .
	IEC 417, No. 5020 Frame or chassis terminal - Used for points other than protective conductor and functional earth terminals where there is a connection to accessible conductive terminals to advise the user of a chassis connection.



IEC 417, No. 5021

Equipotentiality - Used in applications where it is important to indicate to the operator that two or more accessible functional earth terminals or points are equipotential - More for functional rather than for safety purposes.



IEC 417, No. 5007

On (Supply) - Note that this symbol is a bar, normally applied in the vertical orientation. It is not the number 1.



IEC 417, No. 5008

Off (Supply) - Note that this symbol is a true circle. It is not the number 0 or the letter O.



IEC 417, No. 5172

Equipment protected by double insulation or reinforced insulation (equivalent to Class II if IEC 60536).



ISO 3864, No. B.3.6 Background colour - yellow; symbol and outline – black

Caution, risk of electric shock - Generally used only for voltages in excess of 1000 V. It is permissible to use it to indicate lower voltages if an explanation is provided in the manual. Colour requirements do not apply to markings on equipment if the symbol is moulded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in colour with the background.



IEC 417, No. 5041 Background colour - yellow; symbol and outline – black

Caution, hot surface - Colour requirements do not apply to markings on equipment if the symbol is moulded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in colour with the background.



ISO 3864, No. B.3.1 Background colour - yellow; symbol and outline – black

Caution - (refer to accompanying documents) used to direct the user to the instruction manual where it is necessary to follow certain specified instructions where safety is involved. Colour requirements do not apply to markings on equipment if the symbol is moulded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in colour with the background.



IEC 417, No. 5268-a
In-position of bistable push control.



IEC 417, No. 5269-a
Out-position of bistable push control.

Appendix C - COM

Ethernet Interface Overview

The Ethernet module used is a “Digi Connect ME” module supplied by Digi Connectware, Inc. There are several ways to successfully communicate with the pulse generator over Ethernet. The two most popular methods are raw TCP/IP (such as Labview or programming with VISA libraries) and by mapping a pc COM port using the Digi Connectware’s “Realport Drivers”.

Whatever method of Ethernet communication is ultimately desired, the utilities supplied by Digi Connectware (included on the cd shipped with the Ethernet-option Pulse Generator) will be critical to implementing the communications. Please install the following utilities:

Ethernet Communication Notes:

- The Digi Connectware’s “Digi Device Discovery” can be used to determine what IP address was assigned by the local DHCP server (if any).
- “Digi Device Discovery” can also be used to open a web interface to the Ethernet module. Simply double-click on the IP address that is displayed in the Digi Device Discovery utility.

Username: “root”
Password: “dbps”

- If a mapped COM port is the desired communication method, the Digi Connectware’s “Realport Drivers” setup must be used to install the COM port on the pc. The virtual COM port is then local to the computer it was installed on. Please refer to the Digi Connectware Documentation supplied on the CD, or call Berkeley Nucleonics Technical Support.
- The pulse generator’s SCPI parameter “.SYSTEM:COMMunicate:SERial:USB n” is defaulted to 115200 and should not be changed for Ethernet communication, whether or not a mapped COM port is used. The virtual COM port on the pc should be set to 115200 BAUD.
- Echo functionality is not available on the Ethernet port.

Appendix D - Ethernet Connectivity

IP Address and Raw TCP/IP Connection

This document describes one of the most popular methods of setting up Ethernet communication for the Berkeley Nucleonics pulse generators. The method discussed is Raw TCP/IP communication.

The Ethernet module used in Berkeley Nucleonics pulse generators is a “Digi Connect ME” device manufactured by Digi International, Inc. It supports virtually all practical Ethernet communication methods. A set of utilities and documentation by Digi is included on the CD shipped with the pulse generator.

This discussion assumes that the Digi utilities included with your pulse generator and National Instruments VISA (version 3.3 in this procedure, see National Instruments’ website) are installed. The procedures discussed have been prepared using Windows XP service pack 2.

Determining IP Address

The Digi module has been reset to factory defaults before it left the manufacturing facility. In this mode, it is ready to be assigned an IP address by the local DHCP server. If a crossover cable is being used, the Ethernet device will assume a default IP address.

The Digi utility “Digi Device Discovery” can be used to determine the IP address that is currently assigned to the Ethernet module. Hit “Start, All Programs, Digi Connect, Digi Device Discovery”. When the utility opens, it scans the LAN looking for Digi Ethernet modules. It may take a minute after plugging in or powering the Ethernet module before the LAN negotiates the connection with the Digi module. Hit “Refresh View” in the left column after a minute or so if the utility fails to see the unit when you start it. In some situations it is possible that the Windows Firewall will block the Digi Device Discovery from being able to see the unit. It is advisable to turn the Windows Firewall off while performing these tasks. When the utility sees the Digi device, it will display it in the list (Figure 1).

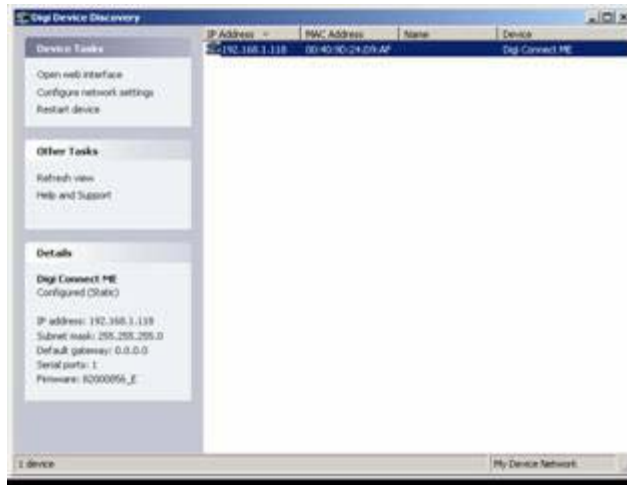


Figure 1: Digi Device Discovery utility displaying Digi module discovered on the LAN.

From this point, a web interface can be opened, allowing access to configuration options for the Digi module. If you are required to enter a username and password, they are as follows:

- Username: “root”
- Password: “dbps”

If a static IP address is desired, this change can be made from the web interface. Please note, however, that if the IP address is changed such that it is incompatible with the LAN, all communication including access to the module’s settings (including the IP address!) will no longer be possible over the LAN. If this happens, a crossover cable must be used to access the Digi module’s settings (again using Digi Device Discovery). Temporarily set the pc’s IP address to be compatible with the Digi module’s IP address to get the pc and pulse generator to ‘see’ each other over the crossover cable.

Appendix E - Dual Trigger Input

DT15 Dual Trigger Module

This module option allows the “Gate” input to function as a second trigger input. For consistency, the enabling menu for this option is located under the “Trig” menu structure. Once the dual trigger mode is enabled, both the “Gate” and “Trig” inputs can act as trigger inputs.

Adjustments for the “Gate” trigger input are located under the “Gate” menu structure. The voltage threshold level and trigger edge for the “Gate” input can be adjusted from this menu. The “Gate” trigger edge choice is only available when in dual trigger mode.

Once dual trigger functionality is enabled on the unit, each channel can be assigned to either of the trigger inputs. The default trigger source for each channel is the “Trig” input. The trigger source selection is accessed in the secondary channel menus. To access this menu, first press the yellow “Func” button followed by the channel of interest. Continue to press “Func” then the channel button until the menu page with “Ch Gate:” and “TrigSrc:” appears. Use the “Next” button to place the cursor on the “TrigSrc” line and use the up/down arrows to change to the desired trigger source.

588 SCPI Dual Trigger Command Summary

Keyword	Parameter	Std/ New	Comments
:PULSe [0]		Std	Subsystem. Contains commands to control the output pulse generation. Commands without suffix refer to the currently selected logical instrument. See INSTRument subsystem.
:TRIGger		Std	Subsystem. Contains commands to define the Trigger function.
:MODE	DUAL	New	Sets the unit into dual trigger mode.
:PULSe [1/2/n]		Std	Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA-1, ChB-2, etc.) Commands without suffix refer to the currently selected logical instrument. See INSTRument subsystem.
:CTRIGger	GATE/TRIG	New	Sets which input is assigned to the channel trigger.

IEEE 488.2 Common Commands

Mnemonic	Command Name	Parameter	Comments
*TTG	Trigger-Trigger Input		Generates a software trigger pulse for the TRIG input only. Operation is the same as receiving an external trigger pulse.
*GTG	Trigger-Gate Input		Generates a software trigger pulse for the GATE input only. Operation is the same as receiving an external trigger pulse.

Appendix F - Impedance Matching Outputs

TZ50 Impedance Matching Output Module

This module option allows a user to have a 50 Ohm load on the output while maintaining an output amplitude of at least 4 Volts while in the TTL/CMOS mode. All other functionality of the module is the same as the AT20 modules, including output while using the Adjustable Mode Function of the channels.

TTL/ADJUSTABLE OUTPUTS

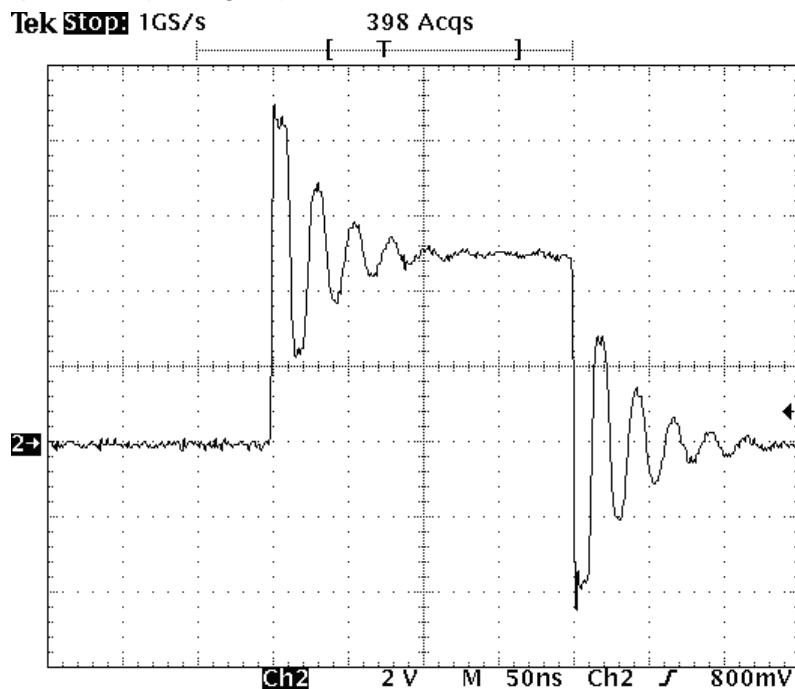
TTL/CMOS Mode

Output Level	4.0v typ into 50 Ohms
Rise Time	3ns
Slew Rate	0.5 V/ns
Jitter - Channel to Channel	50ps RMS

ADJUSTABLE MODE

Output Resolution	10mV
Current	200mA typical, 400 mA max (short pulses)
Slew Rate	0.1V/ns

*Note: The TZ50 module has significant overshoot and ringing through high impedance (see figure).



Appendix G - Increment Mode

Using the Increment System Mode

The System Increment modes are a pair of special modes, which allow the delay and width of each channel to be incremented at the end of a burst of pulses. Each channel is independent and each may be set with different initial values and different values for the step size for both the delay and the pulse width.

There are two incrementing modes, Increment and DC Increment. In the Increment mode, each start command or external trigger produces a burst of pulses. At the end of the burst the appropriate delays and pulse widths are incremented and the instrument is armed for the next start command. In the DC Increment (Duty Cycle) mode the output is starting as with the normal duty cycle mode. At the end of each cycle the delays and pulse widths are incremented. This continues for the number of cycles defined by the Cycles parameter. The modes are selected from the system mode menu. The step sizes are specified in the channel menus.

588 SCPI Increment Command Summary

Keyword	Parameter	Std/ New	Comments
:PULSe[0]		Std	Subsystem. Contains commands to control the output pulse generation. Commands without suffix refer to the currently selected logical instrument. See INSTRument subsystem.
:MODE	BINCRement /	New	Sets the To mode. Added parameters for Burst Increment and Duty Cycle Increment mode.
:CYCLE	<numeric value>	New	Sets the number of cycles to generate in Duty Cycle Increment mode.
:IRESet	1	New	Resets the width and delay increment parameters on all channels.
:PULSe[1/2/n]		Std	Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA-1, ChB-2, etc . . .). Command without suffix refers to the currently selected logical instrument. See INSTRuments subsystem.
:IWIDTH	<numeric value>	New	Sets the pulse width increment step size.
:IDELay	<numeric value>	New	Sets the delay increment step size.

Appendix H - External Clock

588 External Clock Operation

The 588 pulse generator has a special external clock circuit that allows for external clock synchronization when using clock sources that have very narrow pulse widths and amplitudes.

Parameter	Minimum	Maximum
Pulse Width	100ps	-
Pulse Amplitude	50mV	1V Peak
Frequency	10MHz	100MHz
Insertion Delay	-	10ns

**These specifications are preliminary and subject to change.*

Using the external clock function:

- Enter the clock source menu by pressing the menu button until the System Mode page is reached and then press the page button until the clock source page is reached.
- Select the source to External Osc.
- Adjust the threshold level appropriate for the amplitude of the external clock source.
- Adjust the rate to match the frequency of the external clock source.
- A “?” will appear if the system does not lock onto the external clock source.

Possible causes are:

- Threshold level not adjusted correctly.
- External clock source not present.
- External clock has excessive jitter.
- Amplitude of external clock is changing.



Figure 1

