TEK INSTRUCTION MANUAL

070-6687-00
Product Group 75

PG 506A
CALIBRATION GENERATOR

Please Check for
CHANGE INFORMATION
at the Rear of This Manual

First Printing NOV 1987

Tektronix
COMMITTED TO EXCELLENCE

SERVICE SAFETY SUMMARY

FOR QUALIFIED SERVICE PERSONNEL ONLY

Refer also to the preceding Operators 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.

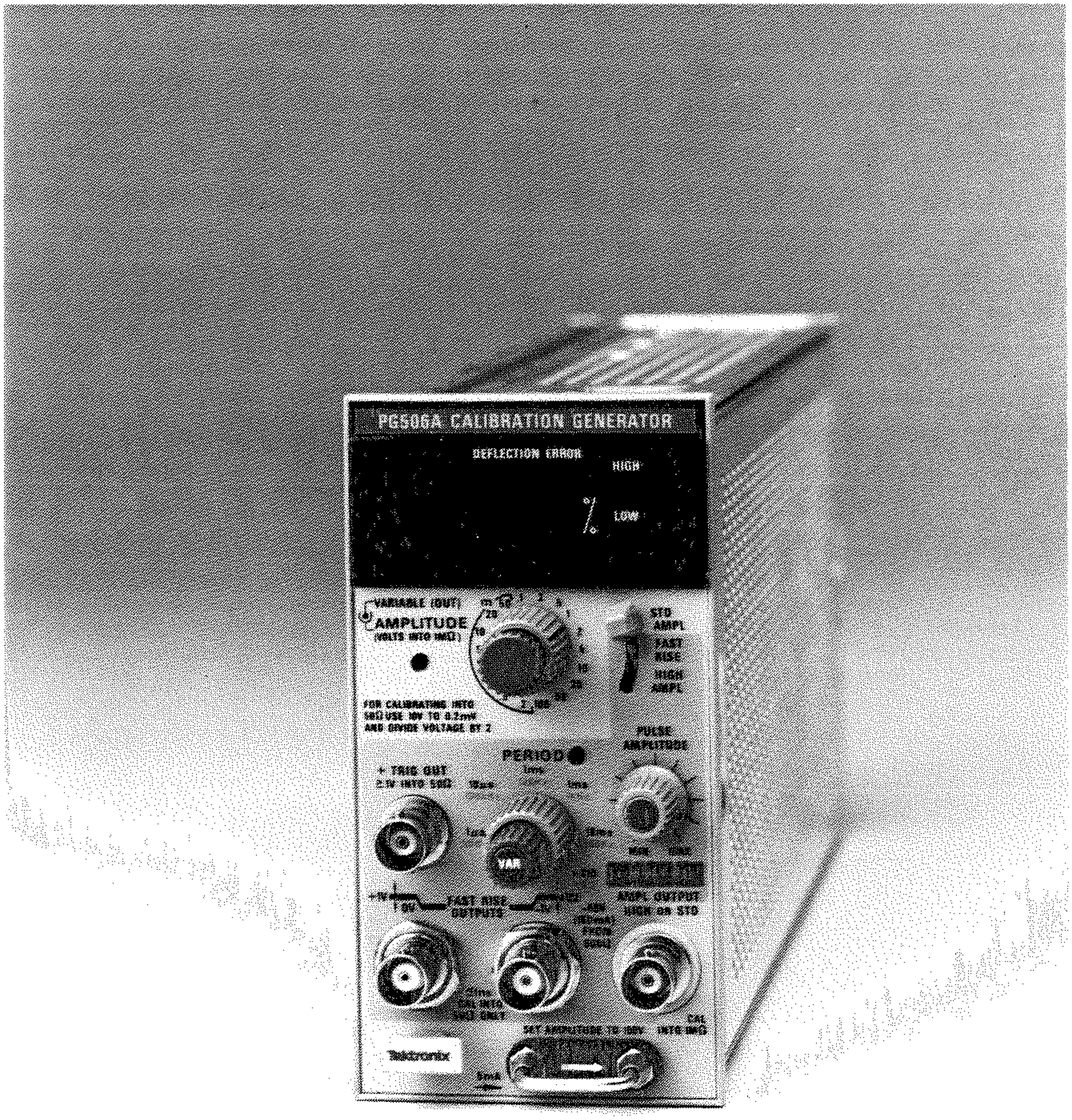
Use Care When Servicing With Power On

Dangerous voltages 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.

Power Source

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



PG 506A Calibration Generator

SPECIFICATION

Performance Conditions

The electrical characteristics are valid only if the PG 506A has been calibrated at an ambient temperature between +20°C and +30°C and is operating at an ambient temperature between 0°C and +50°C. Forced air circulation is required for ambient temperatures above +40°C.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in the Service Section of this manual. Items listed in the Supplemental Information column are not verified in this manual. They are either explanatory notes or performance characteristics for which no limits are specified.

SPECIFICATION

Table 1-1

ELECTRICAL CHARACTERISTICS

Characteristics	Performance Requirements	Supplemental Information
	STANDARD AMPLITUDE OUTPUT	
Range (Peak-to-Peak)		
1 MΩ Load	200 μV to 100 V	
Accuracy	Within 0.25% ±1 μV	
50 Ω Load	100 μV to 5 V	
Accuracy	Within 0.25% ±1 μV	
Period		Approximately 1 ms (1 kHz square wave, chopped DC)
Deflection Error Readout		
Range	+ and − 7.5%	
Resolution	Within 0.1%	
	HIGH AMPLITUDE OUTPUT	
Amplitude (Peak-to-Peak)		
Unterminated	≤6 V to ≥60 V	
50 Ω Load	≤0.5 V to ≥5 V	
Polarity		Positive, measured from a negative potential to ground.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
600 Ω Output Resistance	Within 5%	
Output Period		
1 μs to 10 ms	Within 5%	
Variable		Extends output period to at least 100 ms. X1 to greater than X10 range for each decade step.
Duty Cycle		Approximately 50%.
Rise Time		
Unterminated	⩽100 ns	
50 Ω Load	⩽10 ns	
Leading Edge Aberrations during first 50 ns	Within 2% of signal peak-to-peak amplitude, or 50 mV, whichever is greater.	
FAST RISE OUTPUTS		
Amplitude (Peak-to-Peak)		
50 Ω Load	⩽100 mV to >1 V	
Polarity		Simultaneous positive and negative. Positive is measured from a negative potential to ground. Negative is measured from a positive potential to ground.
Output Resistance, 50 Ω	Within 3%	At either Fast Rise connector.
Risetime, 50 Ω Load	⩽1 ns	
Leading Edge Aberrations, first 10 ns	Within 2% of signal peak-to-peak amplitude, or 10 mV, whichever is greater.	
Flatness	Within 0.5% after first 10 ns	
Output Period	1 μs to 10 ms	In decade steps.
Accuracy	Within 5%	
Variable		Extends output period to >100 ms. X1 to greater than X10 range for each decade step.
Duty Cycle		Approximately 50%.
TRIGGER OUTPUT		
+Trigger Out	⩾1 V peak-to-peak into a 50 Ω load. Fixed amplitude.	Trigger out function available for HIGH AMPL and FAST RISE modes. Output signal leads HIGH AMPL pulse by about 18 ns and leads FAST RISE pulse by about 8 ns.

Table 1-2

ENVIRONMENTAL CHARACTERISTICS

Characteristics	Information
Temperature	Test to procedures of MIL-STD-810C Methods 502.1 and 501.1 using Procedure I as specified in MIL-T-28800B paragraph 4.5.5.1.3 and 4.5.5.1.4.
Operating	0°C to +50°C.
Non-operating	−55°C to +75°C.
Humidity	
Operating	+50°C to 95% relative humidity.
Non-operating	+60°C to 95% relative humidity. Test to MIL-STD-810C Method 507.1 Procedure IV, modified as specified in MIL-T-28800B paragraph 4.5.5.1.1.2.
Altitude	Test to MIL-STD-810C Method 500.1 Procedure I as specified in MIL-T-28800B paragraph 4.5.5.2.
Operating	To 15,000 feet.
Non-operating	To 50,000 feet.
Vibration	
Operating and Non-operating	With the instrument operating, the vibration frequency is swept from 10 to 55 to 10 Hz. Vibrate 15 minutes in each of the three major axes at 0.015" total displacement. Hold 10 minutes at any major resonance, or if none, at 55 Hz. Total time, 75 minutes.
Shock	
Non-operating	30 g's 1/2 sine, 11 ms duration, 3 shocks in each direction along 3 major axes, for a total of 18 shocks.
Transportation	Qualified under National Safe Transmit Committee Test Procedure 1 A, Category II.

Table 1-3

PHYSICAL CHARACTERISTICS

Characteristics	Information
Maximum Overall Dimensions	
Height	4.969 inches (12.621 cm).
Width	2.638 inches (6.701 cm).
Length	12.088 inches (30.704 cm).
Front Panel	
Finish	Anodized aluminum.
Net Weight	≈2 lbs. 4 oz. (1.02 kg).

OPERATING INSTRUCTIONS

INTRODUCTION

Description

The PG 506A Calibration Generator is designed to operate in a TM 500 Series Power Module. The instrument is a combination Amplitude Calibrator and Square Wave Pulse Generator intended for calibration and adjustments of oscilloscope amplifier systems with a 50 Ω or 1 MΩ input resistance.

The Amplitude Calibrator function provides either a + dc voltage or a 1 kHz square-wave output, as selected by an internal switch. Peak-to-peak amplitudes from 0.2 mV to 100 V across a 1 MΩ load and amplitude of 100 mV to 5 V across a 50 Ω load are available. Output amplitudes are selected in a 1,2,5 sequence.

Because errors are often stated as a percentage, an internal digital differential voltmeter with front-panel light-emitting diode (LED) readout is used to provide a display equal to oscilloscope vertical or horizontal deflection errors. If the indicated deflection on an oscilloscope graticule does not agree with the proper reference line, the output amplitude from the PG 506A Amplitude Calibrator can be varied until the proper alignment is obtained. In this operating mode, the front-panel readout is a direct display of the oscilloscope deflection error.

A 5 mA Current Loop is provided, which supplies current (dc or 1 kHz) for calibration of current probes.

The Pulse Generator provides three square-wave outputs: variable High Amplitude pulses and simultaneous positive and negative-going Fast Rise, variable-amplitude pulses. In the Pulse Generator mode, the Period is selectable from 1 μs to 10 ms in decade steps. A variable control extends the maximum period to at least 100 ms (for each decade step, the period is variable over a 10:1 range). A positive going pretrigger output is also provided for triggering external equipment.

Installation and Removal

CAUTION

Turn the power module off before inserting the plug-in; otherwise, damage may occur to the plug-in circuitry. Because of the high current drawn by the PG 506A, it is also recommended that the power module be turned off before removing the PG 506A. Refer to Fig. 2-1. Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment match the cut-outs in the PG 506A circuit board rear edge connector.

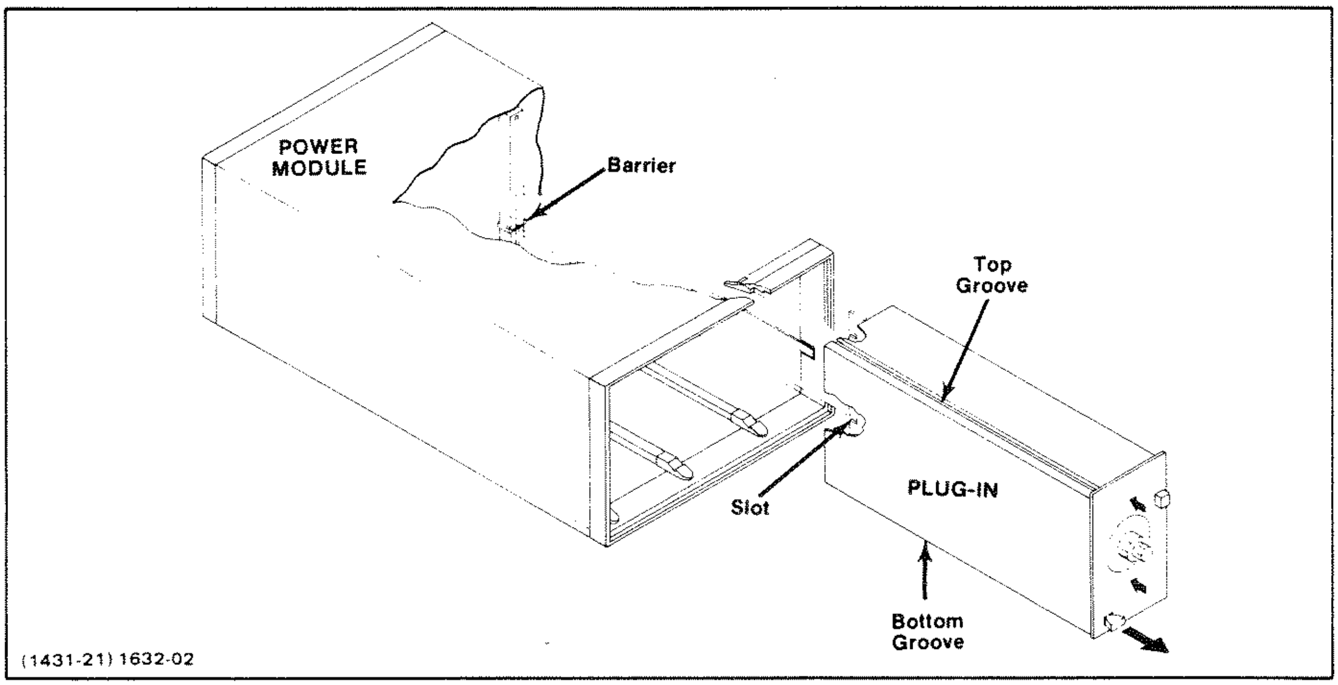


Fig. 2-1. Plug-in installation and removal.

WARNING

Dangerous voltage may be present on the front-panel BNC connector labeled AMPL OUTPUT (HIGH or STD). Before installation, turn the control labled AMPLITUDE (VOLTS INTO 1 MΩ) fully counterclockwise (ccw) and the control labeled PULSE AMPLITUDE to MIN.

Align the upper and lower groove of the PG 506A chassis with the upper and lower guides of the selected compartment. Push the module in and press firmly to seat the circuit board in the interconnecting jack.

To remove the PG 506A, pull on the release latch located in the lower left corner until the interconnecting jack disengages and the PG 506A will slide out.

CONTROLS AND CONNECTORS

(1) DEFLECTION ERROR %: A direct display of output amplitude deflection error.

(2) AMPLITUDE: Selects calibrated output amplitudes across 1 MΩ or 50 Ω load attached to AMPL OUTPUT (STD) connector.

(3) VARIABLE (OUT): When released, operates in the standard amplitude mode. The deflection error readout indicates the error in percentages with 0.1% resolution.

(4) Amplitude Light: indicates instrument is in standard amplitiude mode.

(5) PERIOD light: Illuminated when the function switch is in Fast Rise or High Ampl mode.

(6) +TRIG OUT: Provides a signal source to pretrigger external equipment.

(7) PERIOD: Selects the period of either the Fast Rise or High Ampl square-wave signals.

(8) VAR: Extends the period range 10:1. The calibrated position is counterclockwise.

(9) FAST RISE OUTPUTS: Provides for simultaneous positive and negative going square-waves as selected by the PERIOD/VAR controls.

(10) Release Latch: Pull to remove the instrument from the power module.

(11) Current Loop: A dc or 1 kHz square-wave 5 mA current supply for calibration of current probes. The VARIABLE (OUT) control will vary current through the loop, but DEFLECTION ERROR readout is not directly related to current deviations. The DEFLECTION ERROR readout must be off or adjusted to read 0.0% for a calibrated output.

(12) AMPL OUTPUT HIGH or STD: Common output for High Amplitude or Standard Amplitude modes. 1 kHz square-wave or dc for Standard amplitude. Period of the High Amplitude square-wave is set by the Period controls.

(13) PULSE AMPLITUDE: Controls output amplitude in the High Amplitude or Fast Rise modes.

(14) Function switch: Determines whether the instrument is operated in STD AMPL, HIGH AMPL, or FAST RISE mode.

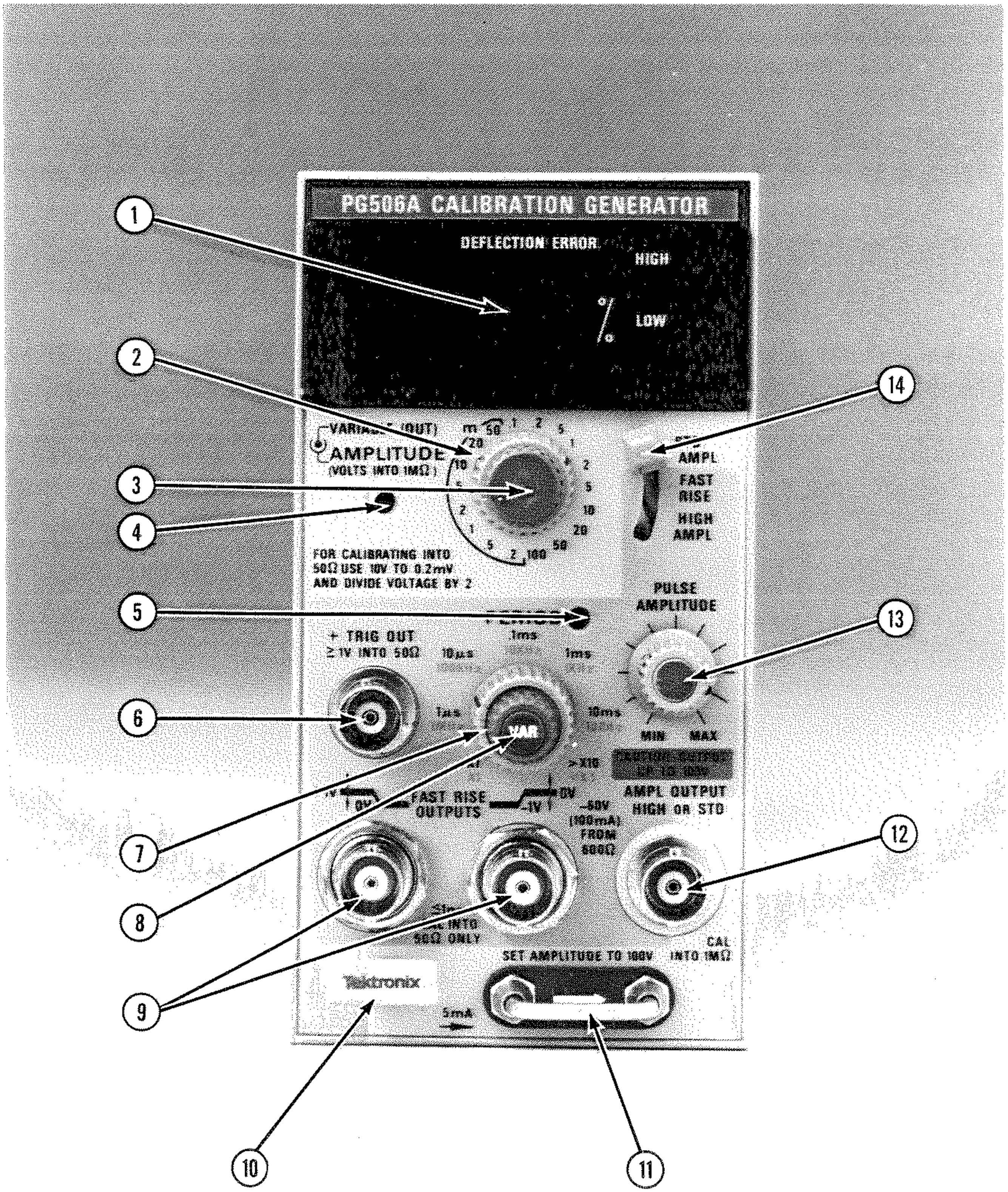


Fig. 2-2. PG 506A controls and connectors.

Preliminary Checks

Make all desired connections to equipment under test before applying power to the PG 506A. The power switch is on the Power Module. Power application to the PG 506A is indicated by the PERIOD or AMPLITUDE light turning on.

To test the digital voltmeter system, pull the VARIABLE knob to the out position and rotate the control in both directions.

Allow 15 to 20 minutes warmup time for all equipment before using the PG 506A.

AMPLITUDE CALIBRATOR MODE

Connections and Terminations

To use the PG 506A Amplitude Calibrator system, set the mode switch to the STD AMPL position. Connect the 1kHz calibrated amplitude signal at the AMPL OUTPUT connector to the input of an oscilloscope through a coaxial cable that has a 50 Ω characteristic impedance (RG-58/U) with a maximum length of 42 inches (shorter cables can be used).

With a cable termination of 1 MΩ and the DEFLECTION ERROR display off, the 1 kHz signal peak-to-peak output amplitude will be equal to the indicated reading on the AMPLITUDE switch. If the cable is terminated into a 50 Ω load, use an output amplitude in the 10 V to 0.2 mV range; the output amplitude will then be one-half the indicated reading on the AMPLITUDE switch.

Oscilloscope Controls

The deflection factor (either vertical or horizontal) for oscilloscopes is the ratio of the amplitude of the input signal to the amount of beam deflection produced on the cathode-ray tube (crt), usually stated as volts per division of deflection (Volts/Div). Calibration procedures for some oscilloscopes require that the gain be set and the deflection accuracy be checked with a probe (properly compensated) connected between the PG 506A and the oscilloscope input connector.

For oscilloscope gain adjustments and checking of deflection accuracies, it is always best to set all oscilloscope controls exactly as called out in the calibration and performance sections of the oscilloscope instruction manual. However, it may be found desirable to set the oscilloscope sweep controls to a 0.1 ms/div (or faster) sweep rate and free-run the sweep when performing vertical deflection (amplitude) checks and adjustments. This procedure produces two horizontal traces that are separated vertically by an amount proportional to the peak-to-peak amplitude of the 1kHz square-wave from the PG 506A. At faster sweep rates, the display becomes more readable.

Deflection Error Readout

When performing gain adjustments on oscilloscope or amplifier systems, it is mandatory that the DEFLECTION ERROR readout be turned off in order to obtain calibrated output amplitudes. The PG 506A DEFLECTION ERROR readout feature finds its greatest use in its ability to allow an operator to verify the oscilloscope deflection accuracy associated with amplifier gain and input attenuators.

Gain adjustments for oscilloscope amplifiers are usually made at low levels, for example; at a 10 mV/div deflection factor and a 50 mV signal from the PG 506A. This ratio corresponds to five major graticule divisions of beam deflection. If the gain of the oscilloscope amplifier system is low, the indicated deflection will be less than five major graticule divisions, for example; 4.8 major division. The VARIABLE AMPLITUDE (OUT) control on the PG 506A can then be used to increase the output amplitude until the total deflection is exactly five major divisions. At this point, the DEFLECTION ERROR readout will read 4.0% LOW. Conversely, if the oscilloscope amplifier system gain is too high, the indicated deflection on the crt will be above the proper reference line, for example; 5.2 major divisions. Using the VARIABLE AMPLITUDE control on the PG 506A to reduce the output amplitude for exactly five major divisions of deflection will produce a DEFLECTION ERROR readout of 4.0% HIGH.

For some oscilloscopes the deflection factor may not be constant throughout the full vertical dimensions of the graticule, due to compression or expansion nonlinearities. To check for this type of nonlinearity; center a two-division display, then position the display to the top of the graticule. Measure any deflection errors with the PG 506A VARIABLE AMPLITUDE control. Next, position the two-division display to the bottom of the graticule and measure the deflection errors. These nonlinearities should be taken into account when making measurements with full graticule deflection, or with the crt trace positioned towards the top or bottom graticule limits and using small deflection factors.

Current Loop

One end of the Current Loop is grounded and terminates a precision voltage divider. The direction of the arrow is oriented for conventional current. To obtain a calibrated 5 mA from the Current Loop, set the mode switch to STD AMPL position and the AMPLITUDE control switch to the 100 V position. The DEFLECTION ERROR readout should be off, or adjusted to read 0.0%. The current signal can be either dc or 1 kHz square-wave current, as selected by an internal switch.

PULSE GENERATOR MODE

General

In order to ensure waveform fidelity when using the Pulse Generator function of the PG 506A, the following precautions should be observed.

1. Use high quality 50 Ω coaxial cable, connectors, and terminations (where applicable). Make all connections as tight and short as possible.

2. Reduce capacitive and inductive loads to a minimum. Risetime degradation occurs with long cable lengths.

3. Minimum risetime and pulse aberrations are obtained with 50 Ω loads and loads must be capable of dissipating the power available at any output connector in any operating mode.

4.The external equipment is assumed to have no dc voltage across the load to which the PG 506A is connected. If a dc voltage exists, the output amplitude from the PG 506A will be in error by the amount of the dc offset. To prevent dc-offset errors, couple the PG 506A outputs through a dc blocking capacitor to the load. The time constant of the coupling capacitor and the total resistance in series must be long enough to maintain pulse flatness.

High Amplitude Output

To use the PG 506A Pulse Generator system to produce high amplitude square-waves, set the mode switch to HIGH AMPL position and connect external equipment to the AMPL OUTPUT HIGH connector. Set the Period controls for the period or frequency desired. The output amplitude of this signal can be adjusted with the PULSE AMPLITUDE control.

This signal can be used to adjust oscilloscope amplifier input capacitance, attenuator compensation networks, and other internal frequency compensation networks. The AMPL OUTPUT HIGH signal is negative with respect to ground, with its risetime related to the rising portion (from a negative potential) of the waveform. Refer to Fig. 2-3. The absolute peak-to-peak value of the square-wave is determined by the load resistance and the setting of the PULSE AMPLITUDE control. Table 2-1 lists the *typical amplitudes* available when the PG 506A is terminated into three different load resistances.

Table 2-1

OUTPUT LOAD VS. VOLTAGE OUT

HIGH AMPL OUTPUT Termination	PULSE AMPLITUDE Control[1] MIN	MAX
50 Ω Load	0.3 V p-p	5.2 V p-p
600 Ω Load	1.9 V p-p	32.5 V p-p
1 MΩ Load	3.8 V p-p	≥60.0 V p-p

[1] **Approximate amplitudes.**

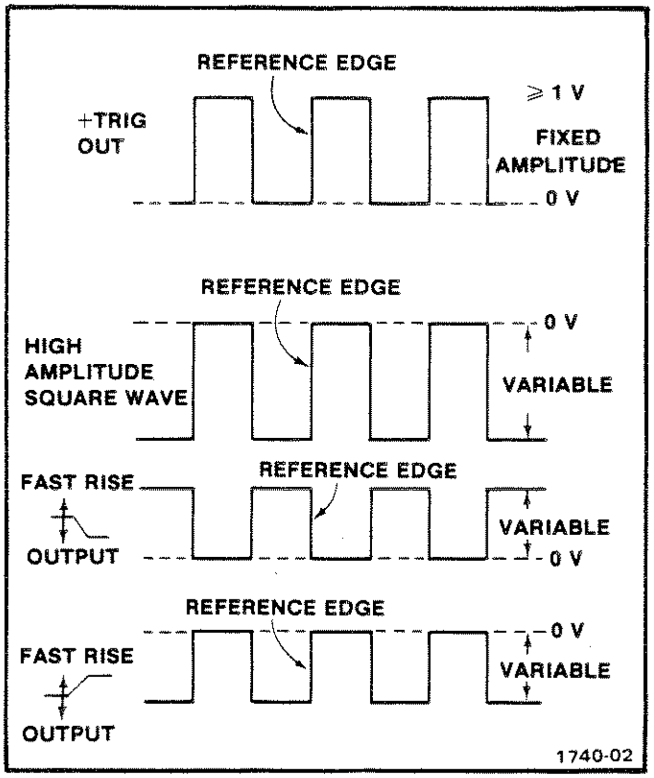


Fig. 2-3. Output signals from the PG 506A Calibration Generator.

Fast Rise Outputs

To use the PG 506A Pulse Generator system to produce low amplitude, fast-rise square-waves, set the mode switch to FAST RISE position and connect external equipment to the FAST RISE OUTPUTS connector(s). Set the PERIOD controls for the period or frequency desired. The output amplitude can be adjusted by the PULSE AMPLITUDE control.

These signals are usually used to adjust high-frequency compensation networks in oscilloscope amplifier circuits. The adjustments are made for optimum response (minimum aberrations). The risetime and amplitude specifications for the FAST RISE outputs apply only when they are terminated into a 50 Ω load. Larger amplitudes (greater than 1 V peak-to-peak) can be obtained from these output connectors under unterminated conditions, but the risetime specification is no longer applicable.

GENERAL INFORMATION

Risetime Considerations

The PG 506A can be used in conjunction with an oscilloscope to determine the risetime of a device under test. Risetime is normally measured (unless otherwise specified) between the 10% and 90% amplitude levels on the leading edge of waveform. The risetime of a displayed waveform is illustrated in Fig. 2-4.

Before measuring the risetime of a device under test, the combined risetime of the PG 506A output signal and the oscilloscope vertical amplifier system must be known. Refer to Fig. 2-4 for the percentage error to be expected when the two devices are cascaded. Sweep timing accuracy should be verified before any risetime measurements are made. Inaccuracies in the sweep timing and display reading errors must be added algebraically to the percentage error obtained from computations related to Fig. 2-4.

The graph for Fig. 2-4 can be used as a guideline for the following general conclusions.

1. Oscilloscopes should have a vertical system risetime about one-seventh of the fastest signal applied to keep system errors to a minimum.

2. Conversely, if the signal risetime is at least seven times faster than the risetime of the oscilloscope vertical system, the displayed (observed) waveform will have a risetime that is very close to the risetime of the vertical system.

3. The displayed risetime as observed on any oscilloscope can never be faster than the risetime of the slowest device in the system.

Risetime of a displayed waveform is related to total system bandwidth. A system with limited high-frequency response will produce a displayed risetime that is slower than expected. If a fast-step signal produces a crt display with little or no overshoot or ringing, the product of oscilloscope risetime and oscilloscope bandwidth should result in a factor whose value lies between 0.329 and 0.350.

The following steps describe the procedure to follow in determining the risetime of a device under test.

1. Connect the appropriate output signal from the PG 506 to the oscilloscope vertical input with a short 50 Ω coaxial cable terminated into a 50 Ω load.

2. Set the oscilloscope controls to display the leading edge of the waveform. Risetime measurements should be made over the largest part of the graticule area possible. When the fastest sweep rate is relatively slow compared with the vertical system risetime (or the scale is small), measurements become confined to small sections of the graticule, and the probability of display reading errors becomes greater.

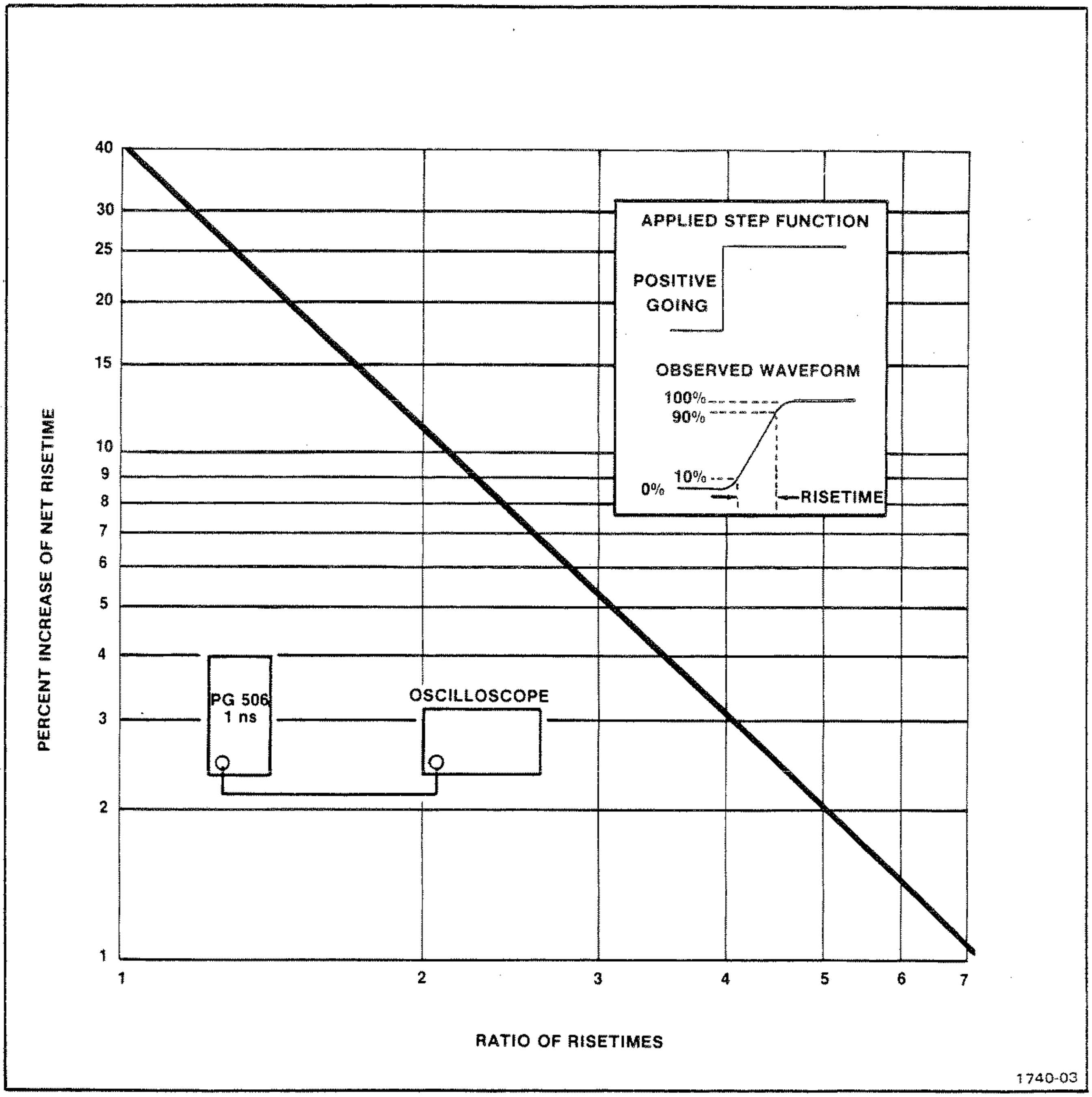


Fig. 2-4. Risetime derating graph.

3. Measure the time duration between the 10% and 90% amplitude levels. This is the combined risetime of the PG 506A and the oscilloscope (T_{rc}).

4. Disconnect the coaxial cable and 50 Ω termination from the oscilloscope.

5. Connect the coaxial cable from the PG 506A to the input of the device under test and connect the output of the device under test to the oscilloscope vertical input. Terminate the device under test in its characteristics impedance for optimum performance.

6. Set the oscilloscope controls to display the leading edge of the displayed waveform and measure the time duration between the 10% and 90% amplitude levels (over the same graticule area, if possible). This is the total system risetime (T_n).

7. Calculate the risetime of the device under test (dut) using the following formula:

$$T_r\ (dut) = \left[(T_{rs})^2 - (T_{rc})^2\right]^{1/2}$$

Checking Amplifier Response

The square-wave output signals from the PG 506A can be used to check the response of active or passive systems. Because the characteristics of a pulse from the PG 506A is known (see ELECTRICAL CHARACTERISTICS), distortion of the waveform beyond these limits is due to the device under test.

The compensation of an ac-voltage divider, such as used in the input attenuator of an oscilloscope or a passive attenuator probe, can be checked by observing its response when a square-wave signal is applied. Correct response is shown by optimum square corner on the displayed waveform. If the waveform has overshoot, rolloff, or front-corner rounding, the system is not correctly compensated. Figure 2-5 shows typical waveforms illustrating correct and incorrect compensation adjustments. When performing these compensation checks, the repetition rate of the applied square-wave signal should be at least 3 to 4 decades above the low-frequency cutoff point (frequency where the equivalent sine-wave amplitude is 30% down).

The low end cut-off frequency (due to RC coupling) for an amplifier can be approximated very closely by using the following procedure.

1. Apply a square-wave at a repetition rate that is not affected by the low-frequency limit.

2. Slowly reduce the square-wave frequency and adjust the oscilloscope (amplifer) controls to display a signal similar to Fig. 2-6.

3. Determine the ratio between the amplitude levels, V_1 and V_2. Note that V_1 and V_2 are peak values above *the zero*-volt reference level.

4. The equivalent RC product can be determined by using the following formula; where F_a is the applied frequency for a given ratio of V_1/V_2 (greater than unity).

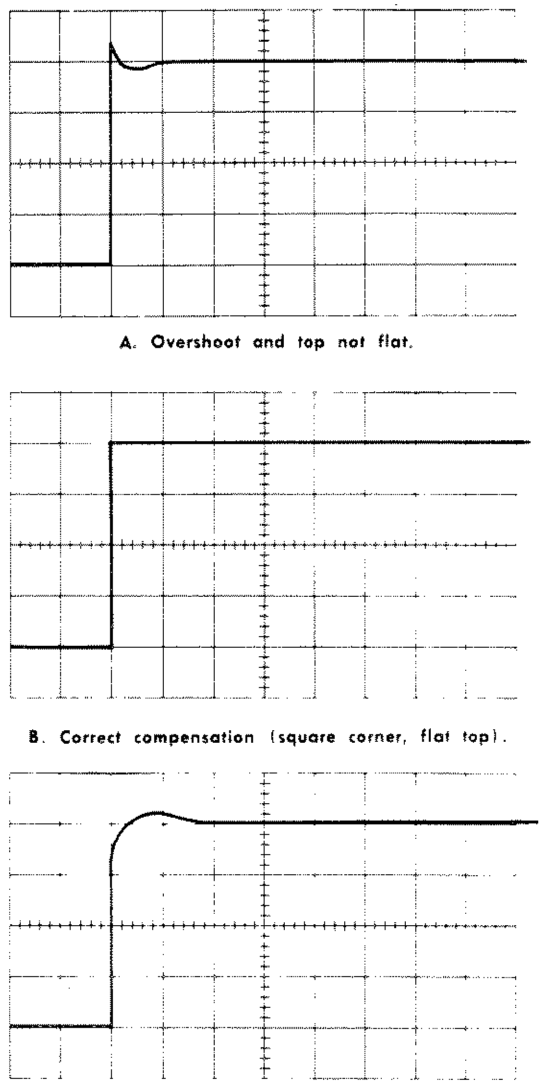
$$\frac{1}{1\ F_a \ln V_1/V_2} = RC \text{ (for square-waves only)}$$

5. Using the RC product obtained in step 4, calculate the low-end cut-off frequency.

$$F_L\ (3\ dB) = \frac{159 \times 10^{-3}}{RC}$$

For example; if the applied frequency, F_a, is 10 Hz and the amplitude values shown in Fig. 2-6 are used, the lower cut-off frequency is calculated to be about 1.6 Hz.

Figure 2-7 illustrates other waveform distortion effects that may be observed if amplifier circuits are not properly compensated for low frequencies.



A. Overshoot and top not flat.

B. Correct compensation (square corner, flat top).

C. Rolloff and top not flat.

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Fig. 2-5. Typical waveforms showing correct and incorrect compensation adjustments.

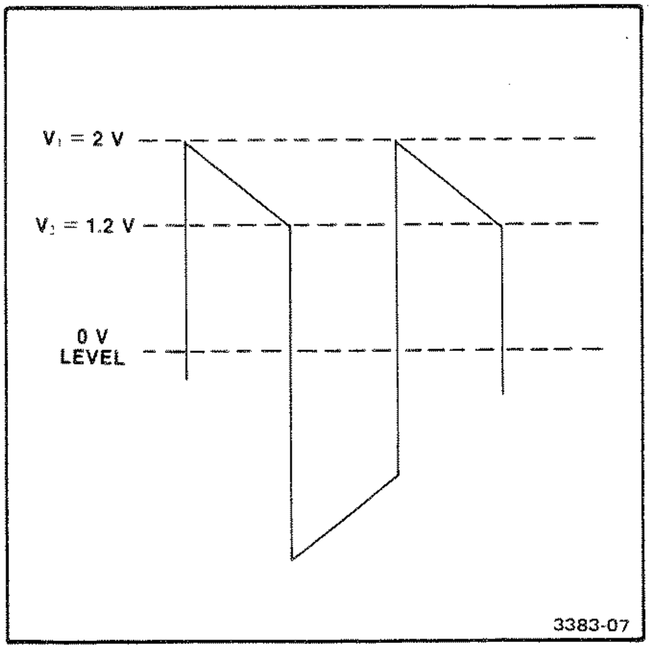

Fig. 2-6. Typical low frequency response curve.

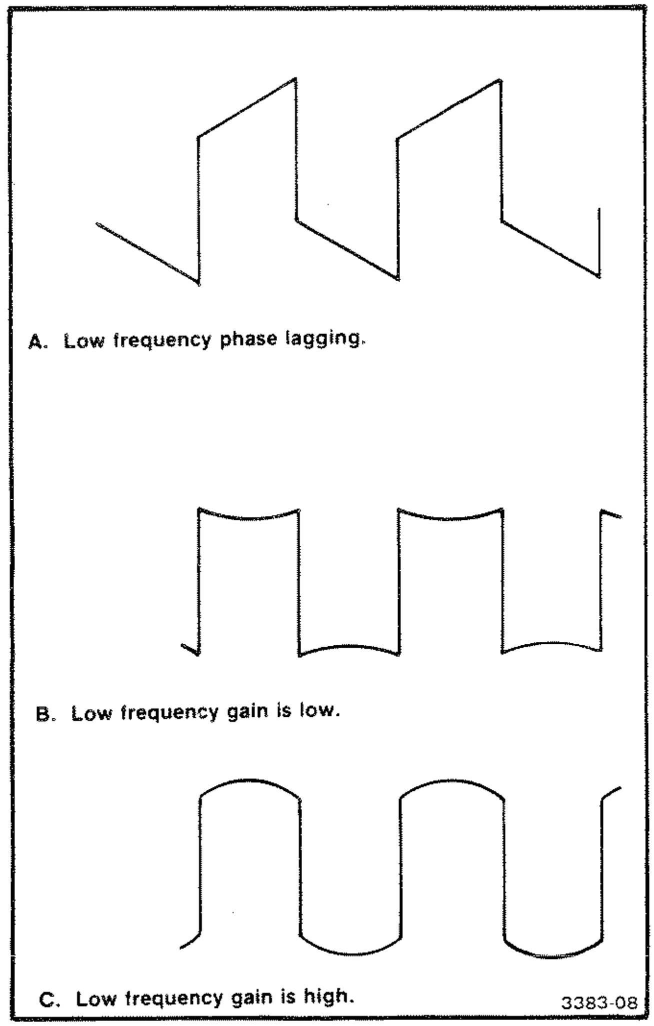

Fig. 2-7. Distortion of square waves caused by low frequency effects.

Figure 2-8 illustrates waveform distortion due to incorrect high-frequency compensations. Ringing indicates incorrect peaking adjustments or undesired inductive effects, while excessive overshoot and rolloff indicates incorrect capacitive adjustments. Limited high-frequency response is also indicated by risetime measurements that are much slower than expected (see Risetime Considerations). Impedance mismatching will usually show up at excessive aberrations somewhere along the flat portion of the waveform.

Repackaging Information

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing the owner (with address) and the name of an individual at your firm that can be contacted. Include the 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 instrument on all sides. Seal the carton with shipping tape or an industrial stapler.

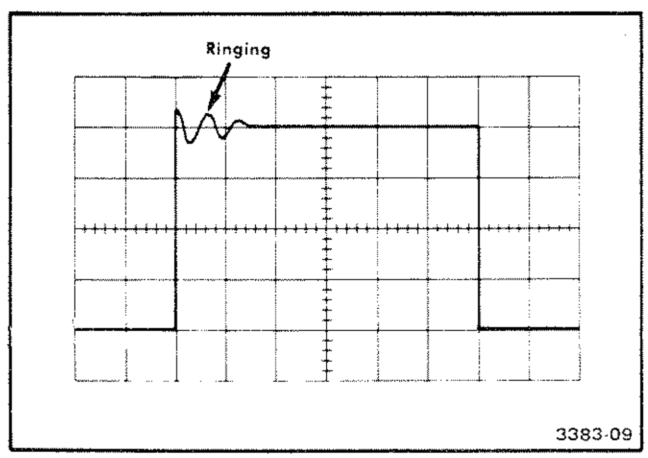

Fig. 2-8. Typical waveform showing ringing at front corner.

The carton test strength for this instrument is 200 pounds per square inch.