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Princeton Instruments

PG-200 Programmable Gate Pulse Generator

ROPER SCIENTIFIC™
BEYOND IMAGING

Manual Version 2
Revision D
August 11, 1998

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Introduction

Unpacking and Initial Checks

Carefully remove the PG-200 Pulser from the carton and inspect both the pulser and carton for any signs of shipping damage. In case of shipping damage, contact the shipper and Princeton Instruments, Inc. at once for instructions. Read all warnings and instructions below before operating the pulser.

Make a backup copy of the calibration disk. It contains calibration constants plus utilities to be used in the event of a battery failure. A README file contains instructions.

DANGERS

This instrument operates at potentially lethal voltages. Internal voltages exceed 1000 volts even though the high voltage gate output pulses have magnitudes of 200 volts. Unauthorized tampering with its operation may render the PG-200 dangerous and is prohibited. To avoid possible hazard to personnel, use the instrument only with the proper connectors and cables and only for the purposes for which it is designed. If used with Princeton Instruments, Inc. detectors, the BNC type cable supplied with the pulser or a similar cable should be used (50 Ω, 25-35 pF/foot, 3 ft. long). If the pulser is to be used in some other application, adequate precautions must be taken to prevent persons from making contact with the output of the pulser.

Never operate the PG-200 without the ground prong of the supplied power cord plug making contact with an earth ground contact of a socket outlet, i.e. never “float” the PG-200. To avoid shock or injury, never operate the PG-200 without all covers in place. If internal jumper plugs must be reconfigured, always turn off power and wait at least 5 minutes before removing covers. The extra time is needed for high voltage capacitors to discharge to safe levels.

WARNINGS

This instrument may be damaged if operated with the line selector set up incorrectly or if the wrong fuse is installed. Before applying power, verify that the line voltage selector card in the rear panel power entry module is in the correct position. The selected voltage may be seen through the clear window in the power entry module.

To change line voltage selection, remove the line cord, slide the window to the side, and eject the fuse by pulling the fuse pull lever out. Using needle-nose pliers, remove the small printed circuit card and reorient it so the desired line voltage will be visible through the window when it is reinstalled. Reinstall the card in the new orientation, replace the fuse with the proper value for the voltage chosen, slide the plastic window to the side, and plug in the line cord. Line voltage and fuse values are marked on the PG-200 rear panel.

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The PG-200 uses a three wire power cord for connection to the power source and to a protective ground. The exposed metal parts of the instrument, including the BNC shields, are connected to the outlet ground to protect against electrical shock. Always use an outlet which has a properly connected ground. Never make connections to other instruments which might have voltages on BNC shields. Disconnecting the protective earth terminal, inside or outside the PG-200, or tampering with its operation may render the PG-200 dangerous and is prohibited.

The air intake for the PG-200 is on the bottom of the unit, the exhaust fan at the rear. The PG-200 should never be placed over another unit which vents warm air through the top cover thereby causing the PG-200 to take in warm air. Also the PG-200 should never be positioned so that the rear exhaust is blocked. If either type of placement is attempted, the TEMP HI error message may be displayed, indicating that the internal ambient temperature has exceeded 50°C. If this error message is observed, power down the unit immediately and do not power up until the cause of the over-heating is remedied.

The PG-200 is designed to drive only 1 MΩ terminated ICCD detectors. Attempting to operate an ICCD with 50 Ω termination will most likely result in damage to the pulser.

The high voltage gate pulse BNC output is on the rear panel of the PG-200. Never connect the gate pulse output to an oscilloscope that is not rated for voltages of at least ±250 volts. The low voltage gate pulse monitor BNC is in close physical proximity to the gate pulse to maintain pulse fidelity. The gate monitor is designed as a high impedance timing reference for oscilloscope monitoring and is not capable of driving loads such as TTL inputs. Caution should be exercised not to confuse the two rear panel outputs.

The EXTERNAL TRIGGER IN input BNC is rated for a maximum input voltage of ±10 volts and a maximum power of 2 watts. Both conditions must be satisfied or damage to the PG-200 may result. Caution should be used when the external trigger input impedance is set for 50 Ω since 20 volts DC will damage the pulser.

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Although the PG-200 output trigger BNCs are normally set for 5 volt levels and are TTL compatible, on some units one or more outputs may be specially modified for 15 volt levels. If a modified 15 volt output is connected to a TTL input, damage to the TTL input instrument will result.

When operating at wide pulse widths, the duty factor should be restricted to ≤80%. Higher duty factors will cause unpredictably lower output levels, which in turn may cause unpredictable gain, non-linearity, loss of resolution and other problems. As a result, for operation at high duty factors and with long on times, the shutter mode will usually give more satisfactory results.

Introduction to the PG-200

The PG-200 Programmable Gate Pulse Generator combines the functions of a high voltage gate pulse generator and a sophisticated timing source/delay generator. It is similar to the Princeton Instruments FG-100 and PG-10 pulsers in that it is primarily intended to provide high speed gating of proximity-focused microchannel plate image intensifiers. The PG-200 matches the relatively high speed performance of the FG-100, extends pulse timing to the relatively long times of the PG-10, and has other advanced features such as continuously variable pulse widths above 3 nsec, simultaneous gating of two detectors (optional), automatic sweeping of gate pulse delays and other automation and communications capabilities.

The PG-200 has been designed to drive ICCD detectors with 1MΩ termination and will not drive ICCD detectors with 50 Ω termination. Driving an ICCD with 50 Ω termination will most likely result in damage to the pulser. See the ICCD detector manual for information on modifying your ICCD detector for 1 MΩ termination.

The PG-200 is designed to operate in either a stand-alone mode with control through a front panel keyboard or with control by computer through a serial interface. Using the serial interface, the PG-200 will be controllable directly from either WinSpec or WinView software.

The PG-200 front panel has the following features:

- External/internal trigger mode selection
- Optional optical trigger input
- External trigger level set digitally or by potentiometer, selectable input impedance, AC/DC coupling, ± trigger edge select, “triggered” indicator
- Inhibit inputs used to disable pulsing
- Internal frequency generator trigger output
- Programmable delayed trigger outputs
- Dedicated function keys for gate pulse delay, gate pulse width, delayed trigger output, input trigger level monitor, input trigger mode select
- Additional keys for features such as gate pulse delay “box-car” like sweep, pulse sequences, internal trigger frequency set, panel dim, parameter review, initialize, etc.

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- 20 character vacuum fluorescent display providing an easily readable, high luminescence display
- Battery backed up memory to save settings and instrument calibration constants

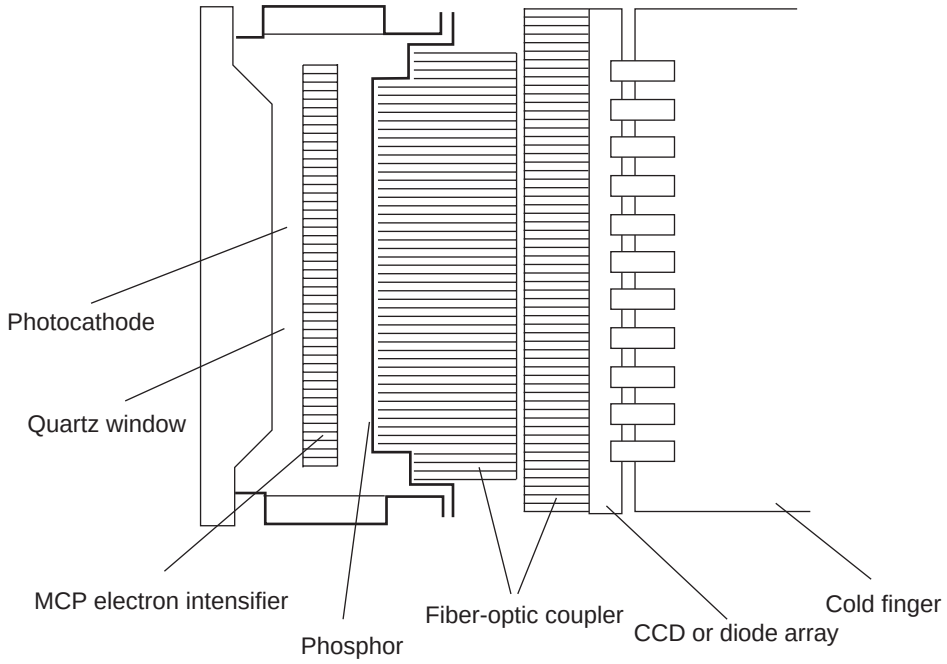
The rear panel has outputs for up to two simultaneous high voltage gate pulses (the first is standard, the second optional), gate monitors, a programmable TTL delayed output trigger and an RS-232 serial interface.

How Gated Detectors Operate

The PG-200 is readily interfaced to the IRY, IPDA, and ICCD series detectors equipped with internal 1 MΩ terminators. Connect the pulser HV gate output to the detector using a 3 ft. (or shorter) BNC connector cable (50 Ω impedance).

The main structural features of Princeton Instruments IRY, IPDA, and ICCD detectors are shown in Figure 1.

Figure 1. Diagram of an MCP image intensifier.



The proximity-focused MCP image intensifier is shown in Figure 1 optically coupled to a CCD or diode array with a fiber optic window. A fiber optic taper may also be used, or a lens assembly.

In the Shutter mode of operation for ICCD detectors (CW for IRY/IPDA) the photocathode potential is held approximately 200 volts more negative than the potential of the MCP input. With this configuration the intensifier “sees” light. The Shutter/CW mode of operation therefore does not require the use of the PG-200 to turn the image intensifier on and off.

In the Gate mode, the photocathode potential is held approximately 20-40 volts more positive than the potential of the MCP input and therefore the photoelectron image or spectrum cannot reach the MCP. To turn the image intensifier “on,” the PG-200 Pulse Generator produces a negative pulse of approximately –200 volts amplitude. This pulse, is applied to the photocathode, and renders it for the duration of the pulse more negative

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than the MCP and therefore the “photoelectron image or spectrum” is transmitted to the MCP and intensified by the MCP.

The MCP intensified “electron image or spectrum” is accelerated and focused (proximity focusing) onto the phosphor, where it is converted to a “photon image or spectrum” with a further optical gain. This “photon image or spectrum” is transmitted to the individual pixels through the phosphor and the diode array or CCD optical fiber coupler. There it is detected, stored, and then read out.

High precision gating depends on the control of a few key parameters, listed below.

- The ability to turn on and off the photocathode with relatively no iris effect, i.e. “switching” on and off the entire photocathode area virtually simultaneously. Unfortunately at the present time this cannot always be fully achieved. The edges of the photocathode are turned on first and off first, and the opposite is true for the center of the photocathode. This iris effect is typically less pronounced for extended red photocathodes since their conductivity is usually higher. It is of course most pronounced when the pulse time is very short.
- The triggering mechanism must be precise and flexible. The PG-200 can trigger on either a negative or a positive edge. Low amplitude signals can be used so that direct signals from a photosensor can trigger without the need for amplification. The PG-200 has a trigger port which accepts a trigger signal from a photosensor directly.
- The inherent internal delay time (propagation delay), i.e. the time duration from the triggering of the PG-200 to the time it produces the high voltage gating pulse. To overcome the propagation delay problem, the user must adopt one of two general approaches: pretrigger the PG-200 prior to triggering the monitored phenomenon, e.g., laser pulse; or optically delay the arrival of the monitored light signal to the MCP window. The PG-200 has a minimum propagation delay time of about 20 nsec.
- The pulse delay time must be precisely settable and repeatable over as wide a range as possible. In addition to the obvious instrument flexibility obtained through such a wide range of delay variability, it also greatly facilitates initial experimental setup where sweeping the gate pulse delay provides the means to easily “capture” the light phenomenon.
- The pulse should have short rise and fall times to provide good temporal resolution.

Specifications

All PG-200 parameter measurements are made using a Princeton Instruments detector simulator, since the PG-200 is designed to drive Princeton Instruments ICCD detectors fitted with high impedance (1 MΩ) terminators. The PG-200 will most likely be damaged if driving a 50 Ω ICCD is attempted.

Delay measurements are made at the PG-200 rear panel, calculated from input trigger leading edge (10% amplitude) to gate pulse leading edge (10% amplitude).

Warm-up time: Approximately 15 minutes

Time base:

Accuracy: ±3 nsec for minimum time interval

Precision: ±1 nsec or 0.1% whichever is greater

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Jitter: < 0.5 nsec or 0.05% whichever is greater

Temperature drift: < ±1 nsec or 200 ppm per degree C, whichever is greater. Total temperature drift is less than 500 ppm immediately after time base calibration.

Gate pulse magnitude: –200 volts typical, –180 to –220 volts absolute, into 1 MΩ terminator.

Gate pulse peak amplitude ringing: ±20 volts

Gate pulse undershoot: < 40 volts

Gate pulse second undershoot: < 30 volts

Gate pulse rise/fall time: < 3 nsec for a pulse width of 3-14 nsec
< 10 nsec for a pulse width of 15-199 nsec
< 30 nsec for a pulse width > 200 nsec

Maximum gate pulse repetition rate: ≥10,000 Hz normally
≥ 5,000 Hz with delay sweeping ("box-car" mode)
≥ 1,900 Hz with pulse sequencing

Internal trigger rep rate: 2-10,000 Hz ±3% accuracy

Internal trigger out pulse: 5 V negative logic BNC output,
factory modifiable to 5 V/15 V positive or negative logic,
peak power = 0.5 W,
peak current 1.5A typical,
width > 10 µsec, rise/fall time < 7 nsec,
coincident with internal trigger within 2 nsec.

Gate pulse delay, external trigger mode: Continuously adjustable in 1 nsec increments up to 80 msec. Gate delay + gate width cannot exceed a total time of 80 msec. Typical minimum delays are:

at 3-14 nsec widths: 20 nsec delay, 25 nsec max.
at 15-199 nsec widths: 35 nsec delay, 42 nsec max.
at > 200 nsec widths: 65 nsec delay, 75 nsec max.
with delay sweep: minimum delay (dependent on width) +20 nsec

Gate pulse delay, internal trigger mode: Continuously adjustable in 10 nsec increments. (The internal frequency generator output, Internal Trigger Out can be used in external trigger mode to achieve gate pulse delay increments of 1 nsec. A BNC cable must be connected from Internal Trigger Output to the external trigger input.

Gate delay sweep: "Box-car" mode with delay step size programmable from 1 nsec – 80 msec, delay step count (number of delay steps) from 1 – 16,000. Normal gate pulse delay specs cannot be exceeded, gate delay + gate width cannot exceed 80 msec total.

DELAYED TRIGGER OUT and AUX DLY'D TRIG OUT do not sweep with gate pulse.

Maximum pulse rate = 5 kHz.

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Pulse sequence: Multiple pulse producing mode where 1-250 pulse points are produced in sequence. Gate delay, width, Delayed Trigger Out, and Aux Del'd Trig Out can be varied. Gate width must remain within 1 of 3 ranges: < 15 nsec, 15-199 nsec, > 15 nsec during sequence. Maximum pulse rate = 1.9 kHz.

Gate pulse width: 3.5 nsec to 80 msec continuously adjustable in 1 nsec increments, except below 15 nsec where it is adjustable in 2 nsec increments. Gate delay + gate width cannot exceed 80 msec total. Width is measured FWHM (Full width at half maximum amplitude).

DELAYED TRIGGER OUT pulse: Initially synchronized to trailing edge of high voltage gate pulse, i.e. delayed from trailing edge of gate pulse by 20 µsec. Sync delay can be varied from 1-100 µsec. Delays can also be programmed from input trigger in 1 nsec increments, 200 nsec – 80 msec.

5 V negative logic BNC output, modifiable to 5 V/15 V negative or positive logic, peak power = 0.5W, peak current 1.5A typical, width >1 µsec, rise/fall times < 7 nsec.

AUX DLY'D TRIG OUT: Initially synchronized to trailing edge of high voltage gate pulse, i.e. delayed from trailing edge of gate pulse by 20 µsec. Sync delay can be varied from 1-100 µsec. Delays can be programmed from input trigger in 80 nsec (±80 nsec accuracy) increments, 1 µsec – 80 msec. TTL compatible (HC series TTL) 5 V negative logic BNC output, modifiable to 5 V positive, width >1 µsec, rise/fall times < 7 nsec.

Pulse monitor: Gate pulse timing reference with an approximate amplitude of –2 volts (100:1 ratio capacitive divider). For longer gate widths, the pulse monitor may appear to be differentiated. However, the vertical edges of the pulse monitor still accurately represent the leading and trailing edges of the gate pulse.

External trigger input, electrical: 5 nsec minimum pulse width, BNC connector, ±10 V range, 40 mV sensitivity, 50/2000 Ω impedance, AC/DC coupling, 2 W maximum power into 50 Ω, ±20 volts maximum voltage (both conditions must be satisfied).

Manual external trigger inputs can be simulated by polarity switch toggling although extra triggers will probably be generated due to switching noise.

External trigger input, optical: 5 nsec minimum pulse, SMA connector, 400-1150 nm, 0.5 A/W at 850 nm. Required settings: 50 Ω trigger impedance, trigger polarity negative, trigger level < 0 V, e.g., –1 V.

INHIBIT/$\overline{\text{INHIBIT}}$ inputs: TTL compatible; ±15 volts maximum voltage, < 50 nsec internal delay. Without connections the PG-200 is always enabled.

$\overline{\text{INHIBIT}}$ is a negative logic INHIBIT input.

Dual gate pulses:

Gate delay skew:
at 3-14 nsec widths: ≤ 2 nsec
at 15-199 nsec widths: ≤ 5 nsec
at 200+ nsec widths: ≤ 10 nsec or 0.1%, whichever is greater

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Gate width skew:

at 3-14 nsec widths: ≤ 2 nsec
at 15-199 nsec widths: ≤ 3 nsec
at 200+ nsec widths: ≤ 4 nsec or 0.1% whichever is greater

Serial interface: RS232-C, 1 start bit, 8 data bits, 1 stop bit, no parity, 9600 baud.

Battery backed-up memory: Data retention is good for 10 years under normal conditions.

Operating environment: 20-30°C, relative humidity 10-80%

Size: 3.5″ H, 17″ W, 13″ D

Weight: 17 lb.

Power: 95-130 V RMS, 210-260 V RMS

50-60 Hz

200 VA maximum

Hardware Overview

The PG-200 contains at least three PC boards, depending on the options purchased with it. The three basic boards are the Processor, Front Panel and Pulser Boards. Also inside the case are a line filter, power supply transformer, and a power line disconnect safety switch.

DANGER

Never rely on the power line safety switch to turn off the high voltage inside the pulser. Always disconnect the line cord and wait at least 5 minutes before removing the PG-200 covers. The extra time is needed to discharge the high voltage capacitors to safe levels.

The Processor Board contains the power supply for all the system logic plus a programmable high voltage power supply for gate pulses. The high voltage power supply must be adjusted for different gate pulse widths to maintain relatively constant gate pulse amplitudes. If a high voltage overload condition occurs, the supply is disabled and can only be re-enabled by turning power off then turning power back on. If the problem persists, power should remain off until it is resolved. Also included on the Processor Board is a microprocessor with EPROM and battery backed up RAM, 8 channel ADC, 4 channel DAC, timers, counters, serial interface, auxiliary delayed trigger output, keyboard controller, parallel I/O registers, internal ambient temperature monitor, and crystal clock references.

The Front Panel Board contains control circuitry for all front panel functions including key switches, alpha-numeric display, BNCs, slide switches, LEDs, etc. Other circuitry includes delay generators, a 100 MHz oscillator, buffers for BNC outputs, etc. The 100 MHz oscillator serves as the PG-200 time base for gate pulse timing, delay out timing, etc. It can be calibrated for temperature drifts by comparing its frequency against the microprocessor crystal frequency.

The Pulser Board contains the pulse shaping circuitry to produce the high voltage gate pulses. It receives timing information from the Front Panel Board. If a system requires

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two high voltage gate outputs, two Pulser Boards are installed, each board getting the same timing signals so that both gate pulses occur simultaneously. Both Pulser Boards should be specially calibrated for proper parallel operation, i.e. they must be calibrated with each other for minimum gate pulse delay and width skews. Additionally the Pulser Board contains a gate monitor circuit which is basically a capacitive divider. The divider produces a faithful replica of the gate pulse, however, the monitored pulse appears distorted since it is derived from the gate pulse at the PG-200 rear panel connector and not at the detector. The PG-200 was designed to produce proper pulses for Princeton Instruments detectors and this apparent distortion does not affect detector performance in any way. The monitor pulse is only useful as a high impedance oscilloscope timing reference.

Before Operating the PG-200

Be sure to read the unpacking and initial checks section first, especially the danger/warning subsections. After performing all initial checks including line voltage, fuse selection, and detector termination, turn the PG-200 on using the power switch on the rear panel. The PG-200 should go through a boot up procedure including a partial self-test. Within about 10 seconds the display will show the READY indication, although to realize the full performance specifications, a 15 minute warm-up period should be observed.

The PG-200 produces high voltage gate output pulses which are delayed from an input trigger. The input trigger can be from an external source, i.e. External Trigger mode, or from the internal programmable frequency generator, i.e. Internal Trigger mode. The active trigger mode is displayed by LED indication: EXT or INT above the Trigger Select key. The Trigger Select key can be pressed to switch between modes. INHIBIT positive and negative logic BNC inputs can be used to inhibit pulsing with the corresponding polarity signal. Without INHIBIT connections, pulsing is always enabled.

Three output triggers are also provided. INTERNAL TRIGGER OUT is an output trigger coincident with the input trigger time in internal trigger mode. DELAYED TRIGGER OUT and AUX DLY'D TRIG OUT output triggers can be programmed for delays from either the input trigger or the trailing edge of the high voltage gate pulse. The AUX output is on the rear panel and has fewer features than the front panel output.

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Chapter 1
Operation

Gating the Detector with the PG-200

This section will describe how to set up the PG-200 with a Princeton Instruments intensified detector for basic operation. In this example, the PG-200 will be the source of timing for the system. In other examples below, external timing will be used. For this setup, you will need a standard dual trace oscilloscope (50 MHz or faster) and some coaxial cables. Even if this example does not correspond to your system configuration exactly, you may want to go through it once to become familiar with the features of the pulser.

The steps are as follows:

- Read the Dangers and Warnings section of this manual (beginning on page 7).
- Make sure that the PG-200 is off and the detector is not exposed to any light. Set up the proper cooling for the detector.
- Connect the “Pulse output” of the PG-200 (on the back panel) to the “Gate” input of the detector using the 3 ft. coaxial cable provided with the PG-200. Make sure this detector is 1 MΩ terminated (it was originally purchased for use with a PG-200).
- Connect the pulse monitor output of the PG-200 (back panel) to channel A of a dual trace oscilloscope using a coaxial cable without termination. Set the oscilloscope amplifier to 1 volt/division (the pulse monitor signal is about 2 volts).
- Connect the Internal Trigger Output of the PG-200 (front panel) to the external trigger input of the oscilloscope. Set the oscilloscope time scale to 5 microseconds per division. Set the oscilloscope to trigger on the falling edge (the Trigger Output is normally a 0 to 5 V negative-logic signal).
- Connect the Delayed Trigger Output of the PG-200 to the other equipment in your experiment which needs to be triggered by the PG-200 (such as a laser) using a coaxial cable without termination.
- Also connect the Delayed Trigger Output to the B channel of the oscilloscope and set the channel B amplifier to 5 volts/division (this is also normally a negative-logic TTL signal).
- Turn on the PG-200. After boot-up, the screen on the front of the instrument should say READY.
- Your PG-200 has an internal battery-backed memory which remembers the settings you have programmed from one usage to the next. To insure the factory default settings, run the function key program #9. This is done by pushing the “F” (Function) key followed by the “9” key, followed by the “E” (Enter) key. The PG-200 will set itself to the values shown in the table below. After restoring the factory default settings, the screen will once again display READY.

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Pulse Length:	100 nsec
Pulse Delay (from the internal timing source which you are using to trigger the oscilloscope): Note that in Internal Trigger Mode, the pulse delay may vary from the set value of 100 nsec by as much as 10 nsec depending on calibration, i.e. in Internal Trigger Mode, pulse delays are programmable in 10 nsec steps.	100 nsec
Delayed Pulse Output (delay from the trailing edge of the gate pulse)	20 µsec
Trigger Source:	Internal
Internal Trigger Frequency:	1 kHz

- At this point, the PG-200 will be producing gate and delayed trigger pulses at 1 kHz. Adjust the oscilloscope triggering and display to see these pulses.

  Both pulses will be small and negative going (standard configuration). The gate pulse monitor, on Channel A, only 100 nsec long, will be only 0.02 divisions wide on the oscilloscope (at 5 microseconds per division). About halfway across the oscilloscope screen, on Channel B, will be the delayed trigger output pulse, 4 microseconds long. Remember that it is normally configured for negative logic. Pulsing can be turned off by pressing the "±" key on the front of the PG-200. Pressing it again will turn the pulsing back on.

- So that the timing of the Delayed Trigger Output can be changed to before or after the gate pulse, we will remove its synchronization from the gate pulse. Thus it will have an independent delay from the trigger and this delay can be longer or shorter than the delay to the gate pulse. To do this, run the DLY'D TRIG'S SYNC program (press "F" (Function), "1", "5" and "E" (Enter)). The user interaction during the running of this program is as follows:

  PG200: DLY'D TRIG'S SYNC

  PG200: DLY SYNC ENABLED

  PG200: 1 = ENABLE 0 = DISABLE

  PG200: ENTER # 1

  USER: "0" [CR]

  PG200: DISABLE

  PG200: AUX SYNC ENABLED

  PG200: 1 = ENABLE 0 = DISABLE

  PG200: ENTER #1

  USER: [CR]

  PG200: ENABLE

  PG200: X SYNC 1.000 µsec

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USER: [CR]

PG200: READY

When the delayed pulse is unsynchronized, it will move about 200 nsec earlier, as its delay (still 20 µsec), will be relative to the trigger and not the gate's trailing edge.

- Next set the delay of the Delayed trigger output to 200 nsec. To do this, first press the DLY'D TRIG key. The display will say: DLY'D TRIG: _ 20 uS. Press "2" and then press "0" twice. The display will look like:

  DLY'D TRIG: 200_ 20 uS

- Now move the cursor right using the right arrow key until it is under the "u". Press the up and down arrow keys to cycle between the choices "uS", "mS" and "nS". When the display says "nS", press the "E" (Enter) key, and the new gate delay will be implemented. This can be seen on the oscilloscope. With the new shorter delay, the time scale of the oscilloscope can be expanded to 50 nanoseconds per division and the pulses should be easier to see.
- Next change the gate pulse length to 5 nanoseconds. This is done by first pressing the "Gate Width" key. This display should say: "Gate width: _ 100 nS". Press "5" and then "E" (Enter). For a few seconds, the message "Adjusting HV" will be displayed. This means that the internal high voltage supply is being automatically adjusted to maintain the same pulse output amplitude at the new pulse length. The gate pulse will change to 5 nanoseconds wide.
- Next change the pulse frequency to 3000 Hz. To do this, run the INT TRIG FREQ program, by pressing "F" (Function), "2" and then "E" (Enter). Note that this is easy to remember as the label FREQ can be found on the front panel above the "2" key. The screen will display:

  INT TRIG FREQ: _ 1000 Hz

- Move the cursor right using the right arrow key until it is under the "1". Press the up arrow key. The digit will increase to "2". Pressing the up arrow key again will increase the number to "3000". When this is done, press "E" (Enter) and the new frequency will be implemented. Note that the new frequency could also have been entered numerically, as has been done with other parameter values earlier in this example.

  The internal trigger frequency value and prompt will stay displayed so that you can keep changing the frequency until you are satisfied with the results. To return to the READY display, press the Trigger Select key twice. This will toggle the trigger source to External and then back to Internal, updating the display along the way.

Sweeping the Gate Pulse Delay

If the Delayed Trigger output is causing an optical pulse (such as a laser or a flash lamp), you may want to sweep the gate pulse past it in time, to collect data at a series of times during and after the flash. If you are taking image data with an intensified CCD camera, the successive frames taken can represent as little as one nanosecond advance in time per frame. These images can later be played back in "movie" mode on a computer screen. Using this approach of sampling a fast but repetitive event, the effective frame rate that your movie is taken at can be as high as 1 GHz!

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- To set up a sweep, run the GATE SWEEP program by pressing “F” (Function), “1”, and “E” (Enter). The screen will prompt you in turn for:

The starting gate delay	e.g., 50 nsec
The gate delay sweep step size	e.g., 1 nsec
The gate delay sweep step count	e.g., 1000

- When this program is complete, the screen will say READY and you will be able to observe the gate pulse delay increase from 50 nanoseconds after the trigger for the first pulse to about 1.05 microsecond after the trigger for the last pulse (pulse 1000). Since pulses are being produced at 3000 per second (the internal trigger frequency set in step # 14), and you have just specified 1000 steps in the sweep, each sweep will take about a third of a second. To stop the sweeping, run the program again and set the step count to 0.
- Note that when you set the step size to 1 nsec, the PG-200 may respond with a step size that is slightly different, e.g., 0.92 nsec, depending on calibration.

PG-200 Triggered by an External Source

In some experiments, the pulser will not be the source of timing. Instead it will respond to timing signals from other devices such as a laser or another pulse generator. To trigger the PG-200 from an external source:

- Press the Trigger Select key. This key toggles the trigger source between internal and external and the corresponding LED on the front panel will light to show the mode selected.
- Connect the trigger signal to the Trigger Input on the front panel of the instrument. The AC/DC coupling, trigger level, ± trigger polarity and input impedance controls operate like those on an oscilloscope. When the PG-200 is being triggered by the external signal, the Triggered LED will light up.
- The trigger input to the PG-200 should also be connected to your oscilloscope, as the internal trigger output, previously connected, is no longer relevant.
- Each time the PG-200 is triggered, the oscilloscope should now show you the pulse.

Trigger Modes

In external trigger mode, there is a choice of electrical or optical inputs. The external trigger section of the PG-200 front panel is similar to that of an oscilloscope. It has input impedance select, AC/DC coupling select, ± polarity select, and a level potentiometer adjustment. The level pot can be monitored by pressing the TRIGGER LEVEL key. The trigger detector operates on inputs from +10 V to –10 V. Although it may accept trigger signals of greater amplitude without damage, depending on the input impedance setting and the input signal duty cycle, the pulser may trigger erratically and in some cases damage may result. For these reasons, do not exceed 10 volts peak input to the trigger detector.

For optical external trigger inputs, the impedance select switch must be set for 50 ± and the trigger polarity for negative. Trigger level must be set below 0 V, e.g., –1 V. The trigger signal should have as fast a leading edge as possible, preferably less than 5 nsec. Slow leading edges increase the trigger jitter. The trigger detector will normally work well with all TTL types as trigger sources. If the 50 ± external trigger input impedance is

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selected, make sure that the low load impedance does not cause problems for the driving circuit, e.g., the trigger should be a separate output which does not drive other logic circuits.

When the front panel trigger level adjustment is active, it is monitored by an 8 bit ADC. If adjusted such that the monitored level is near a bit transition, a slight amount of jitter may be detected due to noise voltage causing bit transitions. If this is a problem, trigger levels can be set digitally.

The front panel external trigger controls are:

50 Ω / 2K switch – Selects the external trigger input impedance. Must be in the 50 Ω position for optical inputs.

AC/DC switch – Selects the external trigger input coupling.

± switch – Selects the external trigger input polarity. Should be set for "-" with optical external trigger input.

LEVEL pot – Sets the external trigger input level. Should be set for negative voltage, e.g., –1 V for optical external trigger input.

TRIGGERED LED – Indicates receiving either an external or an internal trigger. Remains lit during high rate triggering.

In internal trigger mode, the internal frequency generator produces the reference trigger pulses. Gate delays are programmable in 1 nsec increments in external trigger mode, but are only programmable in 10 nsec increments in internal trigger mode. This limitation is necessary to support the very low minimum gate delay specification of the PG-200, but can be overcome by running the PG-200 in external trigger mode while using INTERNAL TRIGGER OUT as an external trigger input, rather than an internal trigger. A cable must be connected from the INTERNAL TRIGGER OUT BNC connector to the external trigger input BNC. This is possible because there is always a frequency output, INTERNAL TRIGGER OUT signal, even in external trigger mode. While in the internal trigger mode, external trigger inputs are disabled and gate delays are only programmable in increments of 10 nsec. Changing delays in 1 nsec increments is prevented.

In internal trigger mode, the INTERNAL TRIGGER OUT BNC connector provides an output pulse which can be used as a timing reference. The leading edge of this pulse is coincident with the leading edge of the internal trigger pulse itself. It is normally configured for +5 V negative logic, but can be modified for +5 V positive logic, or +15 V negative or positive logic. A jumper field on the PG-200 Front Panel Board selects the output configuration. Also the JUMPERS program must be run to inform the PG-200 of the jumper configuration for correct calibration.

The maximum trigger rate in internal trigger mode is about 10 kHz. Operation above the upper limit will not damage the PG-200, but pulses will be lost and triggering may be erratic.

Gate Pulse Control

The time interval between the input trigger pulse and the output gate pulse of the PG-200 (propagation delay) is governed by the gate delay program. The minimum setting for very narrow gate pulse widths is about 20 nsec. The PG-200 will automatically set the minimum delay if a value less than the minimum is entered. For example, if a gate delay

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of 1 nsec is entered, the display might return a value of 20 nsec (with a warning message).

In setting the delay in conjunction with variable width pulses, it is often helpful to use a high speed oscilloscope connected to the GATE MONITOR output. The monitor output is nearly simultaneous with the output pulse. Be sure to allow for the delay in all cabling, including the oscilloscope probes as appropriate, when making these measurements. The pulse monitor output is a low level output for timing adjustment purposes only. It is not meant for analysis of the output pulse waveform or amplitude. The pulse monitor output may be used for the measurement of the delay and to some extent for the measurement of pulse width. Precise pulse width measurements can only be done with a detector simulator since pulse shape will be different at the detector than at the PG-200 rear panel.

Gate pulse widths are entered directly, similar to gate pulse delays. The PG-200 is calibrated for widths measured FWHM at a Princeton Instruments detector simulator. As soon as the new width entry is confirmed, the output pulses will reflect the new value. The PG-200 will automatically set the pulse width to the nearest legal value. For example, if a width of 1 nsec is entered, the display might return a value of 4 nsec (with a warning message).

To meet its performance specifications from a few nanoseconds to milliseconds, the PG-200 uses multiple circuits for different pulse width ranges. For this reason there may be delays when reprogramming gate pulse widths for things such as readjusting the high voltage power supply, recalibration of the time base, etc. Such delays do not apply when reprogramming gate pulse delays.

Inhibits

The PG-200 has two front panel inhibit inputs, positive and negative logic, +5 V signals. This allows for inhibiting pulser operation with either type logic signal. Shortly after receipt of an inhibit signal, all pulser operation is disabled including input triggering, high voltage gating, and output triggering. Operation is restored shortly after all inhibits are removed.

In a Princeton Instruments system, $\overline{\text{INHIBIT}}$ would typically be connected to either the SHUTTER MONITOR output or NOTSCAN ($\overline{\text{SCAN}}$) output of a Princeton Instruments controller. For a CCD camera, use SHUTTER MONITOR. For a PDA detector, use NOTSCAN ($\overline{\text{SCAN}}$).

One exception to the above is that a high voltage gate pulse in progress will not be disabled. (If a second gate pulse arrives during the inhibit period, that gate pulse will be totally disabled.) Gate pulses are not truncated in order to maintain data integrity. It is possible to truncate gate pulses during inhibit by inserting the INH GATE TOT jumper on the Front Panel Board, although this is not recommended.

Trigger Outputs

The PG-200 has three BNC outputs that can be used for triggering other devices. The INTERNAL TRIGGER OUT is time coincident, within a nanosecond, to the internal frequency generator used for the internal trigger mode. It is usually configured for +5 V negative logic TTL signal levels, although it can be configured for +5 V positive logic or +15 V negative or positive logic signals.

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The two remaining outputs, DELAYED TRIGGER OUT and AUX DLY'D TRIG OUT (located on the rear panel) are functionally similar. They produce trigger outputs which are delayed from the input trigger. They default to the SYNC mode in which they are delayed from the trailing edge of the high voltage gate pulse by 20 µsec. As gate delay and gate width are varied, the DELAYED TRIGGER OUT pulses remain synchronized to the gate pulse. During delay sweeping, i.e. "box-car mode", the trigger outputs do not sweep with the gate and will remain at the initial value.

The sync delay period can be varied between 1 and 100 µsec using the DLY'D TRIG'S SYNC program. This program also allows either output to be "unsync'd" so that any delay can be selected. In this case, the trigger out delay is from the input trigger. The DELAYED TRIGGER OUT output can be programmed for delays in 1 nsec increments using the DLY'D TRIG key and the AUX DLY'D TRIG OUT output can be programmed in 80 nsec increments using the AUX DLY'D TRIG program. The front panel trigger out can be configured for either +5 V or +15 V, negative or positive logic signals while the rear panel trigger out is only configurable for +5 V negative or positive signals. Additionally, the rear panel output provides only HC TTL drive while the front panel output provides up to 0.5 watts.

Front Panel Key Switches

Basic pulser operation can be accomplished with dedicated function keys. GATE DELAY and GATE WIDTH are used to set gate pulse parameters. Pulsing is continuous and a change of pulse parameter is immediately reflected in the pulse output. Gate pulses can be disabled entirely by setting pulse width to zero or by pressing the "±" key when values are not being entered. Pressing the "±" key again or setting gate width to a value greater than zero causes pulsing to resume.

The DLY'D TRIG key programs the DELAYED TRIGGER OUTPUT BNC for an output pulse which is delayed from the leading edge of the input trigger. After initialization, DELAYED TRIGGER OUTPUT is set to be synchronized to the high voltage gate pulse, i.e. it has a fixed delay of 20 µsec from the trailing edge of the gate pulse. In this default mode, hitting the DLY'D TRIG key will bring up the message, DLY'D TRG SYNC TO GATE. It can be "unsync'd" by running the DLY'D TRIG SYNC program. (The next section, *Function Key Programs* describes the special purpose programs implemented in the PG-200 and how to run them.) Once "unsync'd", DELAYED TRIGGER OUTPUT can be modified for delays from the input trigger.

The TRIGGER LEVEL key is used to monitor the external trigger level. If the trigger level pot is enabled (default), the pot level is displayed. If the pot is disabled by running the LEVEL POT program, the "digital" level entered through the TRIG LEVEL program is displayed. Value entries are not allowed with this key.

Value entries are done using the numeric keys on the right hand side of the front panel. The CLEAR key can be used to clear an entry. Entries are terminated with the ENTER key. The left/right cursor keys can be used to move to a particular character position on the display. The cursor up/down keys can be used to increment/decrement digits at the cursor location. When numbers are changed in this way, the ENTER key function is bypassed so that values can be quickly stepped up and down. The cursor up/down keys are also used to select units when the cursor is in the units field, e.g., nsec/µsec/msec. The "±" key changes the sign of the entered number. If an entry is out of range, it may be

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changed to the nearest acceptable value automatically or in some cases an error message will appear advising the acceptable range of input values.

Some features must be enabled and disabled, e.g., the DELAYED TRIGGER OUT or AUX DLY'D TRIG OUT outputs can either be synchronized to the high voltage gate pulse or "unsync'd" (delayed from the input trigger). Enabling is done by entering a "1" and disabling by entering a "0" in the appropriate display.

Some of the keys have dual functions, e.g., a number key may be used during value entry to enter a number and may alternately run a program if a value is not being entered. If a value is not being entered, the display will show READY. An easy way to get the READY indication is to hit the TRIGGER SELECT key twice. This program does not require a value entry. (If the TRIGGER SELECT key is hit only once, the trigger mode would be changed.)

List of switches

CLEAR – Clears the previously entered value during a value entry, freezes/unfreezes the display during lengthy printouts such as the HELP display.

CURSORS <, > – Moves the cursor left/right during value entry, decreases or increases display intensity when values are not being entered.

CURSORS ∧, ∨ – Increments/decrements the number at the cursor position during value entry, changes units e.g., nsec/µsec/msec when the cursor is at a units descriptor, increases/decreases display speed when values are not being entered.

DLY'D TRIG – Programs DELAYED TRIGGER OUT for delays measured from the leading edge of the input trigger. When in the default "sync" mode, displays a warning message indicating delay outputs are synchronized to gate pulses.

ENTER – Confirms all value entries, aborts lengthy printouts such as the HELP display.

FUNCTION – Selects special functions which do not have dedicated keys associated with them, e.g., DELAY SWEEP, INTERNAL TRIGGER FREQ, etc. See next section.

GATE DELAY – Programs gate pulse delay (measured from input trigger leading edge).

GATE WIDTH – Programs gate pulse width.

NUMBERS – Used to enter values and select function programs. Some keys have special functions when values are not being entered:

> **ONE** – Freezes/unfreezes gate pulse delay sweeping/sequencing.
>
> **NINE** – Initializes PG-200, e.g., display brightness, speed, etc.
>
> **±** – Changes sign of number entry or enables/disables gate pulses when values are not being entered.

TRIGGER LEVEL – Monitors external trigger level pot or displays trigger level entered in TRIG LEVEL program if pot is disabled by LEVEL POT program.

TRIGGER SELECT – Selects external or internal trigger modes.

Function Key Programs

The FUNCTION key is used to select all pulser functions that are not covered by the basic keys. The FUNCTION key is pressed followed by a number corresponding to the

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selected program. Commonly used function programs are noted above number keys. Function 0 displays a help menu of all the functions. The help display or any other lengthy display can be interrupted by pressing the ENTER key or any of the function keys. The help display or any other display can be sped up or slowed down by using the cursor up/down keys as long as a value entry is not in progress. Following is a listing of the help display plus a description of each program:

0 HELP – Displays a listing of all function programs.

1 GATE SWEEP – Sets gate pulse delay sweep, "box-car" like mode, by entering the following parameters:

starting gate delay

gate delay sweep step size

gate delay sweep step count (total number of steps)

Sweeping starts at the start delay and ends at

start delay + (step size × (step count – 1)).

Sweeping can be disabled by either setting the step size to 0 or setting the step count to 0 or 1.

2 INT TRIG FREQ – Sets the internal trigger frequency. Checks for conflicts between trigger frequency and gate delay, gate width, or delay out times.

3 DIM PANEL – Dims the front panel display and LEDs. The display brightness can be set to levels 0-10, level 10 for maximum brightness and level 0 to turn off display and all indicators. Panel brightness can also be adjusted using the "<" and ">" cursor keys when values are not being entered.

4 REVIEW PARAMETERS – Displays gate pulse delay, gate pulse delay sweep parameters, gate pulse width, DELAYED TRIGGER OUT, AUX DLY'D TRIG OUT, internal trigger frequency, trigger level, trigger level pot enable/disable, trigger mode, CALIBRATE TIMERS AUTO status, jumper configurations.

9 INITIALIZE – Initializes the system including system parameters and operating modes. Used to get the PG-200 to a known condition quickly. The following initial values are set:

Gate delay = 100 nsec

Gate delay sweeping disabled

Gate width = 100 nsec

DELAYED TRIGGER OUT, AUX DLY'D OUT synchronized to gate pulse trailing edge + 20 µsec.

Internal trigger mode enabled and set at 1000 Hz

Trigger level pot active

Automatic internal time base calibration disabled

Front panel display at full brightness

View rate at normal speed

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12 CHANGE VIEW RATE – Changes the display view time by entering seconds per display. The view time can also be adjusted using "∧" "∨" cursor keys when values are not being entered.

13 LEVEL ENTER – Enters new trigger level value. Trigger level pot is disabled.

14 LEVEL POT EN – Enables/disables trigger level pot.

15 DLY'D TRIG'S SYNC – Sync's DELAYED TRIGGER OUT or AUX DLY'D TRIG OUT to the high voltage gate pulse, i.e. the delayed pulse has a fixed delay from the trailing edge of the gate pulse. The default sync delay is 20 µsec, but the sync delay can be varied between 1 and 100 µsec. The sync's can also be removed. The sync feature does not work during gate delay sweeping ("box-car" mode), e.g., a synchronized DELAYED TRIGGER OUT does not sweep along with the gate pulse. The DELAYED TRIGGER OUT will remain at its starting value.

16 AUX DLY'D TRIG – Sets AUX DLY'D TRIG OUT delay from input trigger if AUX DLY'D TRIG OUT not synchronized to gate pulse, in which case AUX DLY'D TRG SYNC TO GATE is displayed. Works similar to DLY'D TRIG key.

18 JUMPERS – Informs the PG-200 of new jumper configurations for proper calibration. Jumper configurations are entered as follows:

DELAY OUT jumper field (DLY'D TRIGGER OUT)

–5: +5 V negative logic

5: +5 V positive logic

–15: +15 V negative logic

15: +15 V positive logic

INT TRIG OUT jumper field (INTERNAL TRIG OUT)

–5: +5 V negative logic

5: +5 V positive logic

–15: +15 V negative logic

15: +15 V positive logic

It is not necessary to inform the system when AUX DEL OUT jumper is changed.

25 TIMERS CAL – Calibrates time base against crystal oscillator for temperature drift compensation.

26 TIMERS CAL AUTO – Calibrates time base against crystal oscillator for temperature drift compensation automatically every time gate pulse width is changed, i.e. runs TIMERS CAL every time pulse width is changed. Calibration will not activate until the PG-200 warm-up time has passed. However, during this period, NOT WARMED UP YET is displayed instead of the usual calibration display.

51 SWEEP CHECK – Forces the gate pulse delay to alternate between the delay sweep end points in order to check the delay sweep end point alignment.

52 ECHO KEYS – Echoes the front panel keys. Used to check key switch operation.

60 VERSION – Displays software version number.

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67 MONITOR INT TEMP – Monitors internal ambient temperature. If the temperature exceeds 50°C, the TEMP HI error message will be displayed. If this occurs, power should be shut off immediately and not turned on again until the over-heating is remedied. See TEMP HI error message.

70 MONITOR HV – Monitors the programmable high voltage power supply voltage which should vary between 200 V and 800 V, depending on the gate pulse width, e.g., narrower pulse widths require higher voltages. See HV FAIL error message.

77 SET MCP VOLTAGE – Controls gain of external MCP for MCP-100 option. See MCP-100 chapter for more details.

80 DELAY SWEEP DEMO – Demonstrates gate pulse delay sweeping, i.e. "box-car" like mode.

81 PULSE SEQ DEMO – Demonstrates programmable pulse sequence.

89 LOGO – Continuously display Princeton Instruments logo and pulser model number.

90 GATE DELAY – Same as dedicated function key. Serves as backup in case of function key failure.

91 GATE WIDTH – Same as dedicated function key. Serves as backup in case of function key failure.

92 DELAYED TRIG – Same as dedicated function key. Serves as backup in case of function key failure.

93 TRIG SELECT – Same as dedicated function key. Serves as backup in case of function key failure.

94 TRIG LEVEL – Same as dedicated function key. Serves as backup in case of function key failure.

100 CLEAR SEQUENCE – Clears out previously entered pulse sequence.

101 ADD SEQ PT – Takes current PG-200 settings as the next sequence point.

102 START SEQ – Starts executing a series of previously entered sequence points.

103 STOP SEQ – Stops executing sequence points. Also stops pulse sweeping if enabled.

105 SKIP TRIG – Skips a pulse in a pulse sequence, i.e. no pulse outputs will be produced in response to an input trigger. This feature can be used to "count input triggers" before producing output pulses.

Pulse Sweeping and Sequencing

The PG-200 has two modes for producing a series of pulses, Pulse Sweeping and Pulse Sequencing. Pulse Sweeping, or "box-car like" mode, is when the gate pulse is varied from an initial delay to a final delay in fixed increments. All other parameters such as gate width remain fixed. Up to 16,000 delay steps can be programmed in step sizes as small as 1 nsec. Pulse sequences are entered on a point by point basis and provide much more flexibility since more parameters may be varied from point to point. The maximum number of points in a sequence is 250 due to memory limitations. Sequences are

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programmed on a point by point basis which can become tedious for long sequences unless implemented through a serial interface.

Pulse sweeping is activated using the “Gate Sweep” program. The program prompts the user to enter the start delay, the delay step size and the delay step count. Sweeping is automatically started after the parameters are entered. Sweeping can be de-activated by either entering a sweep step size of 0, setting a sweep step count < 1, or running the STOP SEQ program. Sweeping varies from the initial delay to the end delay in increasing increments (steps). Upon reaching the end delay, a new sweep begins again at the initial delay.

Pulse Sequences are set up by first clearing out any previous sequences by calling the CLEAR SEQUENCES program. From then on, sequence points are entered in order by first setting the PG-200 with the desired gate pulse delay, gate width, DELAYED and AUX DELAYED TRIGGER out delays and then calling the ADD SEQ PT program. If it is desired to have no output pulses for a sequence point, the SKIP TRIG program is selected rather than the ADD SEQ PT program. This feature can be used to “count input triggers” before producing an output pulse.

Note: Internal trigger frequency and delayed trigger sync modes cannot be varied during a sequence. Also, gate pulse width cannot be varied across ranges due to circuit timing limitations. The three ranges are: <15 nsec, 15-199 nsec, and >200 nsec. The sequence is activated by calling the START SEQ program.

Both pulse sweeping and sequencing can be deactivated using the STOP SEQ program. Additionally hitting the “1” key while not in entry mode, e.g., while READY is displayed, will alternately freeze and unfreeze either sweeping or sequencing.

Automatic System Settings

The PG-200 may require significant instrument setting time delays to perform some of its tasks. To obtain a gate pulse width range from a few nanoseconds to milliseconds, while maintaining a constant gate pulse amplitude of about 200 volts, requires a programmable high voltage power supply. Sometimes when switching between gate pulse widths, the PG-200 must re-adjust its high voltage supply. If a significant system delay is required, ADJUSTING HV PS is displayed. In no case should delays exceed several seconds. Delays are more pronounced for shorter pulse widths, especially for widths less than 15 nsec. Delays will also be observed when changing between width ranges, e.g., from < 15 nsec, to 15-199 nsec, to ≥ 200 nsec.

If TIMERS CAL AUTO is enabled, the internal time base is automatically calibrated for temperature drifts every time the gate pulse width is changed. The larger the time base drift, the longer the time delay required for calibration, and CALIBRATING TIMERS may be observed. Worst case calibration time delays can be as much as 10 seconds although more commonly they should be less than a few seconds.

Another source of instrument setting delay is due to running the PG-200 at near maximum pulse rates. When maximum rates are reached, much of the system microprocessor’s time is spent supporting the high pulse rate leaving less time for servicing user requests. Pulsing tasks are given the highest priority.

In some instances the PG-200 will not accept a user input and will readjust a parameter to the nearest acceptable value. For example, if a long delay is programmed and that delay is impossible at a relatively fast internal trigger frequency, the internal trigger

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frequency will automatically be adjusted. For fast timing, e.g., minimum delays or pulse widths less than 15 nsec, some values may not be achievable. Adjustment is automatically made to the nearest achievable value. A warning message is always displayed indicating that changes to a user entered parameter are being made.

In some cases, entering one parameter necessitates changing another due to circuit interdependencies. For example, minimum gate pulse delay is dependent on the gate pulse width. If a minimum gate pulse delay has been entered at a gate pulse width of 5 nsec and the pulse width is increased to 200 nsec, the gate pulse delay will automatically be adjusted upwards. A warning message is always displayed indicating that changes to a user entered parameter are being made. Other circuit interdependencies include delayed trigger outputs being dependent on gate pulse delay. Changing gate pulse delays near minimum delay values can affect delayed trigger outputs by up to 25 nsec. Also changing from external to internal trigger modes can affect delayed trigger outputs as well as gate pulse delays by up to 10 nsec.

Front Panel Connectors

INPUT – External trigger input BNC

OPTICAL INPUT – Optical external trigger input. SMA type connector.

INHIBIT – Pulsing inhibit. Positive logic, defaults to negative logic level if no connection, i.e. pulsing is enabled if no connection.

$\overline{\text{INHIBIT}}$ – Same as INHIBIT except negative logic. Also defaults to pulsing enabled if no connection.

INTERNAL TRIGGER OUT – Internal trigger output. Normally +5 V negative logic but can be modified for +5 V positive logic or +15 V negative or positive logic.

DELAYED TRIGGER OUT – Delayed trigger output. Measured from input trigger leading edge. Normally +5 V negative logic but can be modified for +5 V negative logic or +15 V negative or positive logic.

Rear Panel Connectors

HV GATE OUT 1 – High voltage gate output BNC.

HV GATE OUT 2 – Optional second gate output BNC. Same timing as HV GATE OUT 1.

GATE MONITOR 1 – 2 volt amplitude replica of HV GATE OUT 1 pulse. The monitor pulse appears distorted because it is based on the gate out pulse at the rear panel connector and not at the detector where it is properly shaped. The monitor should only be used as a high impedance scope timing reference.

GATE MONITOR 2 – Used with optional second gate output.

DLY'D TRIG OUT – Similar to front panel DELAYED TRIGGER OUT, except programmable in 80 nsec intervals. Normally +5 V negative logic but can be modified for +5 V positive logic.

SERIAL INTF – RS232 serial port 9 pin "D" connector, DB9P with the following pin assignments:

Pin 1 No connection

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Pin 2 Transmit

Pin 3 Receive

Pin 4 No connection

Pin 5 Ground

Pin 6 Data terminal ready

Pin 7 Clear to send

Pin 8 Request to send

Pin 9 No connection

Calibration

The PG-200 has been calibrated for good absolute accuracy. The calibration constants are stored in a battery-backed memory which should maintain data for at least ten years under normal conditions. If the calibration constants are lost for some reason, the PG-200 should still have good relative accuracy. Those applications that use an oscilloscope as a reference for setting pulser parameters, for example, will not be affected. If the calibration constants are lost and calibration is required, the existing battery will have to be replaced and the calibration constants will have to be re-entered through the serial interface using special software run on a remote computer. A disk containing the factory calibration constants *for that particular unit* plus utilities is shipped with each unit. The battery is located in the memory IC socket and the entire socket must be replaced. This should only be done by Princeton Instruments authorized personnel.

Two utilities are included on the disk for saving and restoring calibration data that is stored in battery-backed RAM inside the PG-200. PSAVE.EXE saves the calibration values to disk. The only time this has to be done is if a value has to be changed. Do not change calibration values without first contacting the factory. PRESTORE.EXE restores calibration values to the PG-200. This program should be run in the event of battery replacement for the RAM or for a change in the firmware (EPROM update).

Before running these programs, make sure that the serial number on the diskette matches the serial number on the back of the pulser. This is especially important if you own more than one PG-200. When prompted for a file name, use the file name written on the diskette.

If the pulser configuration is modified by changing one of the internal jumpers, the JUMPERS program must be run informing the PG-200 of the change so that it can recalibrate itself. If absolute accuracy within about 30 nanoseconds is not required, this can be omitted.

Jumper Fields

It is recommended that jumper fields be configured by Princeton Instruments authorized personnel before shipment. Unless specified otherwise, units are shipped with outputs configured for +5 V negative logic signals.

Whenever a jumper configuration is changed, the JUMPERS program must be run to inform the system of the new configuration so that the system can recalibrate itself. As an example, when changing the INTERNAL TRIGGER OUTPUT from a +5 V logic

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level to a +15 V logic level, the delay through the new circuit may differ by up to 30 nanoseconds. If an error of this size is inconsequential to the application, i.e. if the user is concerned about relative accuracy as opposed to absolute accuracy (this would be the case when using an oscilloscope as a reference), the recalibration can be omitted.

Note: Positive and negative logic levels are not the same as positive and negative polarity. A 5 V negative polarity pulse has an amplitude of –5 V whereas a 5 V negative logic pulse is asserted false at 5 V and true at 0 V. The PG-200 outputs are all configurable to negative logic signals only and do not support negative polarity outputs, e.g., –5 V or –15 V.

Output configurations

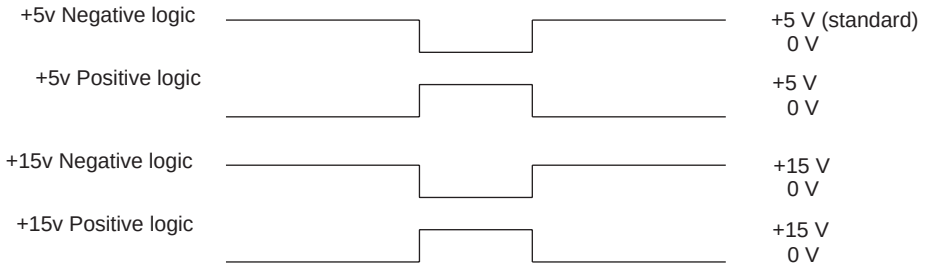


Figure 2. Internal Trigger Output configuration.

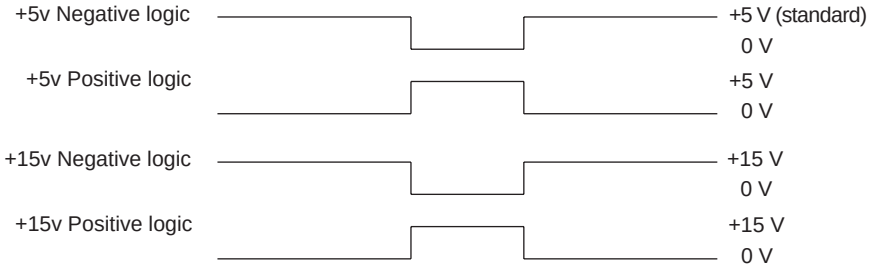


Figure 3. Delayed Trigger Output configuration.

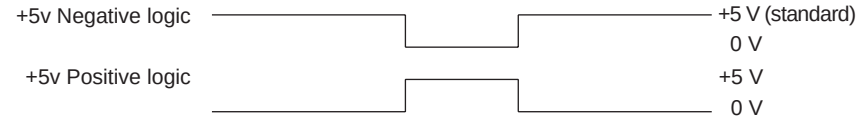


Figure 4. Aux Delayed Trigger Output configuration.

Setting jumper fields

DANGER

The high voltage power supply generates potentially lethal voltages! Never try to operate the PG-200 with the cover removed.

Jumper fields can only be accessed by removing the top cover. Before removing the cover, make sure that the line cord is disconnected and then wait at least 5 minutes for the high voltage capacitors to discharge.

The Front Panel Board is mounted directly behind the front panel. The Processor Board is the larger of the two boards sitting on the bottom pan and is on the right as viewed from the front towards the rear of the instrument. The smaller board(s) on the left is (are) the Pulser Board(s). All boards have identifying silkscreens which can be checked. The

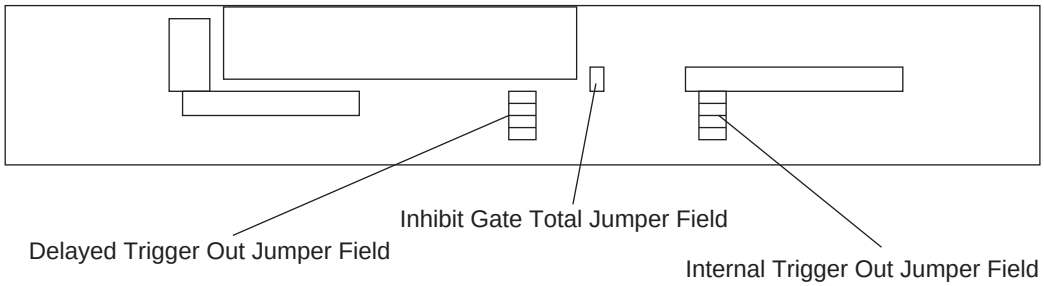
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boards do not have to be removed to change jumpers. Refer to Figure 1 (page 32) and Figure 2 (page 36) for jumper field locations.

The jumper fields are as follows.

INT TRIG OUT – Located on the Front Panel Board. Normally configured for 5 V negative logic output but can be reconfigured for 5 V positive logic, 15 V positive or negative logic. The JUMPERS program must be run for proper calibration following a jumper change.

Figure 5. PG-200 Front Panel Board.



DELAY OUT – Located on the Front Panel Board. Normally configured for 5 V negative logic output but can be re-configured for 5 V positive logic, 15 V positive or negative logic. The JUMPERS program must be run for proper calibration following a jumper change.

DELX – Located on the Processor Board. Normally configured for 5 V negative logic output but can be reconfigured for 5 V positive logic.

INH GATE TOT – Located on the Front Panel Board. When this jumper is inserted, high voltage gate pulses will be immediately disabled upon receipt of an inhibit pulse. Normally this jumper is removed and when an inhibit signal is received during a high voltage gate pulse, the gate pulse is not truncated.

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Chapter 2
Messages

Information Messages

ADJUSTING INT FREQ – Parameter conflict with internal trigger frequency, e.g., delayed trigger out time too long for selected internal trigger frequency.

CALIBRATING TIMERS, NOT WARMED UP YET – Timer base auto-calibration is enabled but the 15 minute warm-up time has not yet passed. The PG-200 must be fully warmed up before time base calibration can be done.

ADJUSTING DELAY – Adjusting gate delay to nearest "legal" value. Either an illegal value was entered or a change in gate width necessitated adjusting minimum gate delay time due to circuit interdependencies. Changing from external to internal trigger modes can also affect gate pulse delay.

ADJUSTING WIDTH – Adjusting gate width to nearest "legal" value. Illegal gate width was entered.

ADJ DLY'D TRIG OUT – Adjusting DELAYED TRIGGER OUTPUT to nearest "legal" value. Varying gate delays, especially near minimum values, can cause delayed trigger outputs to vary by up to 25 nsec due to circuit interdependencies. Changing from external to internal trigger modes can also affect gate pulse delay.

ADJ AUX DLY'D TRG – Adjusting AUX DLY'D TRIG OUT to nearest "legal" value. Varying gate delays, especially near minimum values, can cause delayed trigger outputs to vary by up to 25 nsec due to circuit interdependencies. Changing from external to internal trigger modes can also affect gate pulse delay.

ADJUSTING HV PS – Adjusting high voltage power supply for correct gate pulse amplitude.

SYNC'D TO GATE – DELAYED TRIGGER OUT or AUX DLY'D TRIG OUT synchronized to gate pulse trailing edge, i.e. there is a fixed delay from the gate pulse trailing edge to trigger output.

Error Messages

TEMP HI – Internal ambient temperature is above 50°C. Turn off the PG-200 immediately and do not restore power until the over-heating problem is resolved. Check for warm air coming into the air intake, exhaust port blockage, or the fan not connected or not working. Internal ambient temperature can be monitored using the MONITOR INT TEMP program.

HV FAIL – Unable to adjust the high voltage power supply. This could be due to a component failure or because the high voltage power supply shut down due to an overload. The high voltage power supply will remain shut down until power is turned

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off, then back on again. If a temporary overload causes a shut down, turn power off then wait at least 10 seconds before turning power back on again. This should clear the error condition. If the error persists, there is probably a component failure and power should be turned off until the problem is resolved.

NVRAM FAIL – Non-volatile battery backed RAM failure.

MEM FAIL – Volatile memory failure.

RING BUF OVFL – 8 character command buffer overflow. Too many commands were received, either from the keyboard or one of the interfaces, to be processed.

KEYBD OVFL – Keyboard buffer overflow. Too many keys were struck too quickly to be processed.

TIMERS CAL FAIL – Unable to calibrate time base, probably too large of a temperature correction is required.

SERIAL FAIL – Serial interface communications failure.

? ≤ UPPER BOUND – Previous entry was out of range, must be less than or equal to UPPER BOUND.

? ≥ LOWER BOUND – Previous entry was out of range, must be greater than or equal to LOWER BOUND.

OVFL, CHECK ENTRIES – Gate delay, gate width and delayed trigger output times exceed the total allowed.

NO SWEEP PARAM – Unable to do pulse sweep because step size = 0 or step count ≤ 1.

SEQUENCE BUF OVFL – Too many sequence points entered for memory capacity.

ILLEGAL WIDTH SEQ – Cannot change gate pulse width range during a pulse sequence, ranges are <15 nsec, 15-199 nsec, > 200 nsec.

NO SEQUENCE POINTS – Unable to do pulse sequence because no points entered.

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Chapter 3
Firmware Upgrades

From time to time, the firmware that runs the PG-200 will be updated in order to add additional features and capabilities. The firmware is contained in a PROM inside the PG-200. Upgrading the firmware is done by removing the existing PROM and replacing it with a new PROM.

Replacing the PROM

- Connect the PG-200 to the computer using the 9 pin cable.
- Run the PSAVE program to make a backup of the PG-200 calibration values (PSAVE can be found on the diskette that was shipped with the PG-200).
- Turn the power off and wait 5 minutes for the high voltage capacitors to discharge.
- Unplug the PG-200 and remove the top cover.
- Locate the Processor Board inside the PG-200. It is the largest of the three PC boards inside the PG-200 and can be easily identified by its “L” type shape.
- Locate the PROM on the Processor Board (see Figure 2 on Page 36).
- Remove the PROM from the Processor Board.
- Install the new PROM, being careful not to bend any pins as you insert it into the socket.
- Inspect the PROM for bent pins. If there are any, remove the PROM, carefully straighten the pins and repeat Step 7.
- Locate the Battery Backed RAM on the Processor Board (see Figure 2 on page 36).
- Remove the RAM from the battery socket. Note that there is a difference between separating the RAM from the battery socket and removing the RAM and the battery socket. The objective here is to remove voltage from the RAM in order to erase its contents.
- Reinstall the RAM, being careful not to bend any pins as you insert it into the socket.
- Inspect the RAM for bent pins. If there are any, remove the RAM, carefully straighten the pins and repeat Step 11.
- Reinstall the cover and turn the PG-200 power on.
- Run the PRESTORE program to return the calibration values to the RAM.

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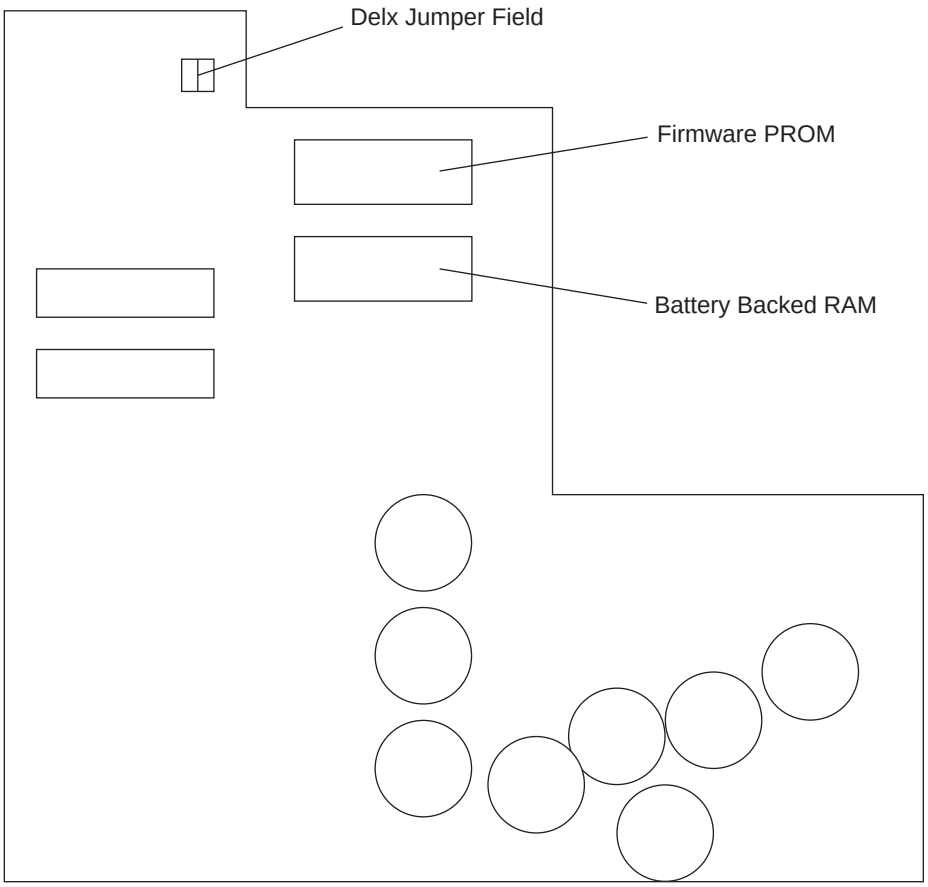


Figure 6. PG-200 Processor Board

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Chapter 4
Serial Communication Interface

The purpose of the PG-200 interface software is to utilize the programmability of the PG-200. The following features of the PG-200 can be controlled through the Serial Port:

Pulse Width
Pulse Delay
Delayed Trigger
Auxiliary Delayed Trigger
Trigger Mode
Sync Mode
Internal Trigger Frequency
Sweep Routines
Gate Enable/Disable
Add Sequence Point
Clear Sequence
Stop Sequence
Start Sequence
Skip a Sequence Point

The PG-200 serial communication interface exists in multiple forms. These include the WinView/WinSpec Interface and the Linkable Object forms described in Appendix A, the Stand Alone Executable Interface Functions described in Appendix C, and the Keystroke Emulation functions described in Appendix D. The WinView/WinSpec Interface and Linkable Object forms are described below.

Form	Purpose
WinView/WinSpec Interface	Interface to WinView or WinSpec through Macro Basic
Linkable Object	Object code which can be linked to an existing C program.

There are only small differences between the WinView/WinSpec Interface and Linkable Object forms. The differences were necessitated either by constraints of a calling function or to facilitate ease of usage. In most cases, error checking has been left to the calling function, except where noted.

The WinView/WinSpec Interface and Linkable Object forms accommodate two types of users: Macro Basic Users (WinView/WinSpec form) and open software developers (Linkable Object).

The Linkable Object form contains the code that formats all of the input values so they can be understood by the PG-200. The WinView/WinSpec interface is used to obtain

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values to be passed to the same routines that are contained in the Linkable Object form. Therefore, it is recommended that the Linkable Object be used by anyone interested in writing their own routines.

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Chapter 5
General Description of Functions

In general, all of the interface functions have one of two types of syntax. The two types are as follows:

- Function-Name (Port, Value, Units)
- Function-Name (Port, Switch)

In all functions, the first argument is the COM (Serial) Port.

In Style 1, a value is expected, followed by a unit which specifies either nanoseconds, microseconds or milliseconds. Examples of this would be programming a new Pulse Width or Delay.

In Style 2, a 1 or a 0 is expected corresponding to a true or a false. An example of this would be the Gate Enable function (GATEEN) where a 1 would enable gating and a 0 would disable gating.

The WinView/WinSpec and Linkable Objects receive parameters. In each case the first parameter or argument is the COM Port. In Style 1, the second argument is a Value and the third argument is a Unit.

Command Example

Task: Set a Pulse Width

Assume the active Serial port to be COM 1.

Using the WinView/WinSpec Interface, a command could be written in a Macro Basic Program using the following syntax:

Let tmp = PG200setwidth (port, width, units)

where port would be 1, width would be a number with up to 5.2 decimal places and units would be either a 0, 1, or 2 corresponding to nanoseconds, microseconds and milliseconds respectively.

Using the Linkable Object format, an existing C program could call a function called setwidth using the following syntax:

return_val=setwidth (port, width, units):

where port would be 0, width would be a float with up to 5.2 decimal places and units would be either an ‘N’, ‘U’ or ‘M’, corresponding to nanoseconds, microseconds, and milliseconds respectively.

Setwidth will return a 1 if the communication is successful, and a 0 if the communication is not successful.

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A complete description the interface functions is contained in Appendix A. The Linkable Object functions are contained in a subdirectory called OBJ. The WinView/WinSpec Interface functions are built into the WinView/WinSpec software.

Error Checking

There is no error checking in the Linkable Object format. Reasonable values are expected to be provided by the user. In the WinView/WinSpec format, the only error checking that exists is used to check for the proper number of parameters.

The PG-200 will correct for unreasonable values. For example, if a width of 100 milliseconds was programmed, an error message would appear on the Front Panel Display stating the range of values permitted. However, there is no provision to send an error flag back to the sending program.

The reason that error checking of values has been omitted is because many values are dependent on other values. For example, by definition, width plus delay are not allowed to exceed 80 milliseconds. This means that in order to determine if a width value is excessive, the communication program would have to know delay value. Also, suppose a width value of 10 milliseconds was programmed and the user wanted to set an internal trigger frequency of 1000 Hz (1 millisecond period). This is obviously a conflict. There are many cases similar to these which could cause conflicts, so it is up to the user to send reasonable values.

Special Considerations

Initializing the serial port

In the WinView/WinSpec and Linkable Object, it is the responsibility of the programmer to ensure that the serial port is initialized. There is an init_serial () function that can be used for this purpose. The init_serial () function sets the required serial parameters of 9600 Baud, 8 characters, 1 Stop bit and Parity disabled.

Changing the pulse width

There are cases where changing a pulse width can cause the PG-200 to adjust its internal high voltage supply to a new value. This can take up to 5 seconds and although no commands will be missed, it should be noted that no pulsing can occur during this time.

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Chapter 6
Timing Modes

This section offers a number of examples of how timing modes can be used in conjunction with the PG-200 to synchronize data collection with an ICCD experiment.

Seven examples of the many possible gating modes are explained below. To simplify matters, a laser system will be the experimental system in each case, although nearly any type of experiment can utilize these schemes. There are many more possible experiment interconnection schemes. If none of these seem to meet your experimental requirements, contact the factory for other suggestions.

Any PI pulser with the appropriate range can be used in the setups below. Contact the factory for information on the suitability of HV pulsers from other manufacturers.

Below is a table to direct the user to the most applicable example, given their specific experimental conditions. The first column indicates the master timing element, which dictates the timing for the entire experiment. The most common timing element is the image producing equipment; in this case a laser. If this component is not a convenient timing reference the controller or the HV pulser can be used as the master instead.

As a third option, a multichannel delay generator can be used as the timing element. Because a delay generator allows one channel to be adjusted with respect to another, it allows complete flexibility in controlling all aspects of the experiment. This, of course, comes at the expense of an additional piece of equipment.

Timing Element	Example	Summary
Laser	1	Readout time of CCD is less than pulse interval of laser
	2	Readout time of CCD is greater than pulse interval of laser
Controller	3	Laser is unsuitable for triggering
	4	Unpredictable delay between laser trigger and image
Pulser	5	Delay between trigger from laser and image not long enough
	6	Pretrigger for laser or other equipment needed
Delay generator	7	All aspects of experiment controlled by generator

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Example 1

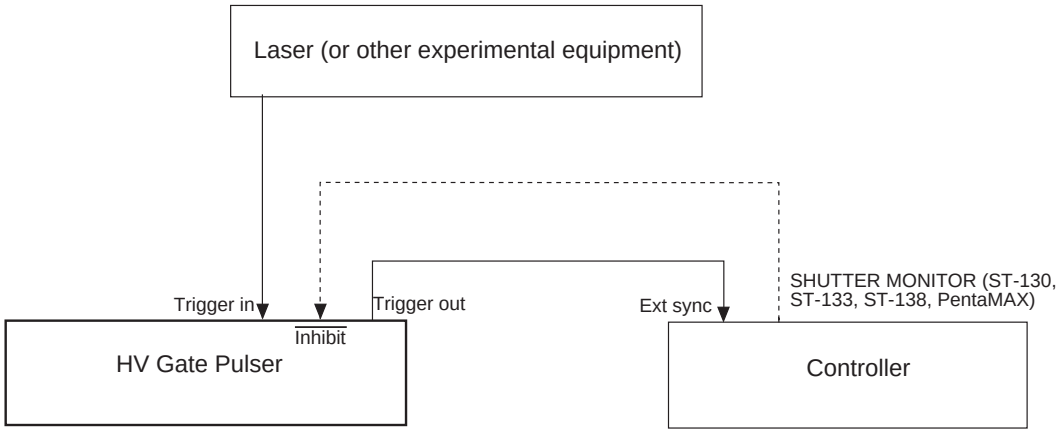


Figure 7. System configuration with laser pulses less frequent than CCD readout.

This mode of operation is useful when the laser pulses are less frequent than the CCD readout (including exposure and shutter compensation times), when the CCD is operated in single strip mode, or when the data from each gating of the detector must be stored separately, as in kinetics measurements. As long as the readout time is less than the laser pulse rate, each set of data will be stored individually in the memory. Otherwise data from consecutive laser pulses could be inadvertently binned together. For example, if the laser pulse rate is 20 Hz and readout time is 100 msec, every 2 pulses will be stored in the same frame.

The laser is the master, directly controlling the pulser which in turn controls the controller. The controller is to be operated in the Ext Sync mode and the pulser Trigger out must be connected to the External Sync input at the rear panel of the controller.

Since there is an inherent delay on any pulser, it is necessary to either optically delay (approximately 1 nsec/foot) the incidence of the laser-induced signal on the detector, or trigger the pulser before actually firing the laser. After the pulser has gated the ICCD, it will trigger the controller.

Note that if the gate pulse happens during CCD readout, a glitch may appear in the data. This is due to RF induction in the array preamplifiers. It can be avoided by using the optional connection shown above. This will prevent gating of the image intensifier when the CCD is in readout mode, but will also result in laser pulses being periodically missed.

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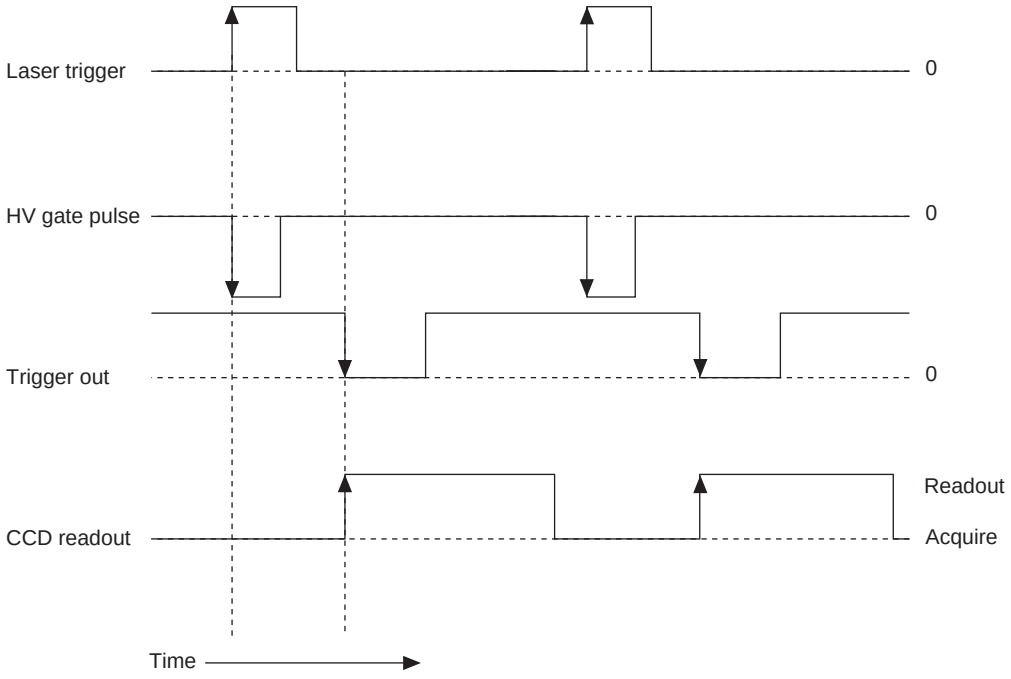


Figure 8. Timing for experiment depicted in Figure 7.

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Example 2

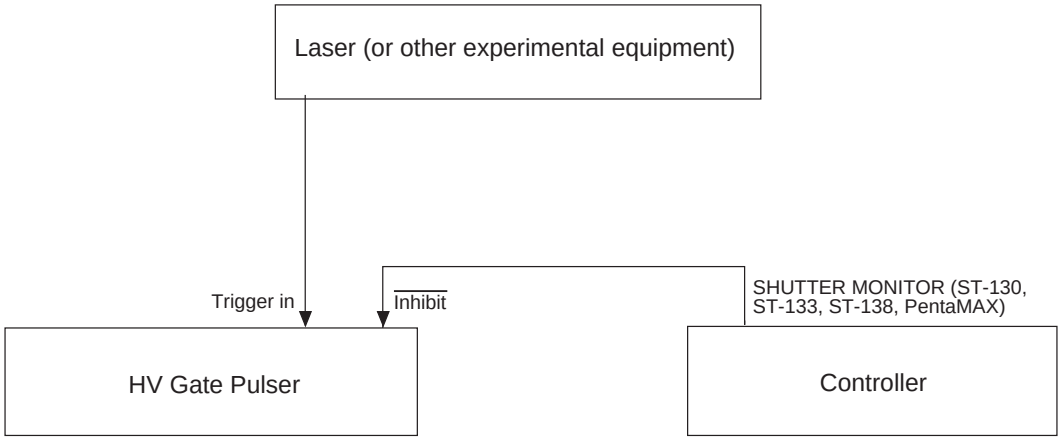


Figure 9. System configuration for allowing multiple laser pulses to be averaged on the CCD.

This mode of operation allows multiple laser pulses to be averaged (accumulated) on the CCD. It is usually used with high repetition rate lasers or when S/N ratio considerations require exposure of the CCD to many laser pulses before readout.

In this mode the controller is operated in the Freerun mode, and the laser is continuously firing. SHUTTER MONITOR enables the pulser at the beginning of the CCD exposure period. Each laser pulse then results in the ICCD being gated. Individual spectra (one from each gate) are accumulated on the array until exposure is over and readout starts. SHUTTER MONITOR then disables the pulser, preventing gating during CCD readout. This is necessary to prevent excessive readout noise.

Since the laser fires at a rate higher than readout time, the sum of several firings will be stored as a single frame. There will most likely be some variation in the intensity from scan to scan. This is due to the laser operating asynchronously with the controller, which implies that there can be a variation in the number of laser pulses occurring in each exposure interval.

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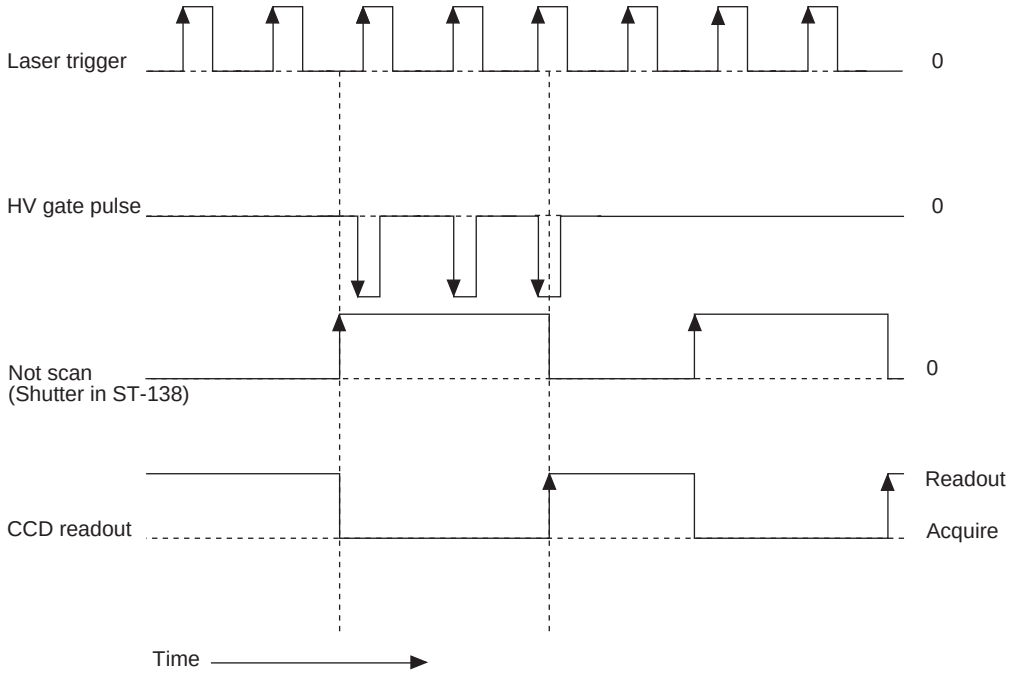


Figure 10. Timing example depicted in Figure 9.

Example 3

This example is appropriate for experiments where the laser is particularly jittery, and thus not able to regulate the overall timing. Here the controller is the master, directly controlling the laser and indirectly the pulser.

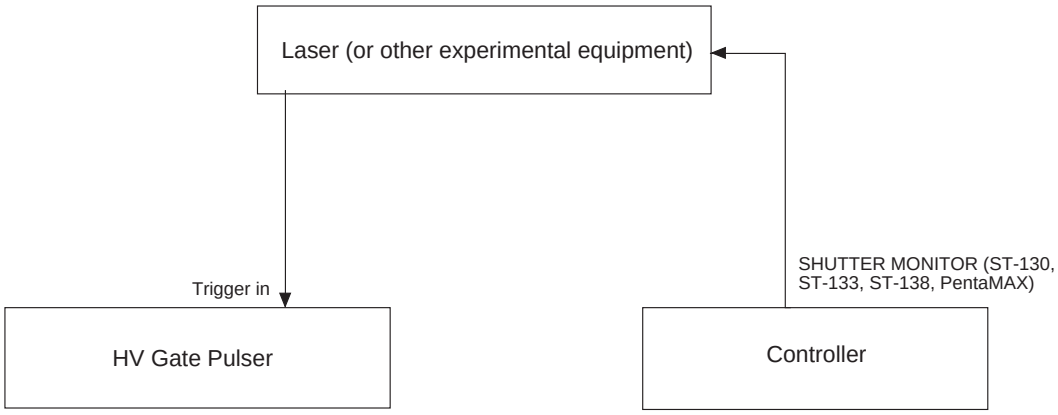


Figure 11. System configuration for experiments having jittery laser.

The controller is in the Freerun mode, and SHUTTER MONITOR from the rear panel of the controller is connected to the experiment. SHUTTER MONITOR goes TTL high at the beginning of each exposure cycle. The CCD readout will occur after exposure is over. Since the controller is the master, the laser is inactive and the pulser will not trigger during CCD readout.

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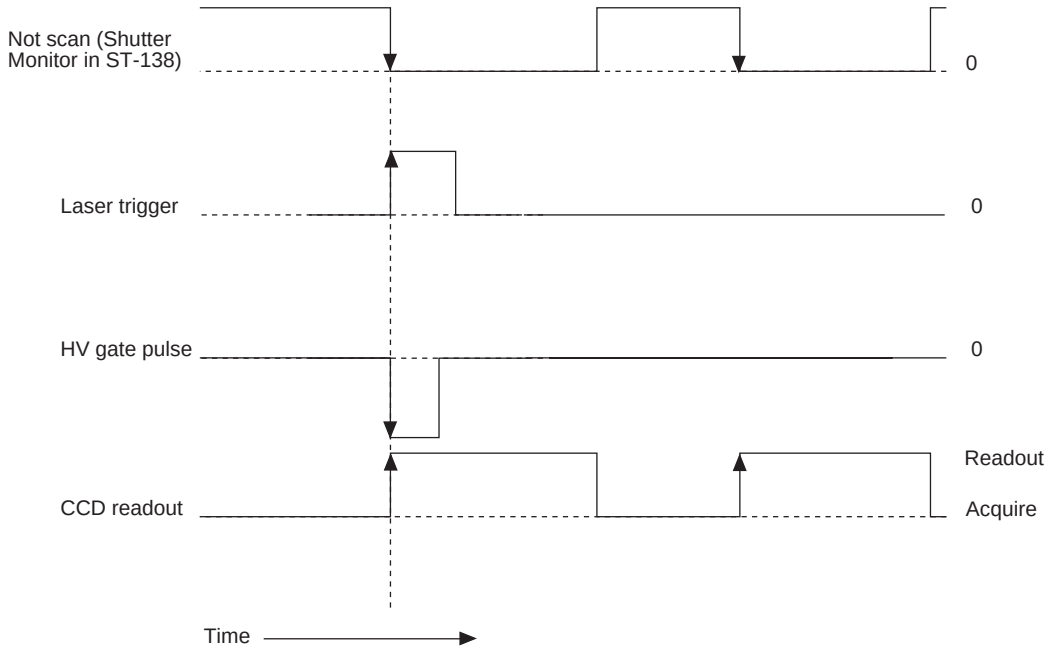


Figure 12. Timing for example depicted in Figure 11.

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Example 4

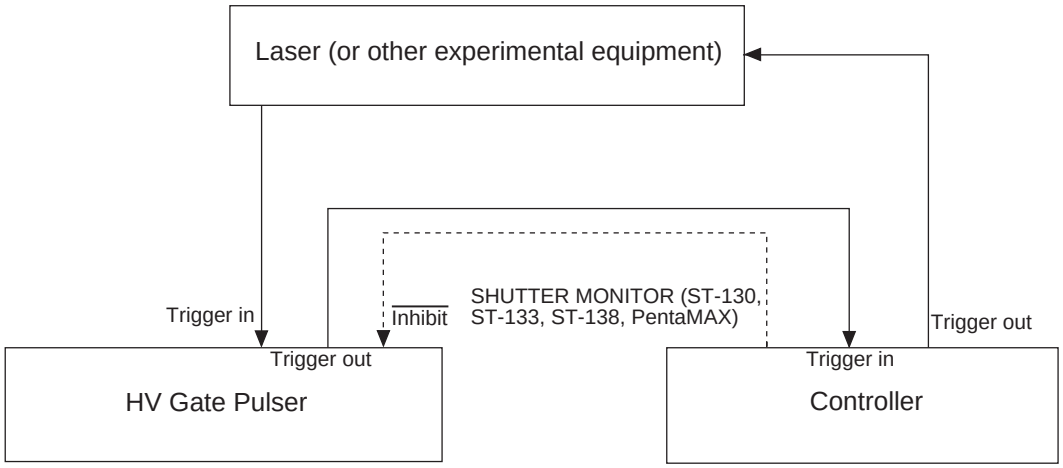


Figure 13. System configured for experiment with long or unpredictable delay.

This example is used when the experiment has a long or unpredictable delay between the time it is gated and when it fires. Here, again, the controller is the master, but the CCD readout is controlled by the pulser, as in Example 1.

First, the controller triggers the laser. When the laser fires it triggers the detector. Immediately following gating the controller is triggered. Following the completion of the exposure, CCD readout begins.

The controller is operated in the Store Enable mode. SHUTTER MONITOR may be connected to the pulser to prevent gating during readout, but laser pulses that coincide with readout will be missed. One way to minimize those occurrences is to set the exposure to the longest feasible value (i.e., keeping background level low enough so that it does not affect the dynamic range of the measurement).

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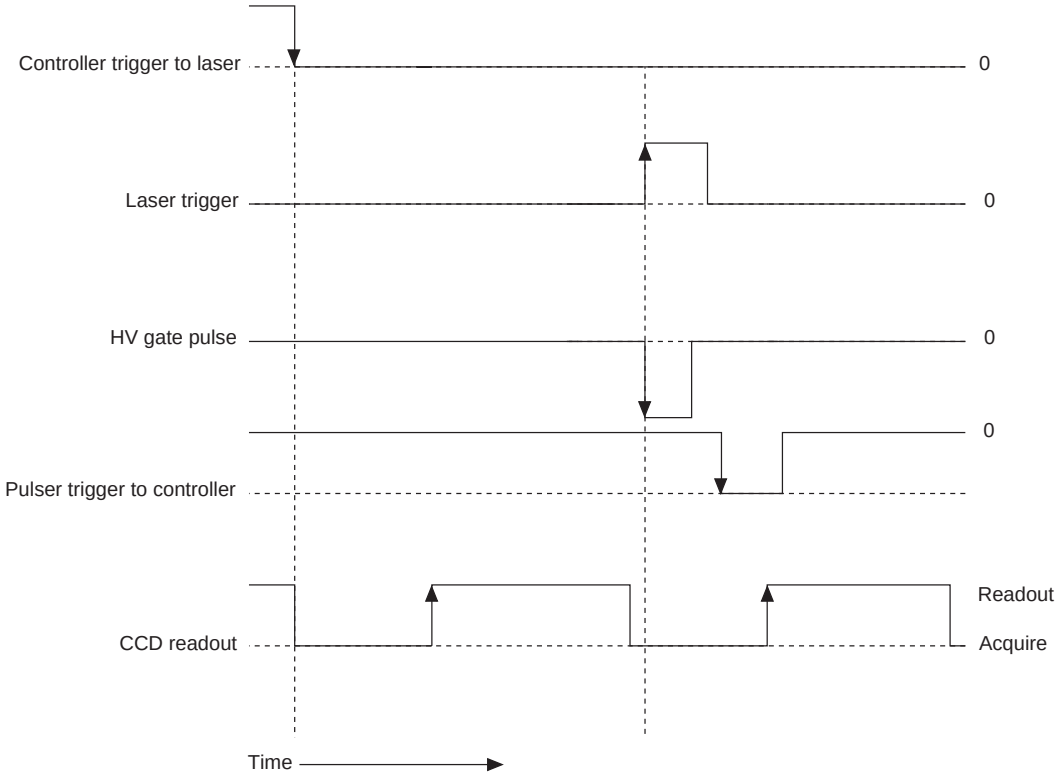


Figure 14. Timing for configuration illustrated in Figure 13.

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Example 5

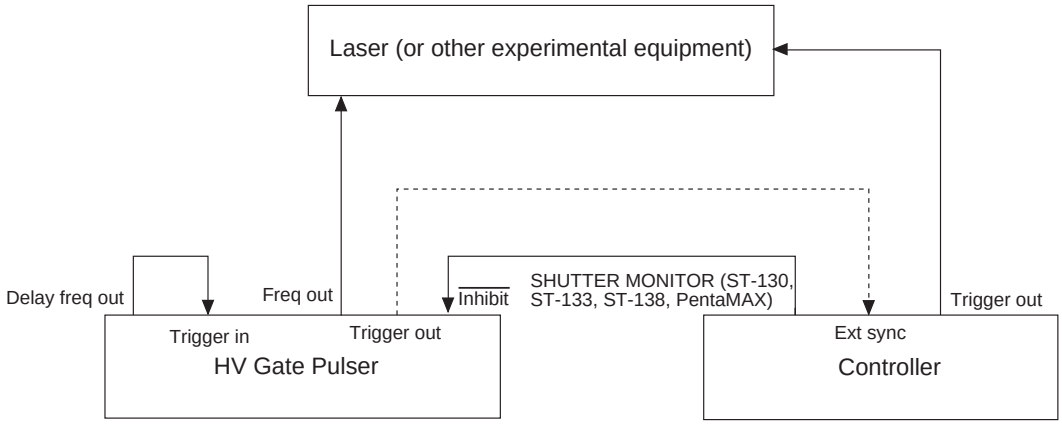


Figure 15. System configuration for experiment where internal frequency generator electronically delays the laser.

Most of the examples up to now required the laser light to be optically delayed to compensate for the delay between the laser pulse and the gate pulse. It is possible to use the internal frequency generator of the pulser to electronically delay the laser instead.

For experiments that require more than 7 µsec between the trigger and data collection, the Frequency Out from the pulser can be used to trigger the laser, and the Delayed Frequency Out from the pulser can be used to trigger itself. By adjusting the delay between the two pulses, the detector can be gated at the proper time with respect to the laser pulse.

For experiments where laser triggering is almost instantaneous, (< 7 µsec), the Frequency Out and the Delayed Frequency Out outputs are reversed. Frequency Out triggers the gate pulse, and the delayed output now triggers the laser. The delay option on the pulser now allows the image intensifier to be gated before the laser is allowed to fire.

In either example, the controller can be operated in either Freerun or External Sync mode (see dotted line above). Both modes use SHUTTER MONITOR to prevent the laser from firing during CCD readout.

The value of 7 µsec is a typical limiting value. Consult the pulser manual for specific minimum values.

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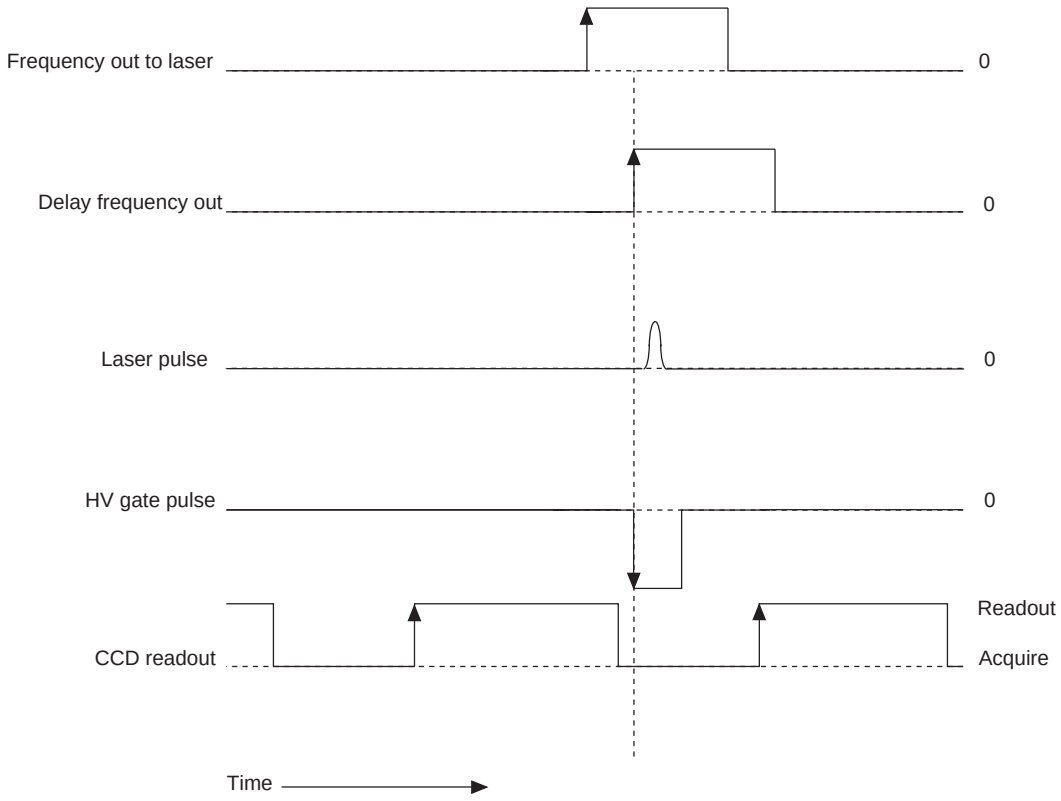


Figure 16. Timing for system configuration depicted in Figure 15.

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Example 6

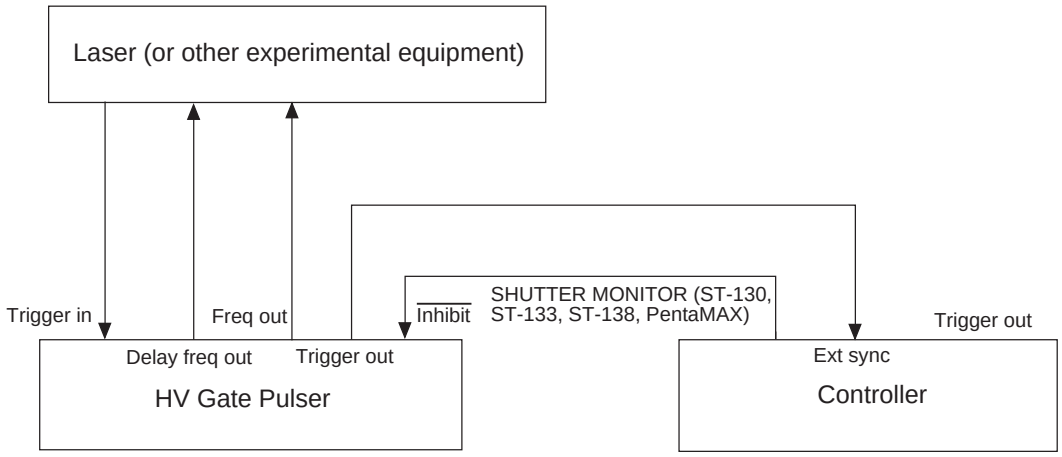


Figure 17. System configuration for system requiring two triggers.

This is an example of a more complicated experimental timing sequence, requiring two system triggers. Some equipment requires a pre-trigger before being ready to fire at a second trigger. Alternatively, trigger 1 can trigger one part of an experiment; e.g., a stop flow pump, a xenon flash lamp, etc., while trigger 2 can trigger another; e.g. laser pulsing.

The controller is set to the External Sync mode. The frequency generator of the pulser is set at the desired repetition rate (see pulser manual for limiting values). Once the computer activates the controller, the pulser is enabled by the SHUTTER MONITOR output.

The Frequency Out pulse is sent to the experiment. The Delayed Frequency Out pulse is then sent to the experiment. A trigger from the experiment then causes the pulser to gate the ICCD.

Following gating the pulser triggers the controller, which reads out the CCD. For pulser frequencies greater than the maximum scan rate of the CCD, SHUTTER MONITOR must be used to prevent gating during CCD readout.

Note: A double trigger (Pretrigger and Trigger) from the pulser can be achieved without using the internal frequency generator, but it requires some factory instrument modifications. Contact the factory for details.

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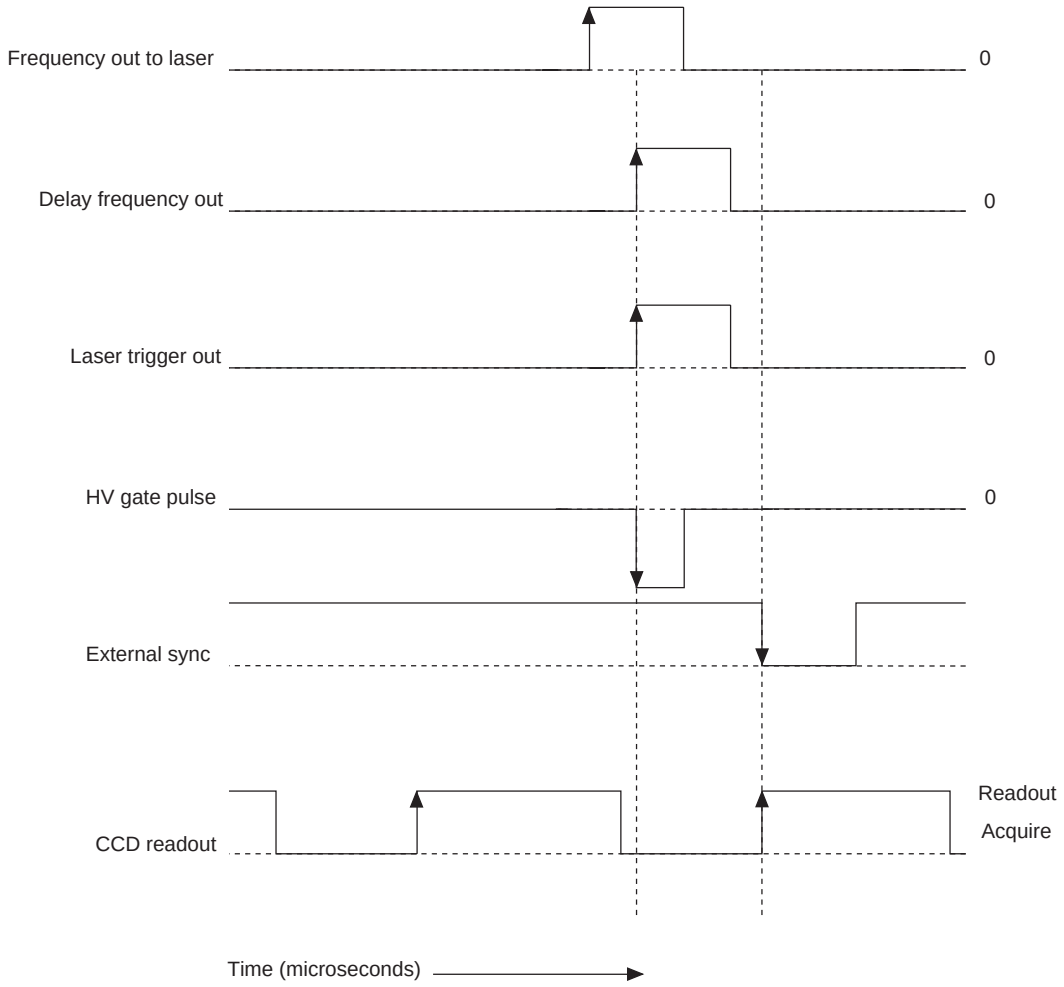


Figure 18. Timing for configuration depicted in Figure 17.

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Example 7

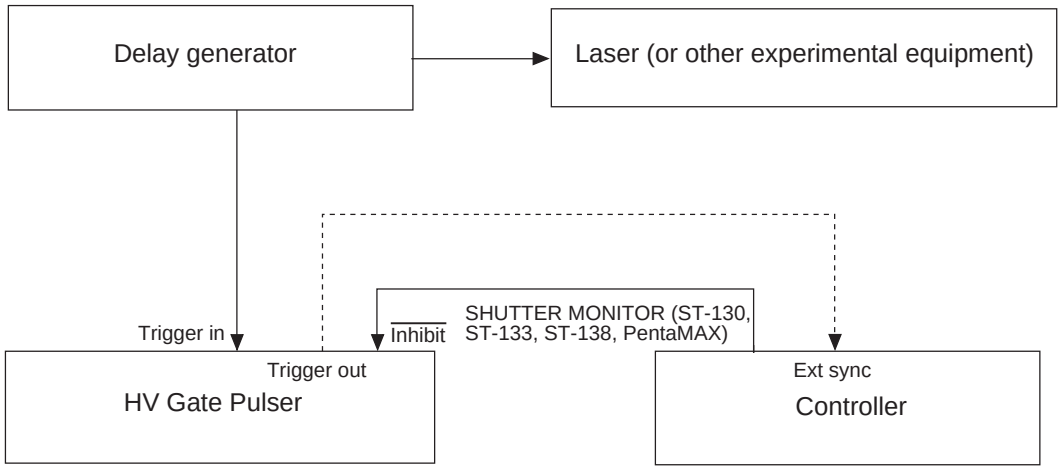


Figure 19. Use of multichannel delay generator to control experiment and WinView/ WinSpec timing.

This example illustrates the use of a multichannel delay generator to control both experiment and WinView/WinSpec timing. One channel of the delay generator triggers the laser. At the appropriate time, the second channel triggers the pulser. After gating, the pulser can be used to trigger the controller, which is in the External Sync mode, or the controller can be left in the Freerun mode and SHUTTER MONITOR used to enable the pulser.

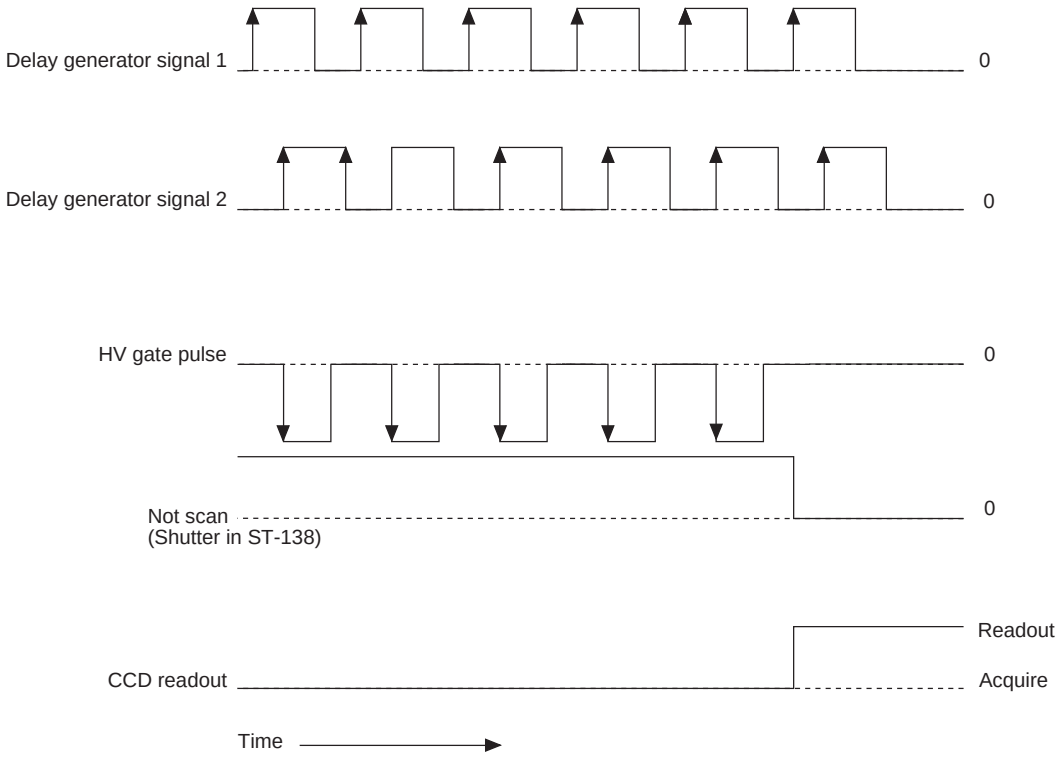


Figure 20. Timing for experiment depicted in Figure 19.

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Chapter 7

MCP-100 Option

This chapter covers the MCP-100 option, an additional HV power supply that can be installed in the PG-200. This option is required for all lens-coupled intensified detectors, as well as some specialized models such as ITE/CCD detectors. If you have not purchased the MCP-100 option, you can skip this chapter.

Dangers and Warnings

DANGERS

Voltages on the MCP-100 option board may exceed 10,000 volts. To avoid possible hazard to personnel, use the instrument only with the proper connectors and cables and only for the purposes for which it is designed, i.e. the operation of image intensifier tubes which are contained in proper housings and equipped with compatible connectors. Adequate precautions must be taken to prevent persons from making contact with the output of the MCP-100.
Never plug the AC cord of the pulser into an outlet which is not properly grounded. Never attempt to operate the unit without covers in place.

WARNINGS

Never operate the unit with the high voltage cable disconnected. The high voltage connectors are designed to seal out air to avoid arcing. An open high voltage connector is a danger to personnel and can cause damage to the equipment. Connections should be made before power is turned on.
Before disconnecting any cables, turn the power off and wait at least 5 minutes for voltages to decay to safe levels.
Always use an outlet which has a properly connected protective ground. Never make connections to other instruments which might have voltages on BNC shields. Disconnecting the protective earth terminal, inside or outside the chassis, or tampering with its operation may render the MCP-100 dangerous and is prohibited.
The high voltage Gate In BNC is located next to the Shutter In BNC on the rear panel. The Shutter In BNC is the input for a logic level (5 V) signal and should not be connected to a high voltage gate pulse or damage may occur. Caution should be exercised not to confuse the two rear panel inputs.

Introduction and Specifications

The MCP-100 option supplies high voltage DC bias for PI image intensifiers plus circuitry to facilitate gating. The MCP-100 option is mounted inside the PG-200 gate pulse generator at the factory.

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The MCP-100 allows independent variation of MCP voltage (intensifier gain) from phosphor voltage. The user varies MCP voltage by using the PG-200 keypad, FUNC 77 (see the Operation section, below). For special applications where average light level varies significantly, the automatic brightness control switch can cause MCP voltage to vary inversely to signal level, enhancing input dynamic range while restricting output dynamic range, and facilitating focusing. An alarm feature automatically shuts down intensifier operation in case of excessive phosphor current.

The MCP-100 allows CW or gated modes of operation. Gating pulses can range from 5 nsec to 1 msec. Longer gate experiments can use the 5 volt logic electronic shutter control.

Features

- Independently variable MCP power supply, independent of phosphor voltage.
- Automatic alarm and shutdown in case of excessive phosphor current.
- Automatic brightness control switch for ease of focus.
- Gate input for gating between 5 nsec and 1 msec, electronic shuttering input for long gate times or CW operation.

Specifications

- MCP power supply: 500 to 1000 volts, 50 µA maximum.
- Intensifier bias levels (Standard Configuration):

  Phosphor: 0 volts, i.e. grounded phosphor.

  MCP-Out: -5500 volts typical.

  MCP-In: -6000 to -6500 volts typical.
- Photocathode to MCP-In voltage: -180 volts in CW mode, +40 volts in gate mode.
- Gate pulse: -180 to -220 volt amplitude, 5 nsec to 1 msec.
- Shutter pulse: 5 volt logic, 0 volts for turn off, 50 µs minimum pulse width (10 ms in older units).
- Automatic Brightness Control: Gain reduction of 16 typical under maximum incident light.
- Phosphor over-current shutdown: 30 nA typical. Over-current condition sounds audio beeper.
- Audio beeper: ~1 kHz; cycles on/off at rate dependent on overload.

Rear Panel Controls

These additional controls appear on the rear panel of a PG-200 equipped with the MCP-100 option.

GATE IN BNC is the input for high voltage (-200 V) gate pulses used to turn on the intensifier.

SHUTTER IN BNC is the input for a logic level (5 V) signal used to synchronize the intensifier with CCD exposure time or to keep the intensifier on in CW mode.

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SHUTTER OR CW/GATE switch selects between Gate mode or Shutter mode. When in Gate mode, the intensifier is normally off and a high voltage gate pulse is needed to turn it on. When in Shutter mode, the intensifier is normally on with no connection or a logic high (5 V) on the Shutter In BNC. A logic low (0 V) is needed to turn it off.

BRIGHT CNTRL ON/OFF switch turns the brightness control feature on or off. Brightness control reduces the MCP gain when exposed to high light levels. This compresses the output dynamic range to keep signal levels on screen during set-up.

MCP POWER ON/OFF switch turns the intensifier voltages on or off while chassis power remains on.

INTENSIFIER H.V.P.S. connector is used to supply High Voltage DC power to the intensifier through the cable supplied by PI. The high voltage cable must always be connected when power is on.

Hardware Overview

The MCP-100 option consists of a printed circuit board and a modular high voltage supply which are mounted in the PG-200 chassis.

The MCP-100 contains circuitry for the following functions:

- A variable high voltage power supply for the MCP voltage. MCP voltage is a linear function of the programming voltage supplied by the keyboard of the PG-200.
- Upper and lower limit circuits for the MCP voltage. (Normally set to -500 V and -1000 V respectively).

Note: When the image intensifier and MCP-100 option are purchased from Princeton Instruments as part of the same order, the upper limit circuit will be set for the maximum limit of the intensifier. The upper limit circuit also provides a slow turn-on during power-up.

- High voltage adjustment circuit for the voltage between MCP-Out and Phosphor (normally set for -5500 V).
- Alarm and shutdown circuit to shut down the high voltage and bring MCP voltage to the minimum value if an over-current condition exists due to excessive light on the Photocathode. This circuit automatically resets and retries after about 0.5 seconds. Thus it will not prevent intensifier damage if excessive light is allowed to continuously fall on the intensifier.
- Automatic Brightness Control circuit to reduce the MCP voltage in response to increasing light intensity on the Photocathode. This can be useful in focusing. When properly interfaced to a PI CCD Controller, the Brightness Control circuit uses a sample/hold to sample phosphor current during CCD exposure, and hold between exposures. The sample/hold is inactive in the Gate mode. The Brightness Control function is disabled for normal operation, since response is not linear (and may not even be constant) when it is used.

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- Shutter circuitry allows an optically isolated logic signal to control the voltage between the Photocathode and MCP In. This allows long gate times or CW operation.

Operation

Read the Danger/Warnings section above before operating.

- Set the PG-200 Power switch off and wait 5 minutes.

CAUTION

The high voltage cable should be handled with care. Dropping the cable, banging the connectors, or applying excessive force when tightening may damage the pins, resulting in a poor or intermittent connection.

- Connect one end of the high voltage cable supplied by Princeton Instruments to the connector on the image intensifier. If you have purchased more than one image intensifier, make sure you are using the cable supplied with this intensifier. The connectors are keyed and must be properly oriented. Push the cable connector into the receptacle and continue to turn the threaded ring clockwise until it is tight. Connect the opposite end of the cable to the high voltage output connector of the MCP-100 using the same procedure.
- For gating, set Shutter or CW/Gate switch to Gate and connect a cable from the HV Gate Out connector of the pulser to the Gate In BNC of the MCP 100 option.

  For shuttering, set Shutter or CW/Gate switch to Shutter or CW. Connect one end of a cable to the Shutter In BNC. The other end can be connected to the Controller's SHUTTER OUT BNC connector.

WARNING

Unlike fiber coupled ICCD detectors, if the Shutter In BNC on the MCP-100 is allowed to float at +5 V the intensifier will be On continuously. Overexposing the image intensifier at any time when the intensifier is turned on can result in permanent damage to the image intensifier.

- Make sure the MCP Power switch is Off. Turn on the PG-200. Adjust MCP Gain to minimum (-500 V) by entering FUNC 77, then entering the MCP voltage.

  Note: As long as the image intensifier and MCP-100 option are purchased from Princeton Instruments as part of the same order, the upper limit circuit will be set for the maximum safe limit of the intensifier. If this is the case, the maximum voltage may be less than -1000 V.

CAUTION

If the intensifier is operated at excessive MCP voltage, ion feedback may occur. If allowed to continue this condition may damage the intensifier. Therefore, be sure to monitor the light output from the intensifier (usually done by reading the CCD or other readout device) when increasing the MCP voltage setting. A sudden increase in output light, especially if not related to light on the input, is evidence of ion feedback. As intensifier tubes age, they sometimes become more susceptible to ion feedback, so it is advisable to check rather than to rely entirely on the factory limit setting.

After the MCP voltage has been properly set, set the MCP Power switch on and slowly bring up the MCP voltage to the desired setting. It is normal for the alarm beeper to sound when power is first applied. However, if it continues to sound, set the MCP power

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switch off and determine the cause (e.g. switch set to CW instead of Gate or excessive light on the Photocathode).

For initial setup, the Brightness Control feature can be used. Set the Bright Cntrl switch to the on position. This will reduce MCP voltage (and hence gain) in proportion to light level, so a greater range of input light can be tolerated. The alarm is still functional in this mode, and the intensifier voltage will still be shut down in case of excessive exposure levels. Be sure to set the Bright Cntrl switch off before taking data, or the intensifier will be nonlinear.

High Voltage Cable

Two versions of the 6-pin high voltage cable have been shipped by Princeton Instruments. Early models of the MCP-100 shipped with cables with a white housing. Later models used a cable with a black housing and a white stripe. These cables are wired differently.

If you have purchased more than one image intensifier unit, you must use the cable supplied with each image intensifier. Intensifiers designed for use with white cables generally only have 4 conductors inside the intensifier connector. Intensifiers for use with black cables always have 6 conductors on the intensifier connector.

Use of the wrong cable is not dangerous, but can result in non-functioning of the image intensifier. If you suspect that you may be using the wrong cable for your intensifier, contact the factory or your local sales representative. If you have only purchased a single image intensifier and pulser combination, the correct cable was certainly shipped with your system.

Princeton Instruments can update any white cable and 4 conductor image intensifier combination to the black cable 6 conductor combination. Contact the factory for details.

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Chapter 8
Dual Pulse Combiner

Description

The Dual Pulse Combiner is an accessory to the PG-200 that facilitates experiments that use a double-pulse laser in which the ICCD must be gated twice in rapid succession. The combiner is a stand-alone box sold separately by Princeton Instruments, specifically designed to accept pulses from two PG-200 Programmable Pulse Generators.

The Combiner is essentially a fast automatic high-voltage switch with two Input BNC connectors and one Output BNC connector. Each Combiner input connects to the output of a PG-200 and the Combiner output connects to the Gate Input of an ICCD. Input pulses are applied in pairs with a maximum separation between the first and second pulse of less than 500 µsec.

As the experiment begins, Input 1 of the Combiner is connected to the Combiner output. When a pulse is applied to Input 1, it goes to the Combiner output and from there to the Gate Input of the ICCD. The Combiner then switches so that Input 2 is connected to the Output and awaits the second pulse of the input pair. The pulse on Input 2 is routed to the Combiner output and from there to the ICCD. After the second pulse is complete or 500 µsec after the end of the first pulse (whichever occurs first), the Combiner switches back to its initial state and Input 1 is connected to the output again, ready for the next pulse pair.

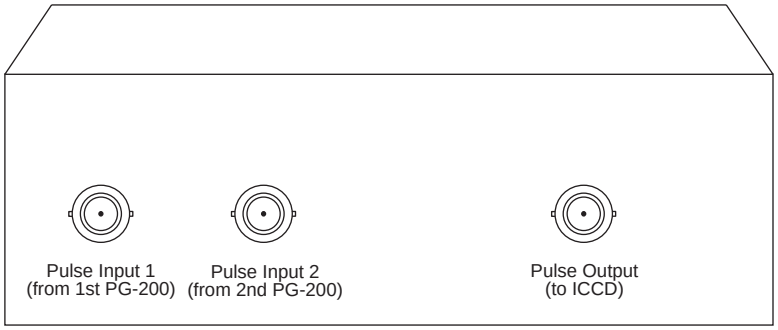


Figure 21. Dual PG-200 Pulse Combiner.

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Specifications

Maximum Pulse Separation: 500 µsec (see Figure 22)

Minimum Pulse Separation: 1 µsec

Input Impedance: PG-200 compatible

Propagation Delay: 2 nsec (typical)

Typical Output Pulse Voltage: ≈ 200 V

Power Supply

The Pulse Combiner is automatic and has no user adjustments. It is provided with a power supply with an IEC mains input that automatically adjusts for power mains voltages of nominally either 120 V AC or 220 V AC, 50-60 Hz. The output of the supply plugs into a mating connector on the back of the Pulse Combiner.

Operation

WARNINGS

The Combiner is designed to work with high voltage pulses. Be sure both pulse generators are switched off before connecting or disconnecting the system. Only use known good, high-quality cables with appropriate BNC connectors. We recommend the use of 50 Ω cable (RG-58/U) .

Only connect the Combiner output to ICCDs having a high-impedance (1 MΩ) termination. *Do NOT use 50 Ω terminators with the Pulse Combiner.* ICCD Detectors manufactured for use with the FG-100 Pulser have a 50 Ω terminator and could be damaged if connected to the Combiner's output.

Operation of the Combiner is extremely simple and largely user transparent. Once the cables are connected, all that is required is to turn on the power supply to the Combiner and then the PG-200 Pulse Generators. From that point on, the Combiner works automatically as previously described. Any remaining operating considerations apply primarily to the PG-200s and are directed towards assuring that the gating pulses arrive at the ICCD properly timed to gate the light input and so eliminate the influence of background illumination. Thus the laser pulses define the exact timing, and the gate pulses must be timed to bracket the laser pulses at the ICCD. One convenient way of accomplishing this is to pretrigger the PG-200s to compensate for the system propagation times. Another is to optically delay the light input to the ICCD using a fiber-optic cable.

Although the interval between pulse pairs may be arbitrarily long, the interval between the end of the first pulse and the end of the second should not exceed 500 µsec (see Figure 22). Also, there should be at least 1 µsec between the end of the first pulse and the start of the second as shown. Pulses can be as narrow as 50 nsec or as long as 200 µsec. The Combiner introduces a slight loss in pulse rise time and a slight increase in pulse width. Using the Combiner with the PG-200 pulse width set to 50 nsec the typical rise time (optical turn-on at the ICCD) will be approximately 20 nsec and the typical fall time 10 nsec (optical turn-off at the ICCD). Degraded operation is possible with pulses narrower than 50 nsec.

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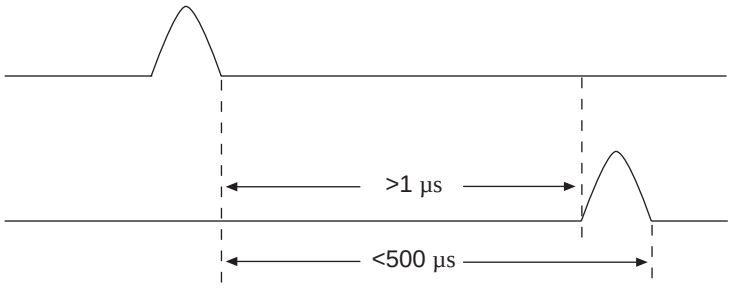


Figure 22. Combiner maximum pulse separation.

Suggested PG-200 Settings

Pulse Width: 50 nsec to 200 µsec

PG-200 Input 1 Delay: As dictated by experiment timing; immaterial to Combiner.

PG-200 Input 2 Delay: The interval from the end of the first pulse to the start of the second can range from 1 µsec to 500 µsec with a 50 nsec gate width. The delay set at PG-200 Input 2 must always be short enough to allow the second pulse to be completed within 500 µsec of the end of the first pulse as indicated in Figure 22.

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Glossary

AUX DELAYED TRIGGER OUT – Rear panel programmable output trigger pulse which is delayed from the leading edge of the input trigger.

BACK TERMINATED – Technique used by Princeton Instruments to minimize gate pulse signal reflections between the detector and the PG-200 rear panel output BNC. It is achieved by placing a proprietary circuit at the transmitting end of the BNC cable instead of the receiving end, as is normally done. This precludes needing a 50 Ω terminator in the detector, thus allowing wider gate pulses.

BOX CAR – Special delay sweep mode where constant width gate pulses are delayed with a constantly increasing delay. After the maximum delay, the delay sweep pattern is repeated.

DELAY SWEEP – Variation of the gate pulse delay from an initial to final delay in increments of "delay steps". The total number of steps is referred to as "step count". This resembles "box-car" operation.

DELAYED TRIGGER OUT – Programmable output trigger pulse which is delayed from the leading edge of the input trigger.

ECL – Emitter-coupled logic. High speed digital logic used in the PG-200 design. Logic levels are at approximately –0.8 V and –1.6 V.

ENABLE – Input used on other Princeton Instruments products which when asserted high enables pulsing. The corresponding input on the PG-200 is $\overline{\text{INHIBIT}}$.

The negative logic inhibit designator is used instead of the positive logic enable to indicate that the absence of a signal corresponds to the absence of the inhibit. (The absence of an enable input might imply the absence of enabling which is not the case.)

EXTERNAL SYNC – Detector readout synchronization mode where the detector array is completely synchronized to an external source, i.e. the array is scanned upon arrival of an external trigger pulse.

EXTERNAL TRIGGER MODE – PG-200 trigger mode where gate pulses are delayed from external input trigger pulses. Also a detector readout synchronization mode where the detector is scanned continuously, i.e. Freerun mode, but data storage does not begin until the arrival of an external trigger pulse.

FG-100 – A Princeton Instruments gate pulser specially designed for short gate pulse delays and widths. It does not have many of the programmable features of the PG-200 and this pulser requires different termination for its detectors.

FIRMWARE – Software instructions typically contained inside a PROM.

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FREERUN – Detector readout synchronization mode where the detector array scanning is continuous, independent of any external parameters.

FWHM – Full width half-maximum. Time period from the mid-point of the leading edge to the mid-point of the trailing edge of the gate pulse. Used to define pulse width.

GATE PULSE – High voltage pulse BNC output at the PG-200 rear panel used to gate detectors. Pulse amplitude is nominally –200 volts.

GATE PULSE MONITOR – Low voltage replica of the gate pulse. Amplitude is nominally –1 V. Used as a high impedance scope timing reference only.

INTERNAL TRIGGER MODE – PG-200 trigger mode where gate pulses are delayed from trigger pulses produced by an internal timer. Delays are programmable in increments of 10 nsec instead of 1 nsec as they are in external trigger mode.

JUMPER FIELD – Group of posts on a printed circuit board with "jumper" plugs making connections between some of the posts. Used to save configuration information. Marked by silkscreen information to aid in proper configuration.

LED – Light emitting diode. Used as front panel lighted indicator.

LINE SYNC – Detector readout synchronization mode where the detector array is completely synchronized to the AC power line.

NEGATIVE LOGIC – Digital logic where logic low levels represent a "true" or "1" logic state, e.g., 5 V negative logic signals would be 5 V ="0", 0 V = "1". Signal names describing negative logic signals are commonly indicated by a line over the signal name or by the NOT prefix or suffix.

NOT – Prefix or suffix indicating that the signal is a negative logic signal, e.g., NOTSCAN is a negative logic SCAN signal. Another convention is to show the signal name with a line over it, e.g., $\overline{\text{SCAN}}$.

NOTSCAN – Signal used by Princeton Instruments controllers which is asserted low during detector scanning.

OSCILLATOR – Timing clock signal generator.

PG-10 – Princeton Instruments gate pulser specially designed for long gate pulse delays and widths. Does not have many of the programmable features of the PG-200.

POSITIVE LOGIC – Digital logic where logic high levels represent a "true" or "1" logic state, e.g., 5 V positive logic signals would be 5 V = "1", 0 V = "0".

PRF – Pulse repetition frequency. High voltage gate pulse frequency that the pulser can provide.

PROM – Programmable read only memory. Contains software that controls the PG-200.

PULSE SEQUENCE – Series of pulses programmed with varying gate delays, gate widths, and trigger outputs.

RAM – Random access memory used to store data such as experiment parameters.

SHUTTER MONITOR – A signal provided by CCD controllers. It is low when the shutter is closed and goes high when the shutter is activated. It is similar to $\overline{\text{SCAN}}$ except

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that it is not follow array cleaning activity or shutter compensation time. SHUTTER MONITOR is used to inhibit the PG-200 when the array is being read out.

SMA – Style of fiber optic cable connector used on PG-200 front panel.

SWEEP – Series of gate pulses with a constantly increasing gate delay from the input trigger.

SYNC'D – State in which either DELAYED TRIGGER OUT OR AUX DLY'D TRIG OUT pulses are synchronized to trailing edge of high voltage gate pulses, i.e. there is a fixed delay from gate pulse trailing edges to trigger out pulses.

TERMINATOR – Resistor mounted at the receiving end of a cable to match the characteristic impedance of the cable and thereby reduce signal reflections in the cable. Also references the cable signal to ground.

VALUE ENTRY – Keyboard entry of either a numerical or units value. While value entry is in progress, keys have a particular definition. That definition may change at times when values are not being entered.

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Appendix A
Serial Interface Functions

WinView/WinSpec Interface Form

PG200ADDSEQ

Add a sequence point.

Parameters: 1

Parameter 1 Type: Integer

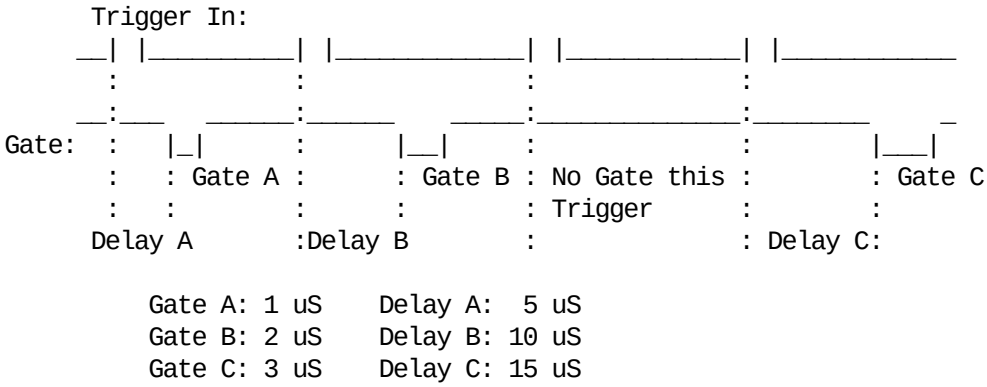
Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example:



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```
  rem: Init com 1. Must do first
let tmp = PG200SERIALINIT( 1 )

  rem: Clear All Sequence Points
let tmp = PG200CLEARSEQ( 1 )

  rem: Set Trigger mode to "external"
let tmp = PG200TRGMODE( 1, 1 )

  rem: trigger # 1: width = 1 uS, delay = 5 uS
  rem: Set pulse delay to 5 micro-seconds
let tmp = PG200SETDEL( 1, 5, 1 )
  rem: Set pulse width to 1 micro-second
let tmp = PG200SETWID( 1, 1, 1 )
  rem: Add Sequence point.
let tmp = PG200ADDSEQ( 1 )

  rem: trigger # 2: width = 2 uS, delay = 10 uS
  rem: Set pulse delay to 10 micro-seconds
let tmp = PG200SETDEL( 1, 10, 1 )
  rem: Set pulse width to 2 micro-second
let tmp = PG200SETWID( 1, 2, 1 )
  rem: Add Sequence point
let tmp = PG200ADDSEQ( 1 )

  rem: trigger # 3: no gate pulse this trigger
  rem: Add Sequence point with no gate pulse
let tmp = PG200SKIPSEQ( 1 )

  rem: trigger # 4: width = 3 uS, delay = 15 uS
  rem: Set pulse delay to 15 micro-seconds
let tmp = PG200SETDEL( 1, 15, 1 )
  rem: Set pulse width to 3 micro-second
let tmp = PG200SETWID( 1, 3, 1)
  rem: Add Sequence point
let tmp = PG200ADDSEQ( 1 )

  rem: begin Pulse Sequence
let tmp = PG200STARTSEQ( 1 )
```

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PG200CLEARSEQ

Clear all sequence points from a particular port.

Parameters: 1

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See Example to PG200ADDSEQ

PG200GATEEN

PG200CLEARSEQ Gate flag to enable or disable a particular ports gate.

Parameters: 2

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Integer

Parameter 2 Definition: Gate Flag: 0 = Disable Gate, 1 = Enable Gate

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

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Example: See example for PG200SETSWEEP

PG200INTFREQ

Sets the internal trigger frequency.

Parameters: 2

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Integer

Parameter 2 Definition: Value to Set the internal trigger frequency to: 2 - 9999 Hz

Note: Check the PG-200 hardware manual before selecting a value to set as it may exceed the frequency which can be achieved by the PG-200.

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See examples for PG200SETSWEEP & PG200SETWID

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PG200SERIALINIT

Initializes a Serial Port to PG200 hard-code settings of 9600 baud, 8 char, 1 stop, and no parity.

Parameters: 1

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200SETWID

PG200SETAUXTRIG

This function sets a Auxiliary Delayed Trigger Value on the PG-200 which is synchronized to the Trigger In. To set this value synchronized to the Gate, use PG200SETSYNCAUX.

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Auxiliary Trigger Value to set

Parameter 3 Type: Integer

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Parameter 3 Definition: Units of the Trigger Value.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example:

```
This function can be used the same as PG200SETDLYTRG but
will use the back panel.  See PG200SETWID example and

                Replace

  let tmp = PG200SETDLYTRG( 1, 1.0, 1 )

                With

  let tmp = PG200SETAUXTRG( 1, 1.0, 1 )
```

PG200SETDEL

Sets the Gate Pulse Delay Value on the PG-200

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Gate Pulse Delay Value to set

Parameter 3 Type: Integer

Parameter 3 Definition: Units of the Gate Pulse Delay Value.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200SETWID

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PG200SETDLYTRG

This function sets a Delay Trigger Out Value on the PG-200 which is synchronized to the Trigger In. To set this value synchronized to the Gate, use PG200SETSYNCDELO.

Parameters:	3
Parameter 1 Type:	Integer
Parameter 1 Definition:	Number of the serial port that the PG-200 is connected to: 1 = COM1 2 = COM2 3 = COM3 4 = COM4 5 = COM5 6 = COM6 7 = COM7 8 = COM8 (Ports 5 - 8 require special hardware)
Parameter 2 Type:	Float
Parameter 2 Definition:	Delay Value to set
Parameter 3 Type:	Integer
Parameter 3 Definition:	Units of the Delay Value. 0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds
Return Type:	Integer
Return Definition:	1 = Successful communication 0 = Error in communication
Status of this function:	V1.0
Example:	See example for PG200SETWID

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PG200SETSWEEP

Set Gate Sweep values.

Parameters: 5

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Starting Delay for Sweep Routine.

Parameter 3 Type: Integer

Parameter 3 Definition: Units of the Starting Delay:
0 = Nanoseconds. 1 = Microseconds, 2 = Milliseconds

Parameter 4 Type: Float

Parameter 4 Definition: Step Size for Routine.

Parameter 5 Type: Integer

Parameter 5 Definition: Units of the step size.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Parameter 6 Type: Integer

Parameter 6 Definitions: Number of steps in sweep routine

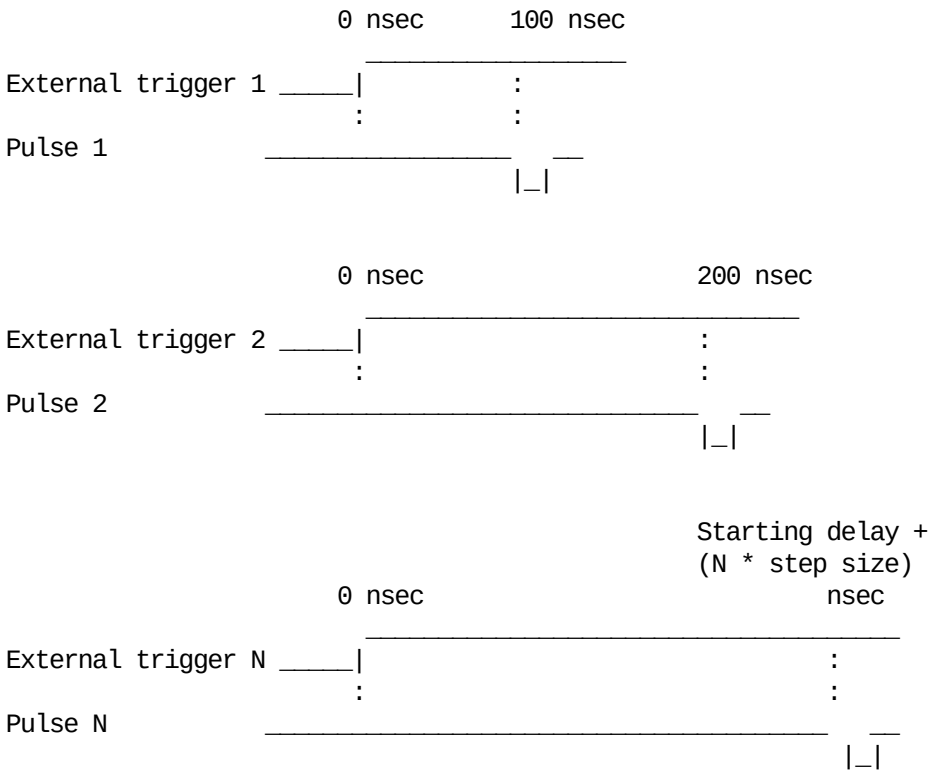
Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

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Example:




```
    rem: Init com 1 for PG200
let tmp = PG200SERIALINIT( 1 )
    rem: Set trigger mode to external
let tmp = PG200TRGMODE( 1, 1 )
    rem: set pulse width to 50 nsec.
let tmp = PG200SETWID( 1, 50, 0 )
    rem: set sweep params : com 1, start delay : 100 ns
    rem: step size : 100 ns and number steps : 25.
let tmp = PG200SETSWEEP( 1, 100, 0, 100, 0, 25 )
    :
    :
    rem: Send command just before starting experiment to
    rem: place pulse at starting delay.
 let tmp = PG200GATEEN( 1, 1 )
 let tmp = START130
```

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PG200SETSYNCAUX

This function sets a Auxiliary Delayed Trigger Value on the PG-200 which is synchronized to the Gate. To set this value synchronized to the Trigger In, use PG200SETAUXTRIG.

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Value to set Trigger to.

Parameter 3 Type: Integer

Parameter 3 Definition: Units of the Trigger value.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example:

```
This function can be used the same as PG200SETDLYTRG but
will use the back panel.  See PG200SETWID example and

                Replace

  let tmp = PG200SETDLYTRG( 1, 1.0, 1 )

                With

  let tmp = PG200SETSYNCAUX( 1, 1.0, 1 )
```

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PG200SETSYNCDELO

This function sets a Delay Trigger Out Value on the PG-200 which is synchronized to the Gate. To set this value synchronized to the Trigger In, use PG200SETDLYTRG.

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Delay Value to set

Parameter 3 Type: Integer

Parameter 3 Definition: Units of the Delay Value.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example:

```
See example for PG200SETWID and

replace

   rem: Set delayed trigger to 1 micro-second Sync'd to Trigger In.
let tmp = PG200SETDLYTRG( 1, 1.0, 1 )

with

   rem: Set delayed trigger to 1 micro-second Sync'd to Gate
let tmp = PG200SETSYNCDELO( 1, 1.0, 1 )
```

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PG200SETWID

Sets up new width for PG200.

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Float

Parameter 2 Definition: Width Value to set

Parameter 3 Type: Integer

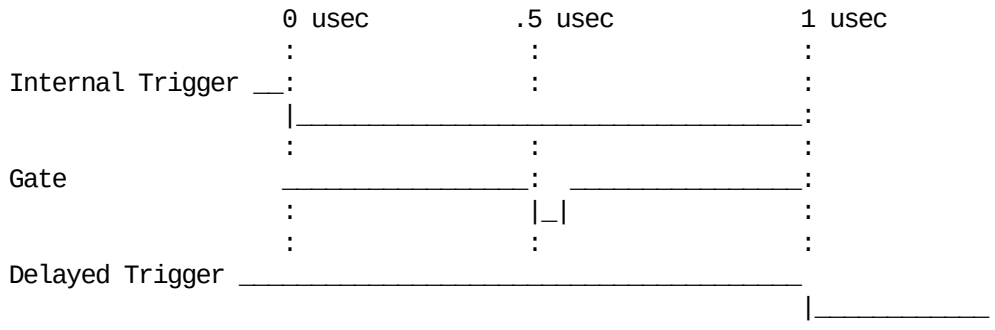
Parameter 3 Definition: Units of the Width value.
0 = Nanoseconds, 1 = Microseconds, 2 = Milliseconds

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example:




```
  rem: Init com 1. Must do first.
let tmp = PG200SERIALINIT( 1 )
  rem: Set Trigger mode to "internal".
let tmp = PG200TRGMODE( 1, 0 )
  rem: Sync delayed trigger and aux trigger to internal trigger
  rem: instead of gate pulse.
let tmp = PG200SYNCMODE( 1, 0, 0 )
  rem: Set internal freq. to 5000.
let tmp = PG200INTFREQ( 1, 5000 )
```

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```
  rem: Set delayed trigger to 1 micro-second Sync'd to Trigger In.
let tmp = PG200SETDLYTRG( 1, 1.0, 1 )
  rem: Set pulse delay to 500 nano-seconds
let tmp = PG200SETDEL( 1, 500, 0 )
  rem: Set pulse width to 4 nano-seconds.
let tmp = PG200SETWID( 1, 4, 0 )
```

PG200SKIPSEQ

Skips a trigger during a pulse sequence.

Parameters: 1

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200ADDSEQ

PG200STARTSEQ

This function will begin a pulsing sequence.

Parameters: 1

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

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Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200ADDSEQ

PG200STOPSEQ

This function will stop a pulse sequence.

Parameters: 1

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200ADDSEQ

PG200SYNCMODE

Sets up the Delayed Output Trigger & Auxiliary Trigger modes for PG200.

Parameters: 3

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Integer

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Parameter 2 Definition: Delayed Trigger Sequence Mode.
0 = Sync to Gate, 1 = Sync to Input Trigger

Parameter 3 Type: Integer

Parameter 3 Definition: Auxiliary Trigger Sequence Mode.
0 = Sync to Gate, 1 = Sync to Input Trigger

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200SETWID

PG200TRGMODE

Sets up the trigger mode for PG200.

Parameters: 2

Parameter 1 Type: Integer

Parameter 1 Definition: Number of the serial port that the PG-200 is connected to:
1 = COM1
2 = COM2
3 = COM3
4 = COM4
5 = COM5
6 = COM6
7 = COM7
8 = COM8
(Ports 5 - 8 require special hardware)

Parameter 2 Type: Integer

Parameter 2 Definition: Trigger Mode.
0 = Internal Trigger Mode, 1 = External Trigger Mode

Return Type: Integer

Return Definition: 1 = Successful communication
0 = Error in communication

Status of this function: V1.0

Example: See example for PG200SETWID

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Linkable Object Form

setwidth **set new pulse width**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number:
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New width value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

setdelay **set new pulse delay**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New delay value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

setdelo **set new delayed trigger value**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Float (5.2 digits)

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Parameter 2 Definitions : New delayed trigger value

Parameter 3 Type : Character

Parameter 3 Definitions : New units value:

('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

setaux **set new auxiliary trigger value**

Number of Parameters : 3

Parameter 1 Type : Integer

Parameter 1 Definitions : Port number

(0=COM1, 1=COM2, 2=COM3, 3=COM4)

Parameter 2 Type : Float (5.2 digits)

Parameter 2 Definitions : New aux trigger value

Parameter 3 Type : Character

Parameter 3 Definitions : New units value:

('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

settrgmode **set new trigger mode**

Number of Parameters : 2

Parameter 1 Type : Integer

Parameter 1 Definitions : Port number

(0=COM1, 1=COM2, 2=COM3, 3=COM4)

Parameter 2 Type: : Integer

Parameter 2 Definitions : New Trigger mode value

0 = internal trigger

1 = external trigger

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

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setsyncmode **set new sync mode**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Integer
Parameter 2 Definitions	:	New delayed trigger sync mode
		0 = sync delayed trig to input trig
		1 = sync delayed trig to gate
Parameter 3 Type	:	Integer
Parameter 3 Definitions	:	New aux trigger sync mode
		0 = sync aux trig to input trig
		1 = sync aux trig to gate

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

setintfreq **set new internal trigger frequency**

Number of Parameters	:	2
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Integer
Parameter 2 Definitions	:	New internal trigger frequency
		(4 digits allowed: 2-9999 Hz)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

setsweep **set new gate sweep values**

Number of Parameters	:	6
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(0=COM1, 1=COM2, 2=COM3, 3=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New starting delay
Parameter 3 Type	:	Character

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Parameter 3 Definitions : New starting delay units:

('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

Parameter 4 Type : Float (5.2 digits)

Parameter 4 Definitions : New delay step size

Parameter 5 Type : Character

Parameter 5 Definitions : New delay step size units:

('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

Parameter 6 Type : Integer

Parameter 6 Definitions : Number of steps in sweep routine

(5 digits allowed)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

gateen **enable/disable gating**

Number of Parameters : 2

Parameter 1 Type : Integer

Parameter 1 Definitions : Port number

(0=COM1, 1=COM2, 2=COM3, 3=COM4)

Parameter 2 Type : Integer

Parameter 2 Definitions : Enable/disable gating

0 = disable gating

1 = enable gating

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

addseq **add a sequence point**

Number of parameters : 1

Parameter 1 type : integer

Parameter 1 definition : Port number

(0=COM1, 1=COM2, 2=COM3, 3=COM4)

This function returns a 1 for a successful communication and a 0 for an unsuccessful communication.

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startseq **begin a pulsing sequence**

Number of parameters : 1
Parameter 1 type : integer
Parameter 1 definition : Port number
(0=COM1, 1=COM2, 2=COM3, 3=COM4)

clearseq **clear a pulsing sequence**

Number of parameters : 1
Parameter 1 type : integer
Parameter 1 definition : Port number
(0=COM1, 1=COM2, 2=COM3, 3=COM4)

stopseq **stop a pulsing sequence**

Number of parameters : 1
Parameter 1 type : integer
Parameter 1 definition : Port number
(0=COM1, 1=COM2, 2=COM3, 3=COM4)

skipseq **skip a trigger during a sequence**

Number of parameters : 1
Parameter 1 type : integer
Parameter 1 definition : Port number
(0=COM1, 1=COM2, 2=COM3, 3=COM4)

init_serial **initialize serial port**

Number of Parameters : 1
Parameter 1 Type : Integer
Parameter 1 Definitions : Port number
(0=COM1, 1=COM2, 2=COM3, 3=COM4)

This function needs to be run before calling any other PG-200 communication functions.

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Appendix B
Application Notes

High Repetition Rate Operation

It should be noted that in order to achieve high rep rate operation (e.g., 10 kHz), certain conditions need to be satisfied. These conditions are as follows:

$$\text{Pulse Width} + \text{Pulse Delay} + \text{Trigger Outputs} \leq 5\ \mu\text{sec}$$

For example, if 10 kHz operation is desired with a Pulse Width of 1 µsec and a Pulse Delay of 1 µsec, both the Delayed Trigger Output and the Aux Delayed Trigger Output must occur within 3 µsec of the end of the Gate pulse.

Note that in the default mode, the Delayed Trigger and Aux Delayed Trigger Outputs occur 20 µsec after the Gate pulse. These need to be changed before 10 kHz operation can be achieved.

The reasons why these conditions must be met are due to the use of a microprocessor in the PG-200. The following description of PG-200 operation may help in illustrating the necessity for meeting these conditions.

Pulse routine events

- A trigger pulse (either internal or external) is sensed by the PG-200.
- The PG-200 waits for the preset Pulse Delay period and then begins the high voltage pulse.
- The high voltage pulse remains asserted for the preset Pulse Width time period.
- At the end of the high voltage pulse, the PG-200 clock remains running until both the Delayed Trigger Out and Aux Delayed Trigger Out are complete.
- At the end of the trigger out pulse, an interrupt is generated to the microprocessor.
- The interrupt handler routine of the PG-200 reinitializes all Pulse Delay, Pulse Width and Trigger Out values for the next pulse routine.
- The interrupt handler takes a minimum of 95 µsec (during a normal pulse sequence) and can take as long as 505 µsec if a Pulse Sequence routine is executing.

The time required for the interrupt handler to execute is as follows:

Normal Operation: 95 µsec
Delay Sweeping: 180 µsec
Pulse Sequencing: 505 µsec

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Based on this information, the above equation concerning maximum repetition rate can be modified:

$$\text{Width} + \text{Delay} + \text{Trigger Outputs} + \text{Interrupt Time} \leq 1/\text{Rep Rate}$$

For example, with a Pulse Width of 10 µsec, a Pulse Delay of 10 µsec and the Trigger Outputs in the default timing mode (20 µsec after the Gate Pulse), and using the Pulse Sequencing mode, the maximum rep rate is defined as

$$10\ \mu\text{sec} + 10\ \mu\text{sec} + 20\ \mu\text{sec} + 505\ \mu\text{sec} = 545\ \mu\text{sec}$$

which corresponds to a repetition rate of 1/545 µsec or 1.835 kHz.

These factors must all be considered when using the PG-200. In addition, the user will note a marked decrease in the speed of the display. This is because pulsing routines are assigned top priority in the PG-200 microprocessor. This means that other functions such as updating the display or processing keyboard and RS-232 commands take on a very low priority. If there is a need to "break out" of a high rep rate pulsing routine, the fastest way is to ground the $\overline{\text{INHIBIT}}$ input BNC, thereby inhibiting pulsing and freeing up the processor to service the display, keyboard, or RS-232 interface.

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Appendix C

Stand Alone Executable Interface Functions

Introduction

The PG-200 serial communication interface also exists in a Stand Alone Executable form. This form consists of Stand Alone programs that can be run separately or called from a batch file. It is provided for the benefit of DSMA users (Stand Alone) who would have to shell out to DOS to program the PG-200. The Stand Alone Executable functions are contained on the PG-200 diskette in a subdirectory called EXE.

Syntax considerations for the stand-alone form are the same as for the other two interface forms as described in Chapter 4. However, unlike the WinView/WinSpec and Linkable Objects forms which receive parameters, the Stand Alone executables receive command line arguments. In each case the first parameter or argument is the COM Port. No error checking is done other than to check for the proper number of parameters. The Stand Alone format does take care of initializing the serial port.

Command Example

Task: Set a Pulse Width

Assume the active Serial port to be COM 1.

The following program could be run from the DOS command line or from a Batch File:

pgwidth port width units

where port would be 1, width would be a number with up to 5.2 decimal places and units would be either an ‘N’, ‘U’ or ‘M’, corresponding to nanoseconds, microseconds, and milliseconds respectively.

A complete description of the Stand Alone Executable functions follows.

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Command Descriptions

pgwidth.exe **set new pulse width**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number:
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New width value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

pgdelay.exe **set new pulse delay**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New delay value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

pgdelo.exe **set new delayed trigger value**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New delayed trigger value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

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pgaux.exe **set new auxiliary trigger value**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Float (5.2)
Parameter 2 Definitions	:	New aux trigger value
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New units value:
		('N' = nanoseconds, 'U' = microseconds, 'M' = milliseconds)

pgtrgmod.exe **set new trigger mode**

Number of Parameters	:	2
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Integer
Parameter 2 Definitions	:	New Trigger mode value
		0 = internal trigger
		1 = external trigger

pgsynmod.exe **set new sync mode**

Number of Parameters	:	3
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type:	:	Integer
Parameter 2 Definitions	:	New delayed trigger sync mode
		0 = sync delayed trig to input trig
		1 = sync delayed trig to gate
Parameter 3 Type	:	Integer
Parameter 3 Definitions	:	New aux trigger sync mode
		0 = sync aux trig to input trig
		1 = sync aux trig to gate

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pgintfrq.exe **set new internal trigger frequency**

Number of Parameters	:	2
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Integer
Parameter 2 Definitions	:	New internal trigger frequency
		(4 digits allowed: 2-9999 Hz)

pgsweep.exe **set new gate sweep values**

Number of Parameters	:	6
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Float (5.2 digits)
Parameter 2 Definitions	:	New starting delay
Parameter 3 Type	:	Character
Parameter 3 Definitions	:	New starting delay units:
		(‘N’ = nanoseconds, 'U’ = microseconds, ‘M’ = milliseconds)
Parameter 4 Type	:	Float (5.2 digits)
Parameter 4 Definitions	:	New delay step size
Parameter 5 Type	:	Character
Parameter 5 Definitions	:	New delay step size units:
		(‘N’ = nanoseconds, ‘U’ = microseconds, ‘M’ = milliseconds)
Parameter 6 Type	:	Integer
Parameter 6 Definitions	:	Number of steps in sweep routine
		(5 digits allowed)

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pggateen.exe **enable/disable gating**

Number of Parameters	:	2
Parameter 1 Type	:	Integer
Parameter 1 Definitions	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)
Parameter 2 Type	:	Integer
Parameter 2 Definitions	:	Enable/disable gating
		0 = disable gating
		1 = enable gating

addseq.exe **add a sequence point**

Number of parameters	:	1
Parameter 1 type	:	integer
Parameter 1 definition	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)

startseq.exe **begin a pulsing sequence**

Number of parameters	:	1
Parameter 1 type	:	integer
Parameter 1 definition	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)

clearseq.exe **clear a pulsing sequence**

Number of parameters	:	1
Parameter 1 type	:	integer
Parameter 1 definition	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)

stopseq.exe **stop a pulsing sequence**

Number of parameters	:	1
Parameter 1 type	:	integer
Parameter 1 definition	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)

skipseq.exe **skip a trigger during a sequence**

Number of parameters	:	1
Parameter 1 type	:	integer
Parameter 1 definition	:	Port number
		(1=COM1, 2=COM2, 3=COM3, 4=COM4)

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Appendix D

Serial Port Keystroke Emulation

Introduction

The serial port allows the PG-200 to be controlled from an external computer. The serial port commands emulate PG-200 front-panel keystrokes wherever possible. As an example, a “W” followed by a number (up to 3 digits), a unit (‘N’, ‘U’, or ‘M’) and a “CR” constitute a command to change the pulse width. The pulse delay and trigger out commands follow the same format. Since there are a limited number of front-panel switches, many functions are achieved via the FUNCTION key. The same is also true for RS-232 communications. To emulate a FUNCTION key operation, send an “F”, followed by the function number.

Byte Rate

Although the serial parameters specify 9600 baud, this is only a bit rate. The byte rate is much lower. The PG-200 can distinguish one ASCII character at 9600 baud, but if sent a string of characters at this rate, the pulser will probably lock up. This is because the serial input buffer is polled only about once every 100 ms. This slow rate occurs because polling the serial port is a low priority task. The frequency of occurrence depends on other pulser operations such as pulsing routines and setting the high voltage.

Echo

On receiving a complete character, the PG-200 echoes the character back to the control source. Because the low baud rate, it is a good idea to have the control software detect the echo before commencing transmission of the next character. This will assure reliable communications with as high a data rate as possible. Software routines that perform the required echo monitoring and data-flow control are available from PI for the PC DOS platform. Contact the factory for additional information, if interested.

Command List

The RS-232 commands recognized by the PG-200 are as follows.

W Set Width
D Set Delay
O Set Delayed Trigger
L Trigger Level (enter a number between -10 and 10)
S Trigger Select (toggles between Internal and External)

F Function (enter number in range of 1 to 215). *Chapter 5 describes the function assigned to each number.*

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C Clear display
b Emulates left arrow key
t Emulates right arrow key
u Emulates up arrow key
d Emulates down arrow key

The following additional commands are valid only when the display indicates **READY**.

V Echo display through serial port
+ Enable/disable pulsing

RS-232 Parameters

Baud Rate:	9600
Parity:	None
Data Bits:	8
Stop Bits:	1

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Warranty & Service

Limited Warranty: Roper Scientific Analytical Instrumentation

Roper Scientific, Inc. (“Roper Scientific,” us,” “we,” “our”) makes the following limited warranties. These limited warranties extend to the original purchaser (“You”, “you”) only and no other purchaser or transferee. We have complete control over all warranties and may alter or terminate any or all warranties at any time we deem necessary.

Basic Limited One (1) Year Warranty

Roper Scientific warrants this product against substantial defects in materials and / or workmanship for a period of up to one (1) year after shipment. During this period, Roper Scientific will repair the product or, at its sole option, repair or replace any defective part without charge to you. You must deliver the entire product to the Roper Scientific factory or, at our option, to a factory-authorized service center. You are responsible for the shipping costs to return the product. International customers should contact their local Roper Scientific authorized representative/distributor for repair information and assistance, or visit our technical support page at www.roperscientific.com.

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Shutter Limited One Year Warranty

Roper Scientific warrants for a period of up to one (1) year after shipment the standard, factory-installed camera shutter of all our products that incorporate an integrated shutter. This limited warranty applies to the standard shutter installed in the camera system at the time of manufacture. *Non-standard shutters, special product request (SPR) shutters, and third-party shutter drive equipment carry NO WARRANTIES EXPRESSED OR IMPLIED.* Roper Scientific will supply, at no cost to the customer, up to one (1) replacement shutter during the warranty period. Roper Scientific will, at Roper Scientific's option, either ship a ready-to-install shutter to the customer site for installation by the customer according to the instructions in the product User Manual or arrange with the customer to return the camera system (or portion of the camera system) to the factory (or factory-authorized service center) for shutter replacement by us or a Roper Scientific-authorized agent. Responsibility for shipping charges is as described above under our Limited One (1) Year Warranty.

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Roper Scientific warrants that the cooling performance of the system will meet our specifications over the lifetime of the VersArray (XP) detector or Roper Scientific will, at its sole option, repair or replace any vacuum chamber components necessary to restore the cooling performance back to the original specifications at no cost to the original purchaser. *Any failure to "cool to spec" beyond our Basic (1) year limited warranty from date of shipment, due to a non-vacuum-related component failure (e.g., any components that are electrical/electronic) is NOT covered and carries NO WARRANTIES EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Sealed Chamber Integrity Limited 24 Month Warranty

Roper Scientific warrants the sealed chamber integrity of all our products for a period of twenty-four (24) months after shipment. If, at anytime within twenty-four (24) months from the date of delivery, the detector should experience a sealed chamber failure, all parts and labor needed to restore the chamber seal will be covered by us. *Open chamber products carry NO WARRANTY TO THE CCD IMAGING DEVICE, EXPRESSED OR IMPLIED.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Vacuum Integrity Limited 24 Month Warranty

Roper Scientific warrants the vacuum integrity of all our products for a period of up to twenty-four (24) months from the date of shipment. We warrant that the detector head will maintain the factory-set operating temperature without the requirement for customer pumping. Should the detector experience a Vacuum Integrity failure at anytime within twenty-four (24) months from the date of delivery all parts and labor needed to restore the vacuum integrity will be covered by us. Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

Image Intensifier Detector Limited One Year Warranty

All image intensifier products are inherently susceptible to Phosphor and/or Photocathode burn (physical damage) when exposed to high intensity light. Roper Scientific warrants, with the exception of image intensifier products that are found to have Phosphor and/or Photocathode burn damage (which carry NO WARRANTIES EXPRESSED OR IMPLIED), all image intensifier products for a period of one (1) year after shipment. *See additional Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

X-Ray Detector Limited One Year Warranty

Roper Scientific warrants, with the exception of CCD imaging device and fiber optic assembly damage due to X-rays (which carry NO WARRANTIES EXPRESSED OR IMPLIED), all X-ray products for one (1) year after shipment. S*ee additional Basic Limited One (1) year Warranty terms and conditions above, which apply to this warranty.* Responsibility for shipping charges is as described above under our Basic Limited One (1) Year Warranty.

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Roper Scientific warrants all of our manufactured software discs to be free from substantial defects in materials and / or workmanship under normal use for a period of one (1) year from shipment. Roper Scientific does not warrant that the function of the software will meet your requirements or that operation will be uninterrupted or error free. You assume responsibility for selecting the software to achieve your intended results and for the use and results obtained from the software. In addition, during the one (1) year limited warranty. The original purchaser is entitled to receive free version upgrades. Version upgrades supplied free of charge will be in the form of a download from the Internet. Those customers who do not have access to the Internet may obtain the version upgrades on a CD-ROM from our factory for an incidental shipping and handling charge. *See Item 12 in the following section of this warranty ("Your Responsibility") for more information.*

Owner's Manual and Troubleshooting

You should read the owner's manual thoroughly before operating this product. In the unlikely event that you should encounter difficulty operating this product, the owner's manual should be consulted before contacting the Roper Scientific technical support staff or authorized service representative for assistance. If you have consulted the owner's manual and the problem still persists, please contact the Roper Scientific technical support staff or our authorized service representative. *See Item 12 in the following section of this warranty ("Your Responsibility") for more information.*

Your Responsibility

The above Limited Warranties are subject to the following terms and conditions:

1. You must retain your bill of sale (invoice) and present it upon request for service and repairs or provide other proof of purchase satisfactory to Roper Scientific.
2. You must notify the Roper Scientific factory service center within (30) days after you have taken delivery of a product or part that you believe to be defective. With the exception of customers who claim a "technical issue" with the operation of the product or part, all invoices must be paid in full in accordance with the terms of sale. Failure to pay invoices when due may result in the interruption and/or cancellation of your one (1) year limited warranty and/or any other warranty, expressed or implied.
3. All warranty service must be made by the Roper Scientific factory or, at our option, an authorized service center.
4. Before products or parts can be returned for service you must contact the Roper Scientific factory and receive a return authorization number (RMA). Products or parts returned for service without a return authorization evidenced by an RMA will be sent back freight collect.
5. These warranties are effective only if purchased from the Roper Scientific factory or one of our authorized manufacturer's representatives or distributors.
6. Unless specified in the original purchase agreement, Roper Scientific is not responsible for installation, setup, or disassembly at the customer's location.

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7. Warranties extend only to defects in materials or workmanship as limited above and do not extend to any product or part which has:
   - been lost or discarded by you;
   - been damaged as a result of misuse, improper installation, faulty or inadequate maintenance or failure to follow instructions furnished by us;
   - had serial numbers removed, altered, defaced, or rendered illegible;
   - been subjected to improper or unauthorized repair; or
   - been damaged due to fire, flood, radiation, or other “acts of God” or other contingencies beyond the control of Roper Scientific.
8. After the warranty period has expired, you may contact the Roper Scientific factory or a Roper Scientific-authorized representative for repair information and/or extended warranty plans.
9. Physically damaged units or units that have been modified are not acceptable for repair in or out of warranty and will be returned as received.
10. All warranties implied by state law or non-U.S. laws, including the implied warranties of merchantability and fitness for a particular purpose, are expressly limited to the duration of the limited warranties set forth above. With the exception of any warranties implied by state law or non-U.S. laws, as hereby limited, the forgoing warranty is exclusive and in lieu of all other warranties, guarantees, agreements, and similar obligations of manufacturer or seller with respect to the repair or replacement of any parts. In no event shall Roper Scientific’s liability exceed the cost of the repair or replacement of the defective product or part.
11. This limited warranty gives you specific legal rights and you may also have other rights that may vary from state to state and from country to country. Some states and countries do not allow limitations on how long an implied warranty lasts, when an action may be brought, or the exclusion or limitation of incidental or consequential damages, so the above provisions may not apply to you.
12. When contacting us for technical support or service assistance, please refer to the Roper Scientific factory of purchase, contact your authorized Roper Scientific representative or reseller, or visit our technical support page at www.roperscientific.com.

Contact Information

Roper Scientific's manufacturing facility for this product is located at the following address:

Roper Scientific
3660 Quakerbridge Road
Trenton, NJ 08619 (USA)

Tel: 609-587-9797
Fax: 609-587-1970

Technical Support E-mail: techsupport@roperscientific.com

For technical support and service outside the United States, see our web page at www.roperscientific.com. An up-to-date list of addresses, telephone numbers, and e-mail addresses of Roper Scientific's overseas offices and representatives is maintained on the web page.

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