# 9100/8100 Series Pulse Generator

# Operating Manual

*4 & 8 Channel Pulse Generators*


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# Contents


**1. INTRODUCTION ..... 4**

TECHNICAL SUPPORT ..... 4
WARRANTY ..... 4
PACKAGE CONTENTS ..... 4

**2. SAFETY ISSUES ..... 5**

**3. SYSTEM OVERVIEW ..... 6**

*9100 Front Panel ..... 6*
FRONT PANEL LAYOUT ..... 6
*9100 Rear Panel ..... 7*
REAR PANEL LAYOUT ..... 7

**4. PULSE CONCEPTS AND PULSE GENERATOR OPERATIONS ..... 8**

Counter Architecture Overview ..... 8
System Timer Functions ..... 8
Channel Timer Functions ..... 9
Digital Output Multiplexer ..... 10
Channel Gate Function ..... 11
Ch 4 - Normal Mode ..... 11
Ch 8 - Normal Mode ..... 11
(extended delay & width) ..... 11
Channel Phase Locking ..... 12
*Operating the 9100/8100 ..... 13*
Quick Start - Normal Internal Rate Generator Operation ..... 13
QUICK START – NORMAL EXTERNAL TRIGGER OPERATION ..... 14
SYSTEM TIMER OVERVIEW ..... 15
Using Continuous Mode ..... 15
Using Single Shot Mode ..... 15
Using System Burst Mode Function ..... 16
Using the System Duty Cycle Function ..... 16
CHANNEL TIMER OVERVIEW ..... 17
Using Channel Normal Function ..... 17
Using Channel Single Shot Function ..... 17
Using the Channel Burst Mode ..... 18
Using the Channel Duty Cycle Mode ..... 18
EXTERNAL INPUT OVERVIEW ..... 19
Using the External Gate to Control the System ..... 19
Using the Channel Gating Function ..... 19
Generate a Pulse on Every Trigger Input ..... 19
Generate a Burst of Pulses on Every Trigger Input ..... 20
Start a Continuous Stream of Pulses Using the External Trigger ..... 20

**5. 9100/8100 APPLICATION ..... 20**

**6. PROGRAMMING THE 9100/8100 ..... 22**

PERSONAL COMPUTER TO PULSE GENERATOR COMMUNICATION ..... 22
RS-232 Interface Overview ..... 22
USB Interface Overview ..... 22
PROGRAMMING COMMAND TYPES AND FORMAT ..... 23
Line Termination ..... 23
IEEE 488.2 Common Command Format ..... 24

SCPI Command Keywords ..... 24
SCPI Command Format ..... 24
SCPI Keyword Separator ..... 24
SCPI Optional Keywords ..... 24
SCPI Specific and Implied Channel ..... 25
SCPI Parameter Types ..... 25
Error Codes ..... 25
Programming Examples ..... 25
9100/8100 SCPI COMMAND SUMMARY ..... 27
IEEE 488.2 COMMON COMMANDS ..... 32

**7. APPENDIX A - SPECIFICATIONS ..... 33**

*9100 Mechanical Dimensions ..... 36*

**8. APPENDIX B - SAFETY SYMBOLS ..... 37**

*Safety Marking Symbols ..... 37*

**9. APPENDIX C – IMPEDANCE MATCHING OUTPUTS ..... 39**

*TZ50 Impedance Matching Output Module ..... 39*
TTL/ADJUSTABLE OUTPUTS ..... 39

**10. APPENDIX D - EXTERNAL CLOCK ..... 40**

*9108/8108 External Clock Specifications ..... 40*

**11. APPENDIX E – 8100 BOARD LEVEL OPTION ..... 41**

*8100 Board Level Connection Information ..... 41*
8100 BOARD LEVEL OVERVIEW ..... 41
DIGITAL CONTROL BOARD CONNECTION INFORMATION (MODEL 8104) ..... 41
DIGITAL CONTROL BOARD CONNECTION INFORMATION (MODEL 8108 ADDITIONAL CONNECTIONS) ..... 43
MOUNTING INFORMATION ..... 44
AUTO POWER ON ..... 44
*8100 Mechanical Dimensions ..... 45*

# 1. Introduction

This manual is a reference designed to familiarize you with the Quantum Composers 9100/8100 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.

| | Chassis Model(s | Board Level Models |
|---|---|---|
| 4 Channel Unit(s) | | QC8104 |
| 8 Channel Unit(s) | QC9108 | QC8108 |

## Technical Support

For questions or comments about operating the 9100 our technical staff can be reached via one of the following methods:

- Phone - (406) 582-0227
- Fax - (406) 582-0237
- Internet - www.quantumcomposers.com

## Warranty

In addition to a 30-day money back guarantee, the 9100/8100 has a two-year limited warranty from the date of delivery. This warranty covers defects in materials and workmanship. Quantum Composers 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:

- 9100/8100 Pulse Generator
- 24 VDC Power adapter
- USB Cable
- User's Manual and Software on USB Drive

Contact Quantum Composers (406) 582-0227 if any parts are missing.

# 2. Safety Issues

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 $V_{RMS}$ 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. System Overview

## 9100 Front Panel


Figure 1 9108 8 Channel Front Panel

### Front Panel Layout

An array of LEDs provide channel status, blue indicates the channel is enabled, off indicates the channel is disabled.

The Run/Stop button is on the right side of the front panel. Pressing the switch for a second or two will power down the unit. A quick press will enable or disable the output.

# 9100 Rear Panel


Figure 2 8 Channel Back Panel

## Rear Panel Layout

The channel outputs are available from an array of BNCs. There is a BNC trigger/gate input. The input range is 0.5v to 30v. On 8 channel units, a pair of BNC connectors provide for the input of a reference oscillator and the output of the internal system T0 pulse or a synthesized oscillator output. The unit provides a USB or optional RS232 comm port. Standard power is provided by a 24VDC power transformer. Power for TTL only mode can be provided by a USB 3.0 or higher comm port. An additional Run/Stop button on the rear can be used to power on/off the unit or enable/disable the outputs.

# 4. Pulse Concepts and Pulse Generator Operations

## Counter Architecture Overview

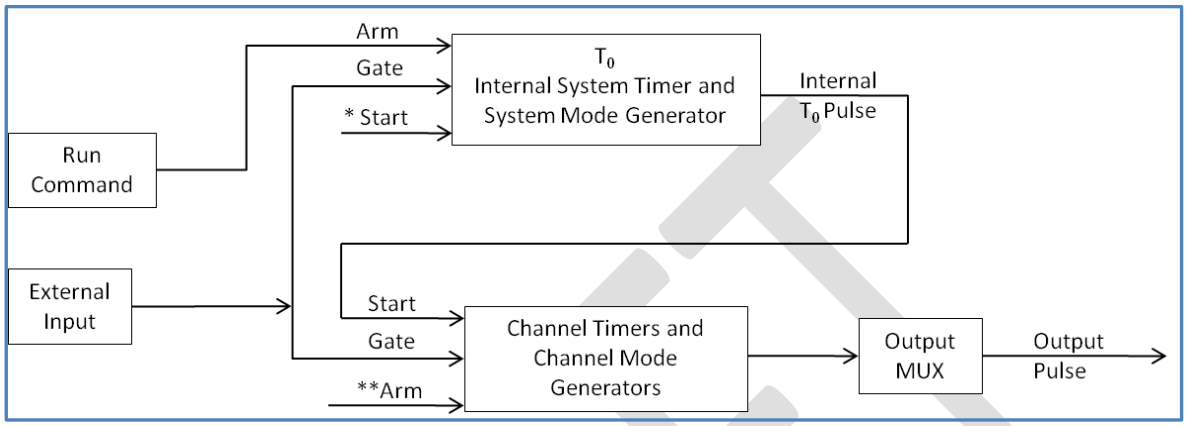



**Figure 3 Pulse Generation**

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

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

## System Timer Functions

The system timer generates the internal T0 pulse which is used as the Start pulse for the channel timers. 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 or using the comm commands. 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 $T_0$ pulse is 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 for the first $T_0$ pulse, after which the output is inhibited.
- Burst — 'n' number of pulses are generated for the first $T_0$ pulse, after which the output is inhibited.
- Duty Cycle — 'n' number of pulses are generated for each $T_0$ pulse after which the output is inhibited for 'm' number of pulses. The cycle is then repeated for each subsequent $T_0$ pulse.

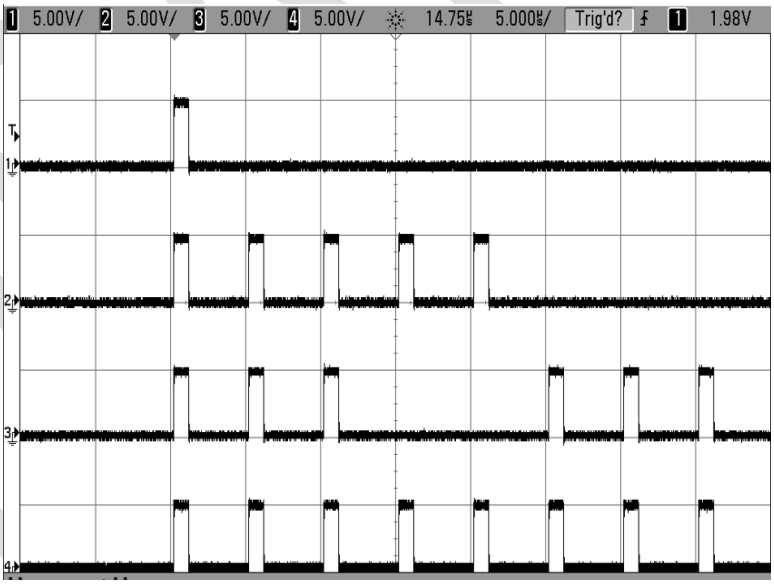
Different modes may be selected for each output, allowing a wide variety of output combinations. Each output may also be independently disabled or gated (using the external gate input).

Scope Ch 1
Ch 1 - Single Shot

Scope Ch 2
Ch 2 - Burst Mode
(5 Pulses)

Scope Ch 3
Ch 3 – Duty Cycle Mode
(3 On, 2 Off)

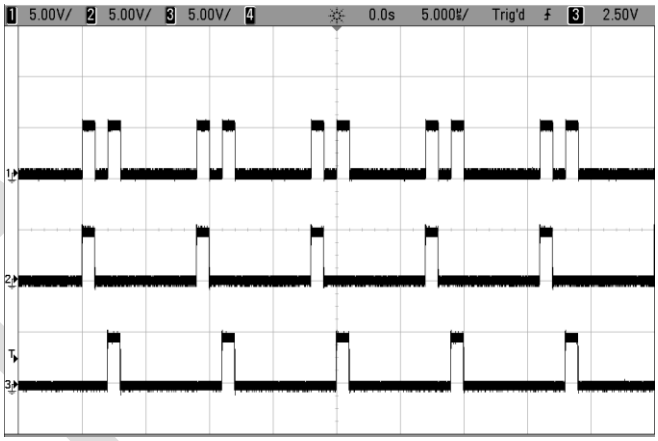
Scope Ch 4
Ch 4 - Normal Mode



## Digital Output Multiplexer

The outputs of each of the Channel Timers are routed to a set of multiplexers. This allows routing of any of the Channel Timers to each of the output ports. In the normal mode of operation the bit corresponding to the timer number is one. For example channel 1 is 0001, channel 2 is 0010, channel 3 is 0100, etc. Using the MUX function with the channel modes allows a number of complex functions, such as double pulsing, modulating pulse widths as shown in the following examples:

**Ex. 1: Double Pulse** – A double pulse waveform can be generated, as shown in the figure, by using the MUX function to combine two channels.

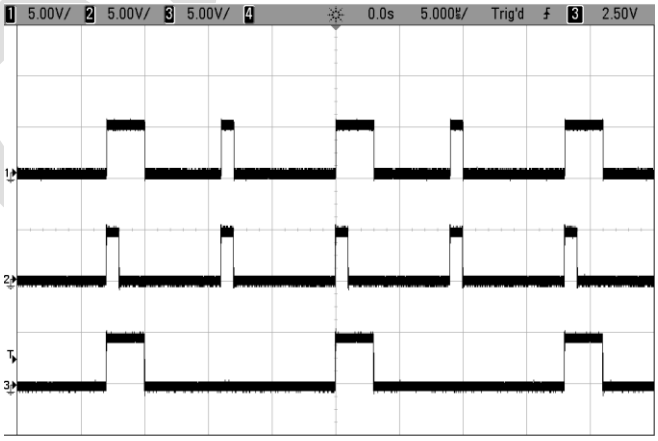



Scope Ch 1: Channel 1 output after combining channel 1 and channel 3 (mux code: 5).

Scope Ch 2: Channel 1 output before combining channel 3 (mux code: 1).

Scope Ch 3: Channel 3 output delayed as necessary to generate the required second pulse (mux code: 4).

**Ex. 2: Alternating Pulsewidth** – An extended pulse can be generated every other pulse, as shown in the figure, by using the MUX function to combine two channels.




Scope Ch 1: Channel 2 output after combining channel 2 and channel 4 (mux code: 10).

Scope Ch 2: Channel 2 output before combining channel 4 (mux code: 2).

Scope Ch 3: Channel 4 output extended as necessary to generate the required second pulse (mux code: 8). The channel is in duty cycle mode (1 on, 1 Off) to generate the alternating pattern.

## Channel Gate Function

The outputs of each of the Channel can be gated by one of two channel timers. 4-channel units use channel 4, 8-channel units can use either channel 4 or channel 8.

- Channel 4 can be used to either gate the other channels or inhibit the other channels.
- Channel 8 can only be used to gate the other channels.

In the gated mode, output of the gated channels only occurs when the gate is high (active high mode). In the inhibit mode, output of the gated channels is inhibited when the gate is high (active low mode).

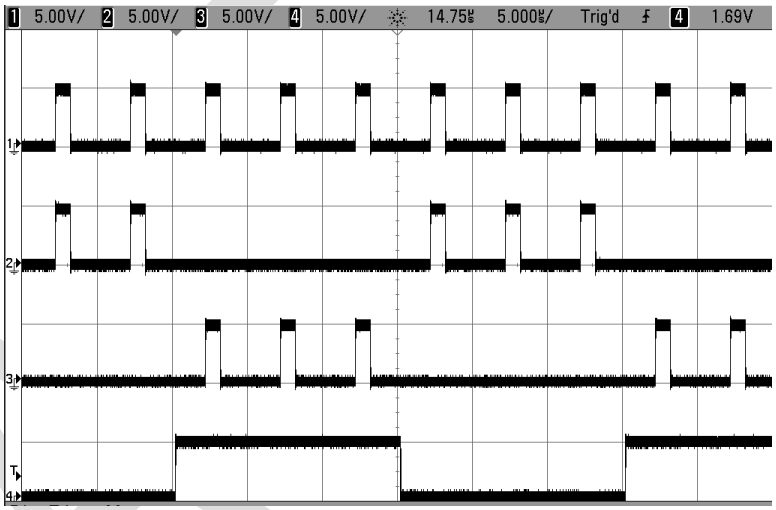
Gate A & INHIBIT A Mode (ch4)

Scope Ch 1
Ch 1 – Normal Mode

Scope Ch 2
Ch 2 – Inhibit A (INHA) Enabled

Scope Ch 3
Ch 3 – Gate A (GATA) Enabled

Scope Ch 4
Ch 4 - Normal Mode
(extended delay & width)



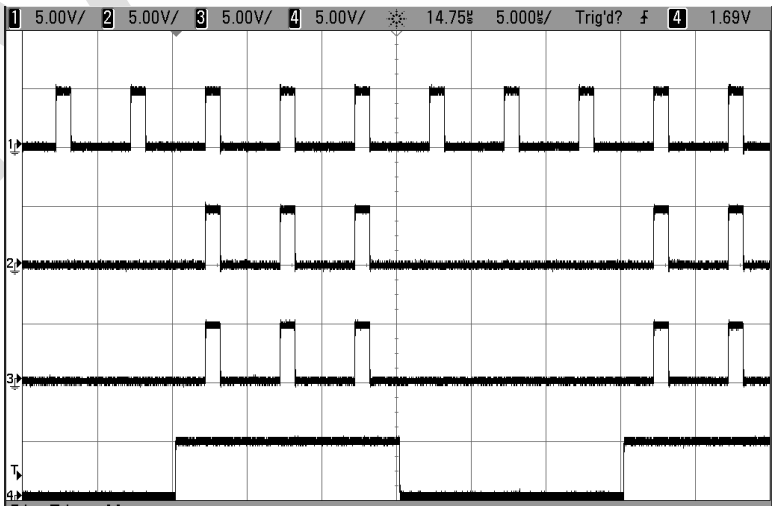

Gate B Mode (ch8)

Scope Ch 1
Ch 1 – Normal Mode

Scope Ch 2
Ch 2 – Gate B (GATB) Enabled

Scope Ch 3
Ch 3 – Gate B (GATB) Enabled

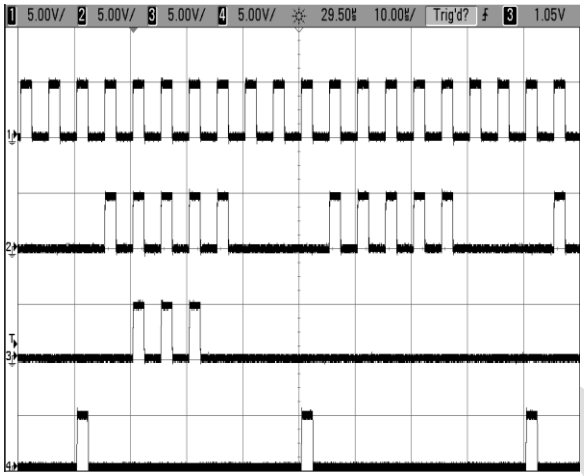
Scope Ch 4
Ch 8 - Normal Mode
(extended delay & width)

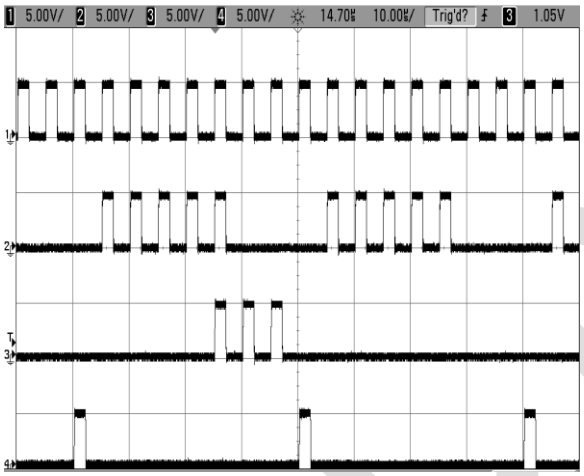


## Channel Phase Locking

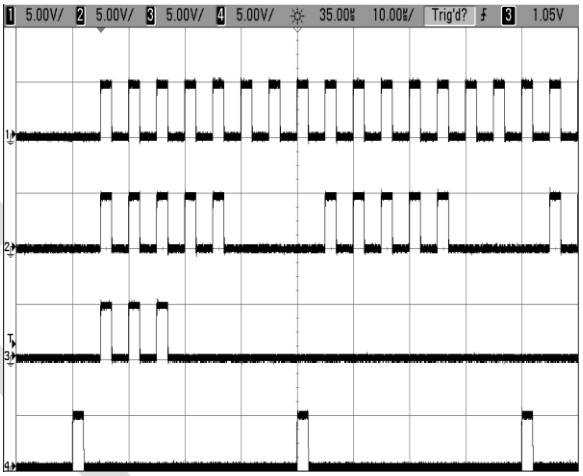
Normally when rearming a channel, the output will start on the next available T0 pulse. This leads to a random phase relationship with other channels that may be in duty cycle mode, as shown in column 1. The 9100/8100 channel sync feature can be used to lock the channel relative to the sync pulse, as shown in column 2. Note that when sync is enabled, the Ch3 burst is always locked to start of Ch2 output. Either channel 2 or channel 8 can be used as the phase locking pulse.

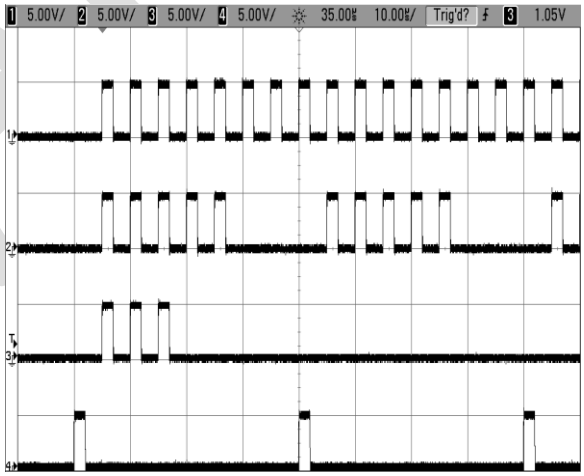
**Column 1 – Sync Mode Disabled**




**Column 2 – Sync Mode Enabled**




Scope Ch1 – channel 1 - normal mode, wait = 1
Scope Ch2 – channel 2 - duty cycle mode (5 on, 3 off), wait = 1
Scope Ch3 – channel 3 - burst mode (3 pulses), wait = 0
Scope Ch4 – channel 8 - (sync pulse) duty cycle mode (1 on, 7 off), wait = 0.

# Operating the 9100/8100

The 9100/8100 has a powerful set of functions providing a number of modes of operation. Both the system timer and the channel timer combine to provide the ability to generate complex waveforms. Configuring the system is done via the QC GUI or using the computer interface command set. The available computer interfaces include a USB port or optional RS232 port.

### Quick Start - Normal Internal Rate Generator Operation

The 9100/8100 has a powerful set of functions providing a number of modes of operation for the internal or "System" rate generator ($T_0$). 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:

| | |
|---|---|
| $T_0$ Period | Set the Rate using either the supplied GUI or using the command set on one of the computer interfaces. The system mode should be in Continuous Mode. |
| Pulse Width and Delay | Set the required pulse width and delay using either the supplied GUI or using the command set on one of the computer interfaces. Enable or Disable the channel as required. The mode will be "normal". Repeat for each output channel. |

**Note: In general, the pulse delay + the pulse width + 75 ns for a hardware reset for any channel, must be less than the $T_0$ period to avoid dropped pulses.*

| | |
|---|---|
| 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 | Set the System Mode using either the supplied GUI or using the command set on one of the computer interfaces. Select Single Shot mode. |
| Trigger | Set the Trigger using either the supplied GUI or using the command set on one of the computer interfaces. Select Trigger Enable |
| Level | Set the Level parameter using either the supplied GUI or using the command set on one of the computer interfaces. Set the trigger threshold voltage to approximately 50% of the trigger signal amplitude. |

**Note: If the threshold is not set correctly the 9100 will have trouble syncing with the trigger source.*

| | |
|---|---|
| Edge | Set the Edge parameter using either the supplied GUI or using the command set on one of the computer interfaces. Set the unit to trigger off the rising or falling edge as desired. |
| Pulse Width and Delay | Set the required pulse width and delay using either the supplied GUI or using the command set on one of the computer interfaces. Repeat for each output channel. |
| Start | Press the Run/Stop key to start generating pulses or use either the supplied GUI or use the command set on one of the computer interfaces. |
| Stop | Press the Run/Stop key a second time, or use either the supplied GUI or use the command set on one of the computer interfaces to stop generating pulses. |

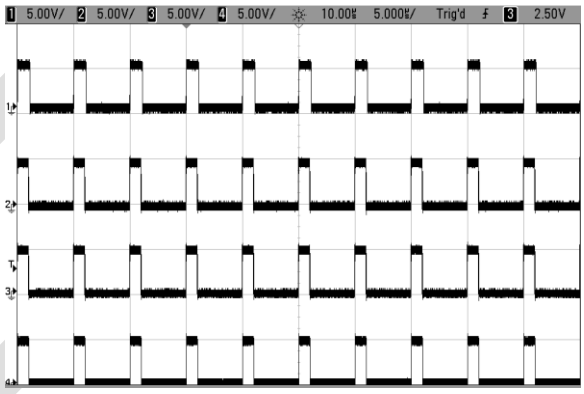
## System Timer Overview

For internal operation, the 9100/8100 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.

### Using Continuous Mode

The Run/Stop button starts and stops a continuous pulse stream at the rate specified by the system Period parameter. This corresponds to the normal output mode for most pulse generators. To generate a continuous stream of pulses:

- System Mode: Continuous mode
- System Period: 10µs



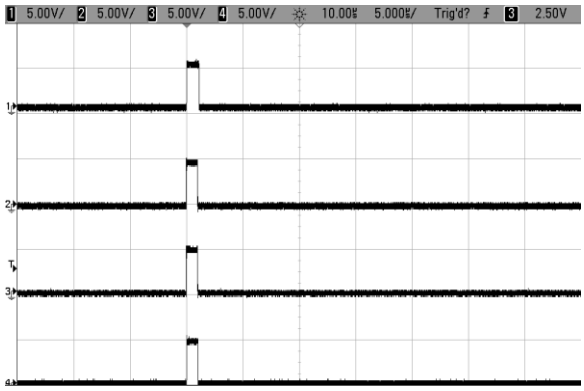

Pressing the front panel Run/Stop key or entering the system State command will now generate a stream of pulses at a rate specified by the period parameter.

Scope Ch 1: Channel 1 set to normal mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

### Using Single Shot Mode

To generate a single pulse with every press of the Run/Stop key or the State enable command:

- System Mode: Single Shot mode



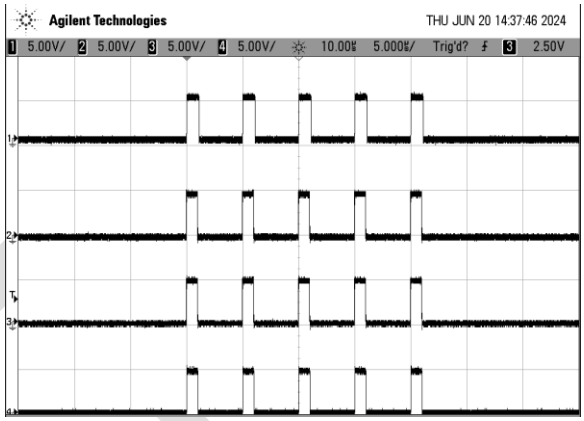

Pressing the front panel Run/Stop key or entering the system State command will now generate one pulse.

Scope Ch 1: Channel 1 set to normal mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

## Using System Burst Mode Function

The Run/Stop button generates a stream of 'N' $T_0$ pulses, where the 'N' is specified by the Burst parameter. The rate is specified in the Rate menu. Pressing the Run/Stop button while in 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 set:

- System Mode: Burst mode
- Burst Count: 5
- System Period: 10µs



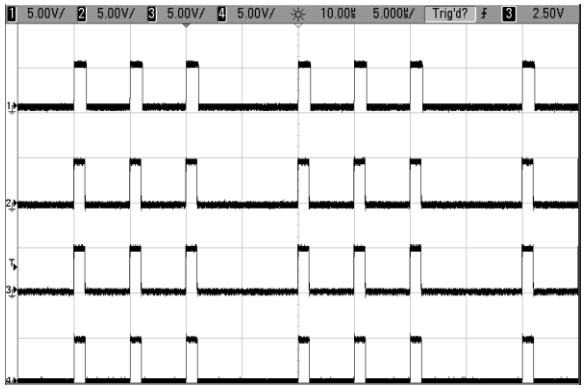

Pressing the front panel Run/Stop key or entering the system State command will now generate a burst of the specified number of pulses.

Scope Ch 1: Channel 1 set to normal mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

## Using the System Duty Cycle Function

The Run/Stop button starts a continuous stream of $T_0$ pulses, which oscillates on for 'N' pulses and off for 'M' pulses, where 'N' and 'M' are specified by the On/Off parameters respectively. The rate at which the pulses are generated is controlled in the Rate menu. To generate a stream of pulses which will oscillate on for 'N' pulses and off for 'M' pulses set:

- System Mode: Duty Cycle mode
- On Count: 3
- Off Count: 1
- System Period: 10µs




Pressing the front panel Run/Stop key or entering the system State command will now generate a continuous stream of pulses in bursts as defined by the on/off parameters.
Scope Ch 1: Channel 1 set to normal mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

## Channel Timer Overview

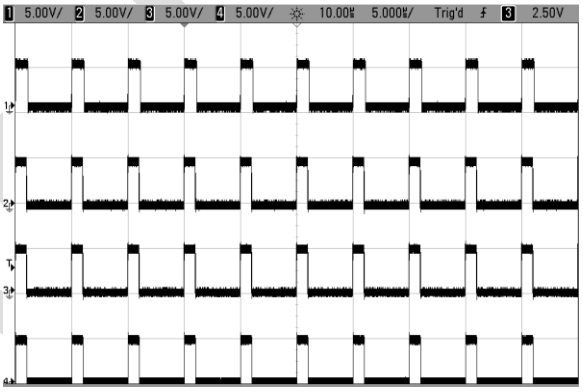
The output of each channel is controlled by two timers to generate the pulse width and the delay timing. All channels are simultaneously triggered, depending on the system mode, by the internal $T_0$ pulse, the external trigger, or a trigger provided by a CPU. A given channel may or may not generate a pulse depending on its own channel mode as described below.

### Using Channel Normal Function

The Normal mode generates a continuous string of pulses once the Run/Stop key is pressed. To use channel normal mode set:

- System Mode: Continuous mode
- System Period: 10µs

- Set the Channel parameters:
  - Enable the channel output
  - Set the delay desired.
  - Set the pulse width desired.




Pressing the front panel Run/Stop key or entering the system State command will now generate a stream of $T_0$ pulses at a rate specified by the system period parameter.

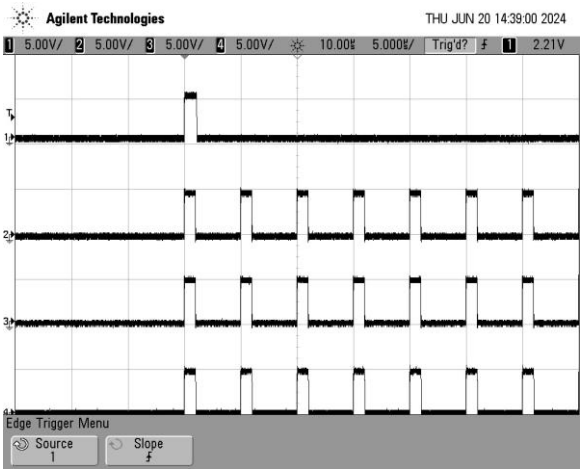
Scope Ch 1: Channel 1 set to normal mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

### Using Channel Single Shot Function

The Single Shot mode generates a single pulse every time the Run/Stop key is pressed. To use the channels' single shot mode set:

- System Mode: Continuous mode
- System Period: 10µs

- Set the Channel parameters:
  - Enable the channel output.
  - Set the delay desired.
  - Set the pulse width desired.
  - Set the mode to Single Shot.



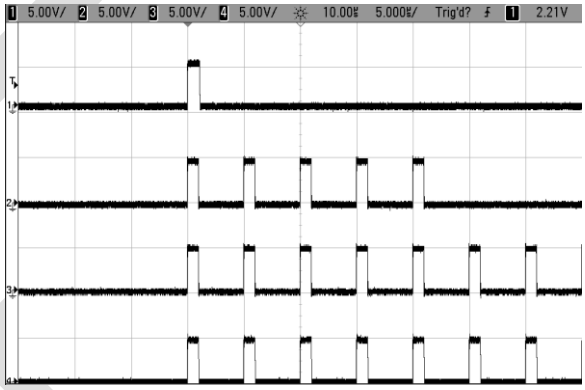

Pressing the front panel Run/Stop key or entering the system State command will now generate one pulse on channel 1. Other channels can continue to generate pulses depending on the System Mode and/or the channel modes.

Scope Ch 1: Channel 1 set to single shot mode.
Scope Ch 2: Channel 2 set to normal mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

**Using the Channel Burst Mode**
The burst mode generates a burst of pulses every time the Run/Stop key is pressed. To use the channels' burst mode set:

- Set the Channel parameters:
  - Enable the channel output.
  - Set the delay desired.
  - Set the pulse width desired.
  - Set the mode to Burst.
  - Set the Burst parameter to the number of pulses to produce in the burst.

Pressing the front panel Run/Stop key or entering the system State command will now generate a burst of pulses. Other channels can continue to generate pulses depending on the System Mode and/or the channel modes.

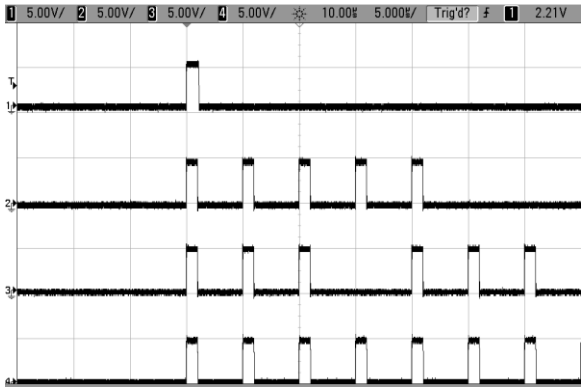



Scope Ch 1: Channel 1 set to single shot mode.
Scope Ch 2: Channel 2 set to burst (5) mode
Scope Ch 3: Channel 3 set to normal mode
Scope Ch 4: Channel 4 set to normal mode

**Using the Channel Duty Cycle Mode**
The channel duty cycle mode will generate a stream of pulses on the channel level which will oscillate on for 'N' pulses and off or 'M' pulses. To generate the required sequence of pulses set:

- Set the Channel parameters:
  - Enable the channel output.
  - Set the delay desired.
  - Set the pulse width desired.
  - Set the mode to Duty Cycle.
  - Set the On parameter to the number of pulses to produce during the on cycle ('N').
  - Set the Off parameter to the number of pulses to suppress during the off cycle ('M').

Pressing the front panel Run/Stop key or entering the system State command will now generate a continuous series of 'N' pulses followed by 'M' suppressed pulses. Other channels can continue to generate pulses depending on the System Mode and/or the channel modes.




Scope Ch 1: Channel 1 set to single shot mode.
Scope Ch 2: Channel 2 set to burst (5) mode
Scope Ch 3: Channel 3 set to duty cycle (3 on, 1 off)
Scope Ch 4: Channel 4 set to normal mode

## External Input Overview

The external input may be used to trigger the unit, gate the system timer, or to gate the channel timers. When using the trigger input the external input acts as a system start pulse. Depending on the system mode, the result of a trigger input can be a single pulse, a burst of pulses, or the start of a stream of pulses. Rear panel contains the trigger / gate input. The trigger input can be a 2.0v to 30v pulse.

### Using the External Gate to Control the System

The external gate may be used to control the output of the unit. To gate the internal system timer with an external source set:

- Set the Gate parameters:
  - Set the mode to System Gate.
  - Set the threshold level to ~50% of the incoming gate signal.
  - Choose either active High or Low for the gate polarity.

Pressing the Run/Stop button will arm the unit. Once the unit is armed it will start generating pulses once the external gate is in the active state. Pressing the Run/Stop key again will disarm the unit.

### Using 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 channel gate set the following parameters:

- Set the Gate parameter:
  - Set the mode to Chan Gate.
- Set the Channel parameters:
  - Set the channel gate mode parameter to either Pulse Inhibit or Output Inhibit.
  - Set the gate logic to either Active High or Active Low.

In Pulse Inhibit mode the gate prevents the channel from being triggered by the channels' trigger source. When in Pulse Inhibit mode if a pulse has already started when the gate disables the channel the pulse will continue normal output, but the output will not restart on the next trigger pulse. In Output Inhibit mode the gate leaves the base triggering alone and will enable/disable the output directly. When in Output Inhibit mode if a pulse has already started when the gate disables the channel the pulse will be immediately cease.

### Generate a Pulse on Every Trigger Input

To generate a pulse on every trigger input set the following parameters:

- Set the System Mode to Single Shot mode.
- Set the Trigger parameters:
  - Select the Triggered mode.
  - Set the trigger threshold level to ~50% of the incoming signal.
  - Select either rising or falling edge for the unit 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 button again will disarm the unit. This mode corresponds to the normal external trigger mode found on most other pulse generators.

**Generate a Burst of Pulses on Every Trigger Input**
To generate a burst of pulses on every trigger input set the following parameters:

- Set the System parameters:
  - Set the mode to Burst.
  - Set the number of pulses that is desired for each input signal.
  - Set the period desired between pulses.
- Set the Trigger parameters:
  - Set the Triggered mode.
  - Set the trigger threshold level to ~50% of the incoming signal.
  - Select either rising or falling edge for the unit to trigger on.

Pressing the Run/Stop button will arm the unit. Once the unit is armed it will generate a set of pulses for every external trigger received. The units' timer 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 will be ignored. Pressing the Run/Stop key again will disarm the unit.

**Start a Continuous Stream of Pulses Using the External Trigger**
The external trigger may be used to cause the unit to start generating pulses by setting:

- Set the System Mode to Continuous mode.
- Set the Trigger parameters:
  - Set the Trigger mode.
  - Set the trigger threshold level to ~50% of the incoming signal.
  - Select either rising or falling edge for the unit to trigger on.

Pressing the Run/Stop button will arm the unit. Once the unit is armed it will start generating pulses after an external trigger is received. Triggers that occur after the initial trigger will be ignored. Pressing the Run/Stop key again will disarm the unit.

# 5. 9100/8100 Application

Aside from using the SCPI command protocol, the included software application is the primary means of communication with the 9100/8100. This application allows simple control of the 9100/8100 unit via the USB or RS232 (optional) communications port. To run the software, simply double click on the application which can be found on the included USB drive. No installation is required. The software can also be copied to your computer and run from any location. The screenshot shows the 9100/8100 application and all of the corresponding default parameters:

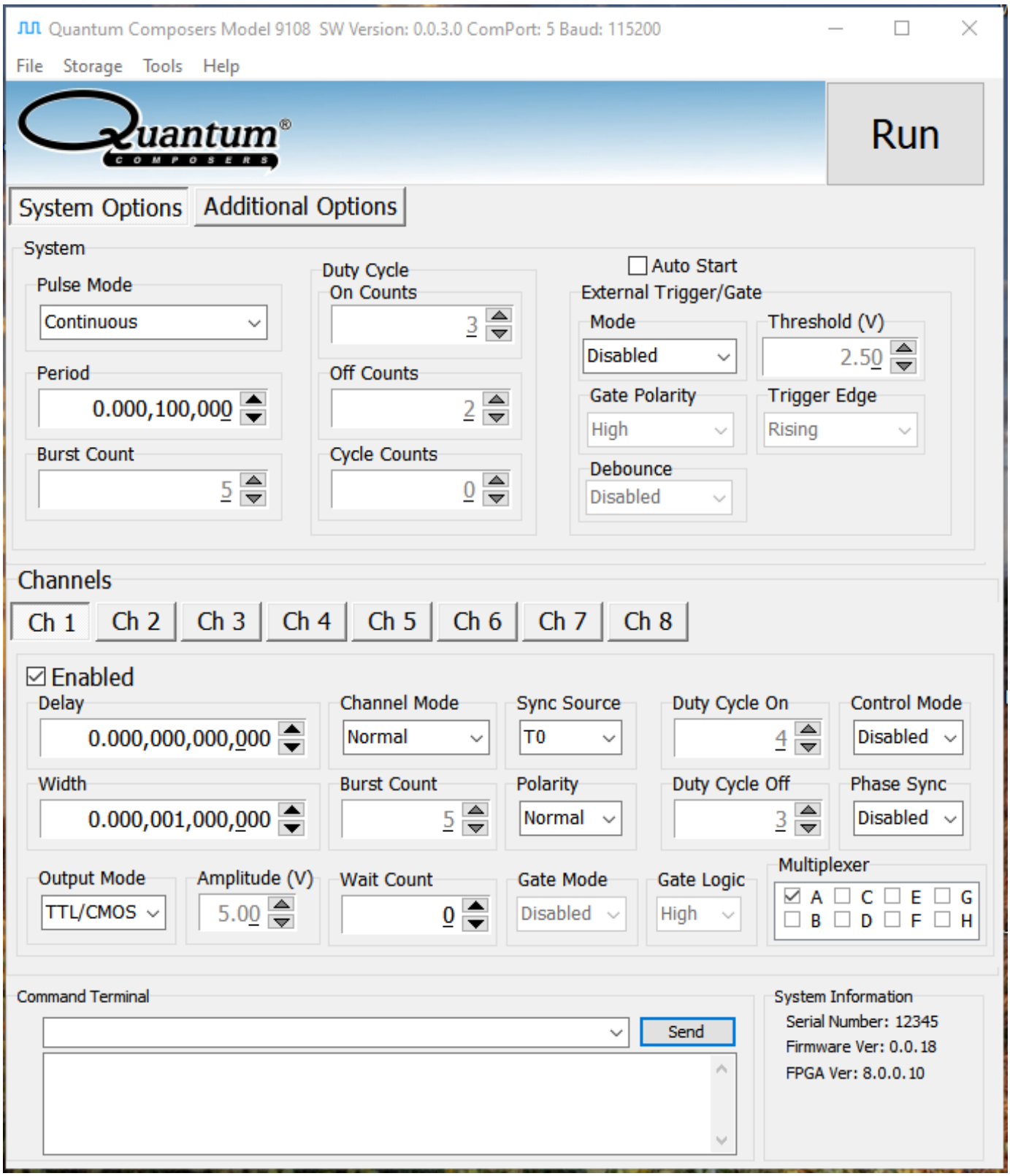



Figure 4 9100/8100 Software Application

# 6. Programming the 9100/8100

## Personal Computer to Pulse Generator Communication

The 9100/8100 has a standard USB interface or an optional RS-232. 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 (SCPI). Although due to the high number of special features found in the 9100/8100, many of the commands are not included in the SCPI specification. The syntax is the same for all interfaces. The amount of time required to receive, process, and respond to a command at a Baud rate of 115200 is 10 ms. Sending commands faster than 10 ms may cause the unit to not respond properly. All commands return a response and best practices require software to wait until the response from the previous command is received before sending the next command. This will provide fast, reliable communication with the system.

### RS-232 Interface Overview

The serial port is only accessible on the board level units (8100). The RS-232 is available on a 3 pin Molex connector with the following pinout:

| | |
|---|---|
| 1 | Tx - Transmit (to computer) |
| 2 | Rx - Receive (from computer) |
| 3 | Ground |

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 |

**Note: The default baud rate for the RS-232 is 115200.*

### USB Interface Overview

The USB interface is standard on the 9100. Once the proper drivers have been installed, the 9100 will show up in the device manager as a USB to Serial Port Adapter. The 9100 can then be communicated with by either the included 9100 application or by using any generic communication terminal program.

### USB communication notes:

- Typically no driver is required to use the unit as the Windows operating system will automatically detect the USB device.
- The unit is baud rate independent, so any speed can be selected. Typically a rate of 115,200bps can be used.
- USB 2.0 specification is used. The USB cable can be removed without “ejecting” the device in the operating system environment.

## Programming Command Types and Format

The 9100/8100 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. Any generic terminal program or the supplied GUI may be used to interactively test the commands using the USB or RS-232 interfaces. 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.

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 pneumonic 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.

**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:

**SCPI Query Format**

:PULSE1:STATE? <cr><lf>
Will return 1<cr><lf>
:PULSE1:WIDTH? <cr><lf>
Will return 0.000120000 <cr><lf>
:PULSE1:POL? <cr><lf>
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.

**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 key word 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 = $T_0$, 1 = Ch1, 2 = Ch2, 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 will default to 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:<br>For Example: 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, and 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) |
| :TRIG:STATE 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)

25µs pulse width, 0 delay, external trigger, and 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 25µs |
| :PULSE1:DELAY 0 <cr> <lf> | sets delay to 0 |
| :PULSE0:MODE SING <cr> <lf> | sets system mode to single shot |
| :TRIG:STATE ENAB <cr> <lf> | sets system to external trigger |
| :TRIG:LEV 2.5 <cr> <lf> | sets trigger level to 2.5 volts |
| :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 |

## 9100/8100 SCPI Command Summary

| Keyword: | Command: | Sub-Command: | Parameter Range: | Notes: |
|---|---|---|---|---|
| :INSTrument | | | | Submenu: Misc. system commands. |
| | :COMMands | | ? | Returns an indentured list of all valid SCPI commands |
| | :NSELect | | 0 - n | Selects a channel using the numeric value, where 'n' is the channel number. |
| | :STATe | | 0/1 or OFF/ON | Enables/Disables the system. This is the same as pressing the RUN button. |

| Keyword: | Command: | Sub-Command: | Parameter Range: | Notes: |
|---|---|---|---|---|
| :SPULse :PULSe0 | | | | Submenu: Commands to change the system timer settings, this is the same as using the :PULse0. |
| | :STATe | | 0/1 or OFF/ON | Enables/Disables the output for all channels. This command is the same as pressing the Run/Stop button. |
| | :PERiod | | 50[ns] – 5000[s] | Sets the $T_0$ period. The command should be sent without units. If for example 100µs is desired the parameter sent should be 0.0001 or using exponential notation i.e. 100e-6. |
| | :MODe | | NORMal / SINGle/ BURSt / DCYCle | Changes the system output mode. |
| | :BCOunter | | 1 - 4,000,000,000 | Changes the number of pulses to output when the system is in burst mode. **Note: Do not include commas.* |
| | :PCOunter | | 1 - 4,000,000,000 | Changes the number of on pulses to output when the system is in Duty Cycle mode. **Note: Do not include commas.* |
| | :OCOunter | | 1 - 4,000,000,000 | Changes the number of off pulses to suppress when the system is in Duty Cycle mode. **Note: Do not include commas.* |
| | :CYCLe | | 0 - 10,000,000 | Changes the number of cycles to output when the system is in Duty Cycle mode, 0 = continuous cycles. **Note: Do not include commas.* |
| | :ICLOCK | | INT / 10 / 20 / 25 / 30 / 40 / 50 / 60 / 80 | Changes the source of the system clock. INT is internal 'n' is the input frequency in MHz. NOTE: Only available on 8 channel units. |
| | :OCLOCK | | T0 / 10 / 20 / 25 / 30 / 40 / 50 / 60 / 80 | Allows the user to select the clock source to output: When ICLock is INT: T0 is the system sync pulse. 'n' is the input frequency in MHz. NOTE: Only available on 8 channel units. |

| Keyword: | Command: | Sub-Command: | Parameter Range: | Notes: |
|---|---|---|---|---|
| | :EXTernal | | | Submenu: Commands to change the system trigger/gate functions. |
| | | :MODe | DISable / TRIGger / SGATe / CGATe | Enables the trigger/gate 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). When in system gate mode, the external signal will gate the system pulses. When in channel gate mode, the channel gate mode is applied. |
| | | :LEVel | .20 – 15[V] | Choose the gate level threshold to trigger on, this should be set to ~ 50% of the input potential. |
| | | :EDGe | RISing / FALLing | Choose the edge of the incoming pulse to trigger on. |
| | | :POLarity | LOW / High | Sets the polarity of the gate signal. HIGH output is active when gate signal is high; LOW output is active when gate signal is low |
| | | :DEBounce | ENABle / DISable | Enables / disables the circuit. Note: *This will increase the insertion delay and jitter.* |

| | | | | |
|---|---|---|---|---|
| | :COUNter | | | |
| | | :STATe | 0/1 or OFF/ON | Enables / disables the counter. |
| | | :CLear | | Clears the counter. Should be done before starting a count. |
| | | :SOURce | To / CH1 / CH2 / CH3 / CH4 / CH5 / CH6 | Selects channel to count. |
| | | :COUNt | ? | Returns the current count. |

| Keyword: | Command: | Sub-Command: | Parameter Range: | Notes: |
|---|---|---|---|---|
| :PULSe[1/2/n] | | | | Submenu: Commands to change the channel settings. 'n' is the channel number. |
| | :STATe | | 0/1 or OFF/ON | Enables/Disables output pulse for selected channel. |
| | :DELay | | 0[s] to 2000[s] | Sets the delay for the selected channel. The command should be sent without units. If for example 25µs is desired the parameter sent should be 0.000025 or using exponential notation i.e. 25e-6. |
| | :WIDTh | | 10[ns] – 2000[s] | Sets the pulse width for the selected channel. The command should be sent without units. If for example 50ns is desired the parameter sent should be 0.00000050 or using exponential notation i.e. 50e-9. |
| | :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 | In Burst mode allows user to select the number of pulses to output with each input clock pulse. **Note: Do not include commas.* |
| | :PCOunter | | 1 to 10,000,000 | In duty cycle mode allows the user to select the number of pulses to create with each input clock pulse. **Note: Do not include commas.* |
| | :OCOunter | | 1 to 10,000,000 | In duty cycle mode allows the user to select the number of pulses to suppress with each input clock pulse. **Note: Do not include commas.* |
| | :WCOunter | | 0 to 10,000,000 | Allows the user to select how many To pulses to wait until the channel should start creating a output pulses. **Note: Do not include commas.* |
| | :CGATe | | DISabled / PULSe / OUTPut | Sets the channel gate mode to Disabled, Pulse Inhibit mode, or Output Inhibit mode. *Note: The system global gate mode must be set to CGATE for this command. |
| | :CLOGic | | LOW / HIGH | Channel gate logic. Choose active Low (will allow pulses when low) or active High (will allow pulses when high) |
| | POLarity | NORMal / COMPlement / INVerted | | Normal is active HIGH, Inverted and Complement are active LOW. |
| | :OUTPut | | | Submenu: Commands to change the channels' output parameters. |

| | | | | |
|---|---|---|---|---|
| | | :MODe | TTL / ADJustable | Allows the user to select either TTL logic mode or Adjustable voltage output mode. |
| | | :AMPLitude | 2.0 to 20[V] | Allows the user to select the voltage potential for Adjustable output mode. |
| | :MUX | | 0 to 63 | Decimal representation of a 6 bit binary number (example: 63 = 111111) |
| | :CONTrol | | DISable / GATA / GATB / INHA | Enables gate / inhibit function:<br>GATA (ch4) as a channel gate.<br>GATB (ch8) as a channel gate.<br>INHA (ch4) as a channel inhibit.<br>*Note: *GATB is not available on the 4-channel unit.* |
| | :PSYNc | | DISabled / SYNA / SYNB / SYNT | Enables phase sync function.<br>SYNA (ch2) as a channel phase sync.<br>SYNB (ch8) as a channel phase sync.<br>SYNT (trig) as a channel phase sync<br>**Note: SYNB is not available on the 4-channel unit.* |
| | :CGATe | | DISabled / LOW / HIGH | Sets the channel gate mode to Disabled, Pulse Inhibit mode, or Output Inhibit mode.<br>**Note: The system global gate mode must be set to CHAN for this command.* |

| **Keyword:** | **Command:** | **Sub-Command:** | **Sub-Command:** | **Parameter Range:** | **Notes:** |
|---|---|---|---|---|---|
| :SYSTem | | | | | Submenu: Commands to change general system settings. |
| | :STATe | | | ? | Query only. |
| | :BEEPer | | | | Submenu: Commands to change the units' beeper settings. |
| | | :STATe | | 0/1 or OFF/ON | Command to turn on or off the systems' beeper. |
| | :COMMunicate | | | | Submenu: Command to set the communication settings. |
| | | :USB | | | |
| | | | :ECHo | 0/1 or OFF/ON | Command to Enable/Disable the echo function. The Echo function will cause the unit to repeat the command received to the PC. |
| | | :RS232 | | | |
| | | | :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. |
| | :AUTorun | | | 0/1 or OFF/ON | When the unit is powered up, if this command is enabled, the unit will start pulsing automatically. |
| | :VERSion | | | ? | Query only. Returns SCPI version number in the form YYYY.V for ex. 1999.0 |
| | :UPDate | | | | |
| | | :AUTO | | 0/1 or OFF/ON | Turns on or off auto register update mode. When off registers are synchronously updated on command |
| | | :EXecute | | | Initiates a synchronous update if in manual update (synchronous) mode. numbers. |

Many applications may need a communication mechanism no more sophisticated than what can be achieved with these simple utilities. At the very least, these tools can be used to verify that the pulse generator and communication hardware are functioning properly. From here, a specific application in whatever preferred programming language can be built.

Although Quantum Composers cannot support all programming languages, we do have extensive experience with many languages, and strive to provide whatever assistance we can. Contact QC technical support for the latest information on what assistance may be available for your application.

## IEEE 488.2 Common Commands

| Command: | Parameter Range: | Notes: |
|---|---|---|
| System Commands | | |
| *IDN | ? | Query only. Returns model, serial number, firmware version, and FPGA version numbers. |
| *SER | ? | Serial number query. |
| Storage Commands | | |
| *RCL | 0 - 6 | Recall the saved configuration. *RCL 0 loads the system default values. |
| *SAV | 1 - 6 | Save a configuration. |
| *RST | | Resets the unit to the default values. This is the same as *RCL 0 |
| Trigger Commands | | |
| *ARM | 0 to #ofChannels | n= 0 resets all channel counters, in either single shot or burst mode, simultaneously.<br>n= 1 to # of Channels resets channel 'n'. |
| *GTE | | Creates a soft trigger for the gate input. |
| *TRG | | Creates a soft trigger for the trigger input. |

# 7. Appendix A - Specifications

| 9100/8100 Specifications | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|
| **I/O Configuration** | | | | |
| Model/Output | 8104 – 4 Independent Channels<br>9108 / 8108 – 8 Independent Channels | | | |
| Input | 1 Trigger/Gate Input | | | |
| **Internal Rate Generator** | | | | |
| Rate (T0Period) | 0.0002 | - | 20,000,000 | Hz |
| Resolution | - | 5 | - | ns |
| Accuracy | 1ns + (0.0001 x Period) | | | |
| T0 Period Jitter | - | - | 50 | ps (RMS) |
| Time Base | 200MHz, Low Jitter PLL | | | |
| Oscillator | 50MHz, 25ppm Crystal Oscillator | | | |
| System Modes | Single, Continuous, Burst, Duty Cycle, External Gate/Trigger | | | |
| Burst Mode | 1 | - | 4,000,000,000 | Pulses |
| Duty Cycle Mode | 1 | - | 4,000,000,000 | Pulses |
| Pulse Control Modes | Internal Rate Generator, External Trigger/Gate | | | |
| External Clock In/Out | Available on 8 Channel Units Only | | | |
| **Channel Timing Generator** | | | | |
| Pulse Width Range | 10n | - | 2,000 | s |
| Width Accuracy | 1ns + [0.0001 x (width + delay)] | | | |
| Width Resolution | - | 250 | - | ps |
| Pulse Delay Range | 0 | - | 2,000 | s |
| Delay Accuracy | 1ns + (0.0001 x delay) | | | |
| Delay Resolution | - | 250 | - | ps |
| Jitter (Channel to Channel) | 50ps + (.00000001 x delay) RMS | | | |
| Multiplexer | All channel timers may be routed to any or all of the output channels.<br>Timers are OR'd together. | | | |
| Time Base | Same as internal rate generator | | | |
| Channel Modes | Single Shot, Normal, Burst, Duty Cycle | | | |
| Burst Mode | 1 | - | 10,000,000 | Pulses |
| Duty Cycle Mode | 1 | - | 10,000,000 | Pulses |
| Wait Function | 0 | - | 10,000,000 | Pulses |

| | | | | |
|---|---|---|---|---|
| Control Modes | Internally triggered or externally gated. Each channel may be independently set to either mode. | | | |
| **System External Trigger/Gate Input** | | | | |
| Trigger/Gate Inputs | 0.5 to 30v input | | | |
| Trigger Input Function | System can generate a single, burst, or duty cycle response of pulses for every external trigger pulse. See “External Input Overview” for more information.<br>External input can also be configured to act like a *ARM command when set to REARM mode. | | | |
| Trigger Edge | Rising / Falling | | | |
| Gate Input Function | External gate input controls the output of the unit | | | |
| Gate Input Modes | System Gate (Pulse Inhibit)<br>Channel Gate (Output Inhibit)<br>See External Trigger/Gate section for more information | | | |
| Gate Polarity | Active High / Active Low | | | |
| **Trigger/Gate Input Module** | | | | |
| Threshold | 0.2 | - | 15 | V |
| Max Input Voltage | - | - | 30 | V |
| Resolution | - | 10 | - | mV |
| Trigger Accuracy | ±3% of Threshold Voltage | | | |
| Impedance | 1.5K ohm + 40pF | | | |
| Trigger Rate | DC | - | 5 | MHz |
| Trigger Input Jitter | - | - | 800 | ps(RMS) |
| Trigger Input Insertion Delay | - | - | 120 | ns |
| Trigger Input Minimum Pulse Width | 20 | - | - | ns |
| Pulse Inhibit Delay | - | - | 120 | ns |
| Output Inhibit Delay | - | - | 50 | ns |
| **Output Module** | | | | |
| **TTL/CMOS MODE** | | | | |
| Output Impedance | - | 50 | - | Ohms |
| Output Level | 4.0 VDC into ≥ 1K ohm | | | |
| Output Current | 5mA typical into 1K ohm<br>50mA typical into 50 ohm | | | |
| Rise Time (10% - 90%) | < 3ns typical into ≥ 1K ohm (10% - 90%) | | | |
| Slew Rate | 0.5 | - | - | V/ns |
| **ADJUSTABLE MODE** | | | | |
| Output Level | 2.0 to 20 VDC into ≥ 1K ohm | | | |

| | | | | |
|---|---|---|---|---|
| | 1.0 to 10 VDC into ≥ 50 ohms | | | |
| Resolution | - | 10 | - | mV |
| Output Current | 200mA typical, 400mA (short pulses) | | | |
| Rise Time (10% - 90%) | 15ns typical @ 20V (High Imp)<br>25ns typical @ 10V (50 ohm) | | | |
| Slew Rate | 0.1 | - | - | V/ns |
| Overshoot | < 100mV + 10% of pulse amplitude | | | |
| **Communications** | | | | |
| USB | USB 2.0 or 3.0 | | | |
| RS232 | Standard via a 3-pin Molex Connector (8100 Models) | | | |
| **External Clock In/Out (Optional)** | | | | |
| Clock In Frequencies | 10 MHz, 20 MHz, 25 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 80 MHz | | | |
| Threshold | - | 2.3 | - | V |
| Max Input Voltage | | | 5.5 | V |
| Duty Cycle (Recommended) | - | 50 | - | % |
| Frequency Jitter | - | - | 10 | % |
| Clock Out Frequencies | T0, 10 MHz, 20 MHz, 25 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 80 MHz | | | |
| **General** | | | | |
| Dimensions | 9100: 165mm x 180mm x 55mm<br>8100: 160mm x 178mm x 26mm | | | |
| Weight (9108) | - | 1.9 | - | lbs |
| Voltage Input | - | 24 | - | VDC |
| | TTL mode operation can be powered by a USB 3.0 or higher port. | | | |
| Current Input (USB) | 0.6 | 0.7 | 0.8 | A |
| Current Input (24V) | 0.2 | 0.4 | 1.5 | A |
| Memory Storage | - | 6 | - | Bins |
| Operation Temperature | 0 | - | 40 | Celsius |
| Storage Temperature | -40 | - | 70 | Celsius |

# 9100 Mechanical Dimensions

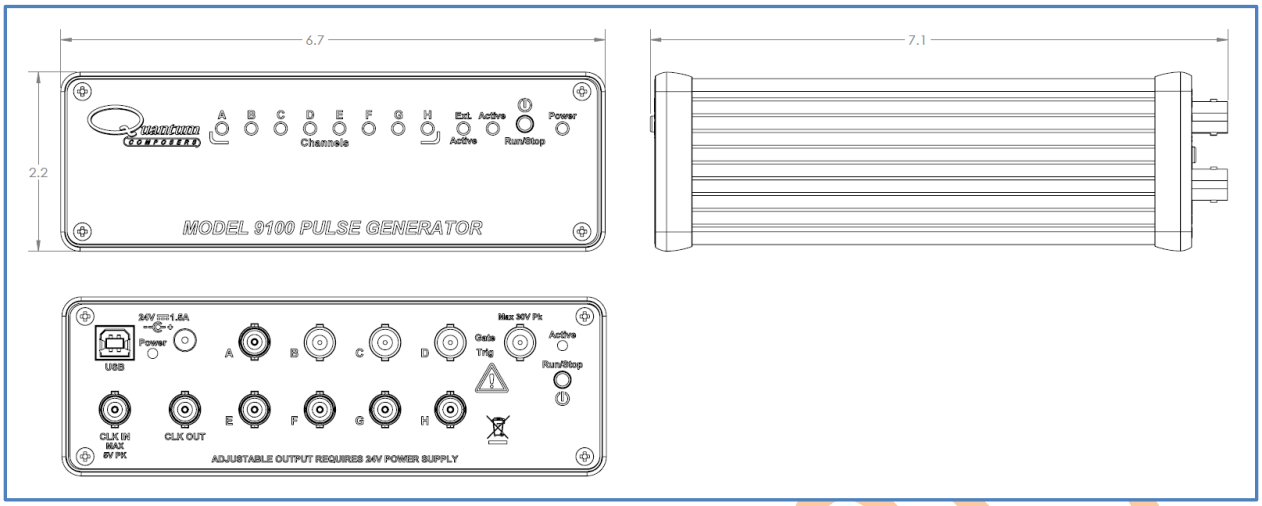



Figure 5 (9108 – 8 Ch Enclosure Dimensions)

# 8. 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 QC 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 overvoltage's
- Maximum Relative Humidity: <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: 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.

| Symbol | Publication | Description/Comment |
|---|---|---|
|  | 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<br>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 color - 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. Color requirements do not apply to markings on equipment if the symbol is molded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in color with the background. |
|  | IEC 417, No. 5041 Background color - yellow; symbol and outline - black | **Caution, hot surface** Color requirements do not apply to markings on equipment if the symbol is molded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in color with the background. |
|  | ISO 3864, No. B.3.1 Background color - 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. Color requirements do not apply to markings on equipment if the symbol is molded or engraved to a depth or raised height of 0.5 mm, or that the symbol and outline are contrasting in color 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** |

# 9. Appendix C – Impedance Matching Outputs

## TZ50 Impedance Matching Output Module

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.

### TTL/ADJUSTABLE OUTPUTS

TTL/CMOS Mode

| | |
|---|---|
| Output Level | 4.0 Volts typical into 50 Ω |
| Rise Time | 3 ns |
| Slew Rate | >0.5 V/ns |
| Jitter – Channel to Channel | <50 ps RMS |

Adjustable Mode

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

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

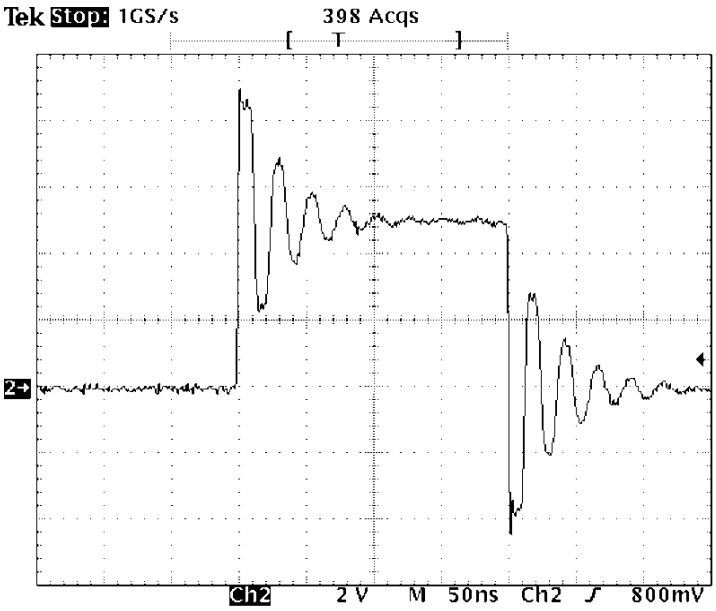



Figure 6 Overshoot on the Output of TZ50 Module

# 10. Appendix D - External Clock

## 9108/8108 External Clock Specifications

NOTE: This feature is only available on 8 channel units.

| Parameter: | Minimum | Maximum |
|---|---|---|
| Clock Input Amplitude | 2.3V | 5V |
| Frequency | 10MHz | 80MHz |
| Jitter, Cycle to Cycle | | ± 300ps |
| Jitter, Period | | ± 1ns |
| Pulse Width Duty Cycle | 45% | 55% |

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

# 11. Appendix E – 8100 Board Level Option

## 8100 Board Level Connection Information

### 8100 Board Level Overview

The 8100 is a board level option based on the 9100 series pulse generator. The specifications, communications, and overall functionality of the 8100 are the same as described for the 9100 series. The 8100 is available with 4 or 8 independent outputs that can be used for synchronizing multiple events. With the 8100 all communications will take place through USB or RS-232 as there is no display or keypad for interactions. The guide for standard SCIP communications with the 8100 unit can be found above in the 9100 standard manual. As with the 9100, the 8100 is capable of generating multiple pulses for all applications; but additional setup is required before even basic pulsing may begin.

### Digital Control Board Connection Information (Model 8104)

Power Input Connector (J3 – +24VDC Jack)

- The recommended connector is a 2.00mm ID (0.079"), 5.50mm OD (0.217") barrel connector or equivalent.

| Pin Number: | Connection: | Specification: |
|---|---|---|
| 1 (Center) | +24 Volts DC | 24V±6%, 1.5A Max |
| 2 (Outside) | Ground | |

Power Input Connector (J4 – Aux 24V)

- The recommended connector is Molex 2 pin female C-grid (Molex #50-57-9402) or equivalent.
- The recommended contacts are Molex female terminals with **gold contacts** (Molex #16-02-0087) or equivalent.

| Pin Number: | Connection: | Specification: |
|---|---|---|
| 1 | +24 Volts DC | 24V±6%, 1.5A Max |
| 2 | Ground | |

USB Communications Connector (J2 – USB)

- The recommended connector is a male USB Type B

| Pin Number: | Connection: |
|---|---|
| 1 | Vbus + (+5 Volts DC, 0.8A Max) |
| 2 | Data - |
| 3 | Data + |
| 4 | Ground |

## RS-232 Communications Connector (J6 – RS-232)

- The recommended connector is a 3 pin Molex connector

| Pin Number: | Connection: |
|---|---|
| 1 | Tx - Transmit (to computer) |
| 2 | Rx - Receive (from computer) |
| 3 | Ground |

## External Trigger/Gate (J11)

- The recommended connector is a male BNC

| Pin Number: | Connection: |
|---|---|
| 1 | Signal Input (0.5 to 30V) |
| 2 | Ground |

## Channel Outputs 1-4 (J7, J8, J9, J10)

- The recommended connector is a male BNC

| Pin Number: | Connection: |
|---|---|
| 1 | Signal Output (+5VDC TTL/0.2-20VDC Adj) |
| 2 | Ground |

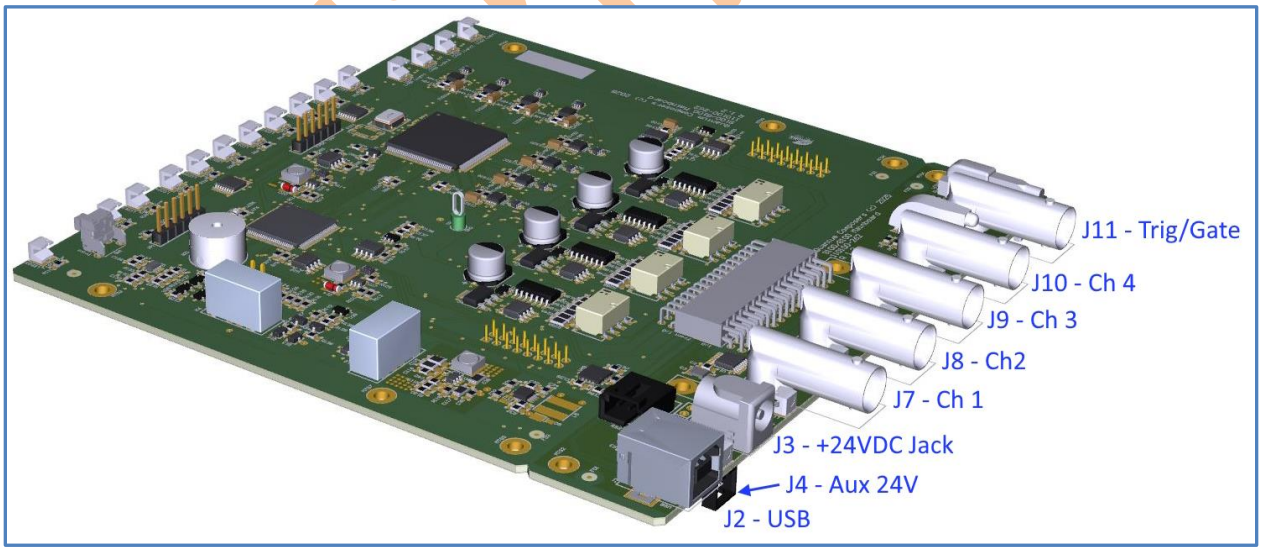



Figure 7 (8104 Connections)

## Digital Control Board Connection Information (Model 8108 Additional Connections)

External Clock Input (J6 – Ext Clock In)

- The recommended connector is a male BNC

| Pin Number: | Connection: |
|---|---|
| 1 | Signal input (+5VDC Max) |
| 2 | Ground |

Internal Clock Output (J7 – Ext Clock Out)

- The recommended connector is a male BNC

| Pin Number: | Connection: |
|---|---|
| 1 | Signal out (+5VDC) |
| 2 | Ground |

Channel Outputs 5-8 (J2, J3, J4, J5)

- The recommended connector is a male BNC

| Pin Number: | Connection: |
|---|---|
| 1 | Signal Output (+5VDC TTL/0.2-20VDC Adj) |
| 2 | Ground |

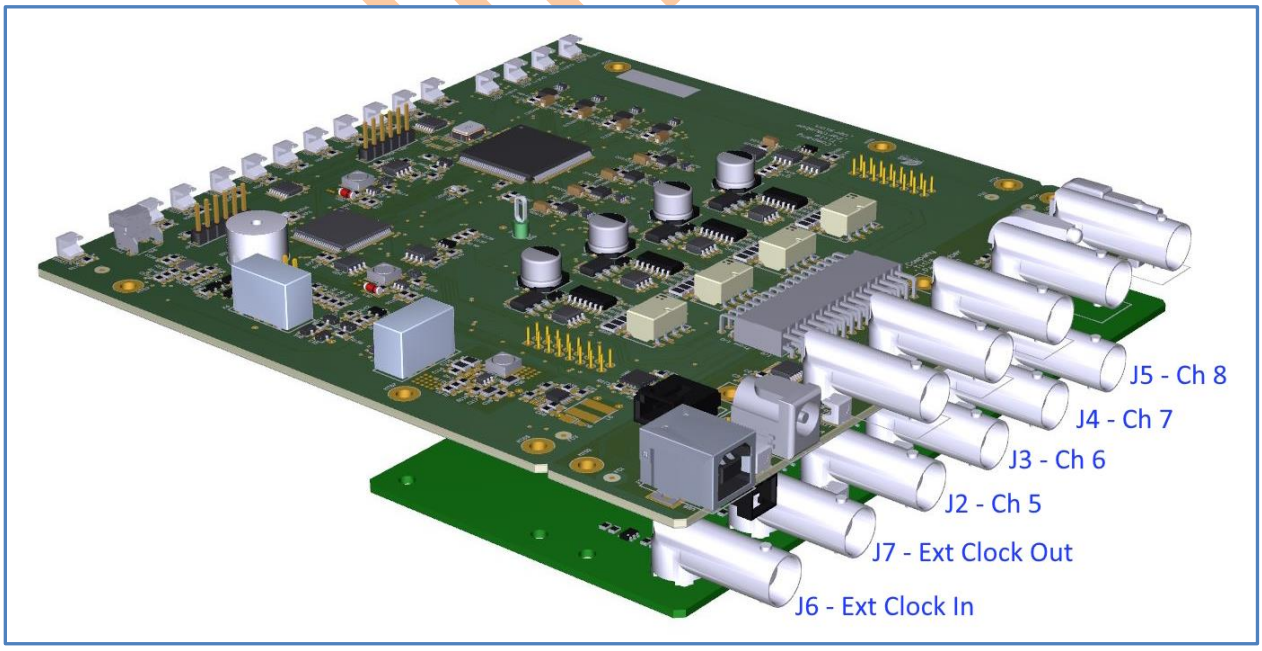



Figure 8 (8108 Connections)

## Mounting Information

- There are up to 8 #4 (Ø.125) clearance holes that can be used to mount the Control Boards depending on the channel options.

**Note: Each of these mounting holes are connected to Ground*

## Auto Power On

- If it is desired to have the unit automatically turn on once power is applied without having to press the power buttons, a jumper can be added to the power enable header (J17).

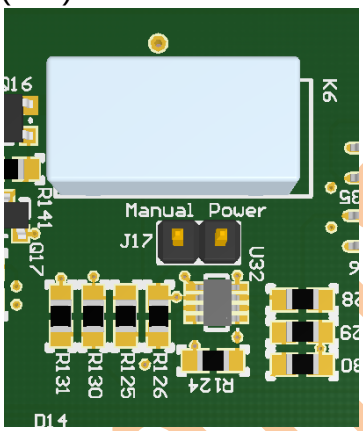



Figure 9 (Power Enable Jumper J17)

# 8100 Mechanical Dimensions

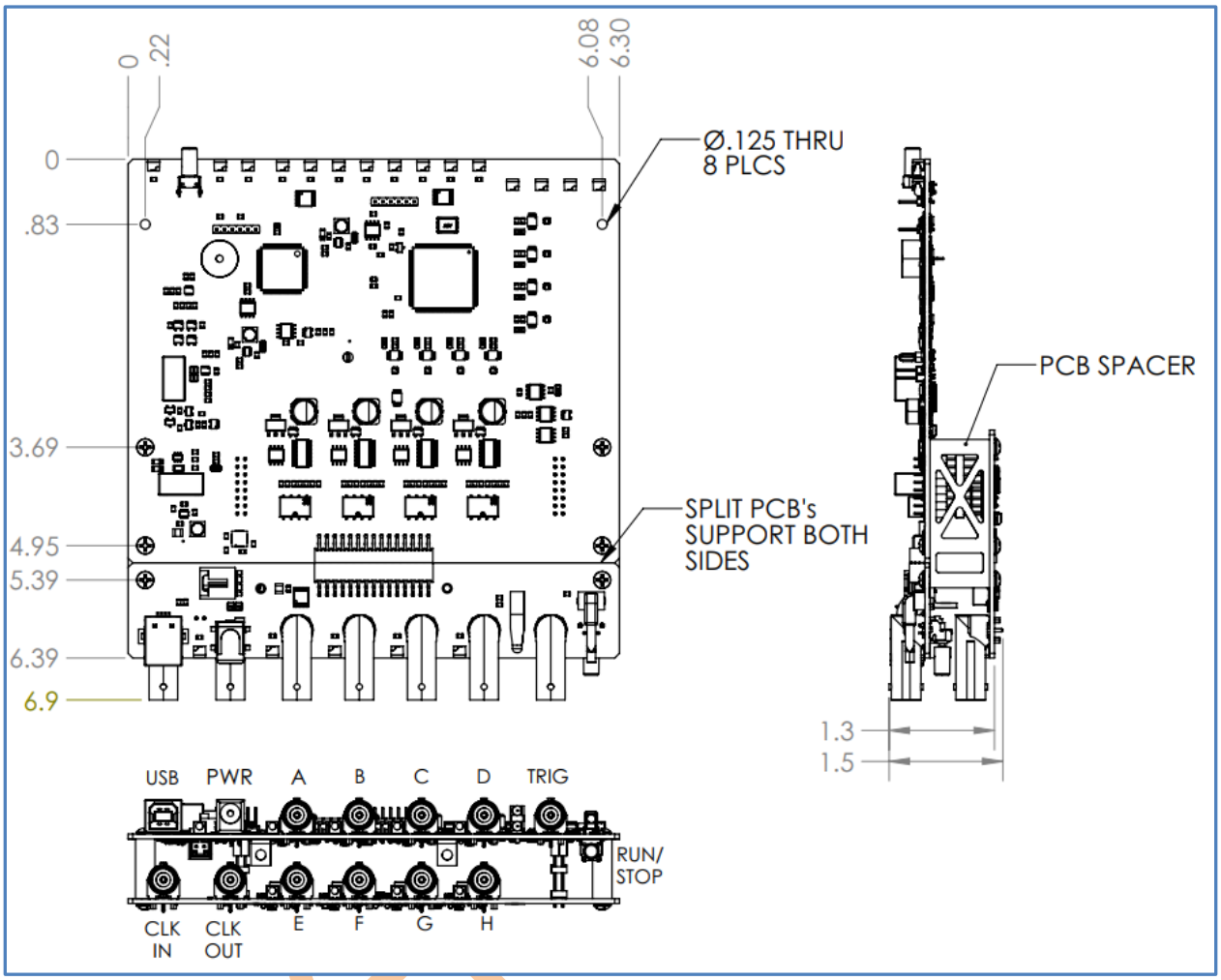



Figure 10 (8108 8 Ch Board Level Dimensions)

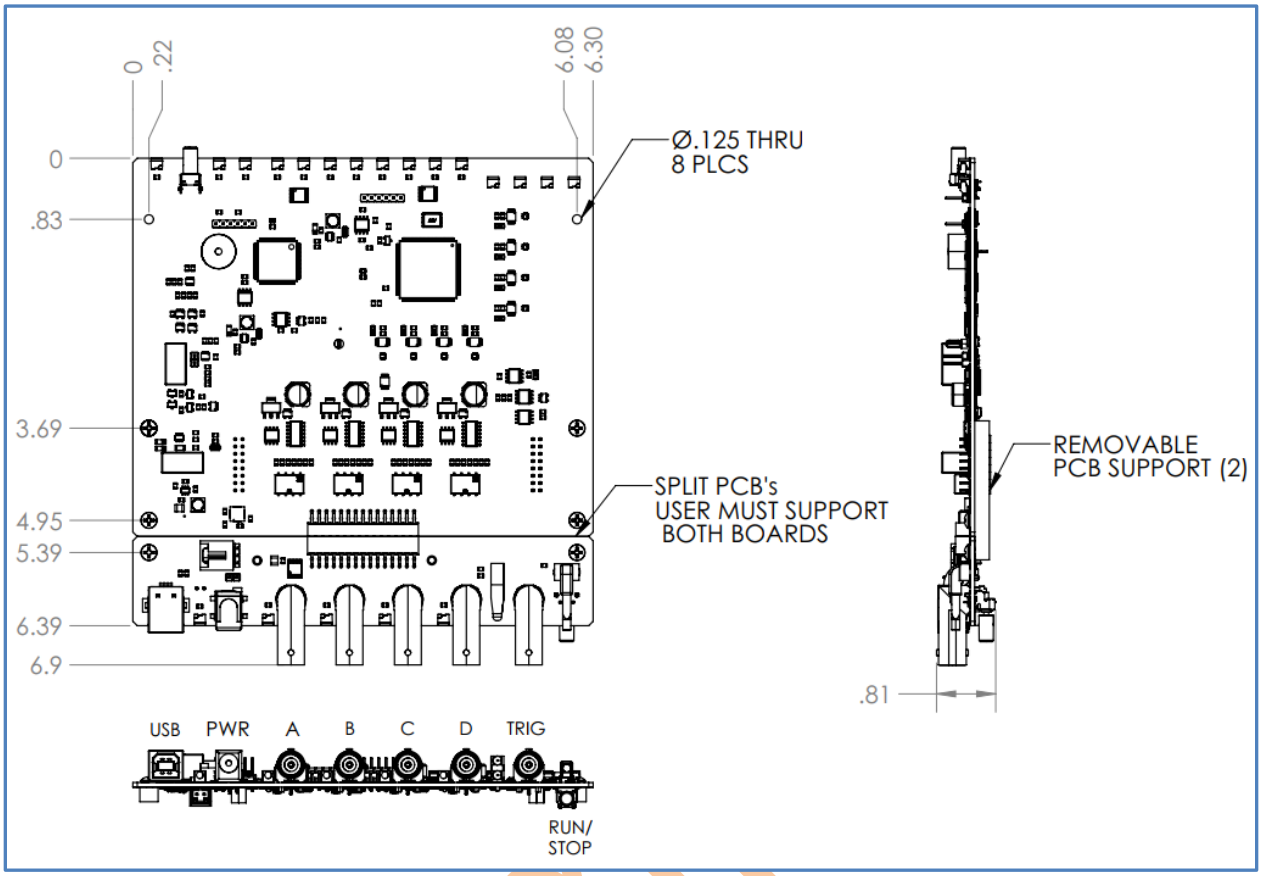



Figure 11 (8104 4 Ch Board Level Dimensions)