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WARNING

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONNEL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO THE SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

PG 2010/PG 2011/ PG 2012

Programmable

Pulse Generator

SERVICE MANUAL

Tektronix, Inc
P.O. Box 500
Beaverton, OR 97077

070-8142-00
Product Group 65

Serial Number _____

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INSTRUMENT SERIAL NUMBERS

Each instrument manufactured by Tektronix has a serial number on a panel insert, tag, or stamped on the chassis. The letter at the beginning of the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two-digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

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OPERATORS SAFETY SUMMARY

The general safety information in this summary is for both operating and servicing personnel. Specific warnings and cautions are found throughout the manual where they apply, and may not appear in this summary.

TERMS

Terms in This Manual

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

CAUTION statements identify conditions or practices that could result in damage to the instrument or other property.

Terms as Marked on Instrument

CAUTION indicates a hazard to property, including the equipment itself, and could cause minor personal injury.

WARNING indicates solely a personal injury hazard not immediately accessible as you read the marking.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

Symbols in This Manual

This symbol indicates where applicable cautionary or other information is to be found.

This symbol indicates where special explanatory information is included in the manual. There is no caution or danger associated with the information.

Symbols as Marked on Instrument

DANGER - High Voltage.

Protective ground (earth) terminal.

ATTENTION - Refer to manual.

Refer to manual before using.

Power Source

This instrument is intended to operate from a power source that does not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection through the grounding conductor in the power cord(s) is essential for safe operation

Grounding the Product

WARNING: This product is grounded through the grounding connector of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle. A protective-ground connection by way of the grounding conductor in the power cord is essential for safe operation. (I.E.C. Safety Class I)

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord that is in good condition. CSA Certification includes the equipment plus those power cords appropriate for use on the North America power network. All other power cords supplied are approved for the country of use.

Use the Proper Fuse

To avoid fire hazard, use only fuses specified in the instrument parts list. A replacement fuse must meet the type, voltage rating, and current rating specifications required for the fuse that it replaces.

Do Not Operate in Explosive Atmosphere

To avoid explosion, do not operate the instrument in an explosive atmosphere.

Do Not Remove Covers or Panels

To avoid personal injury, the instrument covers should be removed only by qualified service personnel. Do not operate the instrument without covers and panels properly installed.

Remove from Operation

If you have reason to believe that the instrument has suffered a component failure, do not operate the instrument until the cause of the failure has been determined and corrected.

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY
Refer also to the preceding Operator Safety Summary.

Do Not Service Alone

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On

Dangerous voltages may exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

Use Caution When Servicing The CRT

The CRT assembly should be replaced only by qualified personnel familiar with CRT servicing procedures and precautions.

CRTs retain hazardous voltages for long periods of time after power-down. Before attempting any work inside the instrument, discharge the CRT by shorting the anode to chassis ground. When discharging the CRT, connect the discharge path to ground and then the anode.

Use extreme caution when handling the CRT. Rough handling may cause it to implode. Do not nick or scratch the glass or subject it to undue pressure during removal or installation. When handling the CRT, wear safety goggles and heavy gloves for protection.

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

SECTION 1
GETTING STARTED

Introduction

This section of the manual contains a general description of the PG 2010, PG 2011, and PG 2012 Pulse Generators (including standard and optional accessories), power turn-on procedure and generation of a sample pulse.

Instrument Description

The PG 2010, PG 2011, and PG 2012 are a series of fully programmable, general purpose pulse generators designed for both digital and analog applications.

The PG 2012 is a dual channel generator while the PG 2010 and PG 2011 generators provide either single or dual output channels in the same instrument. Table 1-1 lists the available output configurations for each instrument.

The PG 2010 is particularly appropriate for use with very high-speed families of logic, the PG 2011 with more common families of logic typically used with microprocessors and analog applications, while the PG 2012 is ideal when mixed families of logic are employed.

Instrument Options

- Option 02 — adds a second channel to the PG 2010 and PG 2011 of the same type as the current channel.
- Option 1R — installs rackmount assembly onto PG 2010, PG 2011, or PG 2012 instrument.
- Option B1 — includes service manual as standard accessory.

Table 1-1
Channel Output Configurations

Instrument	Available Outputs
PG 2010 Single or dual outputs	**Selectable Outputs Available for Each Channel**
	≤250ps fixed rise and fall time (20% — 80%)
	800ps typical fixed rise and fall time (10% — 90%)
	1.8ns typical fixed rise and fall time (10% — 90%)
PG 2011 Single or dual outputs	**Variable Output for Each Channel**
	5.5ns to 10ms variable rise and fall time (10% — 90%)
PG 2012 Dual outputs	**Selectable Output for Channel 1**
	≤250ps fixed rise and fall time (20% — 80%)
	800ps typical fixed rise and fall time (10% — 90%)
	1.8ns typical fixed rise and fall time (10% — 90%)
	Variable Output for Channel 2
	5.5ns to 10ms variable rise and fall time (10% — 90%)

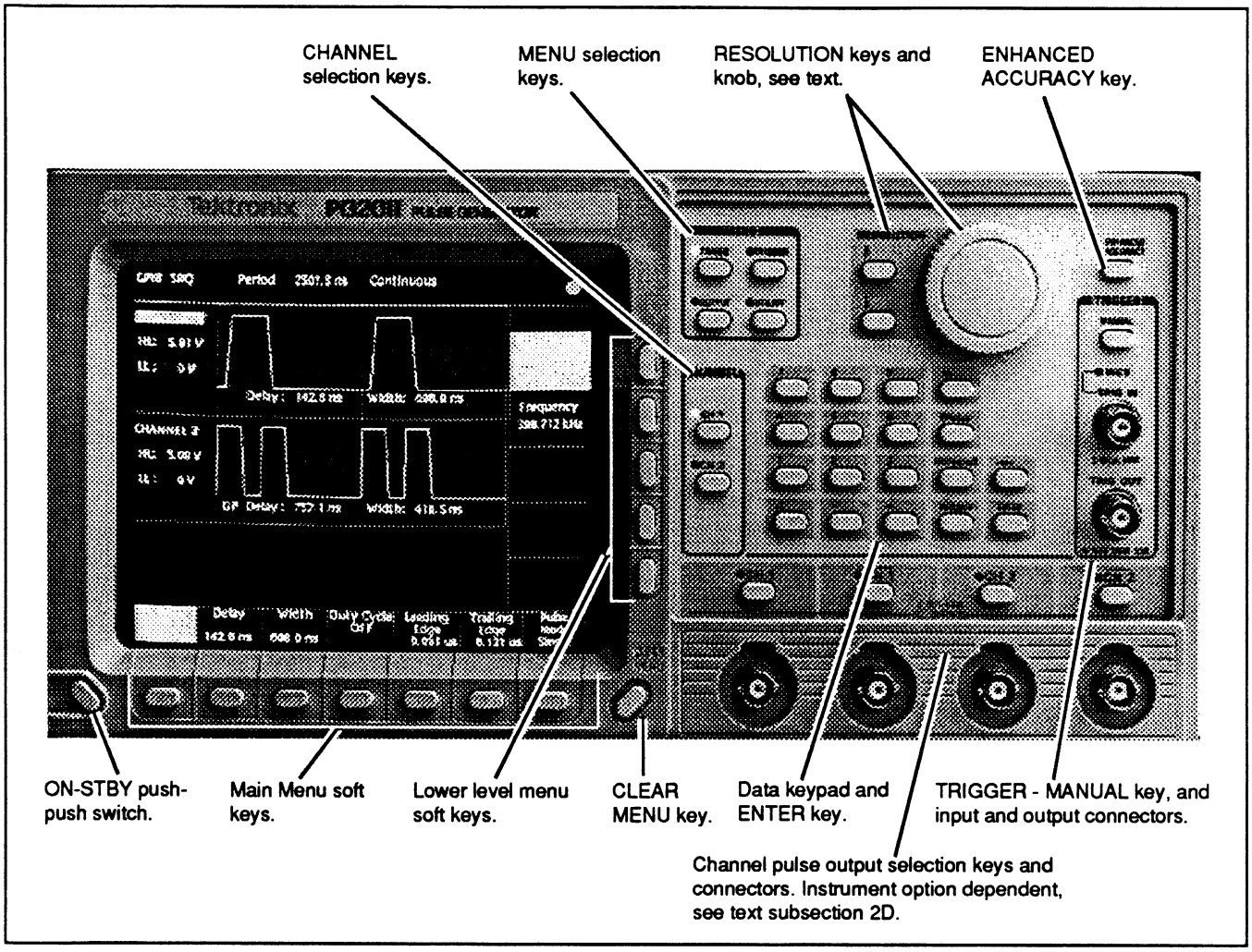


Fig. 1-1. PG 2011 front-panel showing location of detailed control information. See Fig. 2-6 for an explanation of the different crt fields.

Standard Accessories

The PG 2010/2011/2012 instruments include the following standards accessories:

- Operators Manual 070-8143-01
- GPIB extender ..... Order by description

Optional Accessories

The following accessories are optional:

- Service Manual 070-8142-00
  Includes calibration and checkout software.
- GPIB cable 012-0991-00
- 50Ω BNC cable 012-1342-00
- 50Ω BNC termination 011-0049-01
- Rackmount kit ..... Order by description

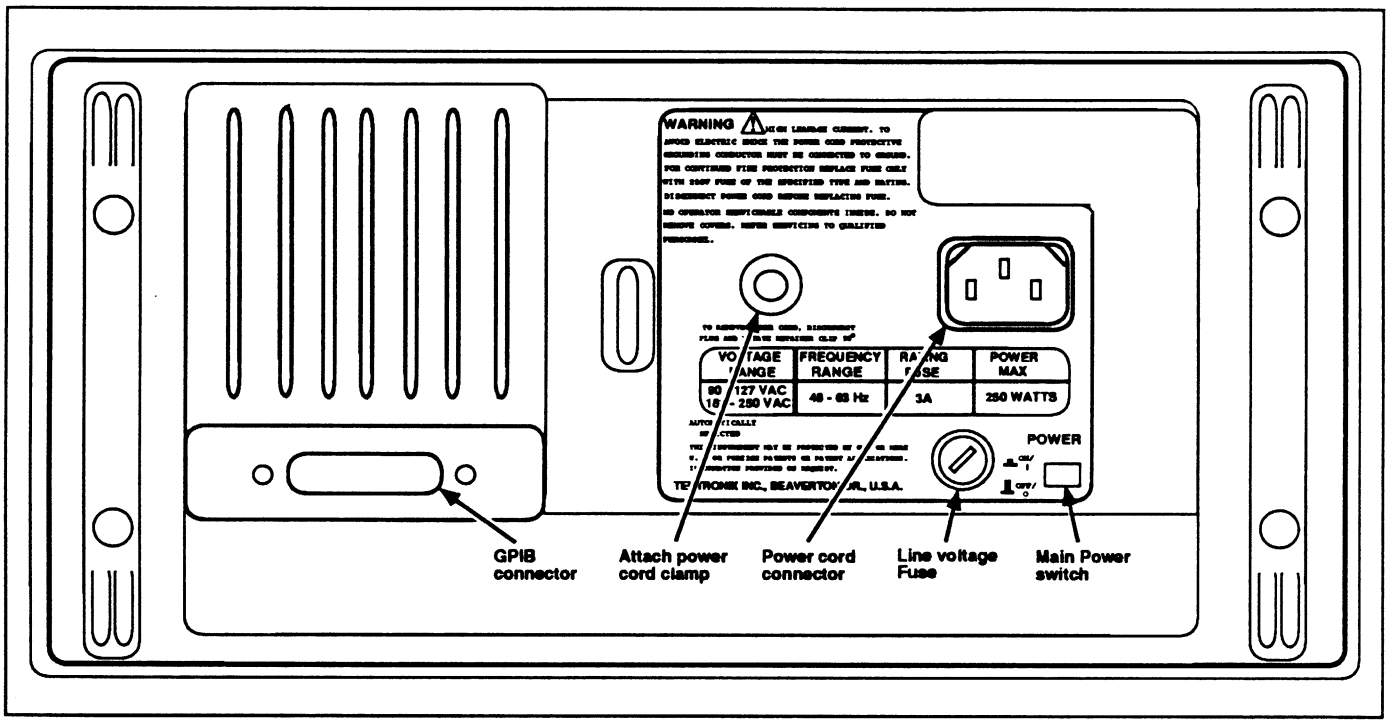


Fig. 1–2. PG 2012 rear–panel showing the location of the GPIB connector, main power switch, fuse, and power cord receptacle.

Preparation for Use

Instrument Cooling

Keep your instrument on a flat, hard, stable work surface. Maintain adequate airflow to prevent instrument damage from internally generated heat. Before applying power to the instrument, verify that the spaces around the air-intake holes on the bottom, sides, top and rear of the instrument cabinet are free of any obstruction to airflow. Use the following recommended clearances:

- Rear of instrument: . . . . . 6 in (15 cm)
- Top, left and right sides: . . . . 3 in (8 cm)

Power Turn-On

Refer to Fig. 1-2 and verify that the correct fuse is installed, and the appropriate power cord is properly connected. The instrument has automatic line voltage sensing circuitry and sets its internal circuitry accordingly. See Table B-1 in appendix B for available power cord plug options.

Line connector power is applied to the instrument by pressing in the push-push rear panel Main Power switch. The rear-panel Main Power switch applies power to the Standby circuitry.

To apply power to the remainder of the instrument circuitry, the front-panel ON–STBY push–push switch must be pushed once after turning on the Main Power switch.

For output accuracy, the instrument should be allowed to warm–up for 20 minutes.

The instrument has a unique architecture that incorporates built-in time and voltage measurement capability that is used to autocalibrate the instrument, when initiated by the user in bench application or in system controller application. The instrument also performs an autocalibration each time an operating parameter is changed in the enhanced accuracy mode.

Sample Pulse Output

Pulse Definitions

Definition of Pulse Parameters

Figs. 1-3A through 1-3D illustrate how the instrument defines the various pulse parameters.

Pulse HIGH LEVEL corresponds to the most positive level of the pulse. Pulse LOW LEVEL corresponds to the most negative level of the pulse. Pulse AMPLITUDE is defined as the difference between the HIGH LEVEL and LOW LEVEL values.

Transition time is the interval required for the pulse to go from 10% to 90% of the selected amplitude or vice versa. Transition time for the ≤250ps setting on PG 2010 and PG 2012 Channel 1 is the interval for the pulse to go from 20% to 80%. 20% to 80% is used to be consistent with high speed ECL logic specifications.

The way in which the instrument defines pulse parameters forces a distinction between the specified pulse which assumes the fastest transition times and the actual pulse output; the latter is referred to as the observed pulse as shown in Fig. 1-3B. As illustrated in Fig. 1-3B, the values specified for WIDTH, PERIOD, and DELAY are defined with reference to the point at which the specified pulse reaches 50% of the amplitude during the leading and trailing edges at the fastest transition time.

WIDTH is the time interval between the 50% points of the leading and trailing edges. If the selected leading and trailing edge transition times (for the PG 2011, and PG 2012 Channel 2) are equal, the time interval between the 50% points is the same as that between the first and third corners.

PERIOD is the time between the 50% points on the rising edges of two consecutive trigger outputs. DELAY is the time between the 50% points on the rising edge of the trig out pulse and the 50% point of the leading edge of the output pulse (at fastest transition time). See Fig. 1-3B.

The time interval between the 50% points of the actual pulse depends on both the width and transition time settings. A trailing edge slower or faster than the leading edge respectively lengthens or shortens the 50% interval. In effect, the pulse edges pivot about the first and third corners while the interval between these corners remains fixed for a given width setting. See Fig. 1-3B.

As long as the leading and trailing edge times are equal, the selected width and the actual width are the same.

In the double pulse mode the instrument defines PERIOD the same as in the single pulse mode: The time between the 50% points on the leading edges of two consecutive trigger outputs. DELAY, in double pulse mode, is the time between the leading edges of the first and second pulse using as a reference point 50% amplitude with fastest transition times. Fig. 1-3C illustrates these definitions.

SETTLING TIME is the interval required for the pulse level to enter and remain in the specified level accuracy range (measured from the 90% amplitude point) (see Figure 1-3D).

Pulse Definitions (continued)

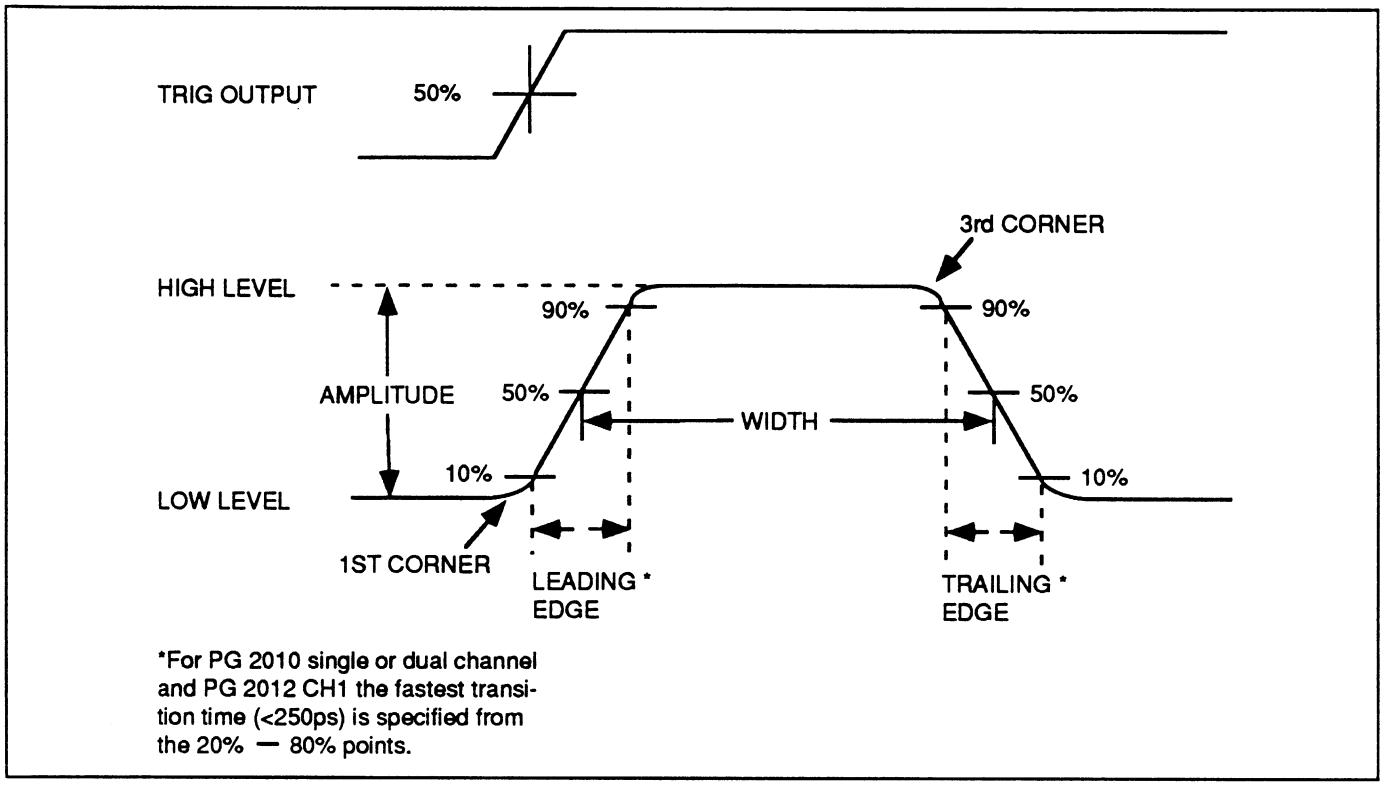


Fig. 1–3A. Pulse Definitions—High and Low Levels

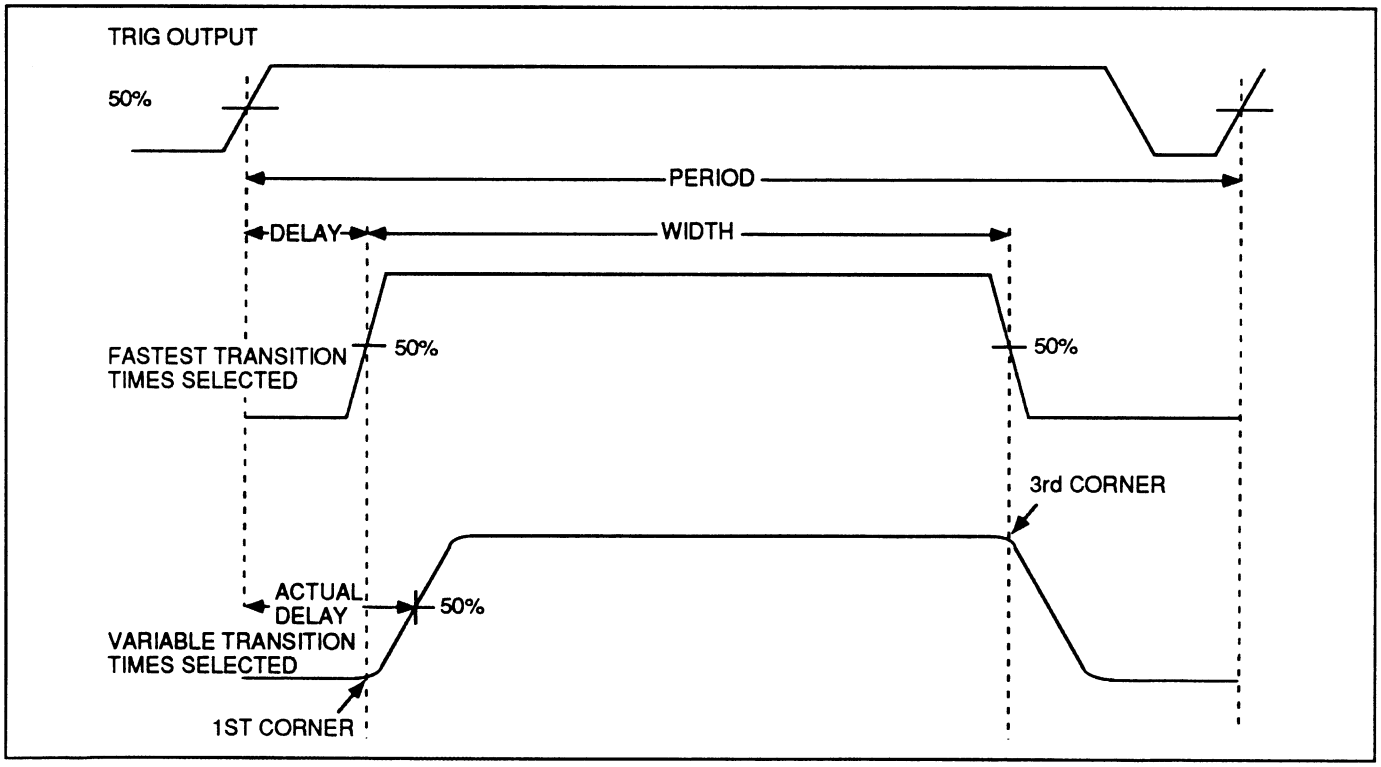


Fig. 1–3B. Pulse Definition—Width, Period, and Delay

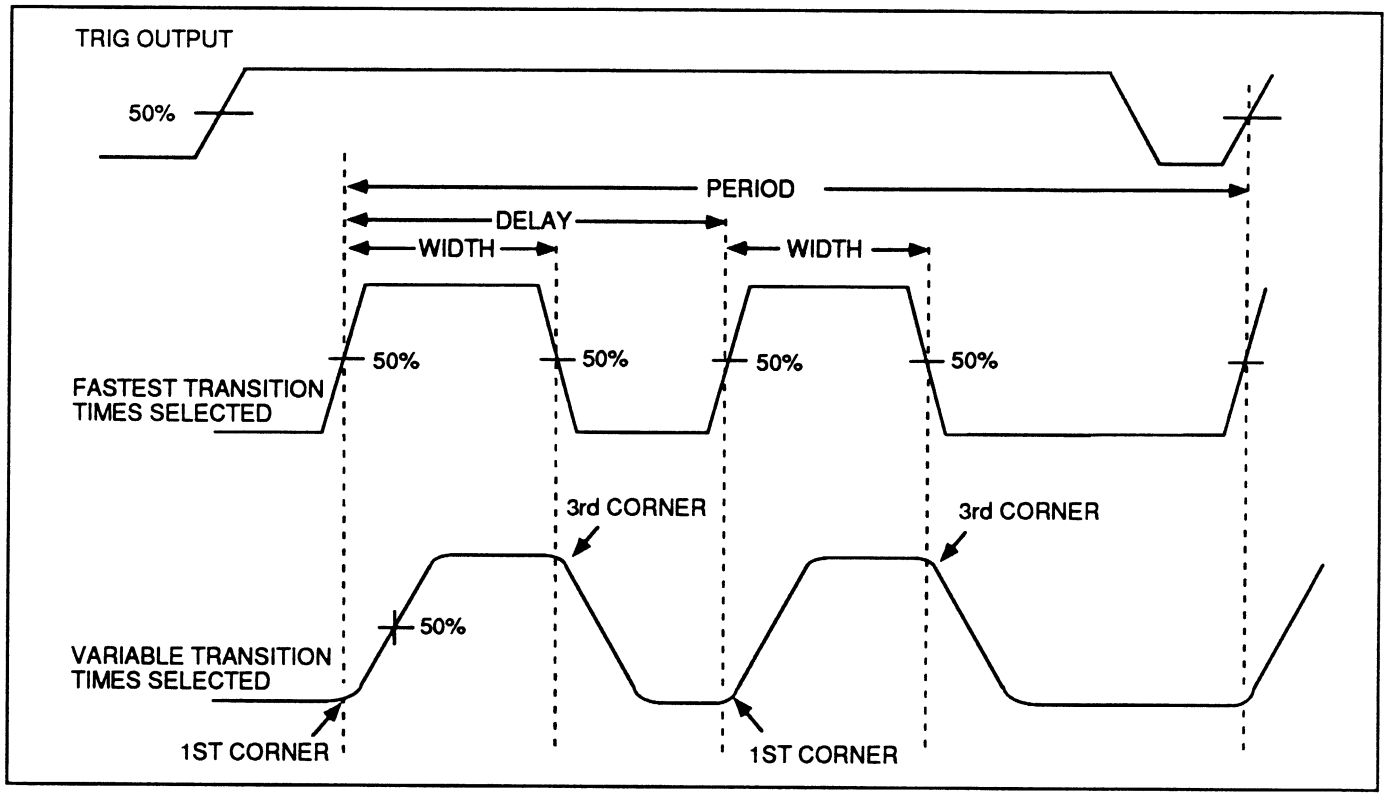


Fig. 1–3C. Pulse Definitions—Period and Delay—Double Pulse Mode

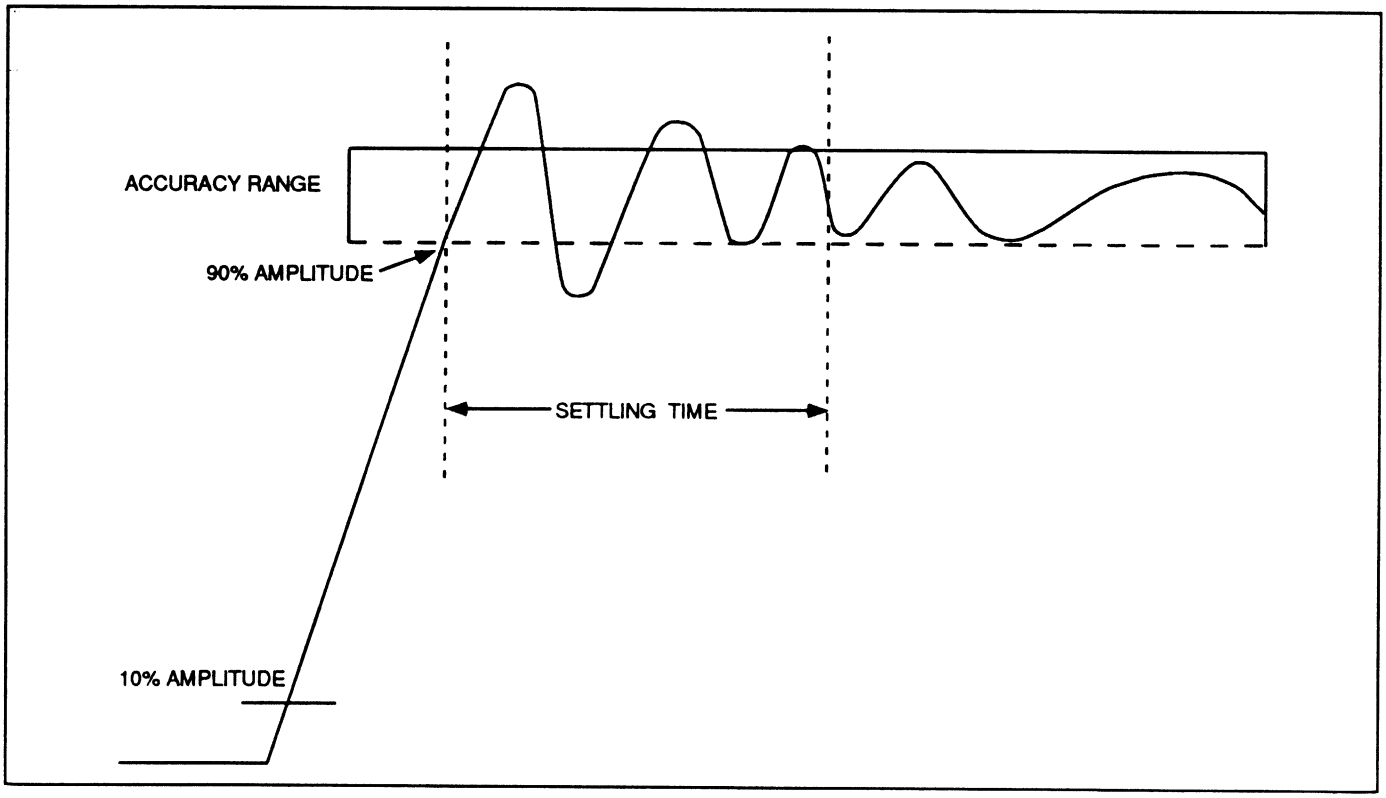


Fig. 1–3D. Pulse Definitions—Settling Time

Pulse Parameter Limitations

The following formulas express the limits on Period, Width, and Delay.

Single Pulse per Period Modes

(Undelayed, Delayed, Counted Burst with single pulse mode)

[Period - (Width + Delay)] must be > 8 ns
0.99 * Period must be > (Width + Delay)

Period max = 10.00 s
Period min = (Width + Delay + 8 ns), but not less than 20 ns
Width max = [(Period * 0.99) – Delay – 8 ns], but not more than 9.90000 s
Width min = 10 ns
Delay max = [(Period * 0.99) – Width – 8 ns], but not more than 9.89999 s
Delay min = 0

Single Pulse Transition Time Restrictions

Width must be > 1.3 * Leading Edge
(Period – Width) must be > 1.3 * Trailing Edge

Double Pulse per Period Modes

(Paired Pulse and Counted Burst with Paired pulses)

Delay must be > Width
0.99 * Delay must be > (Width + 8 ns)

Period max = 10.00 s
Period min = (Width + Delay + 8 ns), but not less than 40 ns
Width max = [(0.99 * Delay) - 8 ns], but not > 4.90000 s
Width min = 10 ns
Delay max = [(Period * 0.99) – Width – 8 ns], but not > 9.89999 s
Delay min = (Width + 8 ns)

Double Pulse Transition Time Restrictions

Width must be > 1.3 * Leading Edge
(Delay – Width) must be > 1.3 * Trailing Edge
[Period – (Delay + Width)] must be > (1.3 * Trailing Edge)

Internal Trigger Burst Mode

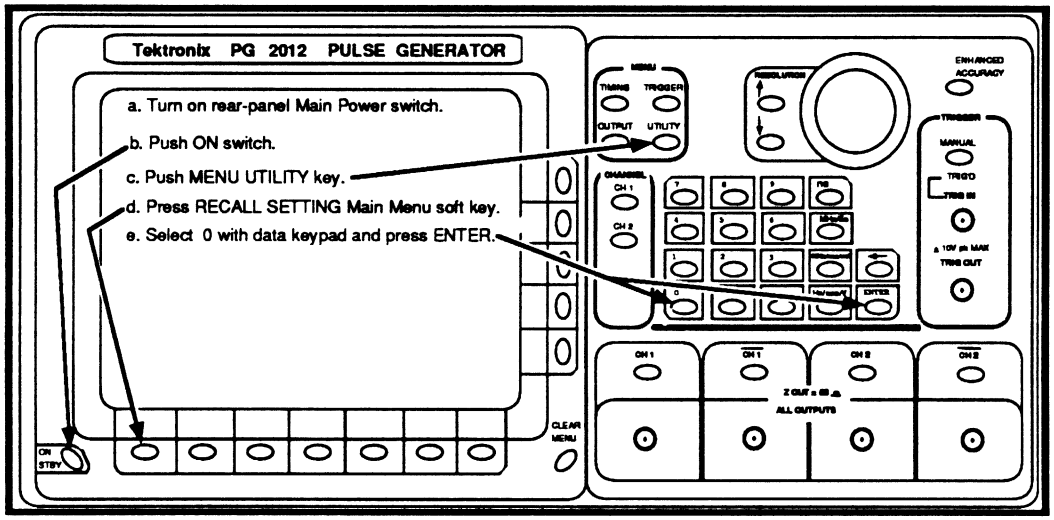
(0.99 * Trig Rate) must be > (Period *Burst Count)

Manual Operation

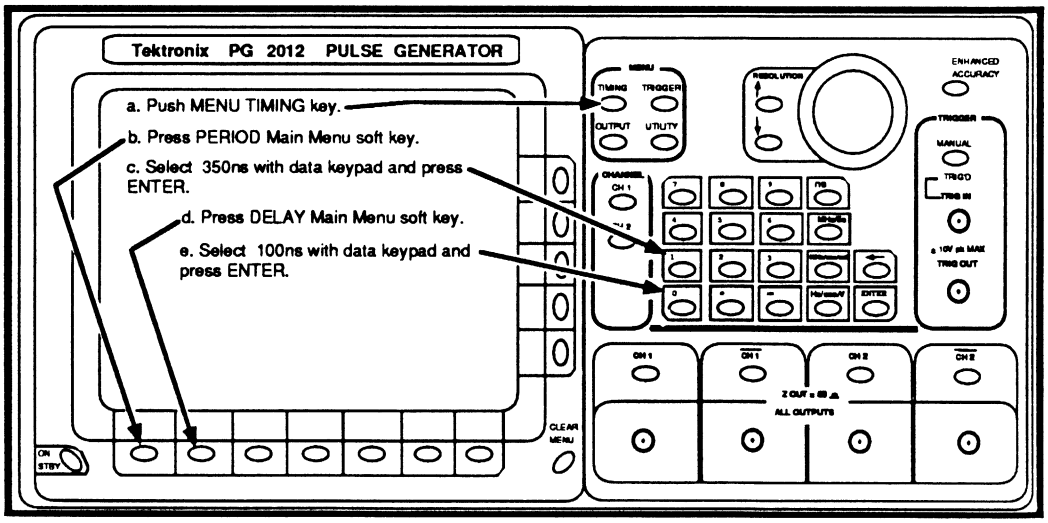
The following example illustrates the ease with which the instrument may be set up to output a typical output pulse. The example describes how to set up and verify the instrument's output for a pulse having the following parameters:

Period — 350ns; Delay — 100ns; Width — 50ns; Duty Cycle — Off; Leading Edge/Trailing Edge — 250ps (PG 2012 CH1 and PG 2010), or 10ns (PG 2012 CH2 and PG 2011); Pulse Mode — Single Pulse; Triggering — Continuous; Output High Level — +1.0V; and Output Low Level — –1.0V.

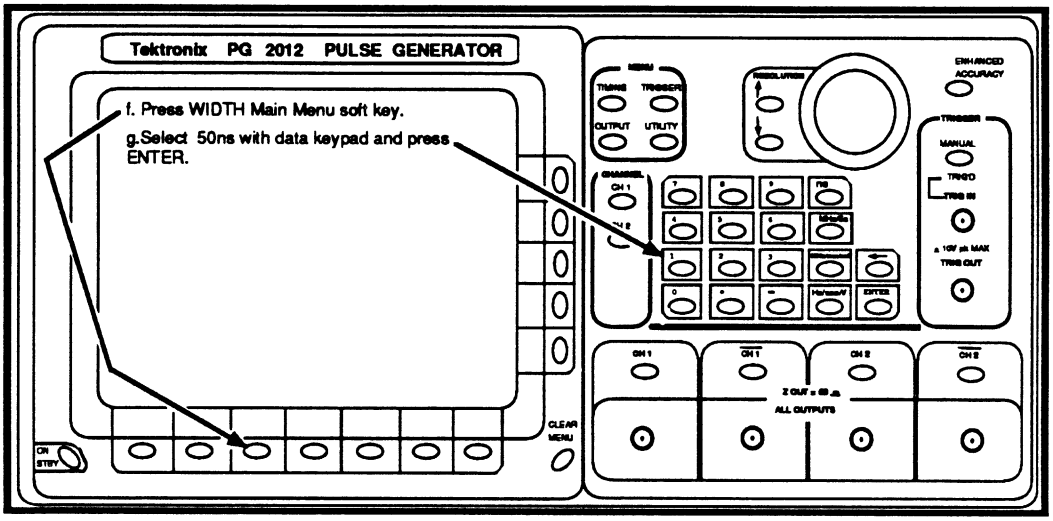
Step 1 Power up and Initalize Instrument



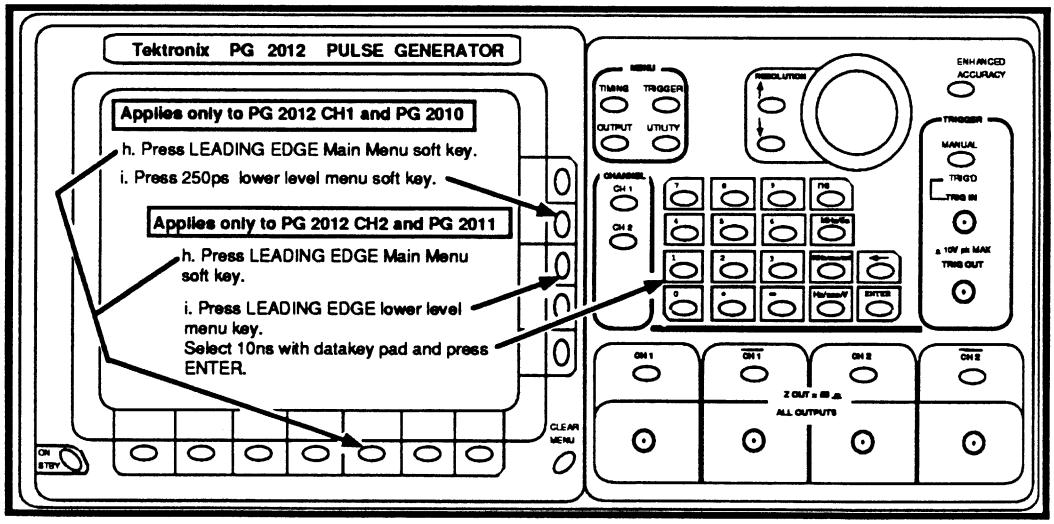
Step 2 Setting up the Pulse Timing



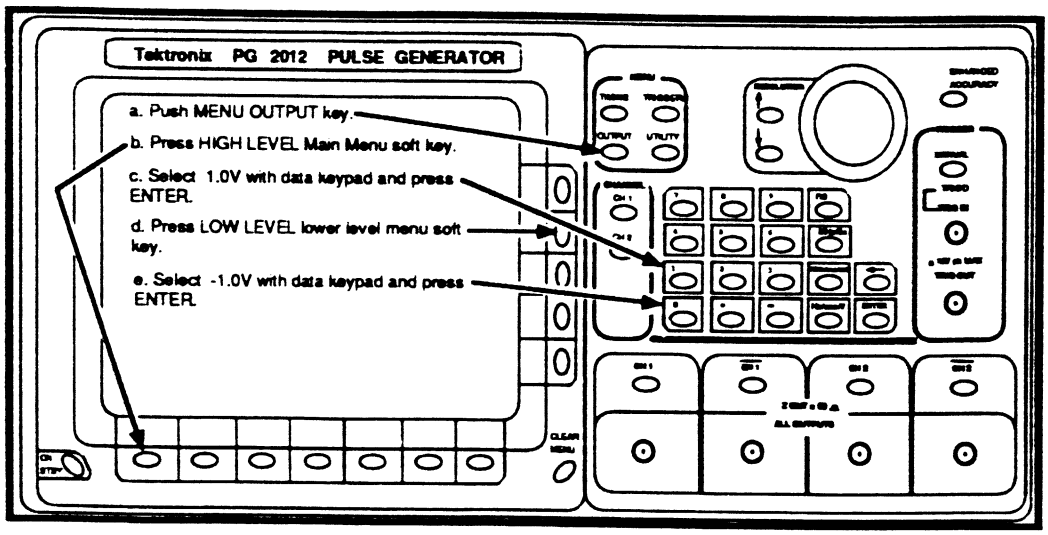
Step 2 Setting up the Pulse Timing (continued)



Step 2 Setting up the Pulse Timing (continued)



Step 3 Setting up the Pulse Output



Observing The Output Pulse

Press the CH1 Output key ON.

NOTE

To prevent aberrations on the output pulse, the unused output (normal or complementary) for the channel ***must*** *be terminated in the same impedance as the selected output for the channel. This applies only to fixed risetime channels. When an output is off, it is internally terminated into 50Ω. If it is necessary to terminate an output in an impedance other than 50Ω, turn the output on and attach the correct termination to the output connector. This also means an unused output should be turned on and left open if the active output is driving a high impedance.*

Connect a correctly terminated 50 ohm coaxial cable from the CH 1 BNC output connector to the input of an oscilloscope and observe a continuous pulse output having the following parameters:

Period	350ns
Delay	100ns
Width	50ns
Leading Edge/ Trailing Edge	250ps (PG 2012 CH 1 and PG2010) or 10ns (PG 2012 CH 2 and PG 2011)
Pulse Mode	Single Pulse
Triggering	Continuous
Output	
High Level	+0.5 V
Low Level	–0.5 V

GPIB Operation

With the instrument's rear-panel Main Power switch turned-on, push the front-panel ON-STBY switch to obtain a crt display. Connect a GPIB cable from the GPIB Controller, for example when using an MS-DOS compatible controller you would connect a the GPIB to the National PC 2A GPIB board, to the GPIB co tor on the rear-panel of the instrument, see Fig.

SECTION 2
OPERATION

Functional Menu Operation

Operation of the PG 2010/PG 2011/PG 2012 is controlled by a multilevel menu structure which branches from four main menus. These are: TIMING, TRIGGER, OUTPUT, and UTILITY. A main menu is selected by pressing a corresponding MENU key on the front panel. The four main menus have at least one lower level menu, see Fig. 2-1. Selection of a lower level menu, from a main menu, is accomplished with the soft keys located below the crt.

Moving Between Menus

To move from one main menu to another press one of the four MENU keys (TIMING, TRIGGER, OUTPUT, UTILITY) on the front panel. Pressing one of these keys always selects the corresponding main menu allowing an escape from any other menu.

There are two ways to move between lower level menus within a main menu:

- Move downward in the menu system by pressing the soft key which selects the desired lower level menu. These keys are located along the right side of the crt.

- Move upward one level by pressing one of the soft keys located below the crt, or select another main menu with the MENU key on the front panel to select the desired main menu screen.

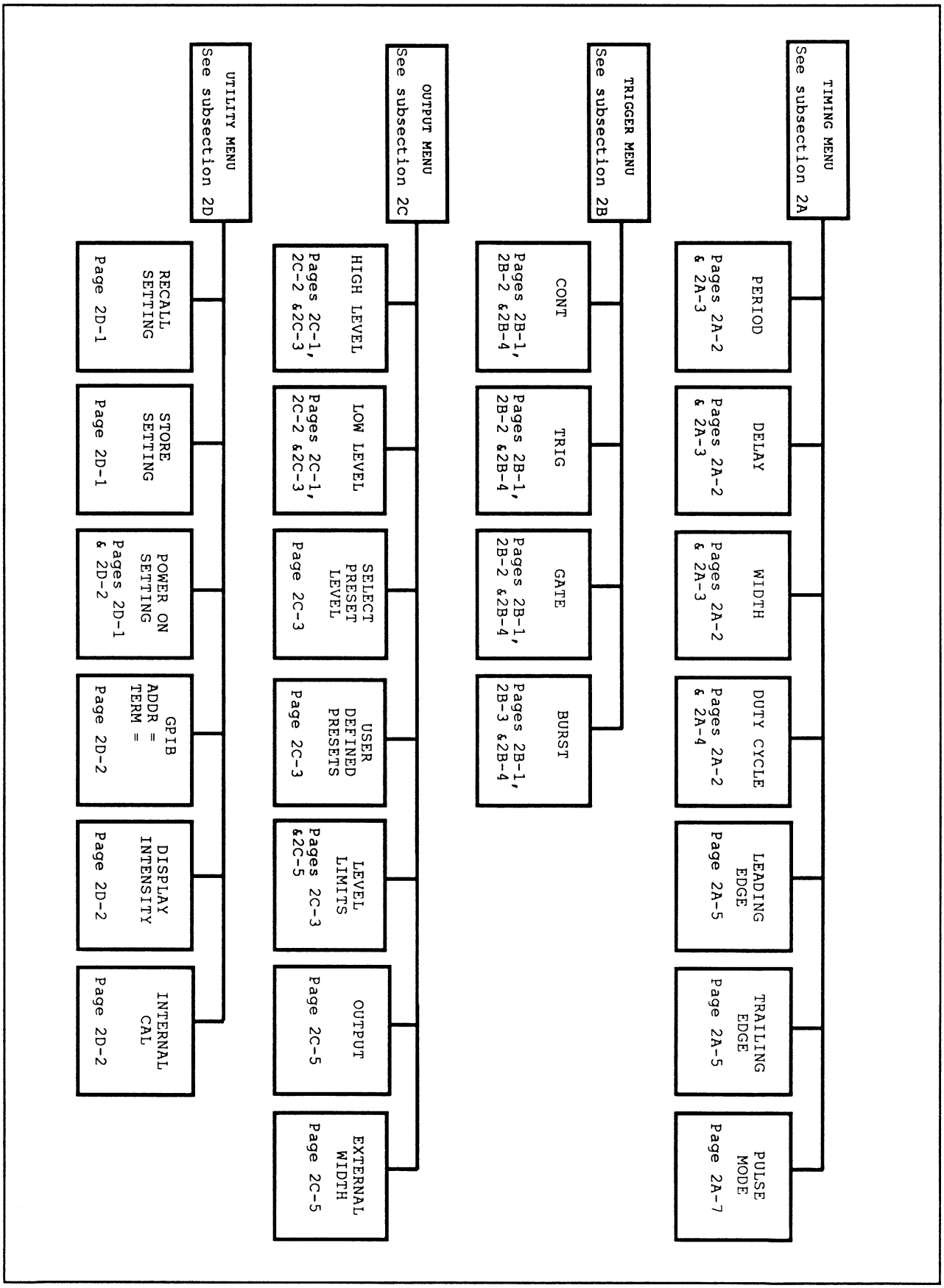


Fig. 2-1. Overall menu hierachy illustration showing the location of additional detailed information on the four main menus.

Controls, Connectors, and Indicators

Display

The instrument function and parameters are displayed with their current values. The value of a displayed parameter can be changed when it is selected . A value is changed by using the knob, or the data keypad and ENTER. A decimal numeric entry can include the leading zero.

The left side of the crt displays the High Level (HL:) and Low Level (LL:) values for each channel. Warning and error messages will be displayed on the crt below the Channel 1 and Channel 2 graphic pulse display area.

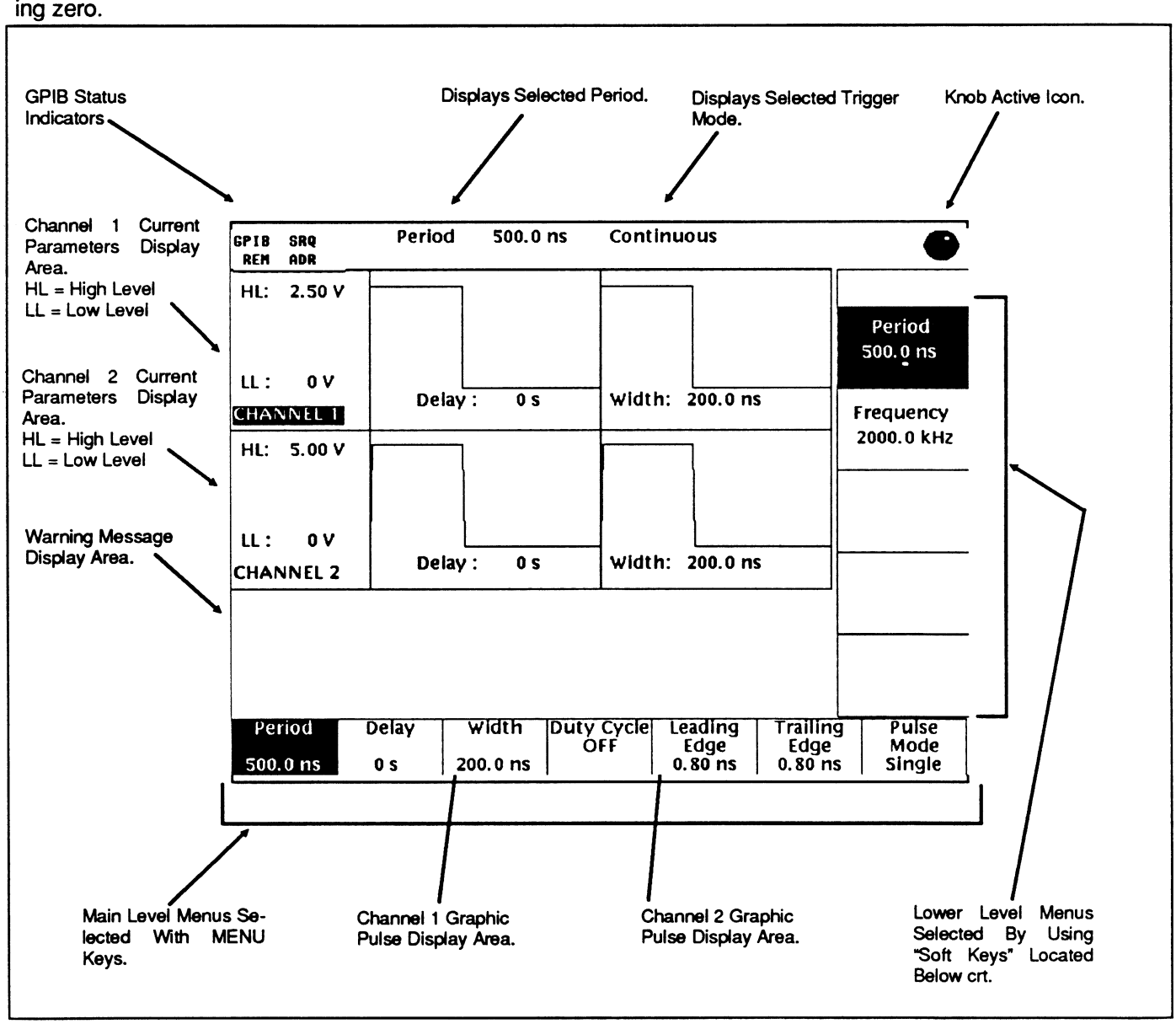


Fig. 2-2. Explanation of different display fields.

The top of the crt display shows the GPIB Indicators on the left and the pulse Period and Trigger status in the center and the knob icon on the right, if the knob is active on the selected parameter. Below each channel waveform in the center of the crt is displayed the Delay and Width values for that channel.

Parameter Units of Measure Keys

The units of measure keys are located in a column to the right of the DATA keypad; these keys are used to scale a numeric entry. The units of measure selected by each key depends on the function or parameter for which the numeric entry is being made. ENTER must be pressed after the units key is pressed. If you wish to maintain the same units as the existing entry, simply enter the new value, skip the units key, and press ENTER.

GPIB Indicators

GPIB — this indicator is illuminated at all times.

SRQ — illuminates when the instrument generates a service request.

REMote — illuminates when the instrument is operating under remote program control via the GPIB.

ADR — illuminates when the instrument is addressed over the GPIB.

Error Indication

A 3-digit error number (the same error code available over the GPIB) and a description of the error appear in the display to indicate the type of error that has occurred. For additional error information, refer to the command descriptions in Section 4 of this document.

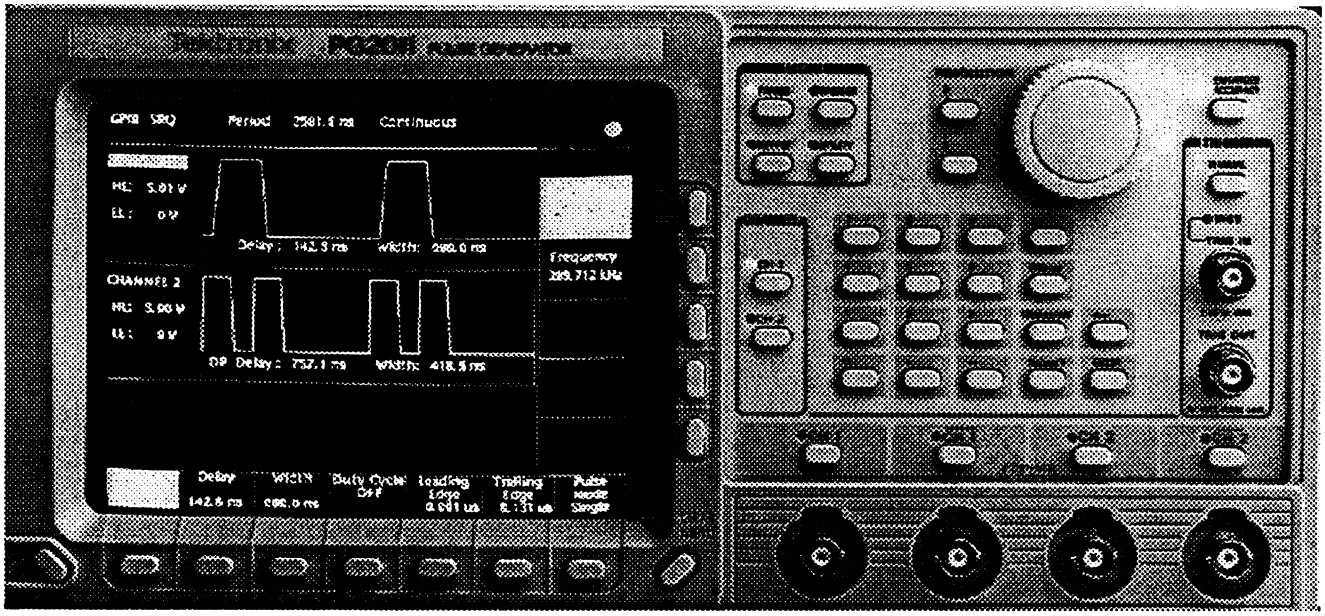


Fig. 2-3. Typical PG 2010/PG 2011/PG 2012 front panel.

Front Panel Controls and Connectors

Refer to Fig. 2-3 while reading this section.

Selection of parameters for pulse output is accomplished through the instrument's menu system. The desired menu (TIMING, TRIGGER, OUTPUT, or UTILITY) is accessed by pressing the corresponding MENU key on the front panel. After selecting the appropriate menu, the current pulse parameters controlled by that menu are displayed and their values may be changed, if desired. The data keypad or knob is used to change the value of the selected item. See "Standard Numeric Entry". Some keys have associated LEDs that turn on and remain on while those key functions are selected. An illumunated key LED indicates which key function is active (turned on).

A key function remains selected until it is replaced by pressing another key. The typical sequence to change a value is: parameter key, new value entered with the data keypad, unit of measure, ENTER; or, parameter key, knob (in this case the unit of measure is determined by the RESOLUTION setting).

NOTE

To clear a partially entered value, press the function or parameter key again.

Operation of the menus is controlled by the use of seven horizontal and five vertical "soft keys" which are located below and to the right of the crt display respectively. The function of a particular soft key is defined by the specific menu being displayed and may vary between menus. The function of each soft key within a specific menu is indicated by a mnemonic located near either the bottom edge of the crt display immediately above the key or to the left of the vertical keys. A blank space in the crt display above or to the left of a soft key indicates that it is not used in that menu and pressing the key will have no effect on the operation of the instrument.

Depending on the particular menu which is being displayed, pressing a soft key may select another lower level menu. To move to one menu level higher, press one of the soft keys located below the crt or select another main menu with the MENU key on the front panel. An outline of the instrument's functional menu operation is given earlier in this section.

For an overview of the current settings of the instrument, pressing each of the main MENU keys allows you to observe the settings.

Soft Key Operation

Standard Numeric Entry — There are two ways of accomplishing a numeric entry:

- Use the knob to increase/decrease a value. A value is increased by turning the knob clockwise until the desired value is obtained. Likewise, a value is decreased by turning the knob counter-clockwise. When a numeric value has been changed using the knob, it is automatically executed, and use of the ENTER key is not required.

  The amount of change that the knob causes is controlled by the RESOLUTION keys. Pressing the ↑ RESOLUTION key allows the user to increase the incremental amount, in decimal units of 10, that governs the amount that the knob, when rotated, will cause a setting to change. Likewise the ↓ RESOLUTION key is used to decrease the incremental amount, in decimal units of 10, by which the knob can cause a change. The underscored digit in the active lower level menu indicates which digit will be effected by rotation of the knob.

- Using the data key pad and ENTER keys. This is accomplished by pressing the appropriate keys on the data key pad followed by the ENTER key. If the ENTER key is not pressed after keying a value with the data key pad, the value will not be saved and will be replaced by the previous value shown after about 10 seconds.

Refer to Fig. 2-4. In illustration Fig.2-4A the PERIOD parameter has been selected. In illustration Fig. 2-4B the data key pad has been used to change the PERIOD value from 500.0ns to 450.0ns. Note the asterisk, indicating that although the value has been changed it has not been entered into a buffer which causes the value to be executed by the instrument when a pulse is output. After the ENTER key has been pressed causing the value to be entered into a buffer and executed, the displayed asterisk will not appear. If the ENTER key is not pressed the display reverts back to the screen shown in Fig. 2-4A and the PERIOD value remains unchanged.

The above information and the following note also applies if only the units or both the value and units have been changed.

NOTE

To clear a partially entered value simply select another item in the display by pressing another "soft key", or press a MENU key on the front panel. Any of these actions will cause the partially entered value to be replaced by the previous one.

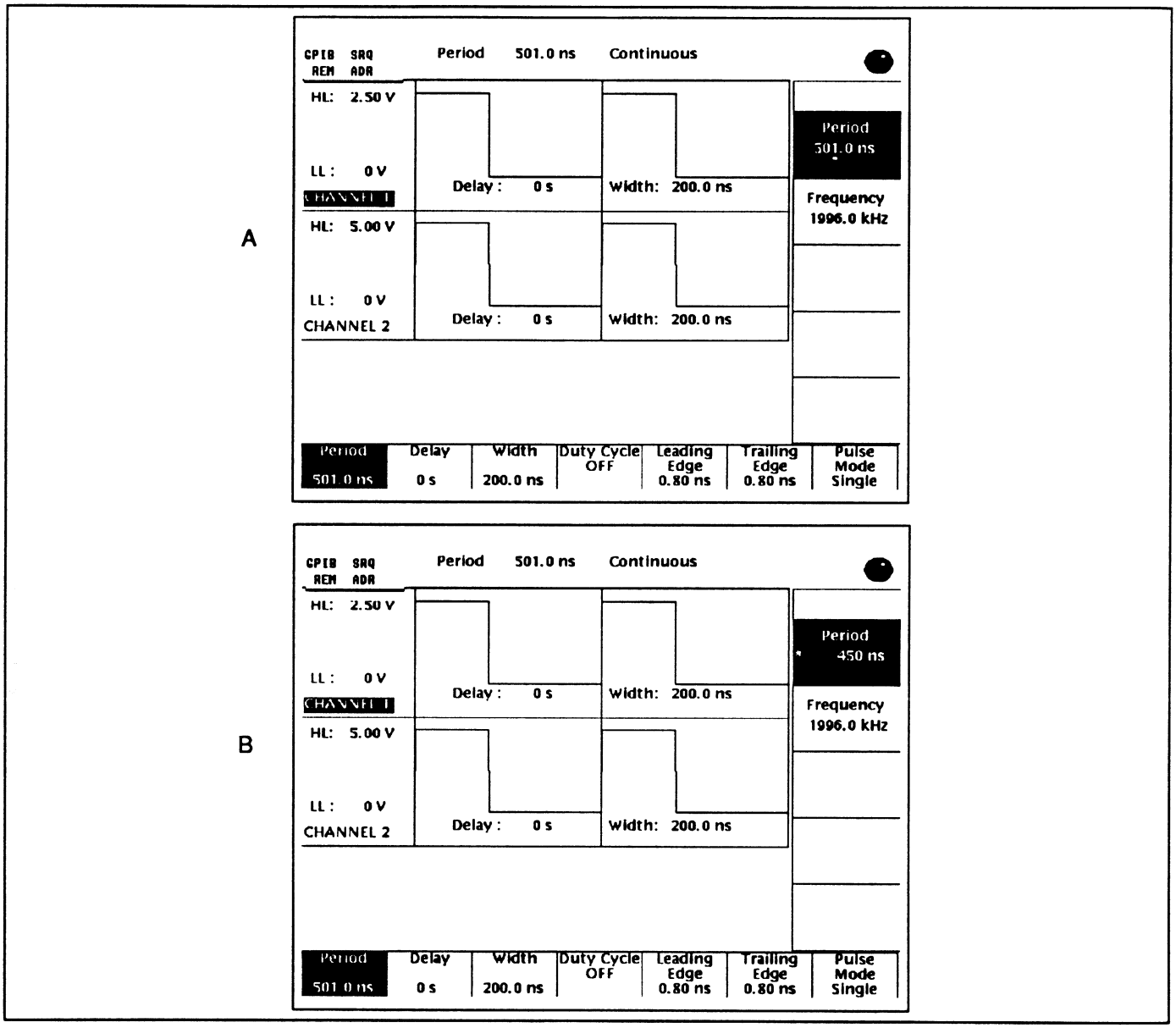


Fig. 2-4. Parameter Change Indicators in the lower level menus. Note underscored digit in the PERIOD Lower Level menu of example A indicating the resolution digit that will be affected by rotation of the knob. The asterisk to the left of the PERIOD value in example B indicates that the value or units has been changed, but not yet entered into a buffer.

Controls

MENU Keys

To move from one menu to another press one of the four MENU keys (TIMING, TRIGGER, OUTPUT, UTILITY) on the front panel. Pressing one of these keys always selects the corresponding main menu allowing an escape from any other menu.

There are two ways to move between lower level menus within a main menu:

- Move downward in the menu system by pressing the soft key which selects the desired lower level menu. These keys are located along the right side of the crt.
- Move upward one level by pressing one of the soft keys located below the crt, or select another main menu with the MENU key on the front panel.

CHANNEL Keys

The CH2 key is operative in dual channel instruments only.

CHANNEL keys select the channel for which parameters are displayed in the menu displays. The channel being displayed is designated by CHANNEL 1 OR 2 in reverse video to the left of the graphics pulse display in the crt display. The parameters displayed in the channel 1 and 2 graphic display areas (see Fig. 2-2) are always valid. The menu level is not affected by the CHANNEL key. When a channel is selected, the corresponding LED is lit. An attempt to use the CH2 key for single channel instruments will result in an error message being displayed.

RESOLUTION Keys

Pressing the ↑RESOLUTION key allows the user to increase the incremental amount, in decimal units of 10, that governs the amount that the knob, when rotated, will cause a setting to change. Likewise the ↓ RESOLUTION key is used to decrease the incremental amount, in decimal units of 10, by which the knob can cause a change. The underscored digit in the active lower level menu indicates which digit will be effected by rotation of the knob.

ENHANCED ACCURACY

Pressing the ENHANCED ACCURACY key turns on the indicator and uses the internal calibration circuitry to achieve the maximum possible accuracy. If the knob is used to change the pulse amplitude the ENHANCED ACCURACY indicator, if lighted, will be extingished.

MANUAL TRIGGER

The MANUAL TRIGGER key is used to generate a manual trigger event in TRIG, GATE, or BURST modes.

CLEAR MENU

Pushing the CLEAR MENU key clears from the crt display any main and lower level menus and disables the knob. The menus can be redisplayed by pushing the desired MENU key.

ON STBY

After the rear-panel Main Power switch applies power to the Standby circuitry, pushing the ON-STBY push-push switch applies power to the remainder of the instrument circuitry.

DATA Keys

The DATA keypad is used to enter numeric data. Using the ns, MHz/µs, KHz/ms/mV, Hz/sec/V allows the user to scale the input. A decimal point key, minus key and backspace key are also included. The ENTER key is used to complete a numeric entry.

If the function or parameter is selected and no data is entered, the ENTER key will terminate the selection with no change to the value of the function or parameter.

CH 1, $\overline{\text{CH 1}}$, CH 2, $\overline{\text{CH 2}}$ Keys

The $\overline{\text{CH 1}}$ and $\overline{\text{CH 2}}$ keys are functional only in the PG 2012 Channel 1 and the PG 2010 single or dual fast-edge channel(s). When the $\overline{\text{CH 1}}$ and $\overline{\text{CH 2}}$ are active, they provide a complementary pulse output. Complementary outputs for PG 2012 Channel 2 or the PG 2011 single or dual channel(s) output can be obtained by using the Output MENU selection. An attempt to use the $\overline{\text{CH 1}}$ and $\overline{\text{CH 2}}$ keys to provide a complementary output for PG 2012 Channel 2 or the PG 2011 single or dual channel(s) output will result in an error message.

Connectors

TRIGGER INPUT

The input connector for external trigger, gate functions, and external width for CH1 and CH2 is a front panel BNC. An LED indicator above the TRIGGER INPUT

connector illuminates to indicate a valid trigger signal (flashes for an actively changing trigger signal).

TRIGGER OUTPUT

The output connector can be used to provide triggering for a TTL-level device. Delay settings are referenced between the trigger output and pulse output.

CH1, $\overline{\text{CH1}}$, CH2, $\overline{\text{CH2}}$

The output connectors for pulse output from channels 1 and 2. The $\overline{\text{CH 1}}$ and $\overline{\text{CH 2}}$ connectors can only be used for the PG 2012 Channel 1 and the PG 2010 single or dual fast-edge channel(s). When $\overline{\text{CH1}}$ and $\overline{\text{CH2}}$ are active, they provide a complementary pulse output that is available simultaneously. Complementary outputs for PG 2012 Channel 2 or the PG 2011 single or dual channel variable-edge output can be obtained by using the Output MENU selection. The PG 2012 Channel 2 and PG 2011 complementary outputs are not available simultaneously since the complementary signal is only available from the CH1 or CH2 normal output connector.

NOTE

To prevent aberrations on the output pulse, the unused output (normal or complementary) for the channel ***must*** *be terminated in the same impedance as the selected output for the channel. This applies only to fixed risetime channels. When an output is off, it is internally terminated into 50Ω. If it is necessary to terminate an output in an impedance other than 50Ω, turn the output on and attach the correct termination to the output connector. This also means an unused output should be turned on and left open if the active output is driving a high impedance.*

Rear Panel Controls and Connectors

Main Power Switch

Rear-panel switch applies line voltage power to the Standby circuitry. To completely apply power to the instrument it is necessary to push the front panel ON-STBY key.

GPIB Connector

Connector for a standard 24 pin GPIB cable so GPIB commands from the GPIB controller can be passed to the instrument.

SECTION 2A

TIMING Menu

The Timing main menu is selected by pressing the TIMING MENU key on the front panel. This menu displays and selects the PERIOD of the pulse output which is common to both channels; it also displays the Delay, Width, Duty Cycle, Leading Edge, Trailing Edge, and Pulse Mode lower level menus for the selected channel. Fig. 2A-1 illustrates a Timing menu display.

In the PG 2012, or PG 2010, and the PG 2011 equipped with the dual channel option, the period parameter is common to both channels. Use either channel's main menu delay and width soft keys along with the appropriate lower level menu soft key to change the width and delay settings for each channel.

If, after entering a new PERIOD value, the message, "Error 284-CH (1|2): Period - (Width + Delay)≤ 8ns," appears, it indicates that the width time plus delay time for the indicated channel is within 8ns of the established period time. To allow sufficient settling time the difference between the width + delay and period time must be greater than 8ns. Correct the situation by either reducing the width or delay values or increase the period value.

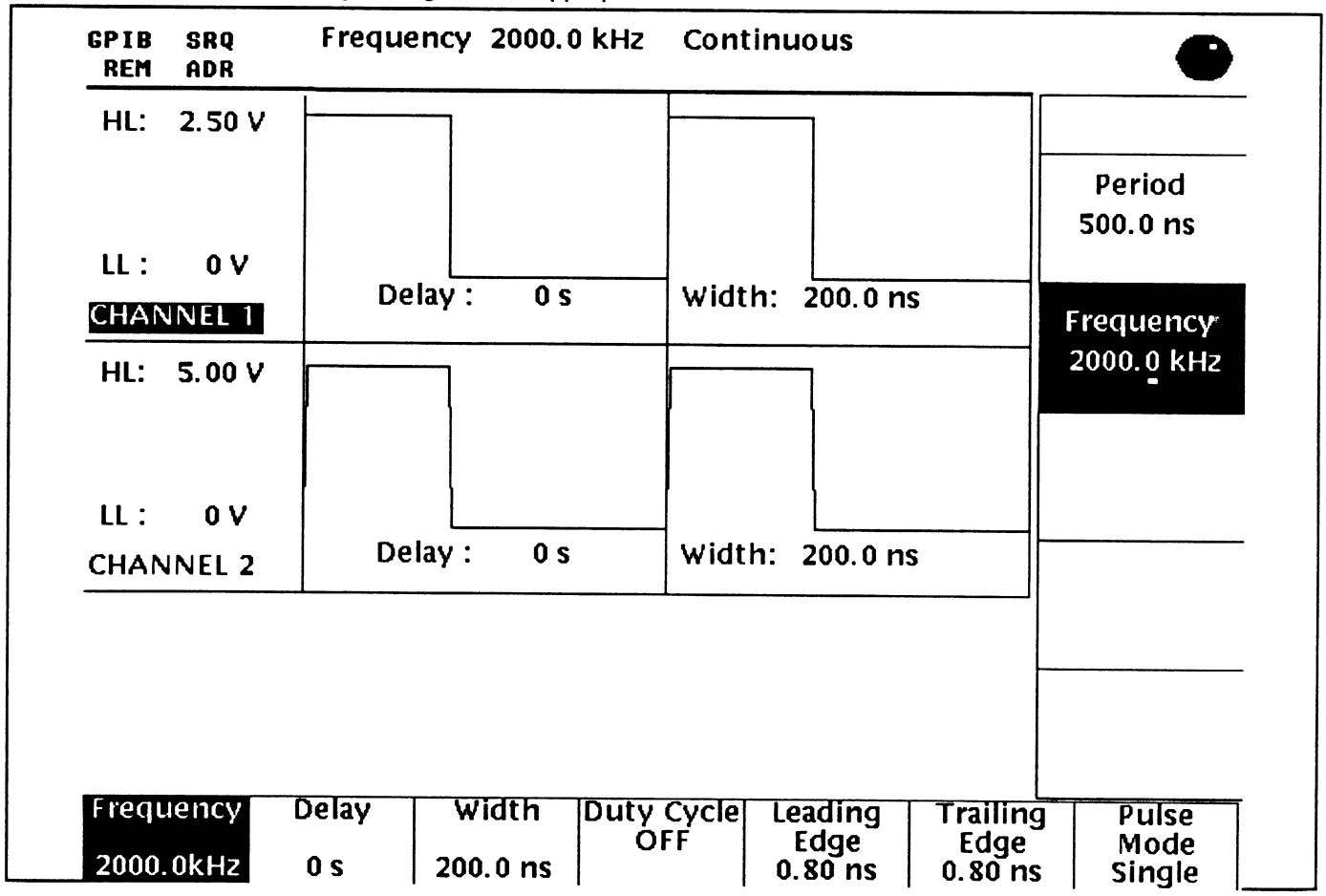


Fig. 2A-1. TIMING Main Menu

This error can be avoided if the period and width/delay parameters are set in the following order:

- To decrease the period from its current value - set the width and delay to their new values first, if necessary, followed by the period.
- To increase the width and delay from their current values - set the period to its new value first, if necessary, followed by the width and delay.

TIMING MENU: Lower Level Menus

The PERIOD, WIDTH, DELAY, LEADING EDGE, TRAILING EDGE, and PULSE MODE modes of the TIMING main menu are selected by pressing the corresponding front-panel soft key below the crt display. The TIMING menu system is used to set the pulse WIDTH, DELAY, DUTY CYCLE, and PULSE MODE.

PERIOD, WIDTH, DELAY, and DUTY CYCLE are defined by the instrument with reference to the 50% points on the leading and trailing edges using the fastest transition time (≤250ps for PG 2012 Channel 1 and PG 2010 single or dual channel(s), and 5.5ns for PG 2012 Channel 2 and PG 2011 single or dual channel(s)). Remembering this common reference, the following definitions apply:

DELAY, in single pulse mode, sets the time from the 50% point on the rising edge of the trigger output to the 50% point on the leading edge of the output pulse (at the fastest transition time settings).

DELAY, in double pulse mode, sets the time between the leading edges of the first and second pulse (at the fastest transition time settings).

WIDTH is the time interval between the 50% points on the leading and trailing edges.

DUTY CYCLE is the ratio of the pulse width to the period, expressed as a percent.

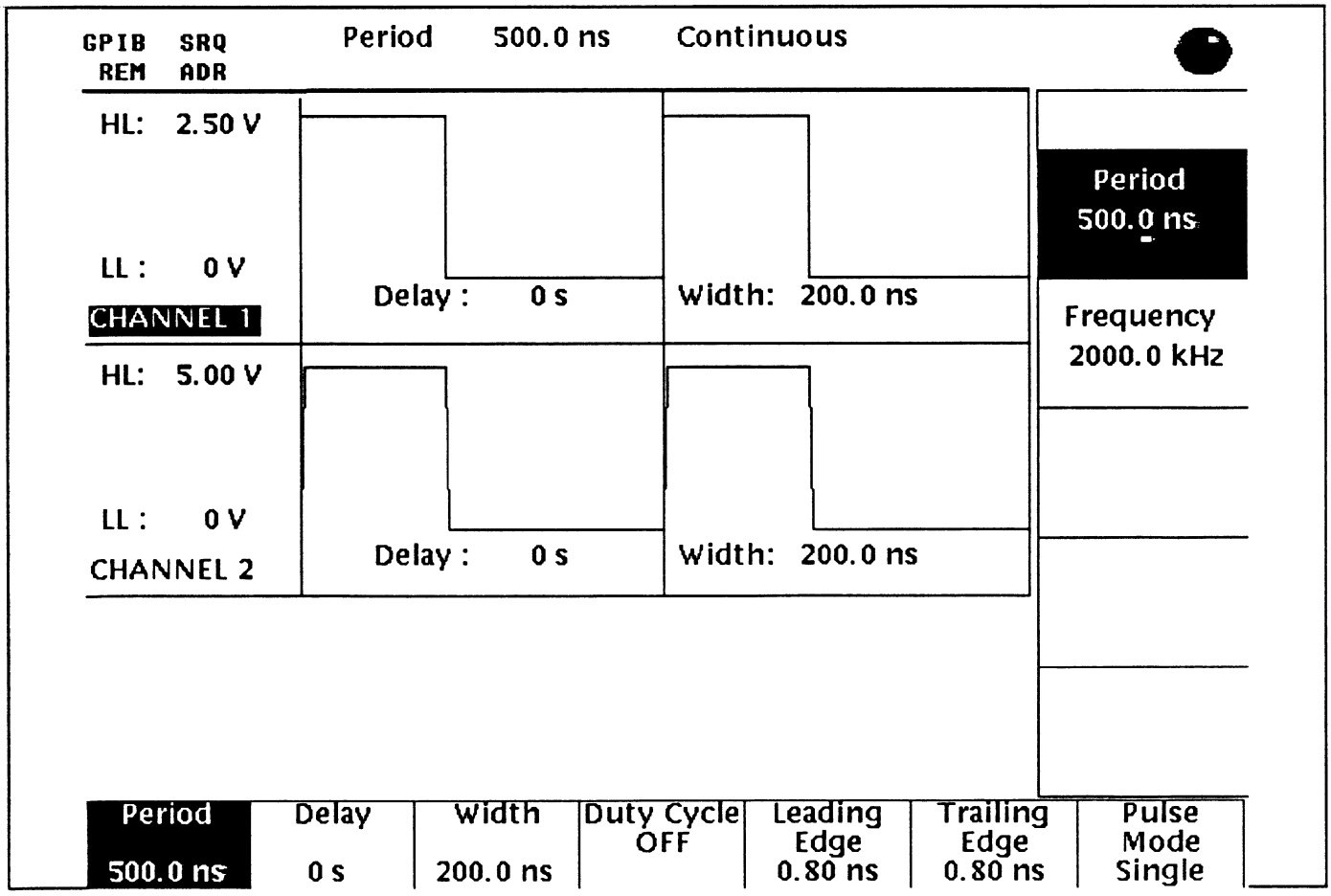


Fig. 2A-2. TIMING Menu, PERIOD Selected.

LEADING EDGE or TRAILING EDGE sets the pulse transition times.

PULSE MODE sets the instrument for single or double pulse output. In single pulse mode one pulse is output for each cycle of the period generator; in double pulse mode two pulses are output per cycle.

Refer to *Pulse Definitions* in section 1 for a detailed explanation of how the instrument defines the various pulse parameters.

Period

The range of the period parameter is:

- In single pulse mode: 20 ns — 10.0 s.
  - — Repetition rate: 50 MHz — 0.1 Hz.
- In double pulse mode: 40 ns — 10.0 s.
  - — Repetition rate: 25 MHz — 0.1 Hz.

Rotation of the knob will increase or decrease the PERIOD value. The DATA keypad and ENTER may also be used.

Fig. 2A-2 illustrates the TIMING menu with PERIOD selected.

PERIOD sets PERIOD in the time domain expressed in seconds (s).

FREQ sets the PERIOD in the frequency domain expressed in hertz (Hz).

Delay

Fig. 2A-3 shows the TIMING main menu with DELAY selected. In single pulse mode, the delay parameter sets the time from the 50% point on the rising edge of the trigger output to the 50% point on the leading edge of the output pulse (at the fastest transition time settings).

In double pulse mode, the delay parameter sets the time between the leading edges of the first and second pulse (at the fastest transition time settings).

Width

Fig. 2A-4 shows the TIMING main menu with WIDTH mode selected. When setting this parameter the interrelationship between the period and the sum of the width

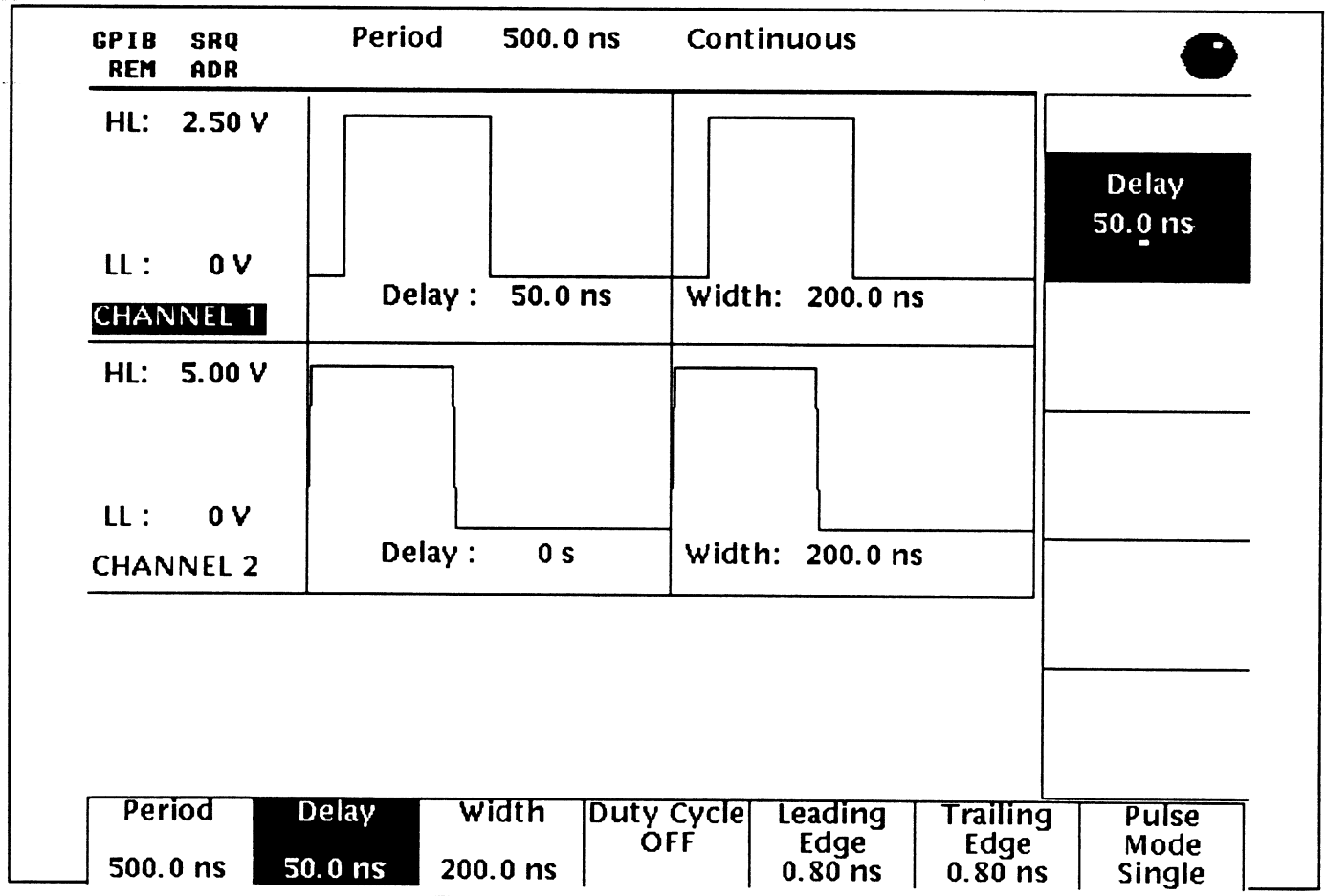


Fig. 2A-3.TIMING Menu, DELAY Selected.

plus delay must be kept in mind. The difference between the period and the sum of the width plus delay must be greater than 8ns or the message "Error 284 - CH (1/2): Period –(Width +Delay) ≤ 8ns," will appear in the display.

Rotation of the knob will increase or decrease the value of the WIDTH parameter. The data keypad and ENTER may also be used.

Duty Cycle

Fig. 2A-5 shows the TIMING main menu with DUTY CYCLE selected. The duty cycle parameter sets the width as a percentage of the period. The width of the signal that is output will correspond to the WIDTH or DUTY CYCLE setting, whichever was most recently set. When setting the width parameter using DUTY CYCLE, care must be taken that the period minus the sum of the width plus delay is greater than 8ns or an error message will appear in the display. When DUTY CYCLE function is active, the width parameter will change whenever the period is changed.

To output a square wave, set the duty cycle to 50%.

When WIDTH mode is selected and set, DUTY CYCLE automatically defaults to OFF.

When DUTY CYCLE is selected and set, the instrument sets the WIDTH value according to the duty cycle value.

The DUTY CYCLE range is 1 — 99%.

Rotation of the knob will increase or decrease the DUTY CYCLE percentage value. The data keypad and ENTER may also be used. When the displayed value is OFF, the duty cycle function is turned off.

Pressing the DUTY CYCLE OFF lower level menu terminates the DUTY CYCLE function.

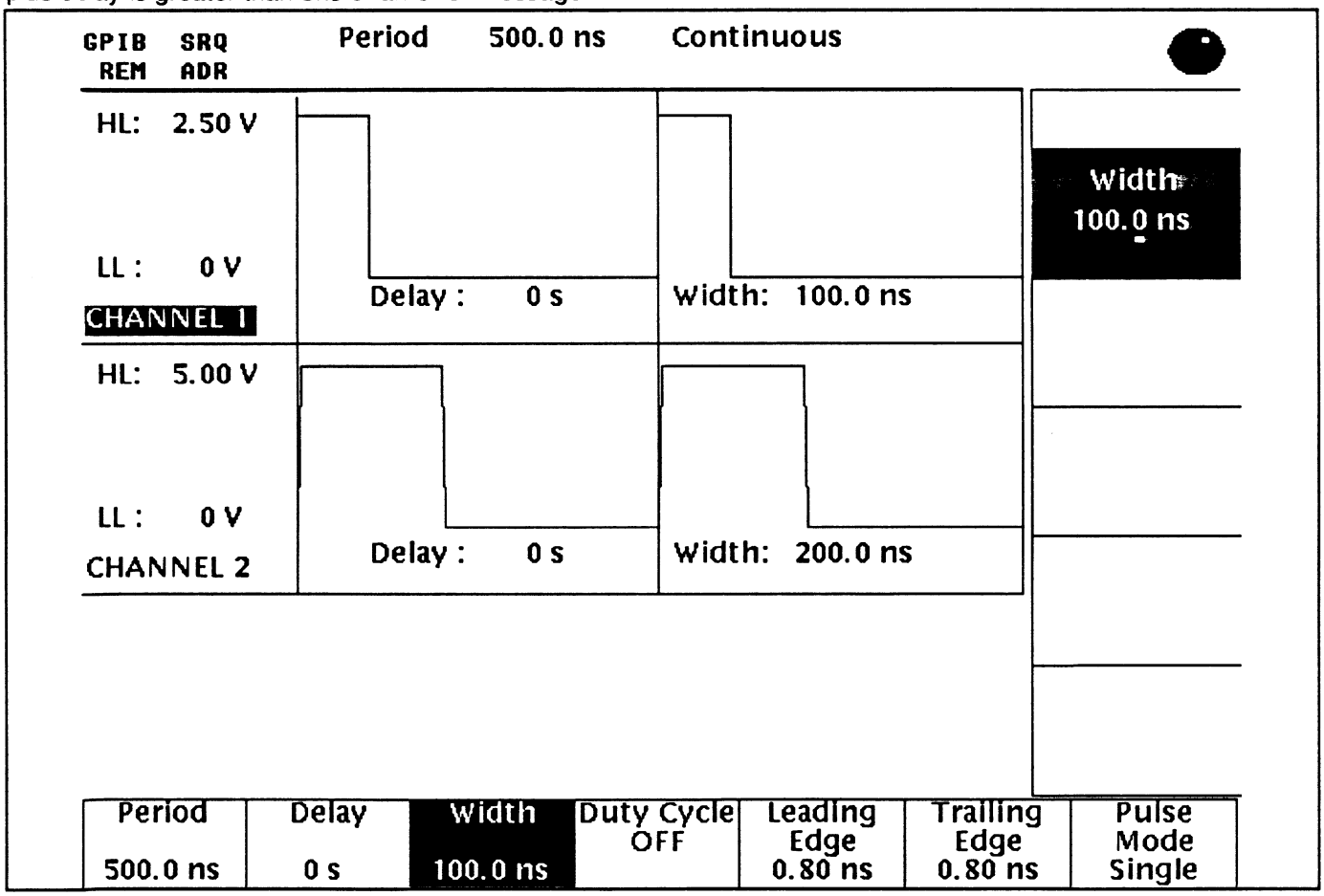


Fig. 2A-4. TIMING Menu, WIDTH Selected.

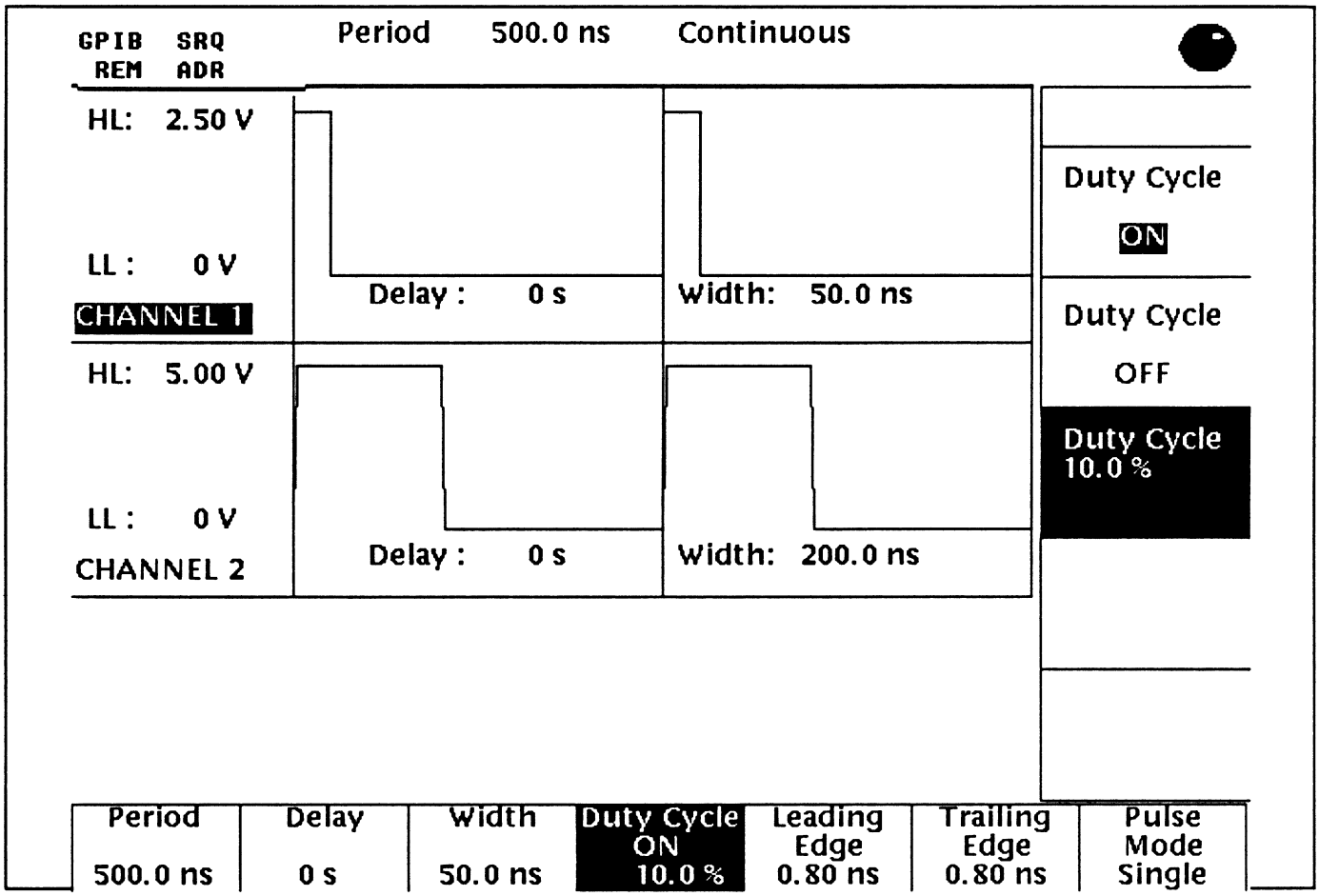


Fig. 2A-5. TIMING Menu, DUTY CYCLE Selected.

Leading Edge/Trailing Edge

For the PG 2012 Channel 2 and PG 2011 dual or single channel(s), the LEADING EDGE or TRAILING EDGE transition times may be set within the range of 5.5ns — 10 ms. The transition times can be set separately. The transition times are limited to a 20:1 ratio between them and both must be within one of the following ranges:

5.0ns — 100 ns
50 ns — 1μs
500 ns — 10 μs
5.0 μs — 100 μs
50 μs — 1 ms
500 μs — 10 ms

If the appropriate constraints are not observed, a warning message will appear in the display. If the front-panel MENU key is pressed while the error condition exists, the instrument will set the transition time values to their previous legal settings.

Rotation of the knob will increase or decrease the LEADING EDGE or TRAILING EDGE value. The DATA keypad and ENTER may also be used.

When TRACKING is on, the instrument sets the transition times so they are the same. When either edge time is changed, the other edge value is automatically reset to the same value. If the edge times are not equal when TRACKING is turned on, the current settings are not changed.

Fig. 2A-6 shows the current TRACKING mode, which is applicable only to the PG 2012 Channel 2 and PG 2011 dual or single channel(s).

TRACKING EQUAL for the PG 2012 Channel 2 and PG 2011 is either turned on or off by press the corresponding menu "soft key".

The LEADING EDGE or TRAILING EDGE for the PG 2012 Channel 1 and the PG 2010 dual or single channel(s) are the same and are selected in one of three fixed transition times from the menu, see Fig. 2A-7.

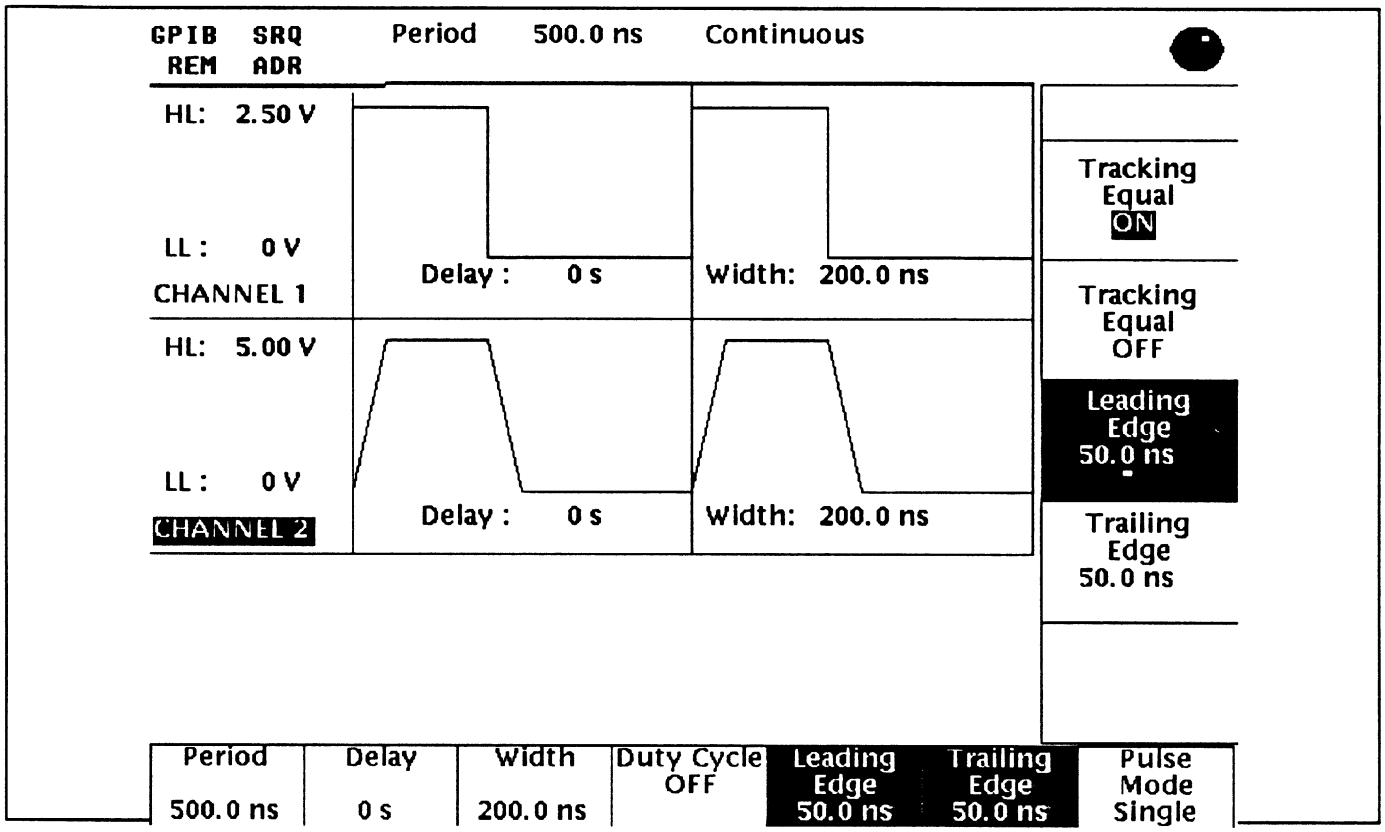


Fig. 2A-6. TIMING Menu, Variable LEADING/TRAILING EDGE Selected.

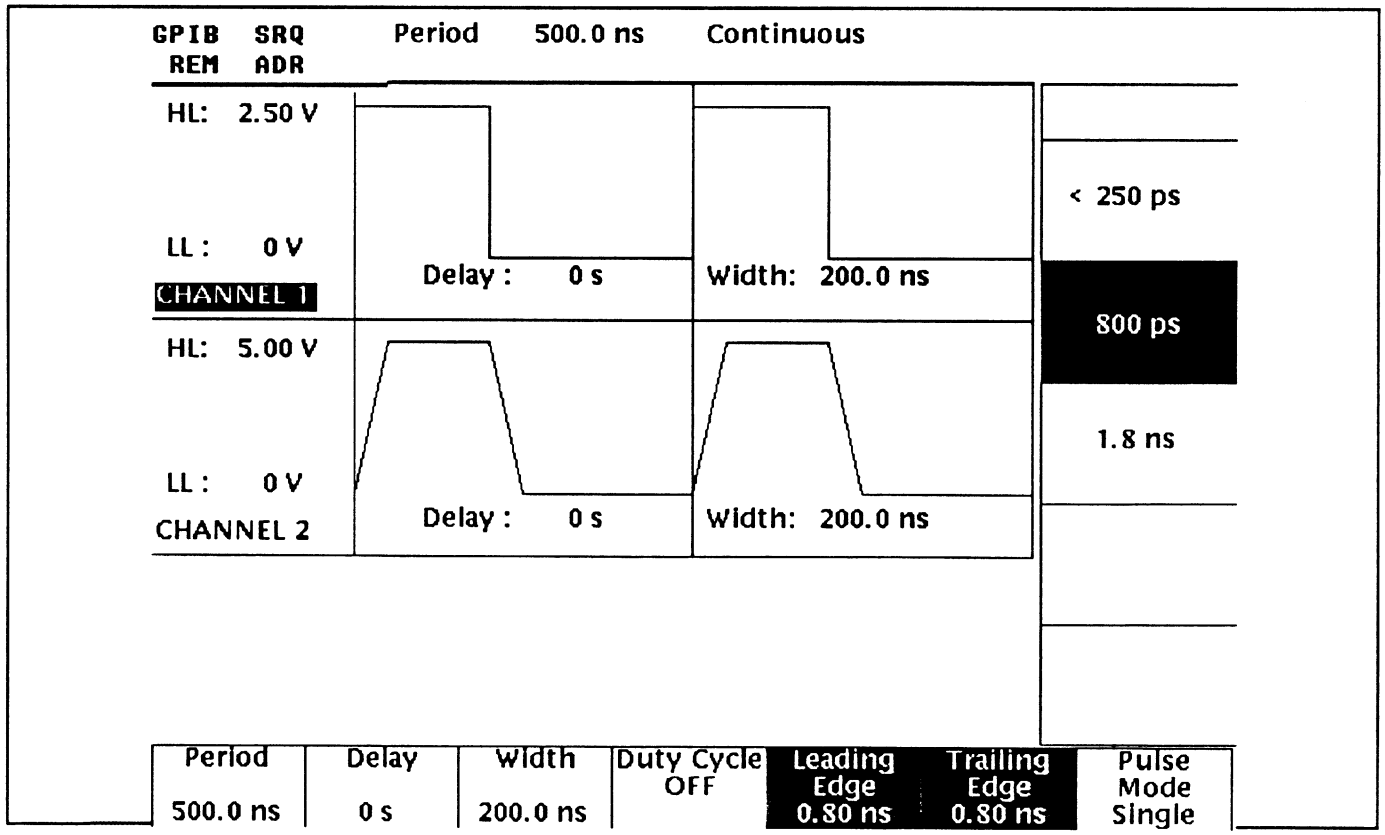


Fig. 2A-7. TIMING Menu, Fast LEADING/TRAILING EDGE Selected.

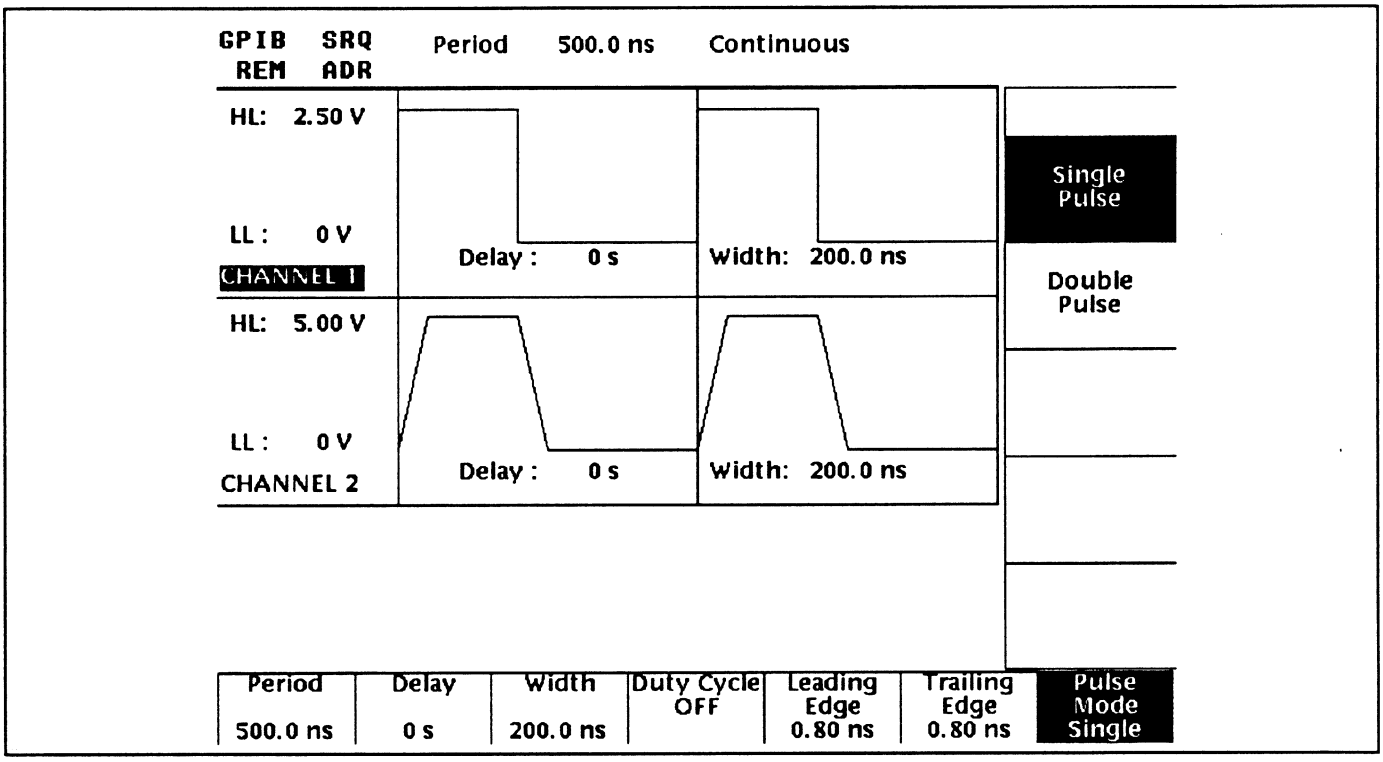


Fig. 2A-8A. TIMING Menu, PULSE MODE — SINGLE PULSE Selected.

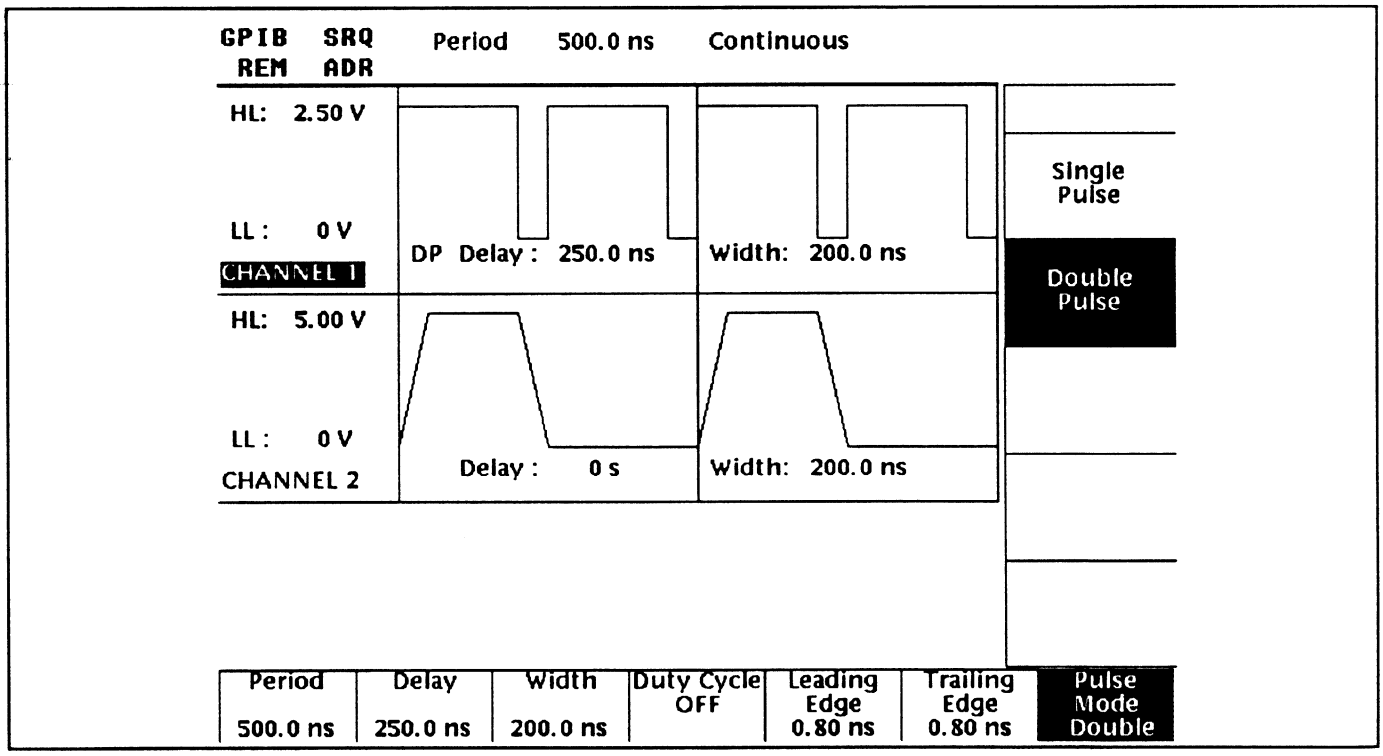


Fig. 2A-8B. TIMING Menu, PULSE MODE — DOUBLE PULSE Selected.

Pulse Mode

PULSE MODE sets the instrument for single or double pulse output. In single pulse mode one pulse is output for each cycle of the period generator; in double pulse mode two pulses are output per cycle. See Figs. 2A-8A and B.

SECTION 2B
TRIGGER MENU

The TRIGGER main menu displays and selects one of four modes. The four modes are: CONTinuous, TRIGgered, GATE, and BURST. These are illustrated in Figs. 2B-1 — 2B-4, and show displays which appear when the appropriate front-panel soft keys are selected. Only those parameters which are appropriate for the selected mode are displayed. The parameters cannot be changed from the main menu; to change a parameter the appropriate lower level menu must be selected by pressing the corresponding soft key.

The soft keys along the bottom of the crt have the following functions for the TRIGGER menu:

CONTinuous selects the continuous mode which continuously outputs pulses at the selected period rate. When CONT is selected there is no lower level menu. See Fig. 2B-1.

TRIG selects the triggered mode which outputs one cycle for each trigger. See Fig. 2B-2. Additional triggers occurring during the ongoing period are ignored.

GATE selects the gate mode which outputs a series of cycles for as long as the trigger input remains enabled. See Fig. 2B-3. If the gate is removed in the middle of a period cycle, the cycle will be completed.

BURST selects the burst mode which outputs up to 999,999 cycles after each trigger input. See Fig. 2B-4.

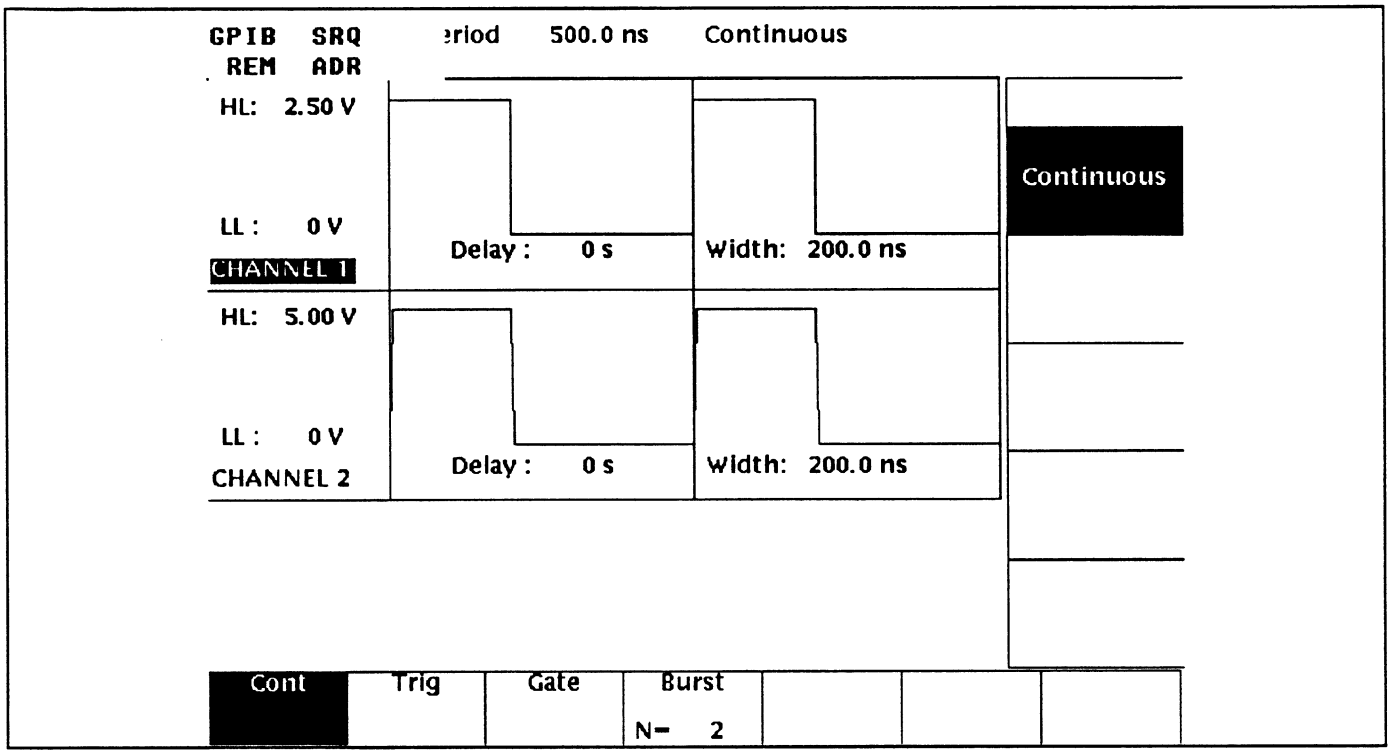


Fig. 2B-1. TRIGGER Menu, CONTINUOUS Selected.

Fig. 2B-1 illustrates the Trigger menu with CONT selected; TRIGger source, trigger slope, trigger level (applies only to an external trigger source), MANUAL TRIG and INTERNAL TRIGGER RATE are not displayed because they do not apply in the continuous mode.

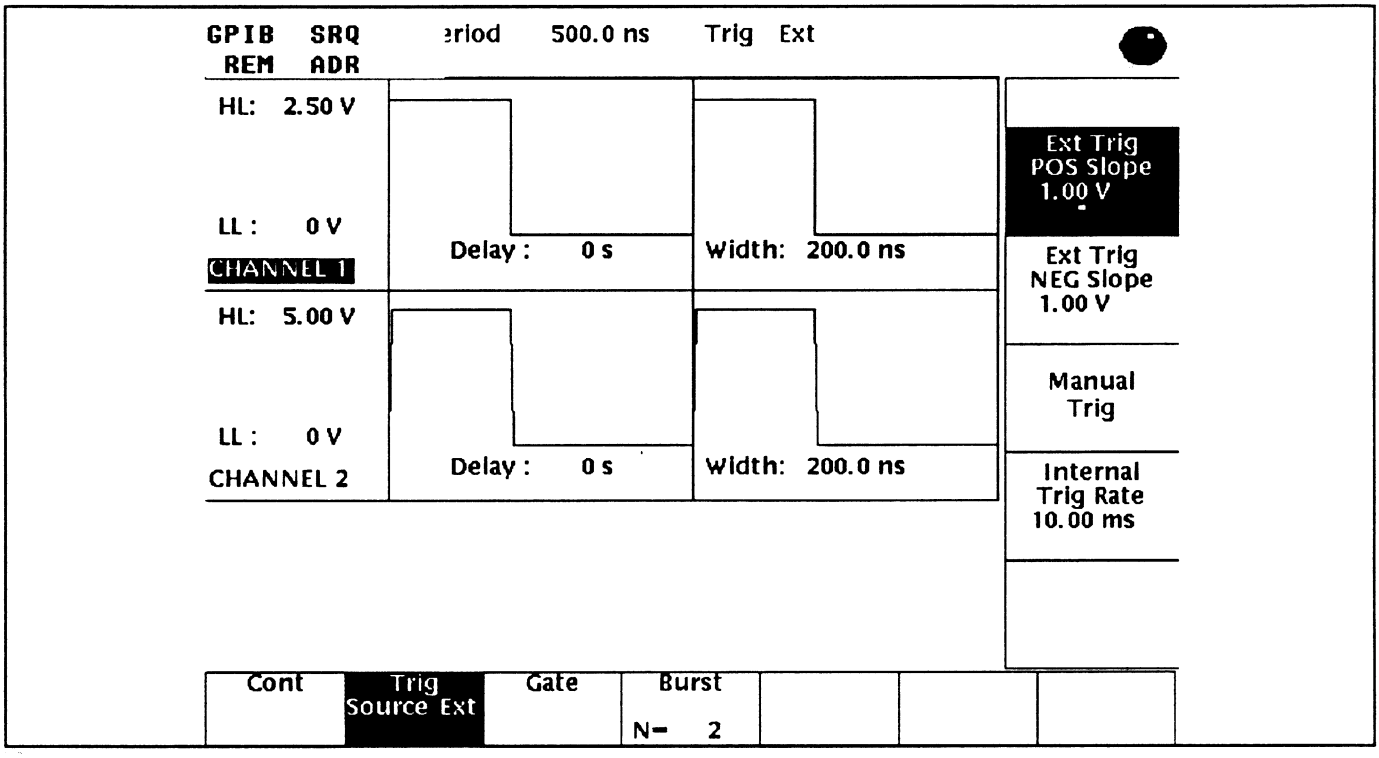


Fig. 2B-2. TRIGGER Menu, TRIG — EXTERNAL SOURCE Selected.

In Fig. 2B-2, the TRIG mode has been selected;

- EXT TRIG source, trigger slope, trigger level (applies only to an external trigger source)
- MANUAL TRIG, and
- INTERNAL TRIGGER RATE (applies only to an internal triggering source) are displayed.

If the trigger source is external, then the period is determined by the external source. In this case the period is limited to the width of the output pulse, plus the delay, plus the reset time for the instrument period generator. In dual channel instruments the channel with the longest delay plus width determines this limit.

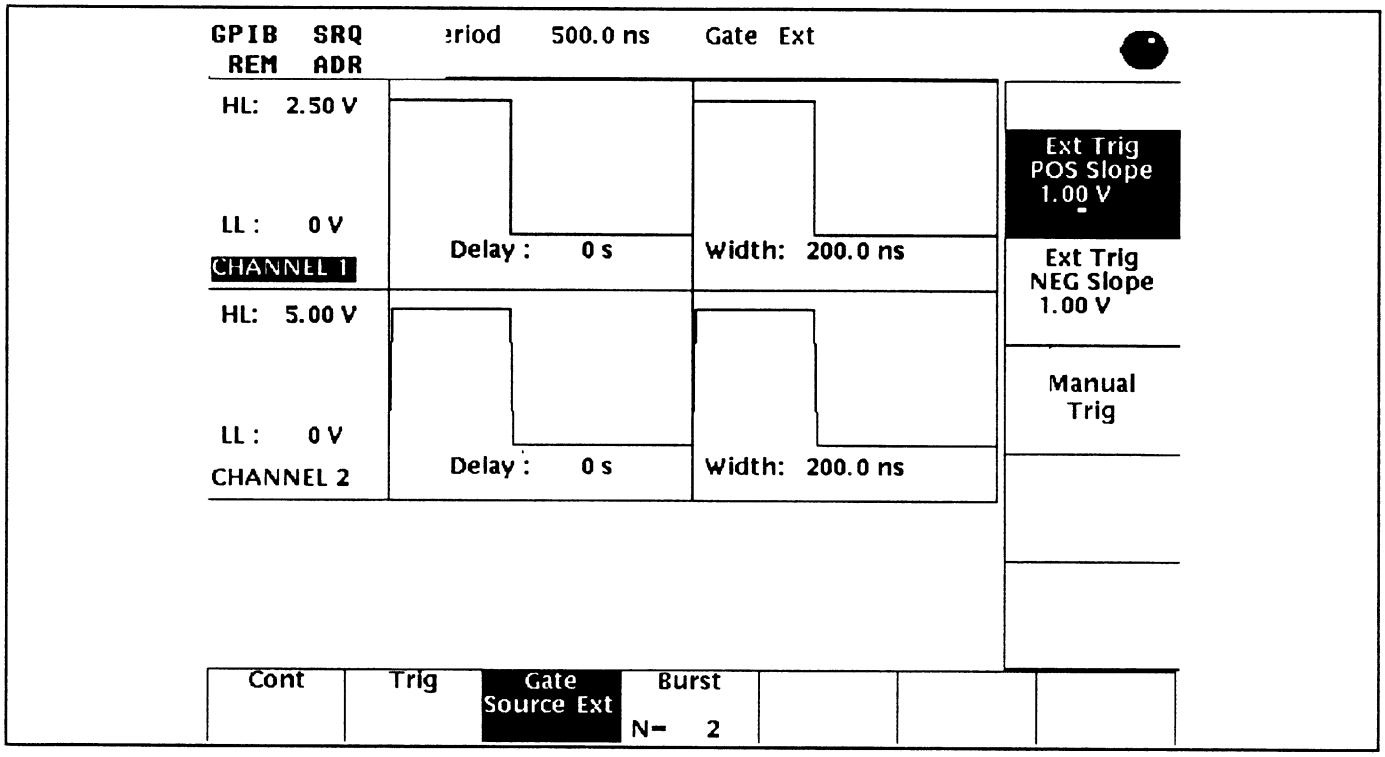


Fig. 2B-3. TRIGGER Menu, GATE — EXTERNAL SOURCE Selected.

The Trigger menu with GATE selected is shown in Fig. 2B-3. MANUAL TRIG, and POSitive and NEGative slope for EXT TRIG modes are shown. Trigger level and trigger slope are displayed as part of the EXT TRIG selections, see Fig. 2B-3.

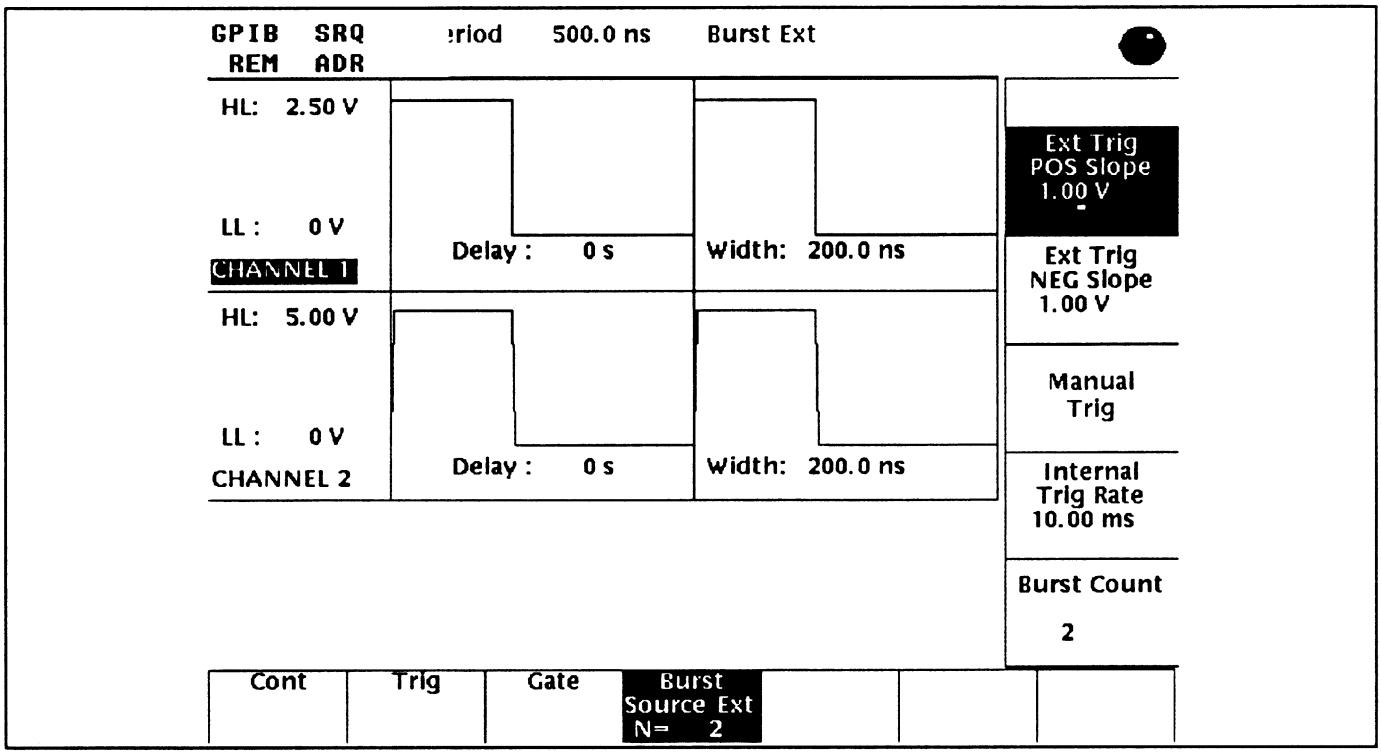


Fig. 2B-4. TRIGGER Menu, BURST — TRIG SOURCE EXTERNAL Selected.

Fig. 2B-4 illustrates the Trigger menu with BURST selected. All parameters which are under the control of the trigger menu system are displayed when BURST is selected. For this reason it is used as the representative lower level menu in the discussion about trigger mode lower level menus.

TRIGGER MENU: Lower Level Menus

Pressing a soft key in the Trigger main menu display selects a corresponding lower level menu. The exception to this is the CONT mode, which has only one selection on its lower level menu display. Fig. 2B-4, illustrates the four selections which appear in the lower level menu displays for both the TRIG and BURST modes and are representative of displays which may be selected using the GATE mode. It also illustrates the last selection (BURST COUNT) in the lower level menu which appears only in the BURST mode.

BURST COUNT displays and sets the number of cycles which will be output when triggering occurs. The range is 2 — 999,999 cycles. After BURST is selected from the TRIGGER main menu a display like that shown in Fig. 2B-4 appears.

EXT TRIG POS SLOPE and **EXT TRIG NEG SLOPE** selects the trigger input on the front-panel, through the use of the appropriate soft key, for positive signal transition (positive-true in the gate mode) or negative signal transition (negative-true in the gate mode). The lower level menus also display and set the threshold for the external trigger input. The threshold range is plus or minus 9.99 V. A minimum signal of 150 mV is required for triggering to occur at frequencies from DC — 50 MHz. The minimum required pulse width for triggering to occur is 10ns.

MANUAL selects the manual trigger source which causes a pulse to be output when the MANUAL key is pressed.

TRIGGER RATE automatically selects the instrument's internal rate generator for triggering. The internal rate is adjustable from 100ns to 99.99s.

Note

*Internal trigger rate * 0.99 must be > period * burst count or an error will occur.*

SECTION 2C
OUTPUT MENU

The OUTPUT menu is selected by pressing the corresponding MENU key on the front panel. It is used to select the pulse HIGH LEVEL, LOW LEVEL, and OUTPUT MODE.

HIGH LEVEL sets the high output level for the instrument; this corresponds to the top line in Figure 2C-1. Certain restrictions apply when setting the HIGH LEVEL; these are discussed in the following text.

LOW LEVEL sets the low level of the output voltage; this corresponds to the base line in Fig. 2C-1. This parameter must be less than the HIGH LEVEL and must conform to the same restrictions as those for the HIGH LEVEL parameter.

Transition time is the interval required for the pulse to go from 10% to 90% of the specified amplitude or vice versa. Transition time for the <250ps setting on PG 2010 and PG 2012 Channel 1 is the interval for the pulse to go from 20% to 80%. 20% to 80% is used to be consistent with high speed ECL logic specifications. Pulse LEADING EDGE is the first transition time to occur in the output pulse coincident with or after the rising edge of the TRIG OUT pulse; TRAILING EDGE is the second transition time. These parameters must be set within the same range or the instrument will not accept the values for execution and a warning will appear in the display.

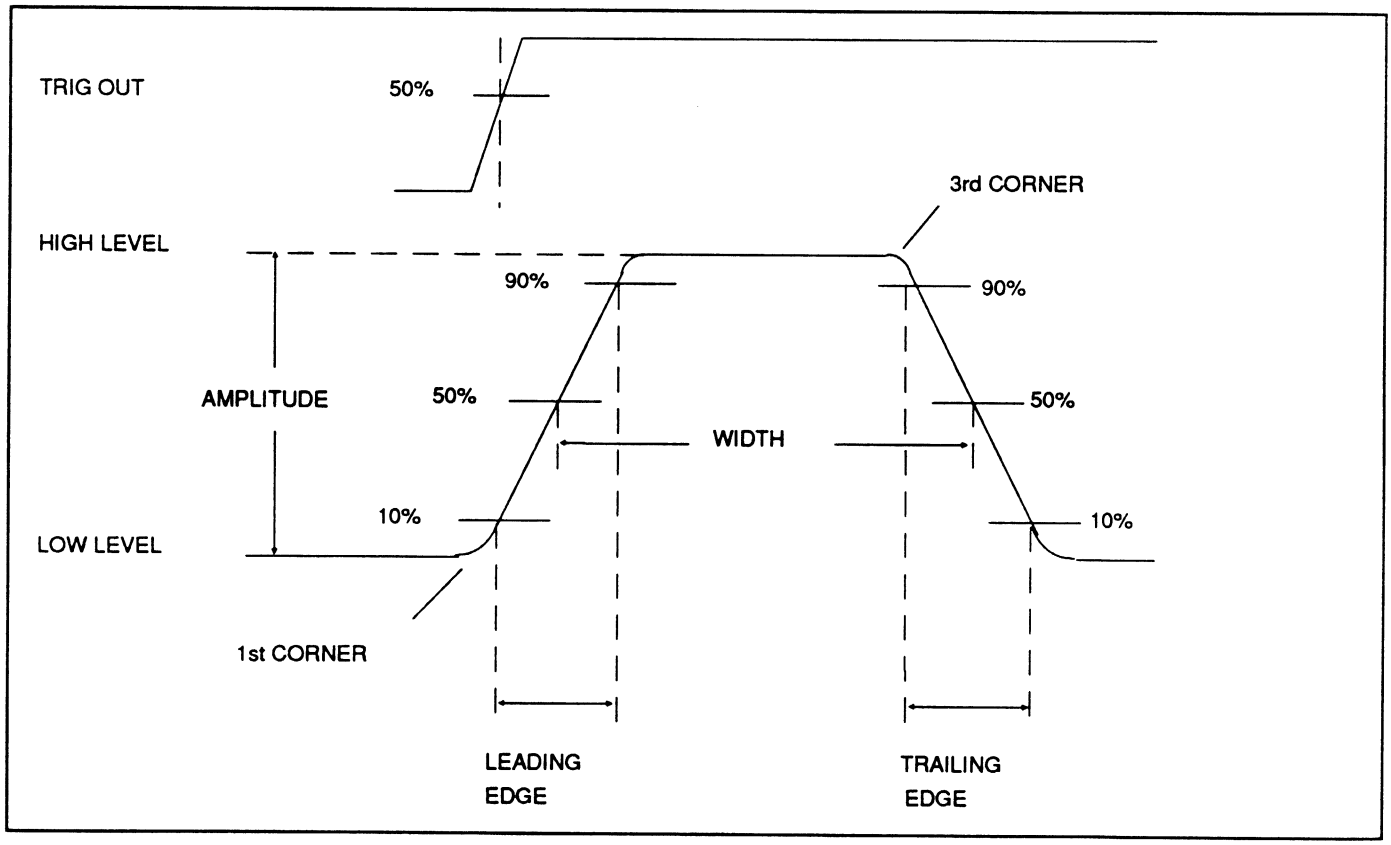


Fig. 2C-1. High and Low Levels.

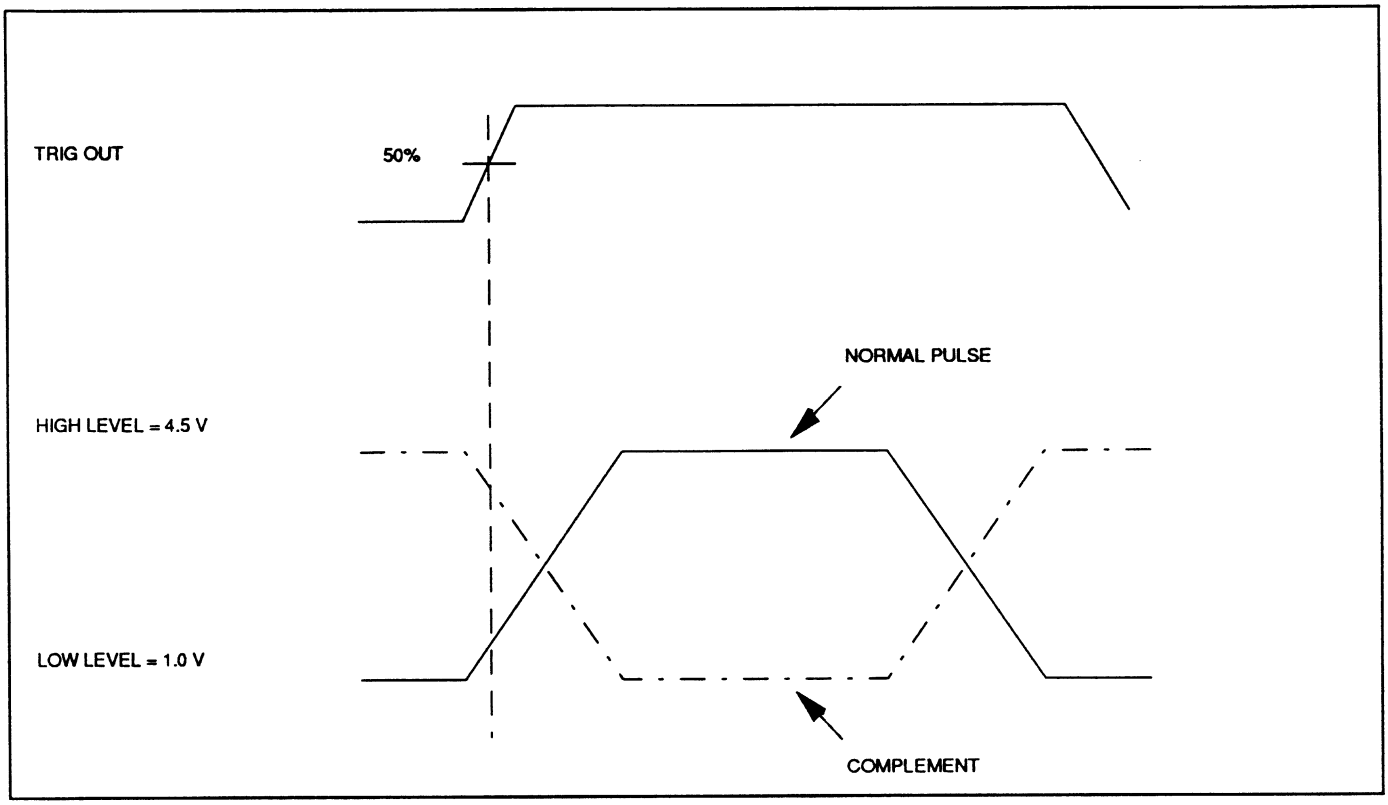


Fig. 2C-2. Normal and Complement Modes.

OUTPUT MENU selection provides NORMAL or COMPLEMENTary output for PG 2012 Channel 2 or the PG 2011 single or dual channel(s) variable-edge. When the instrument is set to the COMPLEMENT mode the HIGH LEVEL and LOW LEVEL values of the NORMAL pulse are reversed (see Fig. 2C-2). Complementary output for PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) is provided by CH 1 and CH 2 front-panel keys. An attempt to use the CH 1 and CH 2 front-panel keys to provide a complementary output for PG 2012 Channel 2 or the PG 2011 single or dual channel(s) slow-edge output will result in an error message.

OUTPUT MENU: Lower Level Menus

Fig. 2C-3 shows the OUTPUT menu with HIGH LEVEL selected.

- The PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) HIGH LEVEL range is –1.2 — +2.5 V into 50 Ω and LOW LEVEL range is –2.5 — +1.9 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.6 — 2.5 V into 50 Ω.
- There are two restrictions on the output level which must be observed when setting the HIGH LEVEL or LOW LEVEL parameters:
  - — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.6 V and ≤2.5 V into 50 Ω.
  - — The maximum output levels are plus and minus 2.5 V into 50 Ω.

A mismatch, or different impedance in a transmission line, generates a reflection back along the line to the source. The amplitude and polarity of the reflection are determined by the load impedance in relation to the characteristic impedance of the cable. If the load impedance is higher than the characteristic 50Ω impedance of the line, the reflection will be of the same polarity as the applied signal, i.e., applied signal will be increased. These reflections add or subtract from the amplitude of the incident pulse causing distortion and irregular pulse shapes.

Rotation of the knob will increase or decrease the value of the HIGH LEVEL or LOW LEVEL. The DATA keypad and ENTER may also be used.

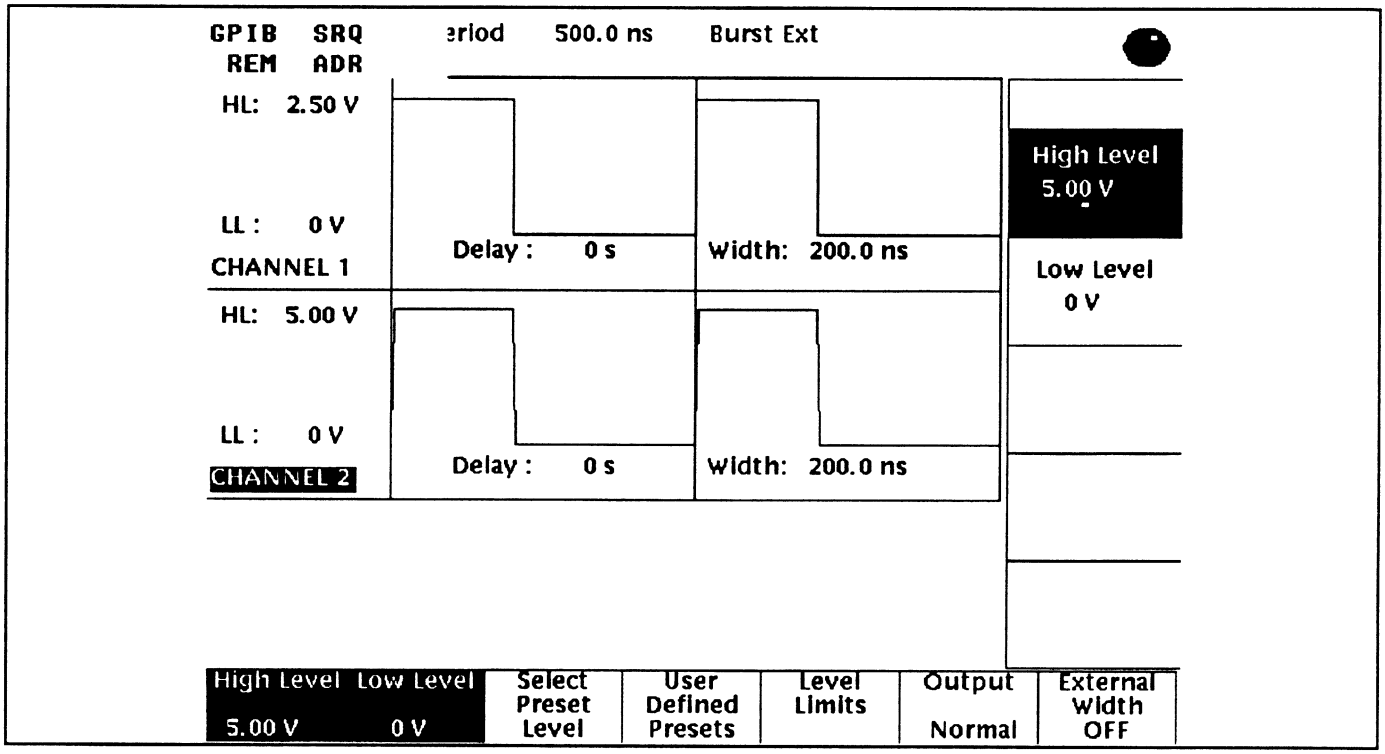


Fig. 2C-3. OUTPUT Menu, HIGH LEVEL Selected.

- The PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) HIGH LEVEL range is –9.50 — 10.0 V into 50 Ω and LOW LEVEL range is –10.0 — 9.50 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.5 — 10.0 V into 50 Ω.
- There are two restrictions on the output level which must be observed when setting the HIGH LEVEL or LOW LEVEL parameters:
  - — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.5 V and ≤10 V into 50 Ω.
  - — The maximum output levels are plus and minus 10.0 V into 50 Ω.

If these restrictions are not observed in setting the high and low level parameters, a warning will appear. If the front panel MENU key is pressed while the error condition exists, the instrument will set the high or low level values to their previous legal settings.

Rotation of the knob will increase or decrease the value of the HIGH LEVEL or LOW LEVEL. The DATA keypad and ENTER may also be used.

SELECT PRESET LEVEL (see Fig. 2C-4.) allows the users to choose from the following predetermined pulse levels:

Type	Low Level	High Level
TTL	0.4 V	2.4 V
CMOS	0 V	5 V ††
ECL	–1.8 V	–0.8 V
USER	†	†

† Changed by using "USER DEFINED PRESETS" mode.

†† Not available in PG 2010 and PG 2012 CH1 due to output level limitations.

USER DEFINED PRESETS allows the user to predetermined pulse levels such as device levels, see Fig. 2C-5.

LEVEL LIMITS mode is used to limit the range of the HIGH LEVEL and LOW LEVEL settings for the defined and predefined pulses, as well as setting the actual high and low predefined levels. When using this feature it is important to observe the restrictions given in the HIGH

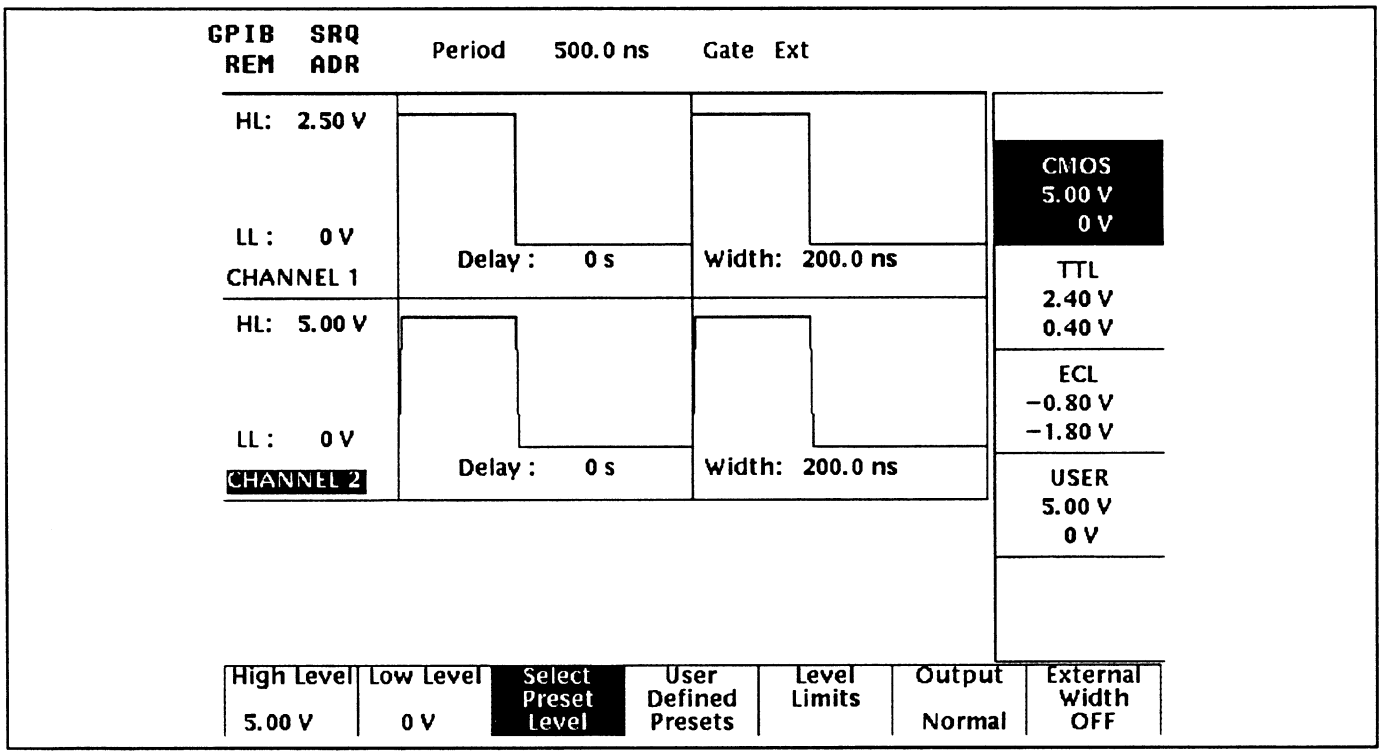


Fig. 2C-4. OUTPUT Menu, SELECT PRESET LEVEL Selected.

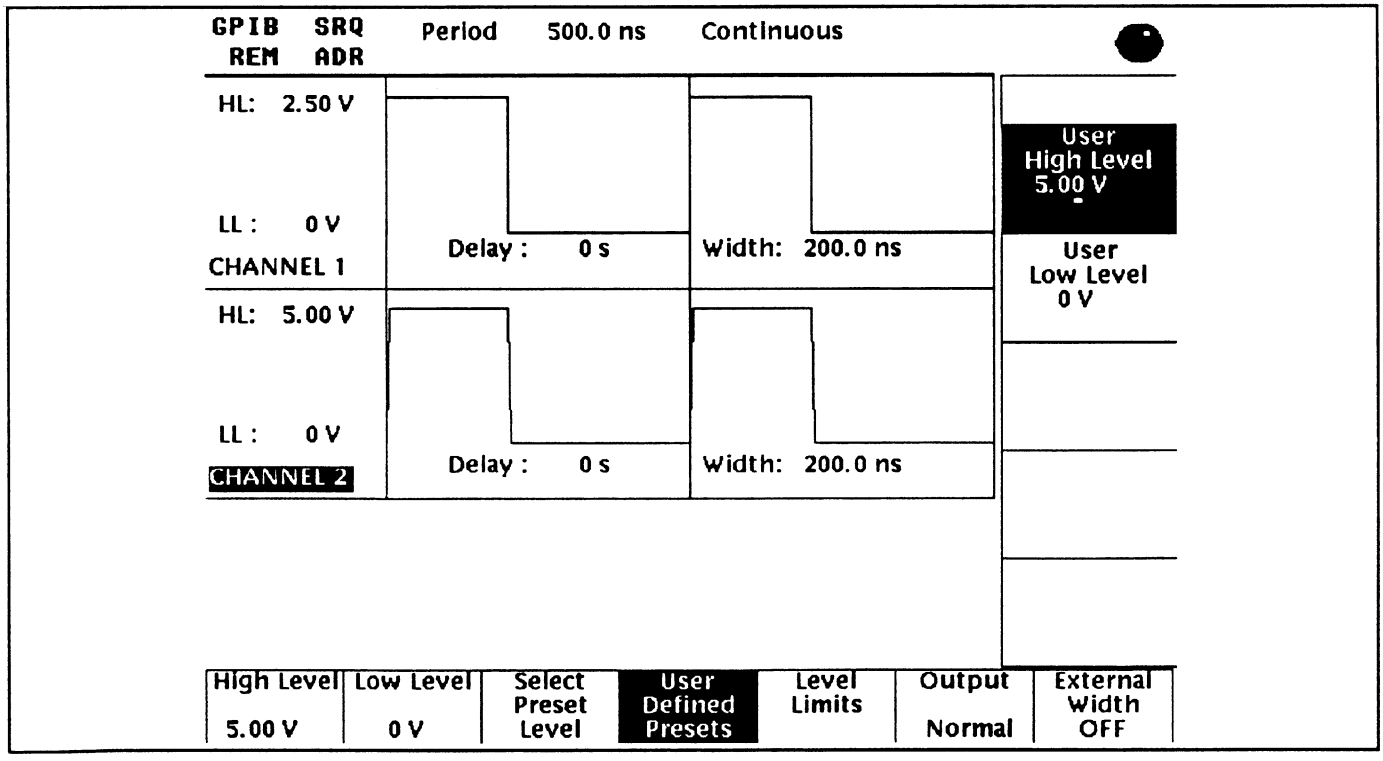


Fig. 2C-5. OUTPUT Menu, USER DEFINED PRESETS Selected.

and LOW LEVEL descriptions earlier in this section. See Fig. 2C-6.

OUTPUT mode set the pulse output for the PG 2012 Channel 2 or the PG 2011 single or dual channel(s) for NORMAL or COMPLEMENT mode (see Fig. 2C-7). When the instrument is set to the COMPLEMENT mode the signal is inverted, see Fig. 2C-2. The PG 2012 Channel 2 and PG 2011 complementary outputs are not available simultaneously since the complementary signal is only available from the CH 1 or CH 2 normal output connector.

NOTE

To prevent aberrations on the output pulse, the unused PG 2010 or PG 2012 CH1 output (normal or complementary) for the channel ***must*** *be terminated in the same impedance as the selected output for the channel. This applies only to fixed risetime channels. When an output is off, it is internally terminated into 50Ω. If it is necessary to terminate an output in an impedance other than 50Ω, turn the output on and attach the correct termination to the output connector. This also means an unused output should be turned on and left open if the active output is driving a high impedance.*

EXTERNAL WIDTH (see Fig. 2C-8.) allows the output pulse period and width to be set by the external trigger signal. In the EXTERNAL WIDTH mode, the instrument internal settings for period and delay are ignored; however, the transition times remain under the control of the instrument.

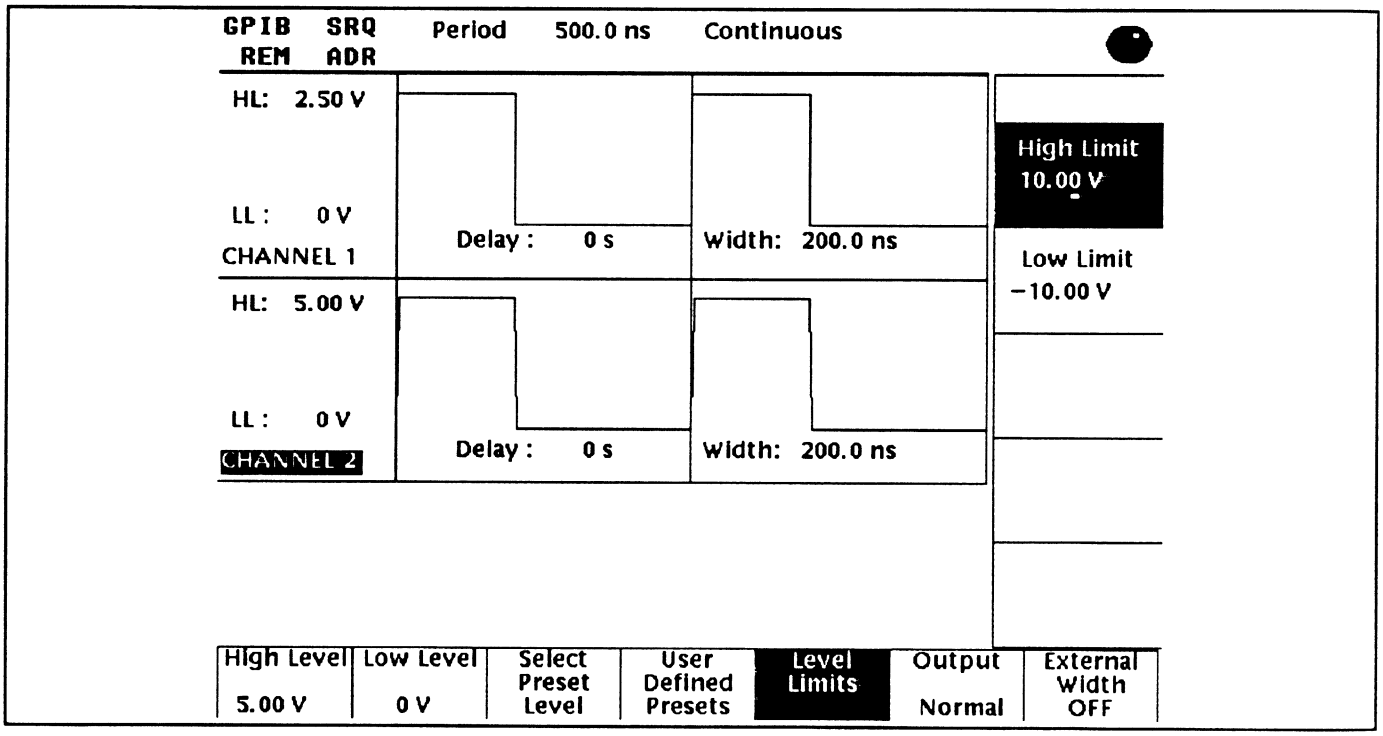


Fig. 2C-6. OUTPUT Menu, LEVEL LIMITS Selected.

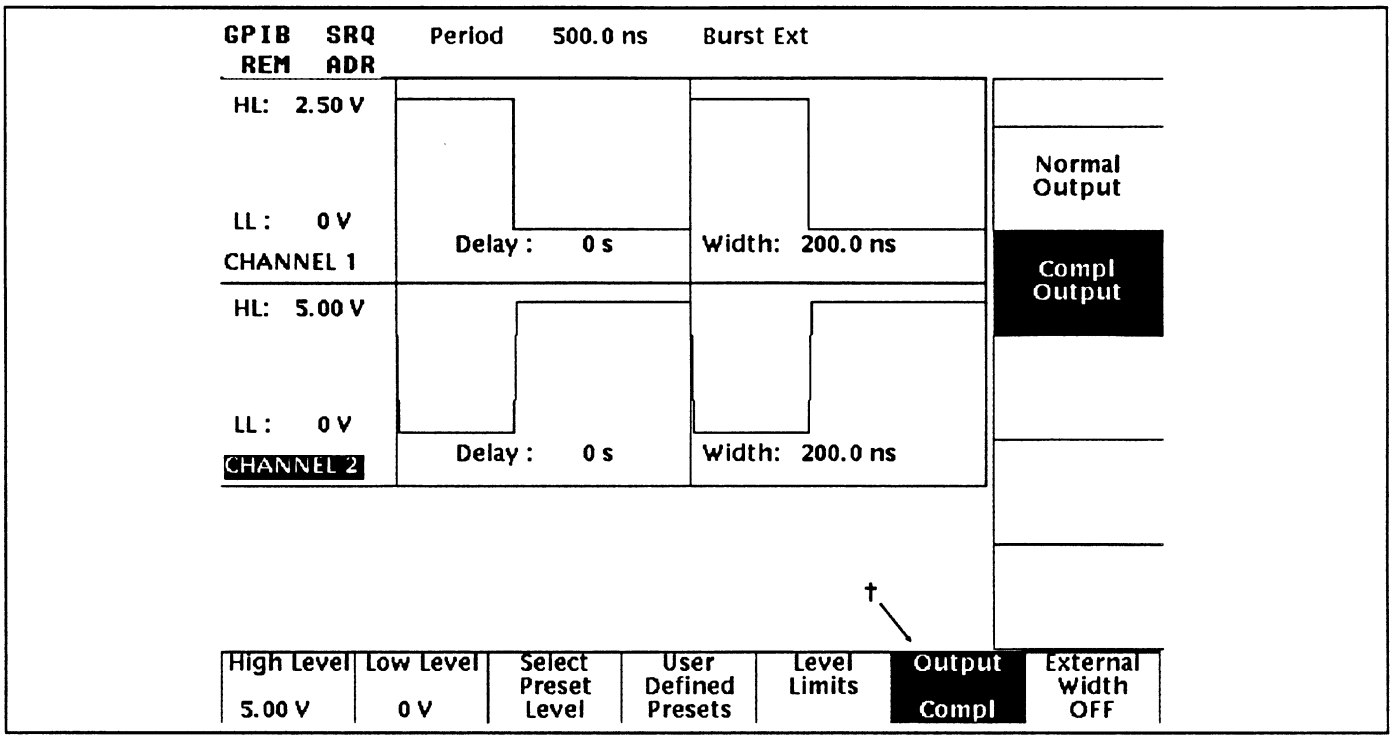


Fig. 2C-7. OUTPUT Menu, OUTPUT Selected. † Not available on PG 2010 and PG 2012 CH1.

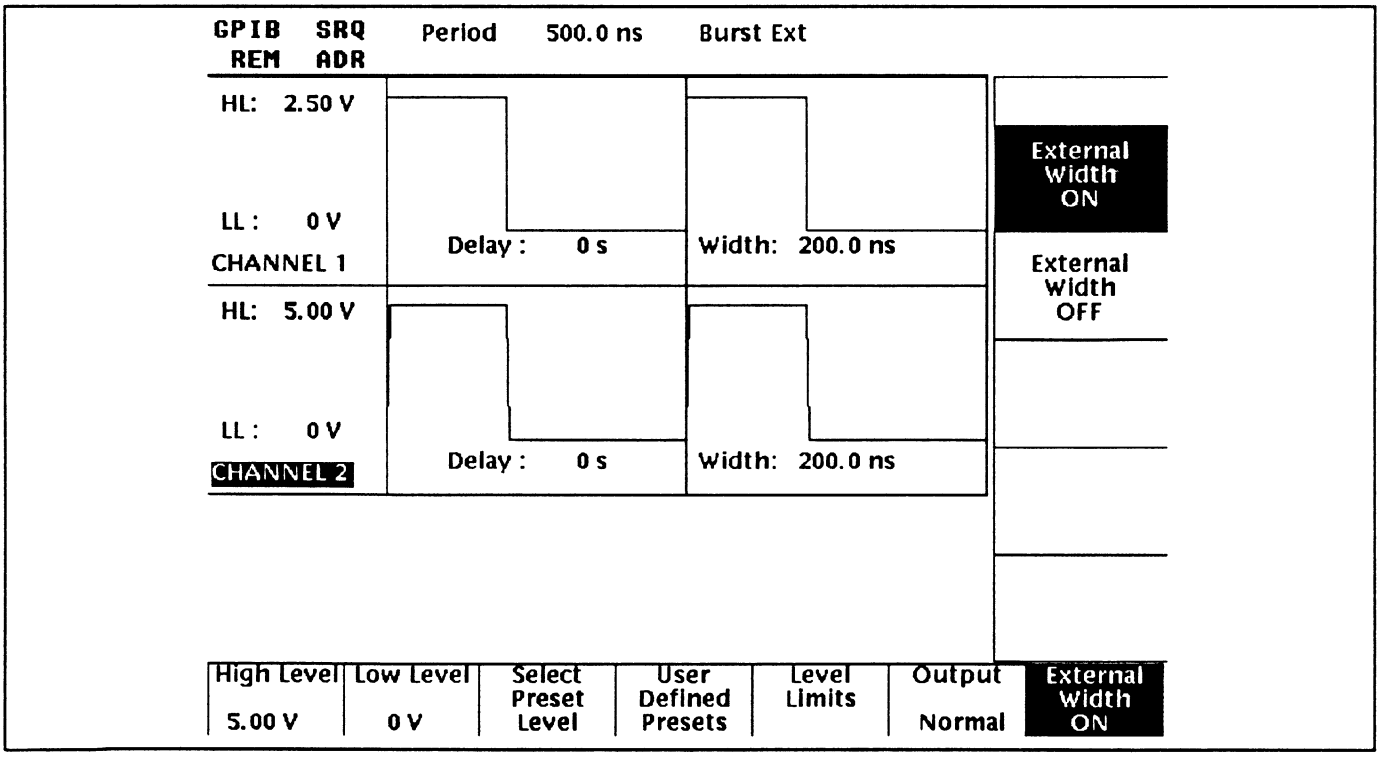


Fig. 2C-8. OUTPUT Menu, EXTERNAL WIDTH Selected.

SECTION 2D
UTILITY MENU

The UTILITY menu (Fig. 2D-1) is selected by pressing the corresponding MENU key on the front-panel and is used to store or recall parameter settings as well as controlling additional instrument functions.

UTILITY MENU: Lower Level Menus

RECALL is used to select settings from a memory location. Use ***only*** the data keypad and ENTER key to select a memory between 1 and 99. The instrument will execute the selected buffer.

STORE is used to store the current settings in a memory location. To store the current settings select the STORE mode by selecting the corresponding "soft key" and use the data keypad to select the desired buffer number between 1 and 99. When STORE is selected the knob ***cannot*** be used. Pressing ENTER causes the current settings to be stored. Any information previously stored in the selected buffer will be written over.

POWER ON SETTING (Fig. 2D-3) provides three options: FACTORY DEFAULT SETTING (stored setting 0), one of the STORED SETTINGs (buffer 1-99), or the parameters which are the CURRENT SETTING at power off.

The FACTORY DEFAULT SETTING is stored in setting buffer 0.

If a different set of power on parameters is desired, a two step process is required. First, the desired parameter set must be stored in one of the normal buffers (Store Setting 1-99). Then the STORED SETTING lower level menu item is set to the appropriate stored setting buffer

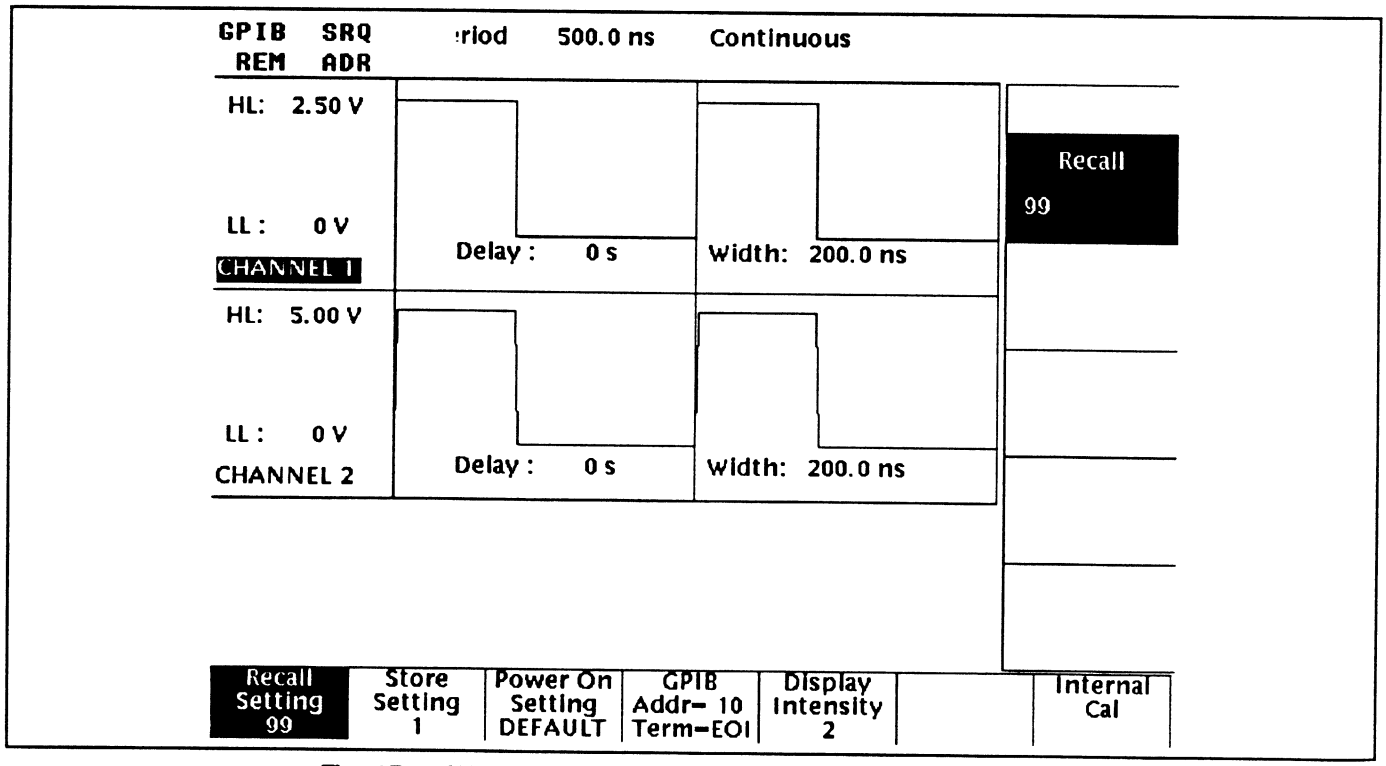


Fig. 2D-1. UTILITY Menu with the RECALL SETTING selected.

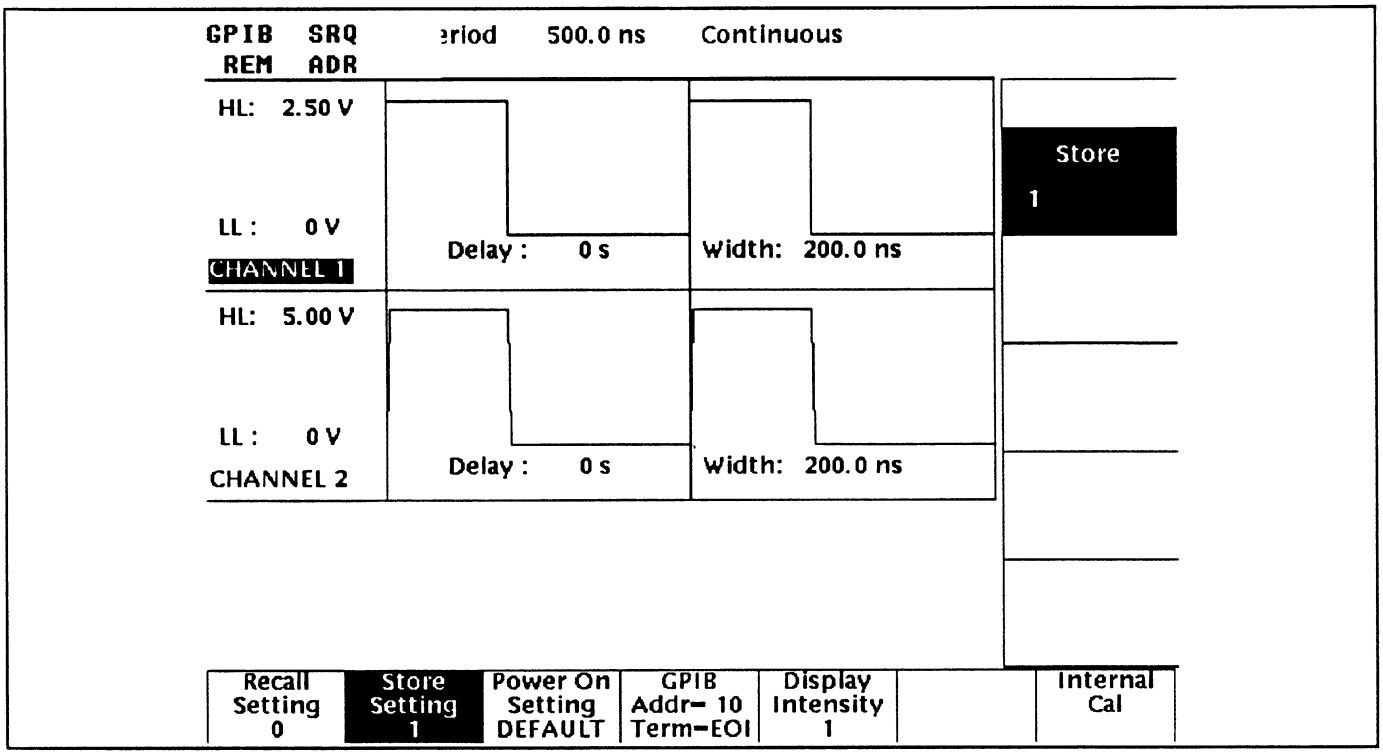


Fig. 2D-2. UTILITY Menu with the STORE SETTING Selected.

number (1-99). Rotation of the knob as well as the data keypad and enter key may be used to select which stored setting buffer will be selected at power on.

If CURRENT SETTING is selected, the instrument will power up with the same parameter settings which were active when the instrument was powered down, except that all outputs will be off.

GPIB selection permits the GPIB address and GPIB termination to be changed through the use of the corresponding soft keys. See Fig. 2D-4.

Rotation of the knob will increase or decrease the GPIB address value. The data keypad and ENTER may also be used.

- EOI ONLY sets the GPIB TERMINATION to EOI.
- LF/EOI sets the GPIB TERMINATION TO LF.

DISPLAY INTENSITY (Fig. 2D-5) Allows intensity adjustment of the crt menu display to compensate for ambient lighting.

Rotation of the knob will increase or decrease the crt display intensity within the brightness range of 1 — 16. The data keypad and ENTER may also be used.

INTERNAL CAL (Fig. 2D-6) performs a calibration cycle which takes approximately 2 seconds on the following parameters: Period, width, delay, high level, and low level. Output from the instrument is disabled during the time in which the calibration is being performed. The instrument must be powered up for at least 20 minutes before this calibration is performed.

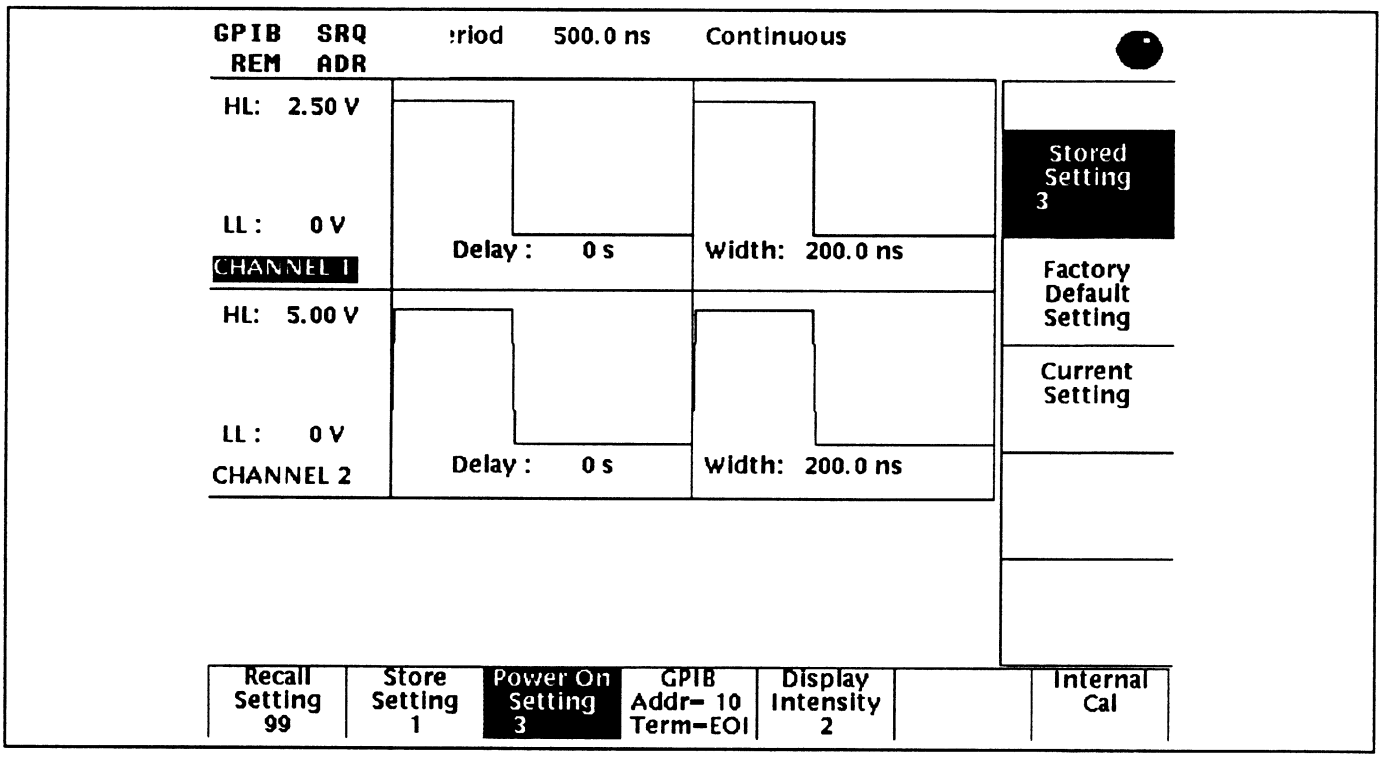


Fig. 2D-3. UTILITY Menu with the POWER ON SETTING Selected.

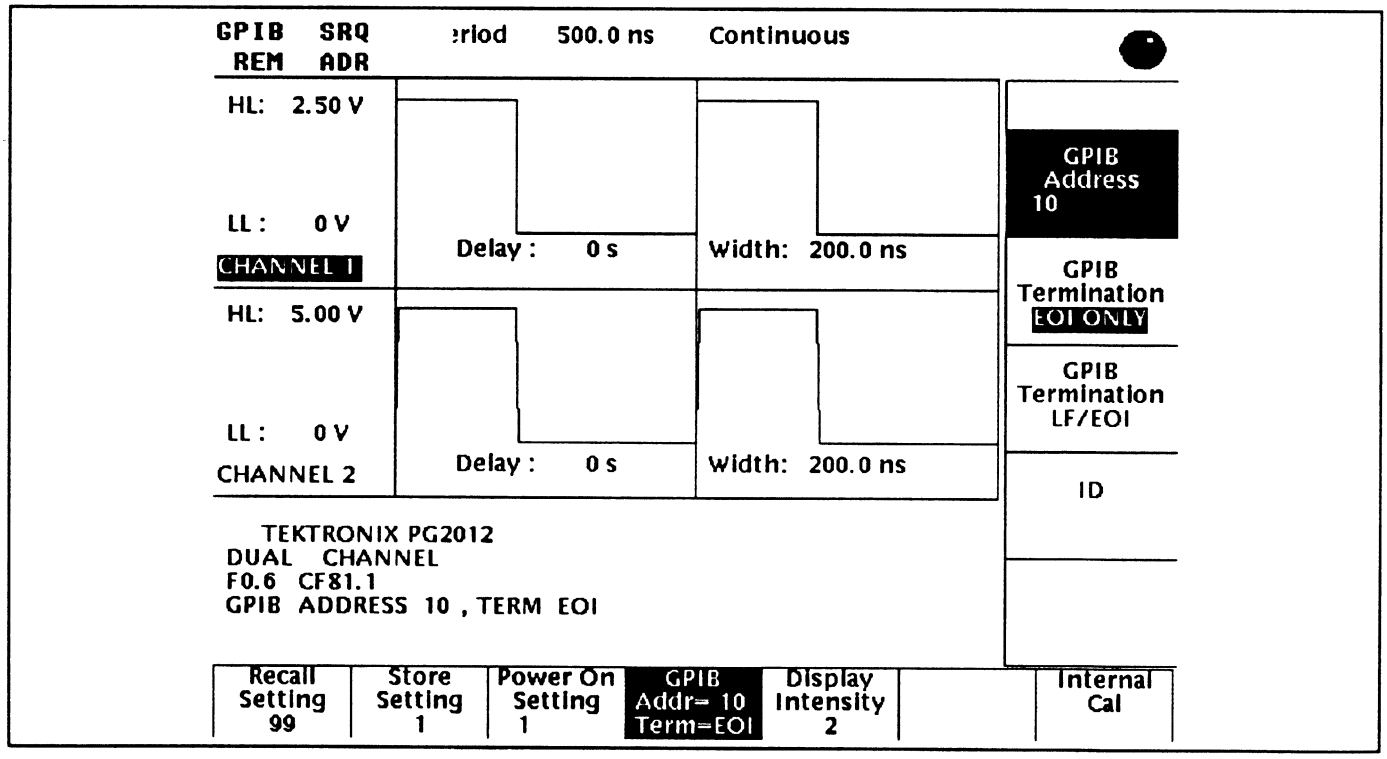


Fig. 2D-4. UTILITY Menu with the GPIB Selected. Lower level ID was selected to display instrument identification information in message display area.

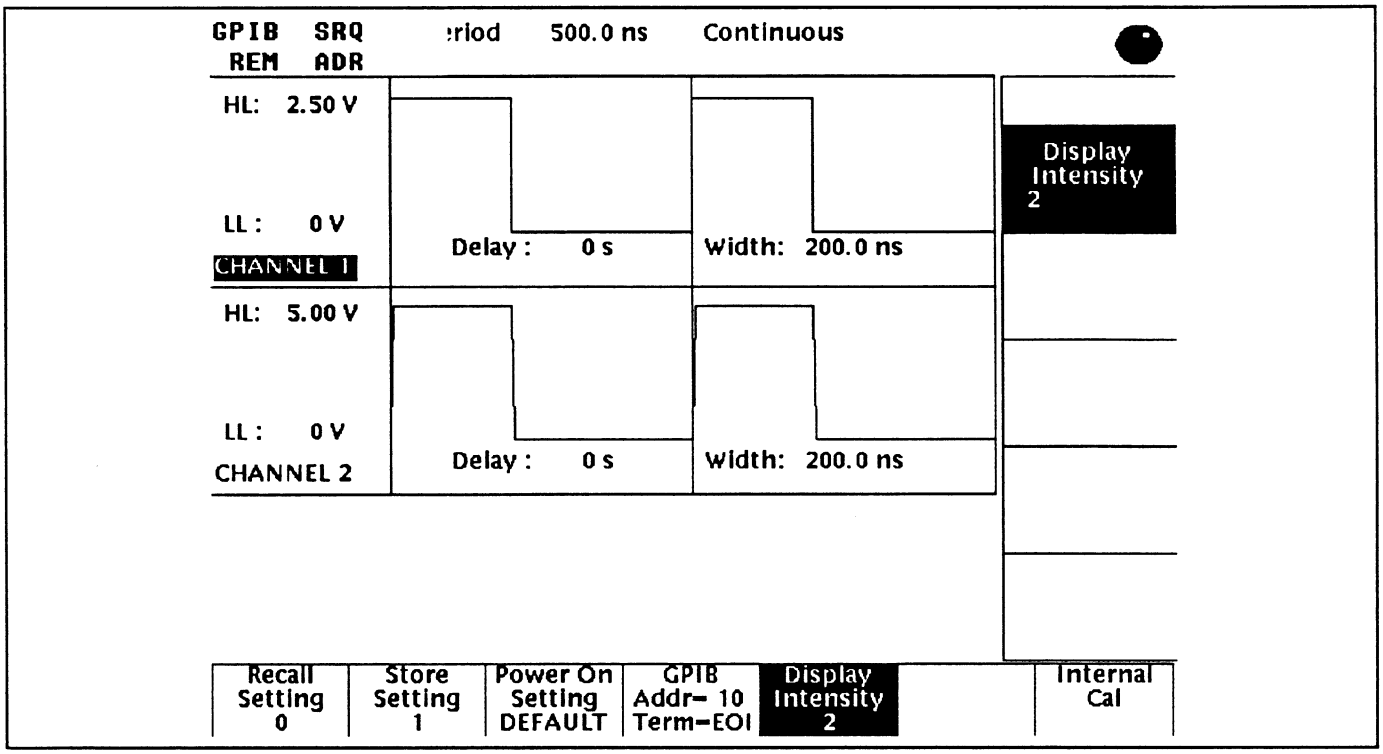


Fig. 2D-5. UTILITY Menu with the DISPLAY INTENSITY Selected.

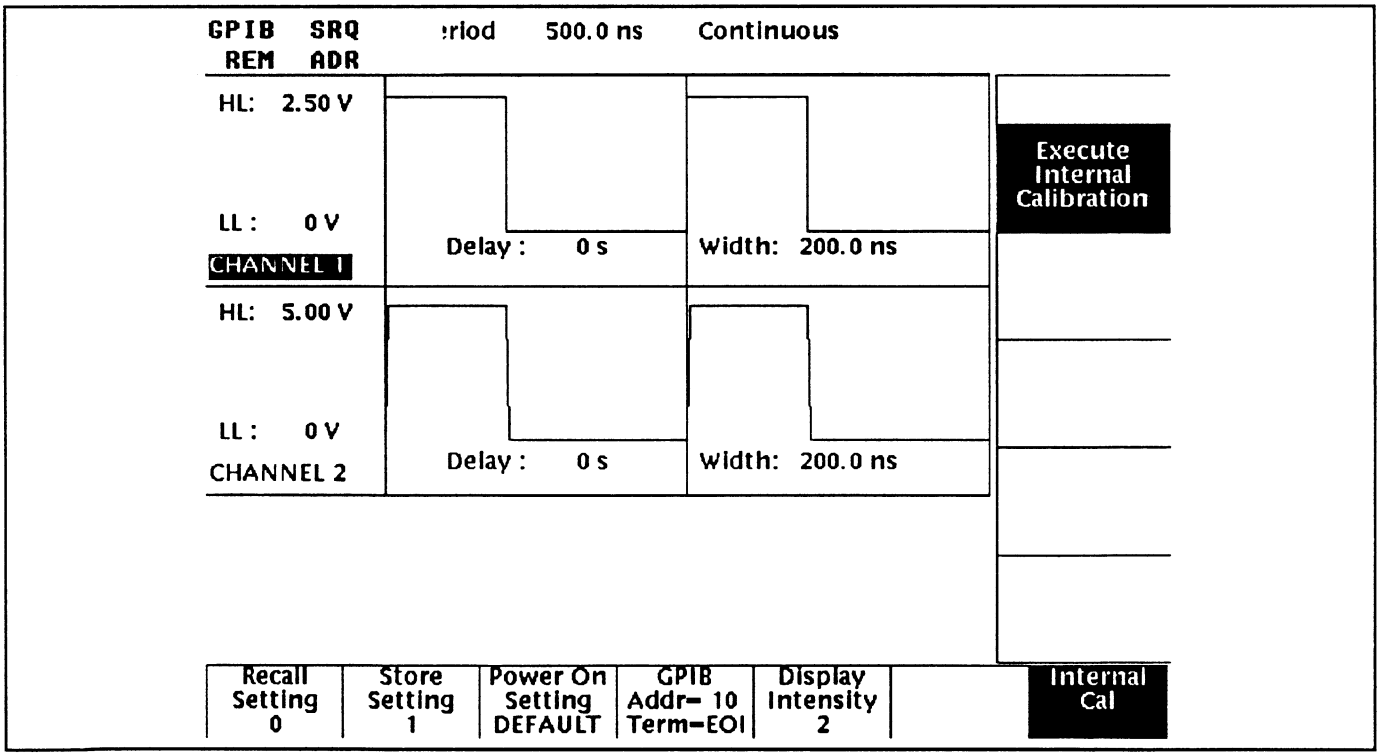


Fig. 2D-6. UTILITY Menu with the INTERNAL CAL Selected.

SECTION 3
APPLICATION NOTES

Output Terminations and Connections

The output of the PG 2010 single or dual channel and PG 2012 Channel 1 are driven differentially. The channel is designed to operate with an external 50 Ω load on both outputs. An unterminated or improperly terminated output causes aberrations on the output pulse (see Impedance Matching). Load resistances less than 50 Ω reduce the pulse amplitude. Load/resistances greater than 50 Ω increase the amplitude. The instrument amplitude can be adjusted for swings of at least 2.5 V into 50 Ω and typically 5 V amplitude swings can be achieved into a high impedance. Termination impedances should be equal for both channel outputs.

NOTE

To prevent aberrations on the output pulse, the unused output (normal or complementary) for the channel ***must*** *be terminated in the same impedance as the selected output for the channel. This applies only to fixed risetime channels. When an output is off, it is internally terminated into 50Ω. If it is necessary to terminate an output in an impedance other than 50Ω, turn the output on and attach the correct termination to the output connector. This also means an unused output should be turned on and left open if the active output is driving a high impedance.*

The PG 2010 and PG 2012 CH 1 can drive a non-ground terminated load. If RLOAD = 50 Ω the Thevenin voltage (V_{term}) must be within the limits –2.5 V_{term} +6 V. This insures that the output voltage (V_o) is within the limits –4 V Vo +6 V. The output voltages will not match the front panel settings for loads which are not 50 Ω and ground terminated. If the load has a Thevenin voltage (as seen by the PG 2010 and PG 2012 CH 1) greater than the maximum allowed, connect a blocking capacitor in series with the output connector and the load. Make certain the time constant of the capacitor and the load is large enough to maintain pulse flatness.

Maintaining Pulse Fidelity

Due to the extremely fast pulse risetimes obtained from the instrument, special consideration must be given to preservation of pulse fidelity. Even at low repetition rates, high frequency components are present in the output waveform. Use high quality coaxial cables, attenuators, and terminations.

RG 58 type coaxial cable and typical BNC connectors exhibit impedance tolerances which may cause visible reflections. For maximum fidelity, use short, high quality, 50 ohm coaxial cables.

When signal comparison measurements or time difference determinations are made, the two signals from the test device should travel through coaxial cables with identical loss and time delay characteristics.

Make certain the attenuators and terminations used can safely handle the maximum PG 2010 and PG 2012 CH1 power output of 0.320 Watts.

When making connections that are not in a 50 Ω environment, keep all lead lengths short, 1/4 inch or less.

Risetime Measurements in Linear Systems

Consider the risetime and falltime of associated equipment when measuring the risetime or falltime of a linear device. If the risetime of the device under test is at least ten times slower than the combined risetimes of the instrument, the monitoring oscilloscope, and associated cables, the error introduced will not exceed 1%, and usually may be ignored. If the risetime or falltime of the test device is less than ten times slower than the combined risetimes of the testing system, determine the actual risetime of the device under test by using the following formula:

$$R_t = \sqrt{Rt_1{}^2 + Rt_2{}^2 + Rt_3{}^2 \ldots\ldots\ldots}$$

Rt equals the overall risetime or falltime of the entire measurement system and R_1, R_2, R_3, etc. are the risetimes or falltimes of the individual components in the system.

Impedance Matching

A mismatch, or different impedance in a transmission line, generates a reflection back along the line to the source. The amplitude and polarity of the reflection are determined by the load impedance in relation to the characteristic impedance of the cable. If the load impedance is higher than the characteristic impedance of the line, the reflection will be of the same polarity as the applied signal. If it is lower, the reflection will be of opposite polarity. These reflections add or subtract from the amplitude of the incident pulse causing distortion and irregular pulse shapes.

A simple resistive minimum attenuation impedance-

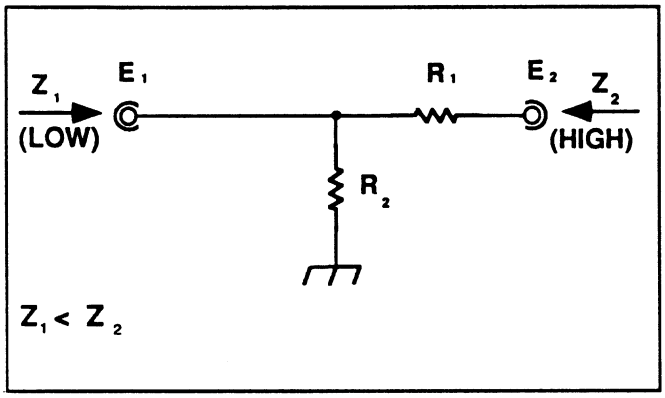


Fig. 3-1 Impedance-matching network that provides minimum attenuation.

matching network that can be used to match the instrument output into relatively low impedances is shown in Fig. 3-1. To match impedances with the illustrated network, the following conditions must exist:

$$\frac{(R_1 + Z_2)\,R_2}{R_1 + Z_2 + R_2} \quad \textit{must equal } Z_1$$

and

$$R_1 + \frac{R_1 + Z_1\,R_2}{Z_1 + R_2} \quad \textit{must equal } Z_2$$

Therefore:

$$R_1\,R_2 = Z_1\,Z_2 \text{ , and } R_1\,Z_1 = R_2\,(Z_2 - Z_1)$$

or

$$R_1 = \sqrt{Z_2\,(Z_2 - Z_1)}$$

and

$$R_2 = Z_1 \sqrt{\frac{Z_2}{Z_2 - Z_1}}$$

For example; to match a 50 Ω system to a 125 Ω system, Z1, equals 50 Ω and Z2 equals 125 Ω.

Therefore:

$$R_1 = \sqrt{125(\,125 - 50)} = 96.8\ \Omega$$

and

$$R_2 = 50 \sqrt{\frac{125}{125 - 50}} \quad 64.6\Omega$$

Though the network in Fig. 3-1 provides minimum attenuation, for a purely resistive impedance-matching device, the attenuation as seen from one end does not equal that seen from the other end. A signal (E_1) applied from the lower impedance source, encounters a voltage attenuation (A_1) which is greater than 1 and less than 2, as follows:

$$A_1 = \frac{E_1}{E_2} = \frac{R_1}{Z_2} + 1$$

A signal (E_2) applied from the higher impedance source (Z_2) encounters a greater voltage attenuation (A_2) which is greater than 1 and less than 2 (Z_2/Z_1):

$$A_2 = \frac{E_2}{E_1} + \frac{R_1}{R_2} = \frac{R_1}{Z_1} + 1$$

In the example of matching 50 Ω to 125 Ω,

$$A_1 = \frac{96.8}{125} + 1 = 1.77$$

and

$$A_2 = \frac{96.8}{64.6}\ \frac{96.8}{50} + 1 = 4.43$$

The illustrated network can be modified to provide different attenuation ratios by adding another resistor (less than R_1) between Z_1 and the junction of R_1 and R_2.

When constructing such a device, the environment surrounding the components should also be designed to provide smooth transition between the impedanances. Acceptable performance can be obtained with discrete components using short lead lengths; however a full coaxial environment is preferred.

The characteristic impedance of a coaxial device is determined by the ratio between the outside diameter of the inner conductor to the inside diameter of the outer conductor expressed as:

$$Z_o = \frac{138}{\sqrt{\varepsilon_r}} \log_{10} \frac{D}{d}$$

The relative dielectric constant is ε_r (ε_r air =1), D is the inside diameter of the outer conductor and d is the diameter of the inner conductor.

Consider carefully the effects of impedance mismatches or discontinuities in transmission lines and terminations. Short lengths of wire exhibit inductance causing pulse aberrations. Use 50 Ω environments or, if this is impossible, keep all lead lengths as short as possible (1/4 inch or shorter).

If the instrument is driving the 1 MΩ vertical input of an oscilloscope, connect a 50 Ω termination to the oscilloscope input. For a further reduction of reflected signals connect the coaxial cable from the instrument to a 50 Ω, 10X attenuator and connect the attenuator to the termination. The attenuator isolates the input capacity, providing an improved termination for the cable.

SECTION 4
PROGRAMMING

Introduction

The PG 2010/PG 2011/PG 2012 can be operated by remote control over the digital bus specified in *IEEE Standard 488-1987*, commonly called the General Purpose Interface Bus (GPIB). This version of the command set for the instrument is based on *Codes and Format Version 81*. This allows use of the ABSTOUCH command.

After the instrument is set to the remote mode by a system controller, its operating modes and front-panel settings can be set and read by programming mnemonics sent to it in ASCII over the bus. Operating modes and front panel settings can be read by the controller in either the local or remote state.

The command set is divided by function following the arrangement of each menu key.

IEEE-488 Interface Function Subsets

IEEE Standard 488-1987 identifies the interface function repertoire of a device on the bus in terms of interface function subsets. These subsets are defined in the standard. The subsets that apply to the instrument are:

Mnemonic	Description	Comments
SH1	Source Handshake	Complete capability.
AH1	Acceptor Handshake.	Complete capability.
T6	Basic Talker	Responds to Serial Poll, Untalk if My Listen Address (MLA) is received. No Talk Only Mode.
TE0	Extended Talker (secondary address)	No capability.
L4	Basic Listener	Unlisten if My Talk Address (MTA) is received. No Listen Only Mode.
LE0	Extended Listener (secondary address)	No capability.
SR1	Service Request	Complete capability.
RL1	Remote Local	Complete capability, including local lockout.
PP0	Paralleled Poll	Does not respond to Paralleled Poll.
DC1	Device Clear	Complete capability.
DT1	Device Trigger	Complete capability.
C0	Controller	No capability.
E2	Electrical Interface	Three-state driver capability.

IEEE-488 Bus Address and Terminator

Setting the GPIB address

Using front panel MENU keys, select the UTILITY menu, then press GPIB ADDR = xx TERM = EOI soft key which selects the GPIB menu. Press GPIB ADDRESS xx soft key which allows the address to be changed using either the data entry keypad, or the knob. The legal values are 0 — 31. Address 31 disconnects the instrument from bus communication; however, the instrument remains an active electrical load. (At shipment, the GPIB address is set to 10.)

Selecting the GPIB Terminator

A GPIB message can be terminated by one of two ways:

- *EOI Mode.* The instrument asserts EOI only on the last byte transmitted, and expects EOI to be asserted on the last byte received.
- *LF Mode.* The instrument sends CR, then LF with EOI asserted on the last byte transmitted, and expects CR, LF; CR, LF with EOI; LF, or EOI on the last byte received.

Select the UTILITY menu, then press the GPIB ADDR = xx TERM = EOI soft key which selects the GPIB menu. Press the GPIB TERMINATION EOI ONLY or GPIB TERMINATION EOI ONLY soft key whichever is the desired GPIB terminator. At shipment, the terminator is set to LF mode.

Instrument Response to Interface Control Messages

The instrument responds to interface control messages as described below. All of the following messages, except *IFC*, are sent with *ATN* (Attention) asserted:

- **DCL** — Device Clear. This message terminates device dependent message processing, resets the input and output buffers, clears any buffered settings waiting for the *GET* message, and clears the instrument status, except for the power-on status.
- **GET** — Group Execute Trigger. If the instrument is in the DT SETTINGS mode, decoded settings are buffered but not executed until the receipt of the *GET* message. If the instrument is in the DT TRIGGER mode, and the instrument is in TRIGGERED or NBURST mode, each *GET* received will cause one cycle (TRIGGER) or a programmed number of cycles (NBURST) to be generated. If the instrument is in the DT GATE mode, the instrument gate setting will be toggled each time *GET* is received. The instrument responds to *GET* only if it is listen-addressed. DT OFF disables response to *GET*.
- **GTL** — Go-To-Local. This causes the instrument to go to a local state. This state is described under Remote-Local Functions. The instrument responds to *GTL* only if it is listen-addressed.
- **IFC** — Interface Clear. When the IFC line is pulsed, the instrument is taken to an idle state. Pulsing IFC is the equivalent of sending *UNT, UNL, SPD.*
- **LLO** — Local Lockout. This causes the instrument to go to the Local With Lockout State (LWLS) or the Remote With Lockout State (RWLS) if REN is asserted.
- **SDC** — Selected Device Clear. Same as *DCL* message. The instrument responds to SDC only if it is listen addressed.
- **SPE, SPD** — Serial Poll Enable and Serial Poll Disable. Configures instrument for serial poll capability.

Remote-Local Function Operation

The Remote-Local functions of the instrument are controlled by the system controller and the front panel controls. There are four states associated with the Remote-Local functions of the instrument; two "local" states and two "remote" states:

- **Local State (LOCS).** While in LOCS, the front panel controls are under the control of the operator; the front panel settings can not be changed via setting commands from the bus. However, the instrument will respond to query commands via the GPIB bus (REN bus line need not be asserted). In a "local" state, all front panel controls are operational. If a remote command cannot be executed because the instrument is in a "local" state, an execution error will be reported to the controller.

- **Local With Lockout State (LWLS).** If the instrument enters the Local With Lockout State, the REM indicator light will not be lit and the instrument operates exactly as it does in the Local State (LOCS).

- **Remote State (REMS).** When the instrument receives its listen address, with the REN bus line asserted, and RTL is false, it enters the Remote State and the REM indicator light is illuminated. While in REMS, the instrument responds to and executes all setting commands, queries, and interface messages from the bus. For all commands having corresponding front panel controls, the front panel is updated to display the new settings as the commands are executed. If the instrument is in REMS, there are three conditions under which it will return to the Local State (LOCS):
  - When any key is depressed by the operator.
  - When the instrument receives the Go To Local (GTL) interface message.
  - If the REN bus line becomes unasserted (false).

Note

The instrument can be in either the Local State (LOCS) or Remote State (REMS) when the Local Lockout (LLO) interface message is received. If in LOCS and REN is asserted, it will enter the Local With Lockout State (LWLS) or if in REMS, it will enter the Remote With Lockout State (LWLS) when LLO is received. The LWLS and RWLS state transitions are completely controlled by the controller.

- **Remote With Lockout State (RWLS).** When the instrument enters the Remote With Lockout State, the operator cannot return the instrument to local control by depressing a front panel key. While in RWLS, the REM indicator will be illuminated, all settings, commands, queries, and interface messages from the bus will be executed, and all front panel controls will be ignored. If the *GTL* message is received while in RWLS, the instrument goes to the Local With Lockout State (LWLS).

Note

The instrument returns to the Local State (LOCS) any time the REN bus line becomes unasserted (false).

Device Dependent Command Set

The remote control messages for the instrument are device-dependent messages on the IEEE-488. As such, they are not specified in *IEEE Standard 488-1987*. However, the *Tektronix Standard Codes and Formats* specifies the syntax, delimiters, and characters allowed for high-level programming of TEKTRONIX instruments. Remote control of the instrument is implemented according to this standard. Refer to the TEKTRONIX standard for correct message format.

Remote Control Messages

Talk Mode

If the instrument is talked without being specifically told what to say, it will return a hexadecimal 'FF' (decimal 255) byte with the selected message terminator to indicate the "talked with nothing to say" condition.

Instrument Commands

The instrument is controlled by the front panel or via commands received from the controller. These commands are of three types:

- **Setting Commands**. These commands control instrument settings. They are not executed until an operational command or an EOI is issued.
- **Query-output commands**. These commands ask for data.
- **Operational commands**. These commands cause a particular action. They are executed immediately.

The instrument responds to and executes all commands when in the remote state. When in the local state, setting and operational commands generate errors since instrument functions are under front panel control; only query-output commands are executed.

Each command begins with a header, which is a word that describes the function implemented. Many commands require an argument following the header; an argument is a word or number that specifies the desired state for the function.

In the command descriptions that follow, commands and arguments are shown in upper and lower case characters; the upper case characters are required characters, the lower case characters are optional but are checked for errors if they are sent.

Command Set Conventions

The following conventions are used to describe the commands which are used to control the operation of the instrument:

Format

The relevant mnemonic or symbol is presented in bold type and its meaning or explanation is given in italic. Example: *<defined further>* means that statements found within the bold brackets are explained further in the text; *: = argument link* means that a colon links arguments.

<defined further>	| = *or*	: = *argument link*
[*optional*]	{*block*}	... = *repeat*
::= *defined as*	*(comments)*	

CAPitals = The use of capitals indicates the smallest legal abbreviation. Use of the given lowercase letters is optional. The actual command sent can be in upper or lower case. Refer to the following examples.

CAP = This is the minimum abbreviation.

CAPIt = This is an intermediate abbreviation.

capitals
CAPITALS } Examples of full commands.

<NR1> = *10*
<NR2> = *10.0*
<NR3> = *10.0 E-6*

<NRf> ::= *<NR1> or <NR2> or <NR3>*

? = *the instrument will return a value when it becomes a talker.*

Note

Instrument commands must be sent with a space between Header and Argument. Query commands must be sent without a space between Header and "?" (question mark). Commands that change settings are not executed in the Local Mode.

CAUTION

The use of abbreviations shorter than those indicated should be done with caution. Erroneous results or damage can result if such data is sent to the wrong instrument type.

Period Commands

PERiod **<period value>[:<units>]**

period value ::= <NRf> (Range: 10.00000 seconds — 20 ns.)

units ::= {s|ms|µs|ns}

Setting

Sets the period of the period generator. The period generator is common to both channels of the instrument. The frequency command is an alias for the period command except that the period is entered as a frequency instead of a unit of time.

PERiod?

Query/operational

Returns the NR3 value of the period generator. Return format is:

PER <period value>:s;

PULSE **<period> ,<width>,<delay>**

period ::= <NRf> (range = 20 ns — 10 s)
width ::= <NRf> (range = 10 ns — 9.90000 s) width for channel
delay ::= <NRf> (range = 0 — 9.89999 s) delay for channel

Setting, (channel specific)*

The *PULSE* command sets the pulse parameters for the selected channel. The *PULSE* command is an alias for the *PERIOD*, *WIDTH*, and *DELAY* commands. This allows the user to think about the relationship between period, width, and delay.

* The selected channel is controlled by the CHAnnel system command described later in this section.

PULSE?

Query/operational

Returns the NR3 values of the period, width, and delay of the generator. Return format is:

PULSE <period>:s,<width>,<delay>

FREQuency **<frequency value>[:<units>]**

frequency value ::= <NRf> (Range: 0.1 Hz — 50 MHz)
units ::= {Hz|KHz|MHz}

Setting

The *FREQUENCY* command is an alias for the *PERIOD* command.

The *FREQUENCY* parameter is treated as a frequency instead of a period.

FREQuency?

Query/operational

Returns the NR3 value for the frequency of the period generator. Return format is:

FREQ <frequency value>:Hz;

Trigger Mode Commands

MODE CONTinuous|GATE| BURst| TRIGger

Setting

The MODE command sets the trigger mode for the period generator.

If the argument is CONTinuous, then the period generator will give a continuous output.

If the argument is GATEd, then when the trigger input is enabled the output will be on. If the gate is removed in the middle of a period cycle, the cycle will be completed before the output stops.

If the argument is BURst, then when a trigger is received the number of cycles defined by the NBURST command will be output.

If the argument is TRIGger, then one cycle will be output for each trigger. If the trigger source is external, then the period of the period generator will be limited according to the width of the output pulse, plus the delay, plus the reset time for the period generator. It will be limited by the channel with the longest delay + width.

MODE?

Query/operational

The MODE query will return the instrument trigger mode. Return format is:

MODE {CONT|GATE|BURST|TRIG};

TRIGger EXTernal|INTernal|MANual

Setting

The TRIGger command selects the trigger source for the instrument.

If the argument is EXTernal, then the signal on the external trigger input will be used for the trigger source.

If the argument is INTernal, then the trigger source will be an internal rate generator that is independent of the period generator.

If the argument is MANual, then the trigger source for the instrument will be the manual trigger with one trigger for each press of the manual trigger button. If the GATEd mode is also active, then the period generator will be turned on until the button is released.

TRIGger?

Query/operational

Returns the trigger source to which the instrument is set. Return format is:

TRIG {EXT|INT|MAN};

TRIGRate **<trigger rate value>**

trigger rate value ::= <NRf> (Range: 0.1 µs — 99.99 seconds)

Setting

The TRIGRate command will set the period of the internal rate generator used for the internal trigger.

TRIGRate?

Query/operational

The TRIGRate query will return the NR3 period value of the internal trigger generator. Return format is:

TRIGR <trigger rate value>;

LEVel **<trigger voltage>**

trigger voltage ::= <NRf> (Range: –9.99 — +9.99 V)

Setting

The LEVel command will set the threshold for the External trigger input.

LEVel?

Query/operational

The LEVel query will return the NR2 voltage value to which the trigger level is set.

Return format is:

LEV <trigger voltage>;

SLOpe **POSitive|NEGative**

Setting

Sets the slope for the external trigger input.

SLOpe?

Query/operational

Returns the trigger slope setting. Return format is:

SLO {POS|NEG};

NBURst **<number of cycles>**

number of cycles ::= <NR1>(Range: 2 — 999,999 (Must be an integer))

Setting

Sets the number of cycles in a burst when in burst mode.

NBURst?

Query/operational

Returns the NR1 number of cycles that will be output when a burst is performed.

Return format is:

NBUR <number of cycles>;

Width/delay Commands

WIDth **<width value>[:<units>]**

width value ::= <NRf> (Range: 10 ns — 9.90000 s) (Resolution is 6 digits limited to 0.1 ns.)

Setting, (channel specific)

Sets the pulse width for the selected channel.

WIDth?

Query/operational, (channel specific)

Returns the NR3 pulse width time for the output pulses. Return format is:

WID <width value>;

DCYCle **<duty cycle percentage>|0**

duty cycle percentage ::= <NRf> (Range: 1.0 — 99.0)

Setting, (channel specific)

Sets the instrument to duty cycle mode. There are two ways to take the instrument out of duty cycle mode: (1) Send DCYCLE 0, or (2) send a width command to set the width.

DCYCle?

Query/operational, (channel specific)

If the instrument is in duty cycle mode, this query returns the NR2 value of the duty cycle parameter. Return format is:

DCYC {duty cycle percentage | 0};

If the duty cycle parameter is 0, then duty cycle mode is off.

DELay **<delay value>[:units]**

delay value ::= <NRf> (Range: 0 ns — 9.89999 s)

Setting, (channel specific)

Sets the delay from the trigger output to the leading edge of the output pulse in single pulse mode or the time between leading edges of the two pulses in double pulse mode.

DELay?

Query/operational, (channel specific)

Returns the NR3 value for the amount of delay between the Trig Out and the first pulse (if in single pulse mode) or between the two pulses if in double pulse mode. Return format is:

DEL<delay value>;

FUNCtion **SPULse|DPULse**

SPULse

DPULse

Setting, (channel specific)

Sets the type of pulse that will be output.

If the argument is SPULse then, the selected channel is put into single pulse mode. For each cycle of the period generator one pulse will be output.

If the argument is DPULse, then the selected channel is put into double pulse mode. For each cycle of the period generator two pulses will be output. The time between the two pulses is set with the delay command.

FUNCtion?

Query/operational, (channel specific)

Returns the pulse output function setting. Return format is:

FUNC {SPUL|DPUL};

Note

Sending SPULse or DPULse without the "FUNCtion" has the same result as sending FUNC SPUL or FUNC DPUL, respectively.

EXTWidth **ON|OFF**

Setting, (channel specific)

Enables the external width function for the selected channel. This function copies the width of an external pulse while maintaining control of the transition times and output levels.

EXTWidth?

Query/operational, (channel specific)

Returns the status of the external width function. Return format is:

EXTW {ON|OFF};

Level/Slope Commands

HIGHlevel <output voltage>

output voltage ::= <NRf> (Range: 10.0 — –9.50 V)

Setting, (channel specific)

Sets the high output level for the selected channel.

- The PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) HIGH LEVEL range is –1.2 — +2.5 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.6 — 2.5 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the HIGH LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.6 V and ≤2.5 V into 50 Ω.

  — The maximum output levels are plus and minus 2.5 V into 50 Ω.

- The PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) HIGH LEVEL range is –9.50 — +10.0 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.5 — 10.0 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the HIGH LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.5 V and ≤10 V into 50 Ω.

  — The maximum output levels are plus and minus 10.0 V into 50 Ω.

HIGHlevel?

Query/operational, (channel specific)

Returns the NR3 value for the high voltage level of the pulse output. The HIGHlevel must be greater than the LOWlevel. Return format is:

HIGH <output voltage>;

LOWlevel **<output voltage>**

output level ::= <NRf> (Range: 9.50 — –10.0 V)

Setting, (channel specific)

Sets the low output level of the selected channel. This parameter must be less than the HIGHlevel parameter.

- The PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) LOW LEVEL range is –2.5 — +1.9 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.6 — 2.5 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the LOW LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.6 V and ≤2.5 V into 50 Ω.

  — The maximum output levels are plus and minus 2.5 V into 50 Ω.

- The PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) LOW LEVEL range is –10.0 — +9.50 V into 50 Ω. The amplitude range (difference between the high and low level values) is 0.5 — 10.0 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the LOW LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.5 V and ≤10 V into 50 Ω.

  — The maximum output levels are plus and minus 10.0 V into 50 Ω.

LOWlevel?

Query/operational, (channel specific)

Returns the NR2 value for the low voltage setting of the output pulse. Return format is:

LOW <output voltage>;

OUTLevel **<high level>,<low level>**

high level ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –1.2 — +2.5 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –9.50 — +10.0 V)

low level ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –2.5 — +1.9 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –10.0 — +9.50 V)

Setting, (channel specific)

The OUTLevel command is an alias for the HIGHlevel and LOWlevel commands. This allows the user to think of the high and low level commands at the same time and saves bus time. The limits imposed on the high level and low level commands apply here.

- The PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) HIGH LEVEL range is –1.2 — +2.5 V into 50 Ω and LOW LEVEL range is –2.5 — +1.9 V into 50Ω. The amplitude range (difference between the high and low level values) is 0.6 — 2.5 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the HIGH LEVEL or LOW LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.6 V and ≤2.5 V into 50 Ω.

  — The maximum output levels are plus and minus 2.5 V into 50 Ω.

- The PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) HIGH LEVEL range is –9.50 — +10.0 V into 50 Ω and LOW LEVEL range is –10.0 — +9.50 V into 50Ω. The amplitude range (difference between the high and low level values) is 0.5 — 10.0 V into 50 Ω.

  There are two restrictions on the output level which must be observed when setting the HIGH LEVEL or LOW LEVEL parameters:

  — The peak-to-peak amplitude (difference between the high and low levels) must be ≥0.5 V and ≤10 V into 50 Ω.

  — The maximum output levels are plus and minus 10.0 V into 50 Ω.

OUTlevel?

Query/operational, (channel specific)

The OUTlevel query will return the NR2 value of the high level and the low level.

Return format is:

OUTL <high level>,<low level>;

This query is not in the set query response.

PRELEVel TTL|CMOS|ECL|USER

Setting, (channel specific)

Sets the high and low levels to pre-defined levels.

TTL = 0.4 — 2.4 V
ECL = -1.8 — -0.8 V
CMOS[1] = 0 — 5.00 V
USER = Sets high and low levels to user defined values (set by PREHIGH and PRELOW)

[1] PRELEVel CMOS can not be used for the PG 2012 Channel 1 or PG 2010 single or dual fast-edge channels due to output level limitations.

LIMITS <high limit>,<low limit>

high limit ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –1.2 — +2.5 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –9.50 — +10.0 V)

low level ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –2.5 — +1.9 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –10.0 — +9.50 V)

Setting, (channel specific)

Changes the factory default high limits and low limits to new values. This allows control of the output level to protect any device on the output from over voltage or under voltage. The factory default (depending upon the instrument and channel) is either +2.5 V or +10.0 V for the high level and either -2.5 V or –10.0 V for the low level. Limits being set must not conflict with the current high and low level settings.

LIMITS?

Query/operational

Returns the NR2 value of the high and low level limits. Return format is:

LIMITS<high limit>,<low limit>;

LEADedge **<leading edge time value>[:units]**

leading edge time value ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Ranges: 250ps, 800ps, or 1.8ns)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: 5.0 ns — 10 ms in 6 ranges)

Setting, (channel specific)

PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s)

Sets the leading edge parameter and hence the trailing edge parameter since they are the same. The leading edge is selected from one of the following three fixed transition times.

0.25ns

0.80ns

1.8ns

The fast output leading edge is always equal to the trailing edge.

PG 2012 Channel 2 and PG 2011 single or dual variable-transition channel(s)

Sets the leading edge parameter for the selected channel. The leading edge time parameter is set in ranges and the LEADedge and TRAILedge parameters must be in the same range. The following ranges are used:

5.0 ns — 100 ns
50 ns — 1.0 µs
500 ns — 10 µs
5 µs — 100 µs
50 µs — 1.0 ms
500 µs — 10 ms

The leading edge and trailing edge time parameters are set as follows:

1) Choose the faster of the two edges.

2) Choose the slowest range that includes this value.

3) Check that both values are within this range.

If the TRACKING command is set to OFF and the leading edge and trailing edge time are not in the same range, then an error will be returned. In order to set the leading edge and trailing edge times to a value in a different range without an error, the LEADedge and TRAILedge time commands must be in the same message.

LEADedge?

Query/operational, (channel specific)

Returns the NR3 value of the leading edge time parameter. Return format is:

LEAD <leading edge time value>;

PREHIGH <level>

<level> ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –1.2 — +2.5 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –9.50 — +10.0 V)

Setting, (channel specific)

Sets the high level used by the PRELEVEL USER command.

NOTE

The same restrictions that govern the HIGHlevel command settings must be observed when setting PREHIGH command.

PREHIGH?

Query/operational, (channel specific)

Returns the NR2 PREHIGH value. Return format is:

PREHIGH <level>;

PRELOW <level>

<level> ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Range: –2.5 — +1.9 V)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: –10.0 — +9.50 V)

Setting, (channel specific)

Sets the low level used by the PRELEVEL USER command.

NOTE

The same restrictions that govern the LOWlevel command settings must be observed when setting PRELOW command.

PRELOW?

Query/operational, (channel specific)

Returns the NR2 PRELOW value. Return format is:

PRELOW <level>;

TRAILedge <trailing edge time value>[:units]

trailing edge time value ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Ranges: ≤250ps, 800ps, or 1.8ns)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s)(Range: 5.0 ns — 10 ms) in ranges (see the LEADedge command)

Setting, (channel specific)

PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s)

Sets the trailing edge parameter and hence the leading edge parameter since they are the same. The trailing edge is selected from one of the following three fixed transition times.

0.25ns

0.80ns

1.8ns

The fast output trailing edge is always equal to the leading edge.

PG 2012 Channel 2 and PG 2011 single or dual variable-transition channel(s)

Sets the trailing edge parameter for the selected channel. This parameter can be linked to the leading edge time using the tracking command. If the command is TRACKING EQUAL and a TRAILedge command is sent, then the leading edge time will be made equal to the trailing edge time. See the LEADedge command for additional information.

TRAILedge?

Query/operational, (channel specific)

Returns the NR3 value of the pulse trailing edge time. Return format is:

TRAIL <trailing edge time value>;

TRANsition **<leading edge time>, <trailing edge time>**

leading edge time ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Ranges: 0.25ns, 0.80ns, or 1.8ns)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: 5.0 ns — 10 ms)

trailing edge time ::= <NRf> PG 2012 Channel 1 and PG 2010 single or dual fast-edge channel(s) (Ranges: 0.25ns, 0.80ns, or 1.8ns)

<NRf> PG 2012 Channel 2 and PG 2011 single or dual variable-edge channel(s) (Range: 5.0 ns — 10 ms)

Setting, (channel specific)

The TRANsition command is an alias for the LEADedge and TRAILedge commands.

PG 2012 Channel 1 and PG 2010 single or dual fast-edge channels. The fast output leading edge and trailing edge are always the same.

PG 2012 Channel 2 and PG 2011 single or dual variable-transition channels. Because both of these parameters must be in the same range, this command will allow the user to look at them at the same time.

TRANsition?

Query/operational

Returns the NR3 values of the transition parameters for the leading and trailing edges.

Return format is:

TRAN <leading>, <trailing>;

This query will not be in the set query.

TRACKing **OFF|EQUal**

Setting, (channel specific)

This command is applicable to PG 2012 Channel 2 and PG 2011 dual or single channel(s).

This command controls the relationship between the leading edge and the trailing edge.

If the argument is OFF, the leading and trailing edges can have separate values. If the range relationship between the leading and trailing edges is violated, then an error is returned.

If the argument is EQUal then the trailing edge time tracks the leading edge time.

TRACKing?

Query/operational, (channel specific)

Returns the value of the TRACKing parameter. Return format is:

TRACK {OFF|EQU};

COMPlement ON|OFF

Setting, (channel specific)

NOTE

This command is only for PG 2012 Channel 2 and PG 2011 dual or single channel(s).

If the complement is set to ON, then the output pulse is complemented at the output.

COMPlement?

Query/operational, (channel specific)

Returns whether or not the output pulse is complemented. Return format is:

COMP {ON|OFF};

COMPOUT ON|OFF

Setting, (channel specific)

NOTE

This command is applicable only to PG 2012 Channel 1 and PG 2010 dual or single channel(s).

If the complement is set to ON, then the PG 2012 $\overline{\text{CH1}}$ or PG 2010 complementary pulse output(s) are available.

Sending this command to PG 2012 Channel 2 or PG 2011 channel(s) will generate an error message.

COMPOUT?

Query/operational, (channel specific)

Returns the complement output status. Return format is:

COMPOUT {ON|OFF};

OUTput **ON|OFF**

Setting, (channel specific)

The OUTput command connects the pulse signal to the output connector. If the argument is ON, then the output is enabled. If the argument is OFF, then the output is disabled.

OUTput?

Query/operational, (channel specific)

Returns the output parameter. Return format is:

OUT{ON|OFF};

System Commands

CHAnnel 1|2

Setting

Selects the channel that channel specific commands will set or query. The argument 1 is for channel 1 and the argument 2 is for channel 2. If the dual channel option is not installed, then CHAnnel 1 is the only valid argument.

CHAnnel?

Query/operational

Returns the selected channel for channel specific commands. Return format is:

CHA {1|2};

ENHACCuracy ON|OFF

Setting

When activated (ON) instrument utilizes internal counter and DVM circuits to optimize the accuracy of the following pulse parameters: Period, Width, Delay, High Level, and Low Level.

ENHACCuracy?

Query/operational

Returns the current staus of the Enhanced Accuracy function. Return format is:

ENHACC {ON|OFF};

TEXT **<string data>**

string data ::= "ascii characters" (number of characters ≤100)

Setting

Opens a text window in the display that has two lines with a total of 100 characters. A double quote ("") in the string will print a quote. A \n in the string will go to the next line. If the display is overrun (more than 100 characters), it will silently truncate the string sent so that it will fit in the display. If a line is greater than 50 characters and \n is not in the string, the display will wrap to the next line.

The text window will remain on the screen until a key is pressed or TEXT "" is sent.

ABSTOUCH <key number>

key number ::= <NRf>(Range: 0 — 60. If not a whole number, will round to whole number)

Operational

The ABSTOUCH command will insert a keystroke into the front panel input buffer and simulate the pressing of a key.

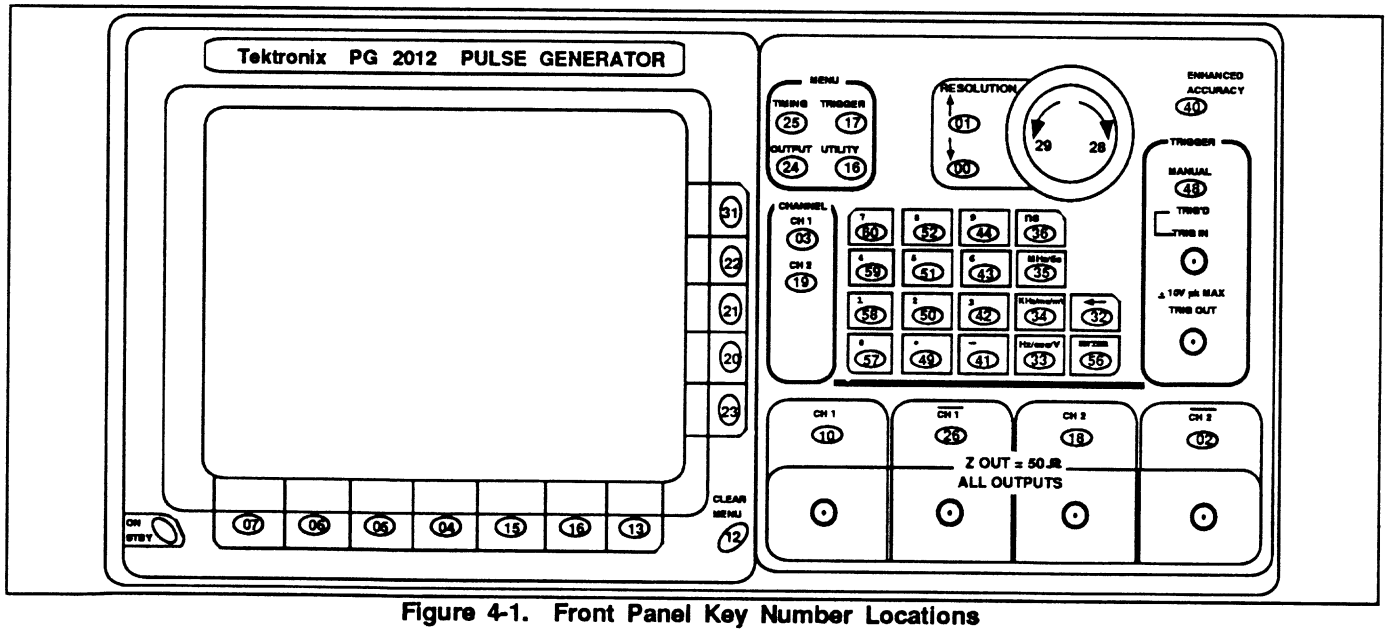


Figure 4-1. Front Panel Key Number Locations

Buffered Settings Control

RECall **<buffer number>**

buffer number ::= <NRf> (Range: 0 - 99)

Operational

Puts the instrument into a state previously saved using the STORE command. The buffer number is the buffer in which the instrument settings were stored.

STOBuff? **<buffer number>{[, <buffer number>]}...|ALL**

buffer number ::= <NRf> (Range: 1 — 99)

Operational

Returns the contents of the selected setting storage buffer(s). Each buffer will be returned in separate binary block format. The query will return the settings in a format that constitutes a valid STORe command ready to be sent back to the instrument.

STORe **<buffer number>|{<buffer number>:<binary block settings>{[,<buffer number>:<binary block settings>]}...}|ALL:<all binary block settings>**

buffer number ::= <NRf> (Range: 1 — 99)
binary block setting ::= binary block data
all binary block settings ::= {binary block setting}... (99 settings buffers)

Operational

Stores settings into the buffer using one of the two methods:

(1) The present settings are stored if only the buffer number is sent.

(2) If the buffer number is followed by a binary block setting, then the binary block setting is loaded into the buffer.

If ALL is the first argument, then it is expected that 99 setting buffers will follow with no delimiter between each buffer. This will load all the buffers.

INIT

Operational

Puts the instrument into the power on state. The power on state will depend on the value of the power on buffer (set by the PONBUF command). If the power on buffer is set to 0, then the instrument will power on to the factory default settings.

If the PONBUF setting is CURRENT and INIT is sent, buffer 0 will be used for the setting instead of the current settings.

PONBUFfer <buffer number>|CURRENT

buffer number ::= <NRf> (Range: 0 — 99)

Setting

Sets the buffers which will be used to load the power on default settings. If the buffer number is 0, then the factory defaults will be loaded. If the buffer number is 1 — 99, then the settings in that buffer will be used to load the power on default settings.

If the argument is CURRENT, then the setting at power off will be restored.

PONBUFfer?

Query/Operational

Returns the NR1 value of the power on buffer number. Return format is:

PONBUF {<buffer number>|CURRENT};

GPIB Control

DT **TRIG|GATE|SET|OFF**

Setting

Selects the function to be triggered by a Group Execute Trigger.

If TRIG is the argument, then a trigger will be produced and ORed with the selected trigger source. If the instrument is in trigger mode, then one cycle of the selected waveform will be output.

If GATE is the argument and the instrument is in GATE mode, then sending *GET* will toggle the gate from on to off or off to on.

If the argument is SET, then any setting commands will hold off execution until *GET* is received. This allows synchronization of the settings of a number of instruments.

If the argument is OFF, then *GET* is ignored by the instrument except a "GET ignored" SRQ is sent to the controller.

DT?

Query/Operational

Returns the value of the DT command. Return format is:

DT {TRIG|GATE|SET|OFF};

ID?

Query/Operational

Returns the instrument model number, codes and formats version number, firmware version number and any installed options. Return format is:

ID TEK/PG201X, V81.1, F1.0[,<two channels>];

ERRor?
EVEnt?
ERRM?

Operational

The ERRor? and EVEnt? commands report any pending errors. In the case of multiple errors in the error queue, the oldest error will be reported first, then the highest priority error will be reported.

If the command is ERRM?, then a one line error message will be appended to the error number.

Return format is:
ERR <error number>;<NR1>

Return format is:
EVE <event number>;<NR1>

Return format is:
ERRM <error number><NR1>, <error message>;<NR1>

The reporting of errors follow these rules:

1)If RQS is ON, then the instrument will report ERROR 0 until a serial poll is performed. This insures synchronization of the serial poll response byte and the error message.

2)If RQS is ON, more than one error needs to be reported, and two serial polls are sent before the ERROR? is sent; then the error reported will match the last serial poll response byte that was sent. The first error message will be lost.

3)If RQS is OFF, then the ERRor? query will return the next error in the queue that needs to be reported.

HELP?

Operational

Returns the header of all valid GPIB commands. Return format is:

HELP {<command header> {[,<command header>]}...};

RQS ON|OFF

Setting

Enables or disables the report of an error or event using the SRQ interrupt.

When RQS is ON, then an event will be reported using *SRQ* and will hold off report of the error using the ERROR? until a serial poll is performed.

When RQS is OFF, then an event will be reported using EVEnt? or ERRor? and *SRQ* will not be asserted. If a serial poll is performed, then STAB (STATUS BYTE) will be 128.

RQS?

Query/Operational

Returns the value of the RQS parameter. Return format is:

RQS {ON|OFF};

SET?

Query/Operational

Returns all parameters that can be set using the GPIB interface except OUTlevel?, TRANsition?, and PULSE?. The format allows the response from the SET? to be sent back to the instrument and place the instrument in the same state as it was at the time the SET? was first sent.

Return format is:

{<query response>;}...

USEReq ON|OFF

Setting

The USEReq command allows the pressing of the ID button to be reported over the GPIB interface. Depending on the state of the RQS parameter the USER event could be sent as a response to the EVEnt? and or as a response to a serial poll.

USEReq?

Query\Operational

Returns the value of the USEReq parameter. Return format is:

USER {ON|OFF};

Calibration Commands

INTCAL

Operational

Performs an internal calibration of the period, width, delay, high level, and low level parameters to optimize performance at the current ambient temperature. The output is disabled while the calibration is being done. The instrument must have been powered up for at least 20 minutes before sending this command.

Event/Error Codes

Following is a list of event/error codes for the instrument:

Error Type	SRQ Status Bytes			
	BUSY Bit = 0		BUSY Bit = 1	
	Decimal	Hex	Decimal	Hex
Command Error	97	61	113	71
Execution Error	98	62	114	72
Internal Error	99	63	115	73
Internal Warning	102	66	118	76
Event Type				
Nothing to Report	0	0	16	10
Power On	65	41	81	51
User Request	67	43	83	53
Syntax and limit	192	C0	208	D0

This section is in the format:

Error Number Error Message
Error Description

Events

0 — Nothing to report SRQ Byte = 0

90 — Incorrect syntax SRQ byte 192

Command Error Group (100) SRQ byte = 97

101 — Command header error

The keyword of the command is unknown or misspelled.

102 — Header Delimiter Error

The delimiter between the header and the argument is the wrong character or missing.

103 — Command argument error

This is a generic error for an argument that is incorrect in some way. The most likely use will be an unrecognized argument.

104 — Argument delimiter error

The delimiter between two arguments is the wrong character.

105 — Non numeric argument

Instrument received a non-numeric character when a numeric argument was expected.

106 — Missing argument

One of the arguments of the command is missing.

107 — Invalid message unit delimiter

The delimiter between two commands is the wrong character or missing.

108 — Checksum error

A binary block argument has an incorrect checksum byte or the calculated checksum is different from the checksum byte.

109 — Bytecount error

The number of bytes in a binary block argument does not match the byte count sent with the argument. (The message terminator was received before the number of bytes in the byte count was received.)

Execution Errors (200) SRQ byte = 98

201 — Command not executable in local

A command cannot be executed because the instrument is under local control. This includes all of the commands that control the setting of the instrument. It does not include queries, *RQS?* or *USEREQ?*.

202 — Settings lost due to rtl

The local button was pressed while a command was being set or executed.

203 — Output buffer full

The input and output buffers are full, causing a possible deadlock; the output buffer has been dumped.

204 — Setting conflict

An attempt has been made to execute a command that conflicts with the current mode of operation.

205 — Argument out of range

A numerical argument is out of the range of the instrument. This is a generic error to catch the errors that do not have a specific error code assigned.

206 — Group execute trigger (GET) ignored

A Group Execute Trigger was ignored because DT was set to OFF.

250 — Period out of range

The period is set to a value out of range (range: 20 ns (40 ns in double pulse mode) — 10 s).

254 — Channel 2 option not installed

A function was accessed that required the use of channel 2, and channel 2 is not installed.

255 — Illegal setting buffer

A stored buffer has been received that is out of range (range: 0 — 99).

256 — Complementary output error

Complementary output not available

261 — Illegal key

A non-existent key number was specified in an ABSTOUCH command.

270 — NBURST out of range

The number of cycles specified for the NBURST argument is out of range (range: 2 — 999,999).

271 — TRIGGER RATE out of range

The TRIG RATE argument is out of range (range: 100 ns — 99.99 s).

PG 2010 and PG 2012 CH1

274 — Peak to Peak amplitude out of range

The amplitude is set greater than 2.5 V peak-to-peak or less than 0.6 V peak to peak.

275 — High level out of range

The high level is set to greater than +2.5 V or less than –1.2 V.

276 — Low level out of range

The low level is set to less than –2.5 V or greater than +1.9 V.

279 — Leading/trailing not in the same range

The leading and trailing edge transition time is out of range (selectable ranges: ≤250ps, 800ps, and 1.8ns).

PG 2011 and PG 2012 CH2

274 — Peak to Peak amplitude out of range

The amplitude is set greater than 10 V peak-to-peak or less than 0.5 V peak to peak.

275 — High level out of range

The high level is set to greater than +10.0 V or less than –9.50 V.

276 — Low level out of range

The low level is set to less than –10.0 V or greater than +9.50 V.

277 — Leading edge out of range

The leading edge transition time is out of range (range: 5.0 ns — 10 ms).

278 — Trailing edge out of range

The trailing edge transition time is out of range (range: 5.0 ns — 10 ms).

279 — Leading/trailing not in the same range

The leading and trailing edges are in different ranges. The ranges are:

5.0 ns — 100 ns
50 ns — 1.0 µs
500 ns — 10 µs
5 µs — 100 µs
50 µs — 1.0 ms
500 µs — 10 ms

281 — Width out of range

The width plus the delay exceeds the maximum duty cycle of the instrument (range: 10 ns — 9.90000 s).

282 — Delay out of range

The delay specified is out of range (range: 0 — 9.89990 s).

283 — CH(1|2): Width + Delay > 99% period

The width plus the delay exceeds the period of the instrument.

284 — CH (1|2): Period - (Width + Delay) ≤ 8 ns

The width plus the delay does not allow enough settling time before the next period begins.

285 — Delay ≤ Width in double pulse mode

The delay is less than the pulse width in double pulse mode.

286 — Delay ≤ Width plus reset time.

There is not enough time between the first pulse and the delayed pulse (delay plus width plus reset time).

289 — Trigger level out of range

The trigger level argument is out of range (range: –9.99 — +9.99 V).

PG 2010 and PG 2012 CH1

291 — High level ≤ low level

The difference between the high level and low level is less than 0.6 V and/or the high level is less than the low level.

292 — High level - Low level < 0.6 V

The difference between the high and low levels must be more than 0.6 V.

293 — High level out of limit

The high level parameter is out of limit (range: –1.2 — +2.5 V).

294 — Low level out of limit

The low level parameter is out of limit (range: –2.5 — +1.9).

PG 2011 and PG 2012 CH2

291 — High level ≤ low level

The difference between the high level and low level is less than 0.5 V and/or the high level is less than the low level.

292 — High level - Low level < 0.5 V

The difference between the high and low levels must be more than 0.5V.

293 — High level out of limit

The high level parameter is out of limit (range: –9.50 — +10.0 V).

294 — Low level out of limit

The low level parameter is out of limit (range: –10.0 — +9.50).

295 — Leading edge conflicts with width

The pulse Width value must be greater than 1.3 times the leading edge value.

296 — CH (1|2): Trailing edge conflicts with off time

297 — Period > internal rate

299 — Calibration available after 20 minutes from power on

Self calibration is not available until after the required 20 minute warmup period.

Internal Errors (300) SRQ byte = 99

350 — Error queue overflow

360 — Save RAM failure

System Events (400) SRQ byte is dependent on error number

401 — Power on (SRQ byte = 65)

This message is issued when the instrument is powered up.

403 — User request (SRQ byte = 67)

The user request function is on and the ID button was pressed.

Internal Warnings (600) SRQ byte = 102

650 — Low battery condition

The battery voltage is low.

800 Store binary block error SRQ byte = 98

A binary block settings buffer packet is bad. The number of the error is the number of the bad buffer packet + 800.

SECTION 5
SPECIFICATION

Electrical Characteristics

Performance Conditions

The limits stated in the Performance Requirements column are valid only if the PG 2010/PG 2011/PG 2012:

- Is allowed 20 minutes warm-up time for operation to specified accuracy; 60 minutes after exposure to or storage in high humidity (condensing) environment.
- Has been calibrated at an ambient temperature between 20 — 30° C and is operating at an ambient temperature between 0° C and +50° C, unless otherwise stated.
- *INTERNAL CAL* has been performed at the current operating temperature (±5° C).
- Is in a non-condensing environment whose limits are described under "Environmental".
- ENHANCED ACCURACY function is active.
- Main outputs are terminated into a 50 Ω load.
- Normal and complement outputs of instrument are terminated into 50Ω.
- Leading and trailing edges are set to the minimum transition time, unless otherwise specified.

NOTE

Specifications are valid with only those connections to the instrument that are required to verify each specification.

Any conditions that are unique to a particular characteristic are expressly stated as part of that characteristic.

The electrical and environmental performance limits together with their related validation procedures comprise a complete statement of the electrical and environmental performance of a calibrated instrument.

Items listed in the Performance Requirements column of the following tables are verified by completing the Performance Check Procedure (see section 6). Items listed in the Supplemental Information column may not be verified in the manual; they are either explanatory notes or performance characteristics for which no limits are specified.

Table 5-1
Period

Note
Period generator is common to both channels.

Characteristic	Performance Requirement	Supplemental Information
Range: Single Pulse Double Pulse	 20ns — 10.0s (Repetition rate: 50MHz — 0.1Hz) 40ns — 10.0s in Paired Pulse per period mode (Repetition rate: 25MHz — 0.1Hz.)	
Accuracy	±1% of setting ±1ns	Measured at 50% point of rising edge of Trig Out pulse
Resolution		Up to 6 digits limited to 0.1ns
Jitter (rms)		≤(0.05% of setting + 30ps) On fastest range, decreasing to ≤0.01% on slowest range

Table 5-2
Width

Note
Width is independent for each channel.

Characteristic	Performance Requirement	Supplemental Information
Range	10ns — 9.90000s limited by 8ns of off time	
Resolution		Up to 6 digits limited to 0.1ns
Accuracy	±2% of setting ±2ns	Measured at 50% point of leading and trailing edges set to fastest transition time
Jitter (rms)		≤(0.05% of setting + 30ps) decreasing to 0.005% on slowest range.
External Width		Pulse period and width is determined by the external trigger signal and the trigger level and slope settings

Table 5-3
Delay

Note
Delay is independent for each channel.

Characteristic	Performance Requirement	Supplemental Information
Range	0 ns — 9.89990s	
Resolution		Up to 6 digits limited to 0.1 ns
Accuracy	±2% of setting ±2 ns	Measured from 50% point of leading edge of Trig Out pulse to 50% point of leading edge of output pulse set to the fastest transition time
Jitter (rms)		≤(0.05% of setting + 30 ps) Decreasing to 0.005% on slowest range.

Table 5-4
Duty Cycle Performance

Note
Duty cycle is independent for each channel.

Characteristic	Performance Requirement	Supplemental Information
Range	1 — 99%	Duty Cycle may be programmed with DUTY function key, or through GPIB.
Accuracy		Accuracy is limited by width and period accuracy.
Resolution		Square Wave is not selectable directly as a mode; use DUTY = 50%. Resolution is 0.1% (3 digits) Duty Cycle setting interacts with Width setting. Pulse width is set according to WIDTH or DUTY, whichever has been programmed most recently. When DUTY is used to set Width, Delay remains active, subject to limitations expressed in the *Performance Requirements* equations following this table. When DUTY is used to set Width, Width will change whenever Period is changed, subject to limitations expressed in the *Performance Requirements* equations following this table.

Performance Requirements

The following formulas express the limits on Period, Width, and Delay.

Single Pulse per Period Modes

(Undelayed, Delayed, Counted Burst with single pulse mode)

Period - (Width + Delay) must be > 8ns
0.99 * Period must be > (Width + Delay)

Pulse max = 10.00s
Pulse min = Width + Delay + 8ns, but not less than 20ns
Width max = (Period * 0.99) – Delay – 8ns, but not more than 9.90000s
Width min = 10 ns
Delay max = (Period * 0.99) – Width – 8ns, but not more than 9.89999s
Delay min = 0

Single Pulse Transition Time Restrictions

Width must be > 1.3 * Leading Edge
Period – Width must be > 1.3 * Trailing Edge

Double Pulse per Period Modes

(Paired Pulse and Counted Burst with Paired pulses)

Delay must be > Width
0.99 * Delay must be > (Width + 8ns)

Pulse max = 10.00 S
Pulse min = Width + Delay + 8ns, but not less than 40ns
Width max = (0.99 * Delay) – 8ns, but not > 4.90000s
Width min = 10 ns
Delay max = (Period * 0.99) – Width - 8ns, but not > 9.89999s
Delay min = Width + 8ns

Double Pulse Transition Time Restrictions

Width must be > 1.3 * Leading Edge
Delay – Width must be > 1.3 * Trailing Edge
Period – (Delay + Width) must be > 1.3 * Trailing Edge

Internal Trigger Burst Mode

0.99 * Trig Rate must be > Period * Burst Count

Table 5-5
Transition Time

PG 2010 Dual or Single Channel and PG 2012 CH 1

Characteristic	Performance Requirement	Supplemental Information	
Minimum Transition Time	≤ 250ps (20% to 80%) Typ 200ps	Measured with 1.0V p-p into 50Ω	
Selectable transition time (independent for each channel)		Measured with 2.5V p-p into 50Ω	
		Selectable Transition	**Typical Transition**
		800ps (10% to 90%)	650ps - 800ps rising and 550ps - 800ps falling
		1.8ns (10% to 90%)	1.6 - 1.8ns rising and 1.5 - 1.8ns falling

Table 5-6
Transition Time

PG 2011 Dual or Single Channel and PG 2012 CH 2

Characteristic	Performance Requirement	Supplemental Information
Minimum Transition Time	≤ 5.5ns	Measured at +5V HILEVEL, –5V LOLEVEL
Transition time (independent for each channel)	Variable: 5.0ns — 10ms	Measured at +5V HILEVEL, –5V LOLEVEL
	Leading edge and trailing edge settable separately. Limited to 20:1 ratio between settings, and both settings must be within any one of the following ranges: 5.0ns — 100ns 50ns — 1.0µs 500ns — 10µs 5.0µs — 100µs 50µs — 1.0ms 500µs — 10ms	Tracking Mode: Leading = Trailing
Resolution		3 digits, limited to 0.1ns
Accuracy	±5% of setting ±2ns measured between 10 — 90% points	≤5% for transition time ≥10ns
Linearity		Between 10 — 90% points, waveform voltage deviates from straight line by less than 5% of [v(90%) - v(10%)] at +5V HILEVEL, –5V LOLEVEL

Table 5-7
Amplitude

PG2011 Dual or Single Channel and PG2012 CH 2

Note
Amplitude specifications are for each channel, with an accurate (0.1%) 50 Ω load installed.

Characteristic	Performance Requirement	Supplemental Information
High level range	–9.50 — +10.0 V, into 50 Ω load.	Typically –19.00 — +20.00 V, into output open circuit
Low level range	–10.0 — +9.50 V, into 50 Ω load.	Typically –20.00 — +19.00 V, into output open circuit
Pulse amplitude range	0.5 V minimum into 50 Ω load 10 V P-P maximum into 50 Ω load	1 V P-P minimum into open circuit 20 V P-P maximum into open circuit
Resolution		3 digits limited to 10 mV
Accuracy: (HIGHlevel or LOWlevel)	±1% of level setting ±2% of P-P amplitude ±50 mV into 50 Ω load	P-P Amplitude Accuracy = ±4% ±100 mV
Aberrations	≤ ±5% + 50 mV into a 50 Ω load for pulse levels between ±5 V.	Measured at 5.5ns transition time
Settling Time		<18ns + transition time. (Settling time is the interval required for the pulse level to enter and remain in the specified accuracy range measured from the 90% point on the leading edge or the 10% point on the trailing edge.)
Output Source Resistance		50 Ω ±2.5 Ω

Table 5-8
Amplitude

PG2010 Dual or Single Channel and PG2012 CH 1

Characteristic	Performance Requirement	Supplemental Information
High level range	–1.2 V — 2.5 V into 50Ω load	The window within which the 2.5 V pulse may be positioned can be increased by varying the load termination voltage. Care should be taken to insure that –4 V <V_o <+6 V. The outputs can typically switch up to 5 V when driving a high impedance load thus providing CMOS or TTL compatibility. Aberrations are not specified under these conditions. Termination impedances should be equal for both normal and complement outputs on each channel.
Low level range	–2.5 V — 1.9 V into 50Ω load	
Pulse amplitude range	0.6 V minimum into 50Ω load 2.5V maximum into 50Ω load	
Resolution		3 digits limited to 10 mV
Accuracy: (HIGHlevel or LOWlevel)	±1% of level setting ±2% of P-P amplitude ±50 mV into 50Ω load.	P-P amplitude accuracy = ±4% ±100 mV
Aberrations	First 1.5 ns (2.5 ns for 1.8 ns transition) of pulse ≤10% p-p for p-p voltages ≥1.25 V. <150 mV p-p for p-p voltage <1.25V.	Into 50Ω load.
Pulse Top Flatness	Flat to within 5%, beginning 1.5 ns (2.5 ns for 1.8 ns transition) after transition at 1.25 V p-p amplitude.	Into 50Ω load.
Output Source Resistance		50Ω ±6Ω

Table 5-9
Amplitude Performance Requirements

Note

With menu, or through GPIB, the following output level settings may be selected:

TTL: V(low)=0.4 V; V(high)=2.4 V, into 50 Ω load
†CMOS: V(low)=0.0 V; V(high)=5.0 V, into 50 Ω load
ECL: V(low)=-1.8 V; V(high)=-0.8 V, into 50 Ω load
USER: User defined values, recallable

† Not available in PG 2010 and PG 2012 CH1 due to output level limitations.

Table 5-10
Auxiliary Outputs

Characteristic	Performance Requirement	Supplemental Information
Trigger output levels	TTL Levels	Delay always measured from Trig Out rising edge 50% point $V_{low} \leq 0.2$ V into 50 Ω $V_{high} \geq 2$ V into 50 Ω
Width		Depends on mode: 10 — 20ns in Continuous mode
Output Resistance		Nominal 50 Ω
Risetime		3.5 ns typical

Table 5-11
Operating Modes

Characteristic	Performance Requirement	Supplemental Information
Continuous	Output continuous at programmed period rate.	
Triggered	Output quiescent until triggered by an internal, external, GPIB, or manual trigger; then generates one period cycle.	
Gated	Same as triggered mode except periods are output for the duration of the gated signal. The last period started is completed.	
Burst	Same as triggered mode for programmed number of period cycles from 2 to 999,999, as set by the N BURST function.	

Table 5-12
Triggering/Gating Input

Characteristic	Performance Requirement	Supplemental Information
Triggering/Gating Input:		
Sensitivity		150 mV p-p minimum, DC — 50 MHz
Minimum Input Pulse Width		10 ns; 150 mV amplitude required for triggering
Maximum repetition rate		50 MHz
Input Impedance		1 MΩ ±5%; ≈30 pf
Maximum Input Voltage		±10 V DC plus peak AC
Threshold:		
Range	±9.99 V	
Resolution		3 digits (10 mV)
Accuracy:	±5% of setting ±25 mV	
Slope Selection	(+) Positive slope for triggering, and positive-true for gating (–) Negative slope for triggering, negative-true for gating	
Counted Burst	2 — 999,999 cycles per burst	
Internal Trigger:		
Repetition Rate Range	100 ns — 99.99 s	
Resolution		Up to 4 digits, limited to 100 ns
Repetition Rate Accuracy	±0.01% ±1 ns	
Jitter		≤(0.1% of setting + 100 ps)

Table 5-13
Propagation Delays

Note
Propagation Delays are specified for each channel.

Characteristic	Performance Requirement	Supplemental Information
Trigger Output to Pulse Output Internal Duration Mode		Programmed delay is measured from Trig Out leading edge 50% point. See Delay section.
External Width Mode: Trigger to Output		30 ns typical
Trigger Input to Trigger Output EXT Trigger mode (fixed delay) TRIGGERED mode GATE mode BURST mode		45 ns typical
Channel synchronization	≤ 0.5 ns	(Dual channel only) Tested at the fastest transition time with 0 delay. At longer delays synchronization will be limited by delay accuracy specification

Timing Charts

Figs. 5-1 and 5-2 show how the instrument defines the various pulse parameters in the single and double pulse modes, respectively. Pulse parameters are specified and displayed with reference to the 50% point using the fastest transition times. As the transition time of the observed pulse increases the corresponding reference points approach the pulse start point.

Figures 5-3 — 5-8, illustrate the output and timing for each mode and function. These charts assume the instrument is set for the fastest transition time which is the reference used by the instrument when pulse parameters are specified and/or displayed.

Square waves are generated by setting the duty cycle at 50%.

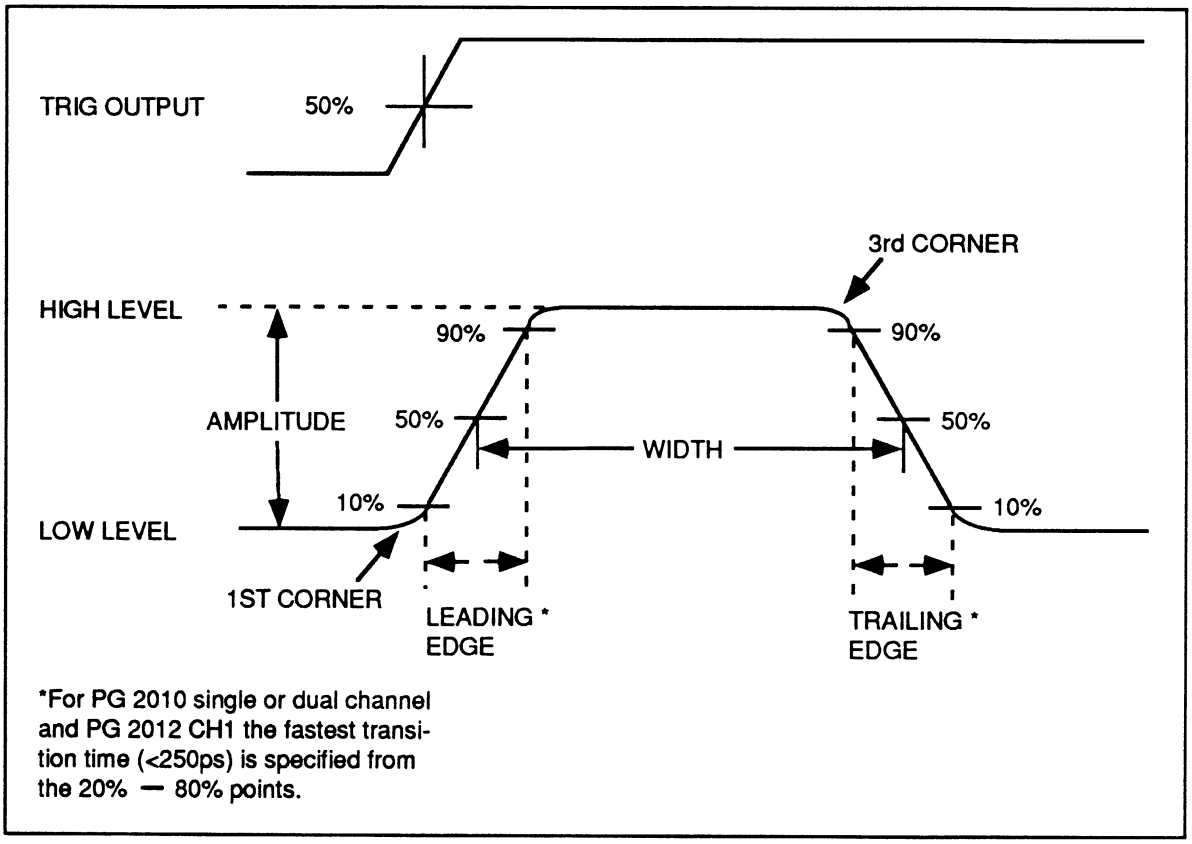


Fig. 5-1. Single Pulse Parameters.

Timing Charts (continued)

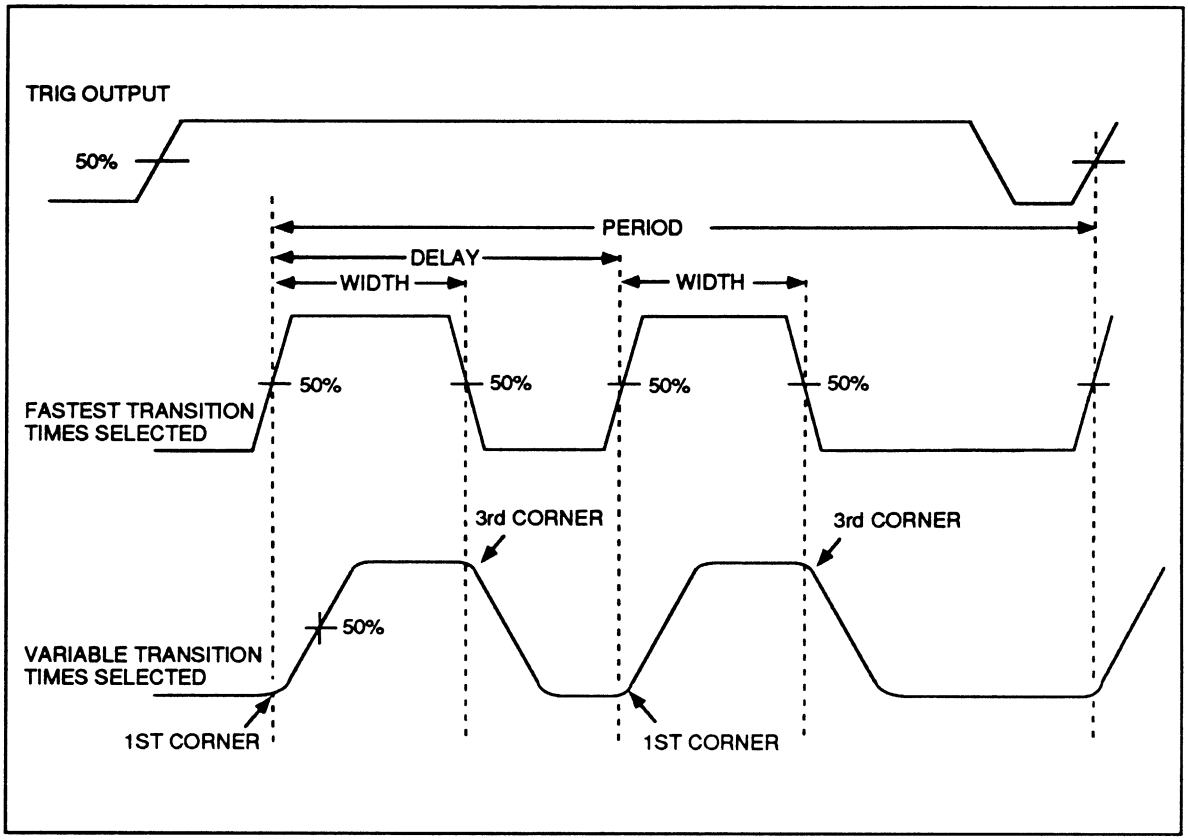


Fig. 5-2. Double Pulse Parameters.

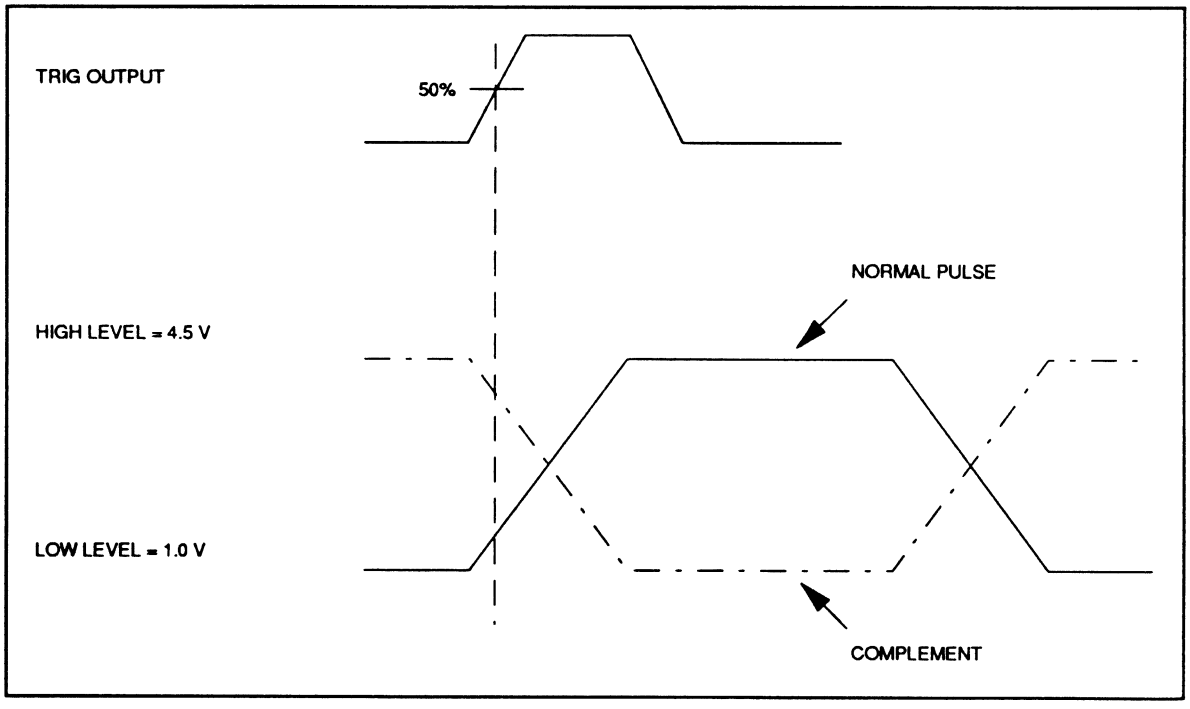


Fig. 5-3. Complement Pulse Parameters.

Timing Charts (continued)

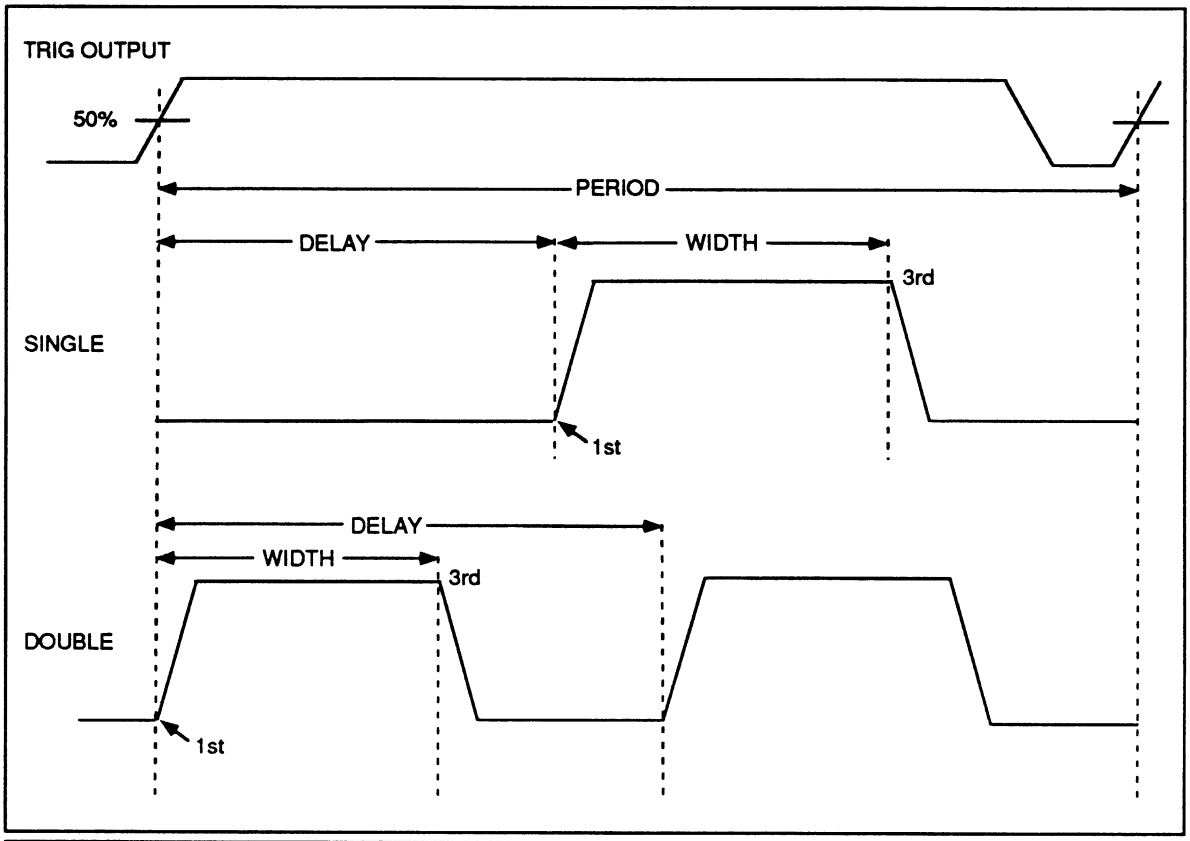


Fig. 5-4. Continuous Mode.

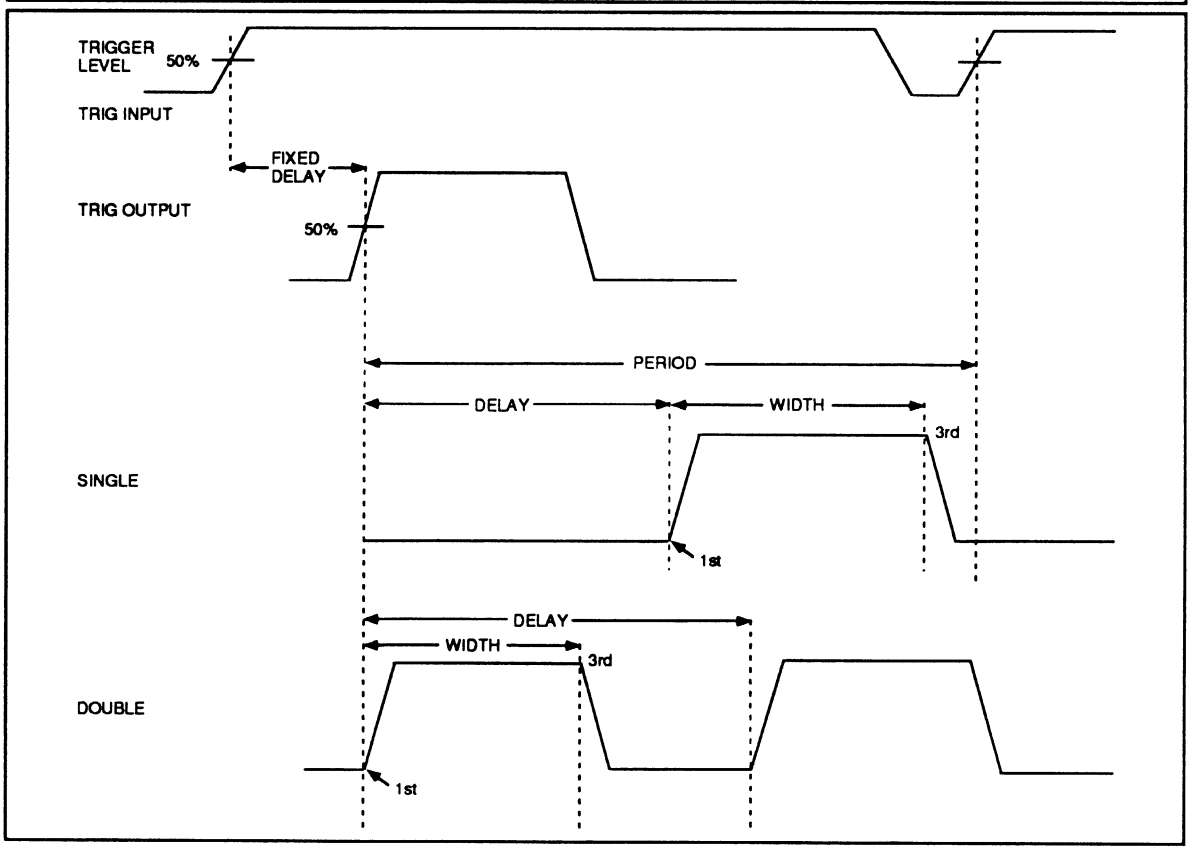


Fig. 5-5. Trigger Mode.

Timing Charts (continued)

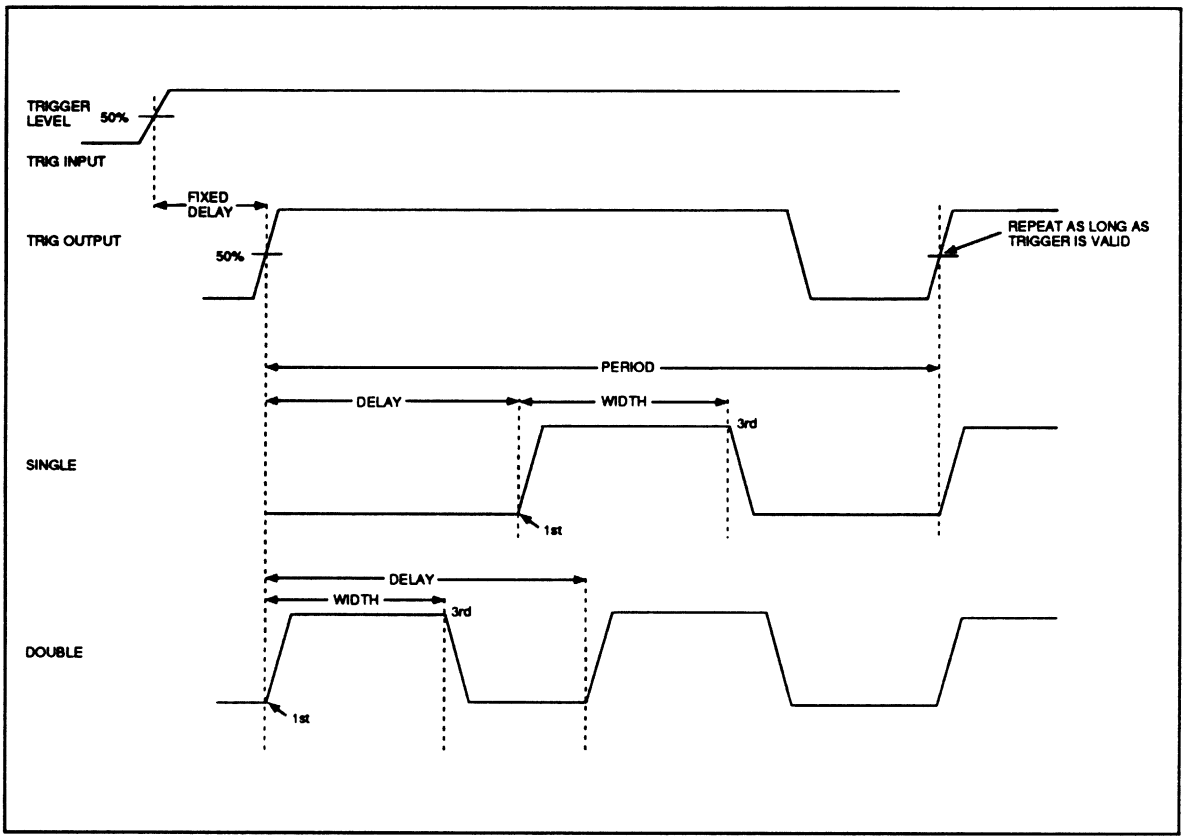


Fig. 5-6. Gated Mode.

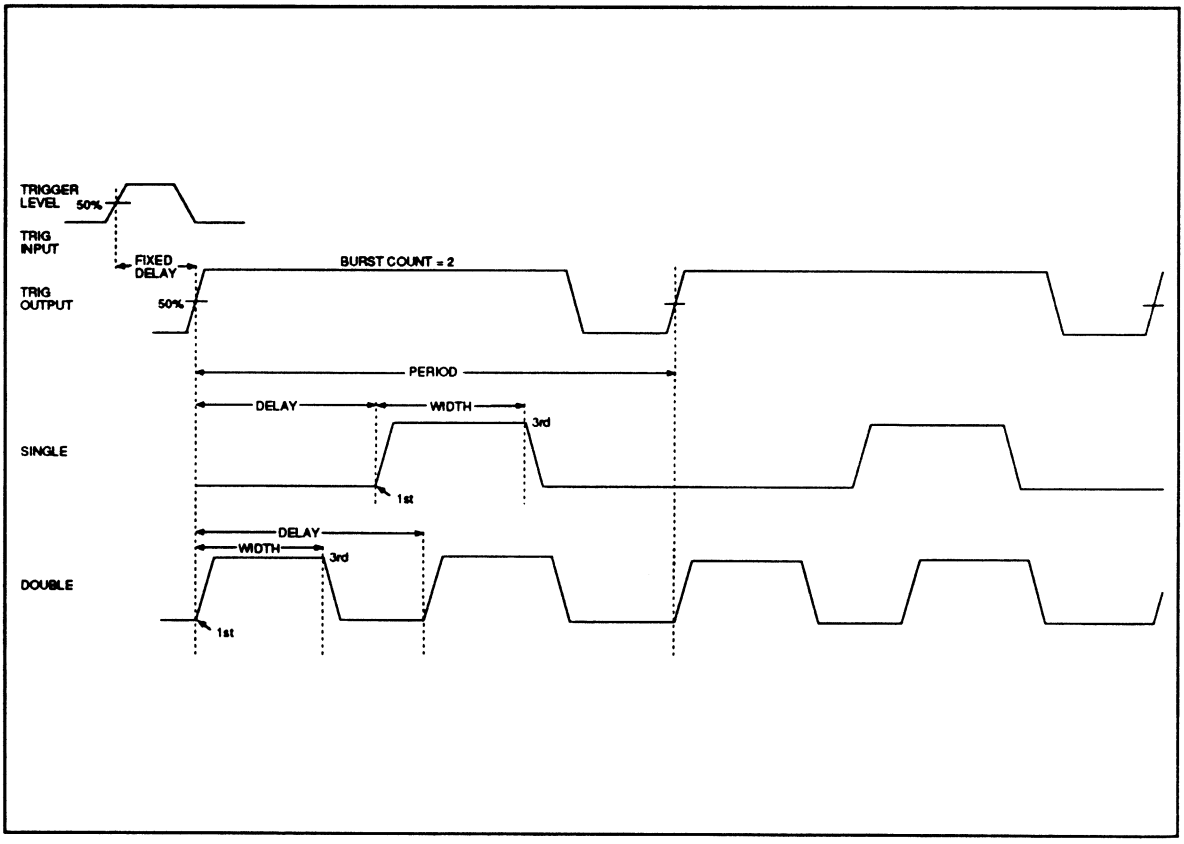


Fig. 5-7. Burst Mode.

Timing Charts (continued)

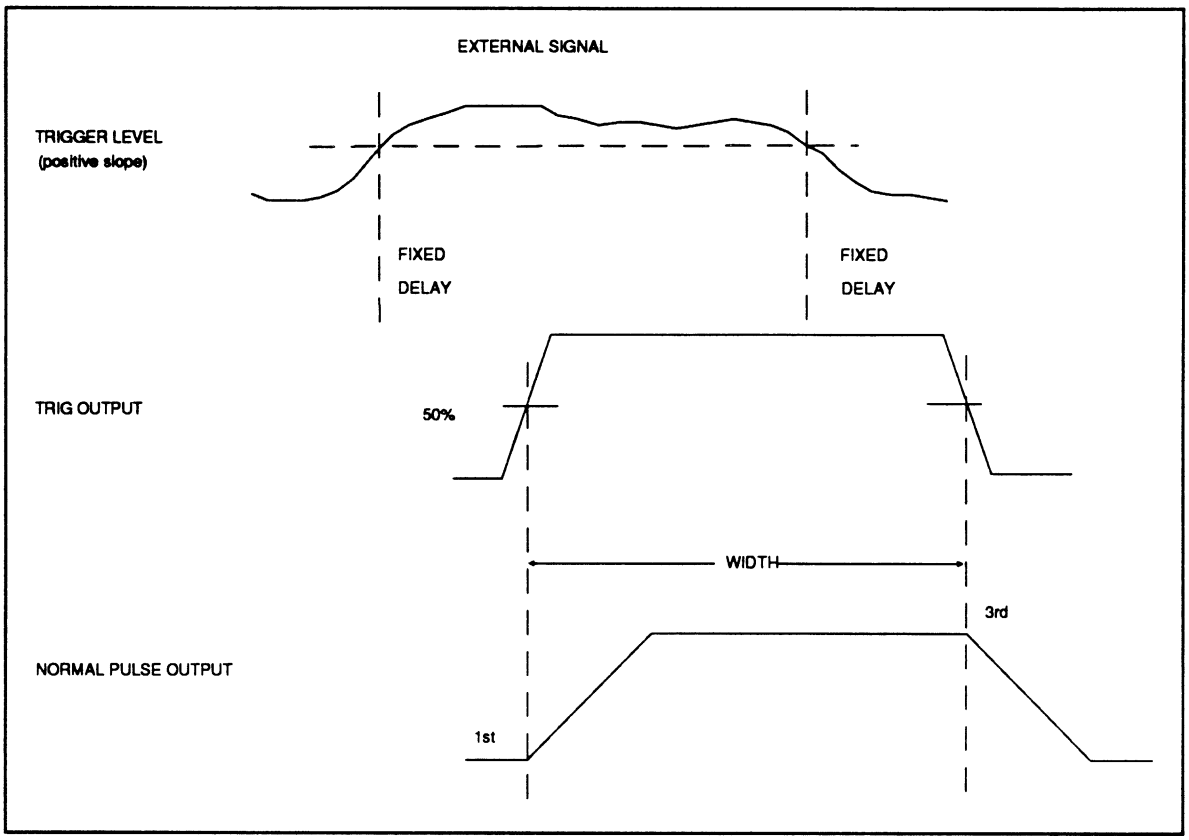


Fig. 5-8. External Width.

Table 5-14
GPIB Characteristics

Characteristic	Performance Requirement	Supplemental Information
Interface	Conforms to IEEE 488.1-1988	

Table 5-15
Source Power Requirement

Characteristic	Performance Requirement	Supplemental Information
Voltage Ranges		90 — 127Vac and 180 — 250Vac Voltage range is automatically selected
Line Frequency		48 — 63Hz

Table 5-16
Miscellaneous Electrical Characteristics

Characteristic	Performance Requirement	Supplemental Information
Fuse Data		1 fuse: 3 A, 250V medium blow — line power. (U.L. listed component) 1 fuse: 5 A, 125V fast blow. (U.L. listed component) 2 fuses: 1 A, 125 V fast blow. (U.L. listed component) 2 fuses: 3.15 A, 125 V, fast blow (U.L. listed component), each channel
Power Consumption		150W (Dual channel instrument)
Recommended Adjustment Interval		5000 hours or 1 year, whichever occurs first
Warm-up Time		20 minutes
Memory Backup Battery Life		5 years, typical (See Section 10 Maintenance for disposal information)

Physical Characteristics

Table 5-16
Environmental

Characteristics	Description	Supplemental Information
Temperature:		Meets MIL-T-28800D, Class 5
Operating	0 — 50° C	
Non-Operating	–20 — +60° C	Class 5 non-operating temperature exception due to internal keep-alive battery
Altitude		Exceeds MIL-T-28800D, class 5
Operating	4.6 km (15,000')	
Non-Operating	15 km (50,000')	
Vibration	0.38 mm (0.015") peak-to-peak, 5 Hz, 75 minutes	Meets MIL-T-28800D, class 5,
Shock	30 g's (1/2 sine) 11 ms duration, 3 shocks, in each direction along 3 axes, 18 total shocks	Meets MIL- T-28800D, class 5
Bench Handling	12 drops from 45°, 4" or equilibrium, whichever occurs first	Meets MIL-T-28800D, class 5
EMC	Tested within limits of F.C.C. Regulations, Part 15, Subpart J, Class A; VDE 0871 category B; and MIL-461B (1980) for RE01, RE02, CE01, CE03, RS01, RS03, CS01, CS02, and CS06	
Electrical Discharge		
Operating Maximum Voltage	15 kV, 150 pF through 150 Ω	
Non-Operating Maximum test voltage	20 kV, 150 pF through 150 Ω	
Safety Specifications	Conforms to the following safety standards:	
U.S.A.	UL1244 (Electrical and Electronic measuring and test equipment)	
Canada	CSA C22.2 No. 231	
International	IEC 348 (Electronic measuring apparatus)	

Table 5-17
Mechanical

Characteristic	Description
Finish:	
Front Panel	Polycarbonate
Chassis	Chromate conversion-coated aluminum
Net Weight	8.5kg (19lbs)
Overall Dimensions:	
Height	16.6cm (6.5")
Width (with handle)	34.4cm (13.5")
Length	48.2cm (18.9")
Enclosure Type and Style, per MIL-T-28800D	
Type	III
Style	C

SECTION 6
THEORY OF OPERATION

PG 201X Block Diagram Description

During the following description, refer to Fig. 14-1. The block diagram, Fig. 14-1, applies specifically to the PG2012 mixed channel version which has one fast channel output and one variable transition channel output.

The PG 2012 will be used as a reference for describing the PG 2010 or PG 2011 Instruments, which consist of either one or two fast output or variable transition channel outputs respectively.

The PG 2012 Instrument consists of the following assemblies:

- A1 MPU Board (Master Processing Unit)
- A2 Period Board
- A3 Width/Delay Board (one per channel)
- A4 Fast Output Board (Controls Pico-second Output Board)
- A5 Variable Output Board (Variable Transition Output Board)
- A6 Interconnect Board
- A7 Pico-second Output Board
- A8 Auxiliary Board
- A9 CRT Display Module
- A10 Front Panel Board
- A11 Power Supply

A1 MPU Board

The microprocessor circuits control all automatic and programmable instrument functions. The Intel 80188 processor is clocked at 8 MHz. Circuitry on the MPU board controls power-on reset, memory, (EPROM and battery-backed RAM), parallel interface, serial interface, video control, keyboard interface, and GPIB interface. The memory backup battery is located on this assembly

A2 Period Board

The Period board controls the repetition rate and the mode of the pulses generated by the subsequent Width/Delay board(s). Four modes of operation are available:

Continuous Mode	— Continuously generates pulses (free-running).
Triggered Mode	— An internal, external, or manual trigger event causes one pulse to be generated.
Gate Mode	— Pulses are continuously generated as long as the gate signal is true.
Burst Mode	— A group of pulses (selectable from 2 to 999,999) is generated .

Circuitry on the Period Board includes the period rate generator/counter, burst counter, trigger/mode select, internal trigger, and external trigger control circuits. The +5 V logic, +5 V MPU, and ECL termination power supplies are also developed on this board. An EEROM (located on this board) is used for storage of calibration constants for the Period board circuitry.

A3 Width/Delay Board

The Width/Delay board(s) produce either a single or a double pulse per period cycle depending on the selected mode of operation. Independent circuits provide the selected pulse width and pulse delay timing parameters. A differential "pulse" output signal is provided to the output board. An EEROM (located on this board) is used for storage of calibration constants.

A4 Fast Output Board — (PG 2010 and PG 2012 CH1 only)

The Fast Output board accepts the "pulse" output signals from the associated A3 Width/Delay board and provides all necessary control signals to drive the A7 Pico-second Output board. This includes high and low level control, signals to drive all output and transition control relays, as well as the output level self-calibration circuitry. +15 V, -15 V, +6.7 V, and -7.9 V power supplies

are also developed on this board. An EEROM (located on this board) is used for storage of calibration constants.

A5 Variable Output Board — (PG2011 and PG2012 CH2 only)

The Variable Transition Output board accepts the "pulse" output signals from the associated A3 Width/Delay board to produce the desired output pulses. Circuits control the high and low output levels, leading and trailing transition times, output relays, and output level self-calibration. +15 V, -15 V, and the high and low output level tracking power supplies are also developed on this board. An EEROM (located on this board) is used for storage of calibration constants.

A6 Interconnect Board

The Interconnect board is used for power supply distribution, serial and parallel data paths between boards, as well as board to board signal interfacing

A7 Pico-second Output Board — (PG2010 and PG2012 CH1 only)

The Pico-second output board accepts control signals from the associated A4 Fast Output board to develop the very fast output transitions. The output device is a GaAs pin driver IC. Relays control the signal path through the transition time filters to the output connector.

A8 Auxiliary Board

The Auxiliary Board has power line filtering circuitry as well as the primary line fuse, and main power switch. The Auxiliary board also routes DC power to both the cooling fan (+12 V) and the CRT display module (+15 V).

A9 CRT

This assembly is a complete video monitor device consisting of CRT and associated support circuitry.

A10 Front Panel Board

The front panel board contains the front panel switches and associated LED indicators as well as the rotary encoder and required multiplexing circuitry.

A11 Power Supply

The power supply module is a high-efficiency switching-mode power supply with four outputs: +8 V, +15 V, +30 V, and -30 V. This supplies the raw DC power which is re-regulated on the A2, A4, and A5 modules. High and low line switching (120V-240V)is done automatically.

PG 201X Power Distribution

Fig. 14-2 shows the internal power distribution for the PG 2012. The PG 2010 and PG 2011 consisting of either one or two Fast Output boards or Variable Transistion Output boards respectively are similiar. Q901 — Q906 are located on the instrument's rear heatsink.

SECTION 7
Performance Check Procedure

Introduction

This Performance Check is designed to increase user confidence that the PG 201X is functional. Should the PG 201X fail to meet any requirements of this check, it should be referred to qualified service personnel for repair. There are no operator adjustments inside the PG 201X.

Each function of the PG 201X (i.e. Amplitude, Period, Delay, etc.) operates in numerous bands or ranges. This Performance Check tests one or two values in each band or range. If a shorter check is desired, it is only necessary to check values near those used in the user application. Also, if desired, any other legal value can be tested, with appropriate test limits applied.

This Performance Check assumes the PG 2010 or PG 2011 has the dual channel option, Option 2, installed. If Option 2 is not installed, ignore all references to the second channel. The procedure for the PG 2012 will differ depending on which channel is being tested.

If a dual channel PG 201X returns an error while attempting to set the Period, it is probable that either the Width/Delay or Output menu is incorrectly set. The most likely error is that only one channel was changed to the latest values. It is important during this Performance Check that both channels 1 and 2 be set to the same values at all times.

Recommended Test Equipment

Description	Tektronix Part or Product Number
Frequency Counter	DC 5010
DC Digital Voltmeter (≤0.1%)	DM 504A
Oscilloscope (≥250 Mhz)	2465B
Sampling Oscilloscope	11801A†
50Ω coaxial cable (2 req'd)	012-0482-00
50Ω termination (2 req'd)	011-0049-01
50Ω precision termination	011-0129-00
50Ω 2X attenuator	011-0069-02
SMA male to BNC female adapter (2 req'd)	015-0554-00
BNC female to dual banana adapter	103-0090-00

†Required to verify risetime and aberration performance of PG 2010 and CH 1 of PG 2012.

Other equipment may be substituted, provided it meets necessary performance requirements for the checks. This procedure is developed for use with the Tektronix equipment listed above. The user is responsible for procedure and test result changes that may be required if different equipment is used.

Procedure

Before starting this check, turn on the PG 201X and set the RECALL Buffer to 0. Leave the instrument on for at least 20 minutes before starting this check. Then go to the UTILITY main menu and perform an INT calibration.

NOTE

*All checks **must** be made with the ENHANCED ACCURACY function active.*

1. Period Check

Instrument Setup:

PG 201X

Timing CH 1 & CH 2

WIDTH	10.0 ns
DELAY	0 ns
DUTY CYCLE	Off
PULSE MODE	Single
LEADING EDGE	5.0 ns
TRAILING EDGE	5.0 ns
PERIOD	20.0 ns

Output CH 1 & CH 2

HIGHLEVEL	+1.00 V
LOWLEVEL	–1.00 V
OUTPUT	Normal
EXTERNAL WIDTH	Off

Trigger

CONT

DC 5010

CH A&B

TERM	1 MΩ
SLOPE	+
ATTEN	X1
COUPL	DC
FUNCTION	PERIOD A
AVGS	–1

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X **CH1** on button to enable the channel 1 output.

c. Press AUTO TRIG on the DC 5010.

d. Set the period of the PG 201X to each of the values listed in column 1 of Table 7-1.

e. CHECK — DC 5010 display is within the min and max values listed in columns 2 and 3.

NOTE

It is not necessary to repeat this test for channel 2, as the period generator is common to both channels.

Table 7-1

PG 201X† Period Setting	DC 5010 Reading Limits	
	Min	Max
20.0 ns	18.8 ns	21.2 ns
38.0 ns	36.6 ns	39.4 ns
50.0 ns	48.5 ns	51.5 ns
100.0 ns	98.0 ns	102.0 ns
200.0 ns	197.0 ns	203.0 ns
400.0 ns	395.0 ns	405.0 ns
800.0 ns	791.0 ns	809.0 ns
1600.0 ns	1.583 µs	1.617 µs
3200.0 ns	3.167 µs	3.233 µs
6400.0 ns	6.335 µs	6.465 µs
12.8000 µs	12.671 µs	12.929 µs
25.0000 µs	24.749 µs	25.251 µs
50.0000 µs	49.499 µs	50.501 µs
100.000 µs	98.999 µs	101.001 µs
200.000 µs	197.999 µs	202.001 µs
400.000 µs	395.999 µs	404.001 µs
800.000 µs	791.999 µs	808.001 µs
1600.00 µs	1.584 ms	1.616 ms
3200.00 µs	3.168 ms	3.232 ms
6400.00 µs	6.336 ms	6.464 ms
12.8000 ms	12.67 ms	12.92 ms
25.0000 ms	24.75 ms	25.25 ms
100.000 ms	99.00 ms	101.00 ms
200.000 ms	198.00 ms	202.00 ms
400.000 ms	396.00 ms	404.00 ms
800.000 ms	792.00 ms	808.00 ms
1000.00 ms	990.00 ms	1.01 sec

†PG 201X Enhanced Accuracy On.

2. Width Check

Instrument Setup:

PG 201X

Timing CH 1 & CH 2

DUTY CYCLE 50.0%

PERIOD

PERIOD 20 ns

DC 5010

WIDTH A

To avoid having to repeatedly change both the period and width settings of the PG 201X, the 50% duty cycle setting will be used. This will result in a width that is automatically set to 1/2 the period setting.

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X **CH 1** on button to enable the channel 1 output.

c. Set the period of the PG 201X to each of the values listed in column 1 of Table 7-2; the width will automatically be set to the values shown in column 2.

d. CHECK — DC 5010 display is within the min and max values listed in columns 3 and 4.

e. After performing all the checks for PG 201X channel 1, repeat this step for PG 201X channel 2.

Table 7-2

PG 201X Settings†		DC 5010 Reading	
Period	**Width**	**Min**	**Max**
20.0 ns	10.0 ns	7.8 ns	12.2 ns
60.0 ns	30.0 ns	27.4 ns	32.6 ns
100.0 ns	50.0 ns	47.0 ns	53.0 ns
200.0 ns	100.0 ns	96.0 ns	104.0 ns
400.0 ns	200.0 ns	194.0 ns	206.0 ns
800.0 ns	400.0 ns	390.0 ns	410.0 ns
1600.0 ns	800.0 ns	782.0 ns	818.0 ns
3200.0 ns	1600.0 ns	1.566 µs	1.634 µs
6400.0 ns	3200.0 ns	3.134 µs	3.266 µs
12.8000 µs	6400.0 ns	6.270 µs	6.530 µs
25.6000 µs	12.8000 µs	12.542 µs	13.058 µs
50.0000 µs	25.0000 µs	24.498 µs	25.502 µs
100.000 µs	50.0000 µs	48.998 µs	51.002 µs
200.000 µs	100.000 µs	97.998 µs	102.002 µs
400.000 µs	200.000 µs	195.998 µs	204.002 µs
800.000 µs	400.000 µs	391.998 µs	408.002 µs
1600.00 µs	800.000 µs	783.998 µs	816.002 µs
3200.00 µs	1600.00 µs	1.568 ms	1.632 ms
6400.00 µs	3200.00 µs	3.136 ms	3.264 ms
12.8000 ms	6400.00 µs	6.27 ms	6.53 ms
25.6000 ms	12.8000 ms	12.54 ms	13.06 ms
50.0000 ms	25.0000 ms	24.50 ms	25.50 ms
100.000 ms	50.0000 ms	49.00 ms	51.00 ms
200.000 ms	100.000 ms	98.00 ms	102.00 ms
400.000 ms	200.000 ms	196.00 ms	204.00 ms
800.000 ms	400.000 ms	392.00 ms	408.00 ms
1600.00 ms	800.000 ms	784.00 ms	816.00 ms
2000.00 ms	1000.00 ms	980.00 ms	1.02 sec

†PG 201X Enhanced Accuracy On.

3. Delay Check

The Tektronix cables specified in the equipment list meet the requirements for this check.

Instrument Setup:

PG 201X

Timing CH 1 & CH 2

PERIOD	1000.0 ns
WIDTH	10.0 ns
DELAY	10.0 ns
DUTY CYCLE	Off

DC 5010

ATTEN	
CH A	X1
CH B	X1
TERM	
CH A	1 MΩ
CH B	1 MΩ
TRIGGER LEVEL	
CH A	1.200 V
CH B	0.000 V
AVGS	–1
TIME A→B	

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH B input of the DC 5010. Connect PG 201X TRIG OUT through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the period and delay of the PG 201X to each of the values listed in columns 1 and 2 of Table 7-3.

d. CHECK — DC 5010 display is within the min and max values listed in columns 3 and 4.

e. After performing all the checks for PG 201X channel 1, repeat this step for PG 201X channel 2.

NOTE

Two precision 50Ω cables of matched lengths are required for this check. Unequal lengths will cause errors in the delay measurements.

Table 7-3

PG 201X Settings†		DC 5010 Reading	
Period	**Delay**	**Min**	**Max**
1000.0 ns	10.0 ns	7.8 ns	12.2 ns
	30.0 ns	27.4 ns	32.6 ns
	50.0 ns	47.0 ns	53.0 ns
	100.0 ns	96.0 ns	104.0 ns
	200.0 ns	194.0 ns	206.0 ns
	400.0 ns	390.0 ns	410.0 ns
	800.0 ns	782.0 ns	818.0 ns
1000.00 µs	1600.0 ns	1.566 µs	1.634 µs
	3200.0 ns	3.134 µs	3.266 µs
	6400.0 ns	6.270 µs	6.530 µs
	12.8000 µs	12.542 µs	13.058 µs
	25.0000 µs	24.498 µs	25.502 µs
	50.0000 µs	48.998 µs	51.002 µs
	100.000 µs	97.998 µs	102.002 µs
	200.000 µs	195.998 µs	204.002 µs
	400.000 µs	391.998 µs	408.002 µs
	800.000 µs	783.998 µs	816.002 µs
1000.00 ms	1600.00 µs	1.56 ms	1.63 ms
	3200.00 µs	3.13 ms	3.26 ms
	6400.00 µs	6.27 ms	6.53 ms
	12.8000 ms	12.54 ms	13.06 ms
	25.0000 ms	24.50 ms	25.50 ms
	50.0000 ms	49.00 ms	51.00 ms
	100.000 ms	98.00 ms	102.00 ms
	200.000 ms	196.00 ms	204.00 ms
	400.000 ms	392.00 ms	408.00 ms
	800.000 ms	784.00 ms	816.00 ms
2000.00 ms	1000.00 ms	980.00 ms	1.02 sec

†PG 201X Enhanced Accuracy On.

4. Variable Transition Time Check for PG 2011 and PG 2012 Channel 2

Due to the difficulty of measuring the fastest transition time, it will be measured by a different procedure than the balance of the transition time checks.

5 ns Transition Time Check

Instrument Setup:

PG 201X

Timing CH 1 & CH 2	
PERIOD	1000.00 ns
DELAY	50.0%
DUTY CYCLE	0
LEADING EDGE	5.0 ns
TRAILING EDGE	5.0 ns
OUTPUT CH 1& CH 2	
HIGH LEVEL	+5.00 V
LOW LEVEL	–5.00 V

DC 5010

TERM	
CH A	1 MΩ
CH B	1 MΩ
ATTEN	
CH A	X1
CH B	X5
TRIGGER LEVEL	
CH A	+1.200 V
CH B	–4.000 V
TRIGGER SLOPE	
CH A	+
CH B	–
TIME A→B	

NOTE

Two precision 50Ω cables of matched lengths are required for this check. Unequal lengths will cause errors in the delay measurements. The Tektronix cables specified in the equipment list meet the requirements for this check.

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH B input of the DC 5010. Connect PG 201X TRIG OUT through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X **CH 1** on button to enable the channel 1 output.

c. Press TIME A→B on the DC 5010 and record the result.

d. Change the DC 5010 CH A slope to – and the CH B slope to +.

e. Press TIME A→B on the DC 5010 and record the result.

f. Change the DC 5010 CH B level to 4.000

g. Press TIME A→B on the DC 5010 and record the result.

h. Change the DC 5010 Ch A slope to + and the CH B slope to –.

i. Press TIME A→B on the DC 5010 and record the result.

j. CHECK — Leading edge transition time must be ≤5.5 ns. Leading edge transition time is the difference between the two TIME A→B measurements taken when the DC 5010 CH B slope was set to + (steps 4e and 4g).

k. CHECK — Trailing edge transition time must be ≤5.5 ns. The trailing edge transition time is the difference between the two TIME A→B measurements taken when the DC 5010 CH B slope was set to – (steps 4c and 4i).

5. >5 ns Transition Time Check

Instrument Setup:

PG 201X

Timing CH 1 & 2

LEADING EDGE	50 ns
TRAILING EDGE	50 ns
TRACKING	Tracking Equal ON

DC 5010

AUTO TRIG

TERM

CH A	1 MΩ
CH B	1 MΩ

ATTEN

CH A	X5
CH B	X5

TRIGGER SLOPE

CH A	+
CH B	+

RISE/FALL A

a. Connect the output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the period and transition time of the PG 201X to each of the values listed below in columns 1 and 2 of Table 7-4.

d. CHECK — DC 5010 display is within the min and max values listed in columns 3 and 4, using the procedure below.

1. Set the DC 5010 Ch A and B slope to + and press DC 5010 RISE/FALL A to measure the leading edge transition time.

2. Set the DC 5010 Ch A and B slope to – and press DC 5010 RISE/FALL A to measure the trailing edge transition time.

3. Be sure to press DC 5010 RISE/FALL A before each reading.

e. After performing all the checks for PG 201X channel 1, repeat this step for PG 201X channel 2.

Table 7-4

PG 201X Settings†		DC 5010 Reading	
Period	**Trans. Time**	**Min**	**Max**
1000.00 ns	50.0 ns	45.5 ns	54.5 ns
	0.100 µs	93.0 ns	107 ns
1000.00 µs	0.500 µs	473.0 ns	527.0 ns
	5.00 µs	4.748 µs	5.252 µs
	10.0 µs	9.498 µs	10.502 µs
	50.0 µs	47.498 µs	52.502 µs
	0.100 ms	94.998 µs	105.002 µs
100.000 ms	0.500 ms	474.998 µs	525.002 µs
	1.00 ms	0.950 ms	1.050 ms
	10.0 ms	9.500 ms	10.500 ms

†PG 201X Enhanced Accuracy On.

6. Selectable Transition Time Check for PG 2010 and PG 2012 Channel 2

≤250ps Transition Time

Instrument Setup:

PG 201X

Timing CH 1 & CH 2 (for PG 2010)	
PERIOD	1000.0 ns
DELAY	70.0 ns
WIDTH	50.0 ns
DUTY CYCLE	Off
LEADING EDGE	250 ps
TRAILING EDGE	250 ps
Output CH 1 & CH 2 (if PG 2010)	
HIGH LEVEL	+0.5 V
LOW LEVEL	−0.5 V

Sampling Oscilloscope

Source	Ext Trig Direct
Slope	+
Trig Level	0.7 V
Auto-Setup	Selected
Timebase	10 ns/div
Delay	Minimum
CH 1	
Risetime and Falltime measurements	Selected
Proximal Level	20%
Distal Level	80% and N=32
Tracking	On
CH 2	
Risetime and Falltime measurements	Selected
Proximal Level	20%
Distal Level	80% and N=32
Tracking	On

a. Connect PG 201X normal channel (CH) output through a 50Ω coax cable and a 50Ω terminator to the Sampling Oscilloscope channel 1. Connect the complement channel ($\overline{CH}$) output through a 50Ω coax cable and a 50Ω terminator to the Sampling Oscilloscope channel 2.

b. Press the PG 201X CH 1(2) and $\overline{CH\ 1(2)}$ on buttons to enable the output channels.

c. Connect the PG 201X TRIG OUT through a 50Ω coax cable to the Sampling Oscilloscope Direct Ext Trig In.

NOTE

Make sure the Sampling Oscilloscope CH 1 and CH 2 Tracking is on, then turn both channels Tracking off to lock in the high and low pulse levels for both channels before expanding the timebase display.

d. Adjust the Sampling Oscilloscope Timebase and Delay controls to keep the rising edge of the CH 1 first pulse in view until the pulse risetime is between two and five horizontal divisions in duration.

e. CHECK — Mean risetime reading on CH1 — <250ps.

f. CHECK — Mean falltime reading on CH2 — <250ps.

g. Set the Sampling Oscilloscope Timebase to 10 ns/div and Delay to 85 ns.

h. Adjust the Sampling Oscilloscope Timebase and Delay controls to keep the falling edge of the CH 1 first pulse in view until the pulse falltime is between two and five horizontal divisions in duration.

i. CHECK — Mean falltime reading on CH1 — <250ps.

j. CHECK — Mean risetime reading on CH2 — <250ps.

800ps Transition Time

k. Change the following Sampling Oscilloscope CH 1 and CH 2 Measurement controls:

Proximal Level	10%
Distal Level	90%

l. Repeat steps 6d, through 6j, substituting the following specifications for steps 6e and 6f, and 6i and 6j to check the 800ps transition time.

NOTE

Be sure to return the Sampling Oscilloscope to its 10 ns/div setting and turn Tracking on then off to lock in the pulse high and low levels for transition measurements.

CHECK — Mean risetime 650 ps ≤ t_r ≤ 800 ps.

CHECK — Mean falltime 550 ps ≤ t_f ≤ 800 ps.

1.8ns Transition Time

m. Repeat steps 6d, through 6j, substituting the fo ing specifications for steps 6e and 6f, and 6i and check the 1.8ns transition time.

NOTE

Be sure to return the Sampling Oscilloscop to its 10 ns/div setting and turn Tracking o then off to lock in the pulse high and lo levels for transition measurements.

CHECK — Mean risetime 1.6 ns ≤ t_r ≤ 1.8 ns.

CHECK — Mean falltime 1.5 ns ≤ t_f ≤ 1.8 ns.

7. High Level Check for PG 2011 and PG 2012 Channel 2

Instrument Setup:

PG 201X

Timing CH 1 & CH 2	
PERIOD	1000.00 µs
LEADING EDGE	5.0 ns
TRAILING EDGE	5.0 ns
Output CH 1 & CH 2	
EXTERNAL WIDTH	On
HIGH LEVEL	0 V
LOW LEVEL	–10.0 V
Trigger	
TRIG	EXT TRIG
	NEG SLOPE
	1.00 V

DM 504A

RANGE	Autoranging
Mode	DC Volts

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the output amplitude of the PG 201X to each of the values listed in columns 1 and 2 of Table 7-5.

d. CHECK — DM 504A display is within the min and max values listed in columns 3 and 4.

e. After performing all the checks for PG 201X channel 1, repeat this step for PG 201X channel 2.

Table 7-5

PG 201X† OUTPUT Settings		DM 504A Reading Limits	
HIGHLEVEL	**LOWLEVEL**	**Min**	**Max**
–9.50 V	–10.00 V	–9.65 V	–9.35 V
–6.00 V	–6.50 V	–6.12 V	–5.88 V
–4.00 V	–4.50 V	–4.10 V	–3.90 V
–2.00 V	–2.50 V	–2.08 V	–1.92 V
–0.50 V	–1.00 V	–0.565 V	–0.435 V
–0.25 V	–0.75 V	–0.312 V	–0.188 V
0 V	–0.50 V	–0.060 V	+0.060 V
+0.25 V	–0.25 V	+0.187 V	+0.313 V
+0.50 V	0 V	+0.435 V	+0.565 V
+2.00 V	+1.50 V	+1.92 V	+2.08 V
+4.00 V	+3.50 V	3.90 V	4.10 V
+6.00 V	+5.50 V	+5.88 V	+6.12 V
+8.00 V	+7.50 V	+7.86 V	+8.14 V
+10.00 V	+9.50 V	+9.84 V	+10.16 V

†PG 201X Enhanced Accuracy On.

8. Low Level Check for PG 2011 and PG 2012 Channel 2

Instrument Setup:

PG 201X
Trigger

TRIG	EXT TRIG
	POS SLOPE
	1.00 V

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the output amplitude of the PG 201X to each of the values listed in columns 1 and 2 of Table 7-6.

d. CHECK — DM 504A display is within the min and max values listed in columns 3 and 4.

e. After performing all the checks for PG 201X channel 1, repeat this step for PG 201X channel 2.

Table 7-6

PG 201X† OUTPUT Settings		DM 504A Reading Limits	
LOWLEVEL	HIGHLEVEL	Min	Max
+9.50 V	+10.00 V	+9.34 V	+9.66 V
+6.00 V	+6.50 V	+5.88 V	+6.12 V
+4.00 V	+4.50 V	+3.90 V	+4.10 V
+2.00 V	+2.50 V	+1.92 V	+2.08 V
+0.50 V	+1.00 V	+0.435 V	+0.565 V
+0.25 V	+0.75 V	+0.187 V	+0.313 V
0 V	+0.50 V	–0.060 V	+0.060 V
–0.25 V	+0.25 V	–0.312 v	–0.188 V
–0.50 V	0 V	–0.565 V	–0.435 V
–2.00 V	–1.50 V	–2.08 V	–1.92 V
–4.00 V	–3.50 V	–4.10 V	–3.90 V
–6.00 V	–5.50 V	–6.12 V	–5.88 V
–8.00 V	–7.50 V	–8.14 V	–7.86 V
–10.00 V	–9.50 V	–10.16 V	–9.84 V

†PG 201X Enhanced Accuracy On.

9. Low Level Check for PG 2010 and PG 2012 Channel 1

Instrument Setup:

PG 201X

Timing CH 1 & CH 2	
PERIOD	1000.00 µs
LEADING EDGE	5.0 ns
TRAILING EDGE	5.0 ns
Output CH 1 & CH 2	
EXTERNAL WIDTH	On
HIGH LEVEL	–1.2 V
LOW LEVEL	–2.5 V
Trigger	
TRIG	EXT TRIG
	NEG SLOPE
	1.00 V

DM 504A

RANGE	Autoranging
Mode	DC Volts

a. Connect the CH 1 output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the output amplitude of the PG 201X to each of the values listed in columns 1 and 2 of Table 7-7.

d. CHECK — DM 504A display is within the min and max values listed in columns 3 and 4.

e. After performing the check for the CH output, disconnect the CH1 output and connect the $\overline{\text{CH 1}}$ output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

f. Turn the PG 201X CH1 ouput off.

g. Press the PG 201X $\overline{\text{CH 1}}$ on button to enable the channel 1 output.

h. Repeat parts 9c through 9d for the PG 201X $\overline{\text{CH1}}$ output.

i. After performing all the checks for CH 1 and $\overline{\text{CH 1}}$ outputs, repeat this step for CH 2 if a PG 2010 dual channel unit is being tested.

Table 7-7

PG 201X† OUTPUT Settings		DM 504A Reading Limits	
HIGHLEVEL	**LOWLEVEL**	**Min**	**Max**
–1.2 V	–2.5 V	–2.60 V	–2.40 V
–1.2 V	–2.25 V	–2.34 V	–2.16 V
–1.2 V	–2.00 V	–2.09 V	–1.91 V
–1.15 V	–1.75 V	–1.83 V	–1.67 V
–0.40 V	–1.00 V	–1.07 V	–0.93 V
–0.15 V	–0.75 V	–0.82 V	–0.68 V
+2.0 V	–0.50 V	–0.60 V	–0.40 V
+2.0 V	–0.25 V	–0.35 V	–0.15 V
+2.5 V	0 V	–0.10 V	+0.10 V
+2.5 V	+0.25 V	+0.15 V	+0.35 V
+2.5 V	+0.50 V	+0.40 V	+0.60 V
+2.5 V	+1.00 V	+0.91 V	+1.09 V
+2.5 V	+1.50 V	+1.41 V	+1.59 V
+2.5 V	+1.90 V	+1.82 V	+1.98 V

†PG 201X Enhanced Accuracy On.

10. High Level Check for PG 2010 and PG 2012 Channel 1

Instrument Setup:

PG 201X
Trigger

TRIG	EXT TRIG
	NEG SLOPE
	1.00 V

a. Connect the channel 1 output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the output amplitude of the PG 201X to each of the values listed in columns 1 and 2 of Table 7-8.

d. CHECK — DM 504A display is within the min and max values listed in columns 3 and 4.

e. After performing the check for the CH output, disconnect the CH1 output and connect the $\overline{\text{CH 1}}$ output of the PG 201X through a 50Ω coax cable and 50Ω precision termination to the input of the DM 504A.

f. Turn the PG 201X CH1 ouput off.

g. Press the PG 201X $\overline{\text{CH 1}}$ on button to enable the channel 1 output.

h. Repeat parts 10c through 10d for the PG 201X $\overline{\text{CH1}}$ output.

i. After performing all the checks for CH 1 and $\overline{\text{CH 1}}$ outputs, repeat this step for CH 2 if a PG 2010 dual channel unit is being tested.

Table 7-8

PG 201X† OUTPUT Settings		DM 504A Reading Limits	
LOWLEVEL	**HIGHLEVEL**	**Min**	**Max**
+1.50 V	+2.5 V	+2.41 V	+2.60 V
+1.0 V	+2.25 V	+2.15 V	+2.38 V
+1.0 V	+2.00 V	+1.91 V	+2.09 V
+1.0 V	+1.75 V	+1.17 V	+1.83 V
+0.40 V	+1.00 V	+0.93 V	+1.07 V
0 V	+0.75 V	+0.68 V	+0.82 V
–0.1 V	+0.50 V	–0.43 V	+0.57 V
–2.0 V	+0.25 V	–0.15 v	–0.35 V
–2.5 V	0 V	–0.10 V	–0.10 V
–2.5 V	–0.25 V	–0.35 V	–0.15 V
–2.5 V	–0.50 V	–0.59 V	–0.41 V
–2.5 V	–0.75 V	–0.84 V	–0.66 V
–2.5 V	–1.0 V	–1.09 V	–0.91 V
–2.5 V	–1.20 V	–1.29 V	–1.11 V

†PG 201X Enhanced Accuracy On.

11. Counted Burst Check

Instrument Setup:

PG 201X

Timing CH 1& CH 2	
WIDTH	200 ns
DELAY	0 ns
PERIOD	500 ns
Output CH 1 & CH 2	
HIGH LEVEL	+1.00 V
LOW LEVEL	–1.00 V
EXTERNAL WIDTH	Off
Trigger	
BURST	
MANUAL	
BURST COUNT	2

DC 5010

TRIGGER LEVEL	
CH A	0.0000 V
TRIGGER SLOPE	
CH A	+
ATTEN	
CH A	X1
TERM	
CH A	1 MΩ
TOTAL A	

a. Connect the CH 1 output of the PG 201X through a 50Ω coax cable and 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X CH1 on button to enable the channel 1 output.

c. Press the MEASUREMENT START/STOP on the DC 5010 to arm the count gate (pushbutton LED dark).

d. Press the **MANUAL** trigger button on the PG 201X.

e. CHECK — DC 5010 should display a 2.

f. Change the PG 201X **Burst Count** to 900.

g. Press MEASUREMENT START/STOP on the DC 5010 (pushbutton LED illuminated), then press the TOTAL A button to clear the display to 0. Again press DC 5010 MEASUREMENT START/STOP (pushbutton LED dark).

h. Press the **MANUAL** Trigger button on the PG 201X.

i. CHECK — DC 5010 should display 900.

j. Change the PG 201X **Burst Count** to 999999.

k. Press MEASUREMENT START/STOP on the DC 5010 (pushbutton LED illuminated), then press the TOTAL A button to clear the display to 0. Again press MEASUREMENT START/STOP (pushbutton LED dark).

l. Press the **MANUAL** trigger button on the PG 201X.

m. CHECK — DC 5010 should display 999999.

It is not necessary to repeat this test for CH 2, as the burst counter is common to both channels.

12. Trigger Rate Check

Instrument Setup:

PG 201X

Timing CH 1& CH 2

WIDTH	20 ns
DELAY	0 ns
PERIOD	50 ns

Output CH 1 & CH 2

HIGH LEVEL	+1.00 V
LOW LEVEL	−1.00 V
EXTERNAL WIDTH	Off

Trigger

INTERNAL	
TRIG RATE	0.1 µs

DC 5010

AUTO TRIG

PERIOD A

a. Connect the CH 1 output of the PG 201X through a 50Ω coax cable and a 50Ω termination to the CH A input of the DC 5010.

b. Press the PG 201X CH 1 on button to enable the channel 1 output.

c. Set the **TRIG RATE** of the PG 201X to each of the values listed in column 1 of Table 7-9.

d. CHECK — DC 5010 display is within the min and max values listed in columns 2 and 3.

It is not necessary to repeat this test for CH 2, as the trigger rate generator is common to both channels.

Table 7-9

PG 201X TRIG RATE	DC 5010 Reading Limits	
	Min	Max
0.1 µs	98.99 ns	101.01 ns
5.0 µs	4.998 µs	5.002 µs
250.0 µs	249.974 µs	250.026 µs
12.50 ms	12.498 ms	12.501 ms
500.0 ms	499.949 ms	500.050 ms

13. Pulse Aberrations Check for PG 2011 and PG 2012 Channel 2

Instrument Setup:

PG 201X

Timing CH 1 & CH 2	
PERIOD	200 ns
WIDTH	100 ns
DELAY	0 ns
LEADING EDGE	5.5 ns
TRAILING EDGE	5.5 ns
Output CH 1 & CH 2	
HIGH LEVEL	+2.5 V
LOW LEVEL	−2.5 V
Trigger	
CONT	

Oscilloscope

Vertical Gain	1 V/Div
Horizontal Sweep	10 ns/Div
Trigger	Auto
Source	Int
Slope	+

a. Connect the CH 1 output of the PG 201X through a 50Ω coax cable and 50Ω termination to the input of the oscilloscope.

b. Press the PG 201X CH1 on button to enable the channel 1 output.

c. Adjust the oscilloscope position and gain controls to display the rising edge of the PG 201X pulse with a vertical amplitude of exactly 5 divisions.

d. CHECK — Aberrations from the 90% point of the rising edge to 24 ns after the 90% point to be less than ±0.3 divisions in peak-to-peak amplitude.

e. Change the oscilloscope trigger slope to −.

f. Adjust the oscilloscope position and gain controls to display the falling edge of the PG 201X pulse with a vertical amplitude of exactly 5 divisions.

g. CHECK — Aberrations from the 10% point of the falling edge to 24 ns after the 10% point to be less than 0.55 divisions in peak-to-peak amplitude.

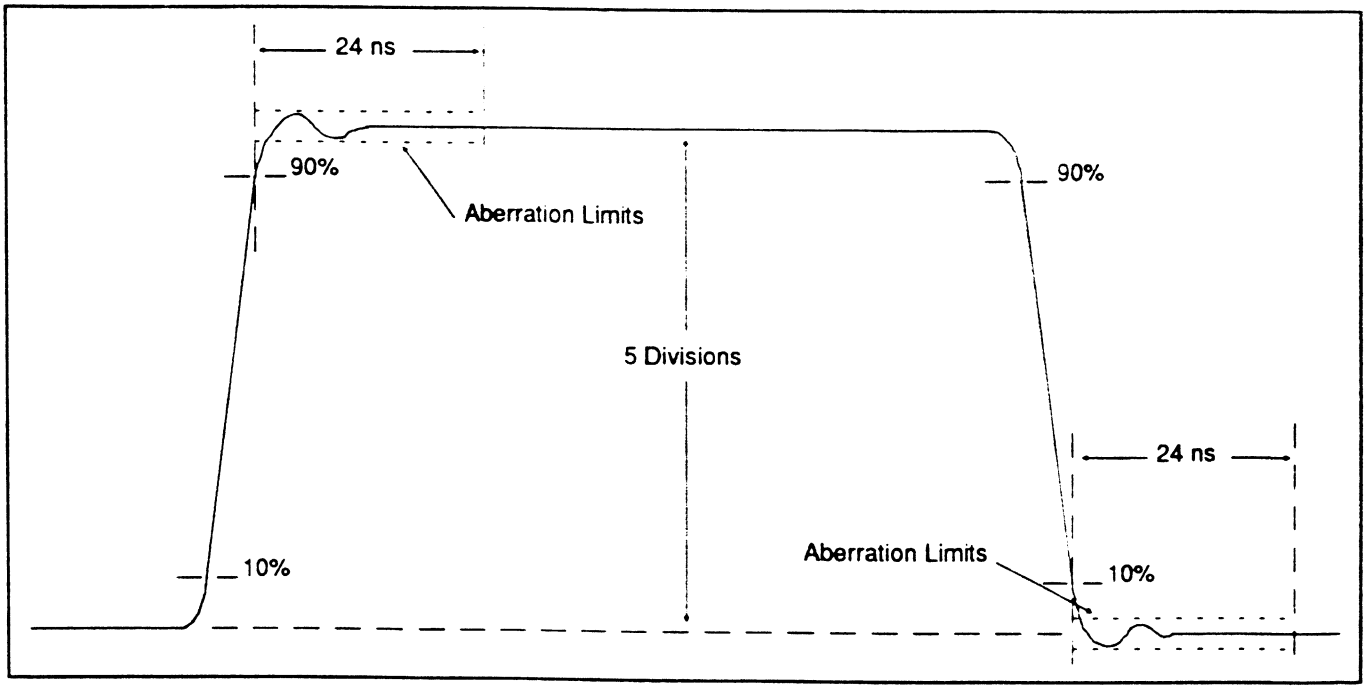


Fig. 7-1. Pulse aberration measurement.

14. Selectable Transition Time Check for PG 2010 and PG 2012 Channel 2

≤250ps Transition Time

Instrument Setup:

PG 201X

Timing CH 1 & CH 2 (for PG 2010)	
PERIOD	1000.0 ns
DELAY	70.0 ns
WIDTH	50.0 ns
DUTY CYCLE	Off
LEADING EDGE	250 ps
TRAILING EDGE	250 ps
Output CH 1 & CH 2 (if PG 2010)	
HIGH LEVEL	+0.5 V
LOW LEVEL	–0.5 V

Sampling Oscilloscope

Source	Ext Trig Direct
Slope	+
Trig Level	0.7 V
Auto-Setup	Selected
Timebase	10 ns/div
Delay	Minimum
CH 1	
Risetime and Falltime measurements	Selected
Proximal Level	20%
Distal Level	80% and N=32
Tracking	On
CH 2	
Risetime and Falltime measurements	Selected
Proximal Level	20%
Distal Level	80% and N=32
Tracking	On

a. Connect PG 201X normal channel (CH) output through a 50Ω coax cable and a 50Ω terminator to the Sampling Oscilloscope channel 1. Connect the complement channel $\overline{(CH)}$ output through a 5C coax cable and a 50Ω terminator to the Sampling Oscilloscope channel 2.

b. Press the PG 201X CH 1(2) and $\overline{CH\ 1(2)}$ on b to enable the output channels.

c. Connect the PG 201X TRIG OUT through a coax cable to the Sampling Oscilloscope Direct E In.

NOTE

Make sure the Sampling Oscilloscope CH and CH 2 Tracking is on, then turn bo channels Tracking off to lock in the high a low pulse levels for both channels befo expanding the timebase display.

d. Adjust the Sampling Oscilloscope Timebas Delay controls to keep the rising edge of the CH pulse in view until the Sampling Oscilloscope Tim is set to 1 ns/div.

e. Using the Sampling Oscilloscope Channel sors, measure the pulse aberrations from the 80% to 1.5 ns after the 80% point.

f. CHECK — All aberrations in the measured ar less than 0.25 V peak-to-peak.

g. Using the Sampling Oscilloscope Channel 2 sors, measure the pulse aberrations from the 20% to 1.5 ns after the 20% point.

h. CHECK — All aberrations in the measured ar less than 0.25 V peak-to-peak.

i. Set the Sampling Oscilloscope Timebase ns/div and the Delay to 85 ns.

j. Adjust the Sampling Oscilloscope Timebas Delay controls to keep the falling edge of the CH pulse in view until the Sampling Oscilloscope Tim is set to 1 ns/div.

k. Using the Sampling Oscilloscope Channel sors, measure the pulse aberrations from the 20% to 1.5 ns after the 20% point.

l. CHECK — All aberrations in the measured ar less than 0.25 V peak-to-peak.

m. Using the Sampling Oscilloscope Channel sors, measure the pulse aberrations from the 80% to 1.5 ns after the 80% point.

n. CHECK — All aberrations in the measured area are less than 0.25 V peak-to-peak.

800ps Transition Time

o. Change the following PG 201X settings:

Timing CH 1 & CH 2 (for PG 2010)

LEADING EDGE	800 ps
TRAILING EDGE	800 ps

p. Change the following Sampling Oscilloscope controls:

CH 1

Risetime and Falltime measurements	Selected
Proximal Level	10%
Distal Level	90% and N=32
Tracking	On

CH 2

Risetime and Falltime measurements	Selected
Proximal Level	10%
Distal Level	90% and N=32
Tracking	On

q. Repeat steps 14a through 14r.

NOTE

The aberrations measured in steps 14f, 14h, 14l, and 14n are now measured to be less than 0.12 V peak-to-peak.

1.8ns Transition Time

r. Change the following PG 201X settings:

Timing CH 1 & CH 2 (for PG 2010)

LEADING EDGE	1.8 ns
TRAILING EDGE	1.8 ns

s. Change the following Sampling Oscilloscope controls:

CH 1

Risetime and Falltime measurements	Selected
Proximal Level	10%
Distal Level	90% and N=32
Tracking	On

CH 2

Risetime and Falltime measurements	Selected
Proximal Level	10%
Distal Level	90% and N=32
Tracking	On

t. Repeat steps 14a through 14r.

NOTE

The aberration measurement area in steps 14e, 14g, 14k, and 14m is now measured as follows:

rising edge — from the 90% point to 2 ns after the 90% point

falling edge — from the 10% point to 2 ns after the 10% point

The aberrations measured in steps 14f, 14h, 14l, and 14n are now measured to be less than 0.12 V peak-to-peak.

Disconnect all connections. This completes the Performance Check of the PG 201X.

SECTION 8
ADJUSTMENT PROCEDURE

Introduction

The following describes the procedure and gives a summary of the steps for the computer run automated Adjustment Procedure. This Adjustment Procedure need not be performed unless the instrument fails to meet the Performance Requirements of the electrical characteristics listed in the Specification section of the operators manual or if the Performance Check procedure cannot be completed satisfactorily. If the instrument has undergone repairs, the Adjustment Procedure is recommended.

Satisfactory completion of all adjustment steps in the automated procedure ensures that the instrument will meet the Performance Requirements.

Test Equipment Required

The test equipment , or equivalent, listed in Table 8-1 is required for adjustment of the PG 201X. All test equipment is assumed to be correctly calibrated and operating within specifications.

If other test equipment is subsituted, the adjustment procedure may need to be altered to meet the requirements of the equipment used.

Table 8-1
TEST EQUIPMENT REQUIREMENTS

Description	Suggested Equipment
Frequency Counter	Tektronix DC 5010 with GPIB address set to 20
DC Digital Voltmeter	Tektronix DM 5110 GPIB address set to 16
Power Module	Tektronix TM 5006A Power Module
MS/DOS GPIB Controller	Controller must have a Tektronix PC-GPIB Package: S3FG210 installed.
BNC 'T' Connector	Tektronix Part Number 103-0030-00

Table 8-1 Cont

BNC to Banana Adapter	Tektronix Part Number 103-0090-00
GPIB Interconnect Cables (2 each)	Tektronix Part Number 012-0630-01
50 Ohm Coaxial Cables (2 each)	Tektronix Part Number 012-0482-00
50 Ohm Terminations (2 each)	Tektronix Part Number 011-0049-01
50 Ohm Precision Termination	Tektronix Part Number 011-0129-00
Calibration Software — 5.25 inch DSDD Disk	Tektronix Part Number 118-8578-00

Preparation

Install the DC 5010, and DM 5110 in the TM 5006A and turn on the power. Turn on the power to the PG 201X and set the GPIB address to 10. Turn on the Controller power. Allow a 20 minutes for all instruments to warm-up.

Make adjustments at an ambient temperature between 21° C and 25° C (70° F and 77° F).

WARNING

Dangerous voltages exist at several points in this instrument. When the instrument is operated with the covers removed, do not touch exposed connections and components. Disconnect power before cleaning the instrument or replacing parts.

CAUTION

When the instrument is operated with the cabinet removed it is necessary to use an external fan to cool the regulator heat sinks on the A4 (Fast Output board) and the A5 (Variable Output board). Failure to properly cool this area may result in thermal shutdown of the ±15 volt power supplies and a loss of pulse output.

Manual Check and Adjustment Procedure

1. +8.0 Volt Supply

a. Connect digital voltmeter low lead to the PG 201X chassis ground. Connect the digital high lead to the collector (tab) of Q903 (lower right transistor on the rear heatsink).

b. ADJUST – V1 potentiometer on the A11 Power Supply assembly (see Fig. 8-2) for +8.00 volts ±50 mV.

2. +15.0 Volt Supply

a. CHECK – +15.0 volts, ±150 mV at pin 8 of P100 (power supply connector).

b. Only make the following adjustment if the +15.0 volt supply is out of specification.

c. ADJUST – V2 potentiometer on the A11 Power Supply assembly (see Fig. 8-2) for +15.0 volts.

3. +30.0 Volt Supply

a. CHECK – +30.0 volts, ±250 mV at pin 6 of P100 (power supply connector).

b. Only make the following adjustment if the +30.0 volt supply is out of specification.

c. ADJUST – V3 potentiometer on the A11 Power Supply assembly (see Fig. 8-2) for +30.0 volts.

4. –30.0 Volt Supply

a. CHECK – –30.0 volts, ±250 mV at pin 1 of P100 (power supply connector).

b. Only make the following adjustment if the –30.0 volt supply is out of specification.

c. ADJUST – V4 potentiometer on the A11 Power Supply assembly (see Fig. 8-2) for –30.0 volts.

5. Offset Adjustment Procedure for A7 Pico-second Output Board (PG 2010 and PG 2012 CH1 ONLY)

a. Set the following PG 201X controls:

Timing CH1 and CH2	
Period	100 µs
Width	10 µs
Output CH1 and CH2	
High Level	+1V
Low Level	0V

Note: Output does not have to be calibrated.

b. Connect the NORMAL polarity output BNC from the PG 201X channel to an oscilloscope input channel using a 50 ohm coaxial cable and a 50 ohm termination (either internal to the oscilloscope or externally).

c. Turn the appropriate PG 201X output on.

d. Place a two pin jumper on P1002 (see Fig. 8-1). The jumper forces the low level input of the Picosecond board to be 0v.

e. Set the oscilloscope to trigger on the falling edge of the PG 201X output signal with the oscilloscope timebase set to 10 µs/div.

f. Start with oscilloscope vertical set at 0.5 v/div. Increase the oscilloscope vertical gain to 10 mv/div, adjusting R2308 (see Fig. 8-1) to keep lower level of the pulse visible on screen.

g. Adjust oscilloscope vertical position so that 0V on oscilloscope display is at center screen with vertical gain set at 10 mv/div.

h. Adjust R2308 (see Fig. 8-1) until the lower level of the pulse is within 1/2 div. of the oscilloscope center screen (0v). Be sure to make the level measurement in the 50 - 60 µs timeframe of the pulse . This eliminates any transients and amplifier recovery problems.

i. Remove jumper from P1002 (located on the Picosecond Output board).

6. CRT Display Intensity

a. Select the UTILITY menu and choose Display Intensity. Rotate the front panel knob counter-clockwise to Display Intensity 1.

b. ADJUST – Video Gain and Brightness controls (see Fig. 8-2.) to achieve a minimum intensity level that is still visible.

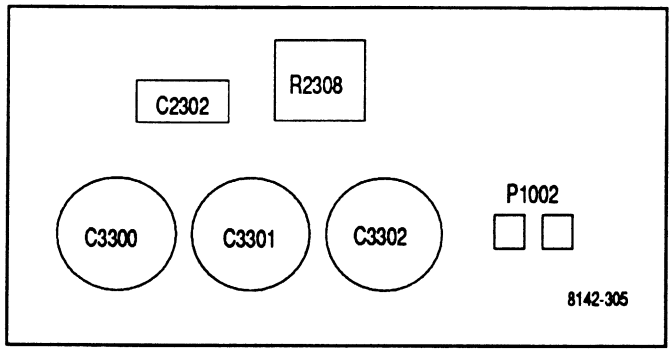


Fig. 8-1. Portion of Pico-second Output board showing location of P1002 and R2308.

c. Rotate the front panel knob clockwise to Display Intensity 16.

d. ADJUST — Video Gain and Brightness controls (see Fig. 8-2.) to achieve a maximum intensity level without excessive "blooming".

e. Repeat steps 5a through 5d to compromise for the settings of the Video Gain and Brightness controls to achieve the best range of minimum to maximum intensity.

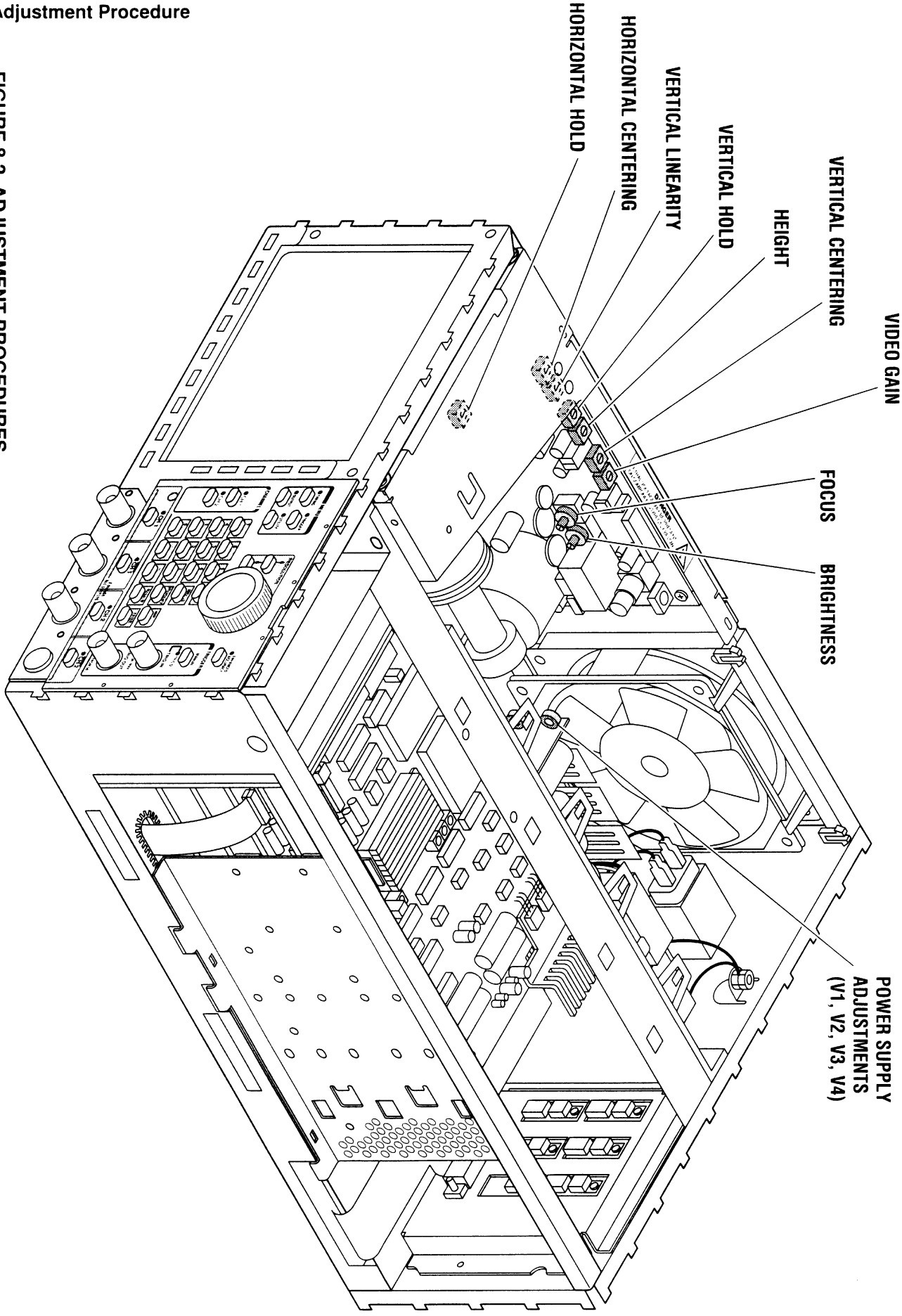


FIGURE 8-2 ADJUSTMENT PROCEDURES

Instructions For Configuring GPIB Interface Software To Work With PG 201X Calibration Program

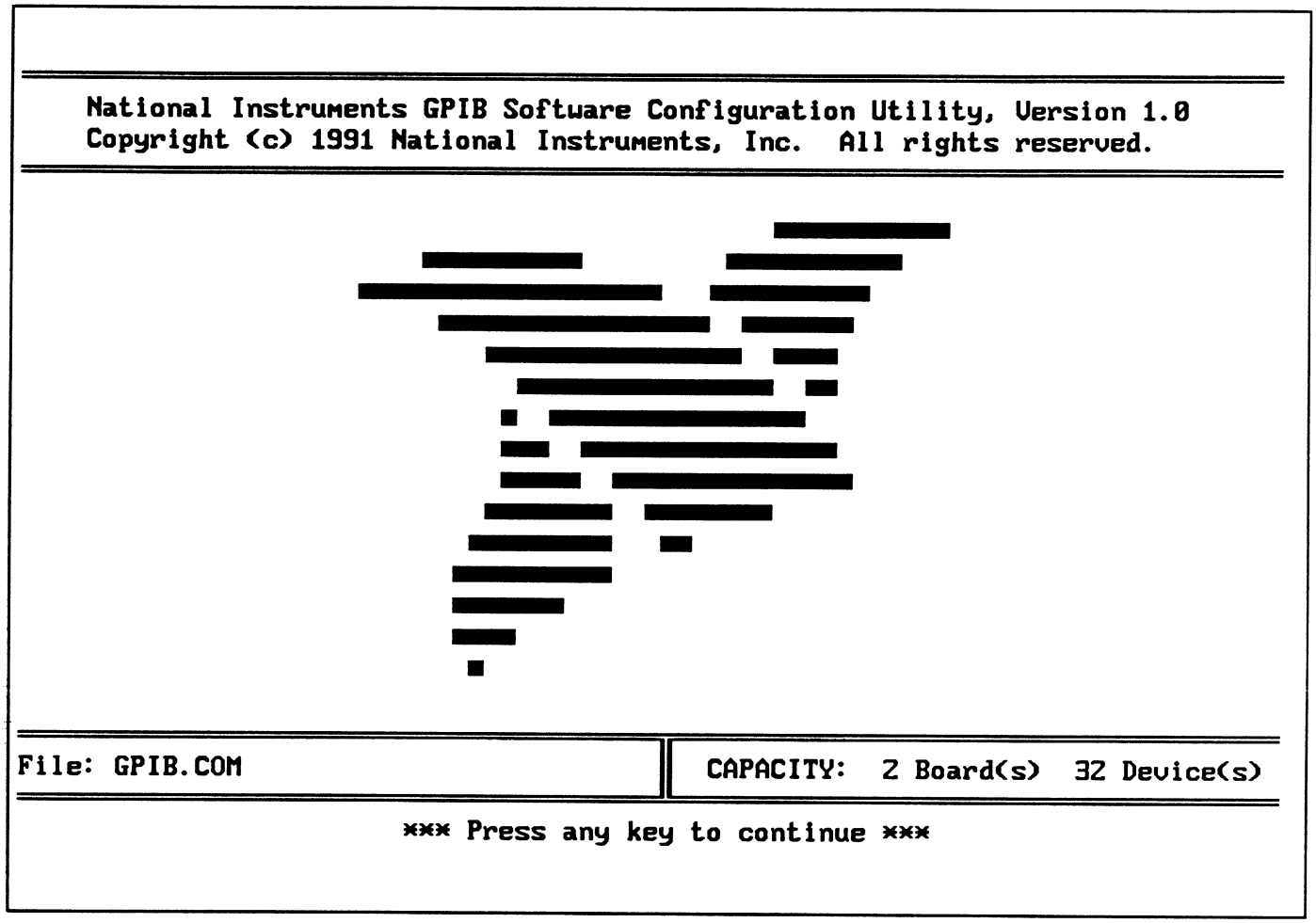


Fig. 8-3. Opening screen for PC-GPIB controller software package.

NOTE

The following instructions are a brief outline for configuring the GPIB Interface Software. For additional information please consult the manuals that came with your Tektronix PC-GPIB Package: S3FG210.

These instructions assume that the user has the GPIB card and software S3FG210 or equivalent installed.

Operation of the pulse generator calibration software requires a controller and GPIB interface software properly configured. The GPIB software configuration is accomplished by using the IBCONF command. After entering this command, the controller monitor will look like Fig. 8-3. Pressing any keyboard key will bring up the Device Map of Fig. 8-4. The calibration software requires the inclusion of device names PG 2000, DC 5110 and DM 5110 in the device map. Use the cursor control key to choose a map position. Press F4 and type the device name then press enter. Press F8 to call up the device characteristics edit menu as in Fig. 8-5. Use the left and right arrow keys to edit the Primary GPIB Address for each device. the required addresses are as follows:

Device	Address
PG 2000	10
DC 5010	20
DM 5110	16

After editing, press F9 from the Device Map menu. Enter Y to the Save Changes? prompt. Reboot the controller before running the calibration software.

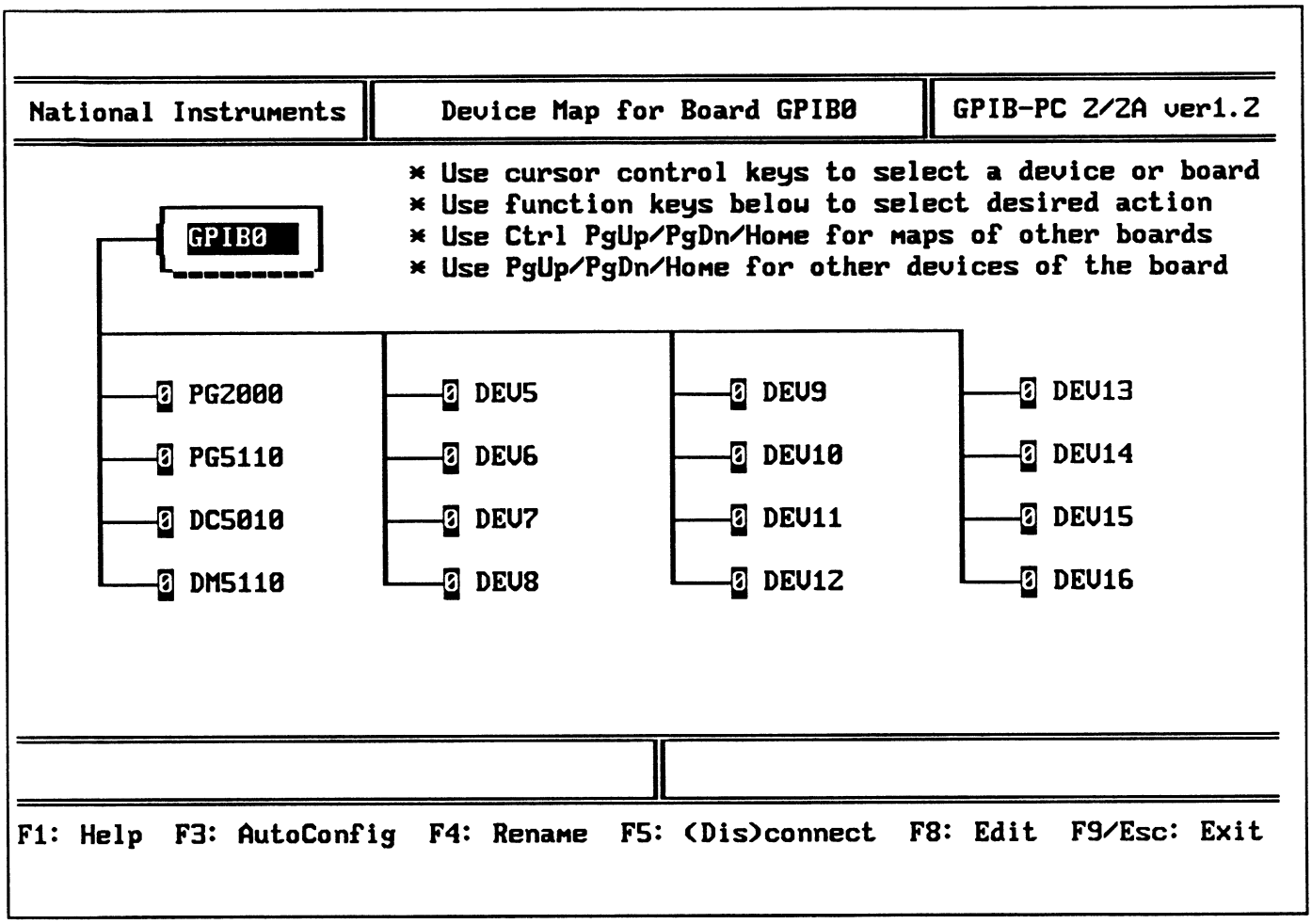


Fig. 8-4. Setup screen for PC-GPIB controller software package.

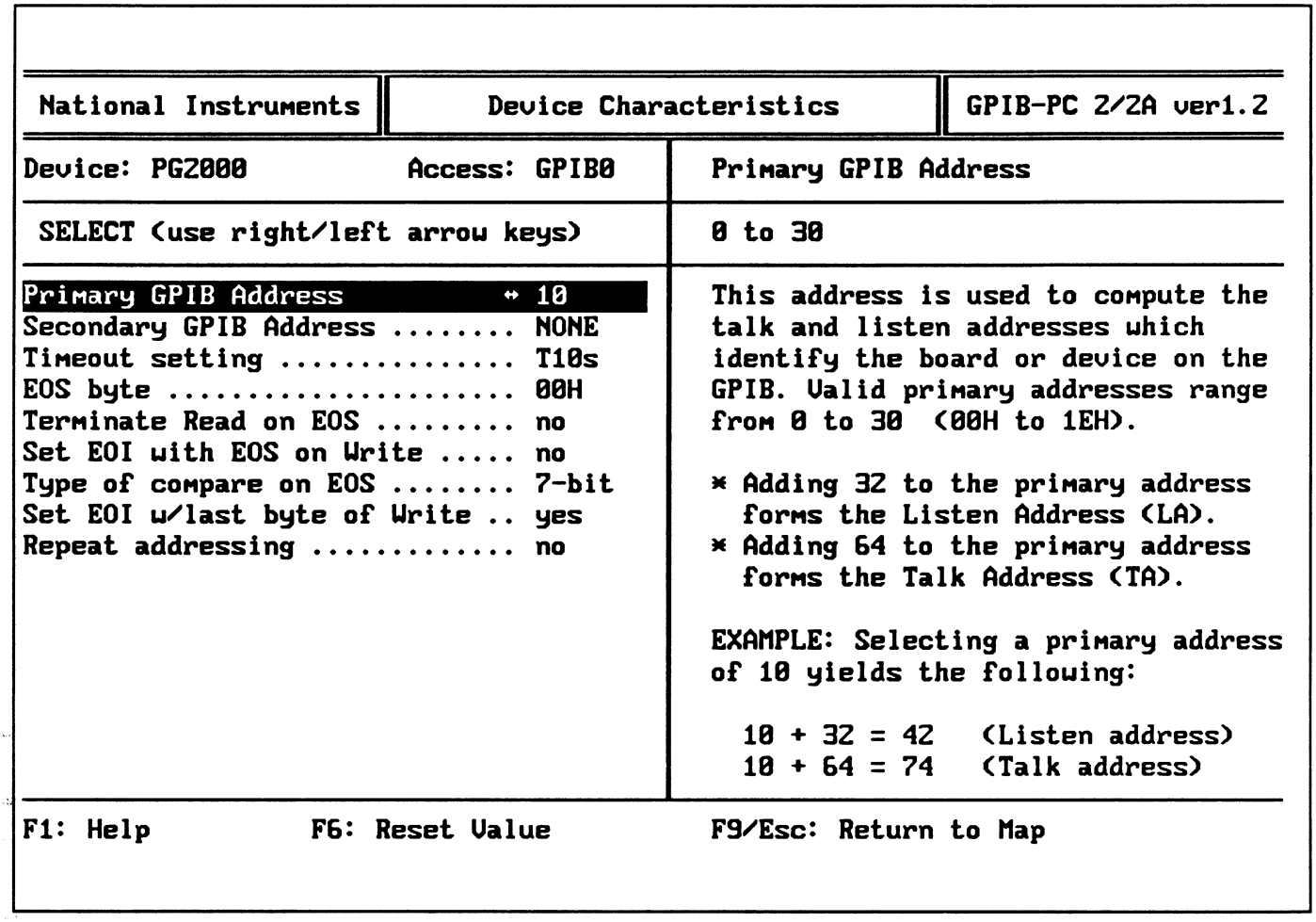


Fig. 8-5. Status screen for PC-GPIB controller software package.

Automated Adjustment Procedure

Insert the PG 201X calibration software floppy disk into the disk drive of the controller and enter the command MPGCAL. At each step the calibration program will prompt the user with the appropriate actions to complete the instrument calibration. The initial screen of the program shows the results of firmware version checks. To continue the user hits enter.

The following is a summary of each step with the user actions needed. For each step after the user changes connections the program prompts to confirm the step with ENTER and to execute the step by hitting F1.

See Section 9 for information on Error Messages.

Step	Setup Instructions
I. Internal oscillator measurement	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 CHANNEL A input. ENTER, then F1
II. Period VCO calibration	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 CHANNEL A input. ENTER, then F1
III. Output level calibration - Channel 1	Connect a 50 ohm coaxial cable from PG 201X Channel 1 output to the DM 5110 input. (use a BNC to banana adapter). **NOTE:** *A 50 ohm precision termination is only required for the PG 2010 and PG 2012* ENTER, then F1
IV. Pulse calibration - Channel 1	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 Channel A input. Connect a 50 ohm coaxial cable from PG 201X Channel 1 output through a 50 ohm termination to DC 5010 Channel B input. ENTER, then F1
V. Transition calibration - Channel 1 (PG 2011 Only)	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 Channel A input. Connect a 50 ohm coaxial cable from PG 201X CHANNEL A output through a 50 ohm termination to DC 5010 Channel B input. ENTER, then F1
NOTE: *Steps VI. through VIII. are for PG 2012, and PG 2010/PG 2011 Option 2 instruments only.*	
VI. Output level calibration - Channel 2	Connect a 50 ohm coaxial cable from PG 201X Channel 2 output to the DM 5110 input (use a BNC to banana adapter). **NOTE:** *A 50 ohm precision termination is only required for the PG 2010 and PG 2012* ENTER, then F1

VII. Pulse calibration - Channel 2	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 Channel A input. Connect a 50 ohm coaxial cable from PG 201X CHANNEL 2 output through a 50 termination to DC 5010 Channel B input.
VIII. Transition calibration - Channel 2 (PG 2011 and PG 2012 Only)	Connect a 50 ohm coaxial cable from PG 201X TRIG OUT through a 50 ohm termination to DC 5010 Channel A input. Connect a 50 ohm coaxial cable from PG 201X CHANNEL 2 output through a 50 ohm termination to DC 5010 Channel B input. ENTER, then F1
IX. Trigger Level Calibration	Connect a 50 ohm coaxial cable from PG 201X CHANNEL 1 output to a BNC 'T' in the input of the PG 201X TRIG IN, through a 50 ohm termination. Connect a 50 ohm coaxial cable from the DM 5110 to the BNC 'T' on the input of the PG 201X TRIG IN. ENTER, then F1

X. After all of the above steps have been successfully completed, the program will prompt the user to hit F1 to write calibration constants to the PG 201X.

NOTE

If any of the above calibration steps have not been successfully executed, the instrument will not allow new calibration constant to be stored. See information below for corrective information.

CORRECTIVE INFORMATION

1. Delay Matching Procedure

NOTE

The following component selection procedure should only be performed if an error occurs during the automated calibration process. The applicable errors are:

- *Error 1100 D2 or S2 (Channel I)*
- *Error 1300 D2 or S2 (Channel 2)*

This procedure generally would only need to be performed if one or more of the following assemblies were replaced:

— A2 - Period Board

— A3 - Width/Delay Board

— A4 - Fast Output Board

— A5 - Variable Output Board

— A7 - Pico-second Board

All assemblies ordered as replacements will include a set of four 18 pF capacitors (Tektronix Part Number 283-0159-00) which may be required in the following procedure.

The following procedure is used to match the Trigger Out delay to the delay(s) of the actual output pulse(s).

A. Check delay matching

Pg 201x control settings:

Timing CH1 and CH2

Period	500.0 ns
Width	200.0 ns
Delay	0 ns
Duty cycle	Off
Leading Edge	250 ps (PG2010 and PG2012 CH1) 5.0 ns (PG2011 and PG2012 CH2)

Trailing Edge	250 ps (PG2010 and PG2012 Ch1)
	5.0 ns (PG2011 and PG2012 CH2)
Output CH1 and CH2	
High Level	+1.0V
Low Level	-1.0V
Output	Normal
Trigger	Continuous

1. Use equal length 50 ohm coaxial cables terminated with 50 ohm terminations.

2. CHECK — time difference between the 50% point of the rising edge of the Trigger Output signal and the 50% point of the rising edge of the pulse output signal (CH1 or CH2) on the oscilloscope.

The acceptable range of Output delay with respect to the Trigger Out is +400 ps, -1.0 ns, i.e.,the output pulse can occur 400 ps before the Trigger Out pulse or up to 1.0 ns after the Trigger Out.

3. Adjust — delay time by selecting components in the following manner:

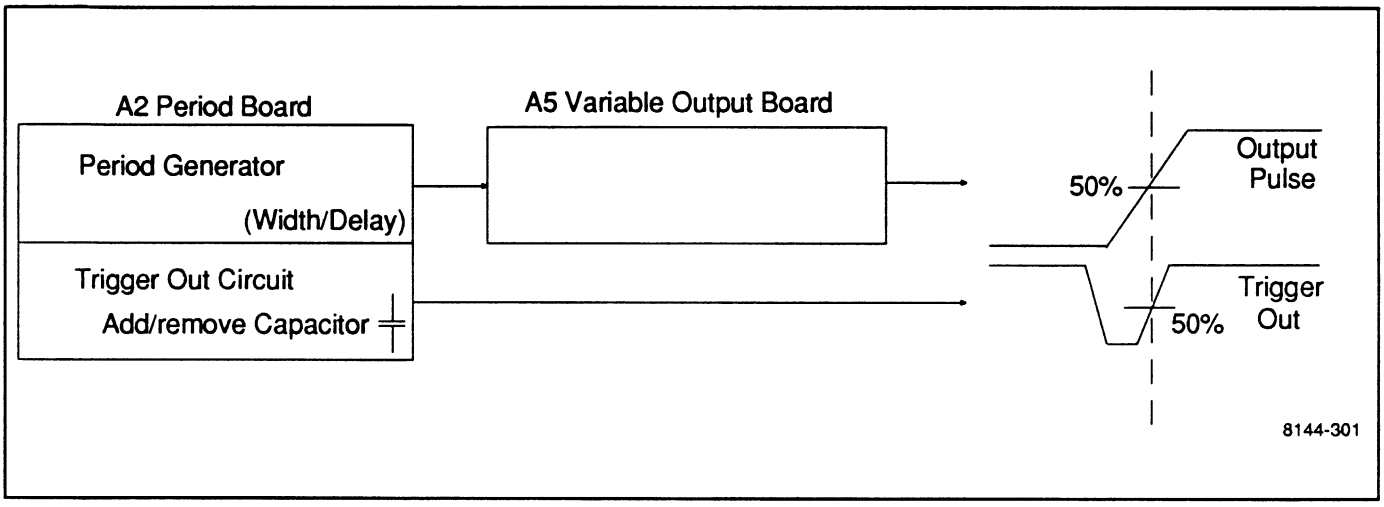


Fig. 8-6. Illustration showing waveform relationship when adding or removing Period Board capacitors.

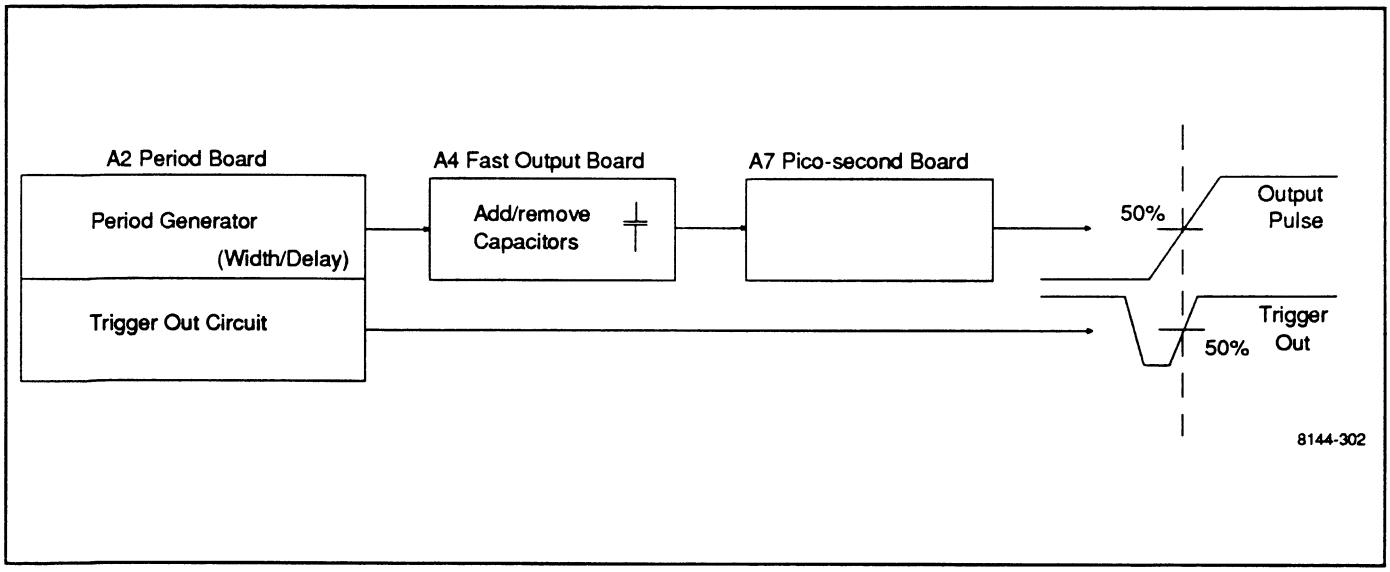


Fig. 8-7. Illustration showing waveform relationship when adding or removing Fast Output Board capacitors.

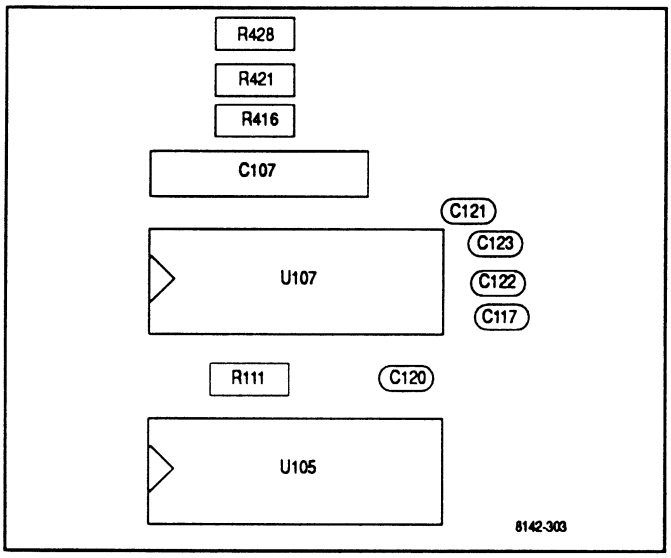


Fig. 8-8. Portion of Period board (A2) showing location of Delay change capacitors.

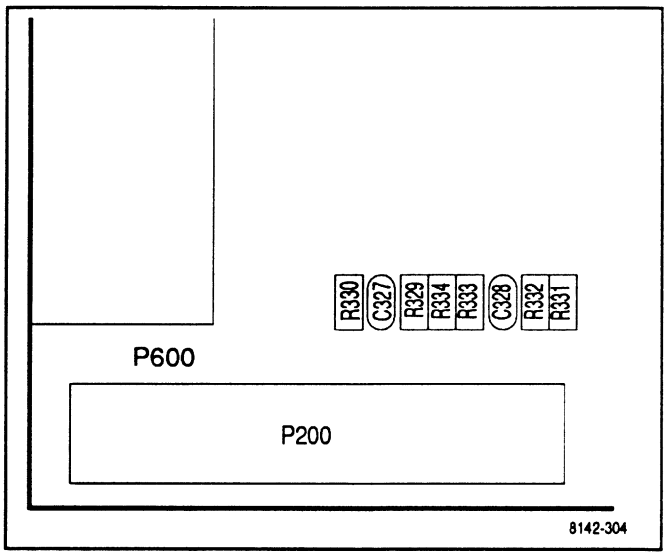


Fig. 8-9. Portion of Fast Output board (A4) showing location of Delay change capacitors.

Variable Output Channels (PG 2011 and PG 2012 CH2)

NOTE

In the case of the PG2012 this adjustment must be performed first.

Delay change is accomplished by adding/removing either 15 pF or 18 pF capacitors on the A2 Period Board. Capacitor locations are C120, C117, C121, C122, and C123, see Figs. 8-6 and 8-8. Adding capacitors will move the output pulse earlier in time with respect to the Trigger Out signal. Removing capacitors will have the opposite effect. In general, adding or removing one capacitor will make approximately a 500 ps timing change.

Fast Output Channels (PG 2010 and PG 2012 CH1)

Delay change is accomplished by adding/removing 15 pF or 18 pF capacitors on the A4 Fast Output board. Capacitor locations are C327 and C328, see Figs. 8-7 and 8-9. Adding capacitors will move the output pulse later in time with respect to the Trigger Output signal. Removing capacitors will have the opposite effect. In general, adding or removing one capacitor will make approximately a 500 ps timing change.

Section 9
ERROR MESSAGES

Introduction

The following information is used in conjunction witn the automated adjustment procedure. These error codes can be used to isolate and identify the defective module for repair purposes.

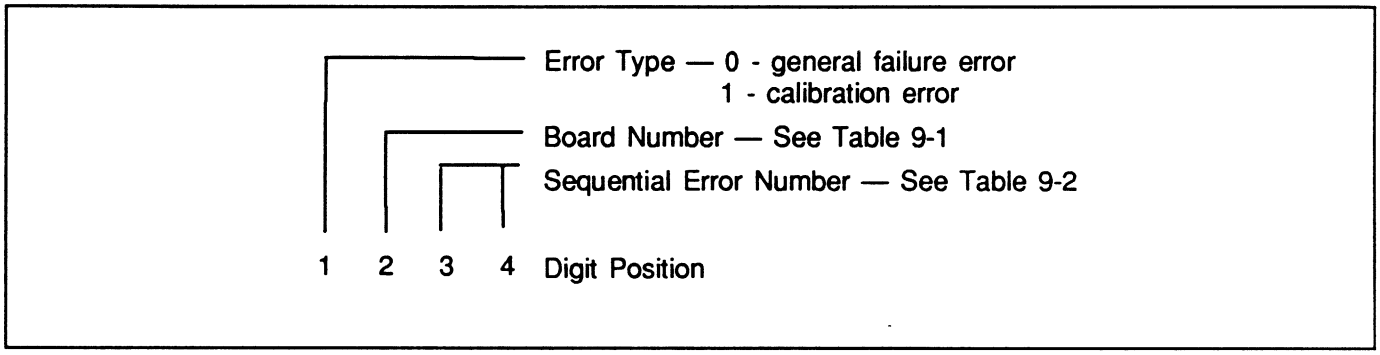


Fig. 9-1. Definition of 4 digit error code.

Error Codes and Messages

Table 9-1
Error Code Circuit Board Numbers

Second Error Digit Number	Circuit Board Description
0	A1 Period Board
1	A3 Width/Delay Board CH 1
2	A4 Fast Output Board/A7 Pico-second Board (PG 2010 or PG 2012 only)
2	A5 Variable Output Board (PG 2011 only)
3	A3 Width/Delay Board CH 2
4	A4 Fast Output Board/A7 Pico-second Board (PG 2010 only)
4	A5 Variable Output Board (PG 2011 or PG 2012 only)

Table 9-2
Error Code Message Numbers

Third & Fourth Error Digit Numbers	Error Message Description
0001	GPIB error - PG 201X (ibfind error)
0002	GPIB error - COUNTER (DC 5010 ibfind error)
0003	GPIB error DVM (DM 5010 or DM 5110 ibfind error)
0004	GPIB error - PG201X (communication error)
0005	GPIB error - COUNTER (DC 5010 communication error)
0006	GPIB error - DVM (DM 5010 or DM 5110 communication error)
0007	GPIB error
0008	DEVICE error - device error message
0009	Instrument version conflict with calibration program version

Table 9-2 cont

Third & Fourth Error Digit Numbers	Error Message Description
0010	PG 201X warm-up is not complete, calibraton available after xx minutes
A2 Period Board Errors	
1001	Can't read counter
1002	Can't read DVM
1010	Internal rate out of range (rate >100 ns or rate 99.99 ns)
1011	Period card out of calibration range (Vco high freq)
1012	Period card out of calibration range (Vco low freq)
1013	Period card cannot be calibrated (number of break points >14)
1018	Trigger Level cannot be calibrated - out of upper limit
1019	Trigger Level cannot be calibrated - out of lower limit
A3 Width/Delay Board Errors	
1x00	A3 Width/Delay Board out of range V0,WD0,WD1,D0,D1,D2,W0,W1,D1,S0,S1 ,S2
	V0 - Vco<19 ns or Vco>20.5ns
	X0 - (PORT0 3810 - PORT0 450)<23 ns (START 21ns)
	X1 - (PORT0 3200 - PORT0 450)>21 ns (START 22 ns)
	X2 - PORT0 450<-1.5 ns or >0.5 ns†
1x10	Fixed Vco out of range (Vco<19 ns or Vco>20.5)
1x11	A3 Width/Delay Board out of range WIDTH+DELAY (point 7 - point 1 >21 ns)
1x12	A3 Width/Delay Board out of range DELAY (point 7 - point 1>21 ns)
1x13	A3 Width/Delay Board out of range WIDTH (point 7 - point 1>21 ns)

†See special component selection procedure section

Table 9-2 cont

Third & Fourth Error Digit Numbers	Error Message Description
1x14	A3 Width/Delay Board out of range START (point 7 - point 1>20 ns)
1x15	A3 Width/Delay Board out of range WIDTH RANGE (width range >10 ns or <5 ns)
1x16	A3 Width/Delay Board out of range DELAY RANGE (delay range >10 ns or <5 ns)
1x17	A3 Width/Delay Board out of range
1x20	A3 Width/Delay Board cannot be calibrated (number of break points >10)

x — Width/Delay board number 1 or 3 (see Table 9-1)

A5 Variable Output Board Errors	
1x10	Level out of limit - (high >-1.0 or low <1.0)
1x11	Level out of limit - A/D upper limit (9.99V >4085)
1x12	Level out of limit - A/D lower limit (-9.99V <10)
1x13	Level out of limit - high level upper limit (9.99V >4085)
1x14	Level out of limit - high level lower limit (-9.50V <10)
1x15	Level out of limit - low level upper limit (9.50V >4085)
1x16	Level out of limit - low level lower limit (-9.99V <10)
1x2y	Transition out of range - RISE range y
1x3y	Transition out of range - FALL range y

x — Output board number 2 or 4 (see Table 9-1)
y — Transistion range 0 - 5

Table 9-2 cont

Third & Fourth Error Digit Numbers	Error Message Description
A4 Fast Output and A7 Pico-second Boards Errors	
1x10	Level out of limit - (high -0.5 or low 0.5)
1x11	Level out of limit - A/D upper limit (2.50V >4085)
1x12	Level out of limit - A/D lower limit (-2.50V <10)
1x13	Level out of limit - high level upper limit (2.50V >4085)
1x14	Level out of limit - high level lower limit (-1.20V <10)
1x15	Level out of limit - low level upper limit (1.90V >4085)
1x16	Level out of limit - low level lower limit (-2.50V <10)
1x17	Level out of limit - (high -1.5 or low 1.5 - fast output)

x - Output board number 2 or 4 (see Table 9-1)

Section 10
MAINTENANCE

GENERAL INFORMATION

Introduction

This section of the manual provides maintenance instructions and servicing information for the PG 201X.

WARNING

Dangerous potentials exist at several points throughout the instrument. When the instrument must be operated with the cabinet removed, do not touch exposed connections or components. Disconnect power before cabinet removal, cleaning, or replacing parts.

Static-Sensitive Components

CAUTION

Static discharge may damage semiconductor components in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 10-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a grounded wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
5. Allow nothing capable of generating or holding a static charge on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.
8. Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.
9. Use a soldering iron that is connected to earth ground.
10. Use only special antistatic suction type or wick type desoldering tools.

Test Equipment

Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

Table 10-1
RELATIVE SUSCEPTIBILITY TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels[a]
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

[a]Voltage equivalent for levels:
1 = 100 to 500 V
2 = 200 to 500 V
3 = 250 V
4 = 500 V
5 = 400 to 600 V
6 = 600 to 800 V
7 = 400 to 1000 V (est.)
8 = 900 V
9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 ohms.)

Cleaning Instructions

This instrument should be cleaned as often as operating conditions require. Loose dust accumulated on the outside of the instrument can be removed with a soft cloth or small brush. Remove dirt that remains with a soft cloth dampened in a mild detergent and water solution. Do not use abrasive cleaners.

CAUTION

To clean the front panel use freon, isopropyl alcohol, or denatured ethyl alcohol. Do not use petroleum based cleansing agents. Do not use air or any solvent to clean the Display (front panel) board. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

The best way to clean the interior is to blow off the accumulated dust with dry, low-velocity air (approximately 5 lb/in^2) or use a soft brush or cloth dampened with a mild detergent and water solution.

Hold the board such that the residue runs away from the connectors. Do not scrape or use an eraser to clean the edge connector contacts. Abrasive cleaning can remove the gold plating.

CAUTION

Circuit boards and components must be dry before applying power.

Obtaining Replacement Parts

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be obtained from a local commercial source. Before purchasing or ordering parts from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is important to include all of the following information.

1. Instrument type (include modification or option numbers).
2. Instrument serial number.
3. A description of the part (if electrical, include the component number).
4. Tektronix part number.

REPACKAGING FOR SHIPMENT

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing: owner (with address) and the name of an individual at your firm that can be contacted, complete instrument serial number, and a description of the service required.

Save and re-use the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and in-

strument, on all sides. Seal carton with shipping tape or industrial stapler.

The carton test strength required for your instrument is 200 pounds.

Soldering Techniques

WARNING

To avoid electric shock hazard, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic-grade solder. The choice of soldering iron is determined by the repair to be made.

When soldering on circuit boards or small wiring, use only a 15 watt, pencil type iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

Semiconductors

To remove the in-line integrated circuits installed in sockets, use an extracting tool. This tool is available from Tektronix, inc.; order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid disengaging one end before the other. IC's that are soldered in should be carefully unsoldered, using commercially available de-soldering tools. If these tools are not available, the pins in the IC may be clipped with diagonal cutters, and the pins then individually removed from the board.

Battery Replacement

Error 360 Save Ram Failure or the inability to turn off the instrument from the ON/STBY front panel switch may indicate the need to replace the battery.

The battery is located on the A1 MPU board assembly, see exploded view Figure 3. Replacement is accomplished by removing the A1 assembly from the instrument. Observe the battery polarity connections, then unsolder the old battery. Solder the replacement battery in place observing the correct polarity connections and reassemble the instrument.

CAUTION

Precautions must be taken to avoid damaging/discharging the replacement battery with a grounded soldering iron.

Lithium Battery Disposal Information

WARNING

The battery used in this instrument should last about five years. This is a safety controlled part, and should be replaced with the same part number.

To avoid personal injury, observe the following proper procedures for handling and disposal of lithium batteries. Improper handling may cause fire, explosion or severe burns. Don't recharge, crush, disassemble, heat the battery above 212° F (100° C), incinerate, or expose contents of the battery to water. Dispose of battery in accordance with local, state, and national regulations.

Typically, small quantities (less than 20) can be safely disposed of with ordinary garbage in a sanitary landfill.

Larger quantities must be sent by surface transport to a Hazardous Waste Disposal Facility. the batteries should be individually packaged to prevent shorting and packed in a sturdy container that is clearly labeled "Lithium Batteries — DO NOT OPEN".

PG 201X DISASSEMBLY

WARNING

Before removing the instrument cabinet, turn the main power switch off and disconnect the line voltage cord.

Refer to exploded view Figure 1 and remove the side grounding screw and the four (4) screws securing the rear panel assembly. The instrument cabinet may now be removed from the chassis by sliding it toward the rear of the instrument..

Module Removal

Refer to exploded view Figures 2, 3, and the additional information when attempting the following procedures.

- **Access to modules A2 through A7** require that the outside card guide bracket (2-40) be removed. This is accomplished by removing all screws in the bracket, removing the two retaining clips, and swinging the outside card bracket up and away from the chassis.
- **A4 (Fast Output) and A5 (Variable Output) assemblies** have an additional heat sink mounting screw that must be removed.
- **A6 (Interconnect)** is secured to the chassis with six (6) screws.
- **A7 (Pico-second)** removal requires that the single screw securing the heat sink under the A2 (Period) must be removed as well as the three (3) circuit board hold-down screws.
- **A9 (CRT Display)** removal is accomplished by removing the six (6) hold-down screws and lifting the assembly up and out of the chassis.
- **A10 (Front Panel)** snaps out after the trim ring (bezel) is removed.
- **A11 (Power Supply)** also snaps out of its plastic mounting bracket.

SECTION 11
RACK ADAPTER

INTRODUCTION

DESCRIPTION

The TEKTRONIX PG 20XX Series Instruments can be mounted into a standard 19-inch equipment rack using the PG20XX Series Rackmounting Kit or by ordering Option 1R. Assembling the Rackmounting Conversion Kit and mounting the adapted instrument in accordance with the following instructions allows the instrument to meet the electrical characteristics stated in both its Operators Manual and Service Manual. Changes to the standard instrument's environmental specification are explained in the following paragraphs. Should mounting methods other than those described in these procedures be used, the instrument may not meet the stated environmental characteristics for temperature, shock, and vibration.

CLEARANCE REQUIREMENTS

The dimensional drawing in Fig. 11-1 illustrates the assembled rack adapter and instrument. At least 7 inches (178 mm) of vertical space is required to mount the instrument (with the attached adapter) into an equipment rack. Minimum width between the left- and right-front rails in the rack must be 17 5/8 inches (448 mm). Total depth of the rack must be at least 20 inches (508 mm). These clearances provide sufficient space for air circulation and accommodation of the power cord and mounting hardware.

TOOLS REQUIRED

The following tools are required to attach the rackmount adapter and install the rackmounted instrument into a standard equipment cabinet.

Phillips-head screwdriver
T-15 Torx-head screwdriver
T-20 Torx-head screwdriver
5/16-inch wrench or nut driver
7/16-inch wrench or nut driver

ENVIRONMENTAL REQUIREMENTS FOR RACKMOUNTED INSTRUMENTS

The environmental specification listed in the associated Operators and Service Manuals apply to the rackmounted instrument.

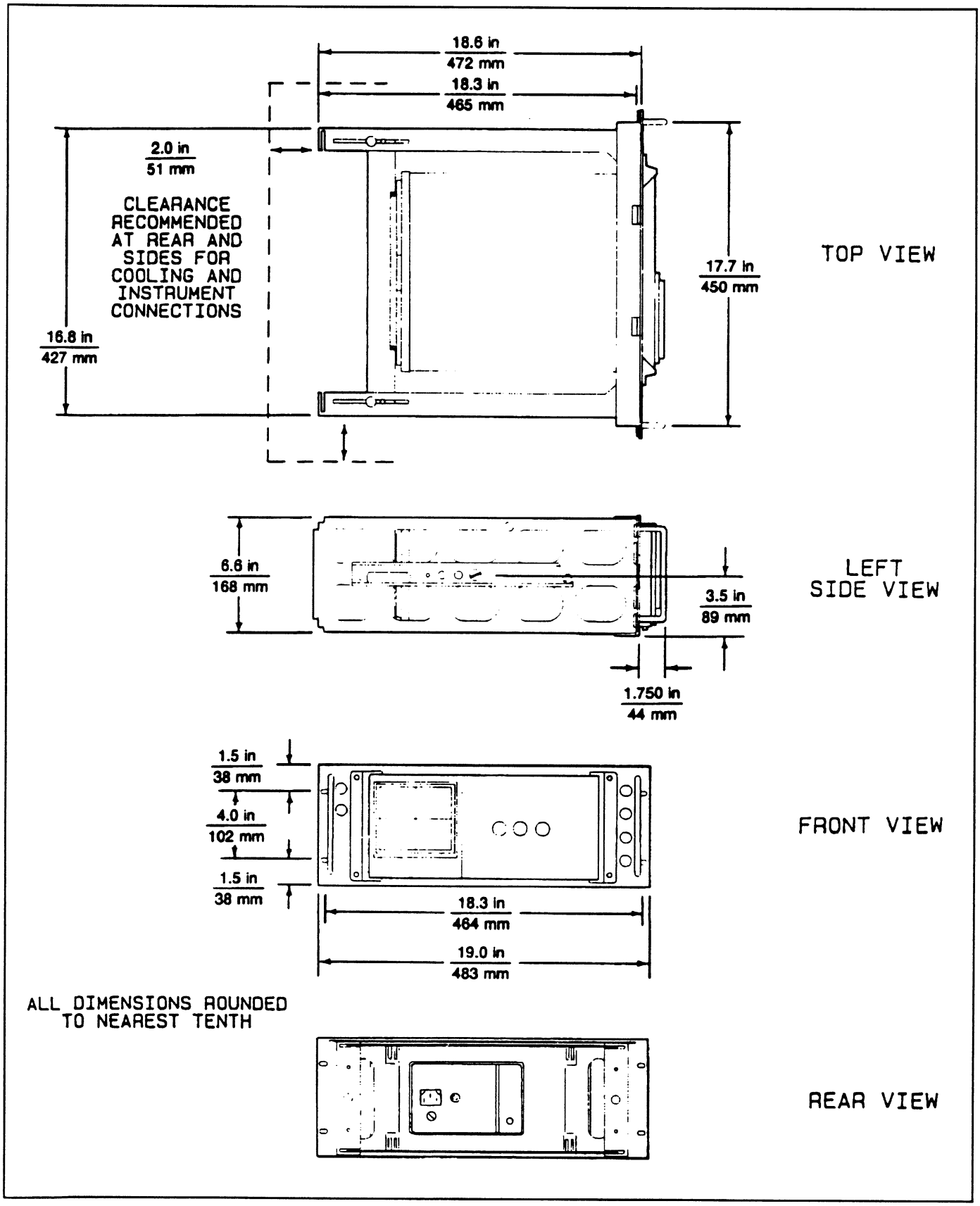


Fig. 11-1. Dimensional drawing.

MOUNTING PROCEDURE

NOTE

If your instrument was purchased in the rackmount configuration (Option 1R), the first steps in the following section were performed at the factory. Proceed to the section titled "INSTALLING THE OPTION 1R AND RACK-ADAPTED INSTRUMENTS".

ATTACHING THE ADAPTER

The rackmounting conversion kit contains the necessary hardware and the directions (this Instruction Sheet) for converting a standard instrument into a rackmounted instrument.

To convert the standard instrument to the rack-adapted version, perform the following steps.

NOTE

All parts removed from the instrument in this procedure should be saved. Some of them will be needed to perform this rack conversion, and the remainder will be needed if reconversion to a standard instrument configuration is desired at a later time.

1. Disconnect the power cord from the power source and detach it from the rear of the instrument. The power cord is secured to the rear panel by a cord-set securing clamp which can easily be removed by rotating the clamp one quarter of a turn in either direction and pulling it out of the rear panel.

2. Place the instrument face down on a smooth work surface.

3. Using a # T15 Torx tip screwdriver, remove the four torx-head screws retaining the instrument's rear cover and one torx-head screw from the right side of the cabinet. Retain this last screw for later use. Note cabinet and rear-cover orientation, then lift the cover from the cabinet.

4. Slide the wrap-around cabinet off the instrument, using care not to pull on any internal instrument wiring.

5. Using a # T20 Torx tip screwdriver, remove the two torx-head screws retaining the cabinet handle and remove the handle. Remove the two front feet from the cabinet by rotating counter-clockwise while pulling them out of the cabinet.

NOTE

The numbers appearing in parentheses refer to the numbers shown in the mechanical parts exploded view, Fig. 11-7, at the rear of this Instruction Sheet.

6. On the rack-adapter chassis, loosen (but don't remove) the four posidrive-head screws (16) with lock washers (17) and the four torx-head screws (14) with nylon washers (15) holding the rear cabinet support (21) in position. Slide the support to the rear of the rack adapter.

7. Place the rear of the rack adapter on a smooth work surface so the chassis is standing face up.

8. Place the instrument's rear cover on top of the rear cabinet support (21). Orient the instrument's rear cover so that the feet are toward the bottom.

9. Insert the cabinet into the rack adapter through the top or bottom of the adapter chassis so that it mates with the rear panel as noted in Step 3 (cabinet seam should be on the bottom and the handle holes nearest the front.)

WARNING

The exposed edges of the cabinet may have sharp edges. Use care not to pinch fingers while installing the instrument into the cabinet during the next step.

10. Orient the instrument to mate with the cabinet and rear cover as noted in step 3, then slide the instrument into the wrap-around cabinet, using care not to pull on any internal instrument wiring.

11. Install the left and right instrument front support brackets (1) using the four screws (2) and four washers (3). Keeping a snug fit against the instrument, tighten the four screws (2).

12. Place the rack adapter face down and install the four screws (22) through the rear support bracket (21) and instrument rear cover into the instrument chassis. Check that the instrument cabinet and rear cover are mated correctly and tighten the four screws.

13. Place the rack adapter on either its top or bottom and being careful not to push the instrument forward, tighten the four screws (16) with lock washers (17). Next, tighten the four screws (14) with nylon washers (15), two of each on each side (top and bottom).

14. Using a # T20 Torx-head screwdriver, remove the screw (12) from the rear of the right chassis slide track and pivot the slide track to allow access to the screw location at the rear of the cabinet's side. Using a # 15 Torx-head screw driver, install the screw removed in Step 3.

15. Pivot the slide rail back into position and re-install the screw (12) and tighten.

Rack conversion of the instrument is now complete. To install the converted instrument into a standard 19-inch rack, use the following procedures.

INSTALLING THE OPTION 1R AND RACK-ADAPTED INSTRUMENTS

NOTE

The rack hardware kit contains hardware needed for mounting the instrument in several configurations. All of the hardware in the kit will not be used.

The slide-out tracks permit the instrument to be extended out of the rack for rear-panel and connector maintenance without removing the instrument from the rack. When the tracks are fully extended, the instrument may be tilted up for easier access to the rear- panel connectors. To operate the instrument in the extended position, be sure the power cord and any interconnecting cables are long enough for this type of use.

To install the rack-adapted instrument into a standard 19-inch rack using the rear-support kit, perform the following procedure.

WARNING

During rackmount installation, interchanging the left and right slide-out track assemblies defeats the extension stop (safety latch) feature of the tracks. Equipment could, when extended, come out of the slides and fall from the rack, possibly causing personal injury and equipment damage.

NOTE

In an environment where the rackmounted instrument will be subject to severe vibration and shock, the supplied rear-support kit (Tektronix Part Number 016-0096-00) must be used. See Fig. 11-4.

1. Select appropriate front-rail mounting holes on the equipment rack cabinet, verifying the 7-inch (178 mm) vertical clearance requirements as shown in Fig. 11-2.

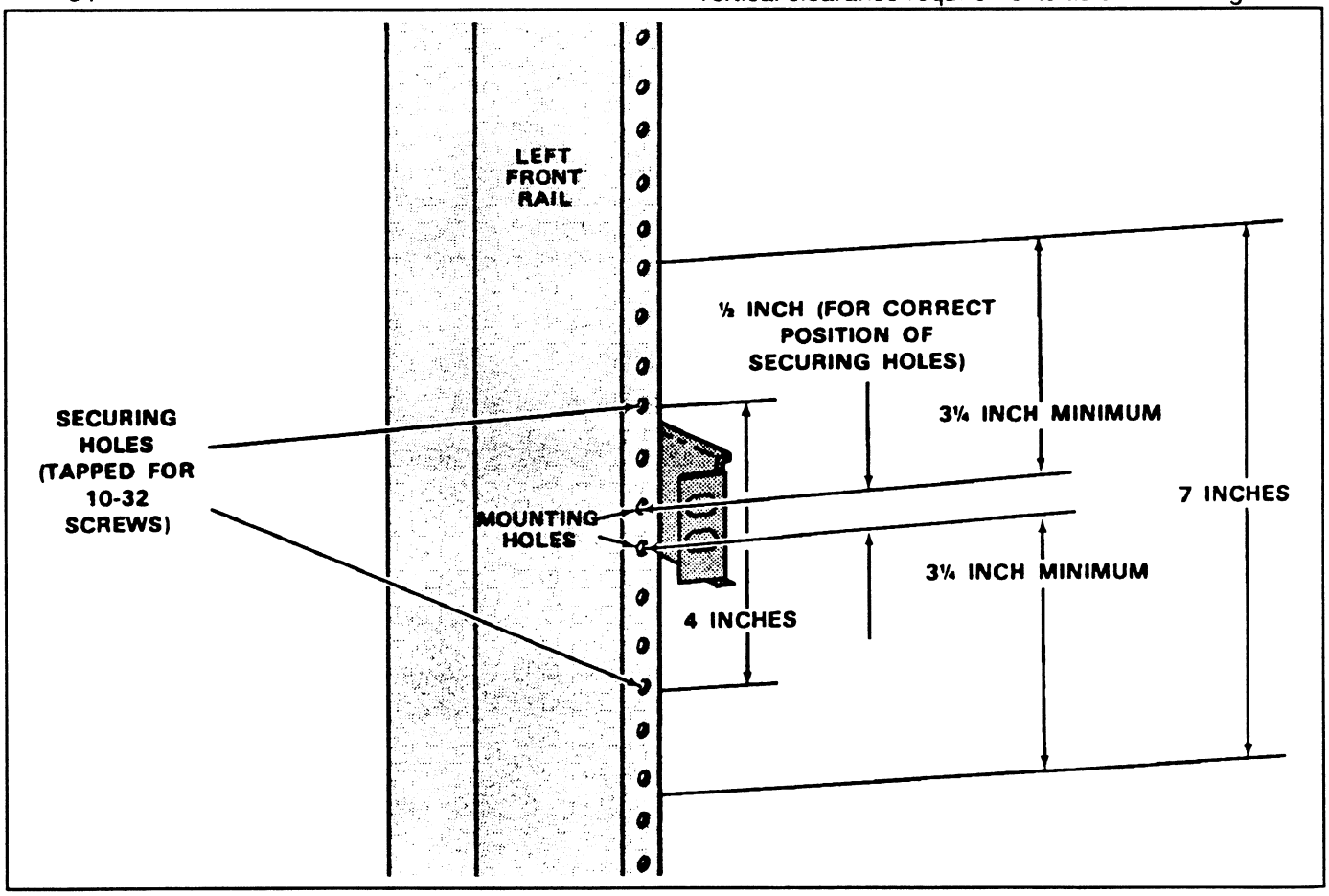


Fig. 11-2. Locating mounting holes for the stationary sections

2. If the mounting flanges of the stationary section are to be mounted in front of the front rails, attach as shown in Fig. 11-3A. If the mounting flanges are to be mounted behind the front rails, attach them using the bar nuts as shown in Fig. 11-3B.

NOTE

The holes in the spacer block (Fig. 11-4) are not centered. The spacer blocks must be mounted with their narrow edges toward the front of the rack. This allows the instrument to slide fully into the rack.

3. Attach an angle bracket to each of the rear rails by inserting the mounting bolts through the angle brackets, spacer blocks, stationary sections of the slide-out tracks, and into the rear support members of the rack cabinet, assembling the parts as shown in Fig. 11-4. The bolts should be fully inserted and lightly seated, but not tightened at this time.

4. Attach the support pins to the angle brackets as shown in Fig. 11-4, temporarily leaving out the spacers between the neoprene support washers and flat washers.

5. Install a support block on each rear corner of the rack-adapter chassis.

6. If you desire to let the instrument tilt up as shown in Fig. 11-5 (for maintenance purposes), remove the swivel retaining screw from the rear of each chassis rail before performing the next step. Fig. 11-6 illustrates the location of the swivel retaining screw in the chassis rails.

7. Insert the slide-out tracks attached to the rack-adapter chassis into the stationary tracks mounted in the rack cabinet. Slide the rack-adapted instrument fully into the rack cabinet.

NOTE

Do not install the power cord or front panel securing screws until Steps 8 through 13 have been performed.

8. With the instrument pushed all the way into the rack, adjust the angle brackets at the rear of the instrument until the neoprene washers on the support pins are firmly seated against the support blocks at the rear of the instrument.

9. Tighten the rear mounting bolts; then pull the instrument partially out of the rack.

10. Remove the neoprene washers, install spacers on the support pins, and re-install the neoprene washers.

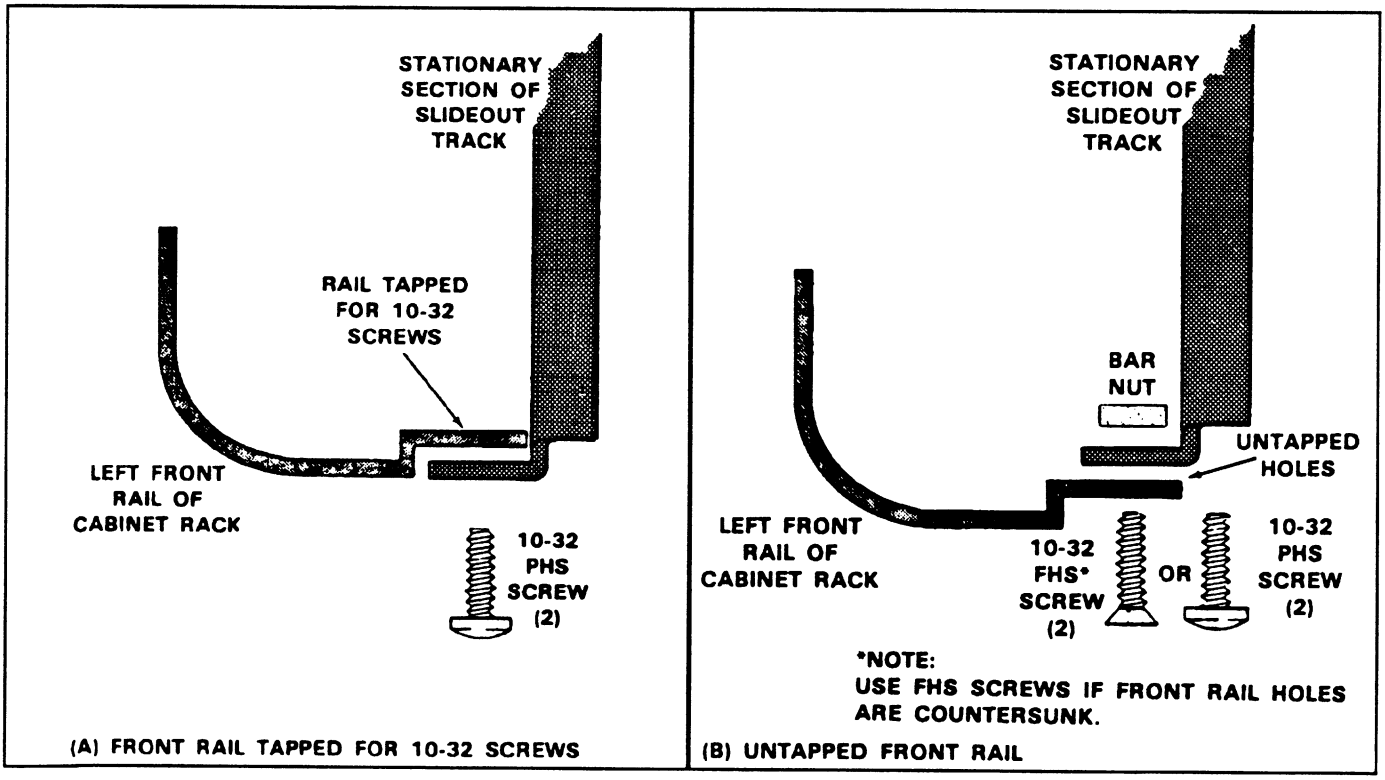


Fig. 11-3. Methods of mounting the stationary sections to the front rails.

11. Position the instrument so the pivot screws are approximately even with the front rails.

12. Loosen the mounting screws at the front of both stationary track sections (the two screws attached to each front rail of the cabinet) and allow the tracks to seek their normal positions.

13. Retighten the screws and push the instrument all the way into the rack. If the tracks do not slide smoothly, recheck track alignment as set in Steps 8 through 13.

14. Attach the power cord and any other cabling to the rear of the instrument.

15. With the instrument pushed all the way into the rack cabinet, install and tighten the mounting screws at the four corners of the rack adapter's front panel.

ALTERNATE MOUNTING METHOD

CAUTION

Although the following method provides satisfactory mounting under normal conditions, it does not provide solid support at the rear of the instrument. Should the instrument be subjected to severe shock or vibration when mounted in the following manner, it may be damaged.

The rear-support extension brackets supplied with the rack adapter chassis tracks (see Fig. 11-6) allow the rack-adapted instrument to be mounted in equipment cabinets having front-to-rear rail spacings between 14 inches and 26 inches. Depending on how the rear-support brackets are attached to the cabinet's rear rail, mounting points for the rear of the stationary track can be provided either in front of or behind the rear cabinet rail. The rear-support kit cannot be properly used with this type of installation.

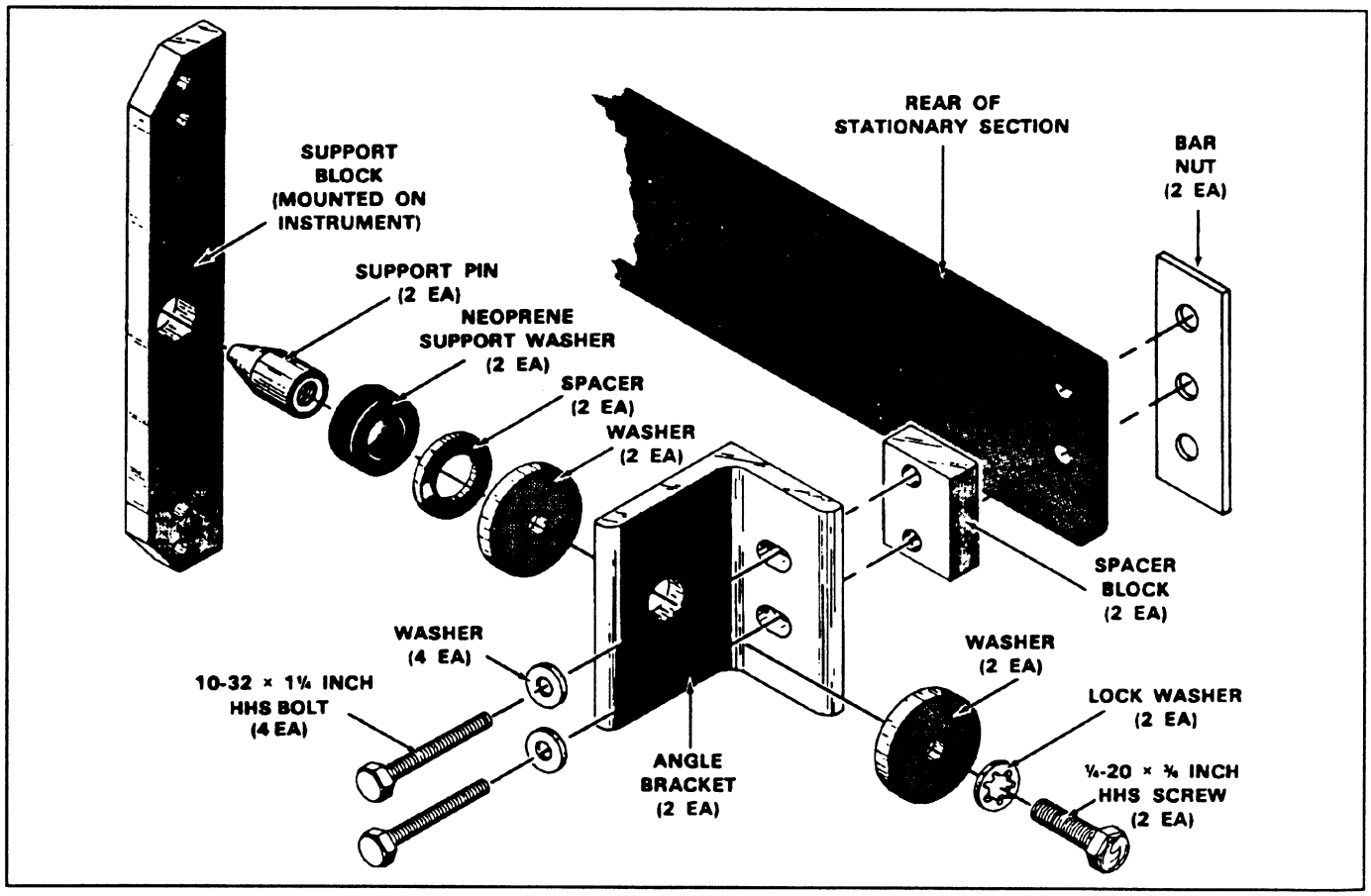


Fig. 11-4. Rear support kit.

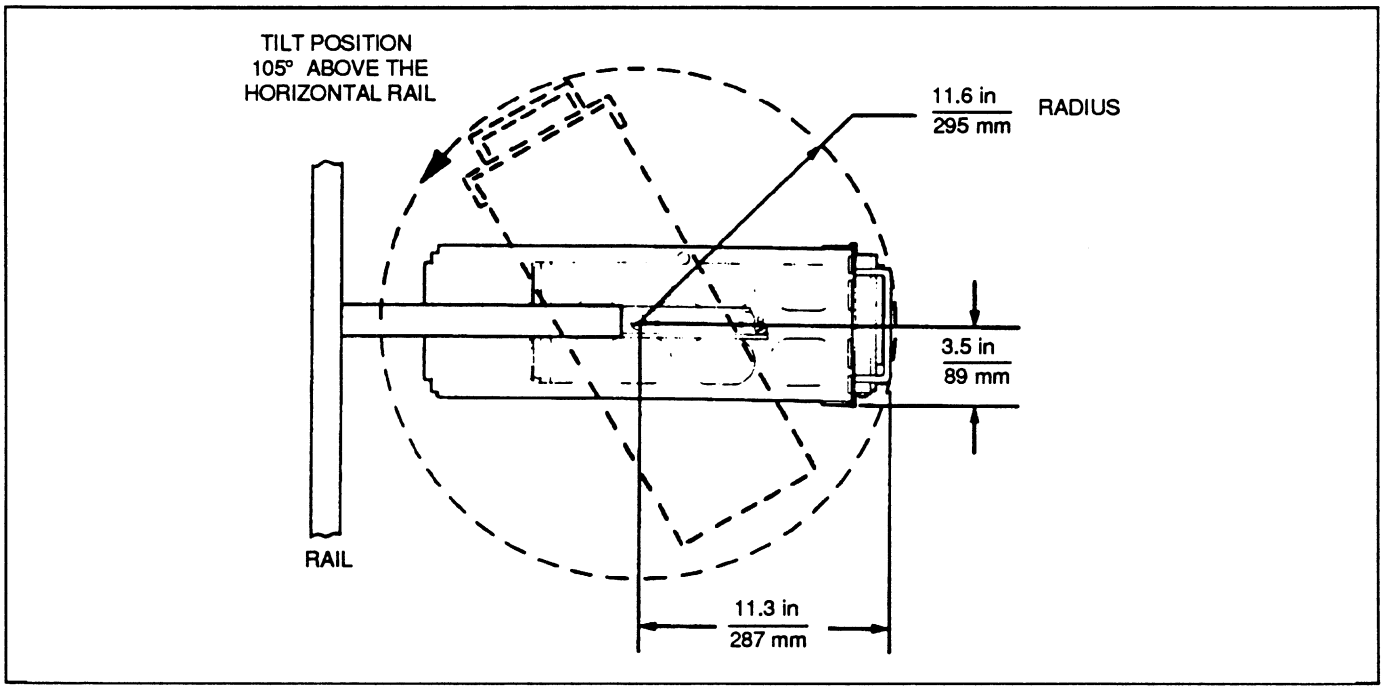


Fig. 11-5. Tilting the rack-adapted instrument.

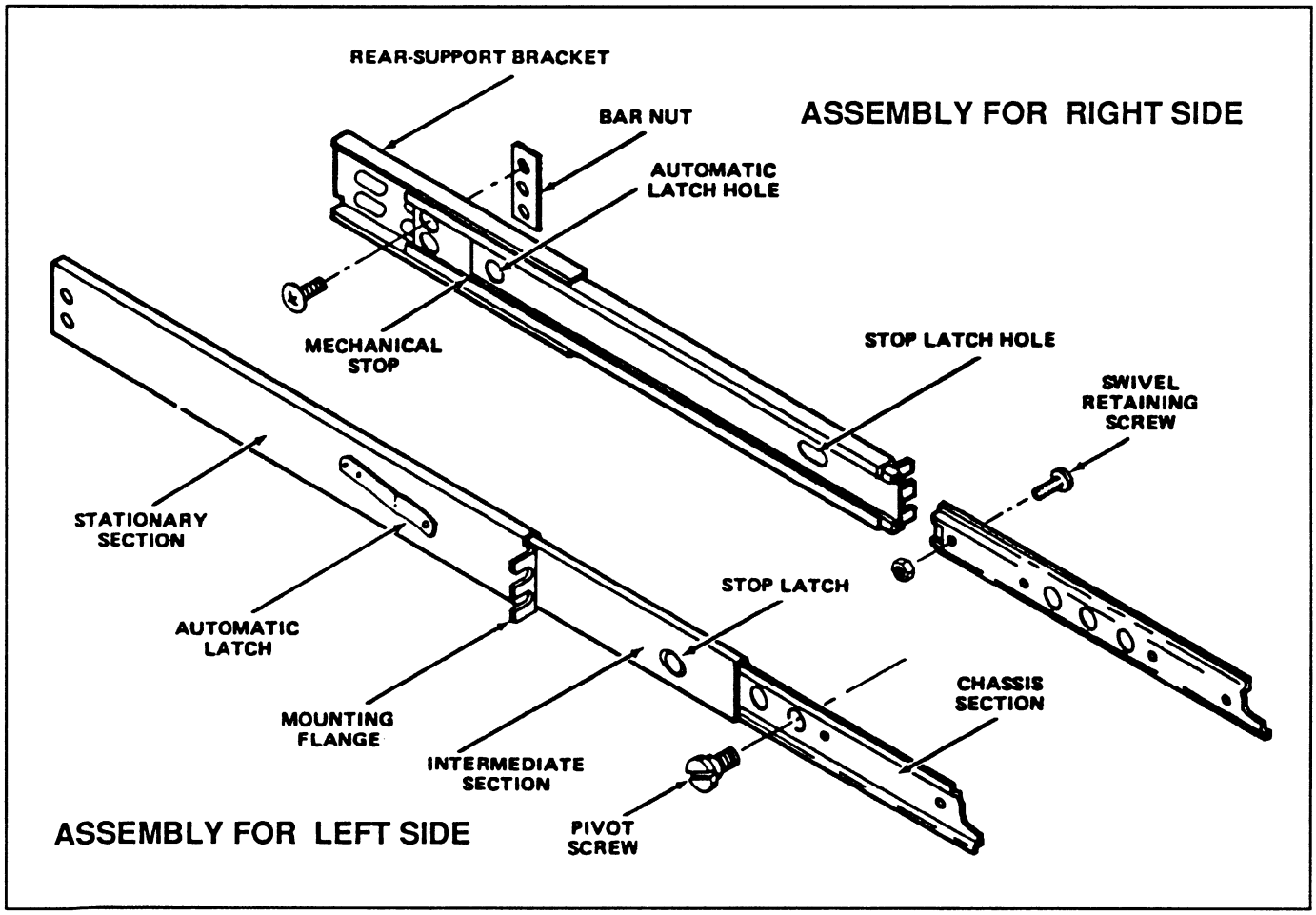


Fig. 11-6. Slide-out track assembly.

CROSS INDEX – MFR.CODE TO MANUFACTURER

Mfr Code	Mfr. Name	Address	City, State, Zip Code
06666	GENERAL DEVICES CO INC	1410 S POST RD P O BOX 39100	INDIANAPOLIS IN 4623
06915	RICHCO PLASTIC CO	5825 N TRIPP AVE	CHICAGO IL 60646
11897	PLASTIGLIDE MFG COPR	2701 W EL SEGUNDO BLVD	HAWTHORNE CA 90250
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125
63743	WARD LEONARD ELECTRIC CO INC	31 SOUTH ST	MOUNT VERNON NY 10550
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIVISION	ST CHARLES ROAD	ELGIN IL 60120
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR P O BOX 500	BEAVERTON OR 97077-0001
83385	MICRODOT MANUFACTURING INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
83486	ELCO INDUSTRIES INC	1101 SAMUELSON RD	ROCKFORD IL 61101
91836	KINGS ELECTRONICS CO INC	40 MARBLEDALE ROAD	TUCKAHOE NY 10707
93907	TEXTRON INC CAMDAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181
TK0435	LEWIS SCREW CO	4114 S PEORIA	CHICAGO IL 60609-3320
TK1498	VEMALINE PRODUCTS CO INC	487 JEFFERSON BLVD	WARWICK RI 02886
TK1908	PLASTIC MOLDED PRODUCTS	4336 SO ADAMS	TACOMA WA 98409

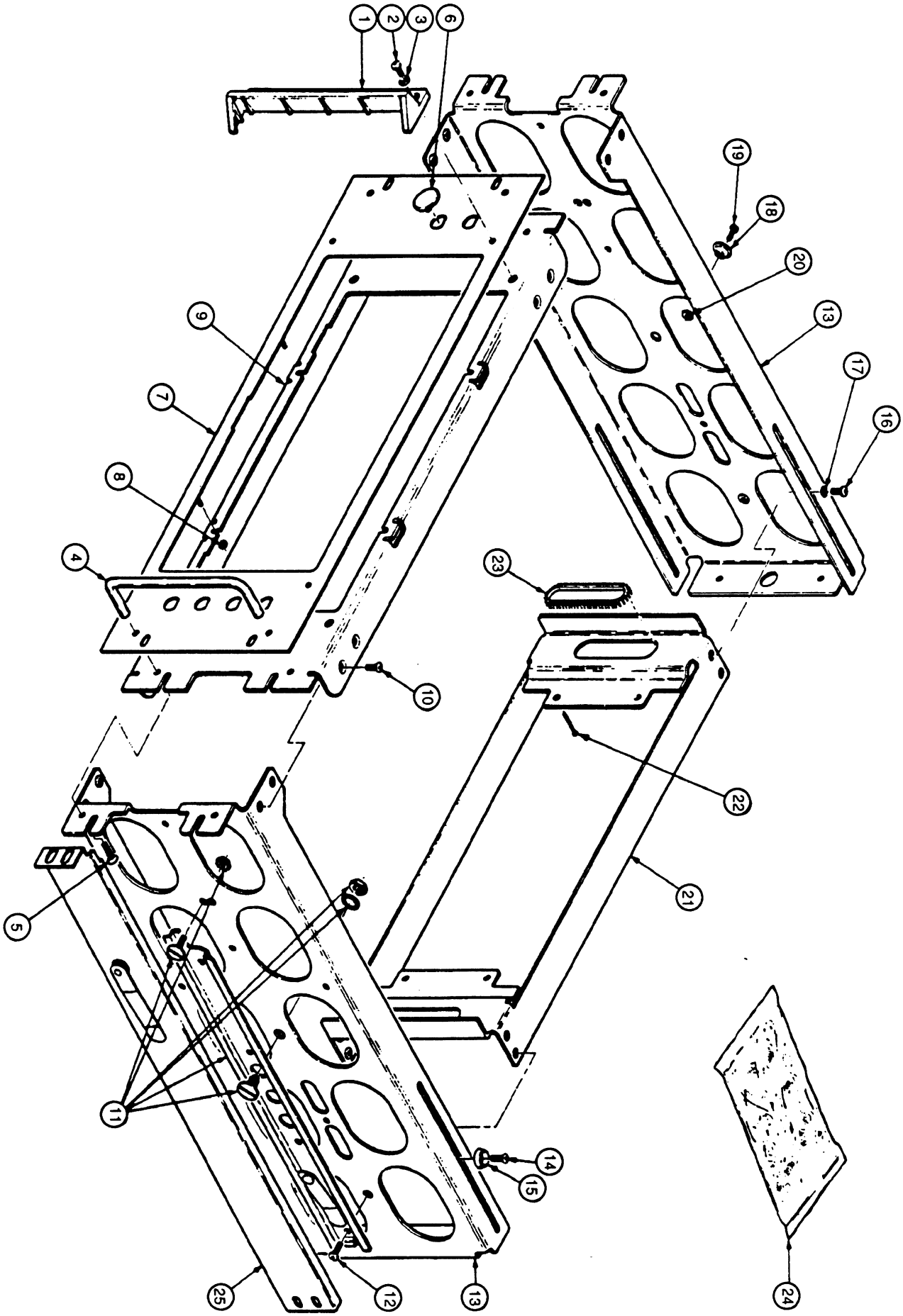
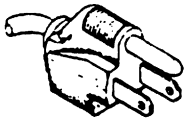
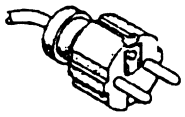
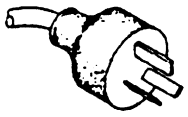
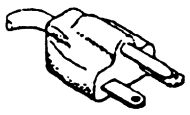
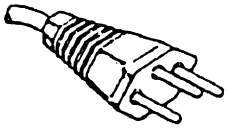


Fig. 11-7. Exploded View

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Discont	Qty	12345	Name & Description	Code	Mfr. Part No.
7-1	386-5564-00			2		SUPPORT,FRONT:POLYCARBONATE	TK1908	ORDER BY DESCR
						ATTACHING PARTS		
-2	212-0008-00			4		SCREW,MACHINE:8032 X 0.5,PNH,STL	83385	ORDER BY DESCR
-3	210-0864-00			4		WASHER,FLAT:0..188 ID X 0.375 OD X 0.05,STL	12327	ORDER BY DESCR
						END ATTACHING PARTS		
-4	367-0359-00			2		HANDLE,CARRYING:5.0 L,BRASS,CRM PL	TK1498	VPC=934
-5	212-0671-00			4		SCREW,MACHINE:10-32 X 0.625,FLH,STL,TORX	83486	ORDER BY DESCR
-6	134-0144-01			6		BUTTON,PLUG:0.876 OD X 0.08,SMOKE TAN	80009	134-0144-01
-7	333-3466-00			1		PANEL,FRONT:	80009	333-3466-00
						ATTACHING PARTS		
-8	210-0586-00			4		NUT,PL,ASSEM WA:4-40 X 0.25,STL CD PL	78189	211-041800-00
						END ATTACHING PARTS		
-9	426-2185-00			1		FRAME PNL,CAB:	80009	426-2185-00
						ATTACHING PARTS		
-10	212-0159-00			8		SCREW,MACHINE:8-32 X 0.375,FLH,100 DEG,STL	93907	ORDER BY DESCR
						END ATTACHING PARTS		
-11	351-0104-00			1		SL SECT,DRW EXT:12.625 X 2.25	06666	C-720-2
						(UNIT OF MEASURE IS PAIR)		
						ATTACHING PARTS		
-12	212-0158-00			2		SCREW,MACHINE:8-32 X 0.375,PNH,STL	83486	ORDER BY DESCR
						END ATTACHING PARTS		
-13	426-2193-00			2		FRAME SECT,CAB.:LEFT & RIGHT	80009	426-2193-00
						ATTACHING PARTS		
-14	212-0157-00			4		SCREW,MACHINE:8-32 X 0.5,FLH,100 DEG,STL	83486	ORDER BY DESCR
-15	210-1143-00			4		WASHER,FNSH:U/W #8 FLATHEAD SCR,NYLON	11897	ORDER BY DESCR
-16	212-0158-00			4		SCREW,MACHINE:8-32 X 0.375,PNH,STL	83486	ORDER BY DESCR
-17	210-0007-00			4		WASHER,LOCK:#8 EXT,0.02 THK,STL	78189	1108-00-00-0541C
						END ATTACHING PARTS		
-18	210-0808-00			2		WASHER,RECESSED:0.173 X 0.156,BRS,0.562 OD	63743	25151.13-3
						ATTACHING PARTS		
-19	211-0721-00			2		SCREW,MACHINE:6-32 X 0.375,PHN,STL	83486	ORDER BY DESCR
-20	210-0457-00			2		NUT,PL,ASSEM WA:6-32 X 0.312,STL CD PL	78189	511-061800-00
						END ATTACHING PARTS		
-21	386-5362-00			1		SUPPORT,CABINET:REAR	80009	386-5362-00
						ATTACHING PARTS		
-22	211-0553-00			4		SCREW,MACHINE:6-32 X 1.5,PNH,STL	TK0435	ORDER BY DESCR
						END ATTACHING PARTS		
-23	255-0334-00			2		PLASTIC CHANNEL:12.75 X 0.175 X .0155,NYLON	11897	122-37-2500
						STANDARD ACCESSORIES		
-24	016-0099-00			1		HDW KIT, ELEC EQ:RACKMOUNTING HDW	80009	016-0099-00
						(FRONT)		
	016-0096-00			1		HDW KIT,ELEK EQ:RACKMOUNTING HDW	80009	016-0096-00
						(REAR)		
-25	351-0241-01			1		SLIDE,DWR,EXT:W/CLOSED MOUNTING SLOTS	80009	351-0241-01
						(UNIT OF MEASURE IS PAIR)		
	070-8238-00			1		SHEET,TECHNICAL:	80009	070-8238-00

SECTION 12
OPTIONS

Table 12-1
Power Cord Options

	North American 125 V/6 A	[1]ANSI C73.11 [2]NEMA 5-15-P [3]IEC 83 [10]UL 198.6 [11]CSA	Standard
	European 220 V/6 A	[3]IEC 83 [3]IEC 127 [4]CEE (7), II, IV, VII [8]VDE [9]SEMKO	A1
	United Kingdom 240 V/6 A	[3]IEC 83 [3]IEC 127 [5]BSI 1363	A2
	Australian 240 V/6 A	[6]AS C112 [3]IEC 127 [12]ETSA	A3
	North American 250 V/10 A	[1]ANSI C73.20 [2]NEMA 6-15-P [3]IEC 83 [10]UL 198.6 [11]CSA	A4
	Switzerland 240 V/6 A	[7]SEV [3]IEC 127	A5

[1]ANSI – American National Standards Institute
[2]NEMA – National Electrical Manufactures' Association
[3]IEC – International Electrotechnical Commission
[4]CEE – International Commission on Rules for the Approval of Electrical Equipment
[5]BSI – British Standards Institute
[6]AS – Standards Association of Australia
[7]SEV – Schweizevischer Elektrotechischer Verein
[8]VDE – Verband Deutscher Elektrotechniker
[9]SEMKO – Swedish Institute for Testing and Approval of Electrical Equipment
[10]UL – Underwriters Laboratories
[11]CSA – Canadian Standards Association
[12]ETSA – Electricity Trust of South Australia

Instrument Options

- Option 02 — adds a second channel to the PG 2010 and PG 2011 of the same type as the current channel.
- Option 1R — installs rackmount assembly onto PG 2010, PG 2011, or PG 2012 instrument.
- Option B1 — includes service manual as standard accessory.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

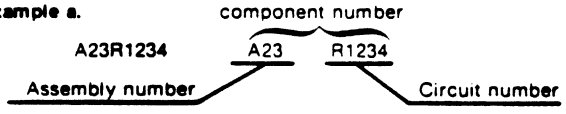
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

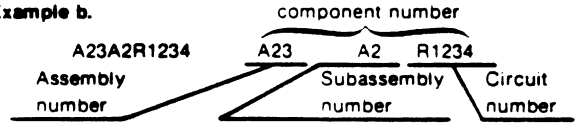
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

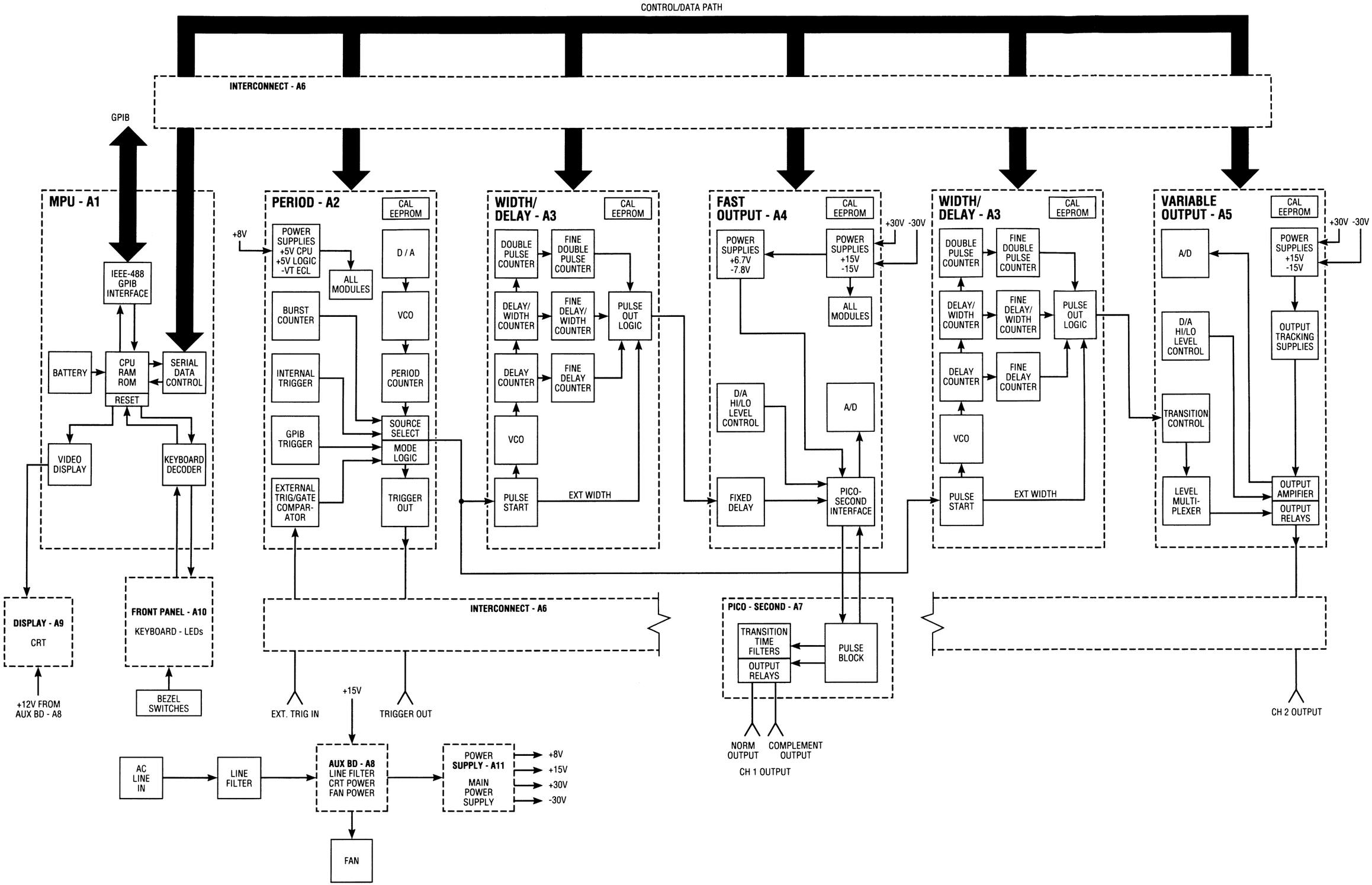
Indicates actual manufacturers part number.

CROSS INDEX - MFR. CODE TO MANUFACTURE

Mfr. Code	Manufacture	Address	City, State, Zip Code
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR	BEAVERTON OR 97077-0001

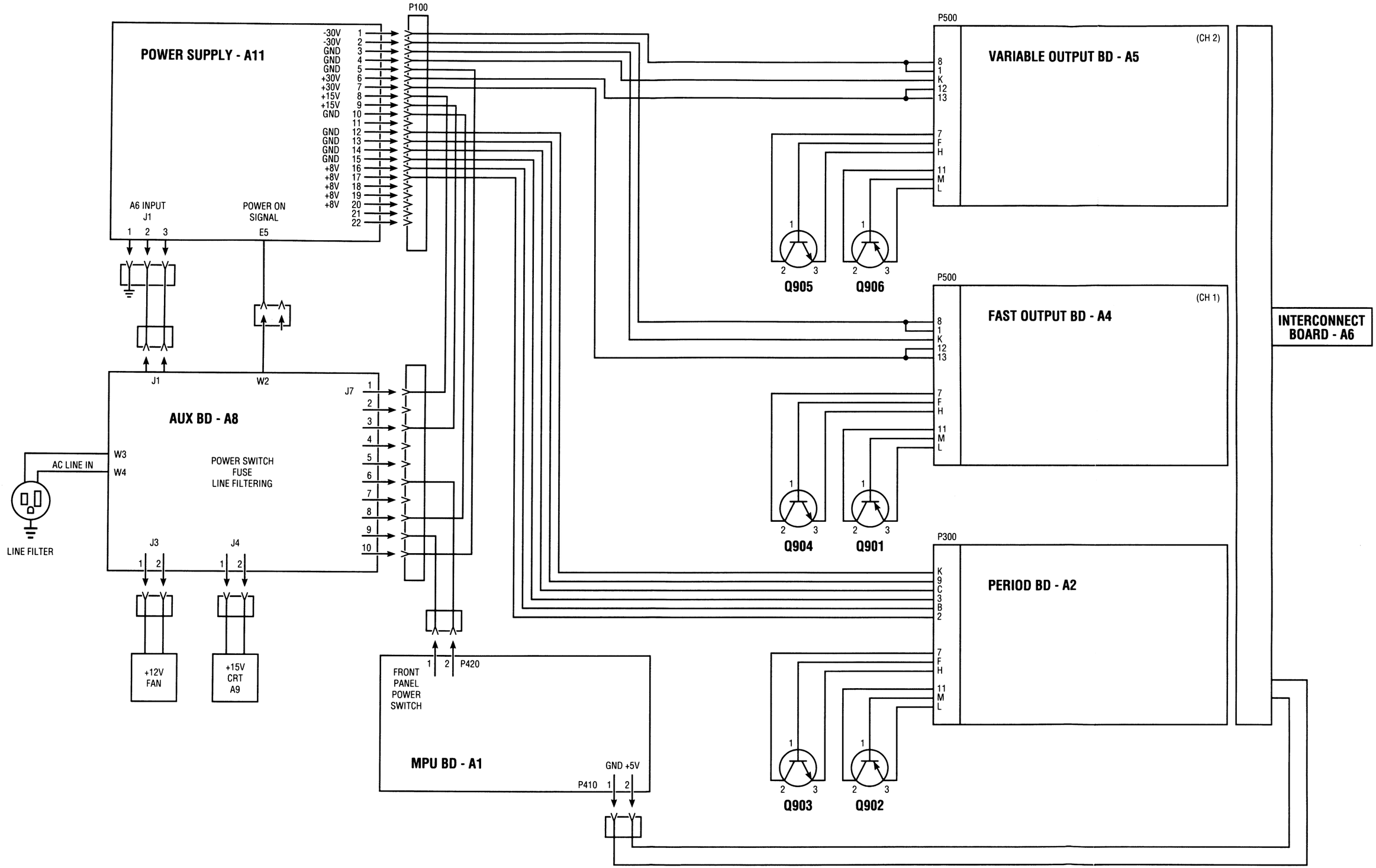
Component No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	118-8648-00			ECB ASSY, MPU	80009	118-8648-00
A2	118-8650-00			ECB ASSY, PERIOD	80009	118-8650-00
A3	118-8514-00			ECB ASSY, WIDTH/DELAY	80009	118-8514-00
A4	118-8651-00			ECB ASSY, FAST OUTPUT (PG 2010 AND PG 2012 CH1 ONLY)	80009	118-8651-00
A5	118-8649-00			ECB ASSY, VARIABLE OUTPUT (PG 2011 AND PG 2012 CH2 ONLY)	80009	118-8649-00
A6	118-8647-00			ECB ASSY, INTERCONNECT	80009	118-8647-00
A7	671-2022-01			ECB ASSY, PICO-SECOND (PG 2010 AND PG 2012 CH1 ONLY)	80009	671-2022-01
A8	671-1682-00			ECB ASSY, AUXILIARY POWER	80009	671-1682-00
A9	119-3917-00			ASSY;MONITOR;7 INCH MONOCHROME	80009	119-3917-00
A10	672-0282-00			ECB ASSY, FRONT PANEL	80009	672-0282-00
A11	119-4132-00			ASSY, POWER SUPPLY	80009	119-4132-00
BAT1	146-0091-00			BATTERY,STORAGE;3V,200mAH,LITHIUM	80009	146-0091-00
F1	159-0015-00			FUSE,CARTRIDGE;3AG,3A,125V	80009	159-0015-00
F401	159-0116-00			FUSE,CARTRIDGE;1A,125V	80009	159-0116-00
F402	159-0116-00			FUSE,CARTRIDGE;1A,125V	80009	159-0116-00
F403	159-0266-00			FUSE,CARTRIDGE;3A,125V	80009	159-0266-00
F404	159-0266-00			FUSE,CARTRIDGE;3A,125V	80009	159-0266-00
F501	159-0207-00			FUSE,CARTRIDGE;5A,125V	80009	159-0207-00
Q901	151-0918-00			TRANSISTOR;PNP PWR, 15A,80V	80009	151-0918-00
Q902	151-0918-00			TRANSISTOR;PNP PWR, 15A,80V	80009	151-0918-00
Q903	151-0917-00			TRANSISTOR;NPN PWR, 15A,80V	80009	151-0917-00
Q904	151-0917-00			TRANSISTOR;NPN PWR, 15A,80V	80009	151-0917-00
Q905	151-0917-00			TRANSISTOR;NPN PWR, 15A,80V	80009	151-0917-00
Q906	151-0918-00			TRANSISTOR;PNP PWR, 15A,80V	80009	151-0918-00
U104	118-8701-00			32768 X 8 EPROM,PRGM 27256	80009	118-8701-00
U105	118-8702-00			65536 X 8 EPROM,PRGM 27512	80009	118-8702-00

DIAGRAMS



PG2012

MODULE BLOCK DIAGRAM


POWER SUPPLY - A11
P100
-30V 1
-30V 2
GND 3
GND 4
GND 5
+30V 6
+30V 7
+15V 8
+15V 9
GND 10
11
GND 12
GND 13
GND 14
GND 15
+8V 16
+8V 17
+8V 18
+8V 19
+8V 20
21
22
A6 INPUT
J1
1 2 3
POWER ON
SIGNAL
E5
J1
W2
AUX BD - A8
J7 1
2
3
4
5
6
7
8
9
10
W3
W4
AC LINE IN
POWER SWITCH
FUSE
LINE FILTERING
LINE FILTER
J3
J4
1 2
1 2
+12V
FAN
+15V
CRT
A9
FRONT
PANEL
POWER
SWITCH
1 2 P420
MPU BD - A1
GND +5V
P410 1 2
P500
VARIABLE OUTPUT BD - A5
(CH 2)
8
1
K
12
13
7
F
H
11
M
L
Q905
Q906
P500
FAST OUTPUT BD - A4
(CH 1)
Q904
Q901
P300
PERIOD BD - A2
K
9
C
3
B
2
Q903
Q902
INTERCONNECT
BOARD - A6

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc., Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important when ordering parts to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc., Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ITEM NAME

In the Parts List, an item name is separated from the description by a semicolon (;). Because of space limitations, an item name may sometimes appear as incomplete. For further item name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustration.

ABBREVIATIONS

Abbreviations conform to American National Standards Institute Y1.1.

CROSS INDEX - MFR. CODE TO MANUFACTURE

Mfr. Code	Manufacture	Address	City, State, Zip Code
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR	BEAVERTON OR 97077-0001

FIGURE 1 CABINET

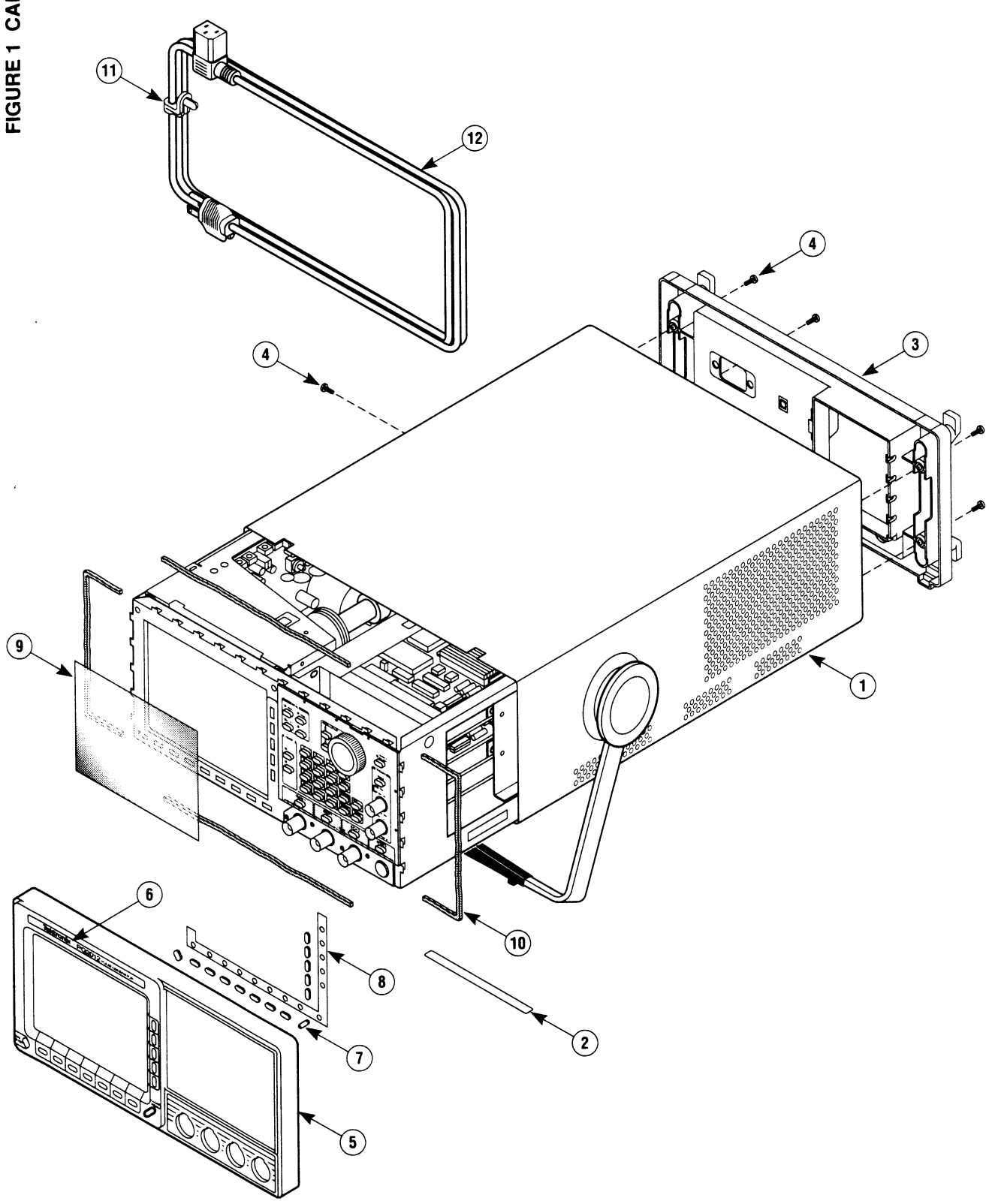


FIGURE 1 CABINET

PG2012

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						CABINET		
1 -1	390-1107-00			1		CABINET ASSY, EMI VERSION	80009	390-1107-00
-2	334-8059-00			1		MARKER ID,PULSE GENERATOR (HANDLE)	80009	334-8059-00
-3	200-3890-10			1		REAR COVER W/LABELS	80009	200-3890-10
-4	213-0882-00			5		SCREW, TPG,TR;6-32 X 0.437	80009	213-0882-00
-5	354-0709-00			1		RING, TRIM; LEXAN 940	80009	354-0709-00
-6	334-8060-00			1		MARKER,IDENT;BEZEL,PG2010	80009	334-8060-00
-6	334-8061-00			1		MARKER,IDENT,BEZEL,PG2011	80009	334-8061-00
-6	334-8062-00			1		MARKER,IDENT,BEZEL,PG2012	80009	334-8062-00
-7	366-2164-00			14		PUSH BUTTON;IVORY GRAY "BEZEL"	80009	366-2164-00
-8	260-2552-00			1		SWITCH,PUSH; 50 BUTTON,SP/ST	80009	260-2552-00
-9	378-0385-00			1		FILTER,CRT	80009	378-0385-00
-10	348-1239-00			4		EMI GASKET 9", FRONT	80009	348-1239-00
-11	343-1213-00			1		CLAMP, POWER CORD;POLYMIDE	80009	343-1213-00
-12	161-0230-01			1		LINE CORD	80009	161-0230-01
						POWER CORD OPTIONS		
-12	161-0104-06			1		PWR CORD, OPT A1,EUROPEAN	80009	161-0104-06
-12	161-0104-07			1		PWR CORD, OPT A2,UNITED KINGDOM	80009	161-0104-07
-12	161-0104-05			1		PWR CORD, OPT A3,AUSTRALIA	80009	161-0104-05
-12	161-0104-08			1		PWR CORD, OPT A4,NORTH AMERICAN	80009	161-0104-08
-12	161-0167-00			1		PWR CORD, OPT A5,SWITZERLAND	80009	161-0167-00

FIGURE 2 MAIN CHASSIS

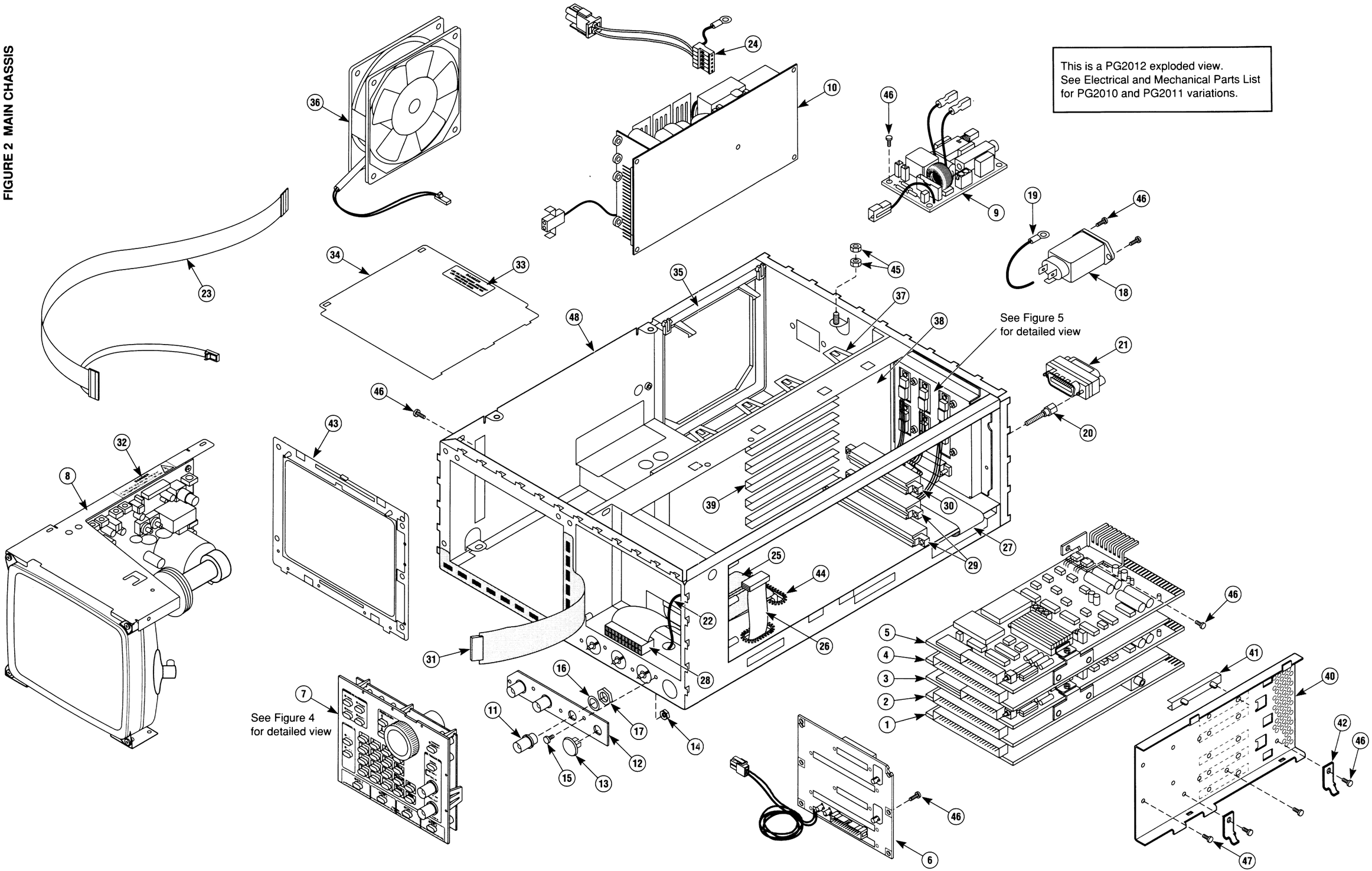


FIGURE 2 MAIN CHASSIS

PG2012

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						ECB ASSEMBLIES		
2 -1	118-8650-00			1		ECB ASSY,PERIOD (SEE REPL A2)	80009	118-8650-00
-2	118-8514-00			1		ECB ASSY,WIDTH/DELAY (SEE REPL A3)	80009	118-8514-00
-3	118-8651-00			1		ECB ASSY,FASTOUTPUT (SEE REPL A4) (PG 2010 AND PG 2012 ONLY)	80009	118-8651-00
-3	118-8649-00			1		ECB ASSY,VARIABLE OUTPUT (SEE REPL A5) (PG 2011 ONLY)	80009	118-8649-00
-4	118-8514-00			1		ECB ASSY,WIDTH/DELAY (SEE REPL A3) (PG 2010 OPT 02, PG 2011 OPT 02, AND PG 2012 ONLY)	80009	118-8514-00
-5	118-8651-00			1		ECB ASSY,FASTOUTPUT (SEE REPL A4) (PG 2010 OPT 02 ONLY)	80009	118-8651-00
-5	118-8649-00			1		ECB ASSY,VARIABLE OUTPUT (SEE REPL A5) (PG 2011 OPT 02 AND PG 2012 ONLY)	80009	118-8649-00
-6	118-8647-00			1		ECB ASSY,INTERCONNECT (SEE REPL A6)	80009	118-8647-00
-7	672-0282-00			1		ECB ASSY,FRONT PANEL (SEE REPL A10)	80009	672-0282-00
-8	119-3917-00			1		MONITOR W/441-1983-00 MONITOR CHASSIS (SEE REPL A9)	80009	119-3917-00
-9	671-1682-00			1		ECB ASSY,AUXILIARY POWER ASSY (SEE REPL A8)	80009	671-1682-00
-10	119-4132-00			1		POWER SUPPLY (SEE REPL A11)	80009	119-4132-00
						BNC BRACKET ASSEMBLY		
-11	131-1315-01			3		CONN,RCPT,ELEC;BNC,FEMALE	80009	131-1315-01
-12	407-4087-00			1		BRACKET,COMPNT;BNC	80009	407-4087-00
-13	134-0218-00			1		BUTTON,PLUG;0.625 DIA,PLASTIC,TAN	80009	134-0218-00
-14	210-0586-00			4		NUT,PL,ASSEM WA;4-40 X 0.25	80009	210-0586-00
-15	211-0373-00			4		SCREW,MACHINE;4-40 X 0.25	80009	211-0373-00
-16	210-0012-00			3		WASHER,LOCK;0.384 ID,INTL	80009	210-0012-00
-17	210-0413-00			3		NUT,PLAIN,HEX;0.375 X 32 X 0.5	80009	210-0413-00
						CHASSIS, ETC.		
-18	119-5019-00			1		FILTER,LINE;3AMP,250V,60HZ	80009	119-5019-00
-19	174-2288-00			1		CABLE,ASSY 1 POS LINE FILTER	80009	174-2288-00
-20	129-1085-00			2		SPACER,POST;0.25L,4-40,BRS,0.25HEX	80009	129-1085-00
-21	131-5298-00			1		CONN,RCPT,ELEC;GPIB,24 POS	80009	131-5298-00
-22	175-5692-00			1		CABLE ASSY,RF;50 OHM COAX,8.0L,9-2	80009	175-5692-00
-23	174-2528-00			1		CABLE,ASSY 10 POS 8WI & 2WI MONITOR TO CPU	80009	174-2528-00
-24	174-2287-00			1		CABLE,ASSY 3 POS POWER INPUT	80009	174-2287-00
-25	174-2421-00			1		CABLE, ASSY 2X13 (INTERFACE TO CPU) 6.750"L	80009	174-2421-00
-26	174-2422-00			1		CABLE, ASSY 2X10 (FASTOUTPUT TO PICOSECOND) 18"	80009	174-2422-00
-27	174-2423-00			1		CABLE, ASSY 2x13 W/GPIB CONN.FROM CPU 6.850"	80009	174-2423-00
-28	174-2424-00			1		CABLE, ASSY 2X17 (FRONT PANEL TO CPU) 8.750"	80009	174-2424-00
-29	179-2993-00			1		CABLE, ASSY, HARNESS POWER DISTRIBUTION 19"	80009	179-2993-00
-30	179-2994-00			1		CABLE HARNESS, PWR TO OUTPUT	80009	179-2994-00
-31	259-0086-00			1		FLEX CIRCUIT; BEZEL BUTTON	80009	259-0086-00
-32	334-2065-00			1		MARKER IDENT;DANGER(MONITOR)	80009	334-2065-00
-33	334-3621-00			1		MARKER, DANGER (POWER SUPPLY SHIELD)	80009	334-3621-00
-34	337-3714-00			1		SHIELD,ELEC;POWER SUPPLY	80009	337-3714-00
-35	426-2426-00			1		FRAME,FAN MOUNTING;POLYCARBONATE	80009	426-2426-00
-36	369-0045-00			1		FAN ASSEMBLY;W/CONNECTOR	80009	369-0045-00
-37	386-6159-00			1		SUPPORT,CKT BD;BACKPLANE AND POWER SUPPLY MOUNT	80009	386-6159-00
-38	407-4084-00			1		BRACKET,CARD GUIDE;LEFT	80009	407-4084-00
-39	351-0702-00			5		GUIDE,CKT BRD;NYLON, 4.5 L	80009	351-0702-00
-40	407-4085-00			1		BRACKET,CARD GUIDE;RIGHT	80009	407-4085-00
-41	351-0761-00			5		GUIDE,CKT BRD;NYLON, 2.5 L	80009	351-0761-00
-42	343-1493-00			2		RETAINER,BRACKET;ALUMINUM	80009	343-1493-00
-43	426-2436-00			1		FRAME, CRT FLTR;POLYCARBONATE	80009	426-2436-00
-44	255-0334-00			1		PLASTIC CHANNEL;12.75 X 0.175 X 0.155	80009	255-0334-00
-45	210-0457-00			2		NUT,PL,ASSEM WA;6-32 X 0.312	80009	210-0457-00
-46	213-0903-00			21		SCREW,TPG,TR;6-32 X 0.375	80009	213-0903-00
-47	211-0373-00			4		SCREW,MACHINE;4-40 X 0.25	80009	211-0373-00
-48	441-1989-00			1		CHASSIS,MAIN ASSEMBLY; PG2010/11/12	80009	441-1989-00

FIGURE 3 CHASSIS BOTTOM

This is a PG2012 exploded view.
See Electrical and Mechanical Parts List
for PG2010 and PG2011 variations.

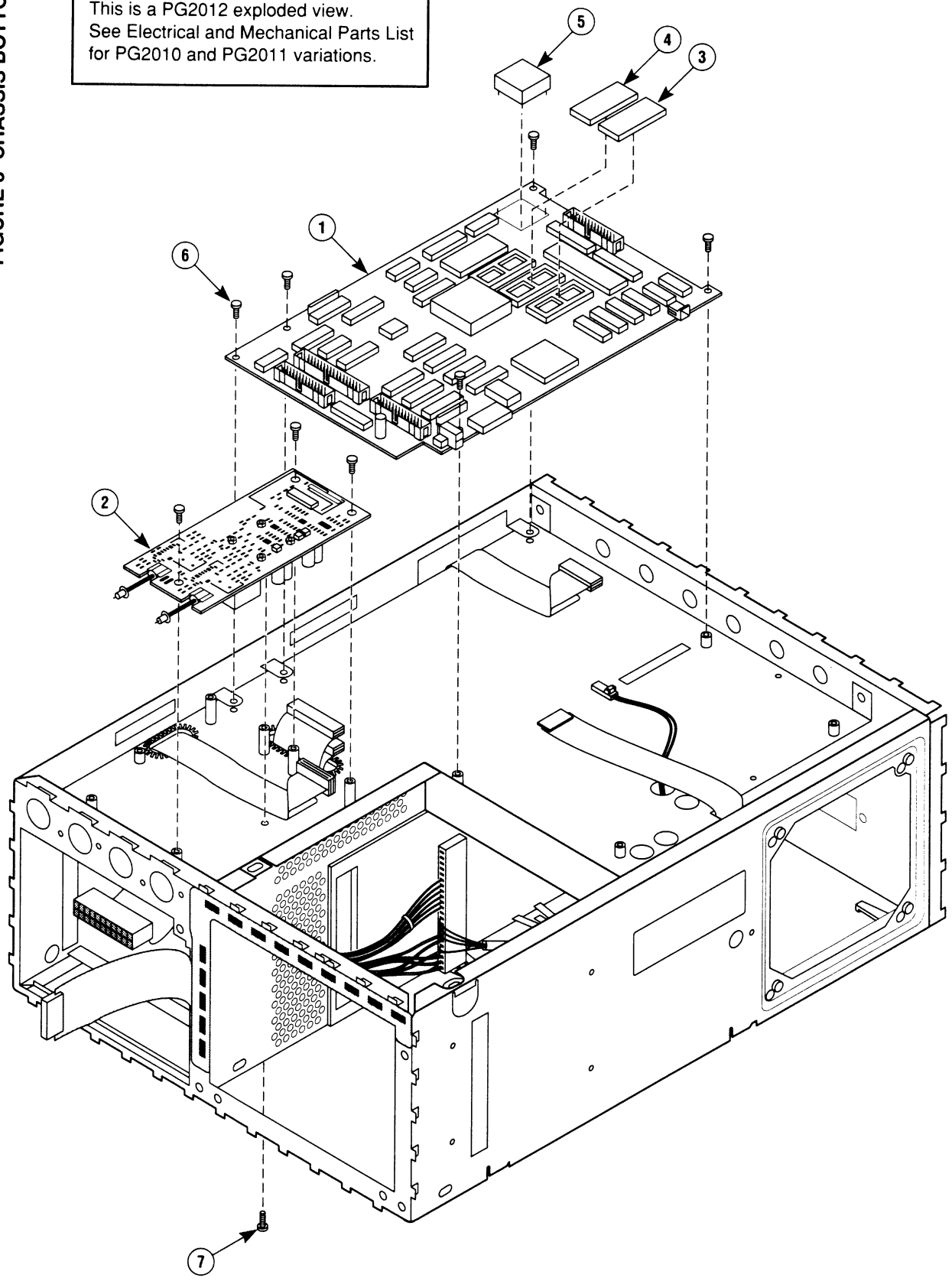


FIGURE 3 CHASSIS BOTTOM

PG2012

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Serial/Assembly No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						CHASSIS BOTTOM		
3 -1	118-8648-00			1		ECB ASSY,MPU (SEE REPL A1)	80009	118-8648-00
-2	671-2022-01			1		ECB ASSY,PICOSECOND (SEE REPL A7) (PG 2010 AND PG 2012 ONLY) (2 REQUIRED FOR PG 2010 OPT 02)	80009	671-2022-01
-3	118-8701-00			1		32768 X 8 EPROM,PRGM 27256 (SYS) (SEE REPL U104)	80009	118-8701-00
-4	118-8702-00			1		65536 X 8 EPROM,PRGM 27512 (APL) (SEE REPL U105)	80009	118-8702-00
-5	146-0091-00			1		BATTERY,STORAGE,3V,200mAH,LITHIUM (SEE REPL BAT1)	80009	146-0091-00
-6	213-0903-00			8		SCREW,TPG,TR;6-32 X 0.375	80009	213-0903-00
-7	211-0373-00			1		SCREW,MACHINE;4-40 X 0.25	80009	211-0373-00

FIGURE 4 FRONT PANEL ASSEMBLY

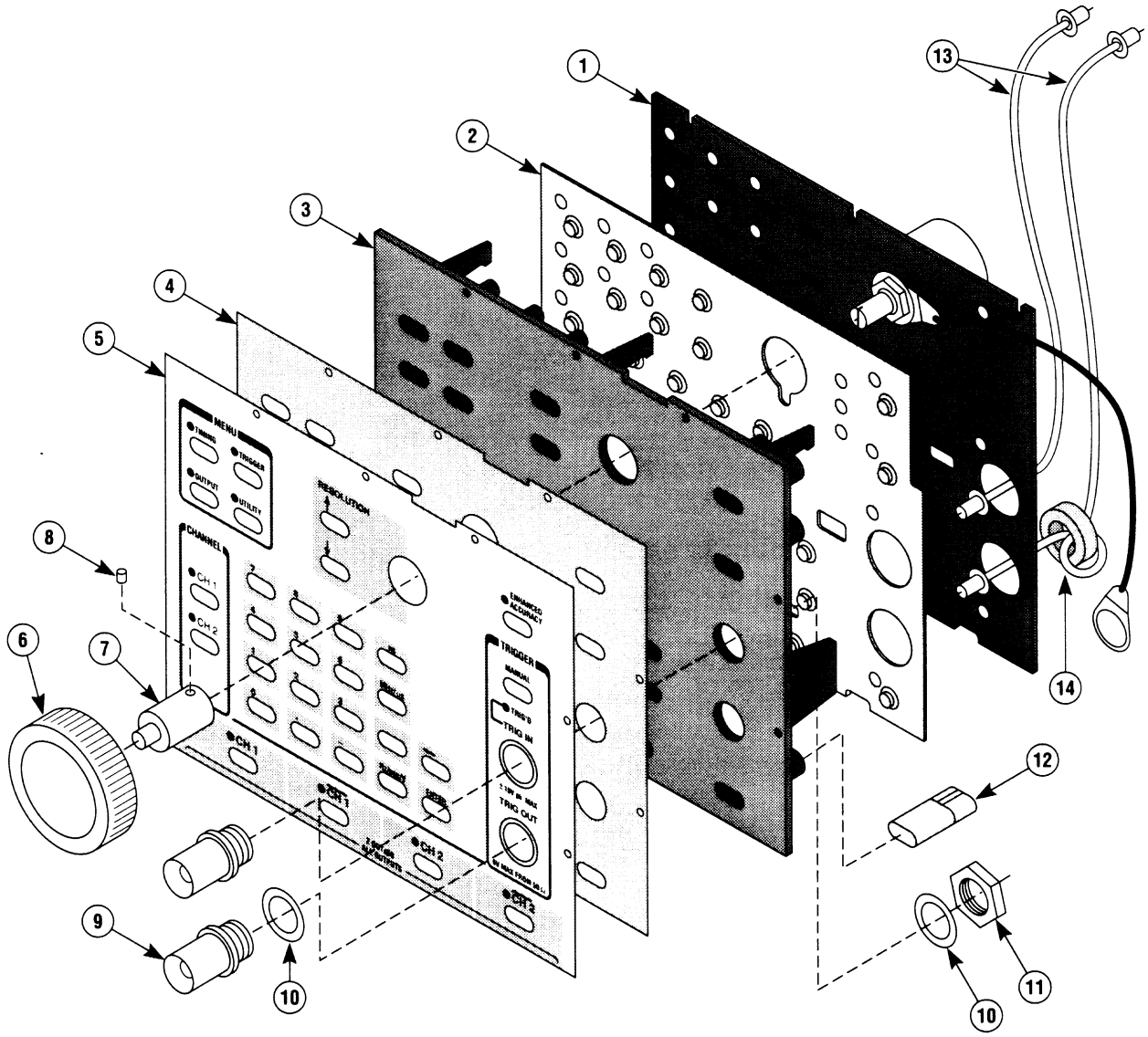


FIGURE 4 FRONT PANEL ASSEMBLY

PG2012

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Serial/Assembly No. Decont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						FRONT PANEL ASSEMBLY		
4 -1	672-0282-00			1		ECB ASSY, FRONT PANEL;PG2010/11/12	80009	672-0282-00
-2	260-2552-00			1		SWITCH,PUSH; 50 BUTTON,SP/ST	80009	260-2552-00
-3	380-1005-00			1		HOUSING,SWITCH;FRONT PANEL	80009	380-1005-00
-4	337-3769-00			1		SHIELD,ELEC;FRONT PANEL, EMI	80009	337-3769-00
-5	334-8063-00			1		OVERLAY, FRONT PANEL;PG2010/11/12	80009	334-8063-00
-6	366-2159-00			1		KNOB;IVORY GRAY,SCROLL	80009	366-2159-00
-7	384-1672-00			1		EXTENSION, SHAFT	80009	384-1672-00
-8	213-0004-00			1		SETSCREW;6-32 X 0.188	80009	213-0004-00
-9	131-1315-01			2		CONN,RCPT,ELEC;BNC,FEMALE	80009	131-1315-01
-10	210-0012-00			4		WASHER,LOCK;0.384 ID,INTL	80009	210-0012-00
-11	210-0413-00			2		NUT,PLAIN,HEX;0.375 X 32 X 0.5	80009	210-0413-00
-12	366-2163-00			32		PUSH BUTTON; IVORY GRAY,OVAL	80009	366-2163-00
-13	175-8671-00			2		CABLE ASSY,RF;50 OHM COAX,10.25L	80009	175-8671-00
-14	276-0599-00			1		CORE, EM; TOROID,FERRITE	80009	276-0599-00

FIGURE 5 HEAT SINK ASSEMBLY

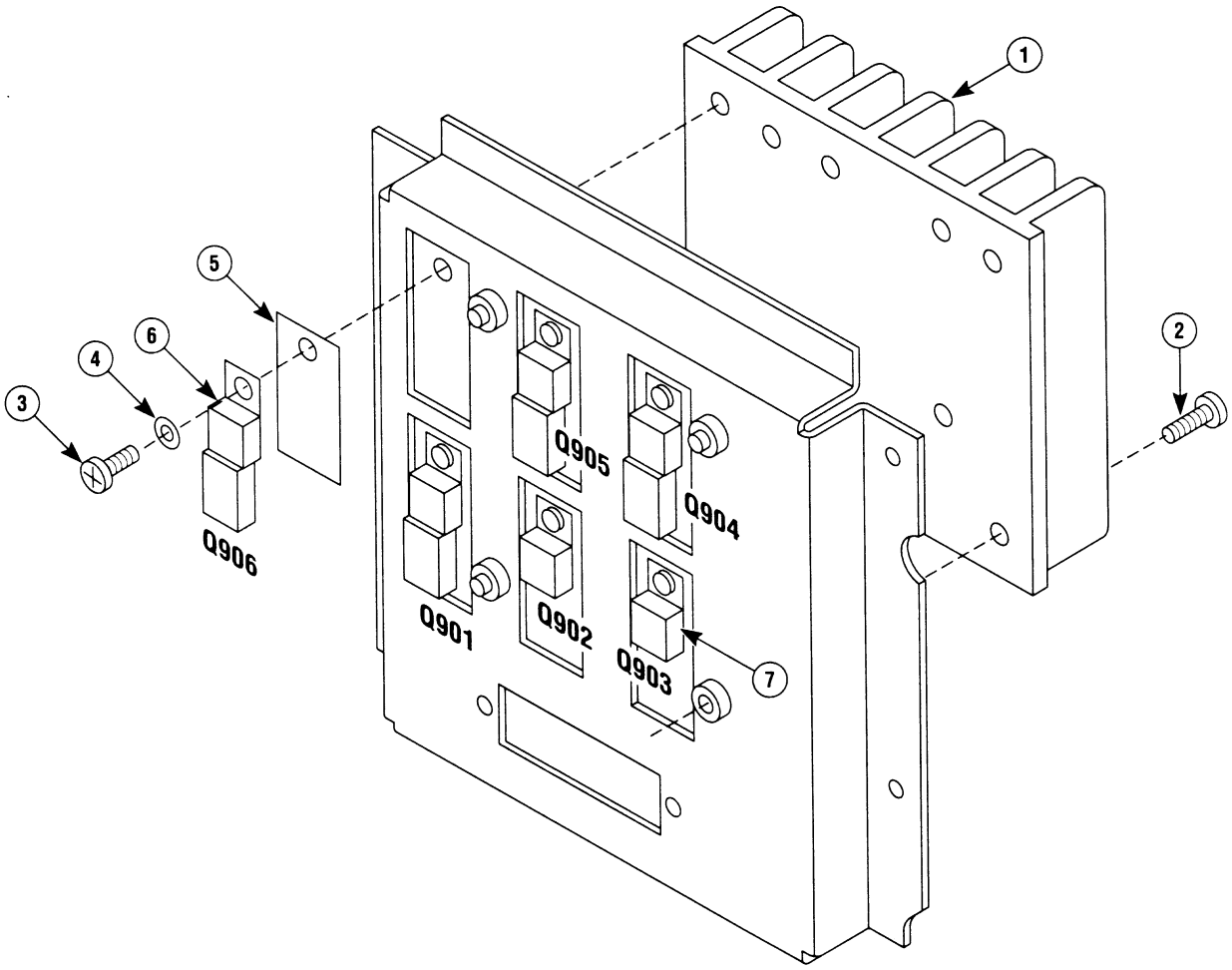


Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						HEATSINK ASSEMBLY		
5 -1	214-4425-00			1		HEATSINK,REAR; ALUMINUM	80009	214-4425-00
-2	213-0903-00			4		SCREW,TPG,TR;6-32 X 0.375	80009	213-0903-00
-3	211-0373-00			6		SCREW,MACHINE;4-40 X 0.25	80009	211-0373-00
-4	210-1181-00			6		WASHER, SHLD;U/W TO-220 TRANSISTOR	80009	210-1181-00
-5	342-0831-00			6		INSULATOR PLATE; TRANSISTOR TO-220	80009	342-0831-00
-6	151-0918-00			3		TRANSISTOR (See Q901, Q902, Q906 REPL)	80009	151-0918-00
-7	151-0917-00			3		TRANSISTOR (See Q903, Q904, Q905 REPL)	80009	151-0917-00

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Serial/Assembly No. Dscont	Qty	12345	Name & Description	Mfr. Code	Mfr. Part No.
						ACCESSORIES		
	070-8143-01			1		OPERATORS MANUAL	80009	070-8143-01
						OPTIONAL ACCESSORIES		
	070-8142-00			1		SERVICE MANUAL (OPTIONAL)	80009	070-8142-00
	200-3232-00			1		COVER,FRONT	80009	200-3232-00
	016-1107-00			1		OPT 1R, RACKMOUNT	80009	016-1107-00