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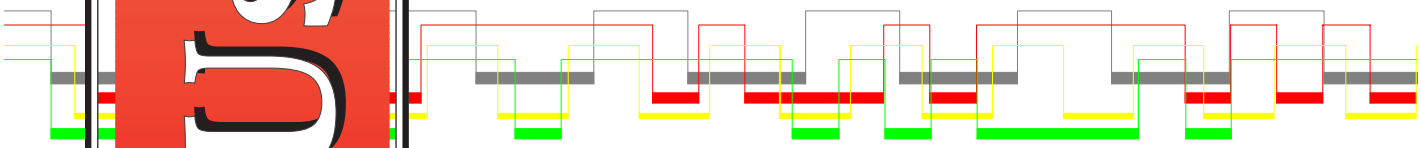
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User's Manual

PG100 / PG110

Pulse Generators



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User's Manual

PG100VXI

100 MHz Pulse Generator Module

PG110VXI

300 MHz Pulse Generator Module

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Rev. B1 Aug 98
Change 3 Jan 03

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Record of Changes

Change No.	Date of Change	Title or Brief Description	Entered By
Rev B1	Aug 98	Added AppNote A-PG100/110-01A and TechNote T-PG100/110-01A	Factory
Change 1	Nov 01, 2001	Changed pg 1-4; added pages 1-5 and 1-6 (specifications). Corrected pgs A-2, A-4 (specifications).	Factory
Change 2	Oct 25, 2002	Changed pg 1-4; corrected pulse delay specifications. Changed pg 3-7; corrected paragraph 3.1.3. Changed pg A-2; corrected pulse delay specifications. Changed pg D-4, D-5, D-11, D12 thru D14 (Appendix D)	Factory
Change 3	Jan 29, 2003	Changed Table of Contents, pgs iii thru vii Changed Specifications, pg 1-4, 1-5 Changed Chapter 1, pg 2-6 Changed Chapter 3, pgs 3-3, 3-4, 3-10, 3-11 Deleted Chapter 4, pgs 4-27 thru 4-30 Changed Chapter 4, pgs 4-39 thru 4-42 Changed Appendix A, pg A-2 Changed Appendix D, pgs D-7, D-19, D-20 Changed Index, pgs i thru v	Factory

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PG100/110 User Note for Firmware Version 2.00

RANGE 2 SLEW RATE

Due to the obsoleting of ICs used on the PG100/110, ITI has had to change the way that slew rates are set for Range 2 slew rates only. No changes have been made to the way Range 1, 3 and 4 slew rates work.

The rising and falling edge slew rates for Range 2 are no longer individually adjustable. When the user selects a slew rate that falls within Range 2 (see page 4-43), the trailing edge slew rate will automatically be coupled to the leading edge slew rate. This coupling is done internally, but is equivalent to issuing the "SOURCE:VOLTAGE:SLEW:TRAILING:AUTO ON" command (see page 4-46). Any command to change the trailing edge slew rate will be accepted by the PG100/110, but will have no effect as long as the slew rates stay within Range 2. Even if a user tries to decouple the leading and trailing slew rates by issuing a "SOURCE:VOLTAGE:SLEW:TRAILING:AUTO OFF" command, the PG100/110 will couple the two slew rates when the next command to change the slew rates is issued by the user. Again, this change only affects Range 2 slew rates; Ranges 1, 3 and 4 will continue to work as in previous firmware versions. Attached are new manual pages that can be used to replace the manual pages used for previous versions of the PG100/110 firmware.

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CHAPTER 1: OVERVIEW

The PG100 Series (PG) are dual-channel, message based pulse generators implemented on a single "C" size VXI module. They are capable of generating two channels of single and/or double pulsed pulse trains at speeds up to 100 MHz (PG100) or 300 MHz (PG110) while providing traditional pulse generator features such as programmable rise/fall times, amplitude and offset, pulse width/duty cycle control, and programmable output delays.

Up to seven PG modules may be synchronized together (1 Master, 6 Slaves), providing 14 output channels. While period timing and trigger timing are provided by the master module, each slave module retains individual control over pulse width/duty cycle, amplitude, offset, rise/fall times, output delays and single/double pulsed modes.

In double pulsed mode, each of the two pulses have independent control for width as well as a programmable delay between the first pulse and the second pulse. The first pulse always occurs with zero delay, relative to the trigger.

Several trigger sources and modes are available. Both the PG100 and PG110 may be triggered via software commands, VXI TTLTRG lines, external hardware inputs (with programmable input thresholds) or an internal burst counter/timer.

This chapter deals with front panel indicators, connectors and internal expansion connectors.

1.1 FRONT PANEL CONNECTORS AND INDICATORS

1.1.1 LEDs

There are four status LEDs located at the top of the PG front panel (Figure 1-1).

POWER **(GREEN)** - On any time power is applied to the PG module.

SYSFAIL **(RED)** - Off during normal operation. During the power-up sequence sysfail will be lit until completion of the internal self test. If SYSFAIL remains lit, this indicates a fault within the PG.

ACCESS **(YELLOW)** - This LED will briefly illuminate anytime the PG module is accessed by the VXI bus.

RUN **(GREEN)** - On indicates that the PG is in a run state.

1.1.2 Front Panel Connectors

The signal outputs, trigger output, trigger input, external clock input, expansion clock input and expansion trigger input connectors are all SMB push-on type.

Output signals

OUTPUT 1 Channel 1 output of the Pulse Generator. This is a 50Ω signal source.

OUTPUT 2 Channel 2 output of the Pulse Generator This is a 50Ω signal source.

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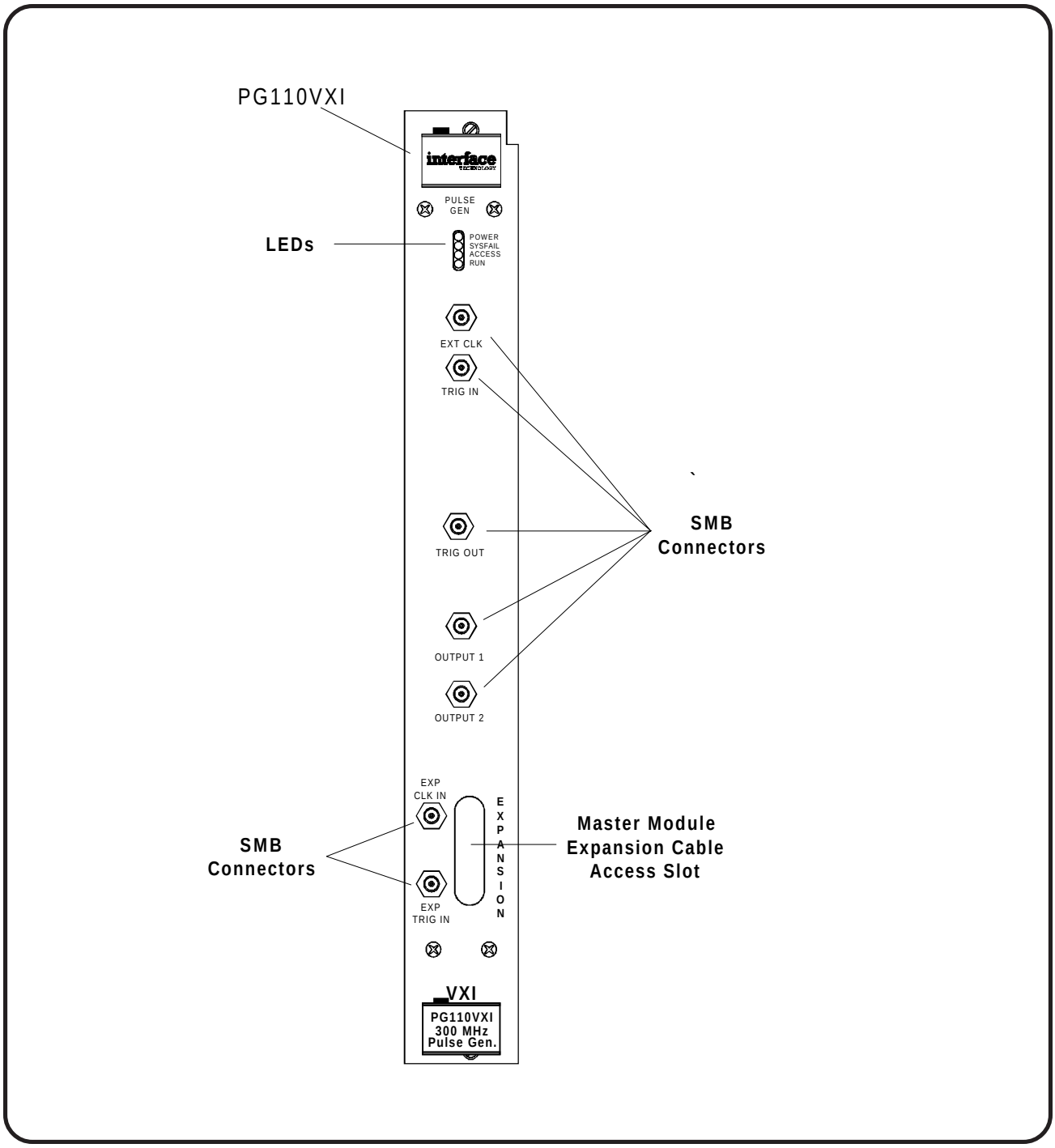


Figure 1-1.
Front Panel Configurationl.

TRIG OUT This is the trigger reference out signal. All channel 1 and channel 2 delays are measured with reference to this signal. The TRIG OUT signal is an ECL source with typical ECL levels (-0.8V to -1.9V). The output may be terminated into 50Ω referenced to ground or referenced to -2.0 volts. An internal current source to -2.0 volts is included.

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Input signals

EXT CLK The PG may be phase locked to an external clock source, which is connected to the EXT CLK input line. The PG is capable of locking to clocks with frequencies from 10 MHz to 20 MHz. Use ROSC:SOUR EXT and ROSC:EXT:FREQ to set up the external clock source.

TRIG IN is used to trigger the PG when TRIG:SOUR EXT is selected.

EXP CLK IN is used when a PG is configured as a slave module. The period clock is provided from a master PG to the EXP CLK IN connector.

EXP TRIG IN is used when a PG is configured as a slave module. The trigger is provided from a master PG to the EXP CLK IN connector.

1.2 INTERNAL CONNECTORS

Expansion signals

EXPANSION CLOCK OUTPUTS J16, J18, J19, J21, J22 and J24 connectors are used to provide master period clock timing to the PG slave modules.

EXPANSION TRIGGER OUTPUTS J7, J8, J9, J10, J11 and J12 are used to provide master trigger timing to PG slave modules. See "GETTING STARTED", Chapter 2, for information on how to interconnect PG Master and Slave units.

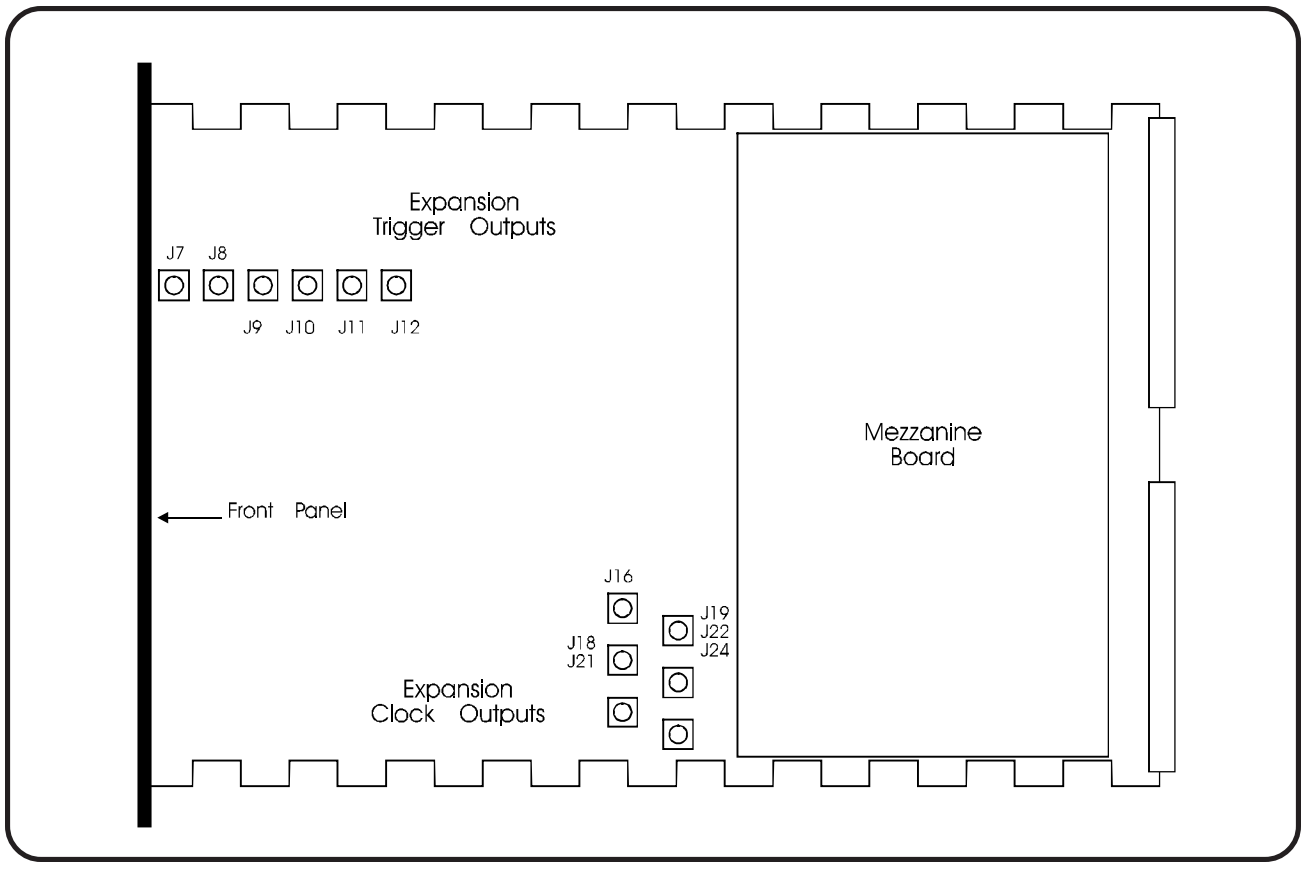


Figure 1-2.
Expansion Clock and Trigger Outputs.

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1.3 PG100 SPECIFICATIONS

All timing specifications are measured at 50% amplitude, fastest slew rate and output high and low levels at +1.0 V and 0.0 V, respectively. All delay times are measured relative to trigger out.

Common Specifications:

Spec. Clock Reference	VXI 10 MHz clock
Clock Accuracy	± 0.01%
Resolution	12-bits
Repeatability	4 times better than accuracy, typical
RMS Jitter	
Period < 100 ns	0.05% of period + 15 ps
Period > 100 ns	0.025% of period + 15 ps
Overshoot / Undershoot	± (8% of setting + 10 mV)
Settling Time	< 20 ns to 2.0% of level

Pulse Period:

Range	10 ns to 100 ms
Accuracy	
Period > 500 ns	± 0.02%
Period ≤ 500 ns	± 1.0%

Pulse Width:

Range	5.0 ns to (period - 5.0 ns)
Duty Cycle	1 to 99%
Accuracy	
Width > 500 ns	± 0.02% ± 1 ns
Width ≤ 500 ns	± 1.0% ± 1 ns

Pulse Delay:

Range	0 ns to (period - 1.5 ns)
Accuracy	
Delay > 500 ns	± 0.02% ± 6 ns
Delay ≤ 500 ns	± 1.0% ± 6 ns

Slew Rates:

Range 2	33 V/µs to 1300 V/µs
Range 3	1 V/µs to < 33 V/µs
Range 4	33 mV/µs to < 1 V/µs
Accuracy	± 20% of setting

Outputs:

Output Channels:

Number	2 single ended
Connector	SMB
Impedance	50 ohms, ± 1 ohm, source terminated
Output Amplitude	
Slew range 2	0.5 V to 7.0 V
Slew ranges 3 & 4	0.5 V to 24.0 V
Output Offset	
Slew range 2	-1.75 V to +6.75 V
Slew ranges 3 & 4	-11.75 V to +11.75 V
Output Low Level	
Slew range 2	-2.0 V to +6.5 V
Slew ranges 3 & 4	-12.0 V to +11.5 V
Output High Level	
Slew range 2	-1.5 V to +7.0 V
Slew ranges 3 & 4	-11.5 V to +12.0 V
Level Accuracy	± (1% of level + 1% of amplitude + 40 mV)

Trigger Output:

Connector	SMB
Output Level	100K ECL into 50 ohm load
Width	Width of first pulse of output channel 2
Transition Time	< 1 ns

Inputs:

Trigger:

Connector	SMB
Slope	Negative
Termination	50 ohms to -2.0 V
Transition	< 50 ns
Minimum Width	3.5 ns
Threshold Range	-5.0 V to +5.0 V, programmable
Threshold Resolution	50 mV

Clock:

Connector	SMB
Range	1 MHz to 20 MHz
Level	100K ECL
Termination	50 ohms to -2.0 V

Functional Modes:

Modes	Auto, Timer, Gate, Burst, External Width, Master/Slave
Double Pulse	Either channel, both or neither
Burst Count Range	1 to 536870944
Auto Timer Range	80 µs to 10 seconds

VXI Specifications

Interface Compatibility:

Size	C-size, single slot
Type	Message-based, servant
Logical Address	Static or dynamic
Interrupt Level	Programmable 1-7
Triggers	TTLTRG 0-7

Power Requirements:

+5.0 volts	3.0 A	15 W
-5.2 volts	4.5 A	23.4 W
+12.0 volts	0.5 A	6 W
-12.0 volts	0.5 A	6 W
-2.0 volts	2.5 A	5 W
+24.0 volts	0.75 A	18 W
-24.0 volts	0.5 A	12 W

Total Power		85.4 W

Cooling Requirements:

Per Slot Average	85 W
Airflow	7L/sec @ 0.3 mm water pressure for 10° C temperature rise

Environmental Specifications:

Temperature	Storage = -40° C to +75° C Operating = 0° C to 45° C
Humidity	5% to 95% relative, noncondensing

Software Drivers:

National Instruments	LabWindows/CVI

* Specifications subject to change without notice.

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1.4 PG110 SPECIFICATIONS

All timing specifications are measured at 50% amplitude, fastest slew rate and output high and low levels at +1.0 V and 0.0 V, respectively. All delay times are measured relative to trigger out.

Common Specifications:

Spec. Clock Reference	VXI 10 MHz clock
Clock Accuracy	± 0.01%
Resolution	12-bits
Repeatability	4 times better than accuracy, typical
RMS Jitter	
Period < 100 ns	0.05% of period + 15 ps
Period > 100 ns	0.025% of period + 15 ps
Overshoot / Undershoot	± (8% of setting + 10 mV)
Settling Time	< 20 ns to 2.0% of level

Pulse Period:

Range:	3.3 ns to 100 ms
Accuracy:	
Period > 500 ns	± 0.02%
Period ≤ 500 ns	± 1.0%

Pulse Width:

Range	1.5 ns to (period - 1.5 ns)
Duty Cycle	1 to 99%
Accuracy	
Width > 500 ns	± 0.02% ± 1 ns
Width ≤ 500 ns	± 1.0% ± 1 ns

Pulse Delay:

Range	0 ns to (period - 1.5 ns)
Accuracy	
Delay > 500 ns	± 0.02% ± 1 ns
Delay ≤ 500 ns	± 1.0% ± 1 ns

Slew Rates:

Range 1	2700 V/µs
Range 2	33 V/µs to 1300 V/µs
Range 3	1 V/µs to < 33 V/µs
Range 4	33 mV/µs to < 1 V/µs
Accuracy	± 20% of setting

Outputs:

Output Channels:

Number	2 single ended
Connector	SMB
Impedance	50 ohms, ± 1 ohm, source terminated
Output Amplitude	
Slew range 1 & 2	0.5 V to 7.0 V
Slew ranges 3 & 4	0.5 V to 24.0 V
Output Offset	
Slew range 1 & 2	-1.75 V to +6.75 V
Slew ranges 3 & 4	-11.75 V to +11.75 V
Output Low Level	
Slew range 1 & 2	-2.0 V to +6.5 V
Slew ranges 3 & 4	-12.0 V to +11.5 V
Output High Level	
Slew range 1 & 2	-1.5 V to +7.0 V
Slew ranges 3 & 4	-11.5 V to +12.0 V
Level Accuracy	± (1% of level + 1% of amplitude + 40 mV)

Trigger Output:

Connector	SMB
Output Level	100K ECL into 50 ohm load
Width	Width of first pulse of output channel 2
Transition Time	< 1 ns

Input:

Trigger:

Connector	SMB
Slope	Negative
Termination	50 ohms to -2.0 V
Transition	< 50 ns
Minimum Width	3.5 ns
Threshold Range	-5.0 V to +5.0 V, programmable
Threshold Resolution	50 mV

Clock:

Connector	SMB
Range	1 MHz to 20 MHz
Level	100K ECL
Termination	50 ohms to -2.0 V

Functional Modes:

Modes	Auto, Timer, Gate, Burst, External Width, Master/Slave
Double Pulse	Either channel, both or neither
Burst Count Range	1 to 536870944
Auto Timer Range	80 µs to 10 seconds

VXI Specifications

Interface Compatibility:

Size	C-size, single slot
Type	Message-based, servant
Logical Address	Static or dynamic
Interrupt Level	Programmable 1-7
Triggers	TTLTRG 0-7

Power Requirements:

+5.0 volts	3.0 A	15 W
-5.2 volts	4.5 A	23.4 W
+12.0 volts	0.5 A	6 W
-12.0 volts	0.5 A	6 W
-2.0 volts	2.5 A	5 W
+24.0 volts	0.75 A	18 W
-24.0 volts	0.5 A	12 W

Total Power		85.4 W

Cooling Requirements:

Per Slot Average	85 W
Airflow	7L/sec @ 0.3 mm water pressure for 10° C temperature rise

Environmental Specifications:

Temperature	Storage = -40° C to +75° C Operating = 0° C to 45° C
Humidity	5% to 95% relative, noncondensing

Software Drivers:

National Instruments	LabWindows/CVI

* Specifications subject to change without notice.

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CHAPTER 2: GETTING STARTED

This chapter will deal with installation issues and provide examples that will allow you to quickly set up the PG (pulse generator) to output pulses. Additional information provided in this chapter includes basic command syntax and self-test procedures.

2.1 QUICK START GUIDE

2.1.1 Installation

If you are familiar with VXI card installation, a quick reference of the hardware switch settings is in section 2.2, Figure 2-1. If you choose to use dynamic configuration, and your Resource Manager is capable of dynamic configuration, set all of the logical address switches to 'OFF'.

2.1.2 Examples

If you are familiar with pulse generators and just need some reference examples, turn to sections 2.4.3 and 2.4.4 for examples of how to output a simple pulse train.

2.1.3 Command Syntax

If you need to know the syntax of the PG commands, the command set is listed on page 4-2, and the commands themselves are listed immediately following this list.

2.2 INSTALLATION

2.2.1 Setting the Logical Address

Before installation, it is necessary to verify that the PG logical address is set correctly. The address switches should be set according to the requirements of your Slot 0 Controller. The address switches are marked with numbers from 1 to 8 (Fig. 2-1). Switch 1 corresponds to the least significant bit of the address. The address is entered in binary where an 'ON' switch sets the bit to 0. If your controller is capable of dynamic configuration, set all of the address switches to 'OFF' (Hexadecimal address = 'FF').

2.2.2 Connecting Master and Slave Modules

If any PG modules are to be used in a master/slave mode, their Expansion Clock and Expansion Trigger signals must be connected to the master modules expansion outputs. When connecting a master PG to a slave, any of the master expansion clock outputs and expansion trigger outputs may be used. All of the expansion output signals provide identical timing to slave modules.

To interconnect the master and slave modules, simply remove the cover to the master module, connect the expansion clock cable to any expansion clock output connector (Fig. 2-2) and the expansion trigger cable to any expansion trigger output connector. Feed the expansion cables through the expansion cable access slot (Fig. 2-3) in the master module's front panel, and replace the top cover. Install all of the modules into the VXI chassis. Connect one expansion clock cable to each EXP CLK IN connector on the slave module's (Fig. 2-4), and an expansion trigger cable to each EXP TRIG IN connector.

A maximum of six PG modules can be slaved to a single PG master module.

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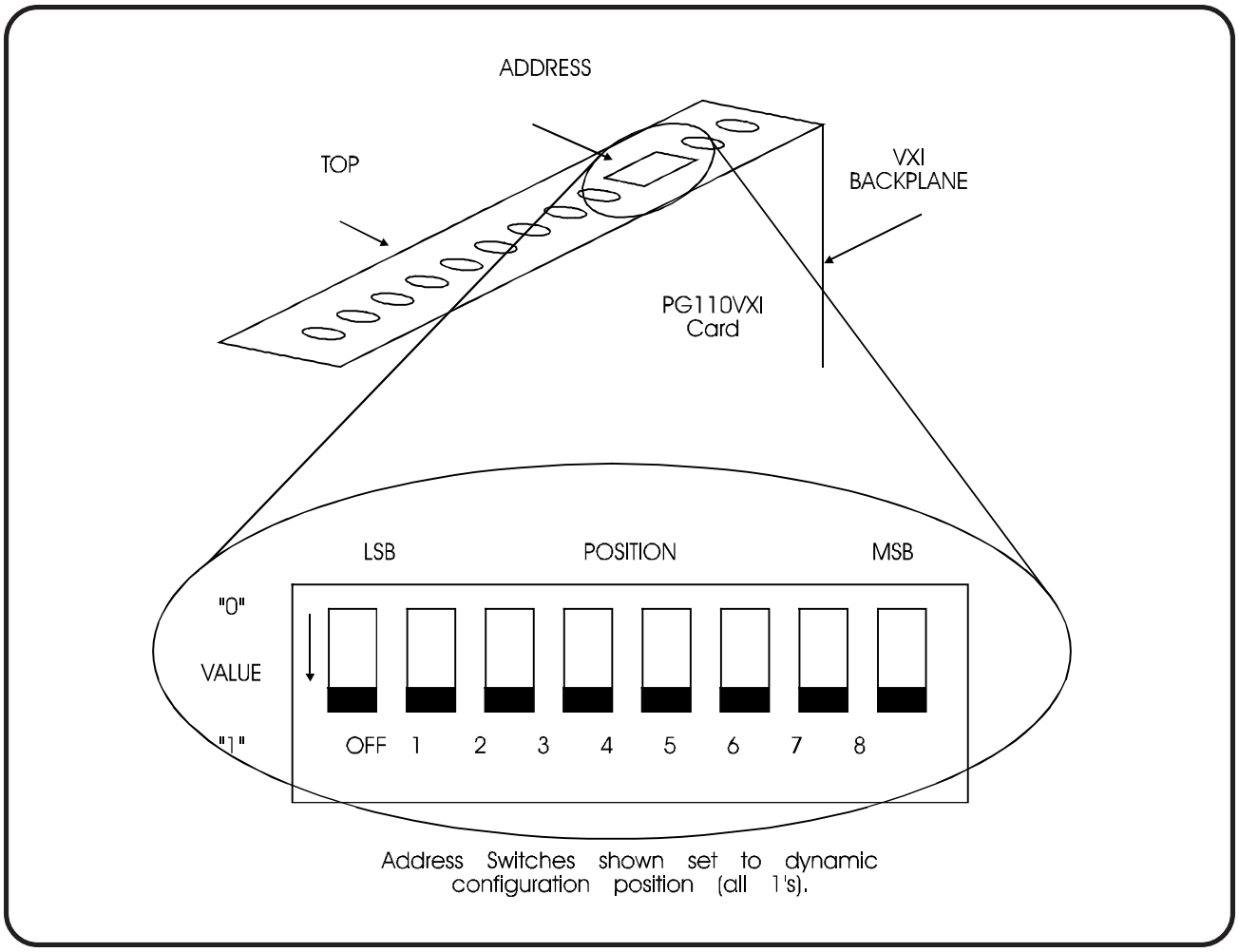


Figure 2-1.
Logical Address Switches.

2.2.3 Installing the Module

After the address switches have been set, install the PG in the card cage. Install any slave PG modules in the slots adjacent to, and downstream from, the PG. After all of the cards are seated in the card cage, carefully tighten the retaining screws located at the top and bottom of the front panel of each module. The PG can be installed in any available VXI slot other than slot 0.

Some VXI backplanes require jumpers for various signal lines. Check the instruction manual for your chassis to properly configure the backplane jumpers if needed. The PG uses the IACK jumper, so this jumper must be removed from the backplane in the slot where the PG is to be installed. The PG does not use any Bus Grant level jumpers. It does, however, pass the Bus Grant signals along to adjacent slot, so it makes no difference to PG operation if Bus Grant backplane jumpers are installed or removed.

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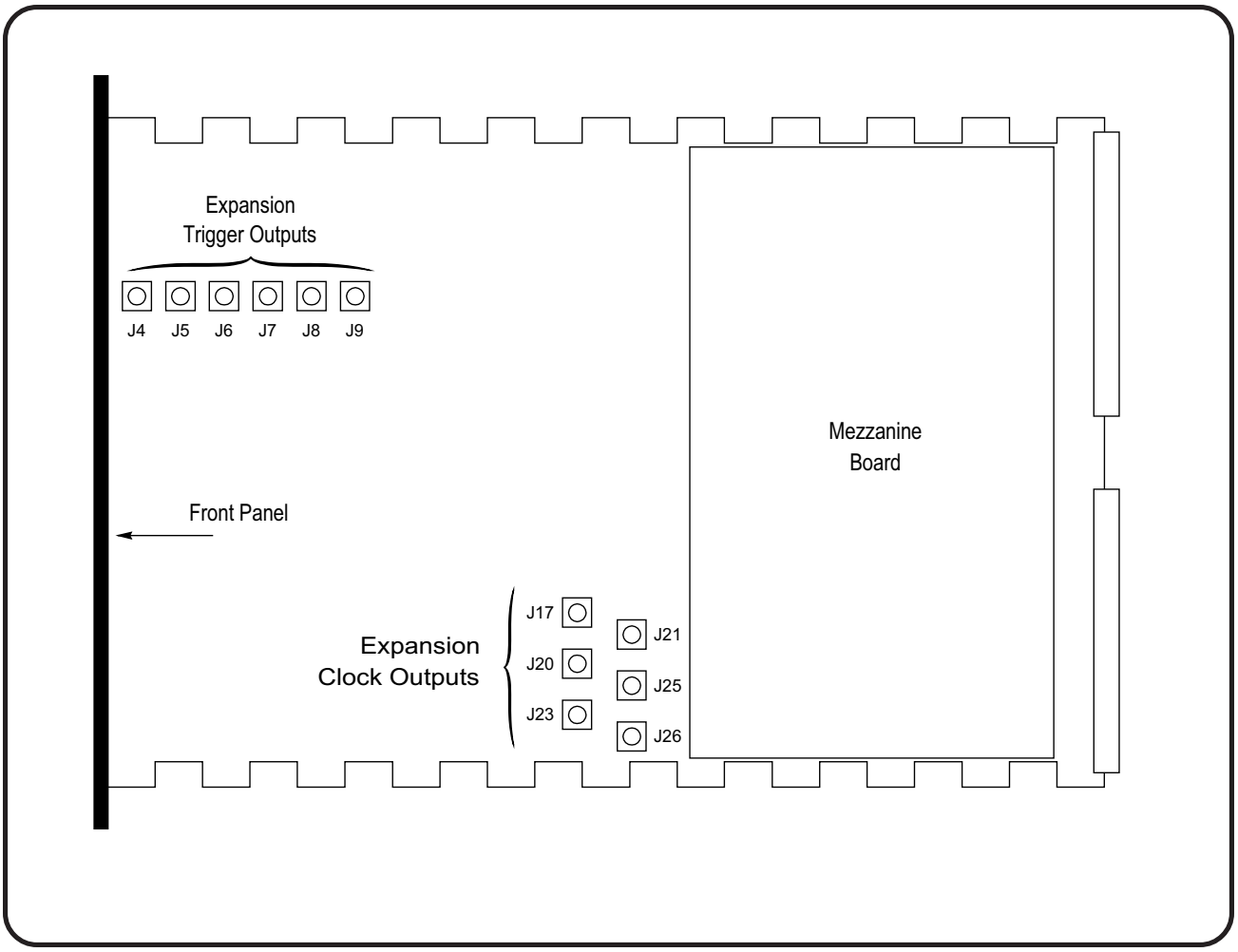


Figure 2-2.
Master Module Expansion Connectors.

2.3 CALIBRATION

The PG is calibrated at the factory and should not require calibration by the user under normal circumstances. If for any reason the PG does require calibration, the module must be returned to the factory.

2.4 BASIC OPERATION

2.4.1 Self-Test

When the VXI card cage is powered up, the PG will perform an internal Self-Test. The internal self-test will perform a test on RAM, Nonvolatile RAM checksum, ROM checksum, VXI interface chip and DUART chip. Upon completion of Self-Test the SYSFAIL LED will extinguish and default settings will be loaded. The default settings are:

```
OUTPUT:STATE OFF
SOURCE:PULSE:MODE AUTO
SOURCE:PULSE:PERIOD 100.00E-9
```


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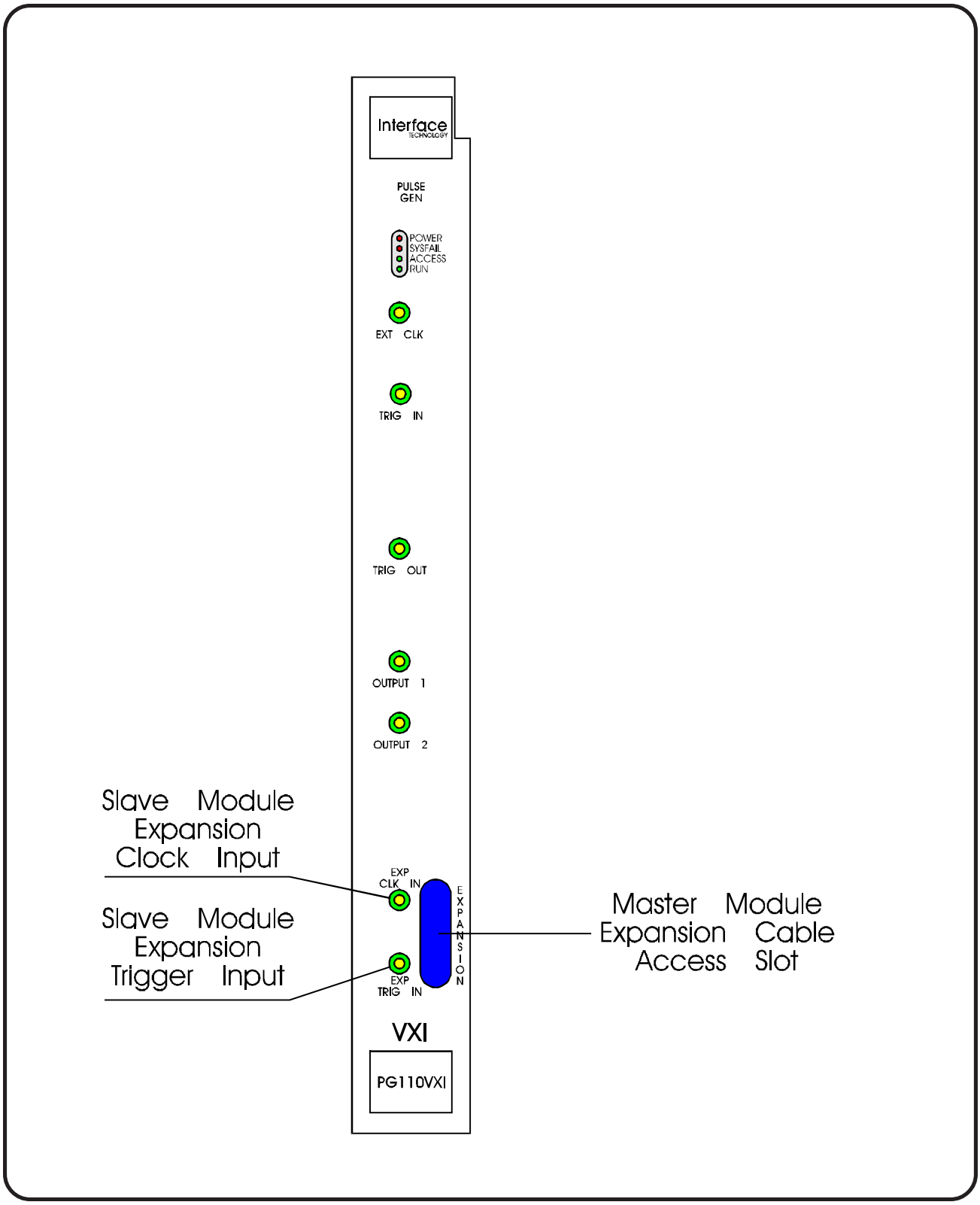


Figure 2-3.
Slave Module Expansion Connectors.

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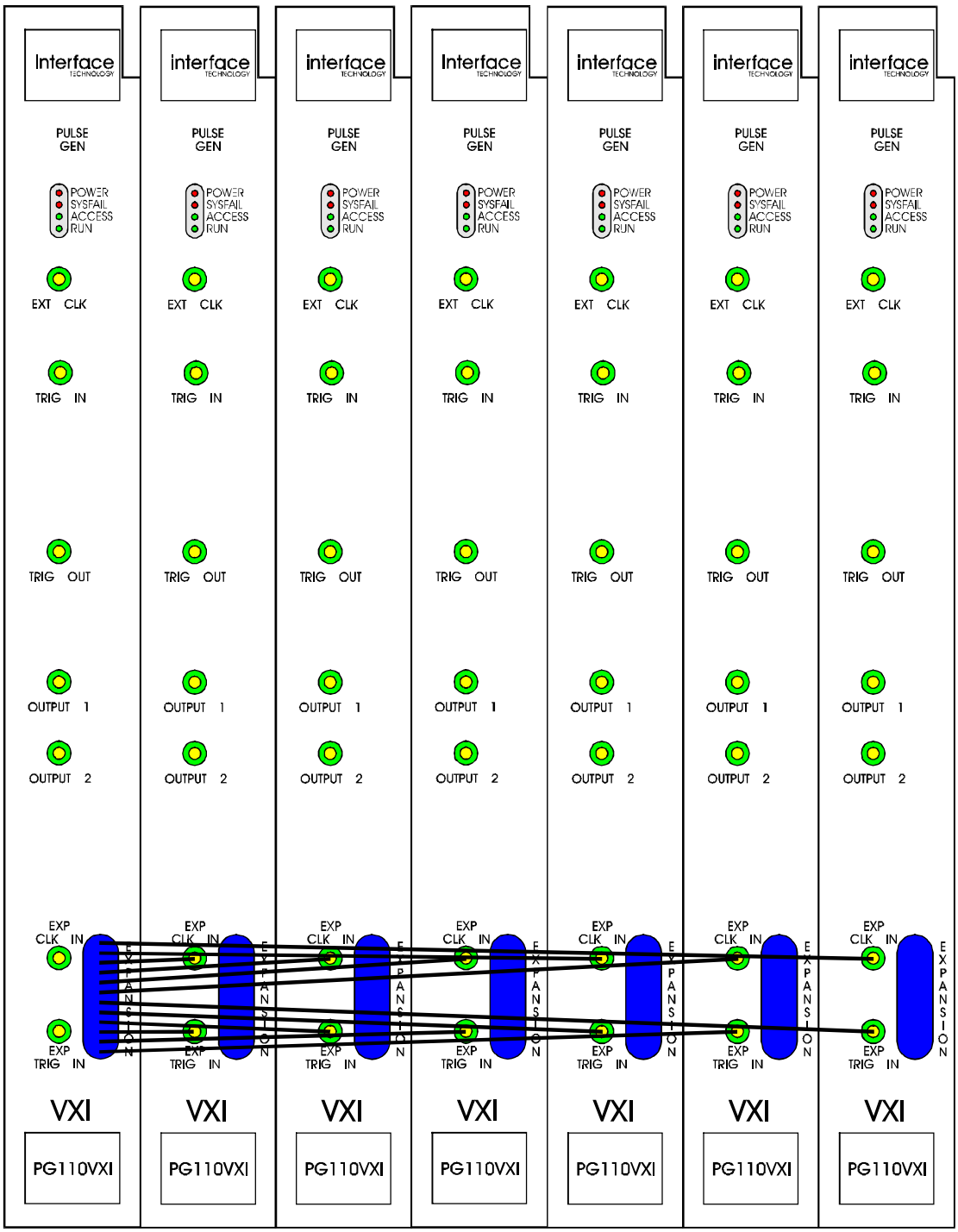


Figure 2-4.
Master / Slave Interconnect.

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```
SOURCE:PULSE:WIDTH 50.00E-9
SOURCE:PULSE:HOLD WIDTH
SOURCE:PULSE:DELAY 0
SOURCE:PULSE:POLARITY NORMAL
SOURCE:VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE 4.0
SOURCE:VOLTAGE:LEVEL:IMMEDIATE:OFFSET 0
INITIATE
```

The SYSFAIL LED should turn off within 5 seconds of power-up. If this LED does not turn off, check the installation of the cards, making sure that no pins on the VXI connectors have been bent during installation. After re-seating the cards, power-up the instrument again. If the SYSFAIL continues to remain lit, try to read the DATA LOW register of the PG module. Software included with your slot 0 controller should provide this capability. If the register can be read, it will provide an error code indicating what section of the self-test failed. Refer to Appendix C for a list of self-test error codes. Do not attempt to repair the card yourself. See the Repair Policy listed in the front of this manual for service instructions.

Several commands in the PG command set allow you to run the internal self-test, or portions of it. Refer to the *TST? and DIAGNOSTIC commands listed in Chapter 4.

2.4.2 PG Command Syntax

The PG commands adhere to the syntax rules defined in Standard Commands for Programmable Instruments (SCPI), 1992 and IEEE 488.2 Standard Commands. SCPI defines a common command set for instrumentation. By providing a framework for a common command set, similar instruments from different manufacturers, with similar capabilities, may be interchanged with a minimum amount of software re-coding. The PG incorporates many of the SCPI commands intended for pulse generators, as well as some commands that take advantage of capabilities unique to the PG. Refer to Chapter 4, COMMAND SET, for a full listing and description of these commands.

2.4.3 Output a Pulse Stream

On power-up, the PG is ready to output pulses with the following characteristics:

Period:	100 nSec (10 MHz)
Pulse Width:	50 nSec
Amplitude:	4.0 Volts (-2.0V to +2.0V)
Slew Rates:	1.3 V/nSec
Pulse Mode:	Single
Pulse Polarity:	Normal
Delay:	0 nSec
Trigger:	Continuous
Run State:	On
Outputs:	Off

At this point, the only action required is to enable the outputs.

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2.4.4 Running and Stopping

The PG powers up in the run state with the outputs disabled. To enable the outputs, simply send the command "OUTPUT:STATE ON". You may disable the outputs by sending the command "OUTPUT:STATE OFF". Also, you may halt the PG, leaving the outputs enabled, using the "ABORT" command. To restart the PG after an abort command, use "INITIATE".

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CHAPTER 3: OPERATION

Generation of pulses with the PG (pulse generator) is a simple matter of sending commands that enable the outputs and define the various pulse parameters. This chapter describes the various pulse parameters and the commands used to affect them.

3.1 PULSE PARAMETERS

One of the features that sets this pulse generator apart from other signal sources is the degree of control provided for the pulse parameters. The PG offers a wide variety of commands that allow you to control the different aspects of the output pulse. Sections 3.1.1 to 3.1.5 address these capabilities. Refer to figure 3-1 for pulse timing parameters discussed in section 3.1.1.

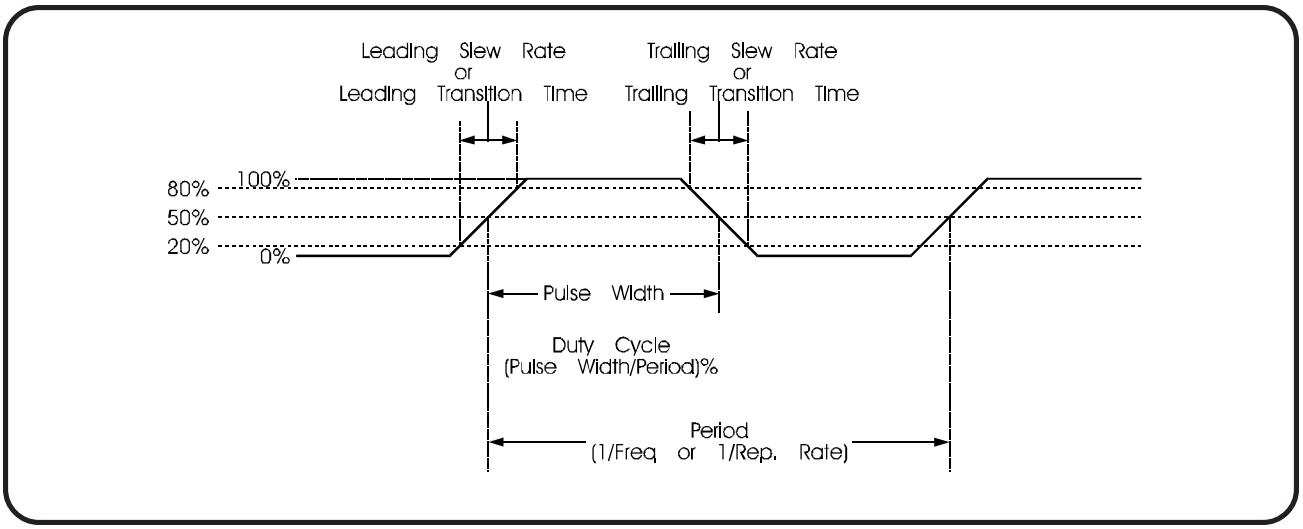


Figure 3-1.
Pulse Timing Parameters.

3.1.1 Pulse Timing

Period

The PG supports periods from 3.33 nsec to 100 ms (PG110) or from 10 nsec to 100 ms (PG100). The pulse period is common to both channels and is measured from the 50% point on the rising edge of the pulse to the 50% point on the next rising edge (assuming the leading and trailing slew rates set to the fastest setting). The following commands demonstrate the generic, long and abbreviated formats used to control the pulse period. Seconds may be entered as a floating point number (.00000000333), a floating point exponential number (3.33E-9) or a floating point number with a unit suffix of "MS", "US" or "NS" (3.33NS):

SOURCE:PULSE:PERIOD <seconds>
SOURCE:PULSE:PERIOD 3.33NS
SOUR:PULS:PER 16.5US
PER 100NS

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Frequency

The frequency command has been included for those who prefer to deal with pulse frequencies instead of pulse periods. All frequency values are internally converted to period values. For the frequency query command, the frequency is calculated as the reciprocal of the pulse period setting (1 / period). The frequency range is from 10 Hz to 300 MHz (PG110) or 10 Hz to 100 MHz (PG100). Long and abbreviated command formats are shown below. The hertz parameter may be entered as a floating point number (10000000), a floating point exponential number (10E6) or a floating point number with a unit suffix of "HZ", "KHZ" or "MHZ" (10MHZ).

```
SOURCE:FREQUENCY:FIXED <hertz>
SOURCE:FREQUENCY:FIXED 100000000
SOUR:FREQ:FIX 10E6
FREQ 150MHZ
```

Pulse Width

Pulse width is measured from the 50% transition point on the leading edge to the 50% transition point on the trailing edge, and measured using the fastest slew rate for both edges. Pulse widths may range from 1.5 ns to 99.999 ms (PG110) or 5 ns to 99.999 ms (PG100). Note that range checking is not performed for the pulse width commands. Care must be taken that the pulse width does not exceed the pulse period. Each output pulse can be independently controlled when HOLD:AUTO is set to OFF. A channel number should be specified as part of the command string. If a channel number is omitted, then the pulse command will default to channel 1. The seconds parameter may be entered as a floating point number (.000000005), a floating point exponential number (5.0E-9) or a floating point number with a unit suffix of "MS", "US" or "NS" (5.0NS). Various pulse width command examples are shown below.

```
SOURCE:PULSE:WIDTH<1|2> <seconds>
SOURCE:PULSE:WIDTH1 .00000015
SOUR:PULS:WIDT2 300E-6
WIDT 350NS
```

Duty Cycle

Duty cycle is an alternate control for pulse width and is expressed as a ratio between the pulse width and the pulse period. Duty cycles may vary from 1% to 99%, in integer steps. Each channel has independent duty cycle control when HOLD:AUTO is set to OFF. If a channel number is not specified as part of the command sequence, channel 1 is assumed. Several command formats for duty cycle are shown below.

```
SOURCE:PULSE:DCYCLE<1|2> <percent>
SOURCE:PULSE:DCYCLE1 50
SOUR:PULS:DCYC2 60
DCYC 40
```


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The HOLD:AUTO command allows you to link the width or duty cycle setting for channel 2 to the width or duty cycle setting of channel 1. This is done by setting the auto parameter ON or OFF (default is HOLD:AUTO ON). For example, if you set the hold parameter to WIDTH, and set auto to ON, any pulse width value entered for channel one will also be used for channel two. To set channel 2 to a different pulse width, you must first turn auto OFF, then enter the channel 2 pulse width on a new line. Examples of these commands are listed below.

```
SOURCE:PULSE:HOLD <WIDTH|DCYCLE>
SOURCE:PULSE:HOLD:AUTO <OFF|ON|0|1>
SOURCE:PULSE:HOLD WIDTH
SOUR:PULS:HOLD DCYCLE
HOLD:AUTO ON
HOLD:AUTO 0
```

Slew Rates

Both channels share a common control for setting the leading and trailing edge slew rates. Slew rate is measure in volts per microsecond and represents the speed of a signal transition. There are three (3) slew rate ranges for the PG100, and four (4) for the PG110. Ranges two, three and four are programmable while range one is fixed. A summary of the slew ranges is as follows.

Range 1:	2700 V/us (PG110 only)
Range 2:	33 V/us to 1300 V/us
Range 3:	1.0 V/us to 32.9 V/us
Range 4:	0.033 V/us to 0.90 V/us

The leading and trailing edge slew rates must be in the same range and must be within a 10:1 ratio of each other. If either slew rate is changed to a new range, the other is automatically changed to the new range as well. The AUTO parameter is use to link the trailing edge rate to the leading edge value. With auto set to ON, the value entered for the leading slew rate will automatically be used for the trailing slew rate. When setting auto OFF you must specify AUTO OFF first, then, on a new line, define the trailing edge slew rate. Slew rate values may be entered as a floating point number (0.5) or a floating point exponent (1E3). Leading and trailing slew rate examples are shown below.

```
SOURCE:VOLTAGE:SLEW:LEADING <v/us>
SOURCE:VOLTAGE:SLEW:TRAILING <v/us>
SOURCE:VOLTAGE:SLEW:TRAILING:AUTO <ON|OFF>
SOURCE:VOLTAGE:SLEW:LEADING 1000
SOUR:VOLT:SLEW:TRA 2.7E3
VOLT:SLEW:LEAD 500
VOLT:SLEW:TRA:AUTO ON
```


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3.1.2 Output Levels

The PG provides each channel with its own amplitude control, so output level commands sent need to specify the active channel. If a channel designator is not included in the command string, then channel 1 is assumed.. The driver circuit is series terminated at 50Ω, making it suitable for driving 50Ω transmission line, and all measurements are specified into an unterminated, high impedance load. The resolution of all output level controls is 12 bits and level accuracy is ± (1% of setting + 1% of amplitude + 40mv). Amplitude accuracy is ± (low level accuracy + high level accuracy). All output level command values are in volts and may be entered as a floating point number (5.0), a floating point exponent (800E-3) or as a floating point number with a suffix of "V", or "MV". See figure 3-2.

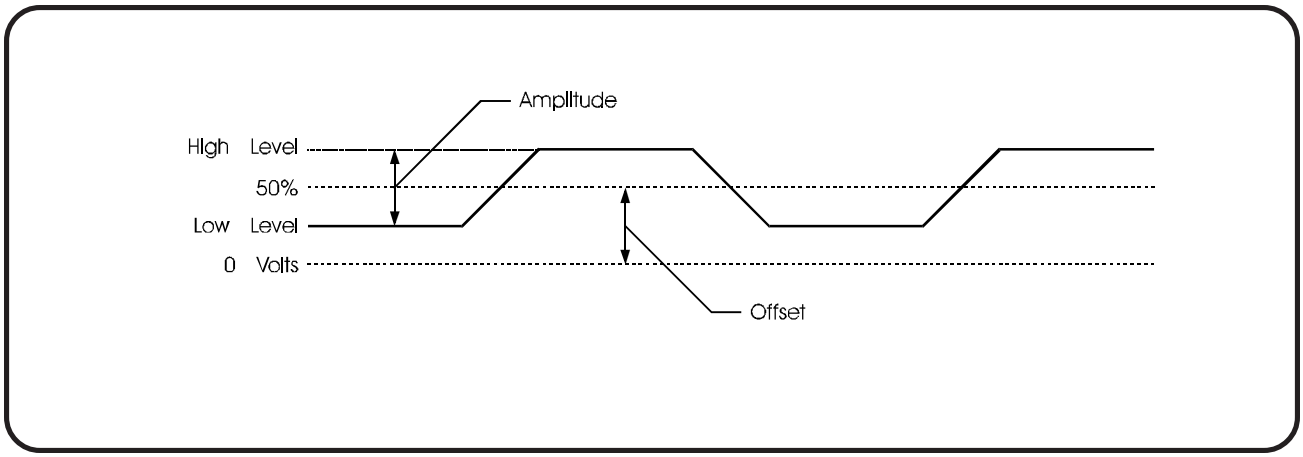


Figure 3-2.
Output Level Parameters.

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Amplitude

The amplitude of the PG outputs are measured from their low level output to their high level output. There are two amplitude ranges for the PG, depending on the slew range in use. The combination of amplitude and offset settings may not exceed the maximum high level or the maximum low level output specifications. Amplitude ranges and a list of generic, long and abbreviated amplitude control commands are provided below.:

Slew Range 1: Amplitude Range = 0.5V p-p to 7.0V p-p (PG110 only)
Slew Range 2: Amplitude Range = 0.5V p-p to 7.0V p-p
Slew Range 3 & 4: Amplitude Range = 0.5V p-p to 24.0V p-p

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:AMPLITUDE <volts>
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:AMPLITUDE 5.0
SOUR:VOLT:LEV2:IMM:AMPL 750E-3
VOLT:LEV2:AMPL 2500MV
VOLT:AMPL 10
VOLT 15

Offset

Offset is measured from 0V to the 50% amplitude level. Like the amplitude command, offset ranges depend on the slew range in use, and the combination of amplitude and offset settings may not exceed the maximum high level or the maximum low level output specifications. Output offset ranges a list of generic, long and abbreviated offset control commands are provided below:

Slew Range 1: Offset Range = -1.75V to +6.75V (PG110 only)
Slew Range 2: Offset Range = -1.75V to +6.75V
Slew Range 3 & 4: Offset Range = -11.75V to +11.75V

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:OFFSET <volts>
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:OFFSET 0
SOUR:VOLT:LEV2:IMM:OFFS -1.35
VOLT:LEV2:OFFS 2.5
VOLT:OFFS 6

High

Output high and output low settings are alternate methods of setting the amplitude and offset. The output high level is measured relative to 0V. Like previous output control parameters, output high has two ranges, depending on the slew range in use. Output high ranges and high level output control commands are shown below:

Slew Range 1: Output High Range = -1.5V to +7.0V (PG110 only)
Slew Range 2: Output High Range = -1.5V to +7.0V
Slew Range 3 & 4: Output High Range = -11.5V to +12.0V

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:HIGH <volts>
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:HIGH 5.0
SOUR:VOLT:LEV2:IMM:HIGH -0.8
VOLT:LEV2:HIGH 10

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VOLT:HIGH 0

Low

Output high and output low settings are alternate methods of setting the amplitude and offset. The output low level is measured relative to 0V. Like previous output control parameters, output low has two ranges, depending on the slew range in use. These reanges and the low level output control commands are shown below:

Slew Range 1: Output Low Range = -2.0V to +6.5V (PG110 only)
Slew Range 2: Output Low Range = -2.0V to +6.5V
Slew Range 3 & 4: Output High Range = -12.0V to +11.5V

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:LOW <volts>
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:LOW 0
SOUR:VOLT:LEV2:IMM:LOW -1.9
VOLT:LEV2:LOW -10
VOLT:LOW 10

TTL Levels

The PG has two standard logic levels defined which allow a quick and easy method of setting output amplitude and offset (or high and low levels). If the PG is used to drive TTL logic, you may set the output as shown in figure 3-3 using any one of the command formats shown below.

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:TTL
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:TTL
SOUR:VOLT:LEV2:IMM:TTL
VOLT:LEV2:TTL
VOLT:TTL

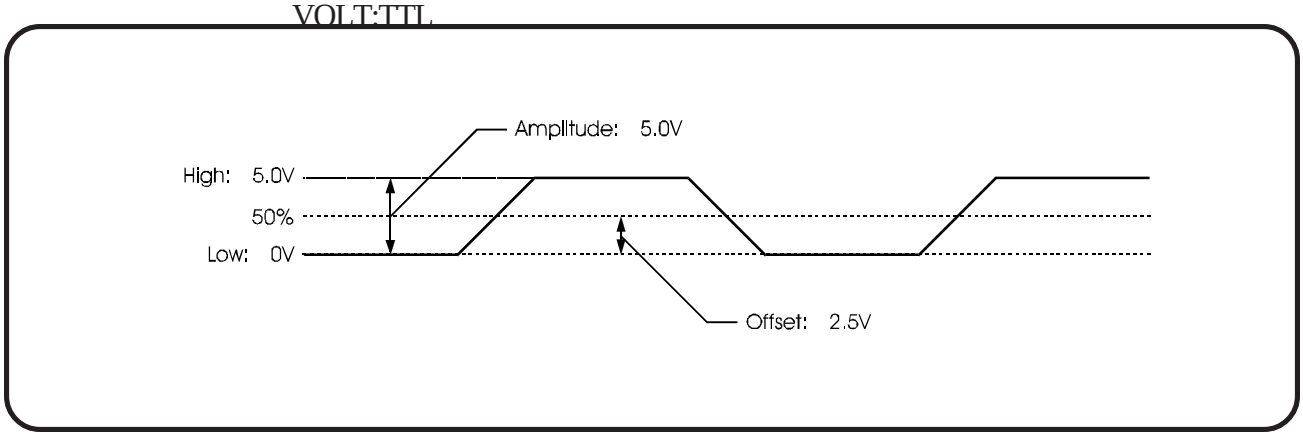


Figure 3-3.
TTL Output Parameters.

ECL Levels

If the PG is used to drive ECL logic, you may set the output parameters as shown in figure

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3-4 using any one of the command formats shown at the top of the following page.

SOURCE:VOLTAGE:LEVEL<1|2>:IMMEDIATE:ECL
SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:ECL
SOUR:VOLT:LEV2:IMM:ECL
VOLT:LEV2:ECL

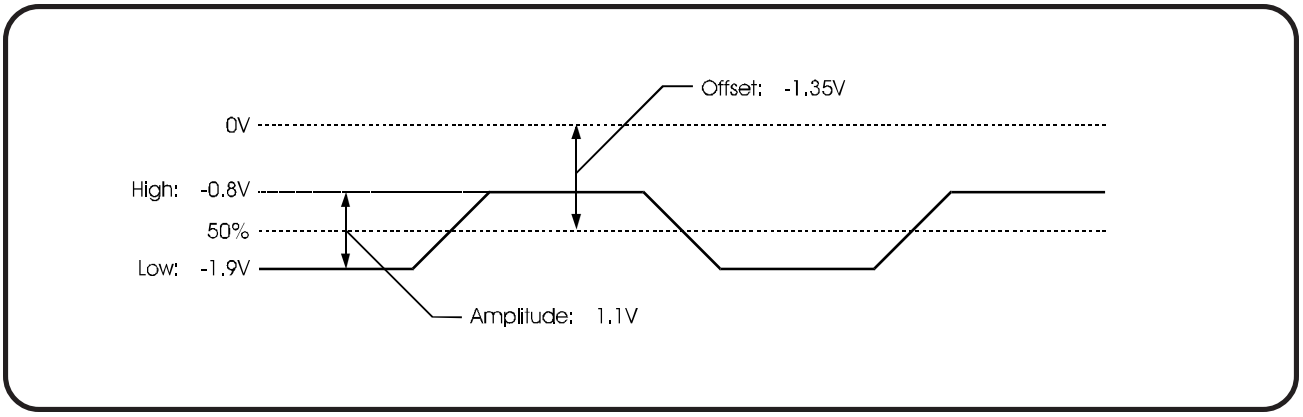


Figure 3-4.
ECL Output Parameters.

VOLT:ECL

Trigger Output

The trigger output is an ECL compatible signal. The width of the trigger output will match the programmed pulse width of channel two. If channel two is set to double pulse mode, the trigger output width will match the width of the first pulse.

3.1.3 Pulse Controls

Delay

The PG has independent delays for each channel. Pulse delay is measured from the 50% transition point of the leading edge of the Trigger pulse to the 50% transition point on the leading edge of the pulse on the output channel, and measured using the fastest slew rate for the output channel. See figure 3-5 on the following page.

Delay units are seconds and range from 0ns to (period - 1.5ns). A channel designator is used to denote which channel will be affected by the delay command. If a channel designator is omitted, then channel 1 is assumed. Seconds may be entered as a floating point number (.00000001), a floating point number with an exponent (50E-9) or as a floating point number with a unit suffix of "MS", "US" or "NS". See the examples provided.

SOURCE:PULSE:DELAY<1|2> <seconds>
SOURCE:PULSE:DELAY1 .000001

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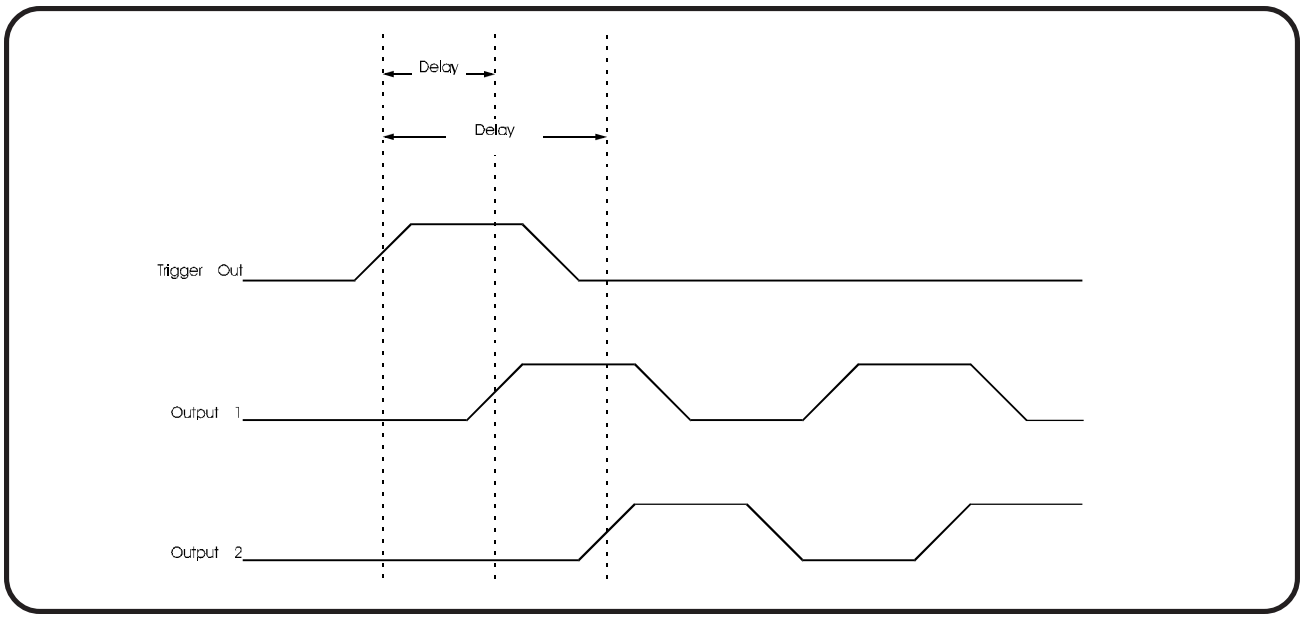


Figure 3-5.
Programmable Delay.

SOUR:PULS:DEL2 2E-6
DEL 1US

Double Pulse

Each output channel of the PG provides the capability of generating double pulse outputs. See figure 3-6. When double pulse outputs are used, another level of commands are available to control delay and to control the width of the second pulse. As each channel is provided its own delay and width control, a channel designator is used to denote which channel will be affected by the double pulse command. If a channel designator is omitted, then channel 1 is assumed.

In double pulse mode, the first pulse is always fixed at 0 delay, referenced to the trigger output. Any delay entered affects only the second pulse. Care must be taken when in the double pulse mode that pulse widths are narrow enough that both pulses fit within the defined pulse period, and that the delay value entered for the second pulse allows enough time for the first pulse to finish prior to the leading edge of the second pulse.

The double commands provides a means for enabling and disabling a channel's double pulse mode. A channel number should be specified as part of the double pulse command string. If a channel number is omitted, then the double pulse command will default to channel 1. The generic command format and command examples for enabling the double pulse mode are shown below.

SOURCE:PULSE:DOUBLE<1|2>:STATE <OFF|ON|0|1>
SOURCE:PULSE:DOUBLE1:STATE ON
SOUR:PULS:DOUB2:STAT 1

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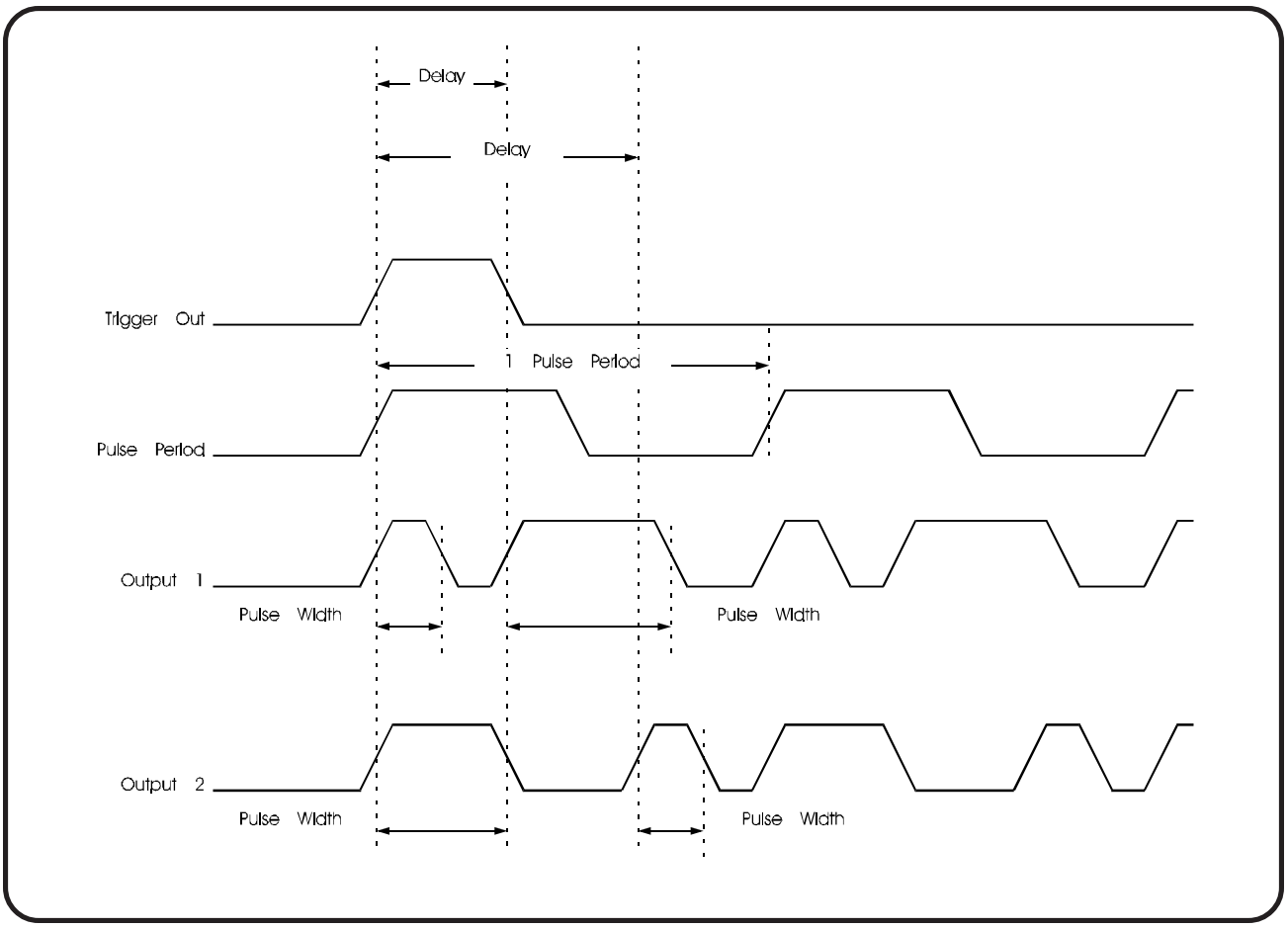


Figure 3-6.
Double Pulse Outputs.

DOUB2:STAT OFF
DOUB2 ON
DOUB OFF

Double pulse delay units are seconds and delay is measured from the rising edge of the trigger output to the leading edge of the second pulse. Each channel has independent control of its own delay, so a channel number should be specified as part of the command string. If a channel number is omitted, then the delay command will default to channel 1. Seconds may be entered as a floating point number (.000002), floating point exponential number (4.7E-6) or as a floating point number with a unit suffix of "MS", "US" or "NS". Generic, long and abbreviated command examples for controlling double pulse delay are provided below.

SOURCE:PULSE:DOUBLE<1|2>:DELAY<seconds>
SOURCE:PULSE:DOUBLE1:DELAY .000045
SOUR:PULS:DOUB2:DEL 33E-6
DOUB:DEL 630NS
DOUB2:DEL 500US

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Double pulse widths are measured from the 50% transition point on the leading edge to the 50% transition point on the trailing edge for both the first and the second pulse. Pulse widths are measured using the fastest slew rates. Each channel has independent control of their own pulse widths, so a channel number should be specified as part of the command string. If a channel number is omitted, then the pulse command will default to channel 1. You may link the width setting for the second pulse to the width setting of the first pulse. This is done by setting the auto parameter ON or OFF. The *RST default links the two pulse widths together.

The seconds parameter for double pulsed pulse widths may be entered as a floating point number (.000000005), a floating point exponential number (5.0E-9) or a floating point number with a unit suffix of "MS", "US" or "NS" (5.0NS): Various double pulse width command examples are shown below.

```
SOURCE:PULSE:DOUBLE<1|2>:WIDTH <seconds>
SOURCE:PULSE:DOUBLE<1|2>:WIDTH:AUTO <OFF|ON|0|1>
SOURCE:PULSE:DOUBLE1:WIDTH .00045
SOUR:PULS:DOUB2:WIDT 333E-3
SOUR:PULS:DOUB:WIDT:AUTO ON
DOUB2:WIDT:AUTO 0
DOUB2:WIDT 100NS
DOUB:WIDT 1.5US
```

3.1.4 Pulse Parameter Interaction

Slew Rates and Pulse Width

Pulse width is specified at the fastest slew setting within each slew range, and is measured at the 50% point of the leading and trailing edges. Changing the slew rate affects the slope of the transition, which in effect, changes the 50% transition point. If the leading and trailing slew rates are set to the same value, this effect is minimal. However, if the leading and trailing slew rates are different, then the apparent pulse width may not match the programmed pulse width. See figure 3-7.

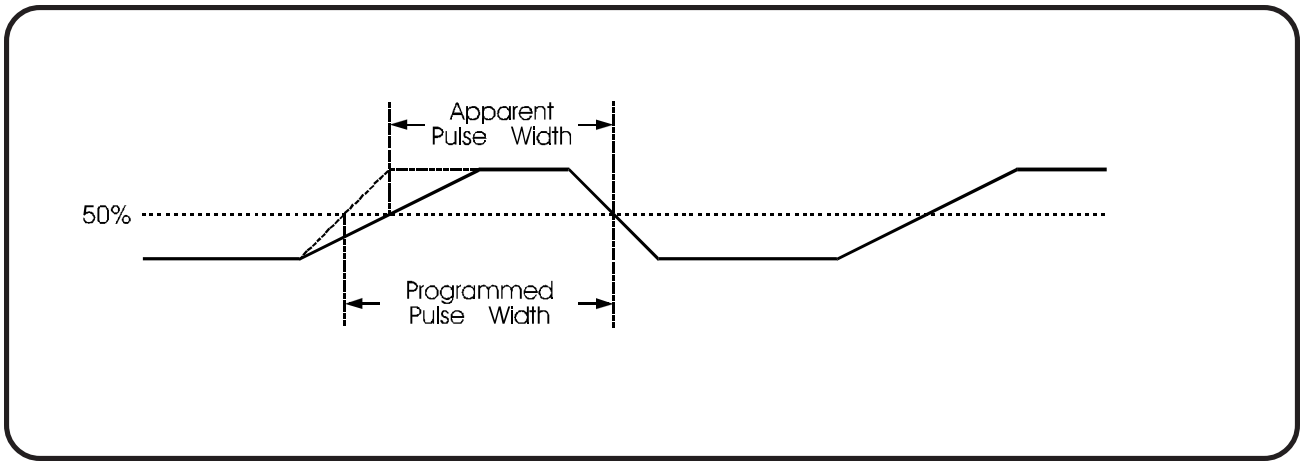


Figure 3-7.
Slew Rate vs. Pulse Width.

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Slew Rates and Amplitude

Like pulse width, the amplitude parameter can also be affected by the slew rate setting. A slow slew rate may not allow a complete transition prior to the end of the pulse, causing a waveform like that depicted in figure 3-8. The leading slew rate must be fast enough to assure a complete transition within the duration of the pulse width. Likewise, the trailing slew rate must be fast enough to assure a complete transition prior to the beginning of the next pulse period.

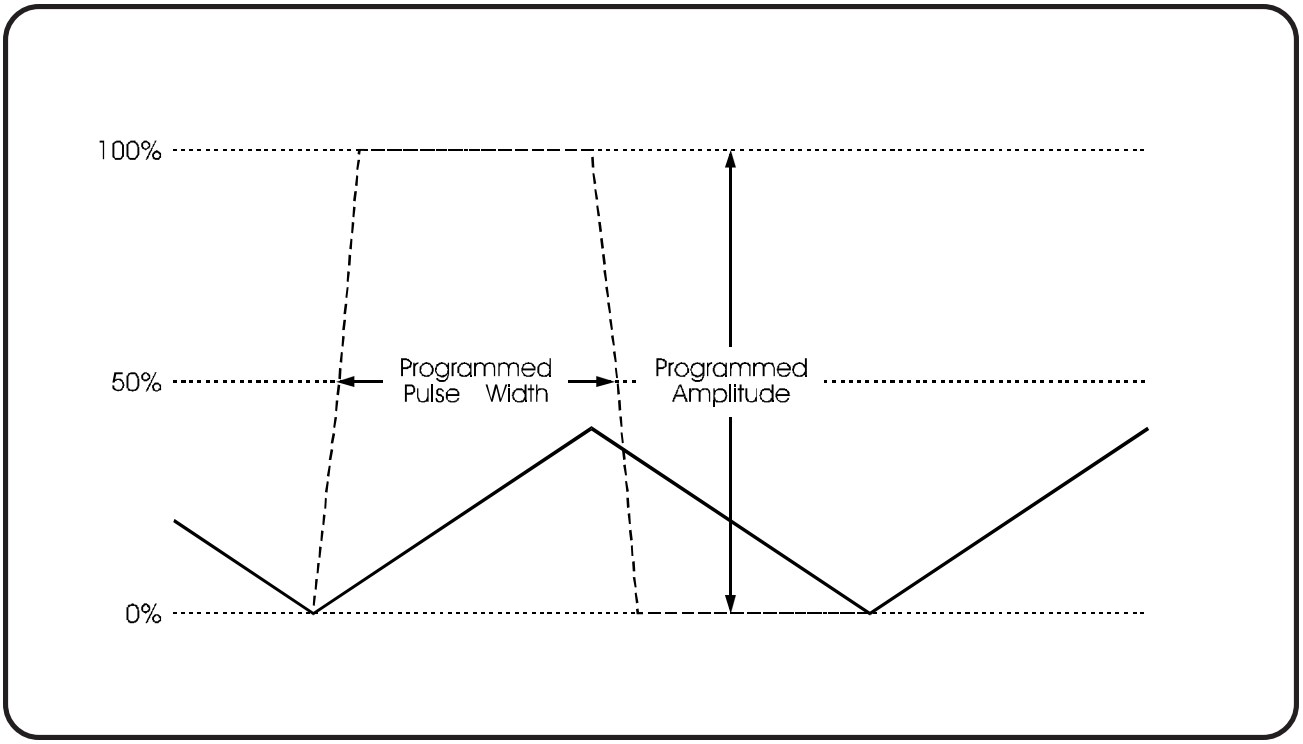


Figure 3-8.
Slew Rate vs. Amplitude.

Pulse Waveforms

By taking advantage of the programmable pulse parameters, waveforms traditionally associated with function generators can be created. The types of waveforms which may be generated are Square Waves, Trapezoidal Waves, Triangle Waves, Ramping Waves and Sawtooth Waves. See figure 3-9.

Several restrictions determine the ultimate flexibility of the waveform. For waveforms with moderate to fast slew rates (slew ranges 1 & 2), the absolute maximum amplitude is 7.0V p-p. If slower slew rates are used, the maximum amplitude is 24.0V p-p. Leading and trailing slew rates must be in the same range and must be within a 10:1 ratio of each other. The PG will force a 10:1 ratio if this rule is violated. In this instance, a query of the slew rate settings would yield a value other than what was programmed.

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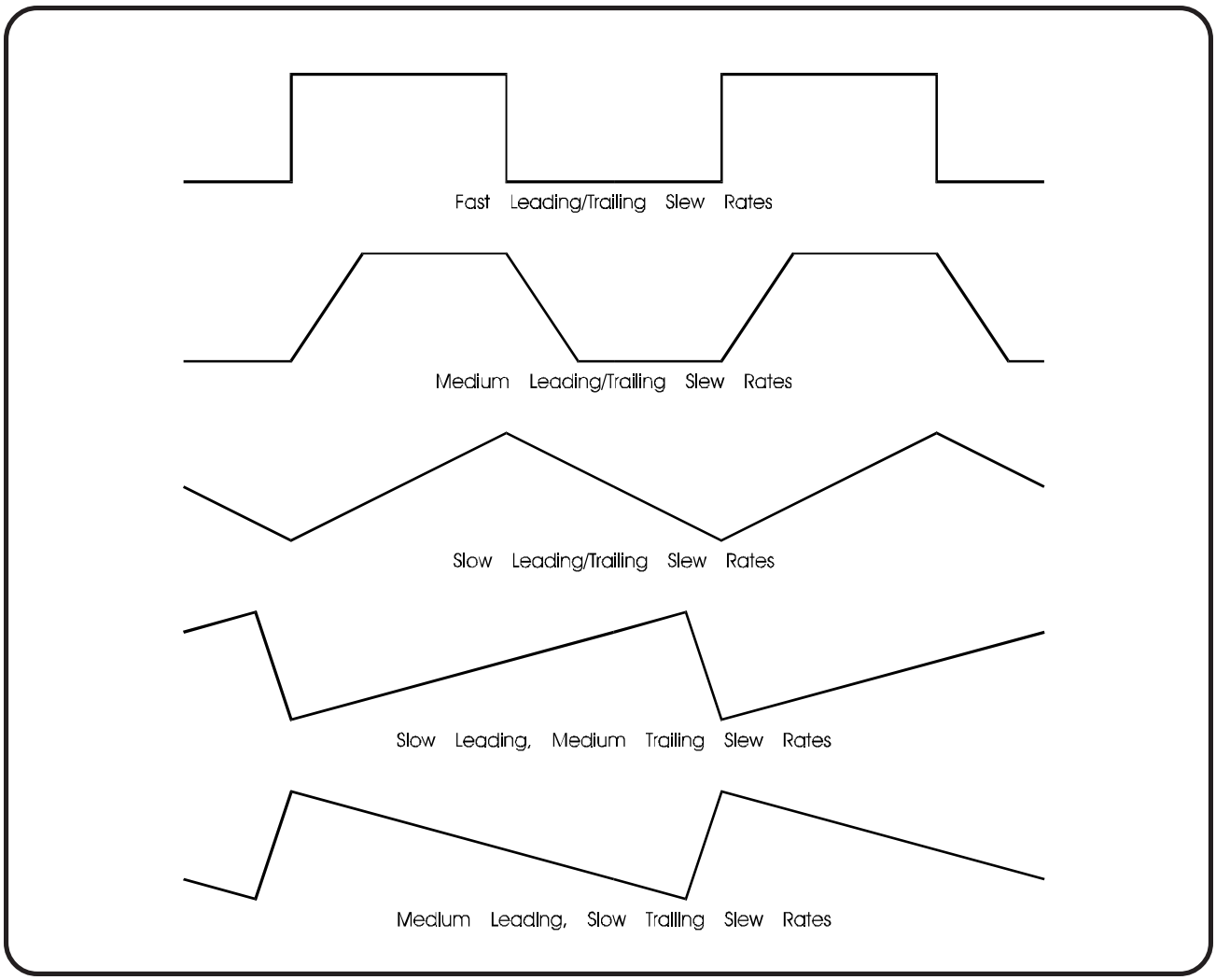


Figure 3-9.
Pulse Waveforms.

3.2 TRIGGERING

3.2.1 Trigger Modes

There are three trigger modes available in the Pulse Generator. The trigger modes work in conjunction with the trigger sources to provide a flexible method of controlling the PG outputs. For a full description of Trigger Modes and Sources, refer to section 3.2.3, Running and Triggering.

3.2.2 Trigger Sources

There are seven trigger sources available in the PG Pulse Generator. The trigger sources work in conjunction with the trigger modes to provide a flexible method of controlling the PG outputs. Anytime an external trigger source is selected, make certain that the trigger input is set to a valid threshold using the TRIG:LEV command. The default threshold for TRIG:LEV is 0.0 volts. For a full description of Trigger Sources and Modes, refer to section 3.2.3, Running and Triggering.

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3.2.3 Running and Triggering

The PG supports many different methods of starting, stopping and triggering. The generic format for all commands having to do with these operations is shown below.

```
SOURCE:PULSE:MODE <AUTO|COUNT|EWIDTH>
TRIGGER:START:SOURCE <BUS|EXTERNAL|IMMEDIATE|TIMER|
                      TTLT<0-7>|MANUAL|EXPANSION>
SOURCE:PULSE:COUNT <count>
TRIGGER:START:TIMER <seconds>
INITIATE
ABORT
*TRG
```

The commands SOURCE:PULSE:MODE and TRIGGER:START:SOURCE are used to define the starting and triggering method. The remaining commands are used for setting the burst count, the timer value, to start the PG or stop the PG.

The following sections describe the various triggering possibilities. The header of each section defines the MODE and SOURCE parameters of the SOUR:PULS:MODE command sequence and the TRIG:STAR:SOUR command sequence, respectively. For example the **Auto Immediate** header refers to the commands SOUR:PULS:MODE AUTO and TRIG:STAR:SOUR IMMEDIATE.

Auto Immediate

Pulse outputs start immediately when the TRIGGER:SOURCE:IMMEDIATE command is sent. This implies that the SOURCE:PULSE:MODE AUTO must be sent first. Pulse outputs are terminated using the ABORT command. See figure 3-10.

Auto Bus

Pulse outputs start when either the word serial trigger command, *TRG or the INITIATE command is sent. The order of the MODE and SOURCE commands are not critical. Pulse outputs are terminated using the ABORT command. See figure 3-10.

Auto Manual

Pulse outputs start when the INITIATE command is sent. The order of the MODE and SOURCE commands are not critical. Pulse outputs are terminated using the ABORT command. See figure 3-10.

Auto External

Pulse outputs are gated via the front panel trigger input signal. Gating is level sensitive, so while the gate is active, pulse outputs are enabled. When the gate goes inactive, pulse activity stops, after completion of the current pulse cycle. See figure 3-11.

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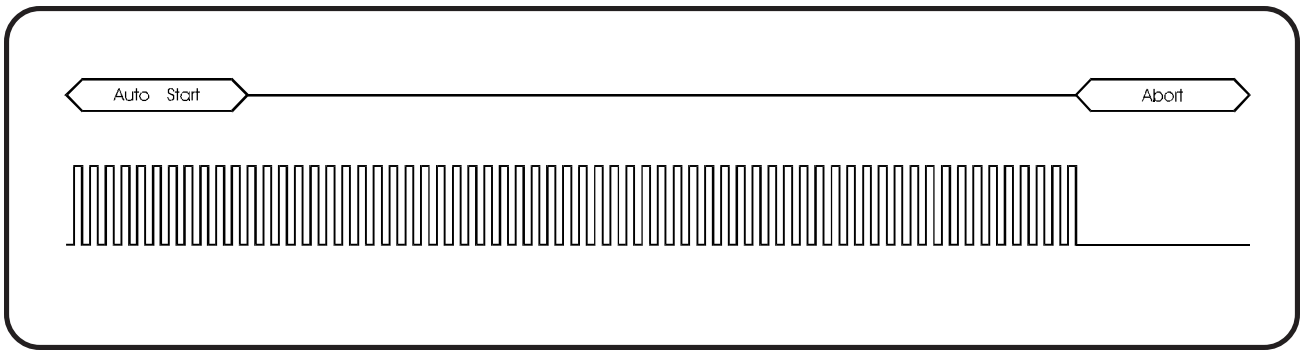


Figure 3-10.
Auto Immediate / Bus / Manual Trigger.

Auto TTLTRG

Pulse outputs are gated via the selected VXI TTLTRG signal. The active TTLTRG signal is selected using the TRIGGER:START:SOURCE TTLT command. Gating is level sensitive, so while the gate is active, pulse outputs are enabled. When the gate goes inactive, pulse activity stops, after completion of the current pulse cycle. See figure 3-11.

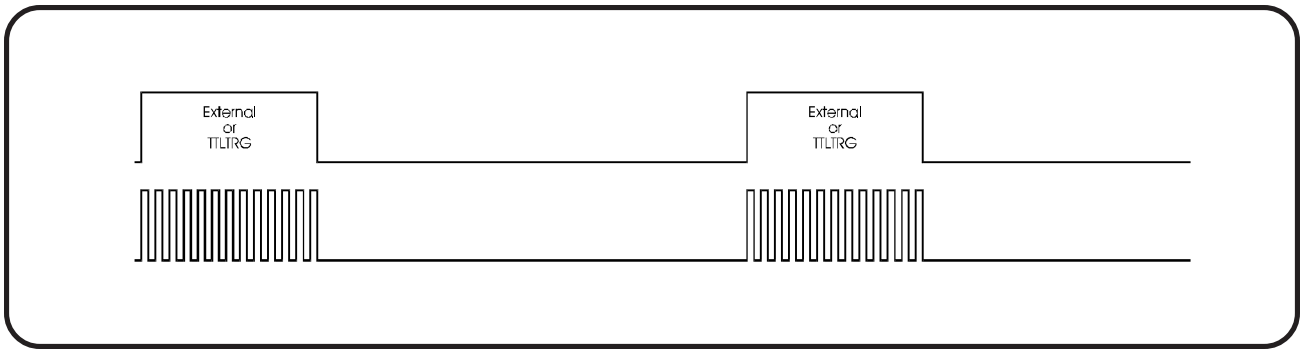


Figure 3-11.
Auto External / TTLTRG Trigger.

Count Immediate

The PG will send a burst of pulses when the TRIGGER:SOURCE:IMMEDIATE command is sent. The SOURCE:PULSE:MODE COUNT command must be set prior to the TRIGGER:SOURCE:IMMEDIATE command. The number of pulses sent in the burst is defined with the SOURCE:PULSE:COUNT command. The count range is 1 to $2^{29+}2^5$ ($536{,}870{,}944_{10}$, 20000020_{16}). After the pulse burst is complete, the PG110 will wait for the next TRIGGER:SOURC:IMMEDIATE command before sending another burst of pulses. See figure 3-12.

Count Bus

The PG will output a burst of pulses when either the VXI bus word serial trigger command, *TRG command or INITIATE command is sent. The number of pulses sent in the burst is defined with the SOURCE:PULSE:COUNT command. The count range is 1 to $2^{29+}2^5$

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($536,870,944_{10}$, 20000020_{16}). After the pulse burst is complete, the PG will wait for the next VXI bus word serial trigger command, *TRG command or INITIATE command before sending another burst of pulses. See figure 3-12.

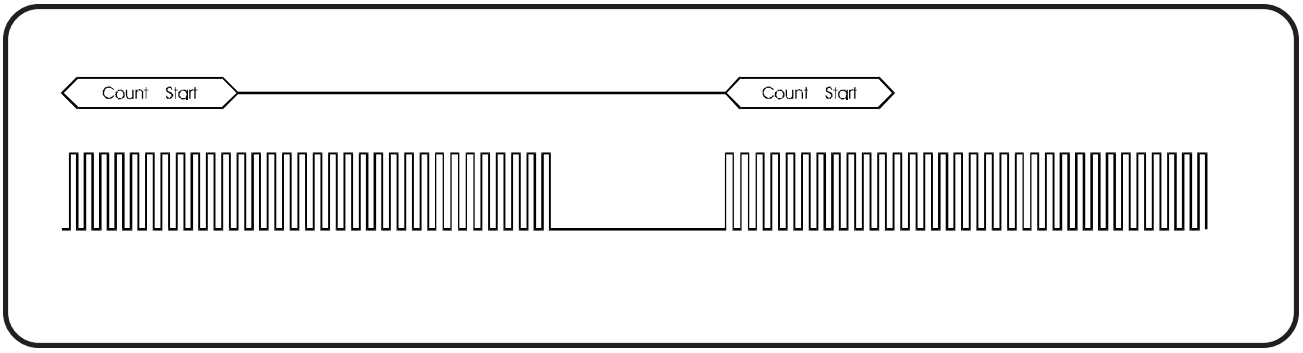


Figure 2-12.
Count Immediate / Bus Trigger.

Count Timer

The PG will output a burst of pulses immediately upon receipt of the TRIGGER: SOURCE: TIMER command, and will periodically re-trigger at the rate defined by TRIGGER:START: TIMER. Valid timer ranges are 80 us to 10 seconds. The number of pulses sent in the burst is defined with the SOURCE:PULSE:COUNT command. Valid count ranges are 1 to $2^{29+}2^5$ ($536,870,944_{10}$, 20000020_{16}). The SOURCE:PULSE:MODE COUNT command, SOURCE:PULSE:COUNT command and the TRIGGER:START:TIMER command must be sent prior to the TRIGGER:START:TIMER command. See figure 3-13.

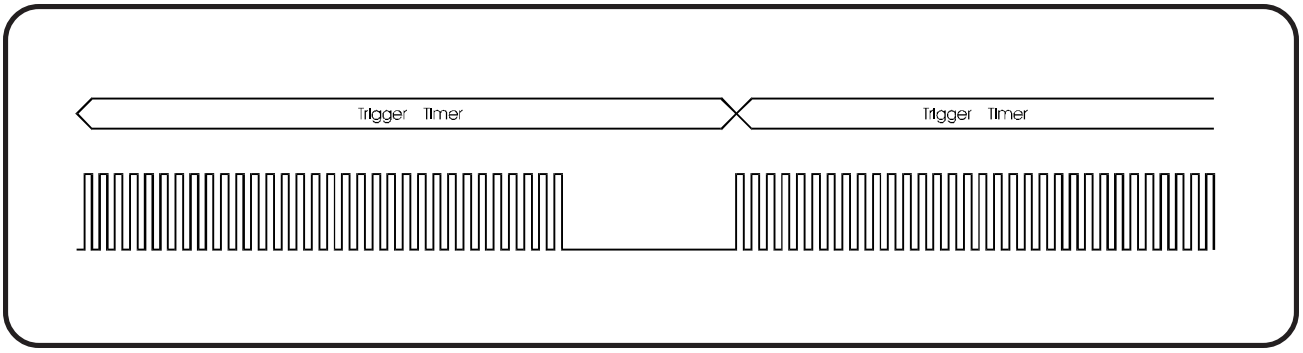


Figure 3-13.
Count Timer Trigger.

Count External

The PG will send a burst of pulses on the rising edge of the front panel trigger signal. The burst count is defined using the SOURCE:PULSE:COUNT command. Valid count ranges are 1 to $2^{29+}2^5$ ($536,870,944_{10}$, 20000020_{16}). The external trigger input is edge sensitive, so after the pulse burst is complete, the PG will wait for another rising edge on the external trigger input before sending another burst of pulses. See figure 3-14.

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Count TTLTRG

The PG will send a burst of pulses concurrent with the rising edge of the selected VXI TTLTRG trigger signal. The active TTLTRG signal is selected using the TRIGGER:START:SOURCE TTLT command. The burst count is defined using the SOURCE:PULSE:COUNT command. Valid count ranges are 1 to $2^{29+}2^5$ (536,870,944$_{10}$, 20000020$_{16}$). The VXI TTLTRG trigger is edge sensitive, so after the pulse burst is complete, the PG will wait for another rising edge of the selected VXI TTLTRG trigger signal before sending another burst of pulses. See figure 3-14.

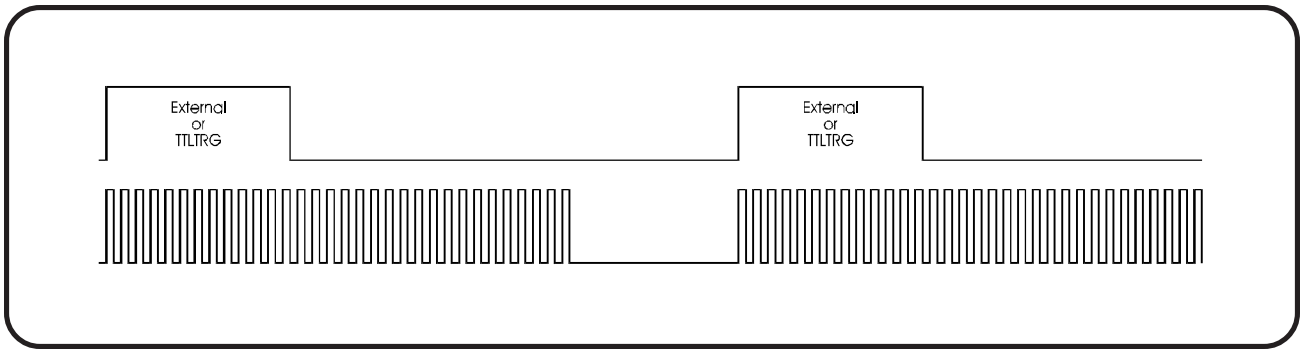


Figure 3-14.
Count External / TTLTRG Trigger.

Ewidth External

The output pulse of both channels mirror the external front panel trigger input signal. Programmable control for the leading and trailing slew rates, as well as individual channel amplitude and trigger delay controls, remain available. There is a typical delay of 17.5 ns from the external trigger edge to the corresponding EWIDTH output edge, measured using the fastest slew rate. When the SOURCE:PULSE:MODE EWIDTH command is entered, the TRIGGER:SOURCE automatically defaults to EXTERNAL. See figure 3-15.

3.2.4 Master/Slave

The PG supports a special mode in which up to six PG modules may be slaved to a master PG. The master PG provides the pulse period and triggering to itself, and to each of the slave modules. Each slave retains control of amplitude, slew rates, pulse width/duty cycle, trigger delay and single/double pulse modes.

Refer to section 2.2.2 for instructions on installing and connecting master and slave PG modules. After installation, program the master and each slave unit for the same PULSE:MODE and PULSE:PERIOD values. If the pulse mode is set to COUNT, then program the master and slave units for identical COUNT values. The master PG may be programmed for any trigger source except IMMEDIATE and EXPANSION. Each slave module must be programmed for a trigger source of EXPANSION. After a slave module's trigger source is set to EXPANSION, a MASTER? query will return the response "SLAVE". Once configured and programmed, any trigger of the master PG will also trigger the slaves. Refer to figure 3-16.

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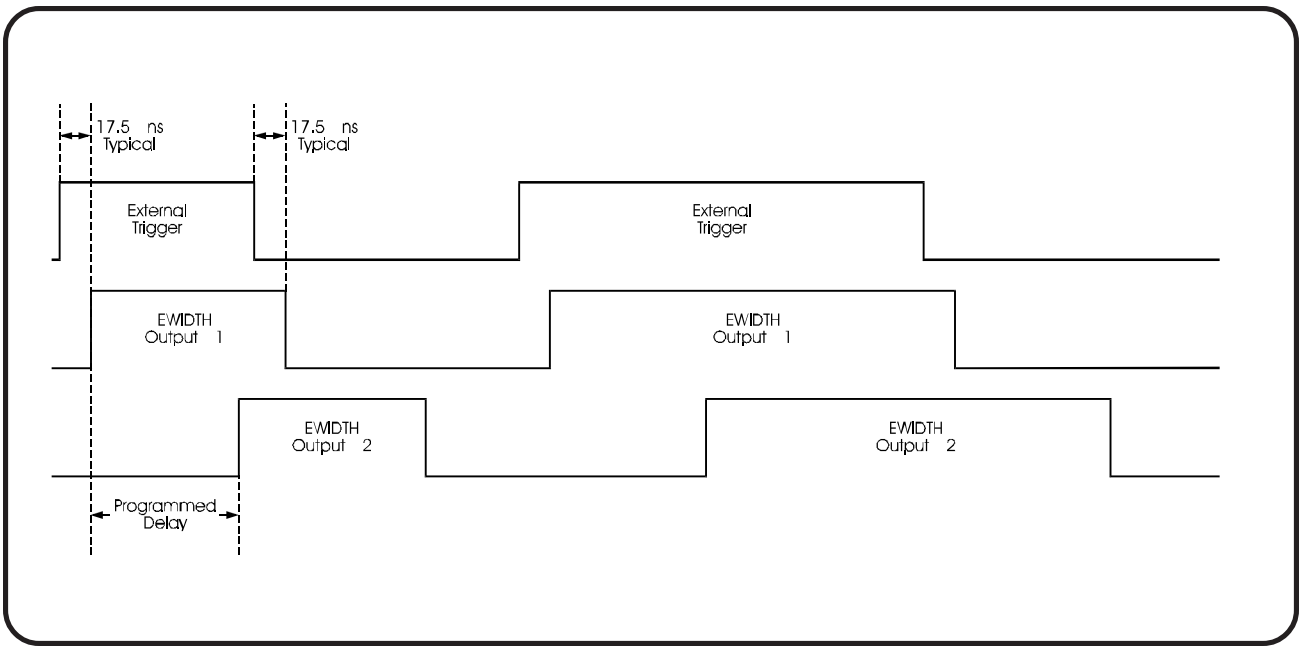


Figure 3-15.
Ewidth External Trigger.

Note, it is acceptable to configure a PG module for Slave operation and to not set the trigger source to EXPANSION. In this case, the PG will operate in the normal, stand-alone, fashion. This eliminates the need to disconnect cables or reconnect cables when changing between the Master and Slave modes.

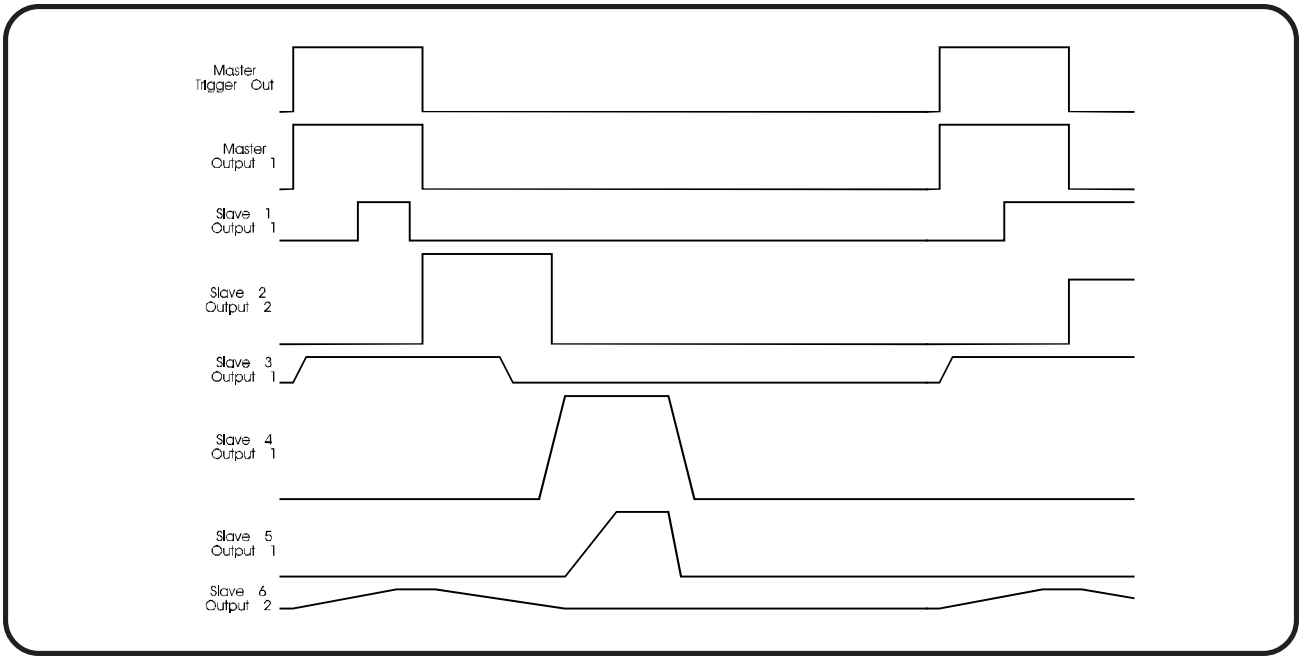


Figure 3-16.
Master / Slave Operation.

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CHAPTER 4: COMMAND SET

The PG (pulse ggenerator) is controlled via a set of word serial commands defined specifically for pulse generator control in the Standard Commands for Programmable Instruments (SCPI), 1992 edition. Due to the robust feature set of the PG, some additional commands have been added that, while not defined in SCPI, do follow the rules and syntax of SCPI commands, and provide access to the unique features found in the PG.

4.1 SCPI SYNTAX

SCPI commands are defined in a tree structure starting with a basic command function, called the command root, and expanding functionality by adding additional command descriptors, called command branches, until the final control parameter, called a command leaf, is defined. In this way, commands may be logically grouped together based on functionality.

The paragraph number for each SCPI defined root, branch and leaf is provided in parenthesis () next to the command (reference SCPI, Volume 2: Command Reference, 1992). For commands not defined by SCPI, the words (NON-SCPI) are found in place of the paragraph number.

To assist in keeping track of the root command and its branches as you negotiate through the various command levels, the complete command syntax up to the level you are accessing is provided in the header space of each page. Commands are listed by root alphabetical order, and then by SCPI branch/leaf paragraph order. Use the command references found on the following pages to help identify commands by function, root, branch and leaf.

SCPI branches and leaf commands use the colon (:) character as a prefix, which means to decend one level in the command tree. Root commands have no prefix. Some SCPI command paths are quite lengthy. To avoid typing in the full command path, several short-cuts are available. For example, some SCPI command words are optional. These commands are listed in brackets []. Also, each SCPI command has a long and an abbreviated format. The required abbreviated format is shown in capital letters, while the characters making up the optional long format are shown in lower case. The following two command strings are identical in function.

1. SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:AMPLITUDE 5.0
2. VOLT 5.0

Another shortcut provided is the semicolon character (;). Using a semicolon allows you to remain at the same level in the command path and enter multiple parameter values, instead of having to re-enter the entire command path for each value entered. The first two commands in the following examples may be replaced by the third example.

1. SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:HIGH 5.0
2. SOURCE:VOLTAGE:LEVEL1:IMMEDIATE:LOW 0
3. VOLT:HIGH 5.0;LOW 0

Since the parameters HIGH and LOW are at the same level within the SOURCE:VOLTAGE command path, the semicolon may be used to omit all of the path command words up to this level where HIGH and LOW are located.

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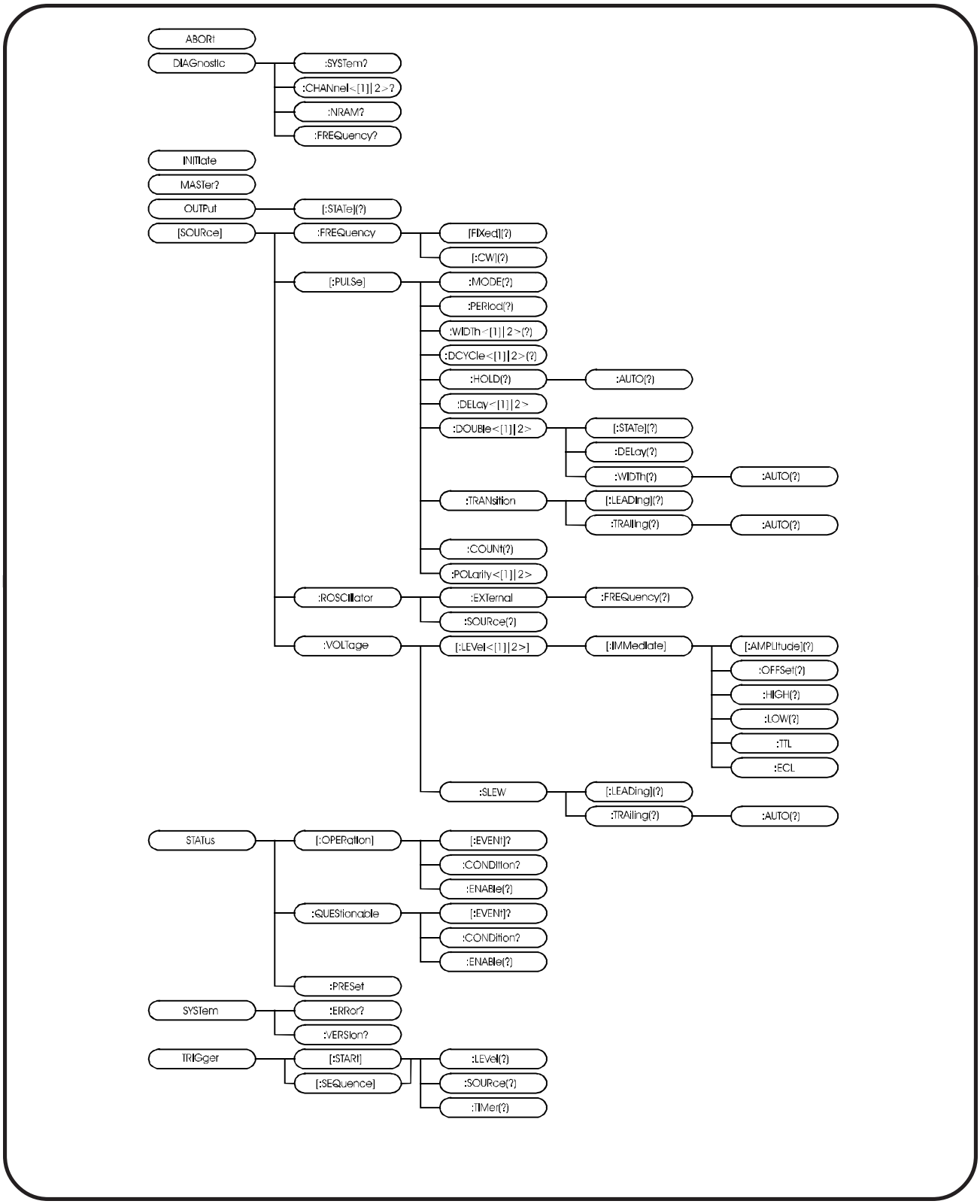


Figure 4-1.
SCPI Quick Reference.

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488.2 QUICK REFERENCE

```
*CLS                    *SAV
*ESE (?)                *SRE(?)
*ESR?                   *STB?
*IDN?                   *TRG
*OPC (?)                *TST?
*RCL                    *WAI
*RST
```

Command Key

command	Command parameters take three forms, ROOT, BRANCH, and LEAF. The ROOT is the beginning of a command structure, i.e. the first command word in a statement. Branches are the connecting paths between the ROOT and the LEAF. Branches do not have parameters associated with them, but may have suffixes, usually a channel indicator. The LEAF terminates the command string and may or may not have parameters associated with them.
command(?)	Commands listed in the SCPI Quick Reference which are followed by a question mark in parenthesis indicate a command format supporting both a command and a command query
command?	Any command string followed by a question mark indicates a command query only
UPPERCASE	Command characters displayed in uppercase are required characters
lowercase	Command characters displayed in lowercase are optional characters
<required>	Required parameter
[option]	Optional command or parameter
{repeat}	Repeat this parameter as many times as required
(min - max)	The parameter value entered must be within the range of min to max, inclusive
aaa | bbb	Acceptable choices are aaa OR bbb . . .
response	Response from PG

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4.2 SCPI COMMANDS

Following is a list of the SCPI and Non-SCPI commands supported by the PG Pulse Generator. Each SCPI command is referenced to the SCPI paragraph defining it, as provided by the SCPI 1992 Command Reference document, Volume 2. If the command is not part of the defined SCPI commands, then they will be designated Non-SCPI.

ABORT (SCPI 22.5)

Function: Places all trigger sequences in the idle state and returns the instrument to the programming state.

Syntax: ABORt

Remarks: If the pulse generator is in the AUTO or EWID mode, the reset occurs immediately. If the pulse generator is in the COUNT mode, then the pulse generators waits for completion of the current count condition before resetting. This root level command has no associated *RST condition or query form.

Example: ABORT

See Also: SOURCE:PULSE:MODE:AUTO, SOURCE:PULSE:MODE:COUNT, SOURCE:PULSE:MODE EWIDTH

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DIAGNOSTIC (SCPI 6.0)

Function: Root command to all diagnostic tests.

Syntax: DIAGnostic

Remarks: The PG has a comprehensive set of diagnostic routines built-in. These tests may be run in whole, or in part, depending on the terminating command option selected. All memory tests are non-destructive to the memory being tested.

DIAGNOSTIC causes the PG to run the indicated diagnostic tests and place a response into the output queue indicating whether or not the self test completed without any detected errors. The diagnostic process will stop execution on the first detected error.

The IEEE 488.2 command *TST? is an alias of the command DIAGNOSTIC:SYSTEM?. A description of the various diagnostic commands follows.

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:SYSTEM? (NON-SCPI)

Function: Performs a system wide diagnostics test and returns the results. Tests run are NRAM, CHAN1, CHAN2 and FREQ. This test performs the same function as the 488.2 command *TST?.

Syntax: SYSTem?

Response: error,message

Remarks: SYSTEM performs all sub-diagnostics test routines and reports back on the results of the tests. Diagnostics routines performed are non-volatile RAM checksum test, channel 1 and channel 2 diagnostics test and a frequency test. DIAG:SYST? is an alias of *TST? and is functionally identical. The diagnostic process will stop execution on the first detected error. If no errors are detected, the SYSTEM diagnostics test should complete in <2 seconds.

Example: DIAGNOSTIC:SYSTEM?
0,"No Error"

:CHANNEL? (NON-SCPI)

Function: Performs a output level test on the selected channel.

Syntax: CHANnel<[1]|2>?

Response: error,message

Remarks: The channel diagnostic test performs a check of the output levels on the selected channel, and the associated DACs. This test uses comparators to test the output with respect to reference levels supplied by the DACs. The test does not check accuracy, only functionality. The CHANNEL diagnostics test should complete in < 1 second.

Example: DIAGNOSTIC:CHANNEL2?
0,"No Error"

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:NRAM? (NON-SCPI)

Function: Performs a non-volatile RAM checksum test and reports back the results.

Syntax: NRAM?

Response: error,message

Remarks: The NRAM test performs a checksum test of all non-volatile RAM in the PG system and reports back the results. The NRAM diagnostics test should complete in <1 second.

Example: DIAGNOSTIC:NRAM?
0,"No Error"

:FREQUENCY? (NON-SCPI)

Function: Performs a frequency diagnostic test and reports results.

Syntax: FREQuency?

Response: error,message

Remarks: The frequency diagnostic test performs gross accuracy check of the internal PLL oscillator and divider circuit by programming a 10ms period, starting an internal timer, waiting for the period to complete and then checking the value of the internal timer. Any response other than "0,No Error" is an error message.

Example: DIAGNOSTIC:FREQ?

0,"No Error"

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INITIATE (SCPI 22.4)

Function: This command is used to initiate a trigger if the trigger source is set to MANUAL or BUS.

Syntax: INITiate

Remarks: This command is an alias for the IEEE 488.2-1987 *TRG command.

Example: INITIATE

MASTER

MASTER? (NON-SCPI)

Function: Queries the software configuration of the PG module to determine Master/Slave status.

Syntax: MASTer?

Response: SLAVE|MASTER

Remarks: PG modules may be configured as a stand-alone pulse generator, or, a single PG module may be configured as a Master module used to control up to six (6) additional PG slave modules. A PG is configured as a slave by setting the trigger source to expansion.

Example: MASTER?
MASTER

See Also: TRIGGER:SOURCE:EXPANSION

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OUTPUT (SCPI 13)

Function: The OUTPUT group of commands are used to enable or disable the output of the Pulse Generator.

Syntax: OUTPut

Remarks: The PG is configured with output isolation relays. OUTPUT is the root command used to enable/disable the relays, and to query the state of the relays.

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:STATE (SCPI 13.10)

Function: Controls whether the output terminals are open or closed.

Syntax: :STATe <OFF | ON | 0 | 1>

Default: OFF

Remarks: When the function is 'OFF', the terminal relays are open and the terminals are at maximum isolation from the signal. This command leaf requires the command root 'OUTPUT'.

Example: OUTPUT:STATE ON

:STATE? (SCPI 13.10)

Function: Query the current output state.

Syntax: :STATe?

Response: 0 | 1

Remarks: Returns the current output state. See the previous command ':STATE' for further explanation of the returned value. This command requires the root 'OUTPUT'.

Example: OUTPUT:STATE?
1

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SOURCE (SCPI 17)

Function: Select the output source commands.

Syntax: [SOURce]

Remarks: This prefix selects the group of commands used to define the output characteristics of the pulse generator signals. This is a root level command, and, being the default command prefix, is optional.

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:FREQUENCY (SCPI 17.6)

Function: Provides an alternate method of setting the PG period.

Syntax: FREQuency

Remarks: The frequency command path allows the PG pulse repetition rate to be programmed as a frequency, instead of as a period. The next level command path supports either :FIXED or :CW. However, since both formats are optional, they may both be omitted.

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:FIXED OR :CW (SCPI 17.6.2)

Function: Sets the fixed frequency of the pulse generator

Syntax: [:FIXed] <hertz | MIN | MAX | DEF>
[:CW] <hertz | MIN | MAX | DEF>

Range: PG110 = (10 - 300E6); PG100 = (10 - 100E6)

Default: 10.00E6 (PG110)

Remarks: This optional terminating leaf defines the output frequency of the Pulse Generator. The command :CW is an alias of :FIXED and is also optional. Frequency units are measured in hertz. The FREQUENCY command supports the suffixes Hz, KHz and MHz.

Example: SOURCE:FREQUENCY:FIXED 100E6
FREQ 100 MHz

:FIXED? OR :CW? (SCPI 17.6.2)

Function: Queries the current period setting

Syntax: [:FIXed]?
[CW]?

Response: hertz

Remarks: Returns the current frequency setting. Returned values are in hertz. The command :FIXED is optional. Its alias, :CW?, is also optional

Example: SOURCE:FREQUENCY:FIXED?
10E6

FREQ?
100E6

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:PULSE (SCPI 17.14)

Remarks: Select the commands for setting the pulse characteristics.

Syntax: [:PULSe]

Remarks: This is a first level branch under SOURCE and is used to set the pulse parameters. Pulse is the default command branch and is optional.

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:MODE (NON-SCPI)

Function: Sets the pulse output mode for the pulse generator.

Syntax: :MODE <AUTO | COUN[T] | EWID[TH]>

Default: AUTO

Remarks: If MODE is set to AUTO, the PG will continuously output pulses. The COUNT parameter is used when it is desired to output a fixed number of pulses. EWIDTH uses the external trigger input as an enable gate.

Example: SOURCE:PULSE:MODE COUNT

See Also: SOURCE:PULSE:COUNT, TRIGGER:SEQUENCE:SOURCE, TRIGGER:SEQUENCE:TIMER, INITIATE, ABORT, *TRG.

:MODE? (NON-SCPI)

Function: Queries the PG output mode.

Syntax: :MODE?

Response: AUTO | COUN | EWID

Remarks: None

Example: SOURCE:PULSE:MODE?
COUNT

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:PERIOD (SCPI 17.14.1)

Function: Sets the period of the pulse generator

Syntax: :PERiod <seconds | MIN | MAX | DEF>

Range: PG110 = (3.33E-9 - 100E-3)
PG100 = (10.0E-9 - 100E-3)

Default: 100.00E-9

Remarks: This terminating leaf defines the output period of the Pulse Generator. Period units are measured in seconds

Example: SOURCE:PULSE:PERIOD 100E-9
PER 1us

:PERIOD? (SCPI 17.14.1)

Function: Queries the current period setting

Syntax: :PERiod?

Response: seconds

Remarks: Returns the current period setting. Returned values are in seconds

Example: SOURCE:PULSE:PERIOD?
100E-9

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:WIDTH (SCPI 17.14.2)

Function: Sets the pulse width or duration.

Syntax: WIDTh<[1] | 2> <seconds | MIN | MAX | DEF>

Range: PG100 = (5.0E-9 to PERIOD-5.0E-9)
PG110 = (1.5E-9 to PERIOD-1.5E-9)

Default: 50E-9

Remarks: When setting pulse width, the PG will default to channel 1 unless otherwise specified. The positive portion of the pulse is determined by the pulse polarity. Sending the *RST command will force the pulse width to the default setting. The default value for MAX will vary depending on the current PERIOD setting. :WIDTH and :DCYCLE are mutually exclusive. Units are measured in seconds.

Example: SOURCE:PULSE:WIDTH 1E-6
WIDT 5ns

See Also: SOURCE:PULSE:POLARITY, SOURCE:PULSE:HOLD

:WIDTH? (SCPI 17.14.2)

Function: Queries the current pulse width setting

Syntax: :WIDTh<[1]|2>?

Response: seconds

Remarks: When querying pulse width, the PG will default to channel 1 unless otherwise specified.

Example: SOURCE:PULSE:WIDTH?
4.5E-3

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:DCYCLE (SCPI 17.14.3)

Function: Set the duty cycle of the pulse waveform.

Syntax: :DCYCle<[1] | 2> <percent | MIN | MAX | DEF>

Range: (1 - 99)

Default: 50% of current period setting

Remarks: The resulting waveform will have a positive width determined by (period x (duty cycle / 100)). When double pulse is enabled, both pulse widths are (period x (duty cycle / 200)). The positive portion of the pulse is determined by the pulse polarity. If a channel is not specified, the PG will default to channel 1. Sending the *RST command will force the pulse duty cycle to the default setting. :DCYCLE and :WIDTH are mutually exclusive.

Example: SOURCE:PULSE:DCYCLE1 25
See Also: SOURCE:PULSE:POLARITY, SOURCE:PULSE:HOLD

:DCYCLE? (SCPI 17.14.3)

Function: Query the duty cycle setting

Syntax: :DCYCle <[1] | 2>?

Response: 1 - 99

Remarks: Response is returned as percentage of total cycle time. See the DCYCLE command for details regarding the returned value. If a channel is not specified, the PG will return the DCYCLE of channel 1.

Example: SOURCE:PULSE:DCYCLE2?
25

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:HOLD (SCPI 17.14.4)

Function: Defines the parameter to be held constant when the period changes

Syntax: :HOLD <WIDTh | DCYCle>

Default: :WIDT

Remarks: The defined hold parameter is valid for both output channels.

Example: SOURCE:PULSE:HOLD WIDTH
See Also: SOURCE:PULSE:WIDTH, SOURCE:PULSE:DCYCLE

:HOLD? (SCPI 17.14.4)

Function: Queries which pulse parameter is held constant when the pulse period changes.

Syntax: :HOLD?

Response: WIDT | DCYC

Remarks: None

Example: SOURCE:PULSE:HOLD?
DCYC

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:AUTO (NON-SCPI)

Function: When set to on, couples the pulse width, or duty cycle, of channel 2 to the pulse width, or duty cycle, of channel 1.

Syntax: :AUTO <OFF | ON | 0 | 1>

Default: :ON

Remarks: None

Example: SOURCE:PULSE:HOLD:WIDTH:AUTO ON

See Also: SOURCE:PULSE:WIDTH, SOURCE:PULSE:DCYCLE, SOURCE:PULSE:HOLD

:AUTO? (NON-SCPI)

Function: Queries the state of the HOLD:AUTO function.

Syntax: :AUTO?

Response: 0 | 1

Remarks: None

Example: SOURCE:PULSE:HOLD:AUTO?
1

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:DELAY (SCPI 17.14.5)

Function: Set delay time from trigger to first output pulse.

Syntax: :DELay<[1] | 2> <seconds | MIN | MAX | DEF>

Range: (0 to PERIOD)

Default: 0

Remarks: Sets the time from the rising edge of the trigger out signal to the leading edge of the pulse. When defining the pulse delay parameter the PG will default to channel 1 unless otherwise specified. The fundamental value for DELAY is seconds, and starts immediately after the pulse generator is triggered.

Example: SOURCE:PULSE:DELAY2 5.0E-6
DEL1 6us

:DELAY? (SCPI 17.14.5)

Function: Query the delay setting.

Syntax: :DELay<[1]|2>?

Response: seconds

Remarks: Returns the time delay setting for the specified channel. If a channel number is not specified, the delay value for channel 1 will be returned.

Example: SOURCE:PULSE:DELAY
100E-6

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:DOUBLE (SCPI 17.14.6)

Function: Defines a channel for double pulsed outputs

Syntax: :DOUBle<[1]|2>

Default: None

Remarks: Sets the corresponding channel for the double pulsed outputs. Since 'SOURCE', and ':PULSE' are default prefixes, their use preceding the ":DOUBLE' branch is optional. When a channel is defined for double pulsed outputs, that channel looses the trigger delay capabilities for the first pulse of the double pulsed sequence. The second pulse retains the capability of delaying its output relative to the first pulse (i.e., the trigger).

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:STATE (SCPI 17.14.6.1)

Function: Set the double pulse mode ON or OFF.

Syntax: :[STATe] <OFF | ON | 0 | 1>

Default: OFF

Remarks: STATE is an optional parameter for the command SOURCE:PULSE:DOUBLE, as are SOURCE and PULSE themselves. SOURCE:PULSE:DOUBLE1:STATE ON abbreviates as DOUB:ON

Examples: SOURCE:PULSE:DOUBLE1:STATE ON
DOUB2 OFF

:STATE? (SCPI 17.14.6.1)

Function: Query the setting for double pulse.

Syntax: [:STATe]?

Response: 0 | 1

Remarks: Returns the current setting for the double pulse on the channel selected.

Example: DOUB:STATE?
1

SOUR:PULS:DOUB2:STAT?
0

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:DELAY (SCPI 17.14.6.2)

Function: Set the delay time between the start of the first pulse and the first edge of the second pulse.

Syntax: :DELay <seconds | MIN | MAX | DEF>

Range: (0 to PERIOD)

Default: 0

Remarks: Time is in seconds. When double pulse is enabled, this delay value must be set such that the second pulse is not coincident with the first pulse.

Example: DOUBLE2:DELAY .00005
DOUB:DEL 3us

:DELAY? (SCPI 17.14.6.2)

Function: Query the delay between double pulses.

Syntax: :DELay?

Response: seconds

Remarks: Returns the time period between the start of the first pulse, and the first edge of the second pulse.

Example: :DOUBLE1:DELAY?
50E-6

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:WIDTH (NON-SCPI)

Function: Sets the pulse width of the second pulse in a double pulsed output.

Syntax: WIDTh <seconds | MIN | MAX | DEF>

Range: PG110 = 1.5E-9 to (100E-3 - 1.5E-9)
PG100 = 5.0E-9 to (100E-3 - 5.0E-9)

Default: 50E-9

Remarks: Width is in seconds. Sending *RST will force the width to the default setting. Width is also a connecting branch to the AUTO parameter.

Example: SOURCE:PULSE:DOUBLE1:WIDTH 10E-6
DOUB:WIDT 25ns

:WIDTH? (NON-SCPI)

Function: Query the width value of the second pulse in a double pulsed output.

Syntax: WIDTh?

Response: seconds

Example: SOURCE:PULSE:DOUBLE2:WIDTH?
100E-9

:DOUB:WIDT?
10E-6

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:AUTO (NON-SCPI)

Function: Couples the width of the second pulse to the width of the first pulse.

Syntax: :AUTO <ON | OFF | 0 | 1>

Default: ON

Remarks: If AUTO is set to ON, then the width of pulse two will follow the setting of the width of pulse 1. In any double pulsed operation, the width of pulse 1 and the delay of pulse 2 must be small enough that the minimum pulse width parameters of pulse 2 are not violated. Otherwise unexpected results may occur.

Example: SOURCE:PULSE:DOUBLE1:WIDTH:AUTO ON

:AUTO? (NON-SCPI)

Function: Query the state of the DOUBLE:WIDTH:AUTO parameter.

Syntax: :AUTO?

Response: 0 | 1

Remarks: None

Example: SOURCE:PULSE:DOUBLE2:WIDTH:AUTO?
0

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:COUNT (SCPI 17.14.8)

Function: Set the number of pulses to output when MODE is set to COUNT.

Syntax: :COUNt <pulses>

Range: 1 to $2^{31}+2^5$ (20000020_{16}, $536,870,944_{10}$)

Default: 1

Remarks: None

Example: SOURCE:PULSE:COUNT 15000
COUN #h4000

See Also: SOURCE:PULSE:MODE

:COUNT? (SCPI 17.14.8)

Function: Query the count value.

Syntax: :COUNt?

Response: pulses

Remarks: None

Example: SOURCE:PULSE:COUNT?
15000

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:POLARITY (SCPI 17.14.9)

Function: Set the polarity of the output pulse.

Syntax: :POLarity<[1]|2> <NORMal|COMPlement|INVerted>

Remarks: COMPlement and INVerted are aliases. In NORMal operation the first state is more positive than the second. In COMPlemented and INVerted operation, the first state is more negative than the second. A *RST command sets this parameter to NORMal.

Example: SOURCE:PULSE:POLARITY2 NORMAL

:POLARITY? (SCPI 17.14.9)

Function: Query the polarity of the pulse.

Syntax: :POLarity<1|2>?

Response: NORM | COMPL

Remarks: None

Example: SOURCE:PULSE:POLARITY1?
COMP

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:ROSCILLATOR (SCPI 17.16)

Remarks: Controls the setting of the reference oscillator.

Syntax: :ROSCillator

Remarks: The pulse generator can be referenced to either internal or external clock sources. Two internal sources may be selected, VXI CLK10 or VXI CLK16. A single external reference input is available on the PG front panel.

:EXTERNAL (SCPI 17.16.2)

Function: Path to the FREQUENCY command, which is used to indicate to the PG the frequency of the external reference oscillator.

Syntax: :EXTernal

Remarks: None

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:FREQUENCY (SCPI 17.16.2.1)

Function: Specifies the frequency of the external reference oscillator.

Syntax: :FREQuency <hertz>

Range: (1E6 to 20E6)

Default: 1E6

Remarks: Units are in hertz. A *RST will force this parameter to the default value.

Example: SOURCE:ROSCILLATOR:EXTERNAL:FREQUENCY 10E6
ROSC:EXT:FREQ 10MHZ

:FREQUENCY? (SCPI 17.16.2.1)

Function: Query the value entered for the frequency of the external reference oscillator.

Syntax: :FREQuency?

Response: hertz

Remarks: None

Example: SOURCE:ROSCILLATOR:EXTERNAL:FREQUENCY?
10E6

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:SOURCE (SCPI 17.16.3)

Function: Controls the selection of the reference oscillator source.

Syntax: :SOURce <INT<1 | 2> | EXT>

Default: INT1

Remarks: The INT1 reference oscillator is derived from the VXI CLK10 signal. INT2 is derived from the VXI CLK16 signal. EXT is provided by the external clock input on the front panel of the PG module. A *RST command will force the oscillator reference source to INT1 (VXI CLK10).

Example: SOURCE:ROSCILLATOR:SOURCE INT1

:SOURCE? (SCPI 17.16.3)

Function: Query the source of the reference oscillator.

Syntax: :SOURce?

Response: INT1 | INT2 | EXT

Remarks: None

Example: SOURCE:ROSCILLATOR:SOURCE?
EXT

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:VOLTAGE (SCPI 17.18)

Remarks: Controls the characteristics of the output voltage.

Syntax: :VOLTage

Remarks: The VOLTAGE branch provides access to all voltage control parameters.

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:LEVEL (SCPI 17.18.4)

Remarks: Controls the voltage levels of the output

Syntax: [:LEVel<[1]|2>]

Remarks: Level is the default command within the VOLTAGE branch and, for brevity, may be omitted. If the channel number is omitted, then the default channel is channel 1.

:IMMEDIATE (SCPI 17.18.4.1)

Remarks: The command for voltage level is to be carried out immediately.

Syntax: :[IMMediate]

Remarks: Immediate is the default command within the LEVEL branch and, for brevity, may be omitted.

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:AMPLITUDE (SCPI 17.18.4.1.1)

Function: Set the magnitude of the output signal.

Syntax: :[AMPLitude] <voltage | MIN | MAX | DEF>

Range: (0.5 to 7.0) for slew range 1 (PG110 only)
(0.5 to 7.0) for slew range 2
(0.5 to 24.0) for slew ranges 3 and 4

Default: 4.0

Remarks: The basic unit for amplitude is volts. Amplitude ranges are dependent on slew settings. Amplitude is the default command within the IMMEDIATE branch and, for brevity, may be omitted. When this command is used, the high and low output voltages will be determined by the amplitude and the offset values. A *RST command will set the output voltage to the default value.

Example: SOUR:VOLT:LEV:IMM:AMP 5.0
See Also: SOUR:VOLT:LEV:IMM:OFFSET, SOUR:VOLT:SLEW

:AMPLITUDE? (SCPI 17.18.4.1.1)

Function: Query the amplitude setting

Syntax: :AMPLitude?

Response: voltage

Remarks: None

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE?
5.0
VOLT:AMP?
5.0

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:OFFSET (SCPI 17.18.4.1.2)

Function: Set the offset value for the output signal

Syntax: :OFFSet <voltage | MIN | MAX | DEF>

Range: (-1.75 to +6.75) for slew range1 (PG110 only)
(-1.75 to +6.75) for slew range 2
(-11.75 to +11.75) for slew ranges 3 and 4

Default: 0

Remarks: The offset is used in conjunction with the amplitude setting to determine the high and low output voltage levels. The offset value determines the voltage level of the negative peak of the output signal. If AMPLITUDE and OFFSET combined exceed the maximum HIGH and LOW output voltages, a range error will be generated.

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:OFFSET 2.0

:OFFSET? (SCPI 17.18.4.1.2)

Function: Query the offset value for the output signal

Syntax: :OFFSet?

Response: voltage

Remarks: None

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:OFFSET?
2.0

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:HIGH (SCPI 17.18.4.1.3)

Function: Set the output high voltage.

Syntax: :HIGH <voltage | MIN | MAX | DEF>

Range: (-1.5 to +7.0) for slew range 1 (PG110 only)
(-1.5 to +7.0) for slew range 2
(-11.5 to +12.0) for slew ranges 3 and 4

Default: 1.0

Remarks: Basic units is volts. If the combination of HIGH and LOW violate the minimum or maximum amplitude range, then a range error will be generated.

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:HIGH 3.0

:HIGH? (SCPI 17.18.4.1.3)

Function: Query the output high voltage.

Syntax: :HIGH?

Response: voltage

Remarks: None

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:HIGH?
3.0

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:LOW (SCPI 17.18.4.1.4)

Function: Set the output low voltage.

Syntax: :LOW <voltage | MIN | MAX | DEF>

Range: (-2.0 to +6.5) for slew range 1 (PG110 only)
(-2.0 to +6.5) for slew range 2
(-12.0 to +11.5) for slew ranges 3 and 4

Default: -1.0

Remarks: Basic units is volts. If the combination of HIGH and LOW violate the minimum or maximum amplitude range, then a range error will be generated.

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:LOW -1.0

:LOW? (SCPI 17.18.4.1.4)

Function: Query the output low voltage.

Syntax: :LOW?

Response: voltage

Remarks: None

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:LOW?
-1.0

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:TTL (NON-SCPI)

Function: Sets the output amplitude to TTL levels.

Syntax: :TTL

Remarks: TTL output levels are defined in the PG as follows:

AMPLITUDE = 5.0 Volts
OFFSET = 2.5 Volts
LOW = 0.0 Volts
HIGH = 5.0 Volts

The TTL command does not have a query counterpart. If desired, the SOURCE:VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE?, :OFFSET?, :HIGH?, or :LOW? queries may be used to read back voltage levels.

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:TTL
VOLT:TTL

:ECL (NON-SCPI)

Function: Sets the output amplitude to ECL levels.

Syntax: :ECL

Remarks: ECL output levels are defined in the PG as follows:

AMPLITUDE = 1.1 Volts
OFFSET = -1.35 Volts
LOW = -0.8 Volts
HIGH = -1.9 Volts

The ECL command does not have a query counterpart. If desired, the SOURCE:VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE?, :OFFSET?,: HIGH?, or :LOW? queries may be used to read back voltage levels.

Example: SOURCE:VOLTAGE:LEVEL:IMMEDIATE:ECL
VOLT:ECL

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:SLEW (SCPI 17.18.11)

Function: The Slew branch allows access to define the rising slew rate and the falling slew rate for both channels

Syntax: :SLEW

Remarks: Slew values are in volts/microsecond. There are four slew ranges:

Range 1: 2400 v/uS, Fixed (PG110 only)
Range 2: 33 v/uS to 1300 v/uS, Programmable
Range 3: 1 v/uS to 32.9 v/uS, Programmable
Range 4: .033 v/uS to .9 v/uS, Programmable

The rising and falling slew rates must fall within the same slew range and must be within a 10:1 ratio. A change of either the rising or falling slew settings to a new slew range will force the other slew settings into the same range. The setting which was forced into the new range will be adjusted up to maintain a 10:1 ratio.

Slew rates remain constant regardless of amplitude and period settings. However, slew settings may not always be practical. For example, a rising slew setting of 1 v/uS would be useless at a period setting of 3.33 nS. The rising edge of the pulse would not have time to rise to a usable level before the falling edge occurs. No range or validity checking is performed. While this puts responsibility on the user to use common sense in setting the various parameters, it also allows the most flexibility in pulse generation. In addition to providing square waves, the PG can also generate trapezoidal, triangle, ramping and sawtooth waveforms with proper settings of period, amplitude and slew rate parameters.

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:LEADING (NON-SCPI)

Function: Sets the leading edge slew rate.

Syntax: :LEADing <volts/uS>

Range 1: 2700, Fixed (PG110 only)
Range 2: (33 to <2400), Programmable
Range 3: (1 to <33), Programmable
Range 4: (0.033 to <1), Programmable

Default: 2400 (PG110)
1300 (PG100)

Remarks: None

Example: SOURCE:VOLTAGE:SLEW:LEADING 2400
VOLT:SLEW:LEAD 300

:LEADING? (NON-SCPI)

Function: Query the leading edge slew rate.

Syntax: :LEADing?

Response: volts/uS

Remarks: None

Example: SOURCE:VOLTAGESLEW:LEADING?
250

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:TRAILING (NON-SCPI)

Function: Sets the trailing edge slew rate.

Syntax: :TRAiling <volts/uS>

Range 1: 2700, Fixed (PG110 only)
Range 2: (33 to <2400), Programmable
Range 3: (1 to <33), Programmable
Range 4: (0.033 to <1), Programmable

Default: 2400 (PG110)
1300 (PG100)

Remarks: None

Example: SOURCE:VOLTAGE:SLEW:TRAILING 2400
VOLT:SLEW:TRA 300

:TRAILING? (NON-SCPI)

Function: Query the trailing edge slew rate.

Syntax: :TRAiling?

Response: volts/uS

Remarks: None

Example: SOURCE:VOLTAGESLEW:TRAILING?
250

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:AUTO (NON-SCPI)

Function: Couple the trailing edge slew rate to the leading edge slew rate.

Syntax: :AUTO <OFF | ON | 0 | 1>

Default: ON

Remarks: When AUTO is ON, the trailing edge slew rate will follow the leading edge slew rate. This changes the stored value for the trailing edge slew rate.

Example: SOURCE:VOLTAGE:SLEW:TRAILING:AUTO ON
VOLT:SLEW:TRA:AUTO 1

:AUTO? (NON-SCPI)

Function: Query the state of the SLEW:TRAILING:AUTO parameter.

Syntax: :AUTO?

Response: 0 | 1

Remarks: None

Example: SOURCE:VOLTAGESLEW:TRAILING:AUTO?
1

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STATUS (SCPI 18)

Function: Provides controls for command status-reporting

Syntax: STATus

Remarks: The status registers conform to the IEEE 488.2 specifications, and each status register is comprised of a condition register, an event register and an enable register. Refer to figure 4-2 below for a description of the registers and their interaction. The Questionable registers are not used by the PG, however, since they are required by SCPI, they have been included in the drawing. The bit definition for the Operation Condition Register and the Questionable Condition Register are identical to the Operation Status Event Register and Questionable Status Event Register, respectively.

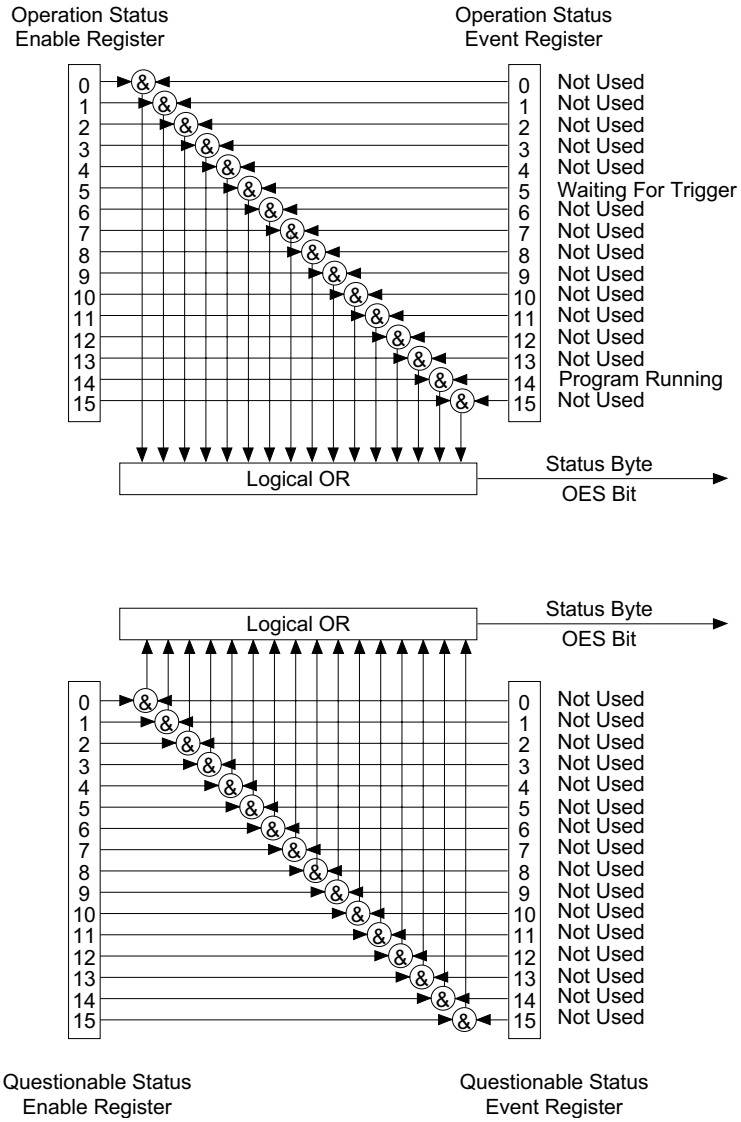


Figure 4-2.

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:OPERATION (SCPI 18)

Function: Provides a query access path to the Status Operation registers.

Syntax: :OPERation

Remarks: The status operation register provides information regarding the operating status of the PG.

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:EVENT? (SCPI 18.1)

Function: Query the operation event register

Syntax: :[EVENt]?

Response: decimal

Remarks: Event returns the contents of the 16 bit event register in decimal format. Event is the default command within the OPERATION branch and, for brevity, may be omitted. Reading the event register clears the register.

Example: STATUS:OPERATION:EVENT?
42

:CONDITION? (SCPI 18.2)

Function: Query the operation condition register.

Syntax: :CONDition?

Response: decimal

Remarks: Returns the contents of the 16 bit Condition register in decimal format. The contents of the Operation Condition register are not altered by this command.

Example: STATUS:OPERATION:CONDITION?
32

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:ENABLE (SCPI 18.3)

Function: Set the enable mask for the operation register.

Syntax: :ENABle <mask>

Default: 0

Remarks: The STATUS:OPERATION:ENABLE register is a 16 bit decimal mask value used for selecting which event(s), if any, will be used to set the event status bit in the status register.

Example: STATUS:OPERATION:ENABLE 255
STAT:OPER:ENAB #H0020

:ENABLE? (SCPI 18.3)

Function: Query the enable mask of the operation register.

Syntax: :ENABle?

Response: decimal

Remarks: Returns the contents of the 16 bit enable register in decimal format.

Example: *STATUS:OPERATION:ENABLE?*
255

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:QUESTIONABLE (SCPI 18)

Function: Provides query access to the questionable status registers

Syntax: :QUEStionable

Remarks: The Questionable status register is not used in the PG.

:EVENT? (SCPI 18.1)

Function: Query the questionable event register

Syntax: [:EVENt]?

Response: decimal

Remarks: Event returns the contents of the 16 bit questionable event register in decimal format. Reading the event register clears the register. Since the questionable register is not used in the PG, a query of the questionable event register will always return a value of 0.

Example: STATUS:QUESTIONABLE:EVENT?
0

STATUS:QUESTIONABLE

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:CONDITION? (SCPI 18.2)

Function: Query the questionable condition register.

Syntax: :CONDition?

Response: decimal

Remarks: Condition returns the contents of the 16 bit condition register in decimal format. The questionable condition register is not altered by this command.

Example: STATUS:QUESTIONABLE:CONDITION?
0

:ENABLE (SCPI 18.3)

Function: Set the enable mask for the questionable event register

Syntax: :ENABle <mask>

Default: 0

Remarks: The STATUS:QUESTIONABLE:ENABLE register is a 16 bit decimal mask value used for selecting which event(s), if any, will be used to set the questionable status bit in the status register.

Example: STATUS:QUESTIONABLE:ENABLE 128
STAT:QUES:ENAB 0x10

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:ENABLE? (SCPI 18.3)

Function: Query the enable mask for the questionable event register

Syntax: :ENABle?

Response: decimal

Remarks: Returns the contents of the 16 bit enable register in decimal format.

Example: *STATUS:QUESTIONABLE:ENABLE?*
128

:PRESET (SCPI 18)

Function: Sets the Operation Enable register and the Questionable Enable register to a preset value of 0.

Syntax: :PRESet

Remarks: The PRESET command configures SCPI and device-dependent status data structures so that device-dependent events are reported at a higher level through the mandatory part of the status-reporting mechanism. The PRESET command affects only the enable register.

Example: STATUS:PRESET

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SYSTEM (SCPI 19)

Function: Provides access to system operation commands.

Syntax: SYSTem

Remarks: Commands not related to performance of the PG are collected together in the SYSTEM group. For the PG, this includes the ERROR and the VERSION commands.

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:ERROR? (SCPI 19.7)

Function: Query the instrument error.

Syntax: :ERRor?

Response: error

Remarks: Request the error from the PG. The error code is returned as a number followed by a string. Refer to Appendix C for a list of error codes. Error codes are divided into sections. Section -100 represents command errors. Section -200 are reserved for execution errors. Device-dependent errors are represented by -300 error codes and query errors use -400 numbers.

Example: SYSTEM:ERROR?
0, "No Error"

:VERSION? (SCPI 19.18)

Function: Query the SCPI version number

Syntax: :VERSion?

Response: year.version

Remarks: Returns a formatted numeric number indicating the SCPI version number for which the PG complies. The number is returned in the format YYYY.V where YYYY represents the year-version and V represents the approved revision number for that year.

Example: SYSTEM:VERSION?
1992.0

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TRIGGER (SCPI 22.7)

Function: Selects and controls the parameters for triggering the PG

Syntax: TRIGger

Remarks: The PG supports a variety of trigger formats allowing the PG to be synchronized with internal or external events. Triggers may come from the VXI backplane as either word serial commands or using a TTL trigger line. Triggers may also come from the PG front panel, another PG (Master/Slave mode), or from a timer internal to the PG instrument.

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:SEQUENCE (SCPI 22.7.1)

Function: Identifies a group of commands used to control the trigger source parameters.

Syntax: [:SEQuence]

Remarks: Start is an alias for sequence. Both commands provide identical access to the trigger source parameters. Both SEQuence and STARt are optional commands and may be omitted.

:START (SCPI 22.7.1)

Function: Identifies a group of commands used to control the trigger source parameters.

Syntax: [:STARt]

Remarks: Sequence is an alias for start. Both commands provide identical access to the trigger source parameters. Both STARt and SEQuence are optional commands and may be omitted.

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:LEVEL (SCPI 22.7.1.9)

Function: Set the external trigger source voltage threshold

Syntax: :LEVel <voltage | MIN | MAX | DEF>

Range: (-5.0 to +5.0)

Default: 0

Remarks: The basic unit for level is volts. Defining the external trigger input level allows various logic levels (TTL, ECL, CMOS) to be used when triggering the PG when trigger source is external.

Example: TRIGGER:START:LEVEL 3.0
TRIG:LEV -2V

:LEVEL? (SCPI 22.7.1.9)

Function: Query the external trigger threshold level.

Syntax: :LEVel?

Response: voltage

Remarks: None.

Example: TRIGGER:START:LEVEL?
3.0

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:SOURCE (SCPI 22.7.1.13)

Function: Define the trigger source.

Syntax: :SOURce <BUS | EXTernal | IMMediate | TIMer | TTLT<(0-7)> | MANual | EXPansion>

Default: IMMediate

Remarks: Descriptions for the various trigger sources are as follows:

BUS	Trigger on *TRG, Word Serial Trigger Command or INITIATE.
EXTERNAL	Trigger using the external trigger input on the front panel.
IMMEDIATE	Trigger immediately upon receipt of this command.
TIMER	Trigger the PG each time the internal timer times out.
TTLTRG(0-7)	Select one of the eight VXI TTLTRG lines to trigger the PG
MANUAL	Triggered upon receipt of the INITIATE command
EXPANSION	Configured as a slave module, trigger is provided by the master module.

Example: TRIGGER:START:SOURCE:BUS

See Also: SOURCE:PULSE:MODE, TRIGGER:START:LEVEL, TRIGGER:START:TIMER, INITIATE

:SOURCE? (SCPI 22.7.1.13)

Function: Query the trigger source

Syntax: :SOURce?

Response: BUS | EXT | IMM | TIM | TTLT(0-7) | MAN | EXP

Remarks: See SOURCE above for response descriptions.

Example: TRIGGER:START:SOURCE?
TIM

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:TIMER (SCPI 22.7.1.14)

Function: Set the internal trigger timer

Syntax: :TIMer <seconds | MIN | MAX | DEF>

Range: 80E-6 to 10 Seconds

Default: 1 Second

Remarks: Sets the period of an internal trigger source. This value is used to periodically trigger the PG when the trigger source is defined as TIMER.

Example: TRIGGER:TIMER 1E-3
TRIG:TIM 500 ms

See Also: TRIGGER:START:SOURCE

:TIMER? (SCPI 22.7.1.14)

Function: Query the period of the internal trigger timer

Syntax: :TIMer?

Response: seconds

Remarks: None

Example: TRIGGER:TIMER?
80E-9

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4.3 IEEE 488.2 MANDATORY COMMANDS

The PG supports the mandatory commands set forth in the IEEE 488.2 specification and the *SAV and *RCL commands. The bulk of the mandatory commands utilize a four register set for passing operational information to the system. These registers are the Standard Event Status Register, Standard Event Status Enable Register, Status Byte Register and the Service Request Enable Register. Together, these register allow certain conditions to generate a service request to the system Slot 0 Controller, in much the same way that GPIB supports the Service Request (SRQ) function. Many of the commands on the following pages make use of these four registers, so an understanding of the working relationship of these registers is required. For this reason, a functional diagram of the registers is shown in figure 4-3. It is also recommended that the user refer to the IEEE 488.2 manual for further information.

Some of the commands also have parameters associated with them. In all cases the parameters may be entered in either decimal (default format), hexadecimal (#h prefix) or binary (#b prefix) formats.

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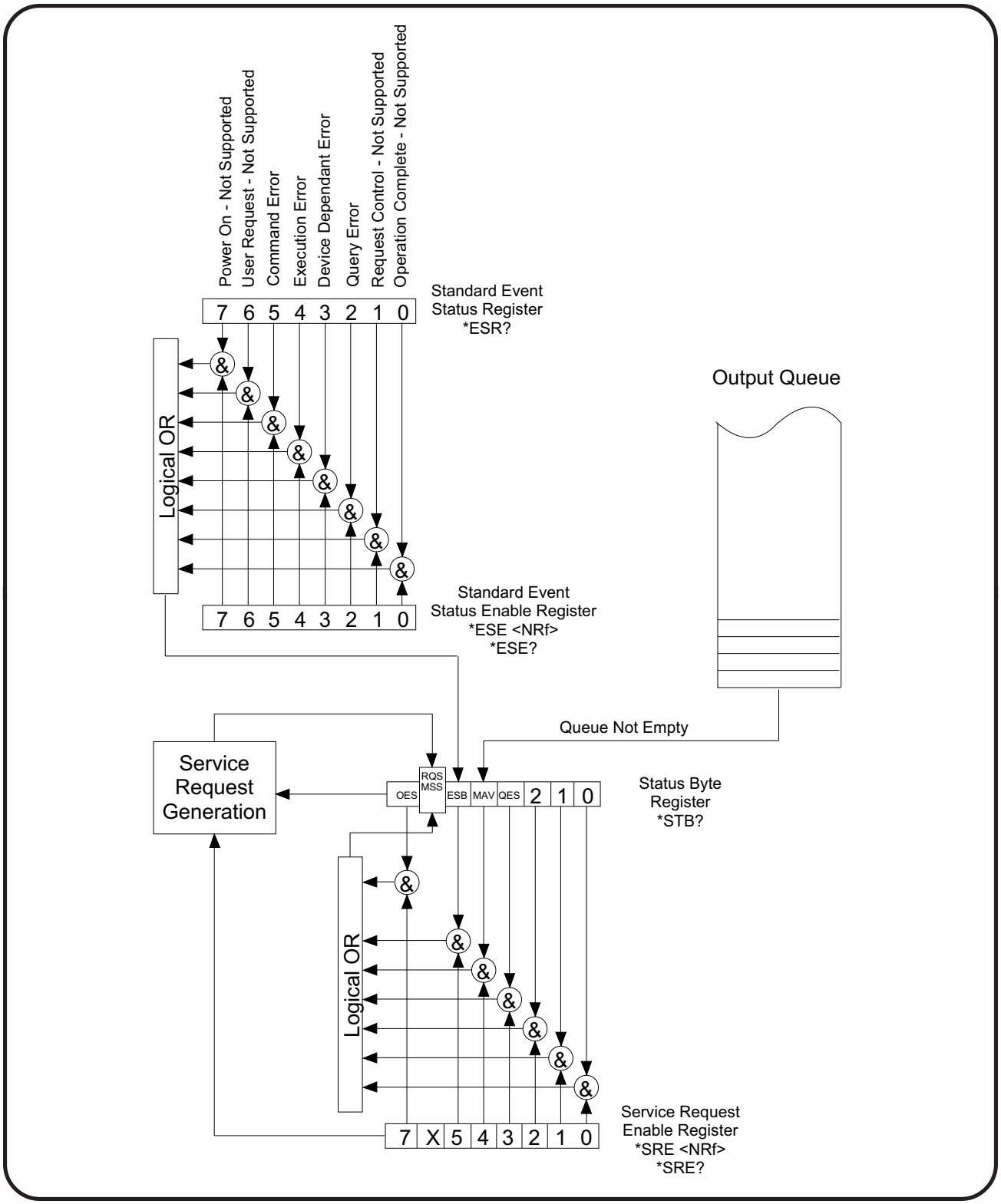


Figure 4-3.
IEEE 488.2 Register Configuration.

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*CLS

Function: Clear Status Command

Syntax: *CLS

Remarks: Clears all Event Registers in the status byte register. All queues, except the output queue, in the status byte are emptied. The device is forced into the operation complete - command idle state and operation complete - query idle state.

Example: *CLS

*ESE

Function: Standard Event Status Enable Command

Syntax: *ESE <number>

Range: 0 to 255

Default: 0

Remarks: A "1" in the bit position enables the corresponding bit of the standard event status enable register. Refer to figure 4-3 for the meaning of each bit.

Example: *ESE #b00000001
*ESE 255

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*ESE?

Function: Standard Event Status Enable Query

Syntax: *ESE?

Response: decimal

Remarks: Returns an integer (0-255) which is the value of the standard event status enable register. Refer to figure 4-3 for the meaning of each bit.

Example: *ESE?
255

*ESR?

Function: Standard Event Status Register Query

Syntax: *ESR?

Response: decimal

Remarks: Returns an integer (0-255) which is the value of the standard event status register. Refer to figure 4-3 for the meaning of each bit.

Example: *ESR?
32

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*IDN?

Function: Identification Query

Syntax: *IDN?

Response: INTERFACE TECHNOLOGY,PG110VXI,0,REV (n) or;
INTERFACE TECHNOLOGY,PG100VXI,0,REV (n)

Remarks: Returns the unique identification of the PG, which is defined in four fields separated by commas (Manufacturer, Model, Serial number., Firmware level). The serial number field, which is not used, will always default to 0. The firmware level may be different than shown.

Example: *IDN?
INTERFACE TECHNOLOGY',PG110,0,1.0

*OPC

Function: Operation Complete Command

Syntax: *OPC

Remarks: The PG has no application for the Operation Complete status and overlap commands. Therefore, *OPC is parsed only; no operation is performed.

Example: *OPC

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*OPC?

Function: Operation Complete Query

Syntax: *OPC?

Response: None

Remarks: The PG has no application for the Operation Complete status and overlap commands. Therefore, *OPC? is parsed only; no operation is performed.

Example: *OPC?

*RCL

Function: Recall setup

Syntax: *RCL <setup number>

Range: 1 to 10

Remarks: Restore the state of the PG from a copy stored in non-volatile memory. Up to ten (10) states may be saved and recalled to non-volatile memory using the *SAV and *RCL commands. Setups are referenced by a setup number assigned when the state of the PG is saved. *RCL must be sent on a line by itself. This insures that the saved state is recalled correctly.

Example: *RCL 5

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*RST

Function: Reset Command

Syntax: *RST

Remarks: Resets the PG to the power-up state (setting all parameters to their default values). Aborts any pulse sequence in progress.

Sets all parameters to their default values and clears all error conditions. Does not change IEEE 488.2 Registers.

Example: *RST

*SAV

Function: Save setup

Syntax: *SAV <setup number>

Range: 1 to 10

Remarks: Stores the current state of the PG into non-volatile memory. Up to ten (10) setup states may be stored and then later recalled using the *RCL command. Saved setup states are referred to by a setup number assigned when the state is saved. *SAV must be sent on a line by itself. This insures that the current state is saved correctly.

Example: *SAV 6

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*SRE

Function: Service Request Enable Register.

Syntax: *SRE <number>

Default: 0

Remarks: This eight bit register is used to enable what event will cause generation of a Service Request (SRQ) to the Slot 0 Controller. For example, if you wanted to generate a SRQ when the output queue has a message available, you would write a 16 to the SRE register. Refer to figure 4-3 for the bit definitions to this register.

Example: *SRE 16
*SRE #b00010000

*SRE?

Function: Service Request Enable Query

Syntax: *SRE?

Response: decimal

Remarks: Returns an integer (0-255) which is the value of the Service Request Enable register. Refer to figure 4-3 for the bit definitions to this register.

Example: *SRE?
112

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*STB?

Function: Read Status Byte Query

Syntax: *STB?

Response: decimal

Remarks: Returns an integer (0-255) which is the value of the status byte register.

Example: *STB?
64

*TRG

Function: Trigger the PG

Syntax: *TRG

Remarks: *TRG will trigger the PG when the trigger source is set to either BUS or MANUAL. *TRG is an alias of the INITIATE command.

Example: *TRG

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*TST?

Function: Self Test Query

Syntax: *TST?

Response: error,message

Remarks: Causes the PG to cycle through all of the diagnostic tests and places a response into the output queue indicating whether or not the self test completed without any detected errors. The diagnostic process will stop execution on the first detected error.

Note: This query takes a few moments to return a value. The Slot 0 Controller's response time-out should be set to allow enough time for this query to execute.

Example: *TST?
0, "No Error"

*WAI

Function: Wait-to-Continue Command

Syntax: *WAI

Remarks: The PG has no application for the Operation Complete status and overlap commands. Therefore, the *WAI command is parsed only; no operation is performed.

Example: *WAI

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APPENDIX A: SPECIFICATIONS

All timing measurement specifications are made at 50% amplitude and fastest slew rate only. Output high and low levels are +1.0V and 0.0V, respectively. See figure A-1.

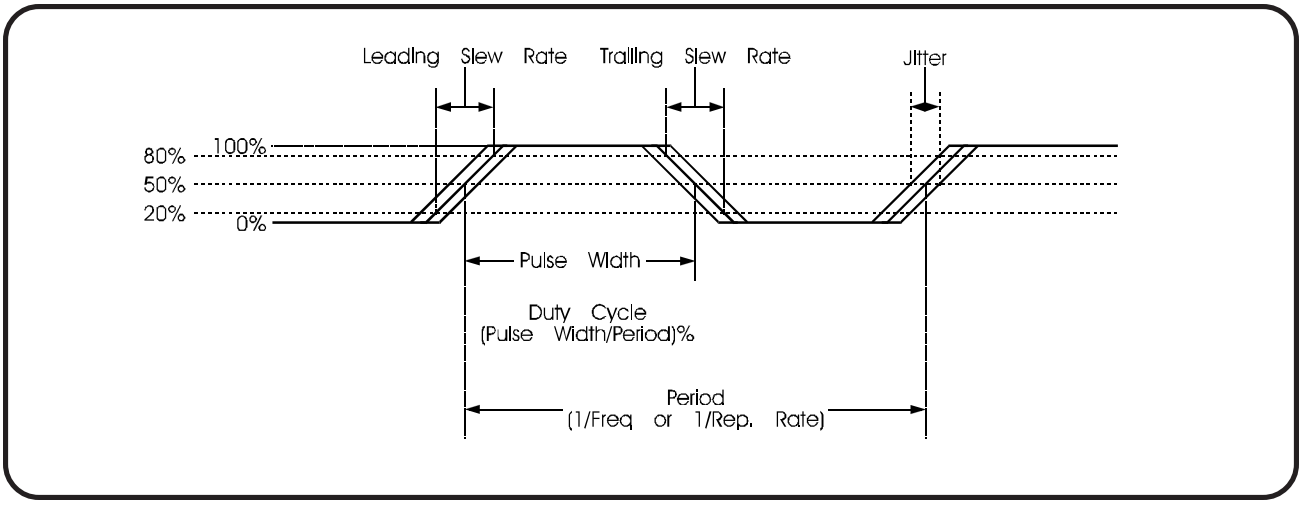


Figure A-1.
Timing Parameters.

A.1 TIMING PARAMETERS

Common Specifications

Specified Clock Source: ..... VXI 10 MHz Clock
Clock Source Accuracy: ..... ±0.01%
Resolution: ..... 12 bits
Repeatability: ..... 4 times better than accuracy, typical
RMS Jitter
  Period < 100ns: ..... 0.05% of period + 15ps
  Period > 100ns: ..... 0.025% of period + 15ps

Pulse Period

Range, PG110: ..... 3.3ns to 100ms
Range, PG100: ..... 10.0ns to 100ms
Accuracy (averaged over 1 second)
  Period > 500ns: ..... ±0.02%
  Period ≤ 500ns: ..... ±1%

Pulse Width

Range, PG110: ..... 1.5ns to (period-1.5ns)
Range, PG100: ..... 5.0ns to (period-5.0ns)
Duty Cycle: ..... 1 to 99%
Accuracy
  Periods > 500ns: ..... ±(0.02% + 1ns)
  Periods ≤ 500ns: ..... ±(1% + 1ns)

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Pulse Delay (relative to trigger out)

Range: ..... 0ns to (period - 1.5ns)
Accuracy
Periods > 500ns: ..... PG100 = ±(0.02% + 6ns); PG110 = ±(0.02% + 1ns)
Periods ≤ 500ns: ..... PG100 = ±(1% + 6ns); PG110 = ±(1% + 1ns)

Slew Rates

Range 1, PG110 only: ..... 2700 V/µs
Range 2: ..... 33 V/µs to 1300 V/µs
Range 3: ..... 1 V/µs to <33 V/µs
Range 4: ..... 33 mV/µs to <1 V/µs
Accuracy: ..... ±20% of setting

A.2 OUTPUTS

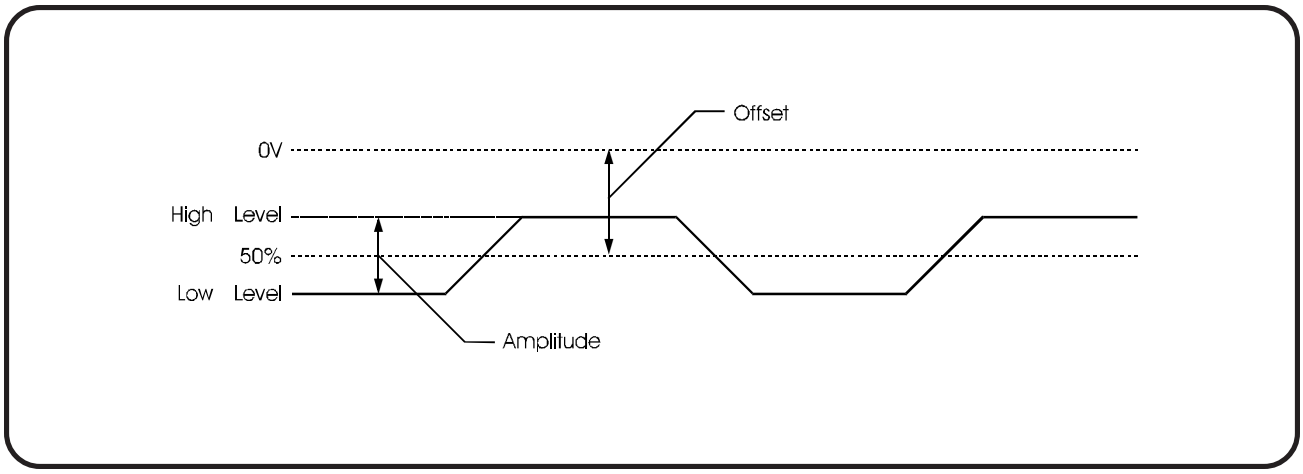


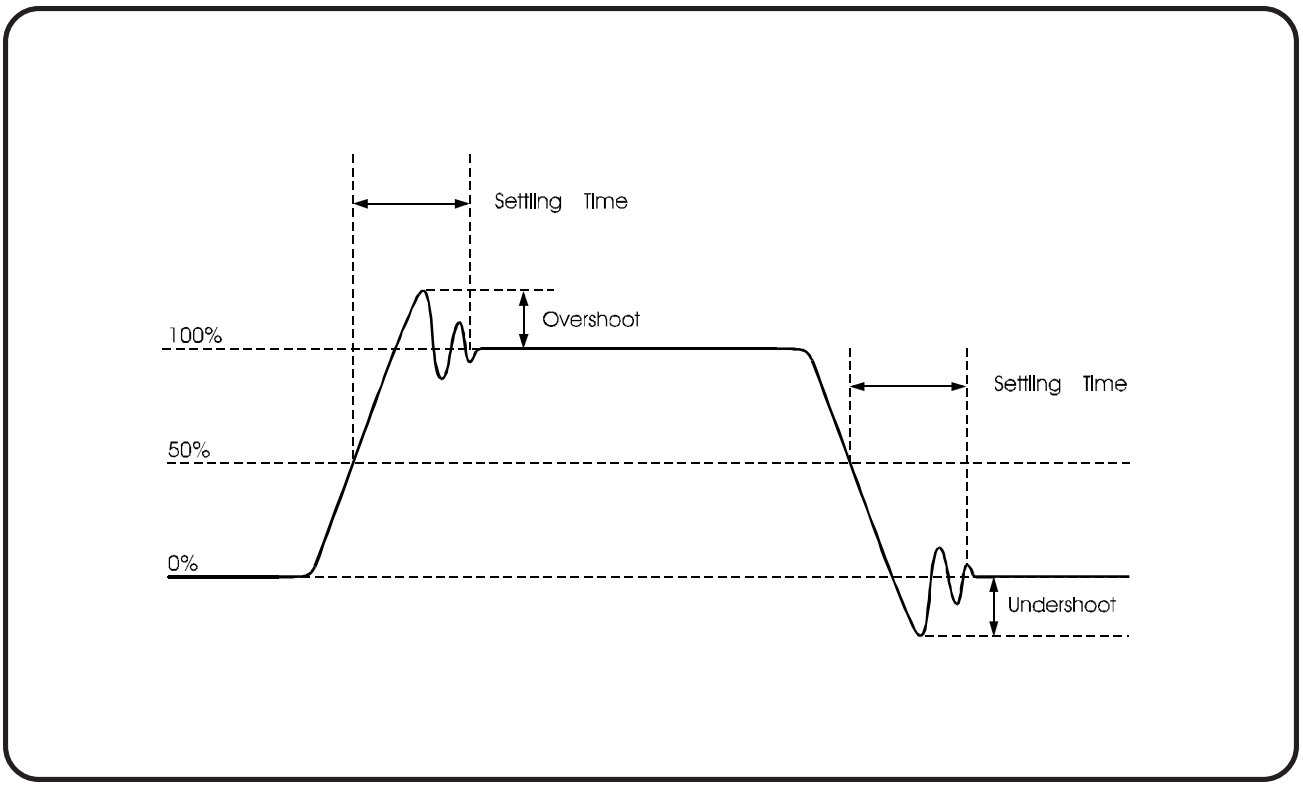
Figure A-2.
Output Level Parameters.

Output Channels

Number: ..... 2 single ended
Connector: ..... SMB
Termination: ..... 50Ω ±1Ω, source terminated
Amplitude
Slew ranges 1 and 2: ..... +0.5V to +7.0V
Slew ranges 3 and 4: ..... +0.5V to +24.0V
Offset
Slew ranges 1 and 2: ..... -1.75V to +6.75V
Slew ranges 3 and 4: ..... -11.75V to +11.75V

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Low Level
Slew range 1: (PG110 only) ..... -2.0V to +6.5V
Slew range 2: ..... -2.0V to +6.5V
Slew ranges 3 and 4: ..... -12V to +11.5V
High Level
Slew range 1: (PG110 only) ..... -1.5V to +7.0V
Slew range 2: ..... -1.5V to +7.0V
Slew ranges 3 and 4: ..... -11.5V to +12.0V
Level Accuracy: ..... ±(1% of setting + 1% of amplitude + 40mV)
Overshoot and Undershoot: ..... ±(8% of setting +10mV)



Settling Time: ..... <20ns to 2% of level
Master/Slave Skew (any channel to any other channel) ..... 2ns, typical

Figure A-3.
Output Specifications.

Trigger Output

Connector: ..... SMB
Output Level: ..... 100K ECL into 50Ω load
Width: ..... Width of output channel 2
(first pulse width if double pulse enabled)

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Transition Time: ..... <1ns

A.3 INPUTS

Trigger

Connector: ..... SMB
Slope: ..... negative
Termination: ..... 50Ω to -2.0V
Transition: ..... <50ns
Minimum Width: 3.5ns
Threshold Range: ..... -5.0V to +5.0V, programmable
Threshold Resolution: 50mV

Clock

Connector: ..... SMB
Range: ..... 1 MHz to 20 MHz
Level: ..... 100K ECL
Termination: ..... 50Ω to -2.0V

A.4 FUNCTIONAL MODES

Modes: ..... Auto, Timer, Gate, Burst, External Width, Master/Slave
Double Pulse: ..... None, either or both outputs
Burst Count Range: ..... 1 to 536870944
Timer Range: ..... 80µs to 10 Seconds

A.5 VXI INTERFACE

Size: ..... C-size
Type: ..... Message-based, Servant
Configuration: ..... Static or Dynamic
Interrupt Level: ..... Programmable, 1-7
Other: ..... TTLTRG 0-7

A.6 ENVIRONMENTAL

Power

+5.0V: 3.0A
-5.2V: 4.5A
-2.0V: 2.5A
+12.0V: 0.5A
-12.0V: 0.5A
+24.0V: 0.75A
-24.0V: 0.5A

Temperature

Storage: ..... -40º C to +75º C
Ambient Operating (for specified performance): ..... 25º C, ±10º C
Operating: ..... 0º C to 45º C

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APPENDIX B: TERMINATION

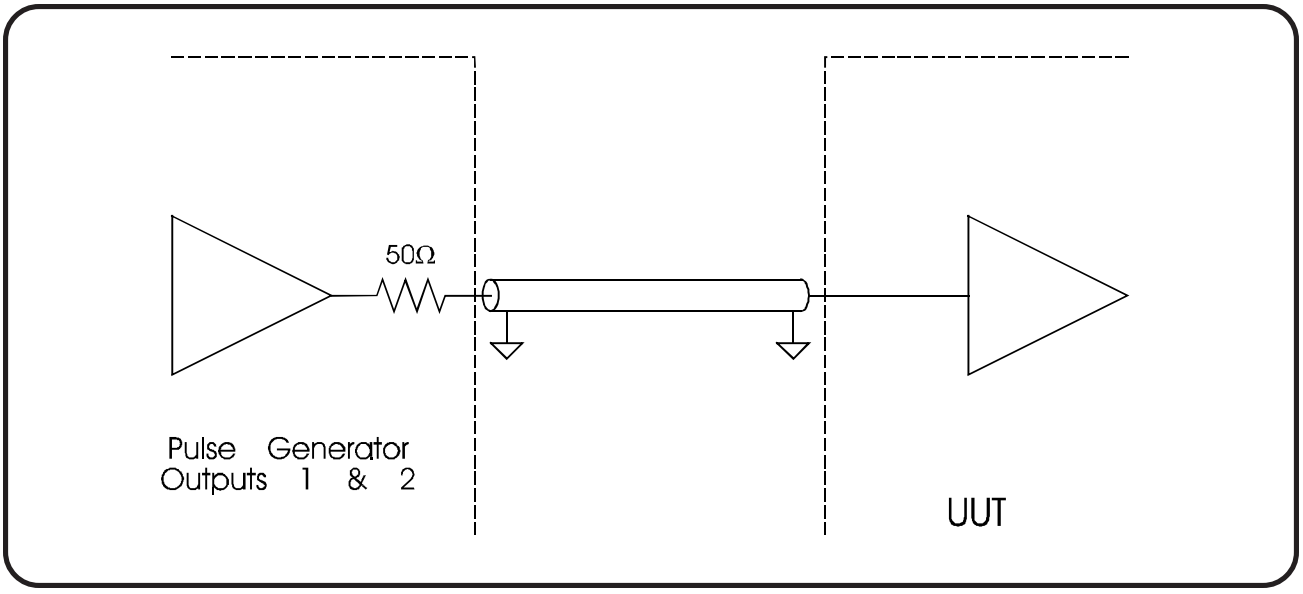


Figure B-1.
Full Amplitude Termination.

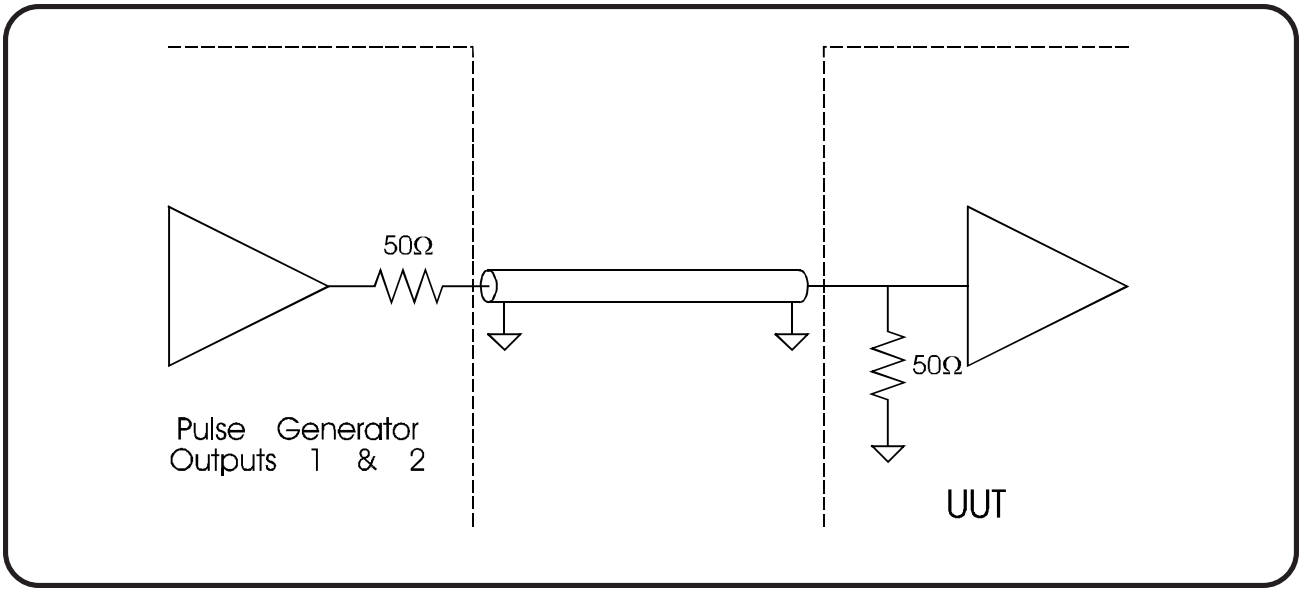


Figure B-2.
Half Amplitude Termination.

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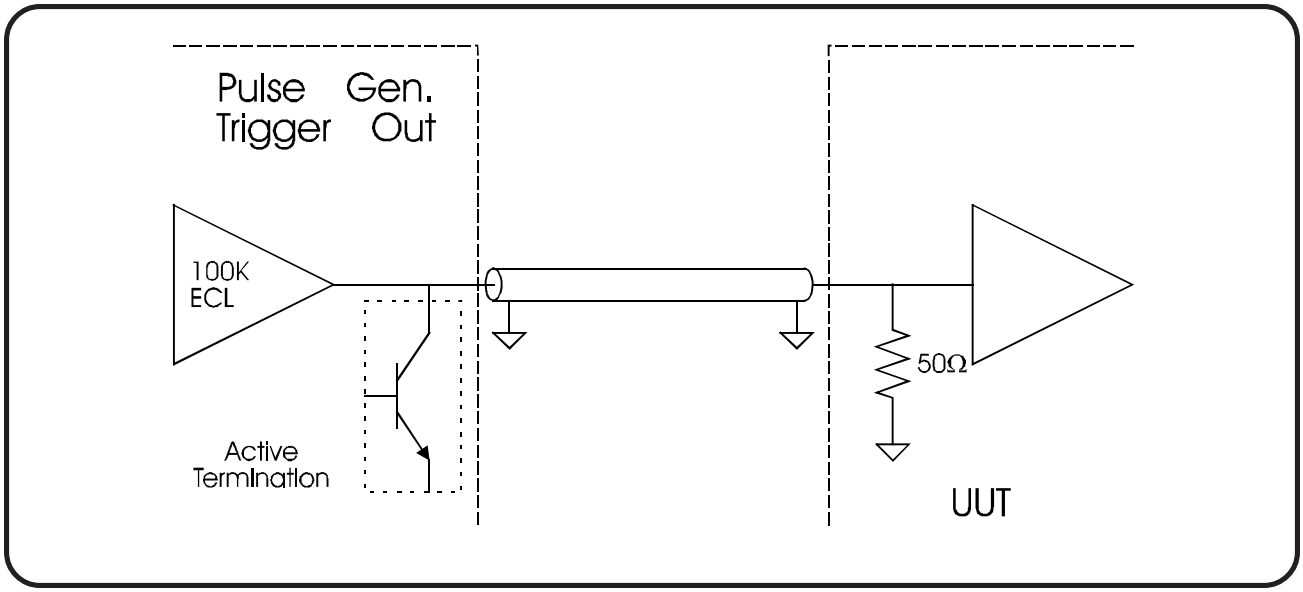


Figure B-3.
Trigger Out Termination.

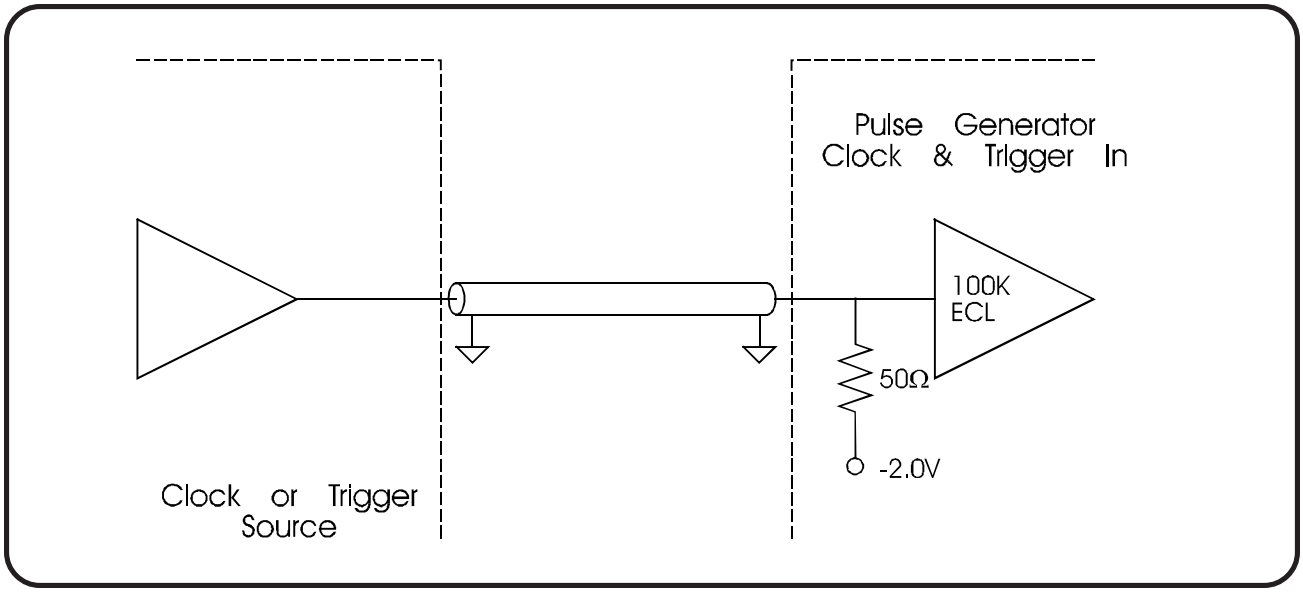


Figure B-4.
Clock & Trigger In Termination.

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APPENDIX C: ERROR CODES

C.1 SELF-TEST ERROR CODES

200_{16}: RAM failure when reading/writing U65, data bits 08-15
201_{16}: RAM failure when reading/writing U64, data bits 00-07
300_{16}: IT9010M failed read/write acknowledge test
301_{16}: IT9010M failed read/write pattern test
500_{16}: 68681 DUART failed read test
600_{16}: ROM checksum test failed
700_{16}: Non-volatile RAM checksum test failed

C.2 SYSTEM ERROR CODES

Command Errors

0,"No Error"
-101,"Invalid character;Semicolon can't start command"
-103,"Invalid separator;Semicolon or colon expected"
-101,"Invalid character;Syntax error at second colon"
-101,"Invalid character;Syntax error at semicolon following colon"
-101,"Invalid character;Double semicolons not allowed"
-103,"Invalid separator;Asterisk found instead of separator"
-111,"Header separator error;Alpha after 488.2 common cmd invalid"
-101,"Invalid character;Double colons not allowed"
-101,"Invalid character;Syntax error at semicolon following colon"
-101,"Invalid character;Unknown in this context"
-101,"Invalid character;Double semicolons not allowed"
-103,"Invalid separator;Asterisk found instead of separator"
-103,"Invalid separator;Alpha found instead of separator"
-101,"Invalid character;Asterisk found instead of separator"
-158,"String data not allowed;No match found for parameter string"
-113,"Undefined header;A 488.2 common command was expected"
-114,"Header suffix out of range;Number after 488.2 cmd not allowed"
-113,"Undefined header;No match found for command"
-131,"Invalid suffix;Suffix not appropriate"
-113,"Undefined header;Question mark expected"
-101,"Invalid character;Unexpected character found after header"
-113,"Undefined header;Number attached to header not allowed"
-111,"Header separator error;A space separator was expected"
-131,"Invalid suffix;Suffix not appropriate for command"
-114,"Header suffix out of range;Incorrect output number specified"

Execution Errors

-224,"Illegal parameter value;Invalid conversion"
-224,"Illegal parameter value;Invalid base value"
-224,"Illegal parameter value;Undefined parameter"
-224,"Illegal parameter value;Invalid data type"
-222,"Data out of range;Value out of 32-bit integer bounds"

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-222,"Data out of range;Valid HIGH range is 12V to -11.5V (slew range 3,4), 7V to -1.5V (slew range 1,2)"

-222,"Data out of range;Valid LOW range is -12V to 11.5V (slew range 3,4), -2V to 6.5V (slew range 1,2)"

-222,"Data out of range;Valid OFFSET is -11.75V to 11.75V (slew range 3,4), 6.75 to -1.75 (slew range 1,2)"

-222,"Data out of range;Valid AMPL is 0.5V to 24V (slew range 3,4), 0.5V to 7V (slew range 1,2)"

-222,"Data out of range;COUNT must be at least 1"
-222,"Data out of range;Valid DCYC range is 1 to 99"
-222,"Data out of range;Valid TRIG:LEVEL range is -5v to +5v"
-222,"Data out of range;Valid ROSC:EXT:FREQ range is 1Mhz to 20 Mhz"
-224,"Illegal parameter value;MIN,MAX,nor DEF not allowed for ROSC:EXT:FREQ"
-222,"Data out of range;Valid TIMER range is 80us to 10 sec"
-222,"Data out of range;Valid DELAY range is 0ns to 1 period"
-222,"Data out of range;Valid WIDTH range is 1.5ns to 100ms-1.5ns" (PG110) or
-222,"Data out of range;Valid WIDTH range is 5.0ns to 100ms-5.0ns" (PG100)
-222,"Data out of range;Valid PERIOD range is 3.33ns to 100ms" (PG110) or
-222,"Data out of range;Valid PERIOD range is 10.0ns to 100ms" (PG100)
-222,"Data out of range;Valid non-volitile memory range is 1 to 10"
-221,"Settings conflict;TRIG:SOURCE and MODE are incompatible"
-241,"Hardware missing;Address generates bus/addr exception"
-222,"Data out of range;Valid slew rate is from 0.033 to 3000 V/uS"
-222,"Data out of range;Unable to calculate valid slew rate from transition time"

Device Dependant Errors

-350,"Queue overflow;Tail of output string is lost"
-314,"Save/recall memory lost;Nonvolatile checksum error"
-310,"System error;Software bug - error number is out of range"
-310,"System error;Software bug - analog delay not in table"
-310,"System error;Software bug - q value not in table"
-330,"Self-test failed;Non volatile setup failed checksum test"
-330,"Self-test failed;Non volatile calibration failed checksum test"
-330,"Self-test failed;U65 ram chip failed memory test"
-330,"Self-test failed;U64 ram chip failed memory test"
-330,"Self-test failed;Output driver test for channel 1 failed"
-330,"Self-test failed;Output driver test for channel 2 failed"
-330,"Self-test failed;Frequency test failed"
-313,"Calibration memory lost;Calibration data not present"

Query Errors

-410,"Query INTERRUPTED;Previous query output within string was overwritten"
-410,"Query INTERRUPTED;Previous query output lost"
-420,"Query UNTERMINATED;Output buffer was empty"

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D.1 INTRODUCTION.

This procedure describes a method of verifying the calibration of the Interface Technology PG100 and PG110 Pulse Generator (PG) Modules by using standard test equipment with NIST traceable calibration. It does not, however, describe the calibration operation itself, which requires special software, specific test instruments and special fixtures.

This procedure assumes that the PG module is working and has passed self-test. The operations verified are *output timing, slew rate,* and *level accuracy* for both channels. No verification procedure is provided for programmable threshold on the trigger input. No verification procedure is provided here for the Master/Slave operation of the PG. The output overshoot and settling times are not verified, as they are design properties and not calibrated.

D.2 REQUIRED EQUIPMENT.

1. VXI Cardrack and Power Supply (providing all VXI specified voltages). A slot-0 controller is required to control the PG module. The slot-0 controller may be an embedded computer, or an interface to some other host computer. The computer controlling the test operation will also require a GPIB interface for controlling other test instruments if the verification is to be automated.

2. Dual Input Counter/Timer for measuring frequency accuracy, frequency stability, pulse width, and time interval accuracy. See below for specifications.

Note that to test the pulse generator at the highest output frequency (i.e., 300 MHz for PG110 or 100 MHz for PG100), would require a counter/timer capable of pulse timing of less than 5 nsec and resolution into the low picoseconds. To avoid requirements for expensive and exotic instruments, lower frequencies are tested to verify the operation of the phase-lock loop and delay circuits. Due to the digital nature of these circuits, performance can be extrapolated from the lower frequencies to the higher ranges.

3. Digital Voltmeter with DC and AC RMS measurement capability, see below for specifications.

4. Pulse Generator calibration verification test cable set. Two SMB-to-SMB coaxial cables are required with their lengths matched to within .25 inch. SMB to BNC adapters may be required for connecting to instruments with BNC inputs. Adapters to dual banana jacks may be required for meter input.

Instrument Specifications: (assume instrument 4X better than UUT).

Counter/Timer: (H-P 5370B, Stanford Research)

> Time interval measurement accuracy; better than 100 psec resolution and 2.5 nsec accuracy (with or without averaging). Capable of period measurements down to 12.5 nsec and pulse measurements down to 8 nsec. Capable of two-channel A-B time interval measurements down to 5 nsec.
>
> Frequency accuracy: better than 500 Hz at 80 MHz between six month calibrations.
>
> Resolution: 9 digits per second gate - better than 10 Hz in the 80 MHz range.

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Digital Voltmeter: (H-P 3458A)

DC measurement: better than .25% accuracy in 10 Vdc range with at least 10 mV resolution. Better than 60 dB normal mode (ripple) rejection at 1 kHz.

AC RMS measurement: true RMS measurement, 1% accuracy at 1 kHz in 10 Vrms range.

Input Impedance: greater than 1 Megohm in DC and RMS functions.

D3.0 VERIFICATION PROCEDURE

D3.1 OVERVIEW.

The basic sequence of operations will be to verify output driver level accuracy using DC voltage readings. The output waveform pulse width, delay, and slew rate timings are then verified using a counter/timer.

The verification philosophy is to test a particular voltage parameter at 10%, 50%, and 90% of full scale. This will verify that the calibration for any gain and offset errors is effective. Since three individual output circuits are used in the pulse generator, test values must be chosen to verify each of the three circuits.

D3.2 OUTPUT DRIVER LEVEL VERIFICATION.

The pulse generator outputs are connected to the DC meter using a test cable that must be moved for testing each of the two outputs in turn, The output drivers are set in volts, calibrated for no-load conditions. The test sequence will allow measurement of the low driver level at 10%, 5-%, and 90% voltage levels. The slew rate is changed three times to insure all three driver output circuits are used. The output polarity is changed to inverted and the same settings are verified for the high driver. After the output levels are tested statically, they are tested dynamically using an AC RMS meter.

The meter is initially set for reading DC voltage in the appropriate range.

Note -- passing criteria does not include meter error. Add DC error for range used (i.e., 2.5 mV for .25% of range at 10 Vdc).

Many low cost DMM's use an average rectifying circuit to measure RMS instead of true RMS conversion. This mean absolute deviation (MAD) circuit topology works for sine waves, but introduces an error for square wave inputs. For a square wave input with a 50% duty cycle, the error will cause the AC RMS to read about 11% higher than the actual RMS value. If a meter using the MAD circuit is used for the dynamic output test, this error must be included.

Meter is set for AC RMS function in the 10 Vrms range. A true RMS reading meter will indicate .5 of the peak-to-peak reading for a square wave with a 50% duty cycle. The meter RMS function bandwidth rolloff should be at least an order of magnitude above one kHz.

Note -- passing criteria does not include meter error. Add AC RMS error for range used.

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Passing Criteria -- Static Output Test.

Driver Level	Slew Range	Output Setting	Reading	Tolerance
Low	Fast 1/2	10%	-1.15	± .13 Vdc
Low	Fast 1/2	50%	2.25	± .11 Vdc
Low	Fast 1/2	90%	5.65	± .11 Vdc
Low	Slow 3/4	10%	-9.65	± .34 Vdc
Low	Slow 3/4	50%	-.25	± .16 Vdc
Low	Slow 3/4	90%	9.15	± .16 Vdc
High	Fast 1/2	10%	-0.65	± .06 Vdc
High	Fast 1/2	50%	2.75	± .11 Vdc
High	Fast 1/2	90%	6.15	± .18 Vdc
High	Slow 3/4	10%	-9.15	± .34 Vdc
High	Slow 3/4	50%	0.25	± .16 Vdc
High	Slow 3/4	90%	9.65	± .16 Vdc

Note: Fast range 1 available on PG110 only.

Passing Criteria -- Static Output Test.

Setting Values	Slew Rate	Reading	Tolerance
5 Vp-p 1 kHz Square Wave	Range 1	PG110 only 2.5 Vac RMS	± .115 Vac RMS
5 Vp-p 1 kHz Square Wave	Range 2	2.5 Vac RMS	± .115 Vac RMS ± .115 Vac RMS
10 Vp-p 1 kHz Square Wave	Range 3	5.0 Vac RMS	± .19 Vac RMS ± .19 Vac RMS

Note

For all code samples -- comment lines begin with ##. Lines where a pause is required to verify a meter reading, or wait for operator, begin with #@.

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SAMPLE PG100/PG110 CODE TO EXECUTE OUTPUT LEVEL TEST

See Test 1 in the example code section for a series of commands to implement the Output Level verification.

D3.3 Output Driver Timing Verification.

D3.3.1 Pulse Period Timing Verification.

The fastest slew rate available is used for testing verification. The first item verified is the pulse period timing. The basic timing accuracy is dependent on the VXI slot-0 controller 10 MHz clock source, required to be .01% or better. The pulse generator internal phase-locked loop uses this source to generate internal timing.

The phase-locked loop and associated counter divider strings are not calibrated, the verification in this step is necessary only to insure that pulse delays can meet expected accuracy.

Output 1 of the pulse generator is tested first, then output 2.

The output 1 connector of the PG is connected to the timer counter input to measure the pulse period. The timer/counter should be set to Period Measure or Time Interval-Rising to Rising function, with readings averaged over 1000 samples if required for 100 psec resolution.

Timing tests use high and low voltage levels of +2.0/-2.0 volts so that counter/timer input threshold can be set to 0.0 volts. Use 50 ohm DC terminated input setting of the timer/counter to eliminate reflections. Use only point-to-point 50 ohm test cables without "T" connectors added for other instruments.

Note

Passing criteria doesn't include counter error. If reading is outside tolerance, be sure to consider drift error for counter at appropriate period (i.e., most counters have at least 2 LS digit error + time base error.

Passing Criteria, Pulse Period Test.

Pulse Period	Tolerance
12.5 nsec	162 psec
14.0 nsec	182.psec
100.0 nsec	1.15 nsec
100.0 µsec	1.15 µsec
100.0 msec	1.06 msec

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D3.3.2 Pulse Delay Timing Verification.

The pulse generator Trigger Output is connected to the timer/counter time interval start channel. The pulse generator Output 1 is connected to the timer/counter time interval stop channel. The two cables must be of matching length to within .25 inch. After all times are verified for Output 1, then Output 2 is checked.

The Trigger Output is an ECL level signal that gives a -0.8 V to -1.9 V transition into a 50 ohm ground load. The timer/counter start channel threshold should, therefore, be set to about -1.5 v. The stop channel threshold can be set at 0 volts, since the output pulse level is set to +2.0 V high and -2.0 V low. The timer/counter should be set for time interval measurement, rising edge to rising edge. Resolution of 100 psec or better is required, and averaging can be used since the pulse train is repetitive. Averaging over 1000 samples should give the desired resolution.

Use the 50 ohm DC terminated input setting of the timer/counter to eliminate reflections. Use only point-to-point 50 ohm test cables without "T" connectors added for other instruments. The time interval is kept above 5 nsec to avoid a counter trying to read negative time.

Passing Criteria, Pulse Delay Test.

Pulse Delay (ns)	PG110 Tolerance (ns)	PG110 Passband (min. ns)	PG110 Passband (max. ns)	PG100 Tolerance (ns)	PG100 Passband (min. ns)	PG110 Passband (max. ns)
100	2.00	98.00	102.00	7.00	93.00	107.00
101	2.01	98.99	103.01	7.01	93.99	108.01
102	2.02	99.98	104.02	7.02	94.98	109.02
103	2.03	100.97	105.03	7.03	95.97	110.03
104	2.04	101.96	106.04	7.04	96.96	111.04
105	2.05	102.95	107.05	7.05	97.95	112.05
106	2.06	103.94	108.06	7.06	98.94	113.06
107	2.07	104.93	109.07	7.07	99.93	114.07
108	2.08	105.92	110.08	7.08	100.92	115.08
109	2.09	106.91	111.09	7.09	101.91	116.09
110	2.10	107.90	112.10	7.10	102.90	117.10
Pulse Delay (ns)	PG110 Tolerance (ns)	PG110 Passband (min. ns)	PG110 Passband (max. ns)	PG100 Tolerance (ns)	PG100 Passband (min. ns)	PG110 Passband (max. ns)
1000	1.20	998.80	1001.20	6.20	993.80	1006.20
1010	1.20	1008.80	1011.20	6.20	1003.80	1016.20
1020	1.20	1018.80	1021.20	6.20	1013.80	1026.20
1030	1.21	1028.79	1031.21	6.21	1023.79	1036.21
1040	1.21	1038.79	1041.21	6.21	1033.79	1046.21
1050	1.21	1048.79	1051.21	6.21	1043.79	1056.21
1060	1.21	1058.79	1061.21	6.21	1053.79	1066.21
1070	1.21	1068.79	1071.21	6.21	1063.79	1076.21
1080	1.22	1078.78	1081.22	6.22	1073.78	1086.22
1090	1.22	1088.78	1091.22	6.22	1083.78	1096.22
1100	1.22	1098.78	1101.22	6.22	1093.78	1106.22

Note 1: Use this reading for counter/timer reference (or offset) to take following readings.

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SAMPLE PG100/PG110 CODE TO EXECUTE PULSE DELAY TIMING TEST.

See Test 2 in the example code section for a series of commands to implement the Pulse Period and Delay Timing verification.

D3.3.3 Pulse Width Timing Verification.

The counter/timer will be set for pulse width measurement with the input thresholds at 0.0 V. The resolution of the counter should be 500 psec, using averaging if necessary. The pulse generator Output 1 is connected to the counter/timer start input for pulse width measurement. On some H-P counters, the start and stop inputs must be internally connected together for pulse measurement.

In this case, the period and pulse delay are held constant, and the pulse width is increased to test the fine and coarse delay circuits.

Passing Criteria, Pulse Width Test.

Pulse Delay	Reading	Tolerance	Passband
100.0 nsec	100.0 nsec	2.00 nsec	98/102 nsec - note 1
101.0 nsec	ref + 1.0	2.01 nsec	-1.01/3.01 to ref
102.0 nsec	ref + 2.0	2.02 nsec	-0.02/4.02 to ref
103.0 nsec	ref + 3.0	2.03 nsec	0.97/5.03 to ref
104.0 nsec	ref + 4.0	2.04 nsec	1.96/6.04 to ref
105.0 nsec	ref + 5.0	2.05 nsec	2.95/7.95 to ref
106.0 nsec	ref + 6.0	2.06 nsec	3.94/8.06 to ref
107.0 nsec	ref + 7.0	2.07 nsec	4.93/9.07 to ref
108.0 nsec	ref + 8.0	2.08 nsec	5.92/10.08 to ref
109.0 nsec	ref + 9.0	2.09 nsec	6.91/11.09 to ref
110.0 nsec	ref + 10.0	2.10 nsec	7.9/12.10 to ref
120.0 nsec	ref + 20.0	2.20 nsec	17.8/22.2 to ref
130.0 nsec	ref + 30.0	2.30 nsec	27.7/32.2 to ref
140.0 nsec	ref + 40.0	2.40 nsec	37.6/42.4 to ref
150.0 nsec	ref + 50.0	2.50 nsec	47.5/52.5 to ref
160.0 nsec	ref + 60.0	2.60 nsec	57.4/62.6 to ref
170.0 nsec	ref + 70.0	2.70 nsec	67.3/72.7 to ref
180.0 nsec	ref + 80.0	2.80 nsec	77.2/82.8 to ref
190.0 nsec	ref + 90.0	2.90 nsec	87.1/92.9 to ref
100.0 usec	100.0 usec	21.0 usec	79/121 usec
1.0 ms	1.0 ms	201.0 ms	799/1.201 ms
50.0 ms	50.0 ms	10.0 ms	49.999/50.01 ms

Note 1: Use this reading for counter/timer reference (or offset) to take following readings.

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SAMPLE PG100/PG110 CODE TO EXECUTE OUTPUT PULSE WIDTH TEST.

D3.3.4 Output Edge Slew Timing Verification.

The edge slew timing can be set in four ranges. The fastest slew time is fixed so no calibration or verification is performed. The three slower ranges use different driver circuits which are calibrated. Some counters can perform rise and fall time measurements directly, some will use a time interval measurement with different trigger levels on the same edge of the measured signal (leading or trailing).

The PG slew command is used to set the signal rise/fall time between 20% and 80% of setting. The counter timer input thresholds will be set at these levels to measure the signal.

The pulse used for the test will be from -2 to 3.0 V, so the counter/timer input thresholds will be set to -1.0 and +2.0 V for the edge to be measured. For leading edge measurement, the Start channel threshold will be -1.0 V and the Stop channel threshold will be +2.0 V(both inputs selecting rising edge). For the trailing edge, the Start threshold is +2.0 V and the Stop threshold is -1.0 V (both inputs selecting falling edge). The inputs are selected for high impedance without 50 ohm termination, since the driver slew rates are calibrated for driving no load.

The timer/counter is set for time interval-single input or rise/fall measurement with resolution of 100 psec, using averaging over 1000 samples if required. The PG Output 1 is connected to the timer/counter Start input. Note that some H-P counters require both inputs to be switched to common to perform the time interval test on a single input.

Passing Criteria, Slew Rate Test.

Slew Rate in V/µs	Trigger Setting	Passband
300	Leading	8.3 ns -- 12.5 ns
60	Leading	41.6 ns -- 62.5 ns
30	Leading	83 ns -- 125 ns
30	Trailing	83 ns -- 125 ns
3.33	Leading	756 ns -- 1126 ns
3.33	Trailing	756 ns -- 1126 ns
0.75	Leading	3.33 µs -- 5.0 µs
0.75	Trailing	3.33 µs -- 5.0 µs
0.0375	Leading	66.6 µs -- 100 µs
0.0375	Trailing	66.6 µs -- 100 µs

$$\text{Transition time in microseconds} = \frac{\text{Amplitude} * 0.6}{\text{slew rate in V/µs}}$$

Note: Trigger Settings:
Leading = Start -1.0 V, Stop +2.0 V, both rising edge.
Trailing = Start +2.0 V, Stop -1.0 V, both falling edge.

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```
********************** TEST 1 **********************
## The static DC test part first

## first verify output 1 at fastest slew setting
## both outputs are the same,  so verify output 2 with
## a second pass

## verify low level first with high set to max
## for PG100, skip to range 2 test below

source:pulse:mode switch
source:pulse:period 1.00e-3
source:pulse:width1 0.50e-3
source:pulse:hold width
source:pulse:hold:auto on
source:pulse:delay 0
source:pulse:polarity1 normal
source:pulse:polarity2 normal
source:voltage:slew:trailing:auto on
source:voltage:slew:leading 2700
source:voltage:level2:immediate:high 1.0
source:voltage:level2:immediate:low 0


source:voltage:level1:immediate:high 4.0
source:voltage:level1:immediate:low -1.15
source:voltage:level2:immediate:high 4.0
source:voltage:level2:immediate:low -1.15

output:state on
#@ verify 10% low drive level

source:voltage:level1:immediate:low 2.25
source:voltage:level2:immediate:low 2.25
#@ verify 50% low drive level

source:voltage:level1:immediate:high 7.0
source:voltage:level1:immediate:low 5.65
source:voltage:level2:immediate:high 7.0
source:voltage:level2:immediate:low 5.65
#@ verify 90% low drive level

## change slew range for range 2 driver circuit
source:voltage:slew:leading 1000

#@ verify 90% low drive level

source:voltage:level1:immediate:low 2.25
source:voltage:level1:immediate:high 4.0
source:voltage:level2:immediate:low 2.25
source:voltage:level2:immediate:high 4.0
#@ verify 50% low drive level
```


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```
source:voltage:level1:immediate:low -1.15
source:voltage:level2:immediate:low -1.15
#@ verify 10% low drive level

## change slew range for range 3 driver circuit
source:voltage:slew:leading 10
source:voltage:level1:immediate:high 12.00
source:voltage:level2:immediate:high 12.00

source:voltage:level1:immediate:low -9.65
source:voltage:level2:immediate:low -9.65
#@ verify 10% low drive level

source:voltage:level1:immediate:low -.25
source:voltage:level2:immediate:low -.25
#@ verify 50% low drive level

source:voltage:level1:immediate:low 9.15
source:voltage:level2:immediate:low 9.15
#@ verify 90% low drive level

## set low drive to minimum, do 10, 50, 90% on high
source:voltage:level1:immediate:low -2.0
source:voltage:level1:immediate:high -.65
source:voltage:level2:immediate:low -2.0
source:voltage:level2:immediate:high -.65
source:voltage:slew:leading 2700

## now invert output to test high drive
source:pulse:polarity1 invert
## for PG100, skip to range 2 test
#@ verify 10% high drive level

source:voltage:level1:immediate:high 2.75
source:voltage:level1:immediate:low 1.0
source:voltage:level2:immediate:high 2.75
source:voltage:level2:immediate:low 1.0
#@ verify 50% high drive level

source:voltage:level1:immediate:high 6.15
source:voltage:level2:immediate:high 6.15
#@ verify 90% high drive level

## change slew range for range 2 driver circuit
source:voltage:slew:leading 1000

#@ verify 90% high drive level

source:voltage:level1:immediate:high 2.75
source:voltage:level1:immediate:low -2.0
source:voltage:level2:immediate:high 2.75
source:voltage:level2:immediate:low -2.0
#@ verify 50% high drive level
```


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```
source:voltage:level1:immediate:high -.65
source:voltage:level2:immediate:high -.65

#@ verify 10% high drive level

## change slew range for range 3 driver circuit
source:voltage:slew:leading 10
source:voltage:level1:immediate:low -12.00
source:voltage:level2:immediate:low -12.00

source:voltage:level1:immediate:high -9.15
source:voltage:level2:immediate:high -9.15
#@ verify 10% high drive level

source:voltage:level1:immediate:high 0.25
source:voltage:level2:immediate:high 0.25
#@ verify 50% high drive level

source:voltage:level1:immediate:high 9.65
source:voltage:level2:immediate:high 9.65
#@ verify 90% high drive level
source:pulse:polarity1 normal

#@ Change meter from DC to AC RMS

## The dynamic AC RMS part starts here
## First 5 Vp-p in fast slew range

source:voltage:level2:immediate:high 5.0
source:voltage:level2:immediate:low 0.0

source:voltage:level1:immediate:high 5.0
source:voltage:level1:immediate:low 0.0
source:voltage:slew:leading 2700
trigger:start:source immediate
source:pulse:mode auto
## for PG100, skip to range 2 test
#@ verify RMS voltage level

## Now range 2 slew
source:voltage:slew:leading 1300
#@ verify RMS voltage level

## Now range 3 slew
source:voltage:slew:leading 32
source:voltage:level1:immediate:high 5.0
source:voltage:level1:immediate:low -5.0
source:voltage:level2:immediate:high 5.0
source:voltage:level2:immediate:low -5.0
#@ verify RMS voltage level

abort
output:state off
```


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```
********************** TEST 2 *********************

## Pulse timing test
*rst
## The period timer check first

## first verify output 1 -
## both outputs are the same, so verify output 2 with
##  a second pass

source:pulse:mode auto
source:pulse:period 12.5e-9
source:pulse:width1  6.25e-9
source:pulse:hold width
source:pulse:hold:auto on
source:pulse:delay1 0
source:pulse:delay2 0
source:pulse:polarity normal
source:voltage:slew:trailing:auto on
source:voltage:slew:leading 2700
## for PG100, use source:voltage:slew:leading 1300
source:voltage:level1:immediate:high 2.0
source:voltage:level1:immediate:low -2.0
source:voltage:level2:immediate:high 2.0
source:voltage:level2:immediate:low -2.0

output:state on
trigger:start:source immeadiate

#@ verify pulse period using frequency - 80 MHz
abort

source:pulse:period 14.0e-9
source:pulse:width1  7.0e-9
source:pulse:width2  7.0e-9
trigger:start:source immeadiate

#@ verify pulse period using frequency - 71.4 MHz
abort

source:pulse:period 100.0e-9
source:pulse:width1  50.0e-9
source:pulse:width2  50.0e-9
trigger:start:source immeadiate

#@ verify pulse period using frequency - 10 MHz
abort

source:pulse:period 100.0e-6
source:pulse:width1  50.0e-6
source:pulse:width2  50.0e-6
trigger:start:source immeadiate
```


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```
#@ verify pulse period using frequency - 10 KHz
abort

source:pulse:period 100.0e-3
source:pulse:width1  50.0e-3
source:pulse:width2  50.0e-3
trigger:start:source immeadiate

#@ verify pulse period using pulse width - 100 Ms
abort

## Now verify pulse delay timing

## first verify output 1 -
## both outputs are the same, so verify output 2 with
##  a second pass

source:pulse:period 2400.0e-9
source:pulse:width1 120.0e-9
source:pulse:width2 120.0e-9
source:pulse:delay1 100.0e-9
source:pulse:delay2 100.0e-9
source:voltage:slew:leading 2700
## for PG100, use source:voltage:slew:leading 1300
## source:voltage:level1:immediate:high 2.0

## source:voltage:level1:immediate:low -2.0

trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 101.0e-9
source:pulse:delay2 101.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 102.0e-9
source:pulse:delay2 102.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 103.0e-9
source:pulse:delay2 103.0e-9
trigger:start:source immeadiate

#@ verify pulse delay
```


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```
abort
source:pulse:delay1 104.0e-9
source:pulse:delay2 104.0e-9
trigger:start:source immeadiate

abort
source:pulse:delay1 105.0e-9
source:pulse:delay2 105.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 106.0e-9
source:pulse:delay2 106.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 107.0e-9
source:pulse:delay2 107.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 108.0e-9
source:pulse:delay2 108.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 109.0e-9
source:pulse:delay2 109.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 110.0e-9
source:pulse:delay2 110.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:period 2400.0e-9
source:pulse:width1 1200.0e-9
source:pulse:delay1 1000.0e-9
source:pulse:delay2 1000.0e-9
trigger:start:source immeadiate
```


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```
#@ verify pulse delay

abort
source:pulse:delay1 1010.0e-9
source:pulse:delay2 1010.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1020.0e-9
source:pulse:delay2 1020.0e-9
trigger:start:source immeadiate

abort
source:pulse:delay1 1030.0e-9
source:pulse:delay2 1030.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1040.0e-9
source:pulse:delay2 1040.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1050.0e-9
source:pulse:delay2 1050.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1060.0e-9
source:pulse:delay2 1060.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1070.0e-9
source:pulse:delay2 1070.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1080.0e-9
```


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```
source:pulse:delay2 1080.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
source:pulse:delay1 1090.0e-9
source:pulse:delay2 1090.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort

source:pulse:delay1 1100.0e-9
source:pulse:delay2 1100.0e-9
trigger:start:source immeadiate

#@ verify pulse delay

abort
```


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```
********************** TEST 3 *********************
## Pulse width test

*rst
## Check pulse width times

## first verify output 1 -
## both outputs are the same, so verify output 2 with
##  a second pass

source:pulse:mode auto
source:pulse:period 200.0e-9
source:pulse:width1 100.0e-9
source:pulse:hold width
source:pulse:hold:auto on
source:pulse:delay 0
source:pulse:polarity normal
source:voltage:slew:trailing:auto on
source:voltage:slew:leading 2700
## for PG100, use source:voltage:slew:leading 1300

source:voltage:level1:immediate:high 2.0
source:voltage:level1:immediate:low -2.0
source:voltage:level2:immediate:high 2.0
source:voltage:level2:immediate:low -2.0

output:state on
trigger:start:source immeadiate

#@ verify pulse width for 100 ns
#! Set Counter Reference
#@ set reading as timer offset/reference
abort

source:pulse:width1 101.0e-9
source:pulse:width2 101.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 102.0e-9
source:pulse:width2 102.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 103.0e-9
source:pulse:width2 103.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 104.0e-9
```


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```
source:pulse:width2 104.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 105.0e-9
source:pulse:width2 105.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 106.0e-9
source:pulse:width2 106.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 107.0e-9
source:pulse:width2 107.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 108.0e-9
source:pulse:width2 108.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 109.0e-9
source:pulse:width2 109.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 110.0e-9
source:pulse:width2 110.0e-9

#@ verify pulse width for 1 ns increment
abort

source:pulse:width1 120.0e-9
source:pulse:width2 120.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 130.0e-9
source:pulse:width2 130.0e-9

#@ verify pulse width for 10 ns increment
abort
```


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```
source:pulse:width1 140.0e-9
source:pulse:width2 140.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 150.0e-9
source:pulse:width2 150.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 160.0e-9
source:pulse:width2 160.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 170.0e-9
source:pulse:width2 170.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 180.0e-9
source:pulse:width2 180.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:width1 190.0e-9
source:pulse:width2 190.0e-9

#@ verify pulse width for 10 ns increment
abort

source:pulse:period 200.0e-6
source:pulse:width1 100.0e-6
source:pulse:width2 100.0e-6

#@ verify pulse width for 100 us period
abort

source:pulse:period 2.0e-3
source:pulse:width1 1.0e-3
source:pulse:width2 1.0e-3

#@ verify pulse width for 1 ms period
abort
```


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```
source:pulse:period 100.0e-3
source:pulse:width1 50.0e-3
source:pulse:width2 50.0e-3

#@ verify pulse width for 100 ms period
abort



********************** TEST 4 **********************

## Check pulse rise/fall times

## first verify output 1 -
## both outputs are the same, so verify output 2 with
##  a second pass

## to avoid continually changing counter setup, first check
## all rise times, then all fall times
*rst
source:pulse:mode auto
source:pulse:period 400.0e-9
source:pulse:width1 200.0e-9
source:pulse:hold width
source:pulse:hold:auto on
source:pulse:delay 0
source:pulse:polarity normal
source:voltage:slew:trailing:auto on
source:voltage:level1:immediate:high 3.0;low -2.0
source:voltage:level2:immediate:high 3.0;low -2.0

output:state on
trigger:start:source immediate
source:voltage:slew:leading 300

#@ verify pulse rise time

source:voltage:slew:leading 60

#@ verify pulse rise time

source:pulse:period 4.0e-6
source:pulse:width1 2.0e-6

source:voltage:slew:leading 30

#@ verify pulse rise time
```


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```
source:voltage:slew:leading 3.33

#@ verify pulse rise time

source:pulse:period 500.0e-6
source:pulse:width1 300.0e-6

source:voltage:slew:leading 0.75

#@ verify pulse rise time


source:voltage:slew:leading 0.0375
#@ verify pulse rise time

#! change counter setup for fall time

#! start with Range 3

source:pulse:period 4.0e-6
source:pulse:width1 2.0e-6

source:voltage:slew:leading 30

#@ verify pulse fall time

source:voltage:slew:leading 3.33

#@ verify pulse fall time

source:pulse:period 500.0e-6
source:pulse:width1 300.0e-6

source:voltage:slew:leading 0.75

#@ verify pulse fall time

source:voltage:slew:leading 0.0375

#@ verify pulse fall time
```


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AppNotes & TechNotes

AppNotes & TechNotes

Note:
This section contains Application Notes and Technical Notes describing the technical details and applications of the subject equipment.

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APPLICATION NOTE

A-PG100/110-01A

Double Pulse

Objective

The objective of this application note is twofold; first to provide step-by-step instructions for using the PG100 / PG110 Pulse Generators to generate a double pulse output. Secondly, after the double pulse output is enabled, we will modify the second pulse with variations distinguishing it from the first pulse, thus allowing the user to set up nonequivalent pulses. The examples described herein are based on the use of Interface Technology software drivers for LABWindows/CVI.

Features

The PG100 / PG110 pulse generators can be programmed to produce double-pulse outputs from each of the two channels. Both the width and the delay of the second pulse can be pre-programmed. In addition, the user can also differentiate the pulses to output non-uniform pulse patterns.

Double Pulse Output

Pulse Generator Setup

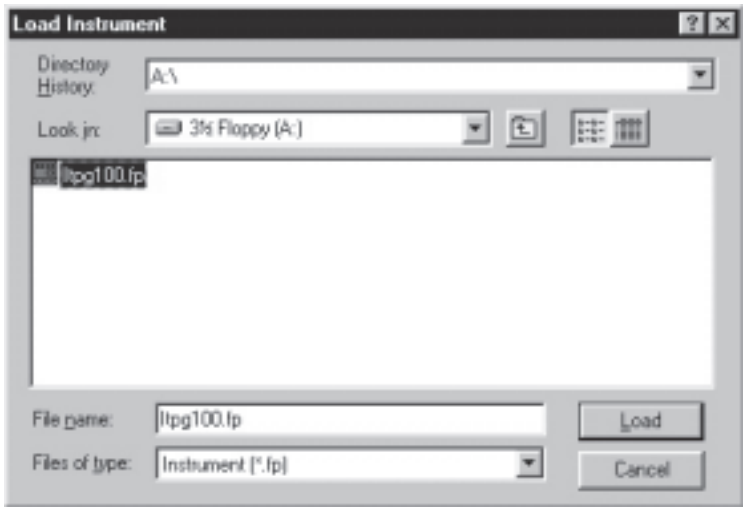
1. Select the "***.prj**" window.
2. Select the "*Instrument*" menu and select "*Load*".



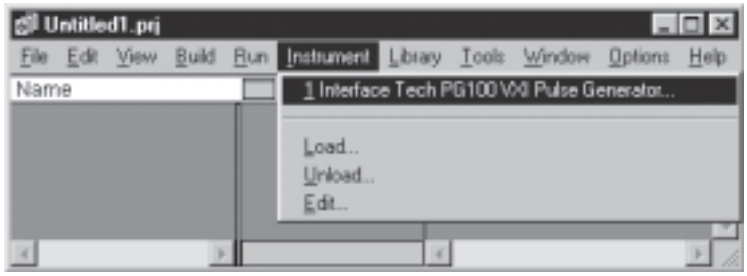
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3. Find the file (driver) labeled "**itpg100.fp".**

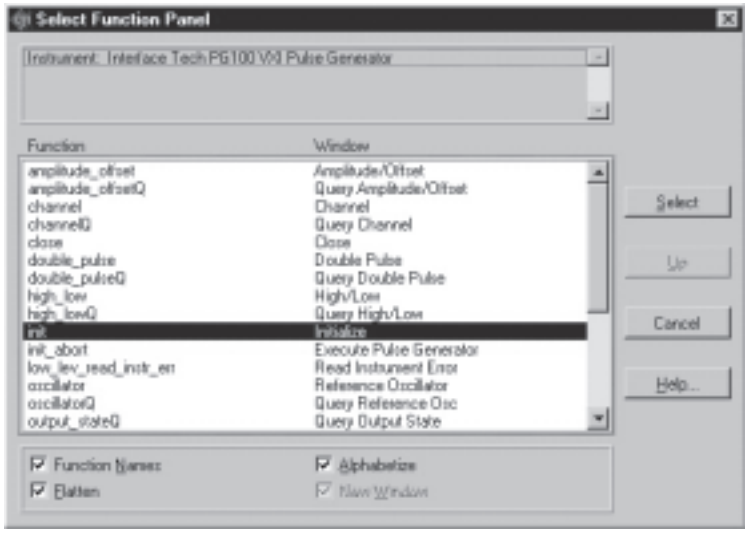
4. Select "**itpg100.fp***"* and hit "*Load*".



5. From the *"Instrument"* top menu, select *"Interface Tech PG100 VXI Pulse Generator".*



6. From the *"Select function Panel"* window, select *"Initialize"* function panel.



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7. Enter the **Logical Address** value (LA) of the Pulse Generator.

Note

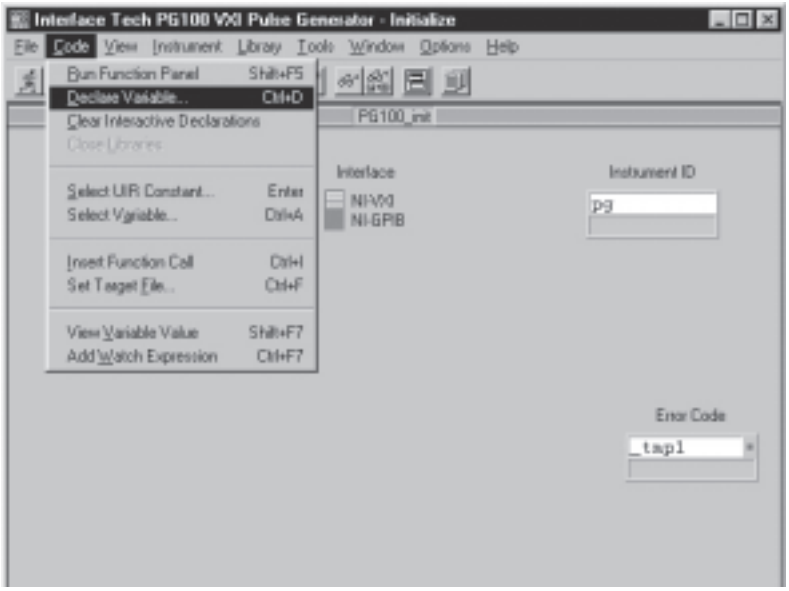
To find the Logical Address of the Pulse Generator, please refer to the PG100 User's Manual under "**Installation**" *Setting the Logical Address* or use a Resource Manager such as "Resman" or "T&M Explorer".

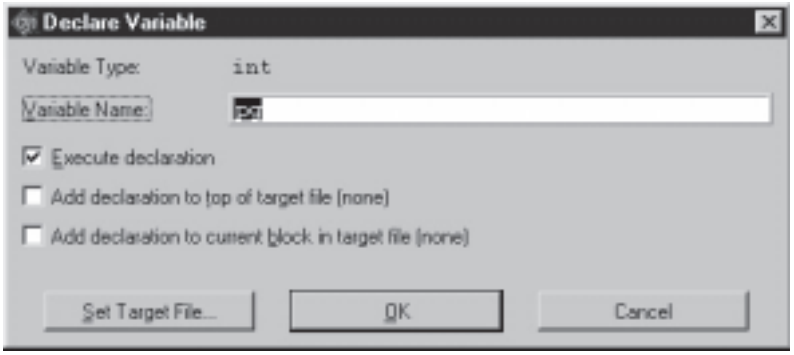
8. Enter a variable for the *"Instrument ID"* such as "**PG**".

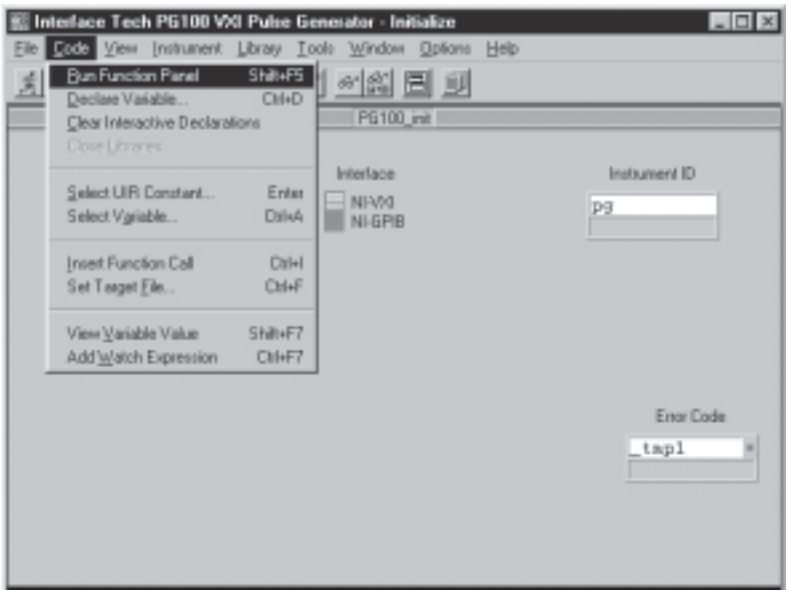
9. From the *"Code"* menu on top, select *"Declare Variable"*.

10. Press "**OK**" when the *"Declare Variable"* dialog box pops up.

11. From the *"Code"* menu, select *"Run Function Panel"*.







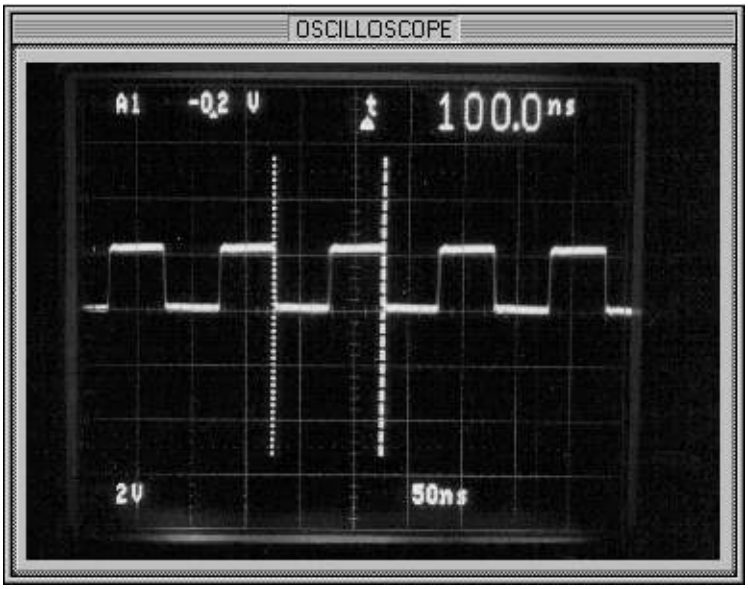
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12. From the *"Instrument"* menu, select the PG100 again.
13. Select the *"Execute Pulse Generator"* function panel.
14. Toggle the *"Enable Outputs"* switch to "**ON**" and *"Run Function Panel"* once again.



Note

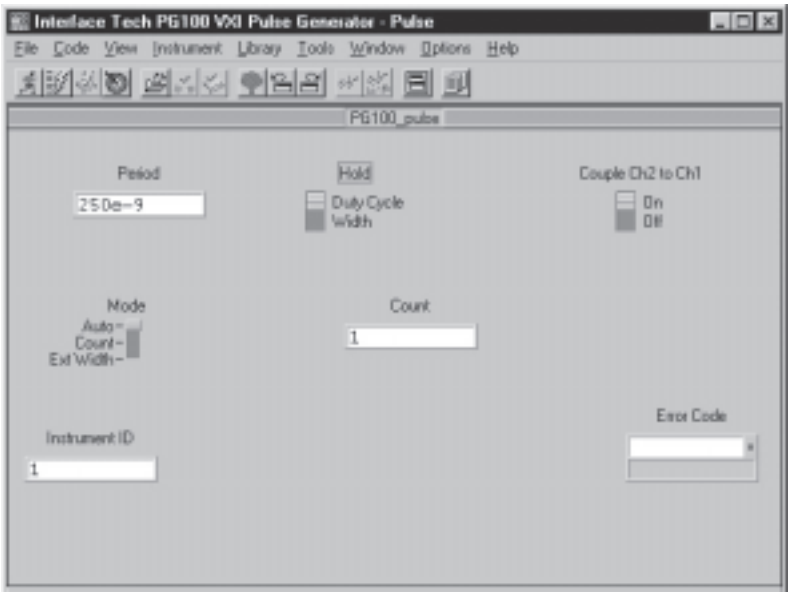
At this point, if you have a scope connected, you should be seeing a 10 MHz pulse from the output.



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Double Pulse Setup

1. From the *"Instrument"* menu, choose the PG100 and select the *"Pulse"* function panel.
2. From the Pulse function panel, toggle the *"Hold"* Switch to ***"Width"*** and change the period to 250e-9 (250 ns).
3. Select ***"Run Function Panel"***.

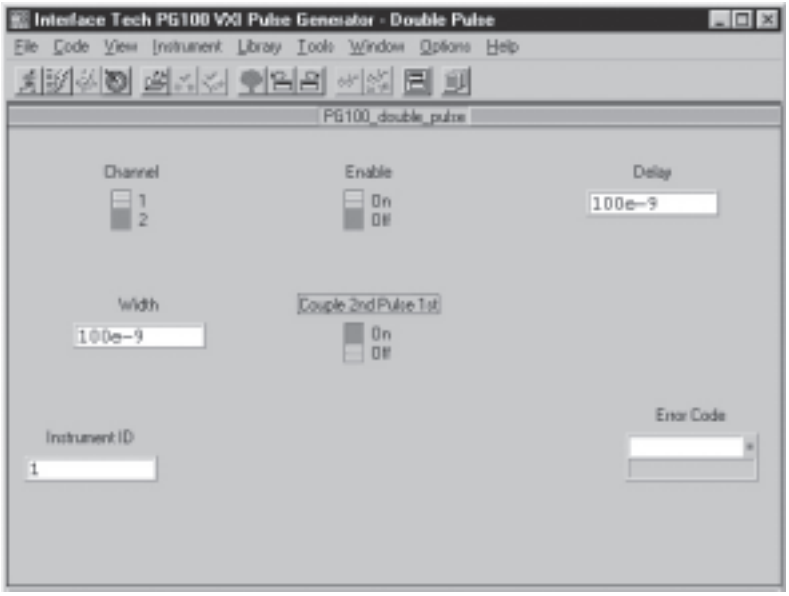


Note

By changing the period and keeping the pulse width, we will be able to see and vary the second pulse.

Double Pulse

1. From the *"Instrument"* menu, choose the PG100 and select the *"Double Pulse"* function panel.
2. From this window, toggle the *"Enable"* switch to "**ON**" and toggle the *"Couple 2nd Pulse to 1st"* to "**OFF**".
3. Set *"Delay"* and *"Width"* to "**100e-9**".
4. "**Run Function Panel**".

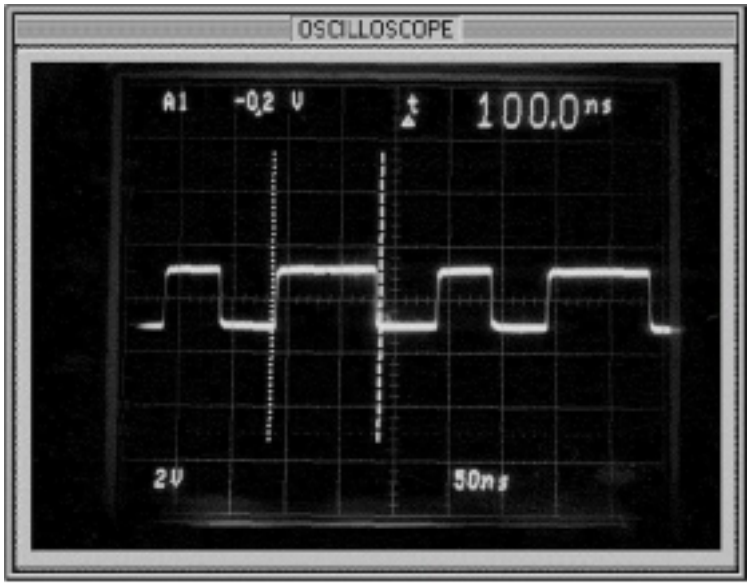


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Note

At this point, you should see a double pulse on the scope with a 100 ns delay and 100 ns width as compared to the original pulse.

Toggling the "Couple 2nd" pulse to 1st" to "ON" will cause the second pulse to be automatically linked to the original pulse. Variations in width will be ignored, but delay values will still be obeyed.



Conclusion

Double pulse capability is another feature of the PG100 / PG110 that can be utilized for a variety of test applications. Such flexibility of programmable pulse parameters ensures fast, accurate, and repeatable test parameters unequaled by conventional test instrumentation.

SCPI Command Listing

Double Pulse

```
INIT
OUTPUT:STATE ON
SOURCE:PULSE:HOLD WIDTH
SOURCE:PULSE:PERIOD 250e-9
SOURCE:PULSE:DOUBLE ON
SOURCE:PULSE:DOUBLE:DELAY 100e-9
SOURCE:PULSE:DOUBLE:WIDTH:AUTO OFF
SOURCE:PULSE:DOUBLE:WIDTH 100e-9
```


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C code Listing for Double-Pulse

This example will show a double pulse output. The original pulse will start off at default values (100 ns period, 50 ns width). The period will be extended to 250 ns. The double-pulse mode will be enabled. The second pulse will be changed to 100 ns delay and 100 ns width.

```
main()

{
static int PG;
        PG100_init (12, 1, & PG, 0);
        /* Initialization of the PG with a LA of 12 and
                an Instrument ID of 1 with an ID designation of "PG" */

        PG100_init_abort (1, 1, 1);
        /* Pulse Generator outputs enabled */

        PG100_pulse (1, 250e-9, 0, 1, 0, 1);
        /* Pulse period extended to 250 ns, width held */

        PG100_write (1, "source:pulse:double on");
        /* Enable double pulse mode ON */

        PG100_pulse (1, "source:pulse:double:delay 100e-9");
        /* Set double pulse delay to 100 ns */

        PG100_write (1, "source:pulse:double:width:auto off");
        /* Decouple 2nd pulse to 1st */

        PG100_write (1, "source:pulse:double:width 100e-9");
        /* Set double pulse width to 100 ns */
}
```


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TECHNICAL NOTE

T-PG100/110-01A

Trapezoidal Wave and Pulse Count

Objective

The objective of this technical note is twofold; first to provide step-by-step instructions for using the PG100 / PG110 Pulse Generators to generate trapezoidal waveforms, and second for generating a predetermined number of pulses. In the first example, the slew rate, amplitude, and voltage offset of the default 10 MHz pulse waveform are changed to produce a trapezoidal waveform. In the second example, the trigger source and count functions are used to generate a series of timed pulses. The examples descibed herein are based on the use of Interface Technology's software drivers for LabWindows/CVI.

Features

Programmability allows the user to control the shape of the waveform generated by the PG100 / PG110. Pulse rise and fall times, for example, can be programmed from 33 mV/us to 1300 V/us. Likewise, voltage thresholds and amplitude can be programmed, and the shape of the waveform can be changed from a square wave to a saw-toothed wave, trapezoidal wave, or to other pulse waveform configurations. The PG100/PG110 can also be programmed to output a timed series of pulses.

Trapezoidal Wave

Pulse Generator Setup

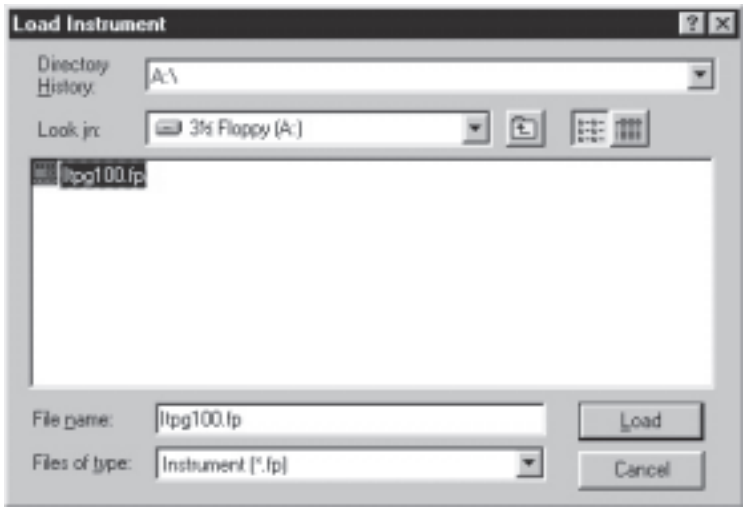
1. Select the "***.prj**" window.
2. Select the "*Instrument*" menu and select "*Load*".



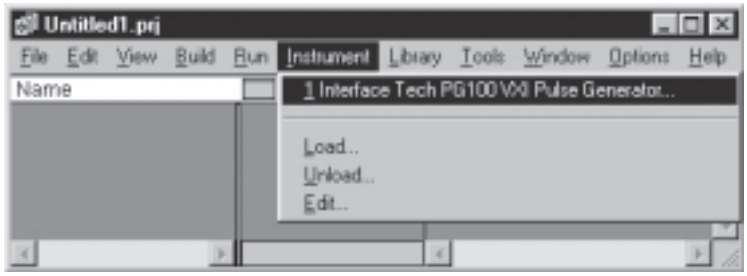
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3. Find the file (driver) labeled "**itpg100.fp".**

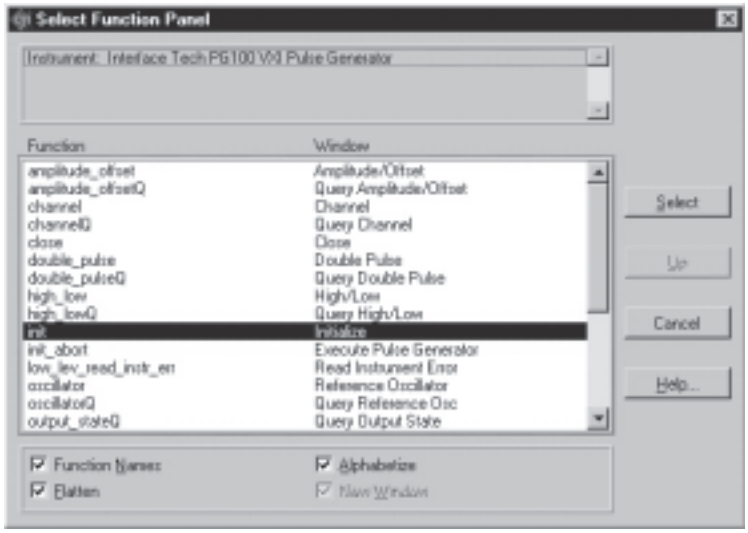
4. Select "**itpg100.fp***"* and hit "*Load*".



5. From the *"Instrument"* top menu, select *"Interface Tech PG100 VXI Pulse Generator"*.



6. From the *"Select function Panel"* window, select *"Initialize"* function.



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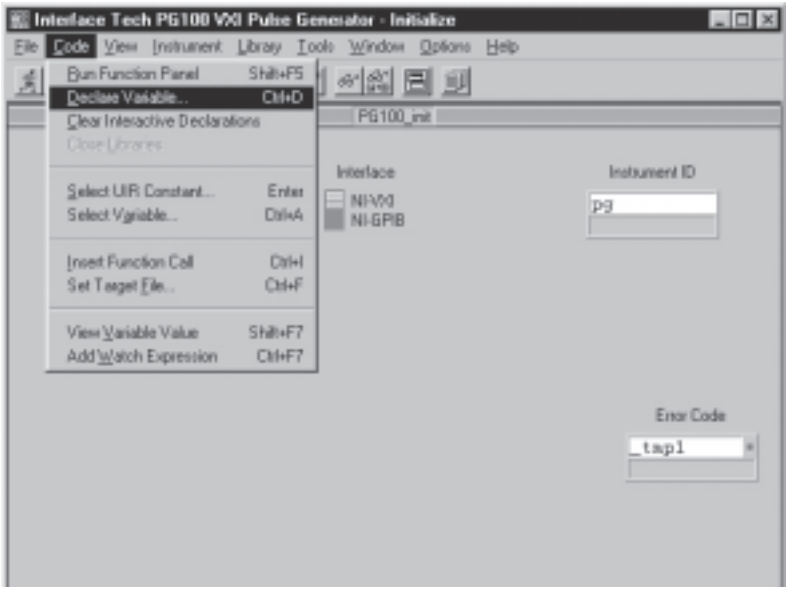
7. Enter the **Logical Address** value (LA) of the Pulse Generator.

Note

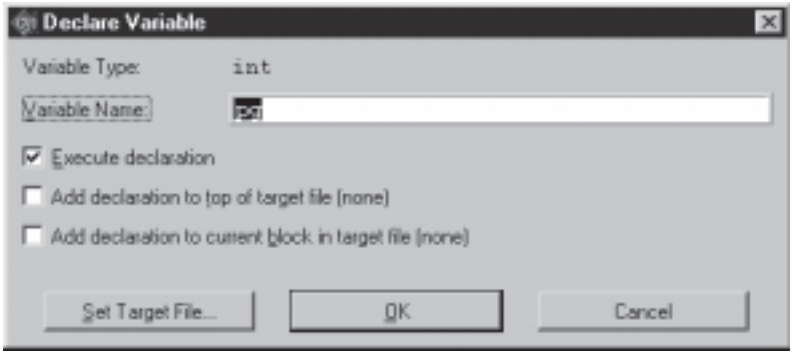
To find the Logical Address of the Pulse Generator, please refer to the PG100 User's Manual under "**Installation**" *Setting the Logical Address* or use a Resource Manager such as "Resman" or "T&M Explorer".

8. Enter a variable for the *"Instrument ID"* such as "**PG**".

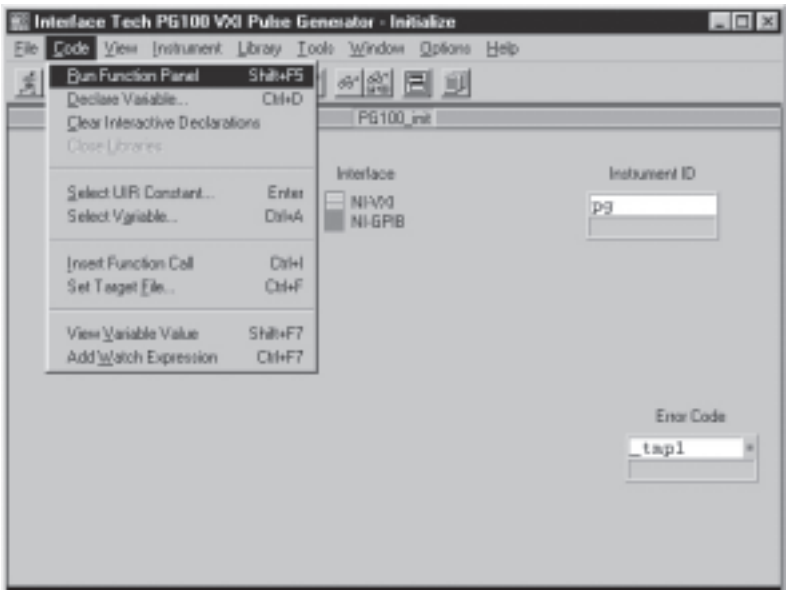
9. From the *"Code"* menu on top, select *"Declare Variable"*.



10. Press "**OK**" when the *"Declare Variable"* dialog box pops up.



11. From the *"Code"* menu, select *"Run Function Panel"*.

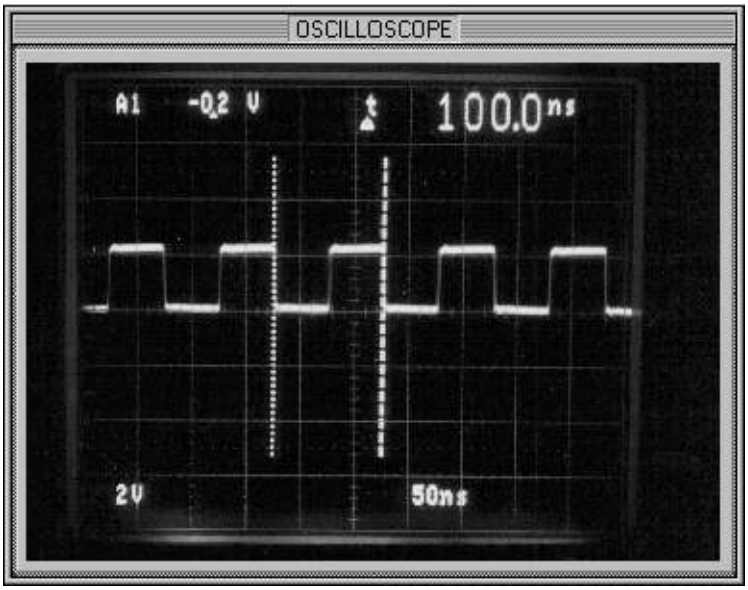


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12. From the *"Instrument"* menu, select the PG100 again.
13. Select the *"Execute Pulse Generator"* function panel.
14. Toggle the *"Enable Outputs"* swirch to "**ON**" and *"Run Function Panel"* once again.



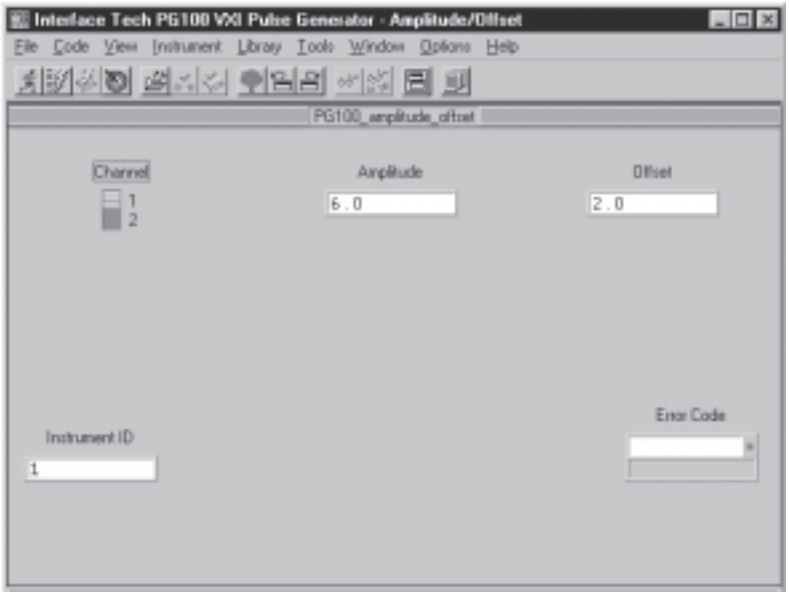
Note
At this point, if you have a scope connected, you should be seeing a 10 MHz pulse from the output.



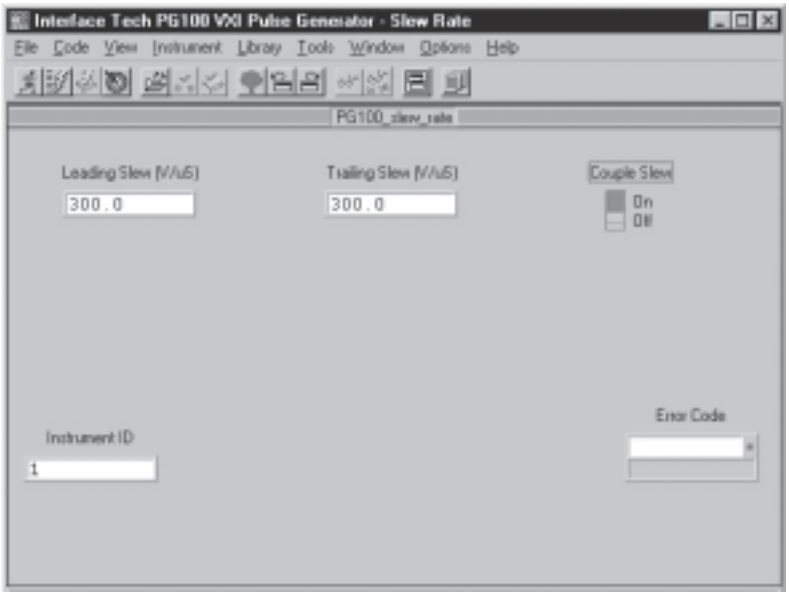
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Trapazoidal Waveform

1. From the *"Instrument"* select *"Interface Tech PG100 VXI Pulse Generator"*.
2. Choose the *"Amplitude Offset"* function.
3. Change the Amplitude to 6.0 Volts and the Offset to 2.0 Volts.
4. Select *"Run Function Panel"*.



5. Select the PG100 again and choose the *"Slew Rate"* function.
6. Change the Leading and Trailing Slew rate to "**300 V/us**".
7. Toggle *"Couple Slew"* switch to "**OFF**".



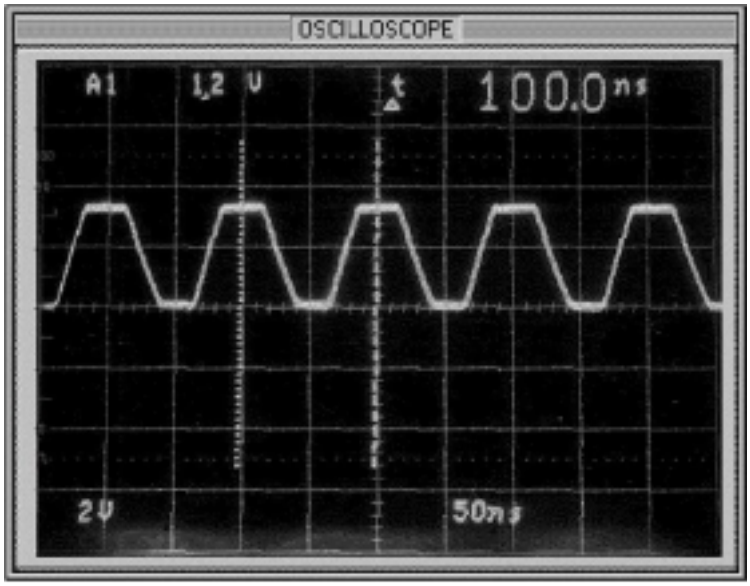
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Note

With a scope connected, you should see a trapezoidal waveform with a 100 ns period and 6-volt peak-peak amplitude.

Note

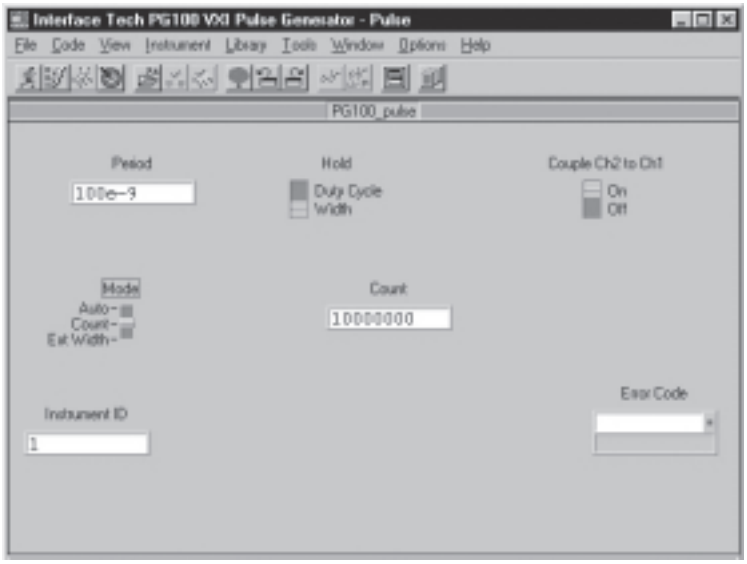
Changing the Offset voltage is needed to keep the Pulse Generator output within the high and low voltage range.



Pulse Count Setup

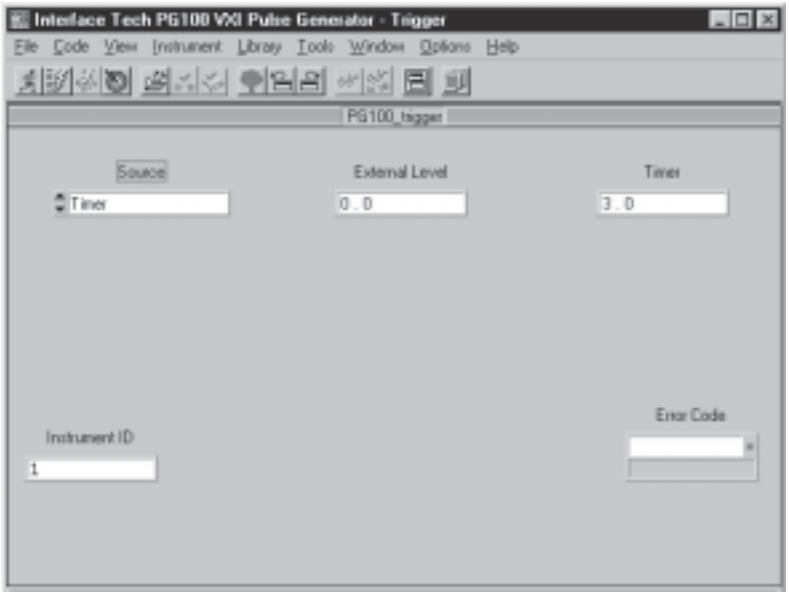
In this next example, we will use the *"Count Timer"* function of the PG to output a one-second pulse of the trapezoidal wave (10 million pulses) at the default 100 ns period every three seconds.

1. Select the *"Pulse"* function panel.
2. Toggle the *"Mode"* switch to *"Count"*.
3. Input a count of "**10,000,000**".
4. Select *"Run Function Panel"*.



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5. Select the *"Trigger"* function panel.
6. Change the source to "**Timer**".
7. Input a *"Timer"* count of "**3**".
8. Select *"Run Function Panel"*.



Note

The scope should be showing the trapezoidal wave pulse for about a one second duration in the 3 second timer duration we set earlier.

Conclusion

The PG100 / PG110 offers a wide variety of program commands to control the characteristics of the output waveform, including the generation of trapezoidal waveforms and timed pulse outputs. The source code for generating these waveforms is included at the end of this document. Additional programming information is included in the PG100 / PG110 User's Manual.

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SCPI Command listing

Trapezoidal & Pulse Count

```
INIT
OUTPUT:STATE ON
SOURCE:VOLTAGE:LEVEL:IMMEDIATE:OFFSET 2.0
SOURCE:VOLTAGE:LEVEL:IMMEDIATE:AMPLITUDE 6.0
SOURCE:VOLTAGE:SLEW:LEADING 300
SOURCE:VOLTAGE:SLEW:TRAILING 300
SOURCE:PULSE:MODE COUNT
SOURCE:PULSE:COUNT 10000000
TRIGGER:START:TIMER 3.0
TRIGGER:SOURCE TIMER
```


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C code Listing for Trapazoidal & Pulse Count

This example will show a trapezoidal pulse with a pulse count output. The original pulse will start off at default values (100 ns period, 50 ns width). The slew rate will be changed to 300 V/us. Amplitude and Offset voltages will be changed to 6.0 and 2.0 volts respectively. The pulse count will be enabled with a count of 10 million and a timer set to sample every 3 seconds.

```
main()

{
static int pg;
        PG100_init (12, 1, & pg, 0);
        /* Initialization of the PG with a LA of 12 and
                an Instrument ID of 1 with an ID designation of "PG" */

        PG100_init_abort (1, 1, 1);
        /* Pulse Generator outputs enabled */

        PG100_amplitude_offset (1, 1, 6.0, 2.0);
        /* Set amplitude of PG to 6.0 volts with an offset of 2.0 volts */

        PG100_slew_rate (1, 300.0, 300.0, 0);
        /* Set leading and trailing slew rates to 300 V/us */

        PG100_pulse (1, 100e-9, 0, 1, 1, 10000000);
        /* Set pulse count to 10 million */

        PG100_trigger (1, 3, 0.0, 3.0);
        /* Set trigger  to output 1 second of pulses every 3 seconds */
}
```


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