INSTRUCTION MANUAL

MODEL PG 1000A 1000 MHZ PULSE GENERATOR

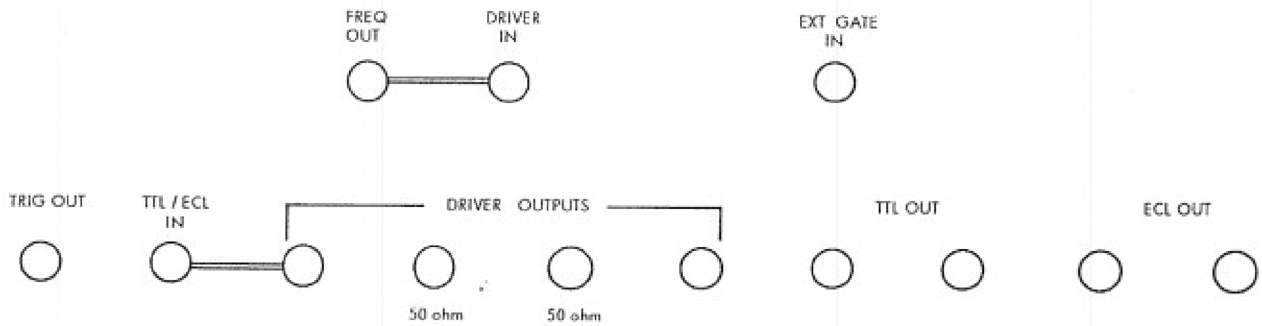
COLBY INSTRUMENTS, INC.

Colby Instruments, Inc.

1814 14th STREET
SANTA MONICA, CA 90404
(310) 450-0261 • FAX (310) 452-0027

FOR NORMAL OPERATION

1. Coaxial cable from FREQ OUT to DRIVER IN (connected to instrument)
2. Coaxial cable from one of the DRIVER OUTPUTS to TTL/ECL IN (connected to instrument)
3. Turn INP OFFSET knob fully COUNTER-CLOCKWISE (**VERY IMPORTANT!**)
4. Inner pair of DRIVER OUTPUTS must be terminated into 50 ohms (**VERY IMPORTANT!**). Termination resistors are attached to instrument.
5. Set duty cycle knob to 5.0 (50%).
6. Set trigger level of your oscilloscope system to approximately +300 mV.



OTHER IMPORTANT INFORMATION

1. Terminate TTL OUT into 50 ohms if not used. (Termination resistors are in place)
2. Terminate unused ECL OUT if only one output is used.
3. PLEASE USE CONNECTOR SAVERS FOR THE OFTEN USED CONNECTORS WHENEVER POSSIBLE!

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STANDARD ACCESSORY KIT FOR

MODEL PG1000A PULSE GENERATOR

(UPDATED)

2 ea. Semi-rigid coaxial cables (elbows)

5 ea. 50 ohm termination resistors (SMA male)

Jan. 1, 1998

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CHAPTER 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The PG 1000A Pulse Generator is a high-performance pulse source which offers many capabilities not presently available in any existing pulse generator. Although the internal frequency source is limited to a lower frequency of 1 MHz, the range can be extended down to dc with any existing signal source. The duty cycle can be set over a wide range with a 10-turn precision potentiometer. One of the unique capabilities of the PG 1000A is that subnanosecond-wide pulses can be produced even at repetition frequencies approaching dc. This is achieved by a separate driver amplifier whose reverse termination is brought out to the front panel. In the normal mode of operation, the reverse termination is terminated by two SMA 50 ohm termination resistors which are provided with the instrument. Only if short pulses independent of repetition rates are desired, one reverse termination is replaced by a shorted transmission line. The length of the line then determines the pulse width. The minimum pulse width is 500 ps for ECL and 2 ns for TTL outputs respectively.

Obviously, the driver amplifier can be used also for general Time-Domain Reflectometry (TDR) applications. Usually, TDR applications are performed with special sampling plug-ins, but with the PG 1000A Pulse Generator, this capability is built into the generator source. For more detailed applications of the PG 1000A, please refer to Chapter 3.

This chapter describes precautions and instructions for first-time users of the PG 1000A Pulse Generator. In Chapter 2, the principle of operation of the PG 1000A will be explained because its operation differs quite significantly from other pulse generators. To emphasize the versatility of the instrument, all input and output connections of the various parts of the pulse generator are brought out to the front panel. Cable connections are therefore required before the instrument will function in the desired way. Cables for this purpose are supplied with the instrument. The instrument is equipped entirely with SMA microwave connectors to assure good high-frequency, low aberration performance. However, SMA to BNC adapters are supplied with the instrument for those who want to work with BNC cables and connectors. In Chapter 3, some special applications will be outlined.

We are pleased to let you know that there will be no maintenance required for the PG 1000A. In fact, the instrument does not have a single adjustment for the many high-frequency functions in the pulse generator. The only adjustments are in the power supply to set the supplies to within 1% tolerance. We do not recommend any service to be performed by the user. The instrument uses many precision laser-trimmed chip components and many carefully selected active devices. Should any service be necessary, we recommed that you follow the procedure outlined in Chapter 4. We guarantee a 3-workday turn-around on any service whether or not the instrument is in warranty. A 24- hour turnaround service is typical.

The specifications of the PG 1000A Pulse Generator are outlined in Chapter 5 and the performance check procedure in Chapter 6. Finally, the warranty information is given in Chapter 7.

1.2 FIRST-TIME USE OF THE INSTRUMENT

After the instrument has been unpacked, check for any shipping damage.

WARNING

> If the instrument is forwarded to another country with 220 V line voltages please reset the power switch which resides inside the instrument.

If your power requirement is different from setting selected by the manufacturer (usually 110 V), you may select the proper voltage setting as follows: unscrew the two screws on the back of the top panel. Remove the panel by sliding it out. When viewed from the front panel, the power select switch can be seen at the back, left side. The power select will read either 115 V or 230 V. Select the proper voltage setting by using a screwdriver. 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 frequency should be between 50 Hz to 60 Hz. The correct fuse for 115 V 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 is used which accepts the 5X20 mm fuse more commonly used overseas.

The instrument is shipped without a power plug to some countries outside the United States. In such cases, the instrument is equipped with a power cord which meets the international color code for power connectors. After correct voltage and fuse have been checked, the instrument will almost be ready to be connected to the power outlet.

CAUTION

Never operate the PG 1000A <u>without</u> reverse termination at the DRIVER OUTPUTS. Avoid making connections to any outputs while the instrument is one. Discharge coaxial cables before making connections to the outputs.

When the instrument is shipped, the reverse terminations of each of the DRIVER OUTPUTS are terminated by two 50 ohm SMA terminations. This will be the normal mode of operations for the instrument.

CAUTION

Never apply more than plus 5 V or minus 5 V to any of the input or output connectors because this can cause immediate and permanent damage to the instrument. Be cautious when using transmission lines. They may have a large charge stored in them. Also, ac-coupling may produce a large spike when connections are made to any of the inputs or outputs.

However, no damage is caused if any of the outputs is shorted to ground. It should be pointed out that none of the inputs and outputs are protected against any overloads other than specified, no matter how short in duration. With these precautions in mind, we now proceed to the standard operations of the instrument as a pulse generator:

<u>Standard Operations:</u>

Connect SMA-to-BNC adapters to the following: FREQ OUT, DRIVER IN, DRIVER OUTPUTS, TTL/ECL IN, and ECL OUT output connectors. It should be pointed out that the two left DRIVER OUTPUTS are electrically connected to the same driver output transistors. Similarly, the two right DRIVER OUTPUTS are electrically connected to the same but complementary output transistors. The SMA terminations, however, should be connected to the inside-pair outputs or the outside-pair outputs to assure equal electrical length. Now connect one BNC cable from FREQ OUT to DRIVER IN and one BNC cable from one of the DRIVER OUTPUTS to the TTL/ ECL IN connectors. Use two additional BNC cables of equal length (not provided with instrument) and connect to any real-time oscilloscope (50 ohm terminated) or sampling scope. Use two X10 pads in front of the vertical plug-in inputs. Set the DUTY CYCLE potentiometer to read 5.0. Turn the INP OFFSET potentiometer to the extreme counter-clockwise position (important). Set FREQUENCY BAND to 1-3 MHz range. Use internal triggering for the time being and set time-base to 500 us/DIV. Set vertical sensitivity to 200 mV/DIV, dc-coupled. Turn-on the PG 1000A . The power-light switch should be illuminated, and the fan in the instrument should be heard when the POWER switch is depressed and turned on.

Now you can start "playing" with the pulse generator. Observe what happens when you turn the OFFSET A and OFFSET B potentiometer or the AMPLITUDE potentiometer. You will observe that the dc output levels may be set independently, but that the AMPLITUDE potentiometer affects both outputs equally. Now observe when you change the DUTY CYCLE. You should be able to adjust the cycle over a 10% to 90% range. As you reach the extreme settings of the DUTY CYCLE potentiometer (approaching 0 or 10.0), the display will disappear altogether. As a good practice, always start at a 5.0 setting when you go to higher frequencies because the duty cycle range reduces. The frequency can be varied in each frequency band by the FINE tuning knob.

In essence, the above is the complete procedure for the use of the pulse generator in its standard operating mode as a high-speed ECL pulse generator. Note that you may use the TTL outputs in the same fashion at the ECL outputs. In fact, both ECL and TTL outputs may be used simultaneously. In Chapter 3 a number of special applications will be outlined.

NOTE

If the instrument does not work at all, follow the procedure as outlined in Chapter 4. We also recommend that you check to see that all the internal cable connections are securely in place. It is possible that very rough handling during shipping may have loosened some of the cable connections.

CHAPTER 2

PRINCIPLE OF OPERATION

The operation of the PG 1000A Pulse Generator differs quite significantly from others on the market because it basically uses highly linear wideband amplifiers with precision overdrive characteristics to produce a squarewave output. Therefore, basically, only a sinusoidal source is required to drive these amplifiers to obtain a squarewave output. For lower repetition rates, however, the slew-rate of the sinusoid would be insufficient to achieve a fast risetime; therefore, for lower frequencies, the sinusoidal signal from the signal source FREQ OUT is preshaped.

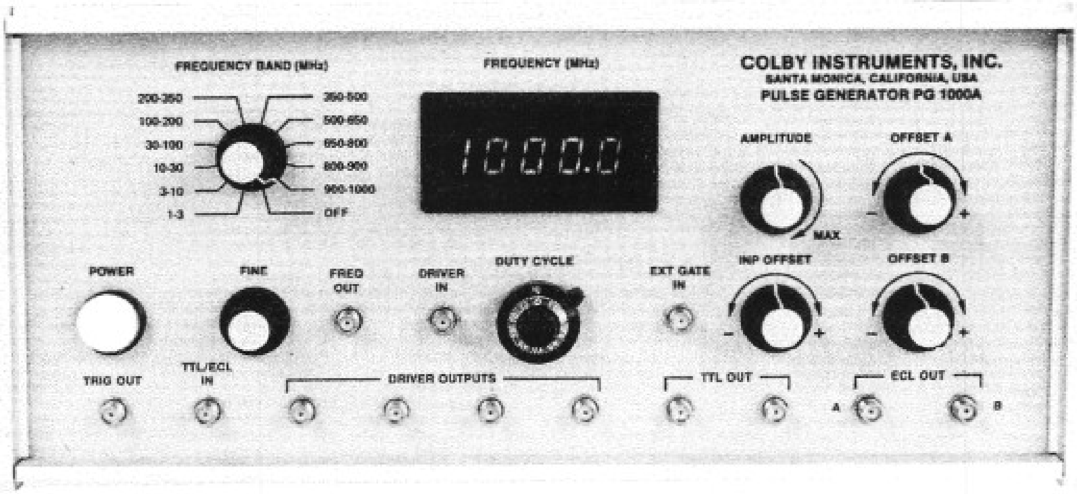
A photograph of the front panel view of the instrument is shown in Figure 1 (next page); the corresponding building block diagram of the pulse generator is shown at the bottom display. The front panel adjustments and connectors are as follows:

(1) <u>POWER on-off switch:</u>

If depressed, the instrument is turned on which is indicated by an orange light on the front panel, and by the starting of a fan inside the instrument. If the POWER switch is depressed again, the instrument will turn off. Do not turn on and off the instrument in rapid succession.

(2) <u>FREQUENCY BAND select switch:</u>

This switch selects the internal signal generating source. From 1 MHz to 350 MHz the output is a squarewave, and duty-cycle is controlled by the DUTY CYCLE 10-turn potentiometer. Above 350 MHz, the output at FREQ OUT is sinusoidal, and the duty cycle will be controlled directly in the DRIVER AMPLIFIER. The fine adjustment of the repetition frequency is achieved with the FINE potentiometer. The repetition frequency is directly displayed in the window with high accuracy and resolution (crystal controlled). If the switch is in the OFF position, no frequencies are generated internally in the instrument. This mode is desirable for avoiding any possible interactions if the DRIVER and TTL/ECL AMPLIFIERS are used as linear amplifiers. The frequency display is also deactivated in this mode.



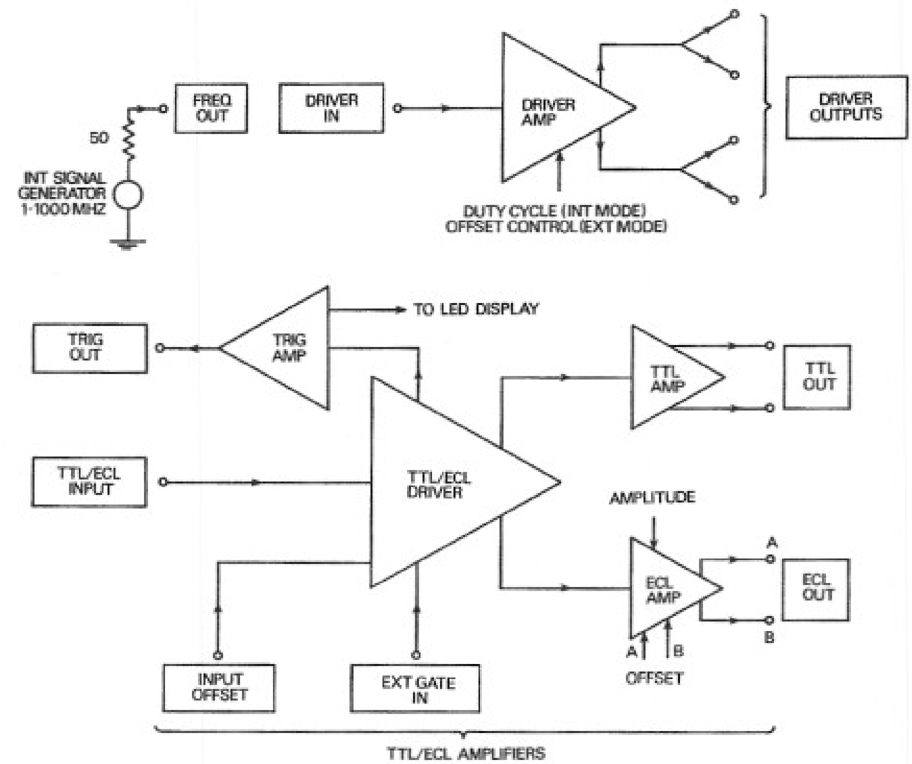


Fig. 1 Front view (top display) and basic building block diagram (bottom display) of the Model PG 1000A Pulse Generator from Colby Instruments, Inc.

(3) DRIVER AMPLIFIER:

The DRIVER AMPLIFIER essentially is a high-gain wideband amplifier with a precision 10-turn offset control. This amplifier is used for signal conditioning and Time-Domain Reflectometry (TDR) applications. The unique feature of the amplifier is that the overdriver characteristic is extremely well defined. In fact, if the DRIVER AMPLIFIER is driven by an external sinusoidal source with varying amplitude, one will obtain a square-wave output whose rise/falltime is directly a function of the amount of the overdrive. Try it out! Obviously, as the offset is varied at the input of the DRIVER AMPLIFIER, an output signal is obtained whose duty cycle is directly a function of the potentiometer setting. If the external sinusoidal signal has a zero dc component, a 50% duty cycle results if the DUTY CYCLE potentiometer is set at 5.0. Since the DUTY CYCLE potentiometer can be set between 0.0 (-0.5 V offset) and 10.0 (+0.5 V offset), the duty cycle of the overdriven amplifier with a 1 V peak-to-peak ac signal can be varied from nearly zero to almost 100 %.

Another unique feature of the DRIVER AMPLIFIER is that the reverse terminations of the complementary outputs are brought out to the front panel. In the standard mode, each of the complementary DRIVER OUTPUTS are reverse terminated with 50 ohm. Two 50 ohm SMA terminations are provided with the instrument for this purpose. However, if a precision narrow pulse width is desired independent of repetition frequency, one of the terminations is replaced by a shorted line. The length of the shorted line then determines the pulse width. Clearly, this special feature may be fully exploited to use the DRIVER AMPLIFIER for TDR applications. A free instruction manual of the TD-50PA tunnel-diode pulse generator (50 ps risetime) is enclosed as an accessory. This manual includes a chapter of TDR theory and applications for small and large resistive and complex terminations.

(4) TTL/ECL DRIVER:

This is the main driver amplifier which produces both TTl and ECL complementary outputs. In many ways it is rather similar to the DRIVER AMPLIFIER, i.e. it is a dc-coupled wideband amplifier with precision overdrive characteristics. However, all outputs are internally terminated into 50 ohms. This output driver has additional functions desirable in a pulse generator:

(a) An internal trigger amplifier is provided which produces high- speed trigger signals for external triggering. For the lowest two ranges, the repetition rate is identical to the source. For all other ranges, the trigger frequency is 1/64th of the input frequency. If you use an external signal source, the trigger amplifier is still fully functional. The LED display, which is crystal controlled, is also derived from this amplifier. The trigger amplifier may cease to function for pulse widths below 10 ns in the two lower frequency settings when the divide-by-64 prescaler is not in operation. Also, if a very narrow pulse width is produced by using a shorted transmission line, the trigger amplifier ceases to function. In all these cases we recommend the use of the complementary unused DRIVER OUTPUT as a trigger source. Just remove its reverse termination and connect it to the trigger input of the time base (terminate into 50 ohms). This will solve potential triggering problems for these extreme pulse width settings. When the internal trigger amplifier ceases to function, it will also affect the frequency display in the same fashion. In other words, even when the internal trigger amplifier and frequency display stops operating for extreme pulse widths, the pulse generator remains fully operational. These restrictions are imposed by the limitations of the prescalers.

A word about displayed trigger jitter when external triggering is used: for most frequency settings (10 MHz to 800 MHz), the displayed jitter is extremly low, usually determined by the time-base used. For frequencies below 10 MHz, and for more extreme duty cycle settings, the phase noise of the internal signal source contributes to trigger jitter. For frequencies above 800 MHz, the prescaler produces some trigger jitter. Some time bases also produce trigger jitter related to repetition rate. We have observed that the prescaler (divided by 64) for the frequency bands above 10 MHz can reduce thermally induced jitter originating in the time base. It is for these reasons that we did not specify display jitter because it depends on so many factors. In none of the frequency settings between 1 MHz and 1000 MHz is the trigger and display jitter objectionable; in fact, the display jitter far exceeds the specifications of many pulse generators.

The internal signal source are based on fundamental oscillators with low phase jitter and good frequency stability. If square-waves are needed with the stability of a synthesized source, feel free to use such a source. The PG 1000A will give you output pulses with variable duty cycle with the stability of a synthesized source! No other pulse generator can offer this.

(b) An INPUT OFFSET with 500 mV range is provided for greater versatility if you want to bypass the DRIVER AMPLIFIER. However, when the TTL/ECL AMPLIFIER is driven from the DRIVER OUTPUT, the INPUT OFFSET potentiometer must be turned completely counter- clockwise. The reason is that the DRIVER OUTPUT amplitude is centered around -500 mV and the INPUT OFFSET potentiometer must be in the same -500 mV setting for proper operation.

(c) Both the TTL and ECL outputs may be gated using the EXT GATE INPUT. A signal of plus or minus 1V is required to fully turn off the TTL and ECL outputs. The gating amplifier is very fast (250 ps rise/falltime, 800 MHz bandwidth). The gating will not affect the triggering or the frequency display.

(d) Finally, we come to the outputs. Each of the ECL outputs can be set independently anywhere between +2 V and -3 V with the OFFSET A and OFFSET B potentiometers. The AMPLITUDE potentiometer, however, affects both outputs equally. The range is limited to 2:1. For smaller signal levels, we recommend the use of external attenuators to maintain pulse fidelity.

Please refer to Chapter 3 for some special applications. For some typical transient figures, see the enclosed brochure for the PG 1000A Pulse Generator. Feel free to call us if you are not clear about any of the front panel adjustments. Also, if you have some special applications in mind, do not hesitate to call us to discuss the technical details. We recognize that many high-speed applications are quite specialized. When we designed the PG 1000A Pulse Generator, we emphasized versatility in this instrument. Additional functions, such as single-shot pulses and delay generator which are not built into the generator, may easily be extended with any other standard pulse generators which employ such features. Even though a typical 50 MHz pulse generator does not have very fast rise/falltimes, you will obtain 200 ps rise/falltime at the ECL outputs and 750 ps rise/falltime at the TTL outputs by driving the PG 1000A Pulse Generator with it. Special attention was given to the complementary outputs whose time-coincidence is 30 ps for ECL and 50 ps for TTL. If you plan to use differential drives, it is essential to match the electrical length of the cable connections to maintain good time-coincidence. Also, ALWAYS terminate an unused output if only a single output drive is used. This will reduce transient aberration.

CHAPTER 3

SPECIAL APPLICATIONS

In this chapter a number of special applications are outlined which greatly expands the usefulness of the PG 1000A Pulse Generator. In fact, all the basic building blocks in the instrument are quite separate and not internally connected. For this reason external cable connections are required for even the most obvious standard pulse generator applications which were outlined in Chapter 2.

The basic building blocks in the instrument are as follows:
(A) Internal signal source which has one output labelled FREQ OUT. (B) DRIVE AMPLIFIER with the input connections DRIVER IN and four output connections DRIVER OUTPUTS. The outputs are truly differential and the reverse terminations of the differential outputs are also brought out to the front panel, which accounts for the total of four output connections.
(C) TTL/ECL output amplifier, which is the main amplifier for the differential TTL and ECL outputs. The TTL/ECL outputs may be inhibited by an external gating signal.

Some special applications are presented below; however, you will undoubtedly find other applications not outlined here. You will appreciate the versatility of this instrument for many high-speed applications. Here are some special applications:

(1) High-Speed Linear Amplifier with Offset Control

Clearly, the DRIVER AMPLIFIER makes a fine linear amplifier which is highly linear over its whole dynamic active range. The 10-turn precision DUTY CYCLE control now takes on the TTL/ECL INPUT connector if you want to display the frequency as well, or if you want to produce an external trigger signal. Naturally, you may want to use the TTL/ECL AMPLIFIER directly as a linear wideband amplifier which will give you both TTL and ECL differential outputs. Or, you may want to cascade both amplifiers for higher gains. The internal frequency source may be in any position, but if you observe any interactions, set the FREQUENCY BAND switch to its OFF position. However, you may want to have the switch in the other positions where the prescalers for the trigger amplifier and the frequency display can be selected. If the FREQUENCY BAND switch is in the

OFF position, the internal trigger amplifier will not prescale, and the display will be inactive. No internal signals will be produced in the frequency source.

(2) Variable Rise/Falltime Pulse Generator

This application is a simple extension of the previous example. You will notice if you overdrive the linear amplifiers with an increasing sinusoidal amplitude, output squarewaves will be obtained with decreasing rise/falltime. See Figure 5 of the enclosed brochure for an example. The variable rise/falltime feature will work satisfactorily on both the DRIVER AMPLIFIER outputs and the ECL outputs, but it is less effective on the TTL outputs.

(3) Pulse Generator with Extremely Fast Settling Time

Because microwave SMA interconnections are used, and the output drive transistors operate in a highly linear mode, you can obtain settling time to 0.1% within 2 ns on the DRIVER OUTPUTS and ECL OUTPUTS if an external sinusoidal signal source is used, and the overdrive is limited such that the resulting rise/falltime is around 500 ps. To our knowledge such a performance feature is not available on any general purpose high-speed pulse generator.

(4) High-Sensitivity Counter

We want to point out that the PG 1000A Pulse Generator contains a crystal-controlled 4 1/2 digit frequency counter, which really is nothing unusual. What is special, however, is that you can obtain extreme sensitivities on the counter feature by cascading both amplifiers. The DUTY CYCLE control should be fine adjusted around the 5.0 setting, and the INPUT OFFSET control should be set fully counter-clockwise.

(5) Time-Domain Reflectometry (TDR) applications

Because the reverse terminations of the DRIVER AMPLIFIER are brought out to the front panel, this amplifier is highly suitable for general TDR applications when driven from the FREQ OUT or any external square-wave source. We enclose a complimentary copy of the manual for the Model TD-50PA 50 ps tunnel-diode pulse generator, also manufactured by Colby Instruments, Inc. This manual has an extra chapter on TDR applications which you will find helpful when characterizing any kind of transmission lines. TDR is a powerful and easy-to-use tool for both passive and active circuit characterization. Usually TDR requires special equipment (sampling heads, etc.) but the PG 1000A enables you to use the TDR without the need for special TDR gear (within the 200 ps risetime limitation of the PG 1000A).

(6) Narrow Pulse Width independent of Repetition Frequency

This feature is a special application on TDR where a shorted transmission line determines the pulse width of the pulse generator. The DUTY CYCLE potentiometer should be set around 5.0. As long as the pulse width τ is short compared to the inverse of the repetition frequency f, i.e.$\tau < 1/2f$, you can achieve a highly stable and precise output pulse width as narrow as 500 ps for ECL and 2 ns for TTL on the PG 1000A Pulse Generator. Very importantly, this pulse width is fully maintained even if the repetition rate approaches dc when using an external low-cost pulse generator. This feature will be most welcome by those who routinely require nanosecond and subnanosecond pulse-width outputs at very low repetition rates. For $\tau = 1/2f$, the output amplitude on the DRIVER OUTPUT will double (2 V).

(7) Precision Squaring of Signal Sources

You can extend the usefulness of any other commercially available pulse generator or function generator with slower risetimes by driving the PG 1000A Pulse Generator from such sources. As one can observe, you can achieve 200 ps rise/falltime on ECL outputs (750 ps on TTL outputs) even when your driving source may have much slower rise/falltimes.

(9) Interfacing to your own Driver Designs

You may have an application where you need a driver which is not met by either the TTL or ECL outputs provided in the PG 1000A Pulse Generator. For example, you may want to drive a deflection system at elevated potentials or you may have different drive requirements. Your special design will be greatly aided by the fact that the PG 1000A provides you with truly differential drive signals with exceptionally good time-coincidence. High-speed designs are greatly simplified if you have truly differential drive signals available. No high-speed signals to ground are produced in this fashion which in turn will contribute to simple and stable drive amplifier designs.

(10) Producing a Pretrigger Signal

If you are using sampling heads with bandwidths exceeding 1000 MHz, and if your application is in the low-repetition frequency range, you will not be able to see the front corner of your pulse because the sampling plug-ins above 1000 MHz do not have a built-in delay line, and the random-sampling mode in the timebase plug-in is nonfunctional. Fortunately, Colby Instruments, Inc. can provide you with an optional delay line which is connected between the DRIVER OUTPUT and the TTL/ECL INPUT. If the trigger signal now is taken from the complementary unused driver output, you will obtain a true low-jitter pretrigger signal. The optional delay line (80 ns), which is fully passive, may also be used for other applications.

(11) High-Speed Gating

Both the TTL and ECL outputs may be inhibited by applying either plus or minus 1 V to the EXT GATE IN connector. The inhibiting function is extremely fast (250 ps) in both directions. The gating amplifier itself has a bandwidth of 800 MHz. For a picture of a gated signal, see Figure 7 of the enclosed brochure.

(12) Variable Delay- Time Generator

Since the pulse generator can be driven with sinusoidal signals, a unique set- up is possible to create a variable delay time generator in which the pulse width can be varied independently. A simple switchable delay with printed and coaxial lines can be easily designed which covers, for example, the range from 100 ps to 100 ns. Use a 6 dB power splitter and feed one signal into one PG 1000A directly, and one through this specially designed network into another PG 1000A. This scheme will allow for maximum flexibility. With some minor restrictions, one of our clock drivers may be substituted for a PG 1000A pulse generator at substantial savings. Please contact us for details. For delays more than 100 ns, we recommend to use a 50 MHz pulse generator which has this feature built- in and drive the PG 1000A with it.

(13) Other Special Application and Customer Service

You may have special applications which do not fall under any of the above categories. For example, you may require single-shot events, or a delay time generator. In these cases, we recommend that you use any other pulse generator which usually have these features built in. If situations should occur in which you are not sure whether the PG 1000A Pulse Generator can be used, please feel free to telephone or write us. We will do our best to assist you.

CHAPTER 4

MAINTENANCE AND SERVICE

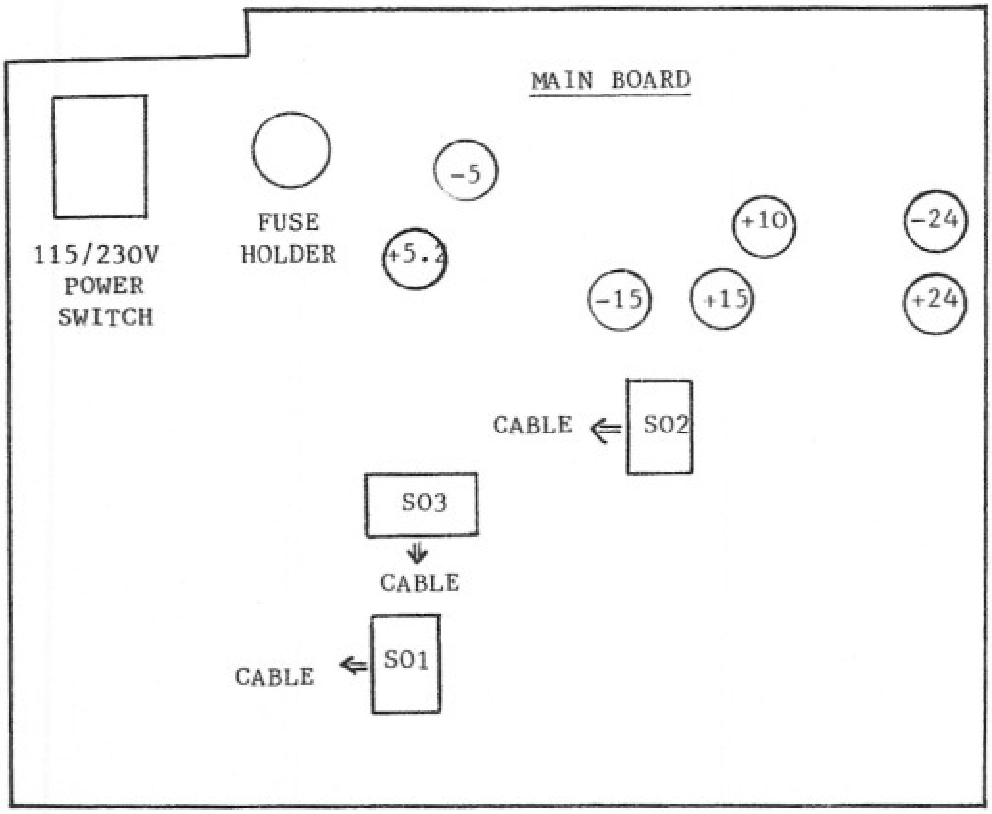
No maintenance will be necessary on the PG 1000A Pulse Generator over the full life of the instrument. In fact, there are only a total of 7 trimpotentiometer adjustments inside the instrument which are in the power supply circuit. These trimpotentiometers adjust the supply voltages to within the following specifications:

1. +5.2 V supply: to within ±0.1 V.
2. -5.0 V supply: to within ±0.1 V.
3. +15.0 V supply: to within ±0.2 V.
4. -15.0 V supply: to within ±0.2 V.
5. +24.0 V supply: to within ±0.3 V.
6. -24.0 V supply: to within ±0.3 V.
7. +10.45V supply: to within ±0.25V. This supply will affect the upper and lower bound on the TTL outputs and may be readjusted to somewhat different levels as desired.

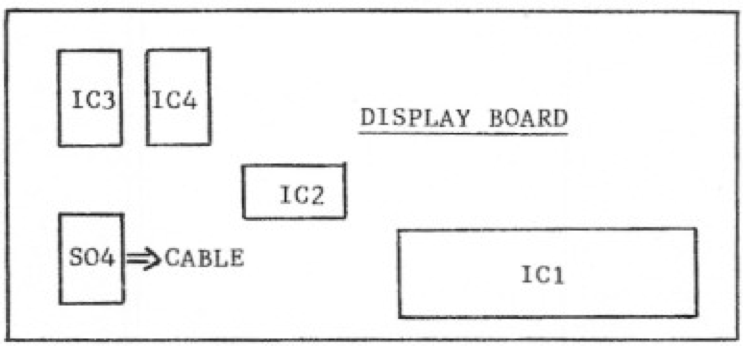
For the physical location of the adjustments on the board, an outline is shown next page. The supply lines are clearly marked on the board which can be seen once the top-panel has been removed from the instrument. To remove the panel, unscrew the two screws on the back of the instrument. The top panel then can be slid out of the instrument.

If there is a malfunction of the instrument, we recommend that you check the power supply voltages. The ripple on all supplies should be less than 2 mV peak-to-peak (50 MHz bandwidth).

No other adjustments are possible. Many laser-trimmed hybrid resistors are used in the instrument. Active devices are carefully selected so that not a single high-frequency adjustment is necessary. If the instrument requires service, it should be sent to us. We guarantee a 3-workday turnaraound on any service, whether or not the instrument is in warranty. A 24- hour turnaround in servicing our equipment is more typical.


MAIN BOARD
115/230V
POWER
SWITCH
FUSE
HOLDER
-5
+5.2
+10
-15
+15
-24
+24
CABLE
SO2
SO3
CABLE
CABLE
SO1

NOT TO SCALE


IC3
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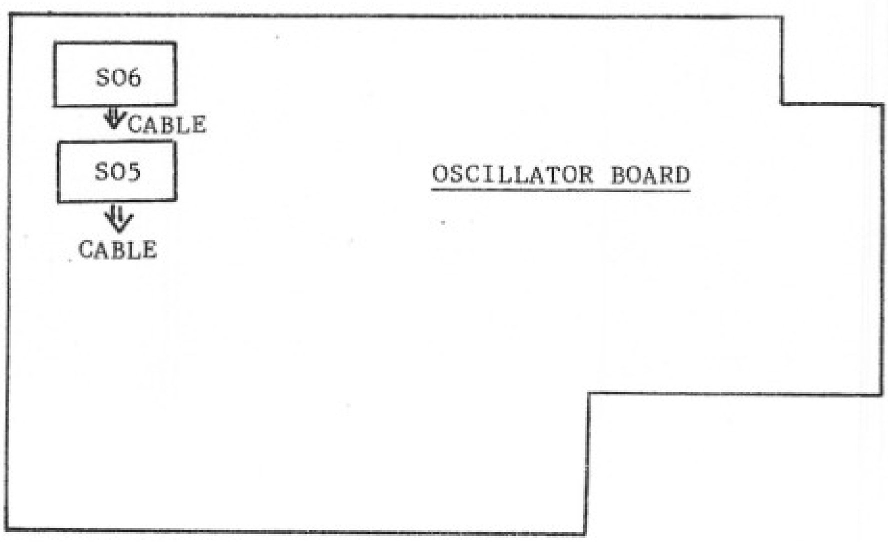
IC2
SO4
CABLE
IC1


SO6
CABLE
SO5
CABLE
OSCILLATOR BOARD

For your convenience, we have diagrammed the cable connectors on the previous page. The connections are as follows: Socket S01 on the main board goes to the socket S04 on the display board. Socket S02 on the main board connects to the front panel adjustments. Socket S03 on the main board connects to the oscillator board socket S05. Socket S06 on the oscillator board connects to some front panel adjustments.

To test the proper operation of the oscillator board: first set the FREQUENCY BAND switch to any range between 1 MHz and 100 MHz. For a 50% duty cycle, you should observe a nearly 50% duty cycle squarewave of 1 V peak-to-peak amplitude centered around 0 V (into 50 ohm system). If the duty cycle is varied from its 50% position, you will observe that the dc-level of the squarewave output will vary too and will be around -1 V for 0% and +1 V for 100% duty cycle setting.

For all other ranges above 350 MHz, one should obtain a sinusoidal output waveform of approximately 1 V peak-to peak amplitude centered around 0 V. If any of these tests fail, you may just send in the oscillator board. The board is disconnected as follows: unscrew the FREQUENCY BAND switch and disconnect the socket connectors S05 and S06 and one SMA connector.

If the display board ceases to function properly, just disconnect socket S04 and unscrew the two screws on top of the metal support bracket. The board can then be sent in for repairs. If the malfunctioning is not due to the oscillator or display boards, assume that the problem is at the main board or front panel controls. In this case, we recommend that you send the complete instrument to us for repair.

If you need to replace the fuse, simply open the top panel and unscrew the top of the fuse holder. Replace the appropriate fuse as follows: For 115 V supplies, the replacement fuse should be 1.6 A, and for 230 V supplies, the fuse should be 0.8 A. Both types should be quick acting. For 230 V supplies, the fuse carrier will accept a 5X20 mm size fuse, whereupon for 115 V, a fuse holder accepting fuses more commonly used in the US (1/4 X 1-1/4 inch) will be supplied.

CHAPTER 5

PERFORMANCE SPECIFICATIONS

GENERAL

Pulse generator frequency range: 1 MHz to 1000 MHz for ECL, 1 MHz to 350 MHz for TTL in internal mode. With an external source, the ranges may be extended down to dc.

Frequency drift: better than ±1 LSD typically after 20 minutes warm- up.

Displayed frequency accuracy: ±1 digit LSD typically, crystal controlled 4 1/2 digit frequency counter.

Displayed frequency resolution 1-10 MHz: 1 kHz; 10-100 MHz: 10 kHz; 100-1000 MHz: 100 kHz

ECL OUTPUTS:

Rise/falltime: ≤ 200 ps

Transition times (20-80%): ≤150 ps

Signal output amplitude: 1 V minimum per side, fully complementary outputs.

The output amplitude can be reduced continuously over a 2:1 range. Output dc range is +2 V to -3 V for signal plus offset. The output offset of each output can be set independently. The output amplitude affects both outputs equally.

Transient aberration in a 1 GHz sampling system: ≤10% for the first 1.5 ns up to f = 100 MHz. The aberration specificiations of the plug-in used may be in addition to this specification. Output amplitude is set to a 1 V.

Time-coincidence for differential outputs: ≤30 ps

Small-signal gain: 22 typical, differential output

Small-signal bandwidth: 300 MHz typical

Duty cycle range: 10–90% up to 50 MHz, 20–80% up to 350 MHz, 30–70% up to 500 MHz. Set by 10-turn precision potentiometer.

Minimum pulse width realizable: 500 ps

Input offset bias range with INP OFFSET potentiometer: ±500 mV typical

TTL OUTPUTS:

Rise/falltime (10–90%): ≤750 ps

Transition times (20–80%): ≤500 ps

Signal output amplitude: 0 to 5 V nominal into 50 ohms, fully complementary TTL compatible outputs. Internal source impedance is 50 ohms.

Transient aberration in a 1 GHz sampling system: ≤10% for the first 2 ns to f = 100 MHz. The aberration specifications of the plug-in used may be in addition to this specification.

Time-coincidence for differential outputs: ≤150 ps

Small-signal gain: 50 typical

Small-signal bandwidth: 80 MHz typical

Duty cycle range: 10–90% up to 50 MHz; 20–80% up to 200 MHz. Set up by 10-turn precision potentiometer.

Minimum pulse width realizable: 2 ns

Input offset bias range with INP OFFSET potentiometer: ±500 mV typical

DRIVER AMPLIFIER:

Rise/falltime(10–90%): ≤200 ps

Transition times (20–80%): ≤150 ps
Note: The rise/falltime and transition times are slightly degraded below f = 10 MHz.

Signal output amplitude: 0 to -1 V typical, complementary outputs. The reverse terminations are brought out to the front panel.

Transient aberration in a 1 GHz sampling system: ≤10% for the first 1 ns to f = 100 MHz.

Time-coincidence for differential outputs: ≤ 30 ps

Small-signal bandwidth: 200 MHz typical.

Duty cycle range: 10-90% up to 50 MHz, 20-80% up to 350 MHz, 30-70% up to 500 MHz. Set by 10-turn precision potentiometer.

Minimum pulse width realizable: 500 ps

Input offset bias range with DUTY CYCLE potentiometer in EXT MODE: 500 mV typical, set with 10-turn precision potentiometer.

GATING AMPLIFIER:

Min. signal to turn off TTL/ECL outputs: plus or minus 1 V. The trigger output and display are unaffected by the gating signal.

Gating turn-off turn-on time: ≤ 250 ps

Frequency range: dc to 800 MHz typical

TRIGGER OUTPUT:

The frequency is identical to the source for the lower two positions of the FREQUENCY BAND switch (up to 10 MHz). In all higher FREQUENCY BAND positions, the trigger output frequency is 1/64th of the input frequency.

Rise/falltime: ≤ 300 ps

Output amplitude: ≥ 500 mV into 50 ohm

MISCELLANEOUS SPECIFICATIONS:

Physical size is 24.5 cm W x 14 cm H x 34.5 cm D

Weight: 6 kg

Operating temperature range: 10° C to 30° C

Power requirements: 115 V (100 V to 130 V) or 230 V (200 V to 260 V), 50/60 Hz, 100 W.

CHAPTER 6

PERFORMANCE CHECK PROCEDURE

The instrument must have had at least a 20 minute warm-up period prior to the performance check. All tolerances specified are for the instrument only and do not include test equipment error. For attenuators, we recommend the 011-series fixed BNC attenuators from Tektronix, because they exhibit best dc tolerances and predictable transient response. BNC cables should be kept below 12 inches (30 cm) in lengths.

INITIAL CONTROL SETTINGS:

Set-up the generator for ECL outputs. Connect two matched BNC cables to a 1 GHz sampling oscilloscope input via two X10 BNC attenuators. Set up the sensitivity to 100 mV/DIV on the sampling plug-in.

1. Check pulse generator frequency range:

   The frequency shown on the display should cover the ranges as indicated on the FREQUENCY band switch position between fully counter-clockwise and fully clockwise positions.

2. Check ECL signal output amplitude:

   By changing the AMPLITUDE control, the output amplitude should vary at least over a range of 0.5 V to 1.0 V.

3. Check ECL output offset range:

   Set the AMPLITUDE to 1 V. By varying OFFSET A or OFFSET B, the dc level of the output should vary at least between +2 V and -3 V for signal plus dc offset.

4. Check ECL transient aberration:

   For any frequency setting between 1 MHz and 100 MHz, the transient aberration should be less than or equal to 10% for the first 1.5 ns after the transition.

5. Check ECL complementary output time- coincidence:

   First match your system and cables carefully. Then invert CH A or CH B in your sampling system. The 50% points should be within 30 ps.

6. Check ECL duty cycle range:

Use Tektronix® S6 sampling head with an appropriate plug- in. Allow for external triggering form TRIG OUT connector. Set frequency to 50 MHz. When changing the DUTY CYCLE potentiometer, the duty cycle can be varied at least between 10% and 90%. Repeat measurement for 350 MHz; the duty cycle range should be at least 20% to 80%. Finally, set the frequency to 500 MHz; the duty cycle should be at least between 30% and 70%.

7. Check for rise/falltime, transition times:

Pick f = 50 MHz. Set sensitivity to effectively 100 mV/DIV. The rise and falltime between 10% (0.5 DIV) and 90% (4.5 DIV) should be equal to or less than 200 ps. The corresponding transition times for 20% to 80% (time difference between 1.0 DIV and 4.0 DIV) should be equal or less than 150 ps.

8. Check minimum pulse width:

Disconnect the SMA termination and connect the shorted BNC cap to the SMA-to-BNC adapter. Pick f = 400 MHz. Vary the DUTY CYCLE in either direction. The output pulse width should be equal to or less than 500 ps. Turning the INP OFFSET potentiometer slightly clockwise will allow you to adjust the pulse width over a narrow range.

9. Check TTL specifications:

Use X50 attenuators in front of plug-in inputs, then follow the procedure as outlined above.

10. Check DRIVER AMPLIFIER specifications:

Follow the procedure as outlined under steps 1 through 8.

11. Check gating amplifier:

Apply plus or minus 1 V to the GATE IN connector. Both ECL and TTL outputs should be now inhibited. If the pulse generators used for the purpose has fast transition times, the gating will turn on or off within 250 ps.

12. Check TRIGGER output:

The output amplitude should be at least 500 mV into 50 ohm, and the rise/falltime equal or less than 300 ps.

CHAPTER 7

WARRANTY INFORMATION

Colby Instrument, Inc. (CII) guarantees that the PG 1000A Pulse Generator meets all specifications as outlined in Chapter 5. The product is warranted against defects in material and workmanship for a period of one year from the date of shipment. During the warranty period, Colby Instrument, Inc. will at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to Colby Instrument, Inc. For details, see Chapter 4. The Buyer shall prepay all shipping charges to CII, and CII shall pay shipping charges to return the product of the Buyer. However, the Buyer shall pay all shipping charge, duties, and taxes for products returned to CII from outside the continental United States of America.

The foregoing warranty shall not apply to defects resulting from improper care by the Buyer. This shall also be true if any of the input or output devices have been damaged due to overload conditions beyond the specified limits.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. COLBY INSTRUMENT, INC. SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

THE REMEDIES PROVIDED HEREIN ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. COLBY INSTRUMENT, INC. SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

General Shipping Information:

Should you ever need to ship the complete PG 1000A, or part of the PG 1000A Pulse Generator, be sure that it is packaged in a protective package. Use the original shipping container and cushioning material to avoid in-transit damage. Such damage is not covered by the warranty. Colby Instruments, Inc. suggest that you always insure shipments. Attach a tag to the instrument identifying the owner and indicating the service or repair needed. We recommend that the owner keeps a separate record of the serial number, which can be found at the rear panel of the instrument. Should your unit be lost or stolen, the complete serial number is often necessary for tracing or recovery, as well as for any insurance claims. In any correspondence, identify the instrument by model number and full serial number.

It is very important that the Buyer provides us with the name and telephone number of the person whom we can contact in case for clarification of specified malfunction of the instrument. It has been our experience that a good percentage of the instruments we receive for repair are working properly, and the the malfunction is with other test equipment and/or cables.

2 V OPTION FOR ECL OUTPUTS

This instrument may be equipped with a 2 V option on the ECL outputs which customers can select when ordering the instrument. The 2 V option is desirable in case you need the larger signal for driving GaAs circuits, for example. We usually do not recommend the 2 V option if not required because transient aberration and rise/falltime are affected by this option. The PERFORMANCE SPECIFICATIONS is changed compared to the standard 1 V option as follows:

Rise/falltime (10-90%): ≤ 250 ps

Transition times (20-80%): ≤ 200 ps

Transient aberration in a 1 GHz sampling system: ≤ 20% for the first 2 ns up to f = 100 MHz. Output amplitude is set to 2 V.

All other specifications remain unchanged. Notice that the rise/falltime has sligthly increased compared to the 1 V version, but that the transient aberration specification has doubled.