



9500 *Plus* Series Pulse Generator
Operating Manual

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Introduction

Introduction

This manual is a reference designed to familiarize you with the Quantum Composers 9500+ pulse generator and is arranged so that you can easily find the information you're looking for. Generally, each topic has its own section and no section assumes that you've read anything else in the manual.

Technical Support

For questions or comments about operating the 9500+ -- our technical staff can be reached via one of the following methods:

- Phone - (406) 582-0227
- Fax - (4406) 582-0237
- Internet - www.quantumcomposers.com

Warranty

In addition to a 30-day money back guarantee, the 9500+ has a one-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:

- 9500+ Pulse Generator
- AC Power Cord
- User's Manual on Disc

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

Safety Issues

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

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

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

Front Panel Overview

Front Panel Overview

9500+ Front Panels

Display Layout and Indicators

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

- Vertical Arrow Indicates there are additional pages to the current menu.
- Blinking Light Indicates the unit is actively generating pulses, or armed and waiting for an external trigger.
- Musical Note Indicates the function key has been pressed.

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

Description of Front-Panel Area

Keypads

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

- Channel Keypad Provides one touch access to the menus for setting up the channel parameters. Pressing the appropriate letter will display the parameters for the corresponding channel.
- Arrow Keypad The up/down arrows are used to increment/decrement the current parameter (indicated by the blinking cursor). The position of the cursor controls the step size for each increment. The right/left arrow moves the cursor to different positions within the current parameter. The **NEXT** key selects the next parameter in the currently displayed menu. The yellow Function key allows the keys to select the yellow functions.
- Numeric Keypad Allows numbers and alphanumeric values to be entered. When entering alphanumeric values, pressing a key will display the first letter shown on the key. Repeated key presses will toggle through all the letters, both upper and lower case, shown on the keycap. To enter two letters which appear on the same keycap,

select the first character, then use the right arrow to shift to the next position and enter the next letter. When data entry is complete the **ENTER** key must be pressed.

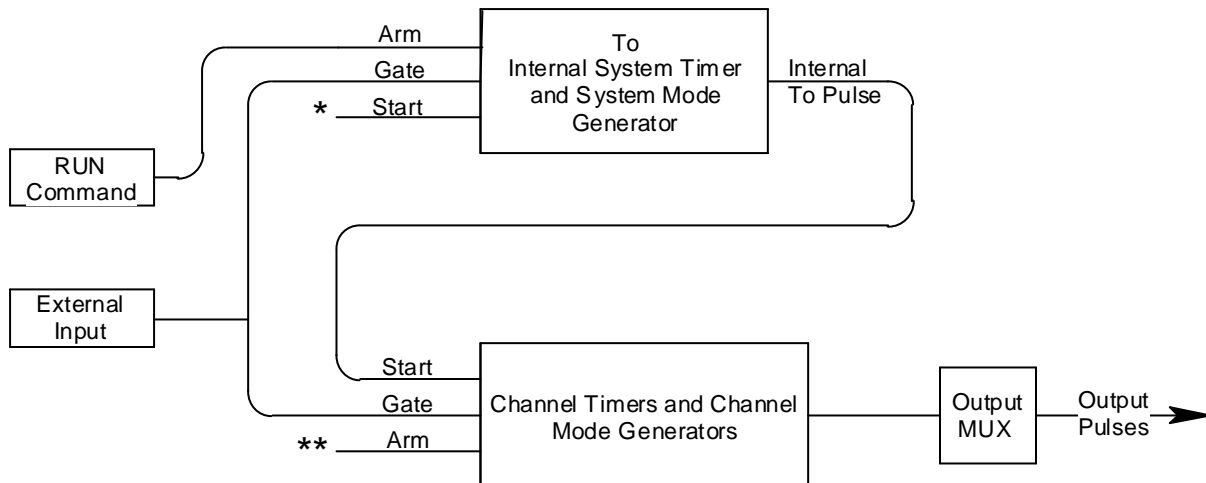
Rotary Adjustment Knob

An alternate to the Arrow Keypad, the Rotary Adjustment Knob may be used to adjust the current 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 switch to the next parameter in the currently displayed menu.

**Pulse Concepts and
Pulse Generator Operations**

Pulse Concepts and Pulse Generator Operation

Counter Architecture Overview



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

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

System Timer Functions

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

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

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

Channel Timer Functions

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

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

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

Output Multiplexer

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

Dependent & Independent Timing Events

The 9500+ allows the user to control the relationship between the Channel Timers by setting the sync source for each timer. Independent events are all timed relative to the internal T_0 start pulse. Dependent events may be linked together by setting the sync source to the controlling event. This allows the instrument to match the timed events and adjustments can be made in one event without detuning the timing between it and a dependent event.

Navigating the 9500+ Front Panel

Selecting Menus

Parameters are grouped in menus, selectable using the function keys. To select the output channel parameters press the letter key corresponding to the desired channel. To select other menus press the FUNCTION key and then the key corresponding to the desired function.

Menus may include a number of different pages. Each page containing up to four parameters. The status block in the upper-left corner of the display shows a vertical arrow if the current menu contains additional pages. To select the next page, select the same menu pressing the FUNCTION key and function again.

Selecting Menu Items

Within a menu, the blinking cursor indicates the current menu item for editing. The NEXT key or pressing the adjustment knob will select a different menu item.

Numeric Input Mode

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

The last entry mode is using the numeric keypad. Enter the number, including decimal point using the numeric keypad. Complete the number using the ENTER key. Errors may be corrected using the backspace key or to start over press the clear key (CLR). Pressing the CLR key a second time will exit the numeric keypad mode and restore the original number.

Entering Non-Numeric Parameters

When the current item is non-numeric, the Up and Down arrow keys are used to select among different options for the parameter. The adjustment knob may also be used to change the selection. If the item is an on-off toggle, the Up arrow (CW adjustment knob) enables the item and the Down arrow (CCW adjustment knob) disables the item.

Alphanumeric Input Mode

When the current item is alphanumeric, the system enters the Alphanumeric Input Mode. In this mode, data is entered using the alphanumeric keypad. When entering alphanumeric values, pressing a key will display the first letter shown on the keypad. Repeated key presses will toggle through all the letters, both upper and lower case, shown on the key cap. To enter two letters which appear on the same key cap, select the first character, then use the right arrow to shift to the next position and enter the next letter. The Left and Right arrow keys may be used to position the cursor to edit any character. When data entry is complete, the ENTER key must be pressed. The keys contain the following characters:

- 1 1 2 3 4 5 6 7 8 9 0
- 2 A B C a b c 2

- 3 DEFdef3
- 4 GHIghi4
- 5 JKLjkl5
- 6 MNOmno6
- 7 PQRSpqrs7
- 8 TUVtuv8
- 9 WXYZwxyz9
- 0 0123456789
- . , # \$ % & ?
- - + * / space

Enabling System Output

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

Enable/Disable Channel Output

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

Rearming the Channel Timers

In the channel single shot mode and burst mode, the Channel Timers may be rearmed after completing the initial output by pushing the Function key and RUN/STOP key. If there are channels currently running in normal mode, single shot and burst channels can be re-armed without affecting the timing on normal mode channels by pressing function RUN/STOP.

Setting Pulse Timing Parameters

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

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

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

Setting Pulse Output Parameters

There are two types of output available on the 9500+: (a) TTL/CMOS compatible high speed output; (b) adjustable amplitude output. The best system performance, accuracy and jitter is achieved using the TTL/CMOS output. The adjustable output has a 50 ohm drive impedance and will produce 2 - 20 volts unloaded.

Out: Selects between TTL/CMOS mode and Adjustable mode output.

Pol: Sets the polarity of the pulse, active high or active low. Note: All outputs are positive voltages - negative voltages are not supported.

Ampl: In adjustable mode, it sets the unloaded output voltage. The actual output voltage will depend on the load impedance. For example: If the load is 50 ohms, the output will be 50% of the stated voltage.

Using the Output Multiplexer

Each output channel includes a multiplexer which allows routing any or all of the timer outputs to the physical output. This allows double pulses and other complex pulse trains to be generated. Two channel units allow for multiplexing of two additional internal channels. To adjust parameters for these additional channels ("C" and "D"), press "Function" and "A" or "Function" and "B".

-HGFEDCBA-
Mux: -00000101-

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

Setting System Internal Rate

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

T_o Per: Sets the internal T_o Period.

To set the system Internal Rate - press the yellow 'Function' key, then press the 'Rate' key, and then use dial or number pad to specify ' T_o Per'.

9500+ Menu

9500+ Menu Structure

System MODE Menu

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

CHANNEL Menu

| Timing Parameters | Pulse Configuration | Channel Mode | Gated Operation | Multiplexer |
|-------------------|---------------------|-------------------|-----------------|-------------|
| Enable | Enable | Enable | Enable | Enable |
| Sync Source | Polarity | Mode | | Help Line |
| Pulsewidth | Output Type | On Cycle | Gate Enable | Mux |
| Delay | Output Level | Off Cycle / Burst | Wait | |

RATE Menu

| |
|-----------|
| To Period |
| |
| |
| |
| To Period |

GATE/TRIG Menu

| Gate/Trigger Mode | Gate/Trigger Mode | Gate/Trigger Mode |
|-------------------|-------------------|-------------------|
| | | |
| MODE: Disabled | MODE: Triggered | MODE: Gated |
| THRESHOLD | THRESHOLD | THRESHOLD |
| | EDGE | POLARITY |

SYSTEM Menu

| Comm. Parameters | Keypad Parameters | Misc. Parameters |
|-------------------------|--------------------------|-------------------------|
| | | |
| Baud Rate | Key Repeat Rate | Auto Start |
| Echo Enable | Key Volume | Decimal Mark |
| GPIB Address | Knob Volume | LCD Brightness |

STORE Menu

| Store Menu |
|-------------------|
| |
| Configuration # |
| Name |
| Help Line |

RECALL Menu

| Recall Menu |
|--------------------|
| |
| Configuration # |
| Name |
| Help Line |

System Mode Menu

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

Setting System Mode of Operation

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

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

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

Channel Menus

| Timing Parameters | Pulse Configuration | Channel Mode | Gated Operation | Multiplexer |
|-------------------|---------------------|-------------------|-----------------|-------------|
| Enable | Enable | Enable | Enable | Enable |
| Sync Source | Polarity | Mode | | Help Line |
| Pulsewidth | Output Type | On Cycle | Gate Enable | Mux |
| Delay | Output Level | Off Cycle / Burst | Wait | |

Enabling Channel Output

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

Setting the Channel Timing Parameters

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

| | |
|--------------|---|
| Sync Source: | Selects the channel sync source. |
| Wid: | Sets the channel pulsewidth. |
| Dly: | Sets the channel delay until the active edge. |

Setting Pulse Output Configuration

The 9500+ supports two types of outputs: a high speed TTL/CMOS compatible output; and, for applications which require different voltage levels or higher current, an adjustable voltage output. The pulses can also be defined to be active high or active low.

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

Setting Pulse Mode of Operation

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

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

Setting Pulse Gate Control

Enables the use of the external input to gate the channel output (within the CHANNEL menu):

- Gate: Enables/disables the channel gating using the EXT/GATE input.

Enables the gate by selecting either active high or active low. This function is independent of any other use of the trigger input. Care should be taken to ensure that all uses of the trigger input are compatible.

NOTE: The gate function disables the channel from being triggered by the T_o pulse. To prevent partial pulses from being generated, the gate does not disable the channel timers. Thus, if a pulse has already started when the gate disables the channel, the pulse will continue normal output but will not restart on the next T_o pulse.

Delaying the Start of Channel Output

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

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

Rate Menu

| |
|-----------|
| To Period |
| |
| |
| |
| To Period |

Setting the Internal Rate

The T_o period, which determines the fundamental frequency of the unit, is controlled by an internal timer.

- T_o Per: Sets the T_o period.

Gate/Trig Menu

| Gate/Trigger Mode | Gate/Trigger Mode | Gate/Trigger Mode |
|-------------------|-------------------|-------------------|
| | | |
| MODE: Disabled | MODE: Triggered | MODE: Gated |
| THRESHOLD | THRESHOLD | THRESHOLD |
| | EDGE | POLARITY |

Enabling System Trigger or Gate

Enables the use of the trigger input by the system timer as a trigger source or a gate source (within the Gate/Trig menu):

- EXTin Selects between disabling the use of external inputs and setting the system trigger mode to trigger or gate mode.
- Level Sets the trigger threshold.
- Gate Selects between active high and active low when the gate mode is selected.
- Edge Selects between rising edge and falling edge as the trigger source when the trigger mode is selected.

**NOTE: When the gate disables the System Timer, the timer is reset. The gate edge, to enable the timer, will restart the System Timer which synchronizes the T_o pulse to the gate and minimizes jitter relative to the gate. The trigger threshold applies to all uses, channel and system, of the trigger/gate input.*

System Menu

| Comm. Parameters | Keypad Parameters | Misc. Parameters |
|------------------|-------------------|------------------|
| | | |
| Baud Rate | Key Repeat Rate | Auto Start |
| Echo Enable | Key Volume | Decimal Mark |
| GPIB Address | Knob Volume | LCD Brightness |

Setting System Communication Parameters

The 9500+ comes with a standard RS232 serial port, USB and GPIB port. The unit will not respond to computer commands unless these ports are properly configured.

- Baud Rate: Selects the baud rate for the db9 RS232 interface.
- Echo: Selects whether to echo characters back to the host computer or not.
- GPIB Addr: Sets the GPIB address.

Setting Keypad Parameters

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

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

Setting the Auto Start Mode

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

Setting the Display Decimal Mark

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

Setting the Display Brightness

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

Store Menu

| |
|-----------------|
| Store Menu |
| |
| Configuration # |
| Name |
| Help Line |

Storing a Configuration

Use the following procedure to store a complete system configuration:

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

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

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

**NOTE: When the unit powers up it will recall the last stored or recalled configuration. Any changes to the configuration which were not saved are not restored.*

Recall Menu

| |
|--------------------|
| Recall Menu |
| |
| Configuration # |
| Name |
| Help Line |

Recalling System Configurations

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

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

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

Operating the 9500+

Quick Start - Normal Internal Rate Generator Operation

The 9500+ has a powerful set of functions providing a number of modes of operation for the internal or “System” rate generator (T_o). Most of these functions can be ignored if all one wants to do is generate a simple continuous stream of pulses. Starting from the default settings, which can be recalled by recalling configuration 0, the following parameters need to be set:

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

Quick Start - Normal External Trigger Operation

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

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

| | |
|--------------------|---|
| Edge | Press the NEXT key until the Edge parameter is highlighted. Set the instrument to trigger off the rising edge or falling edge as desired. |
| Pulse Width, Delay | Enter the Channel menus by pressing the letter key. Enter the required pulse width and delay. Repeat for each output channel. |
| Start | Press the RUN/STOP key to start/arm the instrument. The 9500+ will now generate a pulse for every valid trigger. |
| Stop | Press the RUN/STOP key a second time to stop/disarm the instrument (i.e. to stop generating pulses). |

System Timer Overview

For internal operation, the 9500+ contains a timer and mode generator which generates an internal T_o clock that is used to trigger all the channel timers. System modes are controlled via the MODE menu.

To Use Continuous Mode

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

- within the system MODE menu

Mode Select Continuous for the system mode.

- within the RATE menu

Period Set the desired period.

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

To Use Single Shot Mode

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

- within the system Mode menu

Mode Select Single Shot for the system mode.

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

To Use System Burst Mode Function

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

- within the system MODE menu

Mode: Select the Burst mode.

Burst: Set the number of pulses to produce in the burst.

To Use System Duty Cycle Function

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

- within the system MODE menu

Mode: Select the Duty Cycle mode.

On: Set the number of pulses to produce during the on cycle.

Off: Set the number of pulses to skip during the off cycle.

-within the RATE menu

Period: Set desired Period.

Channel Timer Overview

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

When one channel is generating a continuous stream of pulses, a user can trigger a single shot or burst of pulses on another channel without interrupting the continuous stream by pressing “FUNCTION” and “RUN/STOP”.

To Use Channel Normal Mode Function

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

- within the Channel menus

Enable: Select Enable to enable channel output.

Dly: Set the desired delay.

Wid: Set the desired pulsewidth.

Mode: Select the Normal mode.

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

To Use Channel Single Shot Function

The Single Shot mode generates a single pulse every time the RUN/STOP key is pressed. If the unit is in the active state, (i.e. channels which are set to the Normal mode are producing pulses), pressing the Function key and RUN/STOP key will reset the Single Shot counters and generate one pulse in sync with the other channels running in the Normal mode. To use the Single Shot mode:

- within the Channel menus

| | |
|--------|---|
| Enable | Select Enable to enable channel output. |
| Delay | Set the desired delay. |
| Width | Set the desired pulsewidth. |
| Mode | Select the Single shot mode. |

To Use Channel Burst Mode Function

The Burst mode generates a burst of pulses every time the RUN/STOP key is pressed. If the unit is in the active state, (i.e. channels which are set to the Normal mode are producing pulses), pressing the “FUNCTION - RUN/STOP” key sequence will reset the Burst counters and generate a new set of pulses in sync with the other channels running in the Normal mode. “FUNCTION - RUN/STOP” will not affect T_o pulse status. To use the Burst mode:

-within the Channel menus

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

To Use the Channel Duty Cycle Function

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

- within the Channel menus

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

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

To Use the Channel Gating Function

Each channel may use the external input to gate or control its output. The gate controls the triggering of the channel. Once a channel has started to produce a pulse it will complete the pulse, even if the gate has been removed - no partial pulses will be produced. To use the gate, set the following parameters

- within the Gate/Trig menu

Level: Set the threshold voltage for the external input.

- within the Channel menu

Gate: Select active high or active low.

External Input Overview

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

To Generate a Pulse on Every Trigger Input

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

- within the Mode menu:

Mode Select the Single Shot mode.

- within the Gate/Trig menu:

EXTin Select Triggered mode.

Level Set the trigger threshold level.

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

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

To Generate a Burst of Pulses on Every Trigger Input

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

-within the Mode menu

Mode: Select the Burst mode.

Burst: Set the number of pulses to generate in each burst.

- within the Rate menu

Per: Set the period between pulses.

- within the Gate/Trig menu

EXTin: Select Triggered mode.

Level: Set the trigger threshold level.

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

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

To Start a Continuous Stream of Pulses Using the External Trigger

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

- within the Mode menu

Mode: Select the Continuous mode.

- within the Rate menu

Per: Set the period between pulses.

- within the Gate/Trig menu

EXTin: Select the Trigger mode.

Level: Set the trigger threshold level.

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

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

To use the External Gate to Control the System

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

- within the Mode menu

Mode: Select the desired mode.

- within the Rate menu

Per: Set the period between pulses.

- within the Gate/Trig menu

EXTin: Select Gated mode.
Level: Set the gate threshold level.
Gate: Select active high or active low.

Pressing the RUN/STOP key will arm the unit. Once the unit is armed, it will begin generating pulses whenever the external trigger input is in the active state. When the gate is in the active state, the system timer is reset. Pulses that have already started when the gate enters the inactive state will continue until the pulse is complete. Pressing the RUN/STOP key a second time will disarm the unit.

Programming the 9500+

Personal Computer to Pulse Generator Communication

The 9500+ comes standard with an RS232 serial interface, USB and GPIB interface. An Ethernet interface is available as an option that would replace the USB interface. All menu settings can be set and retrieved over the computer interface using a simple command language. The command set is structured to be consistent with the Standard Commands for Programmable Instruments. Although due to the high number of special features found in the 9500+, many of the commands are not included in the specification. The syntax is the same for all interfaces.

RS232 Interface Overview

The serial port is located on the back of the 9500+ and uses a 9-pin D-type connector with the following pinout (as viewed from the back of the unit):

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

The serial port parameters should be set as follows:

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

GPIB Interface Overview

Also known as IEEE-488 computer interface is standard on the 9500+. Before using this interface, the address must be set using the GPIB address menu item. The command set is the same for the RS-232, GPIB and USB (or Ethernet). Different interfaces may be used at the same time. Responses will be made to the most recently used interface. Beginning with Firmware Version 1.18, the "Echo" functionality is not available on the GPIB, USB or Ethernet port.

USB Interface Overview

The USB interface is standard on the 9500+. 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 Quantum Composers for updated installation files and instructions.

USB communication is achieved by using a mapped (virtual) COM port on the pc. The driver installation executable will obtain an unused COM port number, install the USB drivers, and make that COM port number available for typical RS232 communication to the pulse generator. Hyperterminal or other common software may be used.

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

USB communication notes:

- The correct drivers must be installed on the personal computer before communication can be accomplished via USB.
- The BAUD rates on the pc and on the pulse generator must match for successful communication.
- The USB port’s BAUD rate on the pulse generator can be set using the SCPI command “:SYSTem:COMMunicate:SERial:USB n” where ‘n’ can be:
 - o 4800
 - o 9600
 - o 19200
 - o 38400
 - o 57600
 - o 115200
- The BAUD rate that is accessible from the front panel of the pulse generator applies only to the BAUD rate used by the db9 serial port. SCPI command access to this port is via the command “:SYSTem:COMMunicate:SERial:BAUD n” where ‘n’ has the same acceptable rates as for the USB port.
- USB 1.0 specification is used. The USB cable can be removed without “unplugging” the device in the operating system environment.
- Echo functionality is not available on the USB port.

Ethernet Interface Overview

An Ethernet interface is optional on the 9500+. When this option is chosen, the USB port is replaced by the Ethernet port.

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

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

Ethernet communication notes:

- The Digi Connectware’s “Digi Device Discovery” can be used to determine what IP address was assigned by the local DHCP server (if any).
- “Digi Device Discovery” can also be used to open a web interface to the Ethernet module. Simply double-click on the IP address that is displayed in the Digi Device Discovery utility.
 - o Username: “root”
 - o Password: “dbps”
- If a mapped COM port is the desired communication method, the Digi Connectware’s “Realport Drivers” setup must be used to install the COM port on the pc. This virtual COM port is then local to the computer it was installed on. Please refer to the Digi Connectware documentation supplied on the cd, or call Quantum Composers technical support.
- The pulse generator’s SCPI parameter “:SYSTem:COMMunicate:SERial:USB n” is defaulted to 115200 and should not be changed for Ethernet communication, whether or not a mapped COM port is used. The virtual COM port on the pc should be set to 115200 BAUD.
- Echo functionality is not available on the Ethernet port.

Programming Command Types and Format

The 9500+ Pulse Generator uses two types of programming commands: IEEE 488.2 Common Commands and Standard Commands for Programmable Instruments (SCPI). The format is the same for all interfaces. Hyperterminal (in Windows) or any other generic terminal program may be used to interactively test the commands using the RS232 interface. The format of each type is described in the following paragraphs.

Line Termination

The pulse generator uses text-style line terminations. When a command is sent to the unit, the firmware is programmed to read characters from a communication port until it reads the line termination sequence. The command string is parsed and executed after reading these characters. These characters are the “carriage return” and “linefeed”. They are ascii character set values 13 and 10 respectively (hex 0x0D and 0x0A). All command strings need to have these characters appended.

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

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

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

IEEE 488.2 Common Command Format

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

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

SCPI Command Keywords

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

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

SCPI Command Format

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

SCPI Format

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

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

- QUERY FORMAT

```
:PULSE1:STATE?
```

Will return: 1 <cr><lf>

```
:PULSE1:WIDT? <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. If more than one parameter is used, you must separate subsequent parameters with a comma.

SCPI Optional Keywords

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

SCPI Specific and Implied Channel

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

If you do not specify the channel number, the implied channel is specified by the :INSTrument:SELEct command or the last referenced channel. After power-up or reset (*RST) The instrument default is channel #1.

SCPI Parameter Types

The following parameter types are used:

| | |
|-----------------|---|
| <numeric value> | Accepts all commonly used decimal representation of numbers including optional signs, decimal points and scientific notation: |
| <boolean value> | 123, 123e2, -123, -1.23e2, .123, 1.23e-2, 1.2300E-01 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.

Programming Examples

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

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

To start the pulses use either of the following commands:

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

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

| | |
|--------------------------------|---------------------------------|
| :PULSE1:STATE ON <cr> <lf> | enables channel A |
| :PULSE1:POL NORM <cr> <lf> | sets polarity to active high |
| :PULSE:WIDT 0.000025 <cr> <lf> | sets pulsewidth to 25 μ s |
| :PULSE1:DELAY 0 <cr> <lf> | sets delay to 0 |
| :PULSE0:MODE SING <cr> <lf> | sets system mode to single shot |
| :PULSE:EXT:MOD TRIG <cr> <lf> | sets system to external trigger |
| :PULS:EXT:LEV 2.5 <cr> <lf> | sets trigger level to 2.5 v |
| :PULS:EXT: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 |
|----------------|---------------------------------------|

9500+ SCPI Command Summary

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

9500+ SCPI Command Summary

| Keyword | Parameter | Std/ New | Comments |
|-------------|---|-------------|--|
| [PULSe] [0] | | Std | Subsystem. Contains commands to control the output pulse generation. Commands without suffix refer to the currently selected logical instrument. See INSTRUMENT subsystem. |
| :STATe | <boolean value> | Std | Enables / Disables the output for all channels. Command is the same as pressing the RUN/STOP button. |
| :PERiod | <numeric value> | Std | Sets the To period. |
| :MODE | NORMAL / SINGLE / BURSt / DCYClE | New | Sets the To mode. |
| :BCOunter | <numeric value> | New | Burst Counter. Number of pulses to generate in the Burst mode. |
| :PCOunter | <numeric value> | New | Pulse Counter. Number of pulses to generate during on cycle of the Duty Cycle mode. |
| :OCOunter | <numeric value> | New | Off Counter. Number of pulses to inhibit output during the off cycle of the Duty Cycle mode. |
| :EXTeRnal | | New | Subsystem. Contains the commands to define the system use of the external input. |
| :MODE | DISabled / TRIGger / GATE | New | Selects the trigger mode. |
| :LEVel | <numeric value> | New | Sets the trigger threshold. Value is in volts, with a range of .20 to 15 Volts. |
| :EDGe | RISing FALLing | New | Selects which edge (rising or falling) to use as the trigger signal. |
| :POLarity | LOW / HIGH | New | 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. |

9500+ SCPI Command Summary

| Keyword | Parameter | Std/ New | Comments |
|--------------------|---|-------------|--|
| :PULSe [1 / 2 / n] | | Std | Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA = 1, ChB = 2, etc). Command without suffix refers to the currently selected logical instrument. See INSTRUMENT subsystem. |
| :STATe | <boolean value> | Std | Enables/Disables the output pulse for selected channel. |
| :WIDTh | <numeric value> | Std | Sets the width or duration of the output pulse. |
| :DELay | <numeric value> | Std | Sets the time from the start of the To period to the first edge of the pulse. |
| :SYNC | TO, CHA, CHB, CHC, CHD, etc. | New | Selects the Sync source. |
| :MUX | <numeric value> | New | Selects which timers are enabled as output for the current channel. |
| :POLarity | NORMAL / COMPLEMENT / INVERTed | Std | Sets the polarity of the pulse. For NORMAL operation the second nominal state is more positive than the first. COMPLEMENT and INVERTed are aliases. For both, the second state is more negative than the first. |
| :OUTPut | | New | Subsystem. Contains command to control output mode. |
| :AMPLitude | <numeric values> | New | Sets adjustable output level. |
| :MODE | TTL/ ADJUSTable/ 35V | New | Selects output AMPLitude mode: TTL/CMOS, ADJUSTable, or 35 Volts. |
| :CMODE | NORMAL / SINGLE / BURSt / DCYCLE | New | Channel Mode. Sets the channel pulse series output mode. |
| :BCOUNTER | <numeric value> | New | Burst Counter. Sets the number of pulses to generate when channel is in the BURST mode. |
| :PCOUNTER | <numeric value> | New | Pulse Counter. Sets the number of pulses to generate during the on cycle of the Duty Cycle Mode. |
| :OCOUNTER | <numeric value> | New | Off Counter. Number of pulses to inhibit output during the off cycle of the Duty Cycle mode. |
| :CGATE | DISable LOW HIGH | New | Channel Gate Subsystem. Contains commands to control using the gate input to control the output channel. |
| :WCOunter | <numeric value> | New | Sets the number of To pulses to delay until enabling output. |

9500+ SCPI Command Summary

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

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

IEEE 488.2 Common Commands

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

Appendix

Appendix A - Specifications

9500+ Specifications

PULSE GENERATION

| | |
|-------------|---|
| CHANNELS | 2, 4 or 8 independent outputs, with digitally controlled delay and pulsewidth |
| MODES | normal, single, shot, burst, duty cycle |
| MULTIPLEXER | combine any of the channels |
| DELAY | 0 - 1000 sec |
| PULSEWIDTH | 10 ns - 1000 sec |
| RESOLUTION | 1 ns |
| ACCURACY | 1 ns + .0001 x setpoint |
| TIMEBASE | 50 MHz |
| RMS Jitter | < 250 ps |
| BURST MODE | 1 - 1,000,000 pulses |

EXTERNAL TRIG / GATE

| | |
|-----------------|------------------------|
| RATE | DC -5 MHz |
| THRESHOLD | 200 mV - 15 V |
| INPUT RANGE | 0 - 30 V |
| TRIGGER SLOPE | rising or falling edge |
| RMS JITTER | < 5 ns |
| INSERTION DELAY | < 150 ns |

INTERNAL RATE GENERATOR

| | |
|------------------|--|
| MODES | single shot, burst, continuous, duty cycle |
| RATE (To period) | 200 ns to 5000 sec (.0002 Hz to 5 MHz) |
| RESOLUTION | 10 ns |
| ACCURACY | 1 ns + .0001 x period |
| RMS JITTER | < 250 ps |
| BURST MODE | 1 to 1,000,000 pulses |

OUTPUTS

| | |
|-----------|---|
| IMPEDANCE | 50 Ohms |
| RISE TIME | 3ns typ TTL 15ns typ @ 20V (high imp) Adj 25 ns typ @ 10V (50 ohms) Adj |
| SLEW RATE | >.5 V/ns TTL >0.1 V/ns Adj |
| OVERSHOOT | < 100 mV + 10% of pulse amplitude |

AMPLITUDE

Adjustable Mode:

1 - 10 V into 50 Ohms load

2 - 20 V into high impedance load

Typical Performance in TTL/CMOS Mode:

~ 1.7 V into 50 Ohms load

~ 4.8 V into high impedance load

COMPUTER INTERFACE

RS232 4800, 9600, 19200, 38400, 57600, 115200 Baud.

All instrument functions and settings may be controlled over the interface bus.

GPIB IEEE 488.2

USB v 1.0

ETHERNET Optional.

GENERAL

STORAGE 2 channel 4 channel 8 channel

12 12 12

DIMENSIONS 10.5" x 8.25" x 5.5"

WEIGHT 8 lbs

POWER 20 Watts

100 - 240 VAC

47 - 63 Hz

<1 A

FUSE (Qty 2) 630 mA, 250 V Time-lag

Appendix B - Special Functions

35 Volt Output

For units with the optional 35 volt output, additional BNC connectors are provided on the rear panel. The 35 volt output can be enabled independently for each of the channels from the channel output mode menus. When enabled, the rear panel outputs will provide an adjustable output from 5 volts to 40 volts and the timing will be calibrated to all other channels. The front panel output will be in the TTL/CMOS mode. However, the timing will not be as accurate as the unit is using the 35 volt calibration factors. Typically, the rising edge is within 10 ns but the pulsewidth is off by over 200 ns. The pulsewidth can be set over the standard range of the unit to allow full use of the front panel outputs, but the 35 volt output will self limit to approximately 4 us with some droop. To maintain the highest possible rise time, care must be taken with cabling and termination. Low capacitance cable and 50 ohm 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.

| Keyword | Parameter | Std/ New | Comments |
|--------------------|----------------------------|-------------|--|
| :PULSe [1 / 2 / n] | | Std | Subsystem. Contains commands to control the output pulse generation. Valid suffix range depends on the number of channels (ChA = 1, ChB = 2, etc). Command without suffix refers to the currently selected logical instrument. See INSTRument subsystem. |
| :Mode | TTL / ADJustable / 35 V | New | Selects output mode: TTL/CMOS, Adjustable, or 35 Volt. |
| :AMPLitude | <numeric value> | New | Sets Adjustable output level. Note that 35 V option AMPLitude can only be set when channel is in 35 V mode. |

NOTE: The 35 V output frequency is limited to less than 1000 Hz.

35 V Specifications

OUTPUT AMPLITUDE

| | |
|------------|--------|
| Resolution | 200 mV |
| Accuracy | 200 mV |

T Option

System Period

The minimum period is 50 ns (20 MHz max frequency).

The maximum period is 10 s (.1 Hz frequency).

Pulse Range Limitations

The maximum pulse width is 5 s.

The maximum pulse delay is 5 s

Multiplexer

Multiplexing differs from the base model as follows:

1. Multiplexing is implemented in channel pairs. Channel A and B are paired, Channel C and D, etc. The enable and disable parameter for each channel turns on and off inclusion of the internal pulse of the other channel in the pair for the current channel's output.
2. The SCPI command for the multiplex parameter use a string "ENABLE" or "DISable". For example, ":PULS1:MUX ENAB\n" causes Channel B's internal pulse to be present on Channel A's output.

Channel Menus

| Timing Parameters | Pulse Configurations | Channel Mode | Gate/Mux |
|-------------------|----------------------|-------------------|-------------|
| Enable | Enable | Enable | Enable |
| Sync Source | Polarity | Mode | Max Enable |
| Pulsewidth | Output Type | On Cycle | Gate Enable |
| Delay | Output Level | Off Cycle / Burst | Wait |

Clock In/Clock Out

The "T" option pulse generator has Clock In and Clock Out functionality to allow synchronization of several instruments to an industry standard 10 MHz signal. The rear panel of the unit has BNC connectors for Clock In and Clock Out signals.

The "Clock In" BNC connector allows synchronization of the unit's timers to a signal generated externally. When the Clock In is enabled, a 10 MHz pulse must be present on the Clock in BNC for the unit to generate pulses.

The “Clock Out” BNC connector will output a signal dependent on the current configuration. If the “Clock In” parameter is enabled, the 10 MHz signal present on the Clock In BNC will also be present (and synchronized) on the Clock Out connector. If Clock In is disabled and Clock Out is enabled, the 9500+T will generate and output a 10 MHz signal intended for synchronizing other instruments. If the Clock Out parameter is disabled, the system pulse (T_o) will be present on the output BNC connector, showing whatever frequency is being generated in the current setup.

Mode Menu

To access the Oscillator menu unique to the “T” option instrument, press the “Function-Mode” key sequence twice. The first set will enter into the standard channel mode menu, and the second sequence will enter the Clock In/Out menu.

| T_o Mode | Oscillator Menu |
|-------------|-----------------------|
| | |
| System Mode | Oscillator Out Enable |
| | Oscillator In Enable |

Serial Commands

| Keyword | Parameter | Std/ New | Comments |
|--------------|----------------|-------------|--|
| :PULSe[0] | | | |
| :ICLock | <Boolean> | New | Enables/Disables lock to 10 MHz signal. Can be set to "1" or "0" (Enable or Disable, respectively). Query returns "Enabled" or "Disabled". |
| :OCLock | <Boolean> | New | Enables/Disables output 10 MHz signal. Can be set to "1" or "0" (Enable or Disable, respectively). Query returns "Enabled" or "Disabled". |
| :PULSe[1/2n] | | | |
| :MUX | ENABle/DISAbLe | New | Enables/Disables Multiplexing. Multiplexing is implemented in channel pairs. Channel A can be combined with Channel B, C, with D, etc. |

Clock IN / Clock Out Signal Specifications

Frequency: 10 MHz +/-25 PPM
Duty Cycle: 50% +/-5%
Level (In & Out): TTL/CMOS

Deviations from 9500+ Specifications

PULSE GENERATION

| | |
|-------------|-------------------------------------|
| Multiplexer | Described on p. 1 of this Appendix. |
| Delay | 0 - 5 s |
| Pulsewidth | 10 ns - 5 s |

INTERNAL RATE GENERATOR

Rate (T_o PERIOD) 50 ns to 1000 s (.0002 Hz to 20 MHz)

Optical Outputs and Inputs

The optical output model differs from the standard units as follows:

Optical Outputs: The optical outputs utilize Agilent HFBR-1412 optical connectors. Complete specifications can be downloaded from Avago Technology's website (www.avagotech.com). Pertinent specifications are:

- Wavelength: 820 nm
- Signal rates up to 5 MBd
- Link distances up to 1.5 km
- ST connector type
- Resolution: 500 ps
- Accuracy: 1 ns + .0001 x Delay

Optical Inputs:

- Wavelength: 820 nm
- Signal rates up to 5 MBd
- Link distances up to 1.5 km
- ST connector type
- Resolution: 500 ps
- Accuracy: 2 ns + .0001 x Delay
- Optical Trigger: 2412
- Trigger Delay: < 300 ns
- Jitter: <15 ns

System Mode: Increment

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

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

- Select 'Increment' in the system mode menu and set the number of pulses in a burst..
- Set the step size for both the delay and pulsewidth in the channel menus.
- Reset and initialize the parameters by pressing Function-CLR.
- To operate manually:
 - Press the RUN button to generate a set of pulses.
 - Press Function-CLR to reset the delay and pulsewidths to their original values.
- To operate with external trigger:
 - Enable external trigger.
 - Press the RUN button to arm the pulse generator.
 - Apply external trigger to generate a set of pulses.
 - Press Function-CLR to reset the delay and pulsewidths to their original values.

The DC Increment function is used as follows:

- Select 'DC Increment' in the system mode menu and set the number of pulses ON pulse and the number of OFF pulses per cycle. Select the next Mode menu to set the number of Cycles.
- Set the step size for both the delay and pulsewidth in the channel menus.
- Reset and initialize the parameters by pressing Function-CLR.
- To operate manually:
 - Press the RUN button to generate a complete set of pulses.
 - Press Function-CLR to reset the delay and pulsewidths to their original values.
- To operate with external trigger.
 - Enable external trigger.
 - Press the RUN button to arm the pulse generator.
 - Apply external trigger to start the duty cycle mode. Output will continue until the number of cycles specified has been produced.

Reference Clock

An input and output were added for a 10MHz reference clock. The input

replaces the internal clock and allows multiple pulse generators to share the same clock.

Function-CLR: Pressing the 'FUNCTION' key then 'CLR' initializes the increment parameters and, resets the delays and pulsewidths to their initial conditions. This must be pressed after setting all the step parameters, but before generating any pulses.

MENU Additions

Mode Menu

Mode: Added 'Increment' and 'DC Increment' to mode choices.

CYCLES: Added cycles in the DC Increment mode. (Additional page available when DC Increment mode is selected.)

Rate Menu

Source: Selects the reference clock source input as either the internal System clock or an external user supplied reference clock input of up to 10MHz.

Osc Out: Enables/disables the reference clock output. When the Source is set as External this output contains the external reference clock input, when the Source is set as System this output contains the To internal system pulse.

Channel Menu

WidInc: Sets the step size for the pulsewidth increment.
Range: -0.100s to 0.100s (0 = disabled)

DlyInc: Sets the step size for the delay increment.
Range: -0.100s to 0.100s (0 = disabled)

Note: Any increment value > -10ns and < 10ns will disable the increment function for that parameter.

COMMAND Additions

:PULSe0:MODE Added INCRement and DCINcrement as new parameters.

:PULSe0:IRESet 1 Added IRESET command to initialize and reset the increment parameters

: PULSe0:PCOunter # Added Pulse Counts command to set the number of on/On pulses to generate in DC Increment mode.

| | |
|--------------------|---|
| :PULSe0:OCOunter # | Added Off Counts command to set the number of on/Off pulses to generate in DC Increment mode. |
| :PULSe0:CYCLe # | Added CYCLES command to set the number of cycles to generate in the DC Increment mode. |
| :PULSe0:ICLock # | Enables/disables the clock input. |
| :PULSe0:OCLock # | Enables/disables the clock output. |
| :PULSe#:IWIDth # | Added IWIDTH command to set the pulsewidth step size. Range: -0.100000000s – 0.100000000s |
| :PULSe#:IDELay # | Added IDELAY command to set the delay step size. Range: -0.100000000s – 0.100000000s |

Specifications

| | |
|--------------------------------|---|
| Width Step Size | -100ms to 100ms |
| Width Minimum Step | 10ns (-10ns) |
| Width Step Resolution | 1ns |
| Width Incremented Range | 10,000s |
| Delay Step Size | -100ms to 100ms |
| Delay Minimum Step | 10ns (-10ns) |
| Delay Step Resolution | 1ns |
| Delay Incremented Range | 10,000s |
| On Pulses (DC Increment Mode) | 1,000,000 Pulses |
| Off Pulses (DC Increment Mode) | 1,000,000 Pulses |
| Cycles (DC Increment Mode) | 10,000 Cycles |
| Update Rate | 10us + 30us per active channel (1 Ch @ 25kHz to 8 Ch @ 4kHz) |

Trigger/Gate Option

The trigger/Gate option adds a second external input to the rear panel of the 9500+ family of pulse generators. The added input is an optoisolated signal that can be used as a gate or trigger for either the system or the channels. Either input may be specified as the channel gate input and the remaining input will then be assigned as the system trigger/gate input. All other 9500+ pulse generator functionality stays the same.

Specifications

| | |
|-----------|--------------|
| New Input | Optoisolated |
| Voltage | 2v to 15v |
| Current | 4 mA |

Appendix C - COM

Ethernet Interace Overview

An Ethernet interface is optional on the 9500+. When this option is chosen, the USB port is replaced by the Ethernet port.

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

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

Ethernet Communication Notes:

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

Username: “root”
Password: “dbps”

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

Programming Command Types and Format

The 9500+ 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.