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# PG 50C0A PULSE GENERATOR USER'S MANUAL

VERSION 3.0

JANUARY 1, 1996

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# INTRODUCTION

## 1.1 GENERAL DESCRIPTION

The PG 5000A Pulse Generator is intended for testing very high-speed GaAs circuits and systems, and for driving laser diodes. It covers a wide frequency range from 10 MHz to 5000 MHz with fast rise/falltimes. This manual is kept short but it will emphasize important hints in proper use and possible misuse. We particularly want to stress to read all CAUTION signs. Please read the next section on first-time use of the instrument.

## 1.2 FIRST-TIME USE OF THE INSTRUMENT

After unpacking the instrument, please check for possible shipping damages. The instrument usually is supplied with a power cord and a power plug as used in the United States. In this case the internal power switch is set for 115 V operation. If in doubt, please remove the top panel by removing two screws. The power switch will be clearly visible. Select proper line voltage. The 115 V setting will cover the range from 100 V to 130 V, and the 230 V setting will cover the range from 200 V to 260 V. The line frequency should be between 50 Hz and 60 Hz. The correct fuse for 115 V operation is 1.6 A, and for 230 V, 0.8 A, both quick acting. For 115 V operation, the fuse holder is usually equipped with an adapter which will fit the 1/4 x 1-1/4 inch type fuse. For markets outside the United States, an adapter may be used which accepts the 5x20 mm fuse more commonly found in Europe.

The instrument may be shipped without a power plug to some foreign countries. The cord, however, will follow international color coding (DIN norm) for proper identification and attachment of a power plug used in a specific country.

### CAUTION

Never apply more than plus or minus 5 volts to any input or output terminals because this can cause immediate and permanent damage to the instrument. Great caution should be used when using any coaxial cables or transmission lines. They may have a charge stored in them. Also, ac-coupling may produce a large spike when connection is made to any inputs or outputs. Discharging the lines, or even better using a small value attenuator, will eliminate the problems. Alternatively, if the built-in attenuators are set for minimum output amplitude, it will provide excellent protection for all situations mentioned above.

We strongly recommend to use only flexible low-loss coaxial cables which are mode-free through 40 GHz. If semi-rigid coaxial cables are used, great caution should be applied as not to damage connectors. A special torquing tool should be used, or the hands should be used for tightening coaxial cables and external attenuators.

The instrument is equipped with SMA male-to-female adapters to save the actual SMA output connectors from possible misuse and/or damage. They should be attached to the SMA output connectors at all times. The adapters may be easily replaced if excessive wear is observed.



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Before making any connections to the instrument, set both ATTENUATOR settings for minimum output amplitude. Set both OUTPUT OFFSET potentiometers to read around zero volts which is 5.0 on the 10-turn dial. Provide a signal input to the RF INPUT connector of about +10 dBm, and set the signal FREQUENCY to approximately 100 MHz.

In the following, all measurements were made in a 20 GHz sampling oscilloscope system. If you plan to use additional external attenuators, we strongly recommend to use HP's APC attenuators, or the Silver Series K- attenuators from Wiltron which are mode- free to at least 35 GHz. Other manufacturers also make suitable attenuators. Short semi- rigid or flexible coaxial cables not to exceed 12 inches must be used which are also mode- free to above 30 GHz.

WE CANNOT STRESS THE IMPORTANCE TO USE SUITABLE HARDWARE AS OUTLINED ABOVE, OTHERWISE THE MEASURED RISETIMES WILL BE DIFFERENT THAN OUTLINED ON PAGE 5.

Connect a flexible cable from the trigger output connector TRIG OUT to the input of the time-base. Set both 0/-10 dB switches on the front panel to 0 dB. Set the gain switch to NORMAL. Connect a mode-free coaxial cable (40 GHz) each to the two outputs OUT and insert a X10 attenuator (20 dB K-connector pad) to the input of the sampling plug-in. We strongly urge to use the 20 dB pads as not to overload or destroy accidentally the very sensitive sampling heads. Turn on the POWER switch. The four LED displays will light up and display AMPLITUDE and OFFSET settings. Change OFFSET and/or AMPLITUDE settings and observe effects on the CRT screen. By switching the NORMAL/ 300 MHz switch to 300 MHz, one observes a speed-up in rise/falltime. Automatic rise/falltime measurements may not work in the presence of transient aberrations at higher repetition rates. We recommend to measure all rise/falltimes manually.

Return the switch to NORMAL and increase the input frequency up to 2000 MHz. Some droop may be visible near the front corner due to thermal effects and the nonlinear output resistance of GaAs FETS with frequency. Some also comes from the bias-T.

Isolation on both outputs is satisfactory. Isolation between the two outputs is excellent, though a 50 ohm termination resistor will be needed to terminate an unused output if only one output is used. A short circuit will limit the output current automatically though we recommend to avoid short circuiting the output particularly at higher OFFSETS settings.

If higher AMPLITUDE attenuation than 9 dB is required, remove the short SMA rigid cable under the ATTENUATOR label and insert the 10 dB attenuator plus semi-rigid elbow supplied as an accessory to the instrument. Switch the 0 db/ -10 dB switch to -10 dB, and the output is automatically corrected for the 10 dB pad inserted. The OFFSET voltage will not have changed due to the loop-through technique employed.



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## 1.3 INTENSITY OF LED DISPLAYS

The intensity of the LED displays is preset at a medium level and may be changed over a wide range to suit more individual preferences. To do so, open the top panel and vary the trimpotentiometer next to the power select switch (130/260V) to the desired intensity setting.

## 1.4 TYPICAL AND MEASURED RISETIME

In the TABLE on the next page, the TYPICAL risetime in a 20 GHz sampling system is shown. For ease of verification we also included the ACTUAL MEASURED risetime in the TABLE on page 5. There are five major components affecting the total observed risetime:

| | |
|---|---|
| Risetime of the 20 GHz Sampling System: | 17 ps |
| Pulse Generator (Output Driver only): | 25 ps |
| Built-in Attenuator and Coax Cables: | 18 ps |
| Built-in Bias T's: | 12 ps |
| External low- loss Coaxial Cables: | 10 ps |

The computed risetime with above numbers is 38.5 ps (by squaring each term and taking the root out of the sum) which is close to the measured risetime shown in the TABLE on page 4 at high frequencies.

Transient aberration for most frequency settings is quite good. It can be reduced at higher frequencies by lowering the sinusoidal input drive level. The result in an increase in risetime, but for most instances this effect is small. Reducing transient aberration above 1000 MHz by reducing the input drive is particularly effective.

We cannot stress the importance of using hardware which is fully tested for mode- free operation and proper operation over the the wide bandwidth from dc to 20-40 GHz. Proper connection (good grounding) is absolutely essential for all cable connections. Keep external cables as short as possible but not longer than 12 inches. Only use your hands when tightening the cables, or use a suitable torquing tool.

CAUTION

Avoid using the PG 5000A Pulse Generator with no 50 ohm termination resistors connected to each output OUT when the unit is powered up. Without termination resistors, a full 100 % reflection will occur which should be avoided. For similar reasons, avoid making short circuits at the outputs. If at all possible, use some attenuation (built- in or external) to reduce reflections. You may want to start out with the max. settings of the built- in attenuators, and eventually increase the amplitude to the max. level of 2 volts. WE WANT TO POINT OUT THE WARRANTY DOES NOT COVER ANY DAMAGED OR DESTROYED INPUT OR OUTPUT DEVICES.



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## TYPICAL RISETIME AS A FUNCTION OF PULSE REPETITION RATE

| FREQUENCY (MHz) | tr(10-90%) NORMAL | tr(20-80%) NORMAL | tr(10-90%) 300 MHz | tr(20-80%) 300 MHz |
|---|---|---|---|---|
| 10 | 7.5 ns | 5.0 ns | 120 ps | 80 ps |
| 50 | 1.5 ns | 1.0 ns | 65 ps | 45 ps |
| 100 | 750 ps | 500 ps | 50 ps | 35 ps |
| 300 | 240 ps | 170 ps | 50 ps | 35 ps |
| 500 | 150 ps | 110 ps | 50 ps | 35 ps |
| 1000 | 85 ps | 60 ps | 45 ps | 30 ps |
| 2000 | 50 ps | 35 ps | ------ | ------ |
| 3000 | 40 ps | 28 ps | ------ | ------ |
| 4000 | 37 ps | 28 ps | ------ | ------ |
| 5000 | 37 ps | 28 ps | ------ | ------ |

Above TABLE gives the typical risetime of the PG 5000A pulse generator measured in a 20 GHz sampling system (see page 2 for details). Even though above values are not guaranteed values, the variations from unit to unit will not be significant. Also, the falltimes may be slightly slower than the specified risetimes at some pulse repetition rates.



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ACTUAL MEASURED RISETIME AS A FUNCTION OF PULSE REPETITION RATE

| FREQUENCY (MHz) | tr(10-90%) NORMAL | tr(20-80%) NORMAL | tr(10-90%) 300 MHz | tr(20-80%) 300 MHz |
|---|---|---|---|---|
| 10 | | | | |
| 50 | | | | |
| 100 | | | | |
| 300 | | | | |
| 500 | | | | |
| 1000 | | | | |
| 2000 | | | | |
| 3000 | | | | |
| 4000 | | | | |
| 5000 | | | | |

DATE OF MEASUREMENT:

SERIAL-NUMBER:

NAME OF INSPECTOR:

COMMENTS:

Above measurements were made in a 20 GHz sampling system, for details, see page 2. Any sampling system with less bandwidth, the results will be different or may not give any satisfactory read-outs at higher repetition rates.

We strongly urge to make the measurements manually and not to rely on the automatic measurement capabilities of the mainframe. In presence of overshoot and/or ringing, automatic measurements often give wrong results.



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## PERFORMANCE SPECIFICATIONS

Pulse Repetition Rate: 10 MHz to 5000 MHz in a single range.

Droop at 10 MHz is less than 20 %

Rise/falltime (10-90%): see TABLE on page 4

Rise/falltime (20-80%): see TABLE on page 4

Transition Time matching: 20 ps typical at +10 dBm Input Level.

Output Amplitude per Side: 2 V nominal. Both outputs are independent.

Output Amplitude Variation: typically within ±10 %.

Output Amplitude Attenuation: 0 db to 19 dB in 1 dB steps with microwave attenuators. Transient waveforms and DC Output Offset voltage unaffected by attenuation setting. Each output attenuator is independent. Digitally displayed output amplitude resolution is 10 mV.

Transient Aberration: 5-15 % typically not including transient aberration of sampling head. The transient aberration can be reduced by lowering the Input Drive Level at some nominal increase in rise/falltime.

DC Output Offset Voltage: plus to minus 5 volts, independent from each output and digitally displayed with 10 mV resolution. The DC Ouput Offset Voltage is independent from the Output Amplitude Setting even if additional fixed attenuators are added at the Feed-Through joint.

Variable Rise/falltime: by reducing Input Drivel Level. It also yields lower transient aberration.

Nominal Input Drive Level: +10 dBm. Max. Input Level: +16 dBm. Input Drivel Levels of less than +10 dBm still yields satisfactory performance for sources which cannot provide the full Nominal Input Drivel Level.

Trigger Output Level: approx. -7 dBc with respect to the Input Drive Level.

Output Duty Cycle: approximately 50 % for all input frequencies.



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## WARRANTY INFORMATION

Colby Instruments, Inc. guarantees that the PG 5000A Pulse Generator meets all specifications. The unit is warranted against defects in material and workmanship for a period of one year from the date of shipment. During the warranty period, Colby Instruments, Inc. will, at its option, either repair or replace products which prove to be defective.

The Buyer shall prepay all shipping charges when shipped to Colby Instruments, Inc. for repair. Colby Instruments, Inc. shall pay shipping charges to return the product to the Buyer within the continental United States of America. To foreign countries, shipping charges both ways have to be paid by the Buyer.

IN ALL CASES, WE REQUIRE A RETURN MATERIAL AUTHORIZATION NUMBER (RMA-NO), WHETHER THE INSTRUMENT IS IN WARRANTY OR NOT. WE USUALLY WANT TO TALK TO THE END- USER WHICH OBSERVES A PROBLEM WITH THE INSTRUMENT BEFORE WE ISSUE AN RMA NUMBER.

## IMPORTANT

NO WARRANTY WHATSOEVER WILL BE GIVEN TO ANY INPUT OR OUTPUT DEVICES DAMAGED OR DESTROYED. THIS ALSO APPLIES TO ALL CONNECTORS WHICH HAVE BEEN DAMAGED. PLEASE READ CAUTION HEADINGS CAREFULLY!



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