Operating Manual Version 0.10

Model 577

Pulse Generator

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Firmware Release 1.00
Manual Version 0.10

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WARRANTY

In addition to a 30-day money back guarantee, the 577 has a two-year limited warranty from the date of delivery. This warranty covers defects in materials and workmanship. If repairs are required during the warranty period, contact the factory for component replacement or shipping instructions. Include the serial number of the instrument. This warranty is void if the unit is repaired or altered by others than those authorized by Berkeley Nucleonics Corporation.

IMPORTANT! PLEASE READ CAREFULLY

NOTIFICATION OF COPYRIGHT

THE FIRMWARE IN THIS DEVICE IS PROTECTED BY COPYRIGHT LAWS AND INTERNATIONAL TREATY. YOU MUST TREAT THE FIRMWARE LIKE ANY OTHER COPYRIGHTED MATERIAL. COPYRIGHT LAWS PROHIBIT MAKING ADDITIONAL COPIES OF THE FIRMWARE FOR ANY REASON OTHER THAN SPECIFICALLY DESCRIBED IN THE LICENSE BELOW. YOU MAY NOT COPY THE WRITTEN MATERIALS ACCOMPANYING THE PRODUCT.

Table of Contents

1 Introduction

This manual is a reference designed to familiarize you with the BNC Model 577 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 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 Test and Measurement 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 II
- Installation (overvoltage) Category II for transient overvoltage events
- Maximum Relative Humidity: 0-80% RH, non-condensing
- Operating temperature range of 0 ^{o} C to 40 ^{o} C
- Storage and transportation temperature of -40 ^{o} C to 70 ^{o} C
- Maximum altitude: 2000 m (6562 ft.)
- This equipment is suitable for continuous operation.
- Cleaning Instructions: Light dusting with cloth damp with water and/or usage of compressed air is all that is needed.

1.1 Technical Support

For questions or comments about operating the Model 577 our technical staff can be reached via one of the following methods:

• Phone - (415) 453-9955

• Fax - (415) 453-9956

• Email – info@berkeleynucleonics.com

• Internet - www.berkeleynucleonics.com

1.2 Warranty

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1.3 Package Contents

The box you receive should contain the following:

- Model 577 Digital Delay / Pulse Generator
- AC Power Cord
- Disk that includes
  - Operating Manual
  - Software Drivers
  - Communication Software

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

1.3.1 Unpacking Caution

The Model 577 is shipped in an antistatic package to prevent electrostatic damage to the device. Electrostatic discharge (ESD) can damage several components on the device. Remove the device from the package and inspect the device for loose components or any sign of damage. Notify BNC if the device appears damaged in any way.

Caution:
Be sure that your incoming line is between 100 V to 240 V, 50-60 Hz.

1.3.2 Tilt Stand Arm

The Model 577 has been shipped with a Tilt Arm that is designed to be used as an adjustable tilt selector only. The Arm is not to be used as a handle for moving or carrying the unit. If the 577 it to be moved please pick it up by supporting the entire unit with your hands. If the 577 is carried or moved by the Arm and it breaks in the process BNC is **not** responsible for repair or replacement of the handle or any damage incurred by the subsequent fall.

2 Safety Issues

The 577 has built in equipment protections to prevent harm to the unit and the user, if the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.

Normal use of test equipment presents a certain amount of danger due to electrical shock because it may be necessary for testing to be performed where voltage is exposed.

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 35 VRMS AC, should be considered dangerous and hazardous, as 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.

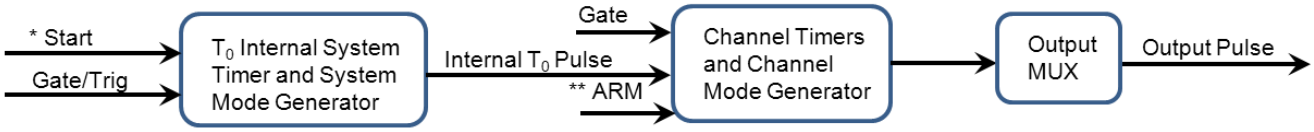
• Use the time-proven “one hand in the pocket” technique while handling an instrument probe. Be particularly careful to avoid contact with metal objects that could provide a good ground return path.

• Never work alone. Someone should always be nearby to render aid if necessary. Training in CPR first aid is highly recommended.

3 Pulse Concepts and Operations

3.1 Counter Architecture Overview

Signal Source



* This can be the **Run/Stop** button or a remote command
** Can rearm the channels in single shot mode

3.2 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 first 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

3.3 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 the output is inhibited.
- Burst — A pulse is generated for each T_0 pulse, 'n' times, after which the 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).

3.4 Digital Output Multiplexer

The outputs 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 Channel "x" Timer is routed to the Channel "x" output connector. As an example, if a double pulse is required on Channel A output, one may multiplex the Channel A timer with the Channel C timer adjusting each timer to provide the necessary pulses. Only timing parameters are multiplexed together, not amplitudes.

```
                -HGFE DCBA-
Mux:            -0000 0101-
```

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.

3.5 Dependent & Independent Timing Events

The 577 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.

For example, the Channel A timer and the Channel B timer may each be selected to use T_0 as their sync source, whereas the Channel C timer may be selected to use Channel A as its sync source so that it is dependent upon the output of Channel A. A user may elect to individually alter Channel A or Channel B timer settings as necessary for an application without having to also alter Channel C. The function of Channel C will continue to be dependent with respect to the function of Channel A.

4 Model 577 Front Panel Overview

4.1 Display Layout and Indicators

The Model 577 front panel has a keyboard, rotary adjustment knob, and a LCD display that allows the user to program all settings.

4.1.1 LCD Screen

A 3”, 240x400 pixel TFT module displays all parameters and status information. The status information is located in the upper portion of the display. Parameters are changed via pushbutton and rotary adjustment menu control. An arrow on the left side of the screen is an indicator that there are additional parameters to that page. A blinking red circle in the upper left is an indication that the system is currently generating pulses or actively waiting for an external trigger. The brightness may be adjusted allowing the instrument to be used under various lighting conditions.

4.1.2 Keypad (Pushbuttons)

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

- Blue Soft Keys — Provide one touch access to the menus for setting up the System and channel parameters. Pressing the appropriate Blue Soft Key will display the sub-menu containing the corresponding parameters.
- Arrow Keypad — The left (◄) and right (►) arrow keys move the cursor to different positions within the currently selected parameter. The **Next** key selects the next parameter in the currently displayed menu
- Numeric Keypad — The number keypad allows parameters to be entered in a numeric format.
- Standby/Power (⏻) — Pressing the Standby/Power button will turn on/off the device and will save the current parameters before shutting down.
- **Run/Stop** — Pressing the **Run/Stop** will arm/disarm the system and begin generating pulses if in the correct mode. If in triggered mode the system will be armed but will not output pulses until a valid trigger.

4.1.3 Rotary Adjustment Knob

The Rotary Adjustment Knob may be used to adjust the currently selected parameter. The step size is controlled by the position of the cursor; however, turning the knob faster will increase the step size. Pushing the knob will perform functions similar to the **Next** key and select the next parameter in the currently displayed menu.

4.1.4 BNC Connectors

One Gate Input (GATE), one Trigger Input (TRIG), and up to 8 Channel Outputs are available on the front of the unit.

5 Model 577 Rear Panel Overview

5.1 Layout and Connectors

The Model 577 rear panel has power input, clock in and out, and communication connections.

5.1.1 AC Power Connector

The Model 577 can be operated from 100 to 240 V at a line frequency of 50-60 Hz.

5.1.2 Power Switch

If this switch is used to turn the Model 577 off, changes that have been made to data or parameters will not be saved.

5.1.3 BNC Connectors

External Clock input (**CLK IN**), and External Clock output (**CLK OUT**), are standard. The input clock connector accepts 10 MHz to 100 MHz in user selectable, discrete values. The clock output connector provides T_0 or Ref out (10 MHz to 100 MHz) in user selectable, discrete values.

5.1.4 USB Port

A female USB B connector is standard to the Model 577 and used to control the device with a computer.

5.1.5 RS-232 Port

A female DB-9 connector using RS-232 serial protocol is standard to the Model 577 and used to control the device with a computer.

5.1.6 Ethernet Port

A RJ45 Ethernet connector is available to control the Model 577 with a computer.

5.1.7 GPIB Port

An IEEE 488 connector is available to control the Model 577 with a computer.

6 Navigating the 577 Front Panel

6.1 Selecting Menus

Parameters are grouped in menus, selectable using the Blue Soft Keys, the **Next** key, and a Rotary Adjustment Knob. For example, to select the output channel parameters, press the Blue Soft Key corresponding to the Channel menu. When the Blue Soft Key is pressed, a submenu will appear containing the corresponding Channels. These may be navigated to, and selected by, the use of the **Next** key and/or the Rotary Adjustment Knob. This menu hierarchy and navigation/selection is consistent with Channel menus, System menus, etc.

6.2 Selecting Menu Items

Within a submenu, the highlighted item indicates the current menu item for selecting. Pressing the **Next** key or the rotary knob will select the item while rotating the Rotary Adjustment Knob will move the cursor to a different submenu item.

6.3 Numeric Input Mode

When the current parameter is numeric, the system enters the Numeric Input Mode. In this mode data may be edited in one of three ways. Using the arrow keypad, the left (**◄)** and right (**►)** arrow keys are used to select a digit to edit. The selected digit will be underlined by a blinking cursor to identify it as the active digit. The Rotary Adjustment Knob may be used to increment and decrement this digit. The adjustment knob features speed dependent resolution. Slow rotation will increment or decrement the active digit by one. As you increase the speed of rotation, the parameter will be 10 to 1000 times faster depending on the speed.

An additional entry mode is using the numeric keypad. Enter the number, including decimal point using the numeric keypad. Complete the entry by pressing the **Enter** (↵) key.

6.4 Entering Non-Numeric Parameters

When the current menu item is non-numeric, Blue Soft Keys are used to select among different options for the parameter. The Rotary Adjustment Knob may also be used to change the selection. If the item is an on-off toggle, the Blue Soft Keys enable and disable the item.

7 577 Menu Structure

7.1 The Screen at a Glance

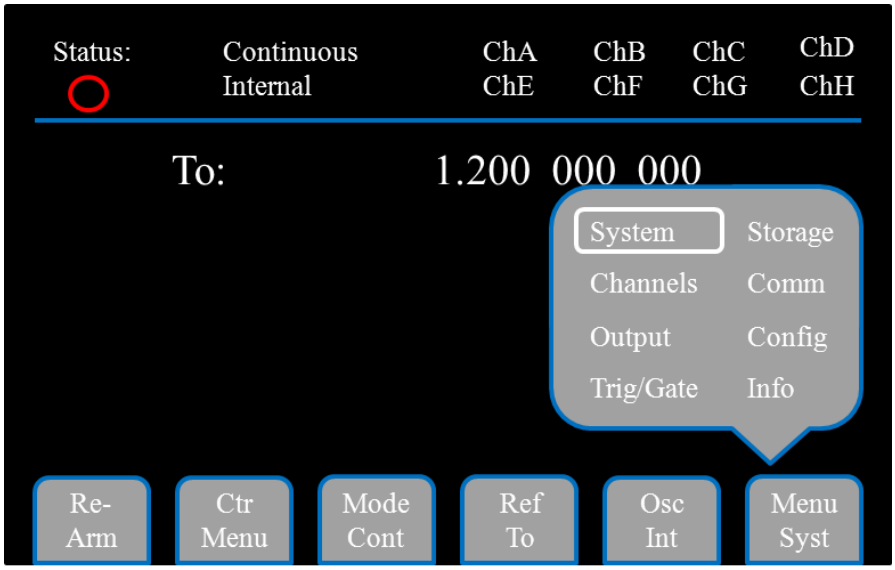
The screen has several areas of interest to the user. The information above the blue line always appears on the screen, and information below the blue line will change with the selected menu or screen. First is the Status in the upper left hand corner. This shows if the unit is armed or generating pulses. If the red circle is hollow, as in the picture below, then the unit is not armed, but if the circle is blinking hollow, then filled, the unit is armed and waiting for a trigger or currently generating output pulses. Next is the System Configuration area. This is just right of the Status and it displays the current System Mode (Continuous, Single Shot, Burst, or Duty Cycle mode), and the T_0 source (internally or externally generated). Just to the right of the System Configuration is the channel area. In this section of the screen the user can quickly determine if a channel is enabled or disabled. If a channel is white the channel is enabled, and if gray, the channel is disabled.

On the bottom of the screen is the Soft Key/Menu area. This section of the screen shows what menus are available, and in some cases, what functions can be invoked. In the middle of the screen is the Setup area. This is where all of the user changeable items will appear. This information will change with each menu selected.

7.2 System Mode Menus

7.2.1 Selecting the Desired Menu

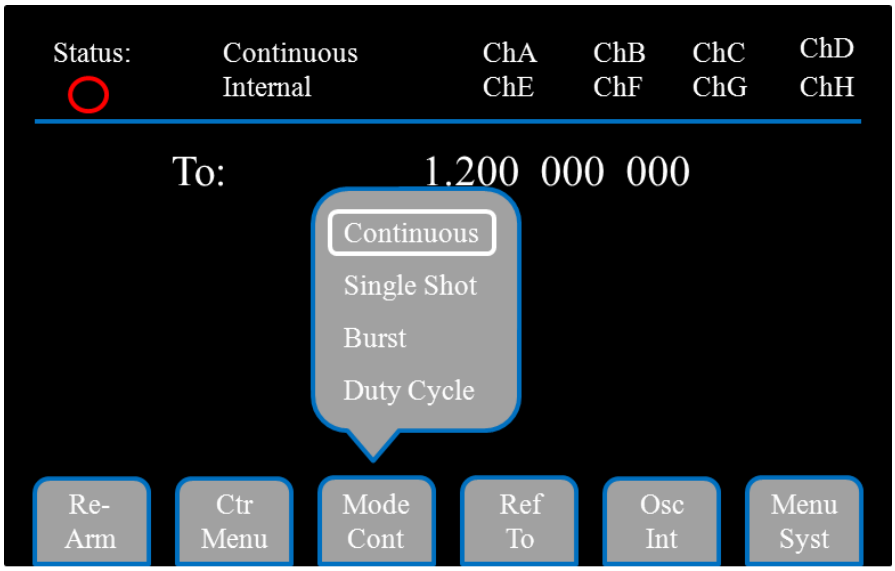
The 577 has a built-in set of menus that can be accessed by pressing the right-most soft key. This sub-menu will allow the user to return to the System menu, select the Channel and Output menus, enable and configure a Gate or Trigger signal, Save or Recall previous settings, and change the Communications and Configuration settings. The Menu soft key sub-menu also has selections for device specific information such as serial number and firmware versions.



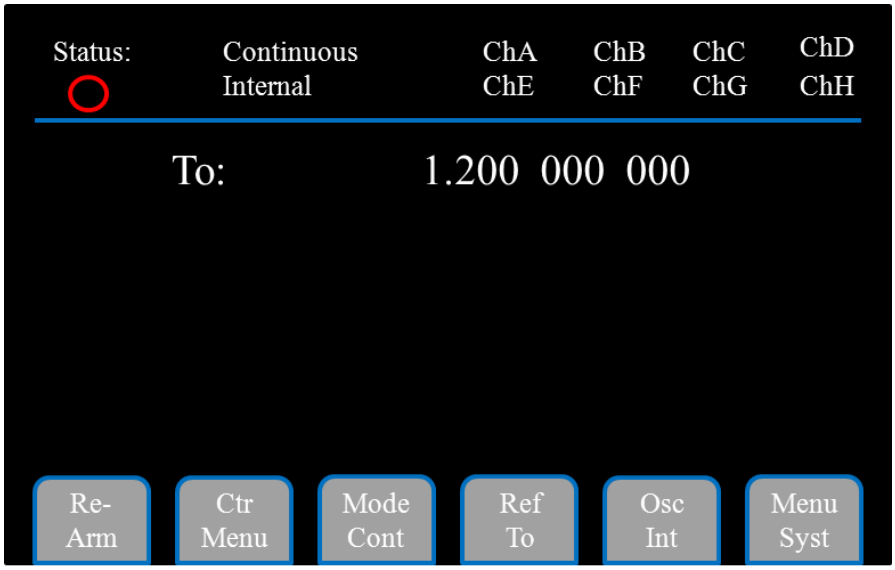
7.2.2 Setting System Mode of Operation

The Mode soft key selects the mode for the T_0 System Timer. The display will show additional parameters choices (Burst, On, Off, etc.) only when they are appropriate.

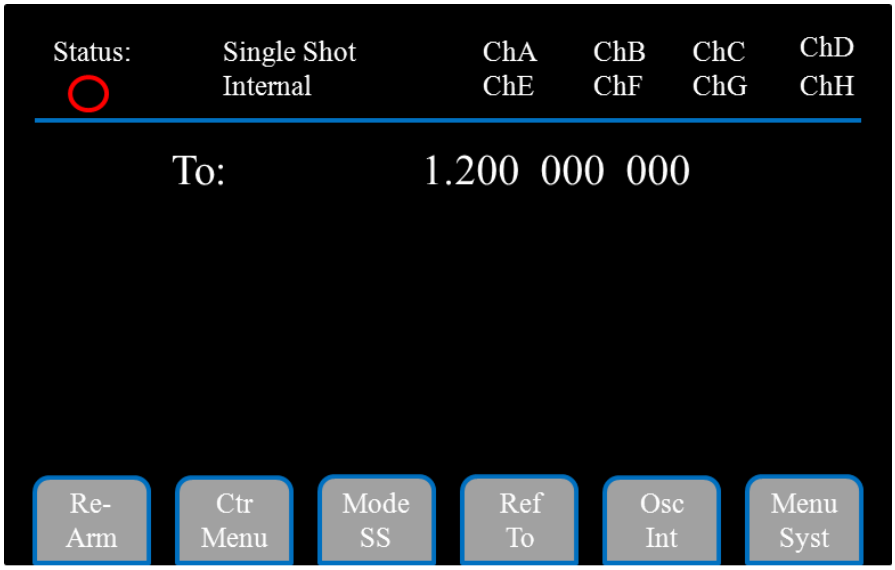
Mode: Selects the T_0 System Timer mode: Continuous, Single Shot, Burst or Duty Cycle.



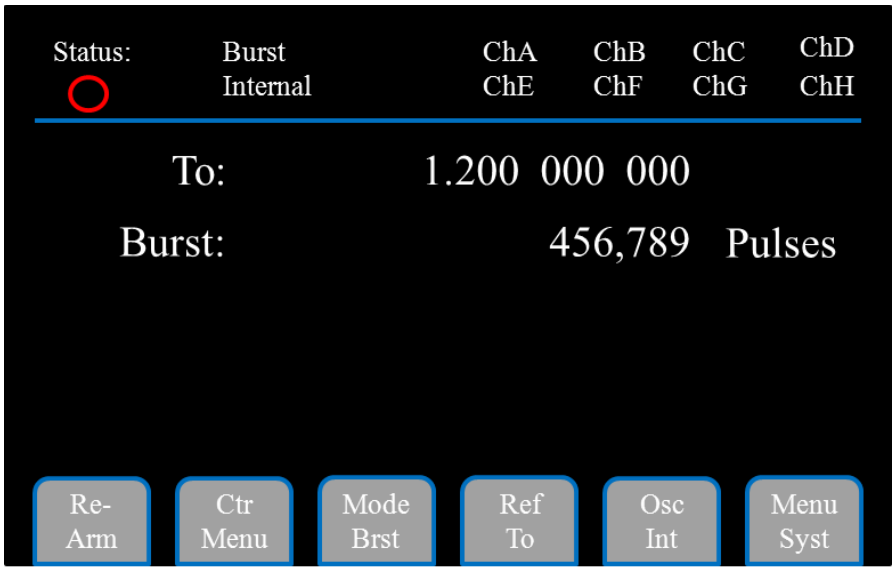
Continuous: Once started, T_0 pulses are generated continuously. Select the rate of the pulses to be generated



Single Shot: One T_0 pulse is generated for each start command.



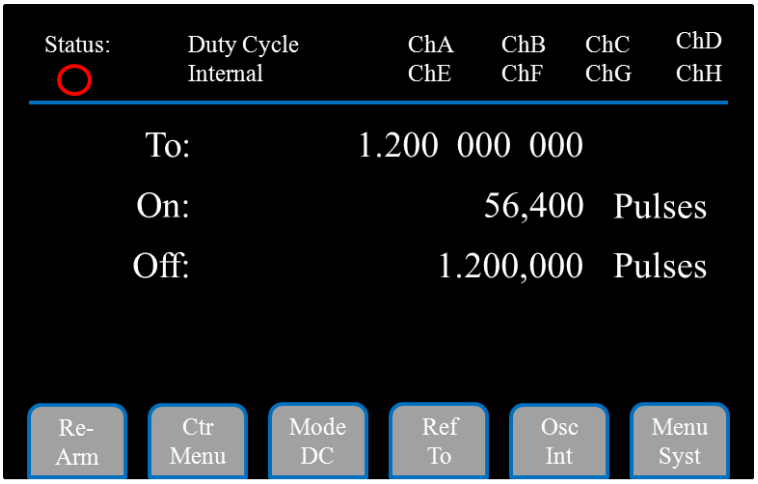
Burst: Sets the number of pulses to be generated when in Burst mode.



Duty Cycle: Allows T_0 rate to be a sub-multiple of the Clock Source.

On: Sets the number of pulses to be generated during each “On” cycle when in Duty Cycle mode.

Off: Sets the number of pulses to skip during each “Off” cycle when in the Duty Cycle mode.



*NOTE: Any mode may be started by the **RUN/STOP** key when the Trigger Input is disabled. Any mode may be armed by the **RUN/STOP** key, and then started by an external trigger when the Trigger Input is enabled. When in Single Shot or Burst modes (and if the Trigger Input is disabled) 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. If in triggered mode the unit will not disarm so that multiple sets of pulses may be generated without user intervention.

7.2.3 Setting the Internal Reference Source and Rate

Not only does the 577 have the ability to be timed by using the internally generated clock, it also has the ability to be timed by an externally connected Clock Source within a range of common frequencies. If the user frequency is not listed a different frequency can be used, but the user cannot put in a faster frequency than the selection made on the soft key. In other words if you have a 35 MHz signal you must tell the 577 to look for a 40 MHz or higher, any choice below that will result in unpredictable results.

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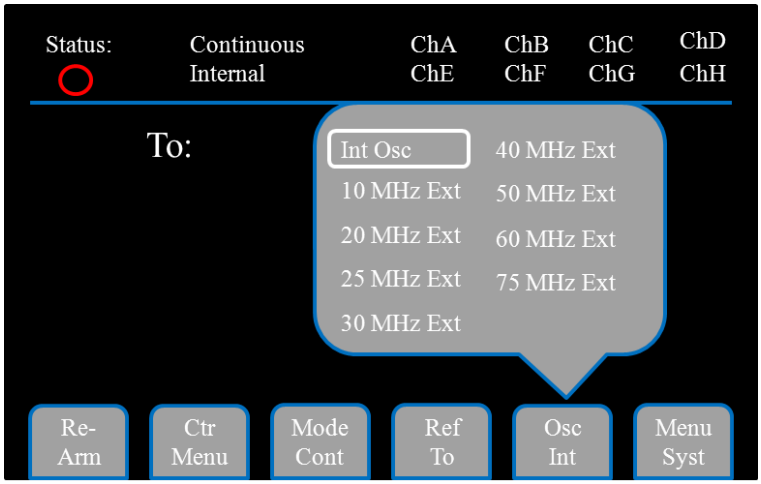
Osc: Selects the internal or external Clock Source from which the unit will operate.

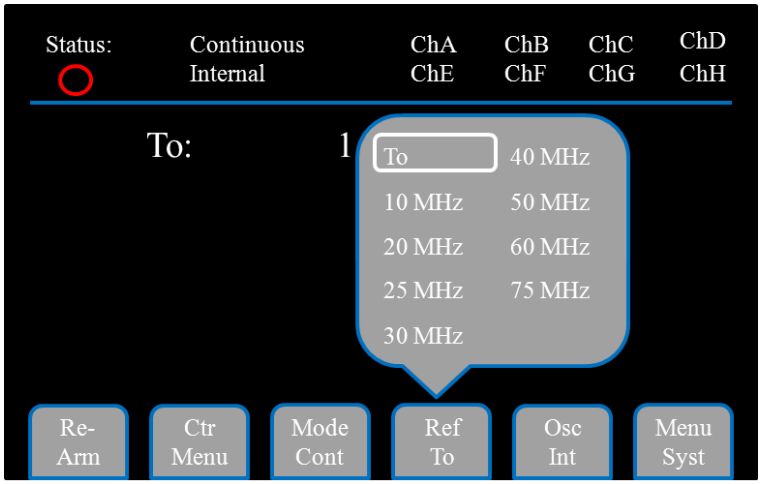
To: Sets the T_0 period (or rate) which determines the fundamental output frequency of the unit.



7.2.4 Setting the Output Reference

The 577 also has the ability to output a clock signal to an external unit if so desired. The user can choose from any of the preset frequencies as well as outputting the T_0 signal. If the unit is in external input mode and a different frequency is input than what the 577 is told to expect, the output would be a factor of the expected frequency.

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

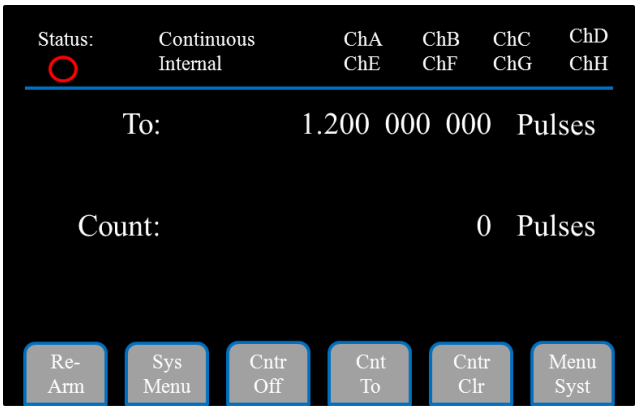


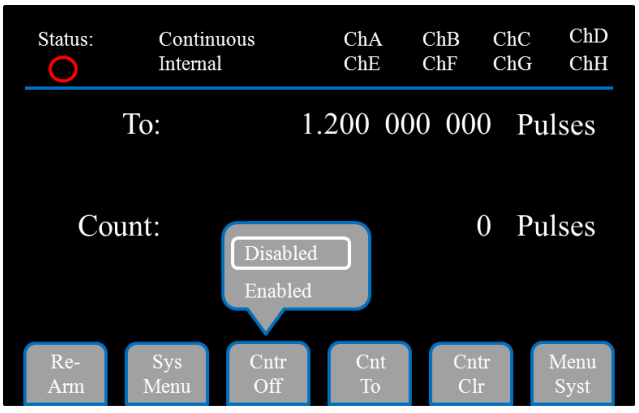
7.2.5 Rearming the System

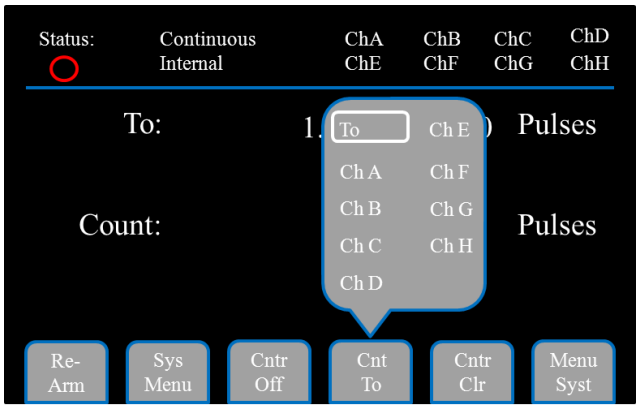
The 577 has the functionality built in to reset the internal channel timers with the press of a soft key or by sending a simple command. When the unit is used in a channel single shot mode (i.e. single shot or burst mode) or externally triggered the desired pulse train will be produced then the unit will remain armed but not producing pulses. With the ReArm capability the pulses on the single shot channels can be reproduced without disruption of the continuous channels. This function is also useful when in external trigger mode and channels are in a single shot mode to produce additional pulses.

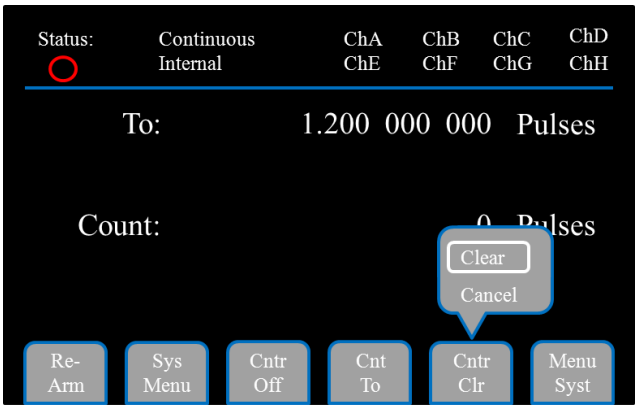
7.2.6 Setting the Shot Counter Parameters

The 577 has the ability to count pulses, whether it be from an internal source or indirectly from an external source. This is a 32 bit counter so the maximum number it can count to is (2^{32}) 4,294,967,296. If the counter is to be used on an internal source simply choose the source form the soft key (T_0 or CH [A-H]). The counter can also be set up to count external pulse by either setting the system or channel to triggered mode and single shot modes. The Counter menu can be accessed by pressing the Ctr soft key while in the System menu page. From the Counter page the counter source can be selected, the counter can be enabled, disabled, and can be cleared.





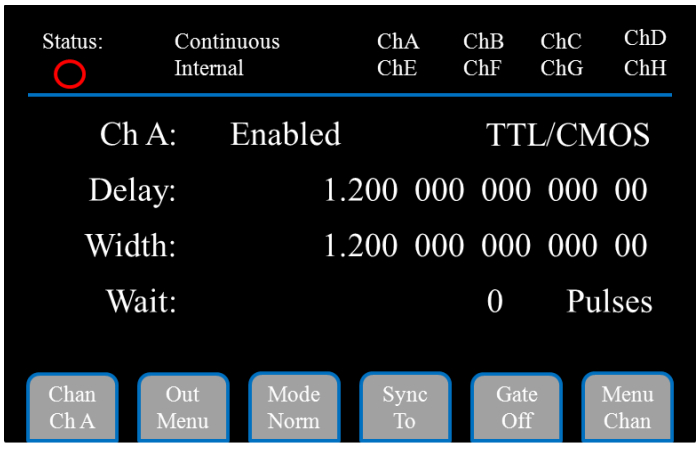




7.3 Channel Menus

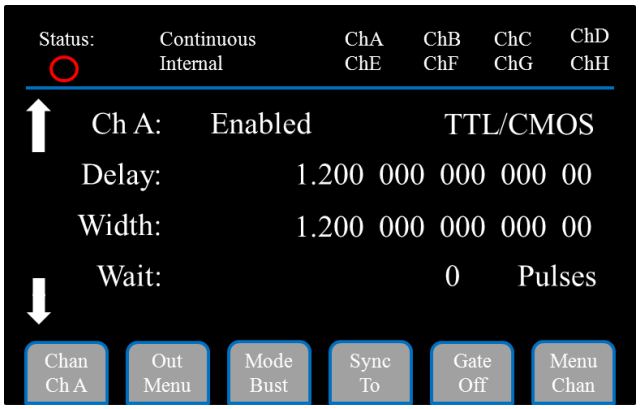
7.3.1 Enabling Channel Output

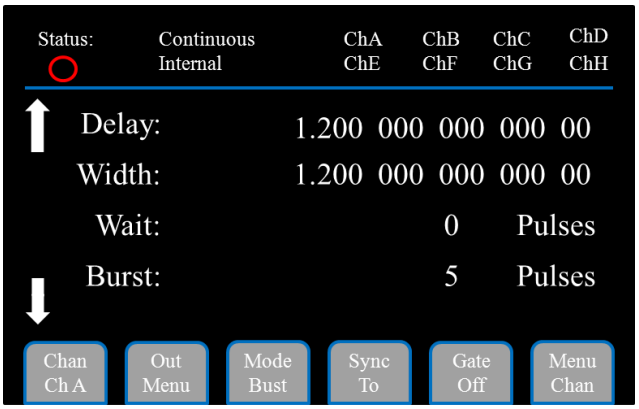
At the top of the Setup area on each of the Channel Menu page is a parameter to Enable or Disable the displayed channel. Each channel may be individually controlled. Each channel is listed in the Status area at the top of the page. If a channel is displayed in white, it is enabled. If a channel is displayed in gray, the channel is disabled.



7.3.2 Channel Menu in Burst Mode

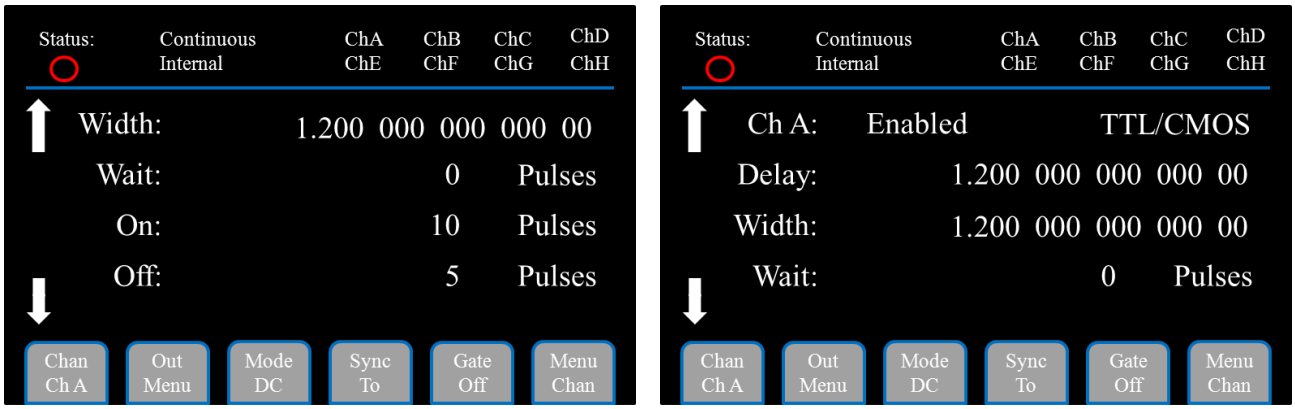
The Burst Mode Channel Menu page includes an additional parameter to set the number of pulses in the burst.





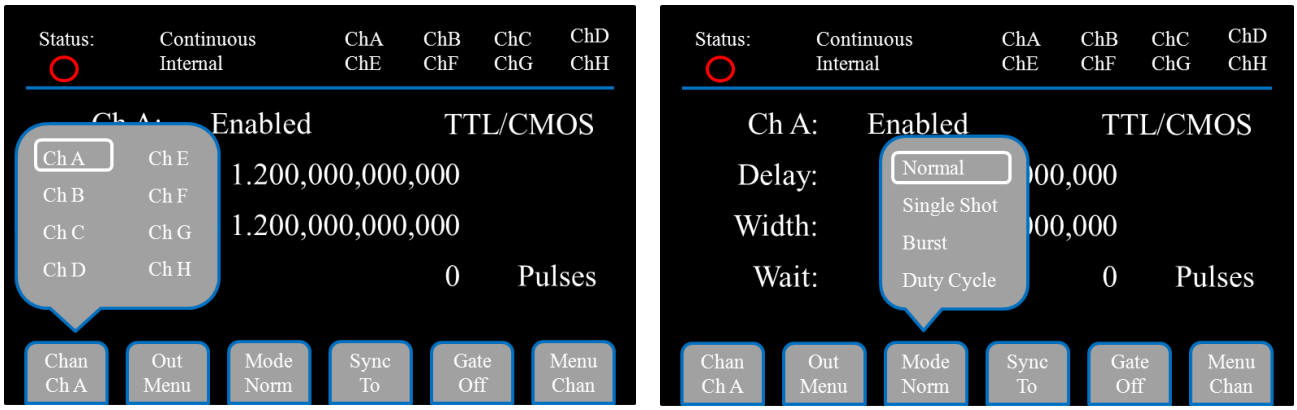
7.3.3 Channel Menu in Duty Cycle Mode

The Duty Cycle Mode Channel page includes additional parameters to set the number of On pulses and the number of Off pulses.



7.3.4 Channel Page Sub-Menus

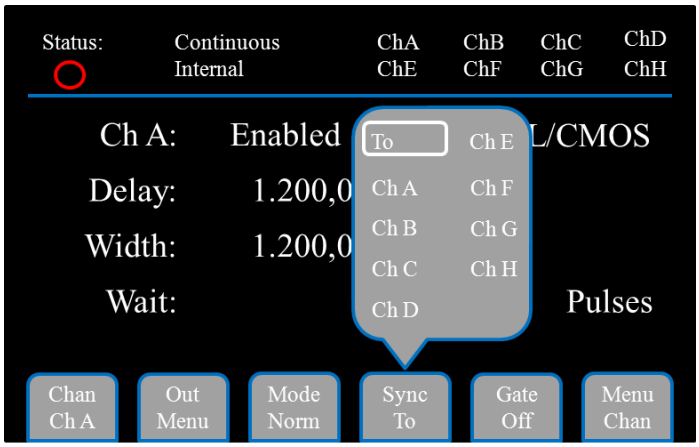
When in the Channel Menu page the soft key sub-menu options will change. The left most soft key allows the user to select the particular channel to be displayed. The next soft key is a function key that toggles the display between the Output page and the Channel page (it will not bring up a sub menu). The third soft key is used to set the Channel Mode (Normal, Single Shot, Burst, or Duty Cycle).



7.3.5 Sync Menu

Although each channel receives its start pulse from the internal T_0 pulse, the start pulse can be assigned such that it is relative to the T_0 pulse or relative to any other channel pulse. This allows the ability to link dependent events. The entered delay value is relative to the selected sync source. This source can be changed by pressing the Sync soft key while in the Channel Menu page.

It is important to note that the 577 will not allow a circular chain of sync sources that would result in a channel triggering itself.



7.3.6 Output Menu

As mentioned earlier, the second key from the left is a function key that toggles the display between the Output page and the Channel page. The 577 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 Polarity of the pulses can also be defined to function as Active High or Active Low.

Mode: Selects the Output Mode; TTL/CMOS, Adjustable, Optical, High Impedance (Hi Z), or Low Impedance (Lo Z)

Pol: Sets the pulse polarity, Active High or Active Low.

Ampl: Sets the output voltage level when in the Adjustable mode.

For safety reasons the 577 should not be driven at 20 volts or higher into a 50 Ω load in either active low mode or in active high mode with a high Duty Cycle (90% or higher) for more than 1 min on any channel. Doing this could cause damage to the unit and or the load connected to it.

7.3.7 Channel Multiplexer

It is possible to generate more than one channel signal from a single channel output. To define which channels are fed into the Channel Multiplexer, the corresponding bit for the desired channels should be set to 1. Channels that are not to be multiplexed should have corresponding bit set to 0. Access to the Multiplexer Menu in one of two ways, select Output Menu from the Menu soft key, or enter the Channel Menu and press the soft key labeled Out Menu.

Mux: Enable/disable bit field.

```
-HGFE DCBA-
-0000 0101-
```

7.4 Other System Menus

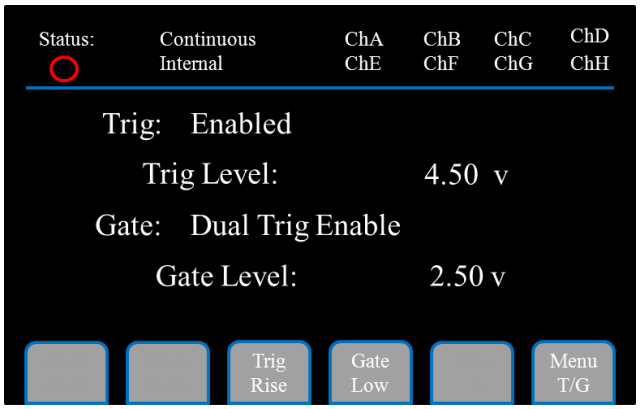
7.4.1 Gate or Trigger Input Menu

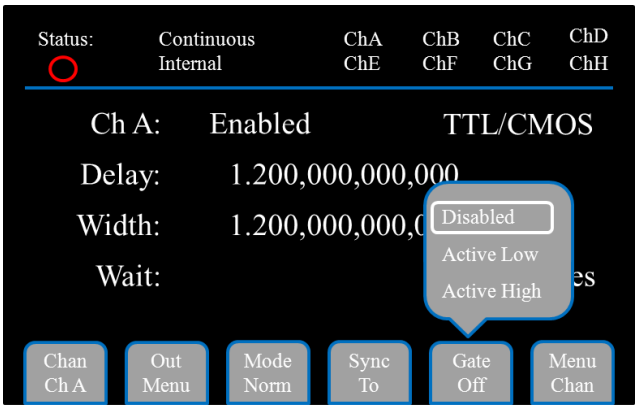
To setup the Gate/Trigger functionality select the Gate/Trig Menu with the Menu soft key. In this menu the Gate and Trigger inputs can be enabled and disabled and threshold levels can be set. The Trig soft key in the Gate/Trig menu is used to set the active edge for the trigger input. Also from here the Gate can be set to one of five modes; Pulse Inhibit, Output Inhibit, Channel Pulse Inhibit, Channel Output Inhibit, or disabled. If the unit has the Dual Trigger option the Gate can also be set to Dual Trigger Enable or System ReArm Enable. If enabled the Dual Trigger option will activate a second soft key to set the active edge for the gate input as a trigger source.

The 577 will ignore incoming triggers until all channels have fully completed their assigned pulses, even if that channel is disabled. For example if all channels were set to 100µs pulse widths and one channel had a 50 µs delay, even if that channel was disabled, the 577 could not be retriggered faster than 150 µs. To ensure this does not cause triggering problems set unused channels to have a combined delay and width time less than the desired trigger rate.

When the system is in Continuous, Single Shot, or Burst mode with a trigger source enabled the 577 will generated one T_0 pulse for every incoming trigger pulse. But if system is in Duty Cycle mode the first incoming trigger will start the 577 pulsing and every trigger after the initial one will be ignored until the system is re-armed.

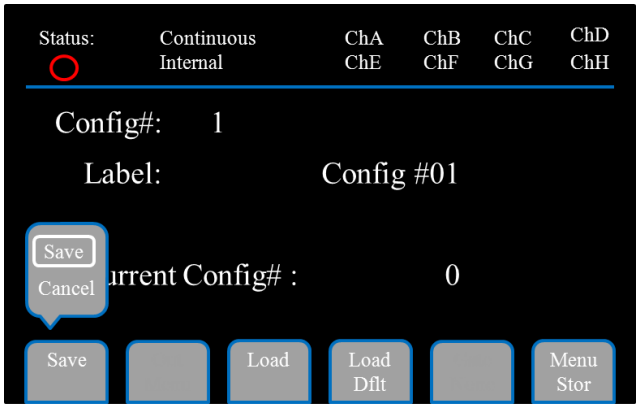
The in the Channel Menu the second soft key from right is the Channel Gate selection sub-menu. To change if the Gate is Active High/Low or disabled for each channel press the Gate soft key. If the Dual Trigger option has been enabled the Gate soft key in the channel menu will now allow the user to see which input will be the trigger source for that channel.

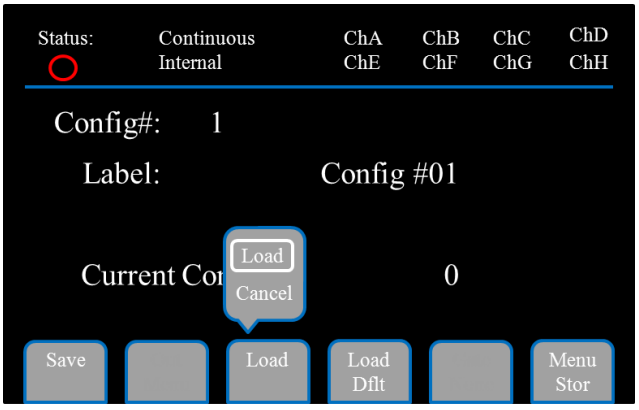




7.4.2 Saving and Loading Configurations

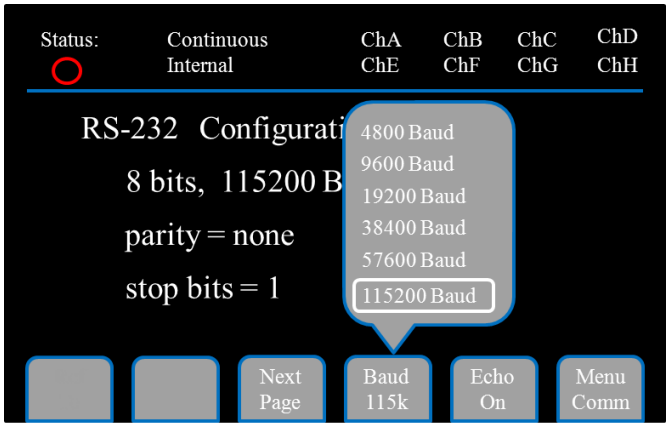
To Save and Recall a unit configuration select the Storage Menu with the Menu soft key. Select the desired number location to save the configuration, press the Save soft key, and then confirm the choice. Also from this menu a previously saved configuration can be loaded by selecting the number location to be recalled, then pressing and confirming with the Load soft key. The system can save and recall up to 16 configurations. The unit also ships with an uncorrectable factory default configuration that is located in Config 0 (Recall 0 by pressing the Load Dflt soft key).

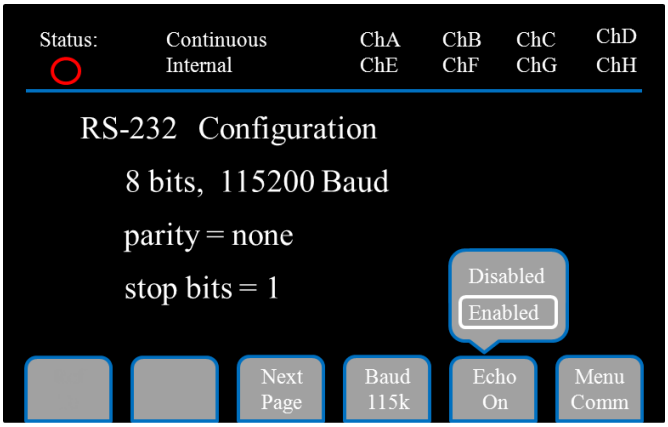




7.4.3 Communication Configurations

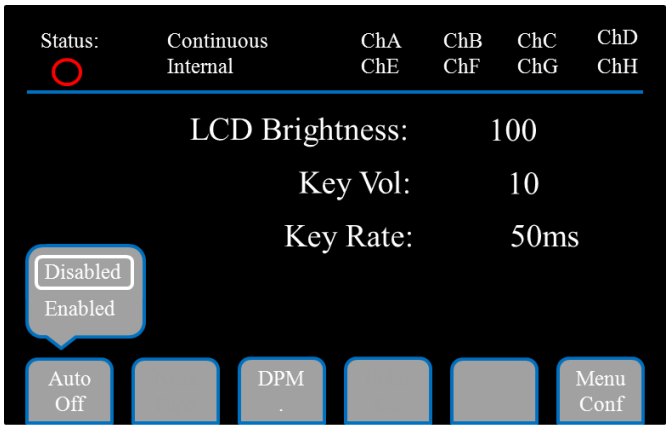
To gather information about the unit's configuration or change a communication parameter select the Comm Menu with the Menu soft key. From the Comm Menu the Baud Rates for USB and RS-232 protocols can be changed independently. In addition the Echo function can be enabled and disabled for both independently. By scrolling through the pages here additional information can be found about all the available communications methods. Also from the additional pages the GPIB Address can be set if the Communications Option has been installed.

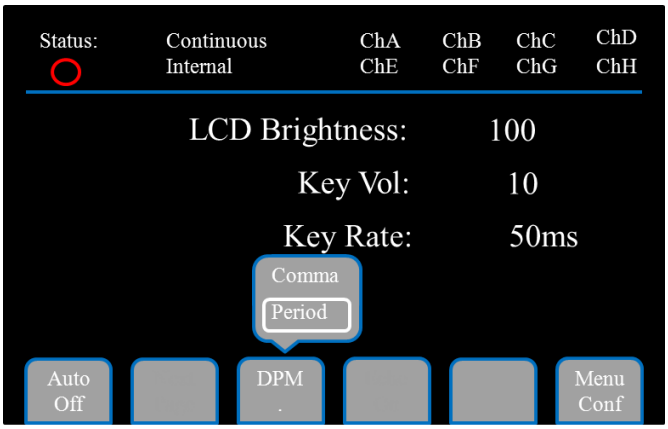




7.4.4 Configuration Menu

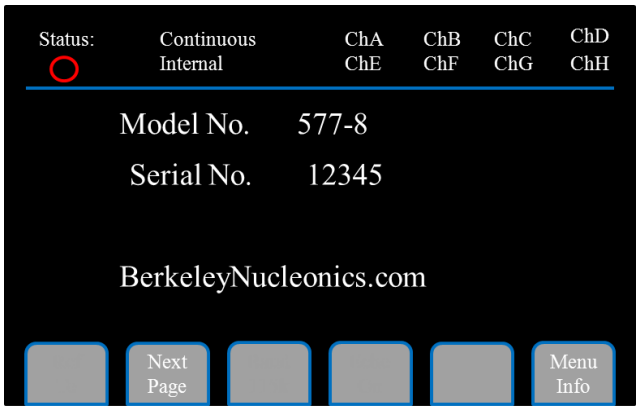
To enter the Configuration Menu select Config with the Menu soft key. In this menu the Screen Brightness, Key Beeper Volume, and Key Repeat Rate can be changed to enhance the user interface. The system can also be set up to generate pulses automatically when powered on by enabling the Auto Start function. The DPM soft key will allow the user to choose English or European delimiter notation.

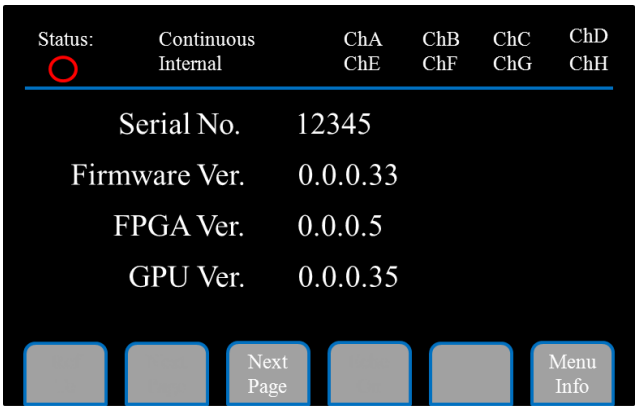


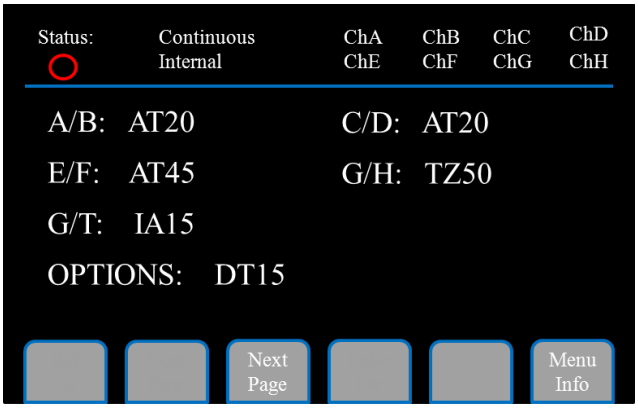


7.4.5 Information Menus

Under the Information Menu the system configuration information is displayed. If calling for support please have this information handy. The menu will display the serial number of the unit, the model and code versions. The third information page will show what type of input/output module is installed in each bay of the device. The page will also show if the Dual Trigger or Communications upgrade option has been purchased.







8 Remote Communication

The 577 ships standard with an RS232 serial and USB interface. Ethernet and GPIB interfaces are available as an option. 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. Due to the high number of special features found in the 577, many of the commands are not included in the SCPI specification. The syntax is the same for all interfaces.

WARNING: When communicating with the unit (USB, Serial or Ethernet), avoid sending any commands that include the "*" character as the unit is booting up. This may result in an undesired lockup of the instrument.

8.1 RS-232 Interface

The serial port is located on the back of the 577 and uses a 9-pin D-type connector with the following pin-out (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.

8.2 USB Interface

The USB interface is standard on the 577. The Model 577 uses an FTB232 UART with FTDI drivers. The drivers are standard on almost any PC. 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.berkeleynucleonics.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 serial 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:USB:BAUD <baud rate>" command. This parameter can be accessed via any communication method. The default baud rate for USB is 115200.

It may be necessary to cycle power on the 577 after connecting a USB serial cable between the 577 and the PC.

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:USB:BAUD <baud rate>" where <baud rate> can be:

  4800
  9600
  19200
  38400
  57600
  115200 (default)

- USB 1.0 specification is used. The USB cable can be removed without "unplugging" the device in the operating system environment.

8.3 GPIB Interface

Also known as IEEE- 488, a GPIB computer interface is optional on the 577. Before using this interface, the address must be set using the GPIB address menu item.

8.4 Ethernet Interface

A RJ- 45 jack is optional on the 577. This interface will use a module to transfer data through the Ethernet port to the host computer.

8.4.1 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 Corp. pulse generators. The method discussed is Raw TCP/IP communication.

The Ethernet module used in Berkeley Nucleonics Corp. 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.

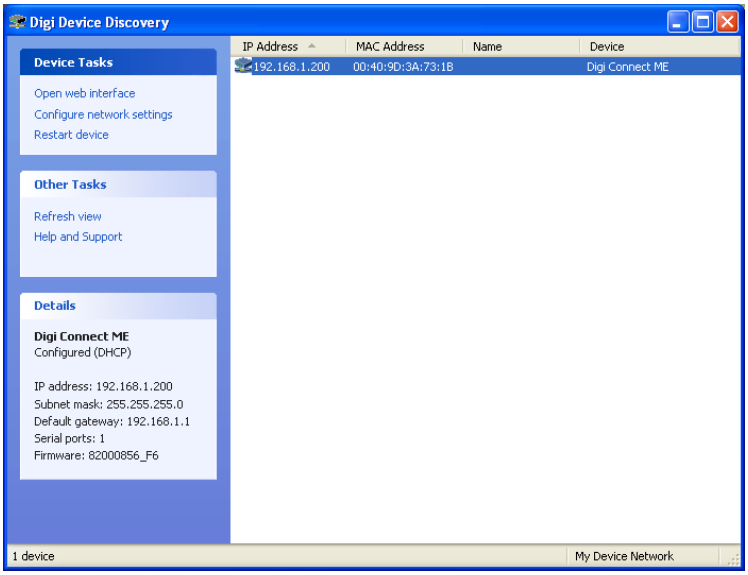
This discussion assumes that the Digi utilities included with your pulse generator and National Instruments VISA (version 3.3 in this procedure, see National Instruments' website) are installed. The procedures discussed have been prepared using Windows XP service pack 2.

8.4.2 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. Go to "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. Click on "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 the currently assigned IP address in the list.



8.4.3 Setting the 577 to Raw TCP Protocol

Note Only follow this process if Raw TCP communications are desired, direct communications with a terminal program is the factory default method.*

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

Username: “root”
Password: “dbps”

You should not see the Digi Connect ME Configuration and Management screen. Select “Serial Ports”. If a named port is already displayed (Port1, for instance), click on the named port, and check the box next to the Enable Raw TCP Sockets selection. The default socket port is 2101. Click Apply

Select “Basic Serial Settings”. Select the following Properties:

- Baud Rate: 115200
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

Click on Apply.

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.

8.5 Programming Command Types and Format

The 577 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 sections

8.5.1 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” (CR+LF). They are ASCII character set values 0D and 0A (13 and 10 in decimal, hex 0x0D0A or ‘\r\n’) respectively. All command strings need to have the appropriate 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 and USB ports 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.

8.5.2 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 pneumonic by a space character. For Example:

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

8.5.3 SCPI Command Format

The commands are shown as a mixture of upper and lower case letters. The upper case letters indicate the minimum essential characters and an 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 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 followed by 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?<cr><lf>
Will return: 1<cr><lf>

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

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

8.5.4 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.

8.5.5 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.

8.5.6 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 = T_0, 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 by the last referenced channel.

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

8.5.7 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 rep-resented by a 0 or OFF. Queries return 1 or 0.
<identifier>	Selects from a finite number of predefined strings

8.5.8 Error Codes

The 577 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.
9	Parameter out of bounds for the given module.

8.6 577 Commands (SCPI Command Summary)

Keyword		Parameter Range	Notes
:INSTrument			The units' upper level command keyword
	:CATalog	?	Returns a comma-separated list of the names of all the channels. Example: a two channel unit would return T_0, CHA, CHB
	:FULL	?	Returns a comma-separated list of the names of all the channels and their associated number. For example: A two channel unit would return T_0, 0, CHA, 1, CHB, 2
	:COMMands	?	Returns an indentured list of all valid SCPI commands
	:NSELect	0 - 8	Selects a channel using the numeric value
	:SELect	T_0 / CH[A-H]	Selects a channel using the identifier
	:STATe	0/1 or OFF/ON	Enables/Disables the selected channel output. If no channel has been selected the command is applied to T_0. If T_0 is selected all outputs are affected. Enabling T_0 is the same as pressing the RUN button.

Keyword		Parameter Range	Notes
:DISPlay			Command to change the units display settings.
	:STATe	0/1 or OFF/ON	Command to lock the display and keypad entry. This command will bring up a window on the display so current settings cannot be seen or changed. The unit can still be powered down for safety, but when turned back on the current settings will not be retained.
	:MODe	0/1 or OFF/ON	Command to change the units display update settings. Setting to 1 will force a display update when a command is received via serial communications. Setting to 0 will turn this feature off. The default setting is 1 **Note: To speed up communication response turn this off.*
	:BRIGhtness	0 - 100	Command to increase or decrease the amount of light the display will output. A value of 0 will turn off the display and a value of 100 will make it the brightest.
	:UPDate	?	Query only. Will force the display to be updated with the current parameters.

Keyword	Parameter Range	Notes
:SYSTem		Command to change the units system settings.
:STATe	?	Query Only Command
:BEEPer		
:STATe	0/1 or OFF/ON	Command to turn on or off the systems' beeper.
:VOLume	0 - 100	Command to change the units' beeper volume.
:COMMunicate		
:USB		
:BAUD	4800 / 9600 / 19200 / 38400 / 57600 / 115200	Command to change the baud rate for the USB interface.
:ECHo	0/1 or OFF/ON	Command to enable/disable the echo function on the USB interface. The Echo function will cause the unit to repeat the command received to the PC.
:SERial		
:BAUD	4800 / 9600 / 19200 / 38400 / 57600 / 115200	Command to change the baud rate for the RS - 232 interface.
:ECHo	0/1 or OFF/ON	Command to enable/disable the echo function on the RS - 232 interface. The Echo function will cause the unit to repeat the command received to the PC.
:GPIB		
:ADDRess	1 - 12	Sets the GPIB Address if the Comm option is installed.
:AUTorun	0/1 or OFF/ON	When the unit is powered up, if this command is enabled, the unit will start pulsing automatically.
:KLOCk	0/1 or OFF/ON	Command to lock out the keypad.
:CAPS	0/1 or OFF/ON	The default value is 1, which means the unit is not case sensitive. 0 means the commands sent to the unit must be capitalized. **Note: To change this parameter the unit must be power cycled before the command will take effect.*
:SERNumber	?	Query only. Returns the Serial Number the 577
:VERSion	?	Query only. Returns the current Firmware and Bootloader versions installed on the 577 Main Processor
:BVERsion	?	Query only. Returns only the current Bootloader version installed on the 577 Main Processor
:DVERsion	?	Query only. Returns the current Firmware version installed on the 577 Front Panel Processor
:GVERsion	?	Query only. Returns the current FPGA code version installed on the 577
:SERNumber	?	Query only. Returns the serial number of the unit.
:NSID	?	Query only. Returns firmware and FPGA identification numbers. Is used to identify Non-Standard FW and FPGA codes that may have been created for customer testing.

Keyword			Parameter Range	Notes
:PULSe[0]				Command to change the units global settings, this is the same as using the :SPULse command
	:STATe		0/1 or OFF/ON	Enables or disables the output for all channels. This command is the same as pressing the Run/Stop button.
	:PERiod		50 ns to 999.999,995 s	Sets the T_0 period. Value can be integer, decimal or scientific notation. There is a rate limitation for a 35 and 45 volt modules.
	:MODe		NORMal/ SINGle/ BURSt/ DCYCle	Changes the system output mode.
	:BCOunter		1 to 10,000,000	Changes the number of pulses to output when the system is in burst mode.
	:PCOunter		1 to 10,000,000	Changes the number of on pulses to output when the system is in Duty Cycle mode.
	:OCOunter		1 to 10,000,000	Changes the number of off pulses to suppress when the system is in Duty Cycle mode.
	:ICLock		Sys, 10,20,25,30,40,50,60, 70,75	Menu for selecting the clock source. Sys is the internal system clock and for external select the frequency in MHz desired.
	:OCLock		T_0, 10,20,25, 30,40,50, 60,70,75	Allows the user to select the clock source to output. The choices are the Internal system clock or a range of frequencies in MHz
	:COUNter			Subsystem. Contains commands to define the Counter function.
		:STATe	0/1 or OFF/ON	Enables/Disables the counter function
		:CLear	0/1 or OFF/ON	Clears the *trigger counter.*
		:COUNt	T_0 / CH[A-H]	Sets and queries what the source the counter will count.
		:PULSES?	0 to 4,294,967,296	Will return the current count up to 2^{32} counts
	:TRIGger			
		:MODe	DIS or TRIG	Sets the global trigger mode for the unit: When the unit is set to single pulse each trigger input will produce a output pulse, When in burst mode each trigger input will produce a burst of output pulses, and when in continuous or duty cycle mode the trigger input will start the pulses (the trigger will function the same as pressing the run/stop button)
		:EDGe	RISing / FALLing	Choose the edge to trigger on (only used when the option for the gate to be a second trigger input is enabled)
		:LEVel	.20 V - 15 V	Choose the gate level threshold to trigger on, this should be set to ~ 50% of the input potential

Keyword			Parameter Range	Notes
:PULSe[0]				Command to change the units global settings, this is the same as using the :SPULse command
	:GATe			
		:MODe	DISable, PULSeinh, OUTPutinh, CHPUlseinh, CHOUtputinh	Sets the gate mode for the unit: When in pulse inhibit mode if the pulse has started before the gate is seen the output pulse will finish, but any further pulses will be prevented, In output inhibit mode if a pulse has started it will be truncated as soon as the gate signal is seen and will prevent any further pulses, and when in channel mode each channel can be setup individually (be aware of insertion delay for each mode, this is listed in the specifications)
			ENABLE / DISable	In Trigger or ReArm mode the Mode command is the enable/disable. When the gate is changed to Trigger with the Smode command it will default to disabled, in order to utilize this function it first must be enabled with the Mode command
		SMODe	GATe, TRIG, or RARM	Smode commands are part of the Dual Trigger option and are only available on units with the Dual Trigger Module installed.
		:LOGic	LOW / HIGH	Choose active Low (will allow pulses when low) or active High (will allow pulses when high) This is also the setting used for the ReArm option.
		:EDGe	RISing / FALLing	Choose the edge to trigger on (only used when the option for the gate to be a second trigger input is enabled)
		:LEVel	.20 V - 15 V	Choose the gate level threshold to trigger on, this should be set to ~ 50% of the input potential

Command	Parameter Range	Notes
*IDN	?	Query only. Returns model, serial number, firmware version, and FPGA version numbers.
*RCL	0-16	RECALL
*RST		This command will RESET the unit, perform a stop and a Recall 0
*SAV	1-16	SAVE
*TRG		Create a soft Trigger on the Trigger Input
*GTG		Create a soft Trigger on the Gate input (Only active when the dual trigger option is enabled)
*GTE	0/1	Sets a software gate state. Equal to setting Gate input to Active High/Low
*LBL	?	Used to query the label of the last saved or recalled configuration.
	String Value	String must be in double quotes and no longer than 14 characters. Command must be followed by a *sav [1/2/n] command to take effect.
*ARM		Resets all channel counters simultaneously when the channels are in either single shot or burst mode. **Note: The system must be in continuous mode (this command is functionally the same as pressing the Run/Stop button).*

Keyword			Parameter Range	Notes
:PULSe[1/2/n]				Command to change the units channel specific settings.
	:STATe		0/1 or OFF/ON	enables/disables output pulse for selected channel.
	:WIDTh		10 ns to 999.999,999,999,75 s	Sets the pulse width for the selected channel.
	:DELay		0 to 999.999,999,999,75 s	Sets the delay from the timing reference to when the pulse is created.
	:SYNC		T0,CHA,CHB-CHH	Allows the user to select the timing reference for each channel. **Note: When in external clock input mode T_0 will be the clock input.*
	:MUX		0-255	Decimal representation of an 8 bit binary number (example: 255 = 1111 1111)
	:POLarity		NORMal, COMPlement, INVerted	Normal is active HIGH, Inverted and Complement are active LOW.
	:OUTPut			
		:MODe	TTL / ADJustable	Allows the user to select either TTL logic mode or Adjustable voltage output mode.
		:AMPLitude	2.0 V to 20 V	Allows the user to select the voltage potential for Adjustable output mode.
	:CMODe		NORMal, SINGle, BURSt, DCYCle	Allows the user to select the pattern of outputs to use on the channel level.
	:BCOunter		1 to 10,000,000	When the channel is in Burst mode will allow user to select the number of pulses to output with each input clock pulse.
	:PCOunter		1 to 10,000,000	When the channel is in duty cycle mode will allow the user to select the number of pulses to create with each clock pulse.
	:OCOunter		1 to 10,000,000	When the channel is in duty cycle mode will allow the user to select the number of pulses to suppress with each clock pulse.
	:WCOunter		1 to 10,000,000	Allows the user to select how many clock cycles to wait until the channel should start creating a output pulse.
	:CTRIg		?	Allows the user to query the trigger source for that channel when the gate is used in trigger mode. **Note: For the gate to be used as a trigger source the unit must have the dual trigger option.*
	:CGATe		DIS / LOW / HIGH	Sets the channel gate mode to Disabled, Active High or Active Low mode.

9 Option DT15 (Dual Trigger)

In the Gate/Trigger menu the Gate soft key will allow the user to set the functionality of the Gate input. The Choices are Gate, Trigger, or ReArm. This module option allows the GATE input to function as a second Trigger input. The Dual Trigger Option also enables the Gate input to ReArm the unit. For consistency, the enabling menu for this option is located in the Gate function selection. Once the Dual Trigger Mode is enabled, both the GATE and TRIG inputs can act as Trigger inputs

Adjustments for the GATE input are located in the Gate/Trigger menu. 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 (both the Trigger and the Gate inputs must be enabled and set to Triggering mode), each channel will be assigned to a trigger source input. The Trigger input will be the source for channels A, B, E, and F and the gate will be the trigger source for channels C, D, G, and H. The trigger source for each channel can be viewed in the given channel menu in the soft keys.

The ReArm function will behave the same as the ReArm soft key, Refer to that section above for a detailed description of the ReArm function.

9.1 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 and falling edges as the trigger source when a trigger mode is enabled.

* The GATE Input functions as a standard Gate when not in “Dual Trig” or “ReArm” modes.

Considering the event itself, or the documentation requirements that follow, enlist our team of spectroscopists with an Enhanced Reachback Program.

10 Option AT35 (35V Output / Fast Rise)

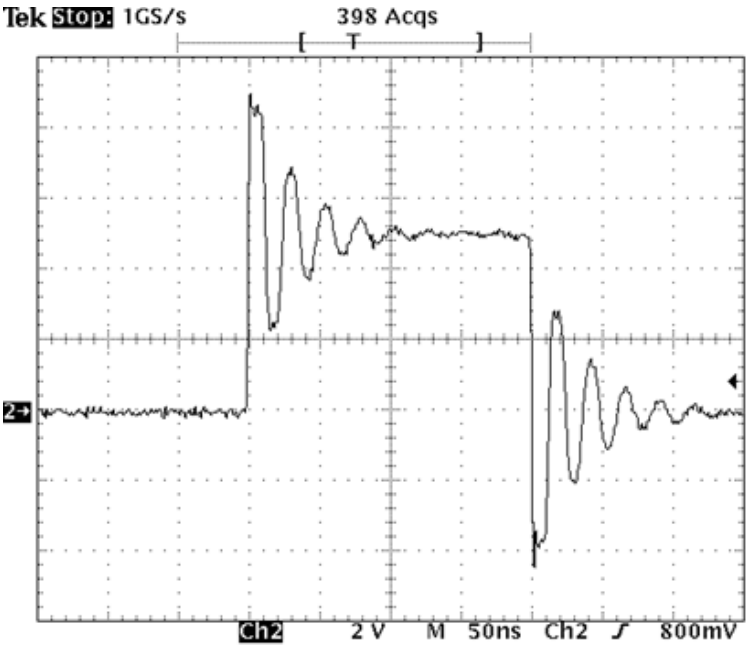
When the Adjustable Mode is enabled for this module, the outputs will provide an output that is adjustable from 5 to 35 volts. The pulse width can be set over the standard range of the unit, but the 35 volt output will self-limit to approximately 4 µs with some droop. There is no change to TTL Output Mode functionality with this module.

To maintain the highest possible rise time, care must be taken with cabling and termination. Low capacitance cable and 50 Ω termination will provide the fastest rise times without overshoot. Faster rise times can be achieved by increasing the termination resistance, but some overshoot is likely to occur. While the 35 volt output provides a fast, controlled rising edge, the pulse width and falling edge are not tightly controlled. Also, when using the 35 V mode, the option will only function if the Polarity is set for Active High.

11 Option TZ50 (TTL Impedance Matching)

This module option allows a user to have a 50 Ω load on the output while maintaining 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.

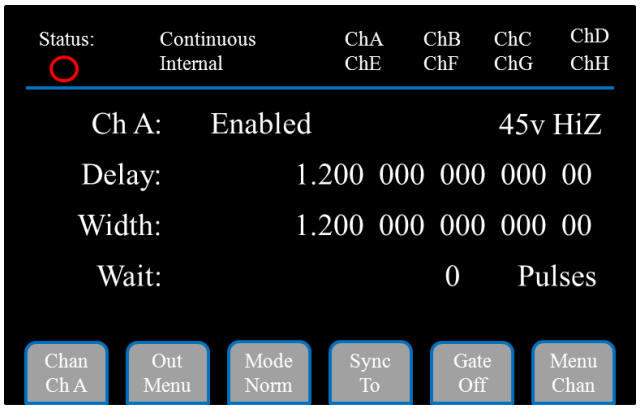
*Note: The TZ50 module has significant overshoot and ringing through high impedance (see figure below).

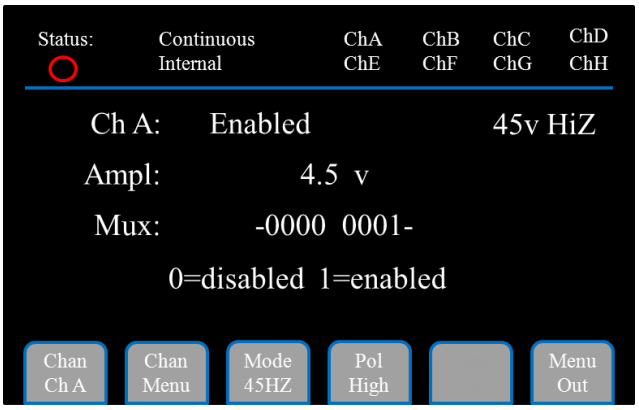


12 Option AT45 (45V Output)

For channels with AT45 output option, the maximum frequency is limited to 100 KHz. The pulse width can be set over the standard range of the unit with both active high and low outputs when set to high impedance mode. In low impedance mode, the pulse width is limited to a maximum of 10s and the active low output is no longer allowed. To maintain the highest possible rise time, care must be taken with cabling and termination. Low capacitance cable and 50 Ω termination will provide the fastest rise times without overshoot. Additional commands now available in the Command Line interface are described in the table below. The channel menu structure for the AT45 module changes as follows:

1. When in the output menu for an AT45 module there is now a soft key for HiZ and LoZ modes that replaces the Adjustable vs TTL modes.
2. Outputs amplitudes can now be set from 4-45 volts.





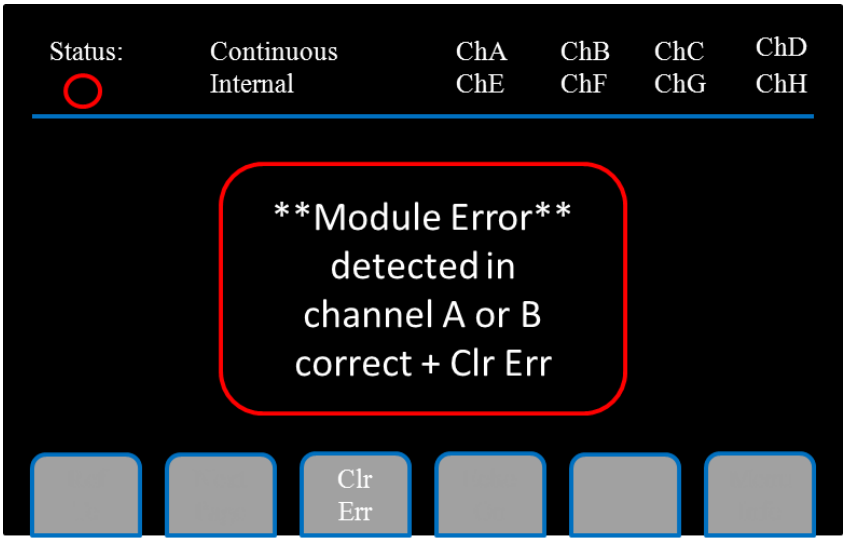
12.1 AT45 Protection Error Messages

When an AT45 module is present, the system performs self-checks to insure the module is not damaged when attempting to over-drive, however the overdrive protection is NOT SHORT CIRCUIT PROTECTED, and caution must be taken to prevent damage to the board when driving into a short!

12.1.1 Module Errors

If a channel on any AT45 module is over-driven, the channel will disable itself and the system will indicate an error on the module. The error will not clear until the user fixes the error causing condition and presses the Clr Err soft key, or power cycles the instrument. The overdriving protection is limited to low resistance errors not to direct shorts to ground. Damage to the output will occur when driving into short circuits. Module errors may occur due to any of the following:

- Over current.
- Over temperature.
- Internal hardware.



12.1.2 System Limit Error

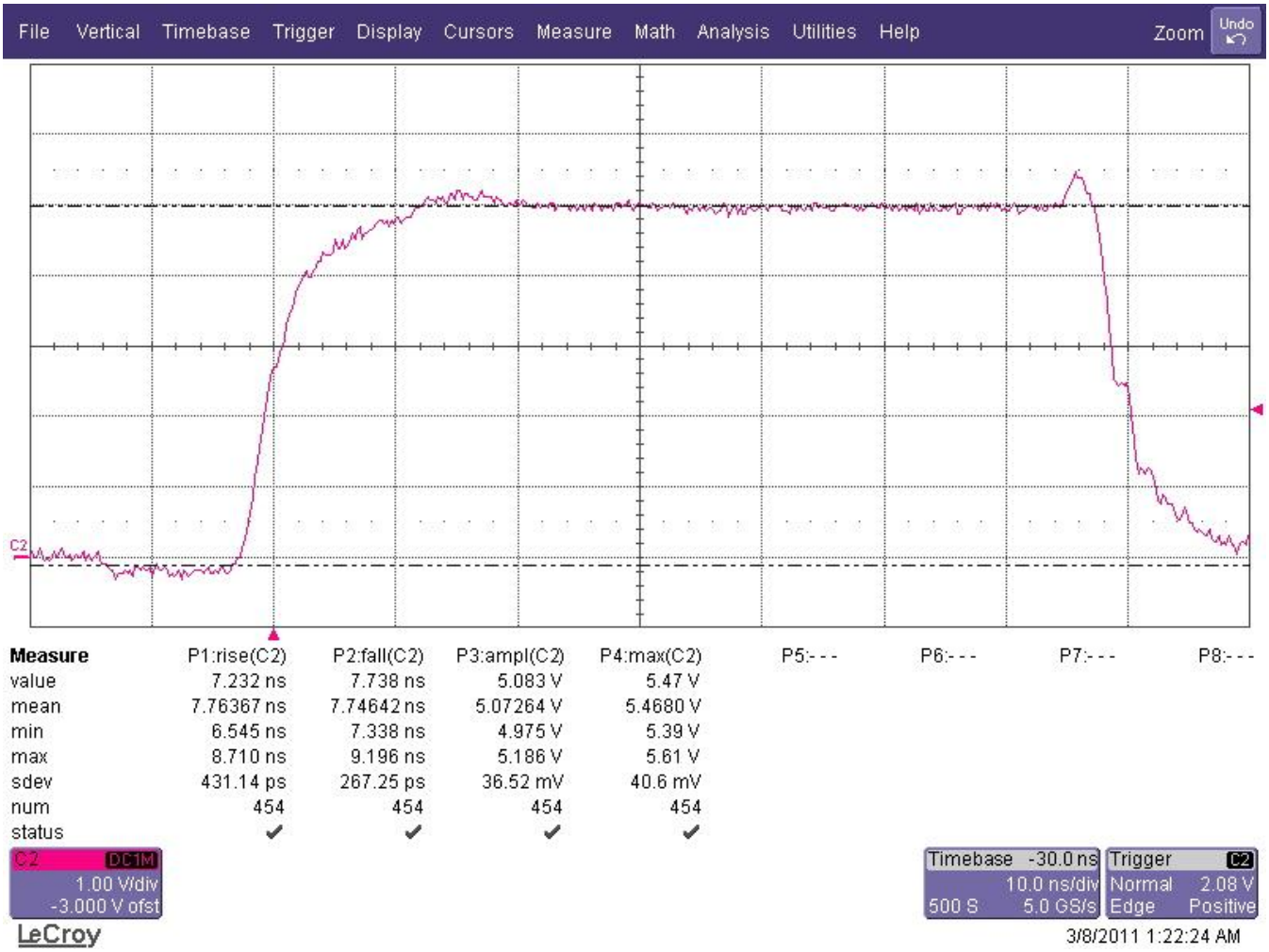
The system will not allow the Lo Impedance enabled AT45 channels to exceed 150 V total amplitude. If this situation occurs, the “Over-Driving Unit” error is displayed and the currently adjusting amplitude is reduced to the 150 V enabled channel limit.

12.2 Voltage Change Timing

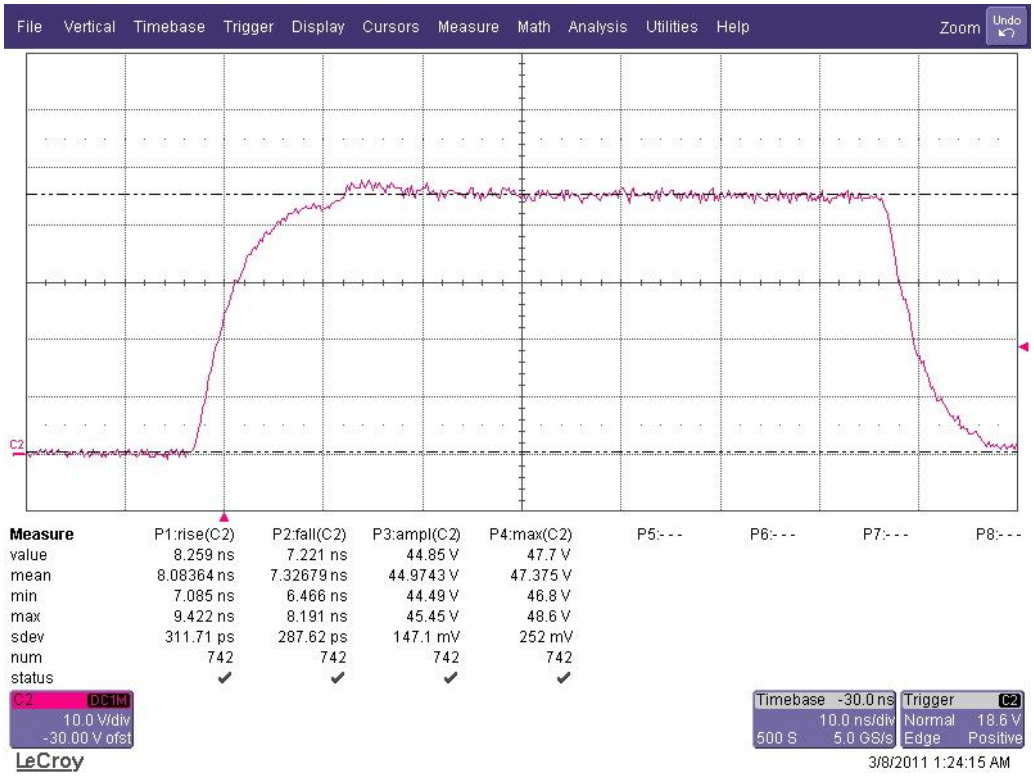
The channels adjustable voltage changes very quickly when adjusting from a lower voltage to a higher voltage but changes slowly when changing from a higher voltage to a lower voltage. It takes approximately 30 sec to change from 45 V to 4.0 V so caution must be taken when adjusting the voltage to a lower voltage tolerant circuit.

12.3 AT45 SCPI Command Extension Summary

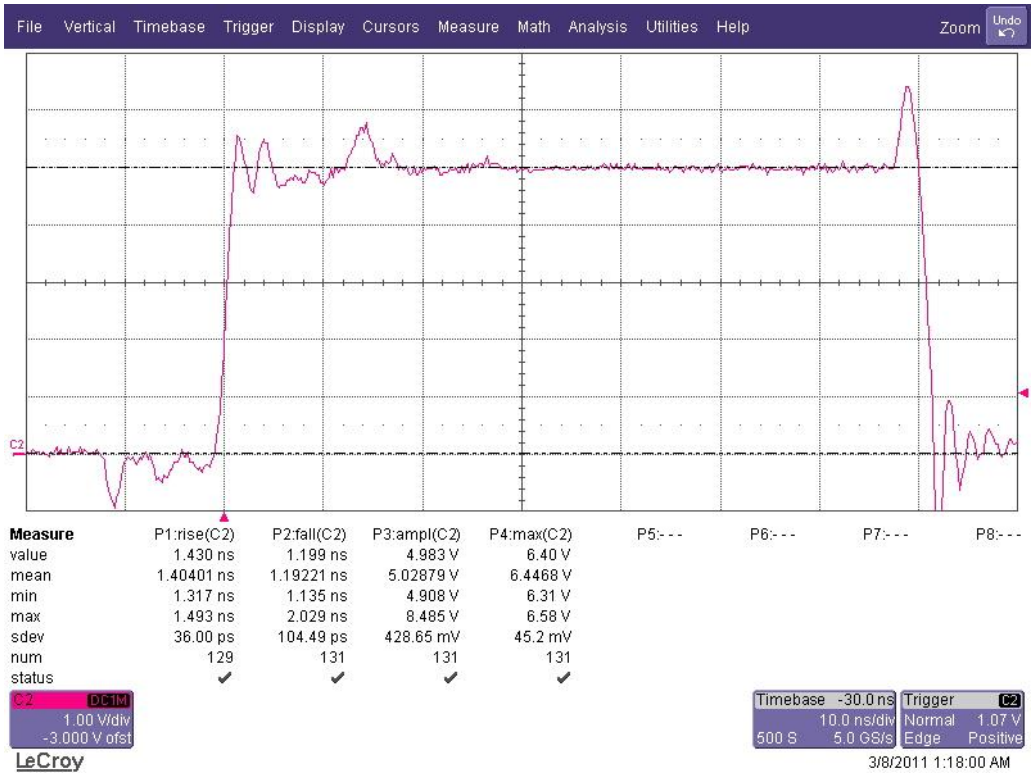
Keyword	Parameter	Comments
:PULSe [1 / 2 / n]		Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA = 1, ChB = 2, etc.). Command without suffix refers to the currently selected logical instrument. See INSTrument subsystem.
:OUTPut		Subsystem. Contains command to control output mode.
:MODe	HIZ / LOZ	Selects output Amplitude mode: High Impedance or Low Impedance
:AMP	4 V to 45 V	Sets adjustable output level.
:MERRor	1	Command clears the last module error to allow the unit to generate pulses again. Query returns the last displayed error.



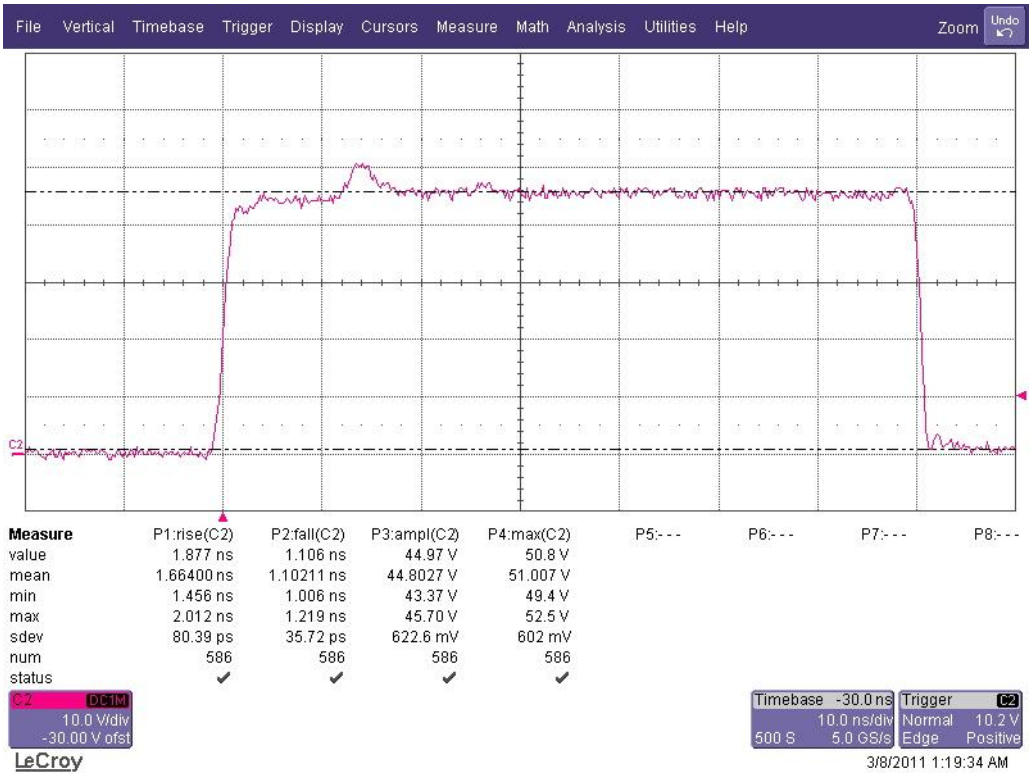
High Z Load at 5 V



High Z Load at 45 V

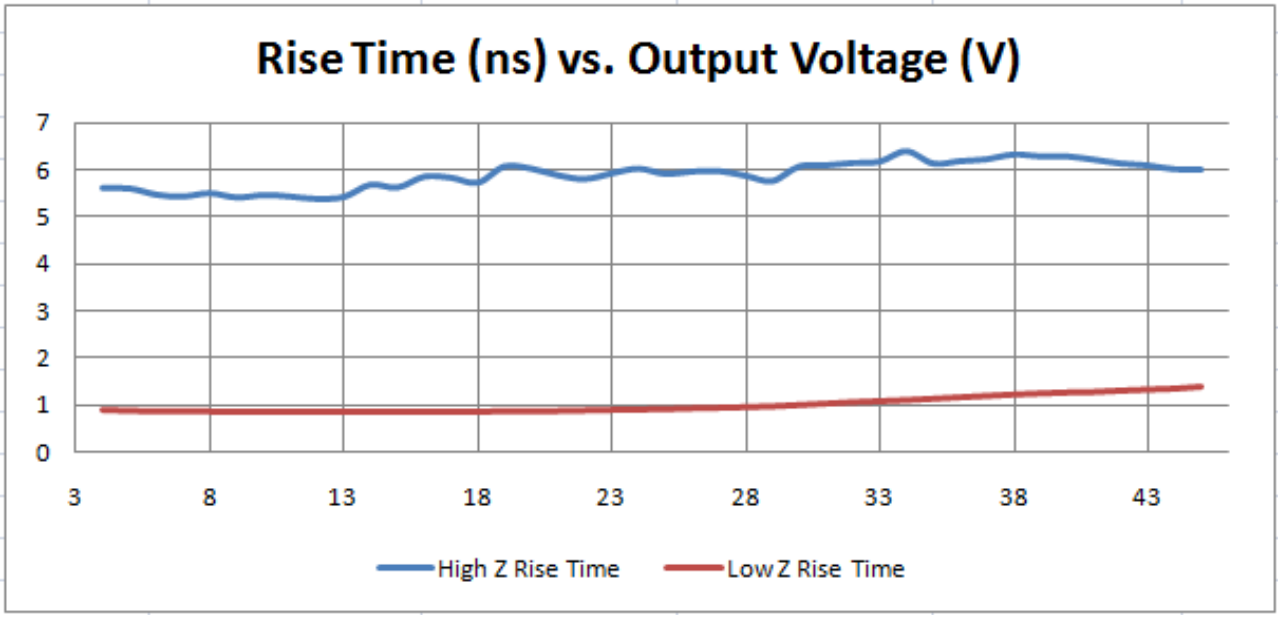


Low Z Load at 5 V

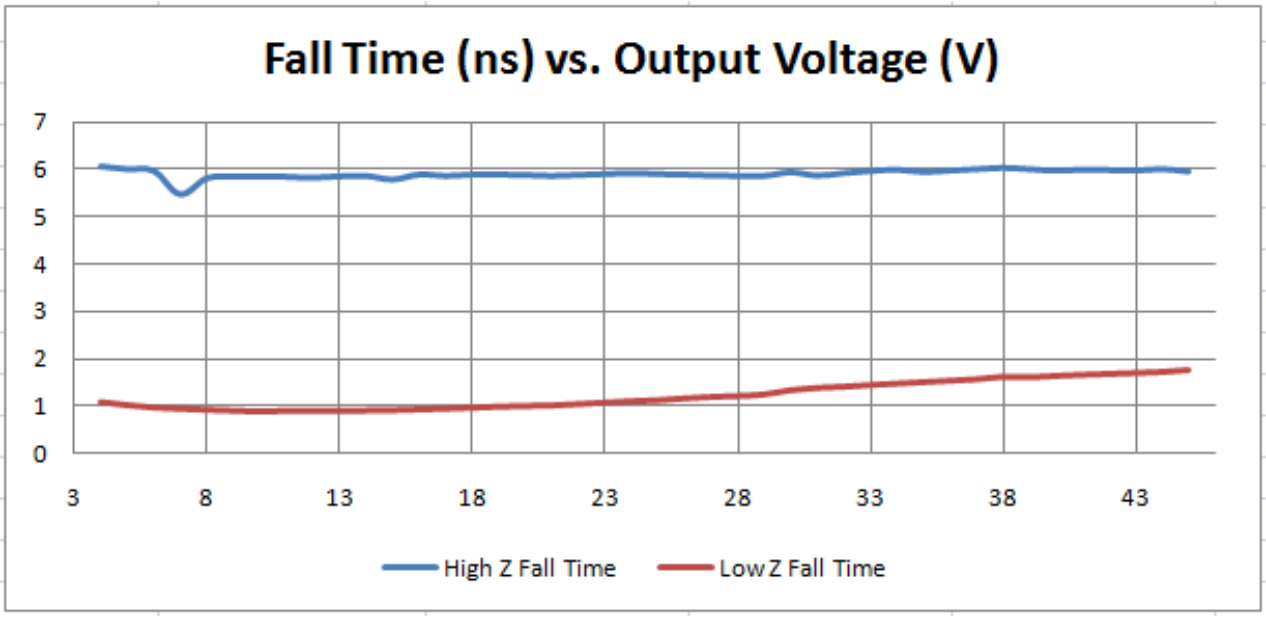


Low Z Load at 45 V

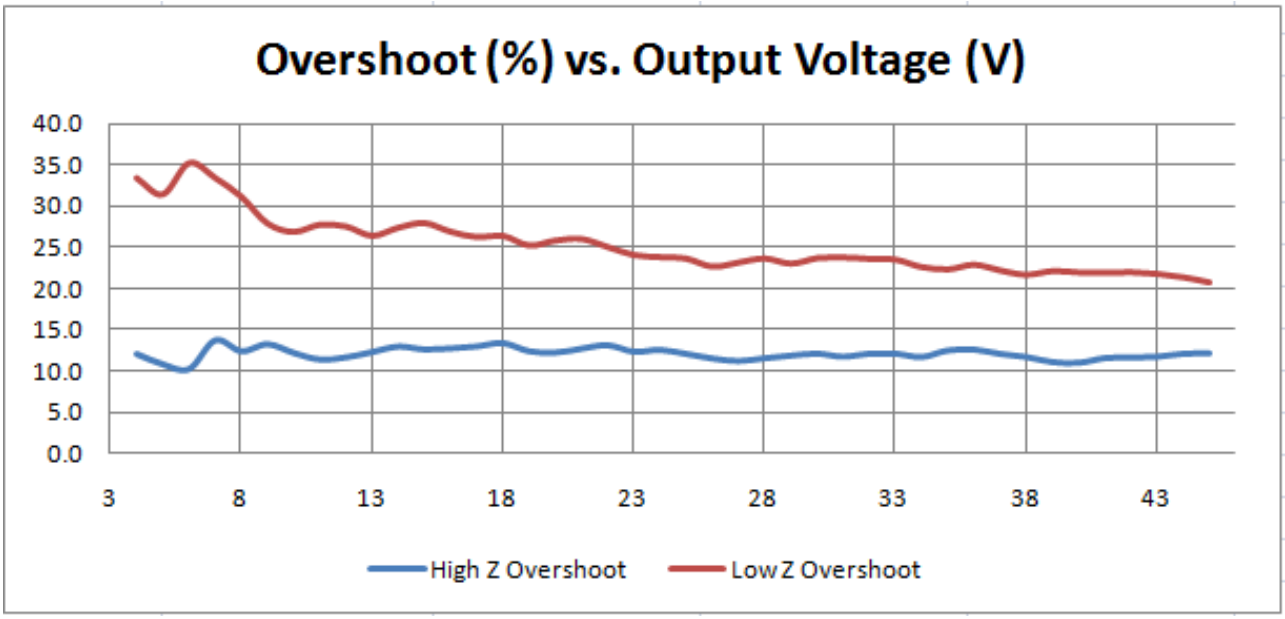
Rise time and overshoot are tuned for best response at low impedance (low Z)



Rise Time vs. Output Voltage



Fall Time vs. Output Voltage



Overshoot vs. Output Voltage

13 Safety Marking Symbols

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

Symbol	Publication	Description/Comment
	IEC 417, No. 5032	**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 Earthing 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 (Class I) 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. 5007	**On** (AC Mains) Located on the power switch at the rear of the unit
	IEC 417, No. 5008	**Off** (AC Mains) Located on the power switch at the rear of the unit
	IEC 417, No. 5172	**Class II Equipment protected by double insulation or reinforced insulation.** The equipment typically does not require a Safety Ground (Protective Ground).
	ISO 3864, No. B.3.6	**Caution, risk of electric shock**
	IEC 417, No. 5041	**Caution, hot surface**

	ISO 3864, No. B.3.1	**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.
	IEC 417, No. 5268-a	**In-position of bistable push control**
	IEC 417, No. 5269-a	**Out-position of bistable push control**
	IEC 60417, No.5009	**Standby/On Symbol** momentary contact switch, does not disconnect AC mains voltage.
	-	**Indicates compliance with the WEEE Directive. Please dispose of the product in accordance with local regulations and conventions.**
	CE Mark	**Indicates compliance with European Union Legislation for the relevant Safety (Low Voltage Directive 2006/95/EC) and EMC (EMC Directive 2004/108/EC) requirements.**

14 Model 577 Specifications

I/O Configuration

Model/Output	577 – 2C: 2 Independent Channels 577 – 4C: 4 Independent Channels 577 – 8C: 8 Independent Channels
Output Modules:	
Standard	
AT20	Dual Channel, TTL/CMOS & Adjustable Output Module
Optional	
L82	Dual Channel, 820 nm Optical Output Module
L130	Dual Channel, 1300 nm Optical Output Module
AT35	Dual Channel, TTL/35 V High Voltage Output Module
AT45	Dual Channel, 45 V High and Low Impedance Voltage Output Module (limited to 4 channels)
TZ50	Dual Channel, High Current TTL/CMOS (for driving 50 ohm loads) & Adjustable Output Module
TZ35	Dual Channel, High Current TTL/CMOS (for driving 50 ohm loads) & 35V High Voltage Output Module
Input Modules:	
Standard	
IA15	Dual Channel, 1 Trigger / 1 Gate Input Module * Standard dual channel input module, providing one Trigger input and one Gate input. May be used with the Dual Trigger firmware Option to provide two independent Trigger sources.
Optional	
IL82	Dual Channel, 820 nm Optical Input Module
IL130	Dual Channel, 1300 nm Optical Input Module

Internal Rate Generator

Rate (T_0 period)	0.001 Hz to 20.000 MHz (1000 s – 50 ns)
Resolution	5 ns
Accuracy	5 ns + (0.0001 x period)
T_0 Period Jitter	< 500 ps RMS
Time Base	200 MHz, low jitter PLL
Oscillator	50 MHz, 50 ppm crystal oscillator
System Output Modes	Single, Normal, Burst, Duty Cycle, External Gate/Trigger
Burst Mode	1 to 1,000,000 pulses
Duty Cycle Mode	1 to 1,000,000 pulses ON and/or OFF
Pulse Control Modes	Internally triggered, externally triggered or external gate.

Channel Timing Generator

Pulse Width Range	1000 s – 10 ns
Width Accuracy	10 ns + [0.0001 x (width + delay)]
Width Resolution	10 ns
Pulse Delay Range	+1000 s

Delay Accuracy	10 ns + (0.0001 x delay)
Delay Resolution	250 ps
Jitter (channel to channel)	< 250 ps RMS
Output Multiplexor	Any/all channels may be OR'd to any/all outputs.
Time Base	Same as internal rate generator
Channel Output Modes	Single, Normal, Burst, Duty Cycle
Burst Mode	1 to 1,000,000 pulses
Duty Cycle Mode	1 to 1,000,000 pulses on and/or off
Wait Counts	1 to 1,000,000 pulses
Channel Control Modes	Internally triggered or external gated. Each channel may be independently set to either mode.

Standard Features

Communications:	
USB	USB 1.0 Standard
RS-232	DB-9 Connector using RS-232 Communications Standard
External Clock In	10 MHz – 100 MHz user selectable in discrete values
External Clock Input Voltage	2.5 V - 5 V(Max)
External Clock Out	To or Ref out (10 to 100MHz) user selectable in discrete values

System Options

DT15	Dual Trigger Logic – provides additional trigger via gate input
COM	Extended Communications – Adds Ethernet & GPIB
SRM	Single Rack Mount
DRM	Dual Rack Mount

General

Storage	16 storage bins
Dimensions	10.5" x 8.25" x 5.5"
Weight	8 lbs
Power	100 - 240 VAC 50/60 Hz 3 A
Fuse	(Qty 2) 3.15A, 250 V Time-lag
Temperature	
Operation	0 – 40 °C (32 – 104 °F)
Transportation & Storage	-40 – 70 °C (-40 – 158 °F)

Module Specifications

TTL/Adjustable Dual Channel Output Module (Standard)

TTL/CMOS Mode:	
Output Impedance	50 Ohms
Output Level	4.0 V typ into 1 Kohm 2.0 V typ into 50 ohm
Rise Time	2.8 ns typ (10% - 90%)
Slew Rate	> 0.5 V/ns
Jitter	50 ps RMS channel to channel
Adjustable Mode:	
Output Impedance	50 Ohms
Output Level	200 mV to 20 VDC into 1 Kohm 100 mV to 10.0 VDC into 50 ohm

Output Resolution	10 mV
Current	200 mA typical, 400 mA (short pulses)
Rise Time	15 ns typ @ 20V (high imp) 25 ns typ @ 10V (50 ohms) (10% - 90%)
Slew Rate	>0.1 V/ns
Overshoot	<100 mV + 10% of pulse amplitude

Trigger/Gate Dual Input Module (Standard)

Trigger Input:

Function	Generate individual pulses, start a burst or continuous stream
Rate	DC to 1/ (200 ns + longest active pulse). Maximum of 20 MHz
Slope	Rising or Falling
Threshold	0.2 to 15 VDC
Maximum Input	60 V Peak
Resolution	10 mV
Trigger Accuracy	±3% of Threshold Voltage
Impedance	5.3 Kohm + 40 pF
Rate	DC to 20 MHz
Trigger Jitter	< 800 ps RMS
Insertion Delay	< 100 ns
Minimum Pulse Width	≥ 20 ns
Pulse Inhibit Delay	< 150 ns RMS
Output Inhibit Delay	< 100 ns RMS

Gate Input:

Mode	Pulse inhibit or output inhibit
Polarity	Active high/active low
Trigger Jitter (Gate as Trigger Input)	< 800 ps RMS

Optical Outputs

Wavelength	820 nm or 1300nm
Maximum Signal Rate	5 MBd
Maximum Link Dist.	1.5 Km
Connector Type	ST

Optical Inputs

Wavelength	820 nm or 1300 nm
Maximum Signal Rate	5 MBd
Maximum Link Dist.	1.5 km
Connector Type	ST
Insertion Delay	<300 ns
Jitter	<1.4 ns RMS

AT35 Specifications

Through a 50Ω load at 200 Hz

Output	5 V – 35 V
Setpoint Resolution	10 mV
Rise Time	< 30 ns
Accuracy	500 mV
Max. Frequency (Internal & External)	4000 Hz

TZ50 Specifications

TTL/CMOS Mode	
Output Level	4.0 V typ into 50 Ohms
Rise Time	2.8 ns
Slew Rate	0.5 V/ns
Jitter - Channel to Channel	50 ps RMS
Adjustable Mode	
Output Resolution	10 mV
Current	100 mA typ, 400 mA max (short pulses)
Slew Rate	0.1 V/ns

AT45 Specifications

Amplitude	4 V – 45 V
Resolution	20 mV
Accuracy	+/-1.5%
Rise Time	< 2 ns Typical 10%-90% (Low Z) < 9 ns Typical 10%-90% (High Z)
Fall Time	< 2 ns Typical 90%-10% (Low Z) < 9 ns Typical 90%-10% (High Z)
Frequency (Internal & External)	DC – 100 KHz
Overshoot	<35% Typical Allowed for Fast Rise Time
Polarity - High Z (>10k)	Active High or Active Low
Polarity - Low Z (50 Ohms)	Active High Only
Pulse Width - High Z (>10k)	10 ns to DC
Pulse Width - Low Z (50 Ohms)	10 ns to 10s
Current (maximum)	35 mA (High Z @10ms width) 900 mA (Low Z @ 10ms width)