PB-503

DESKTOP ANALOG & DIGITAL DESIGN TRAINER

User Manual

1 INTRODUCTION

The PB-503 Analog/Digital Electronic Workstation is a versatile, time-saving tool for circuit designers, engineering technicians, students, and hobbyists. A large breadboard area and a wide choice of built-in circuit accessories allow rapid and accurate construction of virtually any type of analog or digital circuit.

Circuit power is provided by three power supplies, two variable and one fixed. The circuit breadboard area includes over 2500 contact points. A multiple-waveform function generator supplies sine, triangle, and square wave output for analog circuits. A built-in speaker may be used for analog output.

Outputs also include a TTL-level square wave generator, two debounced pushbutton switches, and a bank of eight logic switches. Eight logic indicators may be used to display high and low logic levels. Two built-in potentiometers and two SPDT switches are provided for circuit control and adjustment. Connections to external test equipment or signal sources may be made using the two BNC connectors on the PB-503.

The PB-503 eliminates the clutter and confusion that often results when constructing sophisticated circuits. Alligator clips and similar connectors are seldom needed. Sockets on the PB-503 allow insertion of components or wires of up to 20 gauge.

A detailed panel layout and description of the PB-503 is given in the section “Description of Individual Features”.

2 Features & Applications

The PB-503 Analog & Digital Design Workstation is a robust electronics trainer suitable for all levels of electronics instruction and design. Utilizing the PB-503, students will learn valuable hands-on breadboarding techniques and build a solid foundation in circuit experimentation, construction and analysis. Experienced designers will find the PB-503 an invaluable instrument, providing a reliable platform for the most advanced and demanding design applications. The PB-503 can be used to construct basic series and parallel circuits to the most complicated multi-stage microcomputer circuits, incorporating the latest in industrial technology. Use the PB-503 to construct a wide variety of experiments, including but not limited to.

- Opto-Device Circuits
- Clocks
- Multivibrators
- Oscillator Circuits
- Timers
- Function Generator Circuits
- Logic Circuits

- Gates
- Counters
- Flip-Flops
- Analog-to-Digital Converters
- Digital-to-Analog Converters
- Medium Scale Integration Circuits
- Phase Lock Loops
- Operational Amplifiers

3 PB-503 COURSEWARE

Courseware is available separately through our website or as part of the PB-503LAB package. The PB-503LAB package offers comprehensive course instruction covering the following areas:

Electronic Fundamentals	Digital Electronics
Fundamentals of Electricity	Number Systems & Codes
Ohm's Law	Binary, Decimal, Hexadecimal, Octal & ASCII
Series Circuits	Logic Gates & Boolean Algebra
Parallel Circuits	Combinational Logic Circuits
Combinational Circuits	Flip-Flops
Current Control	Digital Arithmetic
Closed, open, shorts	Counters & Registers
Switches	Integrated Circuit Logic Families
Thevenin's Theorem	TTL Logic
Wheatstone Bridge	MOSFETS
Capacitors	CMOS
Inductors	Interfacing CMOS & TTL
Phase Shift Circuits	Medium Scale Integration

Impedance	Decoders
Resonant Circuits	Encoders
Transformers	Data Conversion & Acquisition
Rectifiers & Filtering	Microcomputer Concepts
Integrated Circuits	
Transistor Amplifiers	
Oscillators	
Power Control Circuits	

4 DESCRIPTION OF INDIVIDUAL FEATURES

In order to properly use the full capabilities of the PB-503, it is highly recommended that the user become familiar with the panel layout and the features of the components. See Figure 1.

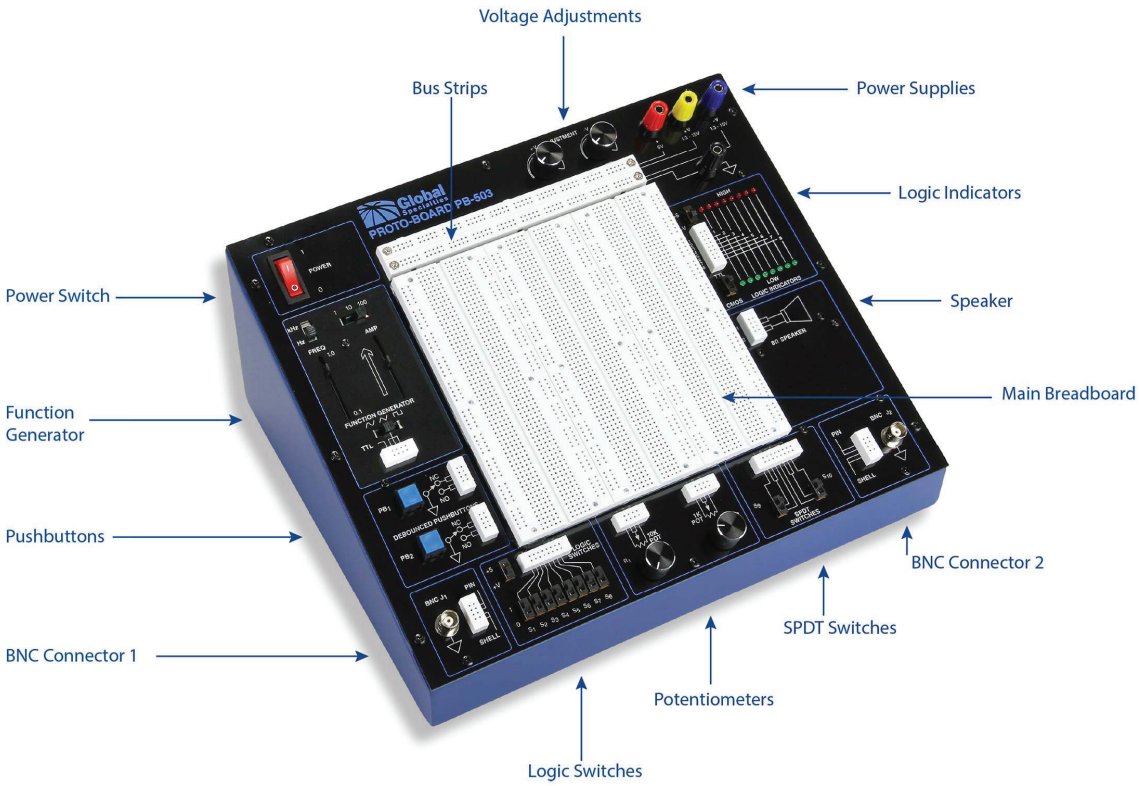

Figure 1 ***PB-503 Components***

4.1 AC Line Input

The PB-503 can run off of 115 or 230 VAC. The unit comes standard with a fuse for 115 VAC. In order to use with 230 VAC, please slide the switch on back to 230 V. You will also need to replace the fuse with a 5 x 20 mm time lag fuse that is rated at 0.25 A and 250 V (not included).

4.2 Power Supplies

By combining the three DC power supplies on the PB-503, the user may work with virtually any type of integrated circuit or discrete component. The fixed 5 volt supply has become an industry standard for powering digital IC's. IC's which require +5 V, +12 V, and -5 V are easily accommodated by the PB-503. The variable supply output voltages may be changed by using the screwdriver adjustment on the front panel. The positive and negative outputs are continuously variable from +1.3 to +15 volts and -1.3 to -15 volts respectively. Both variable supply outputs are referenced to circuit common. This creates a split supply which is often used with differential and operational amplifiers (op amps). The adjustments are recessed to prevent inadvertent voltage changes which could be destructive to a circuit.

In addition to the DC power supplies, the PB-503 also provides a 12.6 volt center-tapped AC supply. This allows the user to construct any of a variety of half-wave and full-wave rectified power supplies on the breadboarding area and apply power by simply connecting jumper wires to the three AC supply output pins.

4.3 Function Generator

The multi-waveform function generator provides continuously variable frequency signals from 0.1 Hz (for extra-low frequency work) to radio frequency signals of 100 KHz. The frequency is selected in six decade ranges, with a slide potentiometer to adjust frequency within each range. The sine wave output is factory adjusted for minimum distortion. The triangle waveform is adjusted for best linearity. The standard square wave and TTL level outputs are both set at a 5 0% duty cycle. The TTL output, capable of driving up to 10 TTL loads, is continuously available for the square wave output and is in phase with it.. The low output impedance of the sine, square, and triangle waveforms (600 Ω) assures maximum coupling of the output signal to the device being driven. All outputs can withstand a continuous short circuit to ground.

4.4 Logic Indicators

Sixteen LEDs, eight red and eight green, make up eight Logic Indicators that will display logic high and low conditions based on either TTL or CMOS thresholds, selectable by the user. Operating voltage can also be selected by the user to be either at +5 volts, or at the setting of the 1.3 - 15 volts +V supply. This selection should be the same as the operating circuitry that is to be monitored. The red LEDs will light when the voltages at the inputs are 2.2 volts or higher when in the TTL position, or

70% of the operating voltage or higher when in the CMOS position. The green LEDs will light when the voltages at the inputs are 0.8 volts or less when in the TTL position, or 3 0% of the operating voltage or less when in the CMOS position. An unconnected input, or an input not at a valid logic level, will cause both LEDs to be extinguished. Note that the thresholds determined by the TTL positions are only accurate when the +5 volt range is selected. The 100KΩ input impedance ensures minimal loading effects of the circuit under test.

4.5 Debounced Pushbuttons (Pulsers)

The PB-503 uses clocked flip-flops to provide debounced pushbutton switch functions. The pushbutton circuitry has open-collector outputs which can sink up to 250 mA each. This type of debouncing gives the user a sharp, glitch-free trigger source which assures reliable operation in digital circuits. Each pushbutton has a normally-open and a normally-closed output. If necessary, a pull-up resistor can connect any pulser output to any of the positive voltage sources.

4.6 Potentiometers

Two potentiometers are provided on the PB-503. The resistance values chosen (1KΩ and 10KΩ) may be used in common circuit applications such as volume controls, DC offset controls for op amps, and timing circuit controls. All leads for both potentiometers are available and uncommitted.

4.7 BNC Connectors

The PB-503 may be connected to other pieces of equipment via two BNC connectors. This allows the use of shielded cable to minimize noise and interference.

4.8 Switches

Two single pole, double throw (SPDT) switches are provided for general switching functions. All leads are available and clearly marked on the PB-503 for easy connection. Eight switches are configured as Logic Switches to provide a convenient source of digital outputs. These switches will provide logic levels of zero volts (ground) for a logic low, and logic high levels of either +5 volts or the voltage setting of the 1.3 -15 volt +V supply. The high level is determined by the setting of the +5/+V switch. This arrangement makes connecting special digital circuitry such as an eight-bit input port quick and easy, and allows compatibility with virtually any logic family.

CAUTION
Integrated circuits can be destroyed if a voltage is applied to their inputs that is higher than the operating voltage of the ICs. Always insure that the setting of the +5/+V high-level switch is in the correct position before making connections to any device.

5 SPECIFICATIONS

Description	Specification
AC Line Input	115 VAC @ 60Hz or 230 VAC @ 50 Hz (switchable)
Power Supplies	**Fixed DC**: +5 VDC 1.0 A max, current limited Ripple <5 mV **Variable DC**: +1.3V @ 150 mA to +15 VDC @ 500 mA Ripple <5 mV **Variable DC**: -1.3 VDC @ 150 mA to -15 VDC @ 500mA Ripple <±5 mV
Binding Posts	(4) Ground, +5VDC, Variable ±VDC Power Supply Outputs
Pulsers	(2) Pushbutton-operated, open-collector output pulsers. Each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250 mA.
Function Generator	**Frequency Range**: 0.1 Hz to 100 kHz in six ranges **Output Voltage**: 0 to +10Vp-p into 50 Ω Load (20Vp-p in open circuit), short circuit protected **Output Impedance**: 600 Ω except TTL **Output waveforms**: Sine, Square,Triangle & TTL **Sine Wave Distortion**: <3% @ 1 khz typical **TTL Pulse**: Rise & fall time <25 ns, drive 100 TTL Loads **Square Wave**: Rise and fall times <0.5 µs
Logic Switches	(8) Logic Switches select Logic High and Logic Low **Logic Low Level**: Ground **Logic High Level**: Switchable between +5 V and the variable positive power supplies.
Switches	(2) Single Pull Double Throw (SPDT) - uncommitted

Logic Indicators	**LEDs**: 16 LEDs; (8) red to indicate logic high and (8) green to indicate logic low **Logic High Threshold**: 2.2 V (nominal) in TTL/+5 V mode, 70% (nominal) of selected operating voltage in CMOS mode **Logic Low Threshold**: 0.8V (nominal) in TTL/+5 V mode, 30% (nominal) of selected operating voltage in CMOS mode
Connectors	(2) BNC - uncommitted
Potentiometers	(2) 1 kΩ and 10 kΩ - uncommitted
Speaker	8 Ω, 0.25 W - uncommitted
Breadboards	Removable Plexiglas Socket Plate (PB-3) with 2520 tie-points with 200 additional bus strip tie-points internally connected to power supply outputs and ground
Weight	7 lbs
Dimensions	6.5” x 16” x 11.5”

6 CHECKING OUT THE PB-503

The PB-503 may be checked out for proper operation by making a few simple measurements and connections. Begin by connecting the AC line cord to a suitable receptacle. The AC power indicator should light when the power switch is turned on.

Using a DC voltmeter, check for +5 volts between the ground terminal and the +5 volt terminal. Repeat the measurement for the positive (+) variable supply terminal and the negative (-) variable supply terminal. Check the variability of each supply by turning the appropriate adjusting screw. To test the logic indicators, switch the +5/+V operating voltage switch to the +5 position. The TTL/CMOS threshold switch can be in either position. With no input to the logic indicators, all LEDs should be turned off. Connect one end of a jumper wire to the + 5 volt terminal and the other end to logic indicator 1; the red LED of logic indicator 1 should light. Repeat this test for logic indicators 2 through 8. Disconnect the jumper from the +5 volt terminal and connect it to the ground terminal. Connect the other end to logic indicator 1; the green LED of logic indicator 1 should light. Repeat this test for logic indicators 2 through 8.

The function generator may be tested by connecting its output to one of the speaker

inputs. Connect the other speaker input to the ground terminal (or one of the connectors on the ground bus strip). Switch the function generator range switch to “1” and the Hz/kHz switch to “kHz”. Move the frequency control all the way to the top. Move the amplitude control upward until you hear a tone coming from the speaker. Switch the waveform selector to select sine, square, and triangle. A changing but clearly audible tone should be heard in each position. Changing the position of the frequency control should vary the pitch of the tone.

If an oscilloscope is available, you may check the function generator for proper waveform and frequency using standard measurement techniques.

The debounced pushbuttons can be checked by connecting one side of a resistor (20Ω to 100 KΩ) to +5 volts and the other side to PB1-1, the NC point. Then connect PB1-1 to LED-1 with the Logic Indicator +5/+V switch in the +5 position, the red LED should light when PB1 is pressed and the green LED should light when PB1 is released. Next, move the connections from PB1-1 to PB1-2, the NO point. Now the red LED should be lit when PB1 is not pressed, and the green LED should be lit when PB1 is pressed. Repeat these steps to test PB2.

The logic switches can be tested by connecting the output of logic switches 1 through 8 to the input of logic indicators 1 through 8. Switch the logic switch +5V/+V high level switch to +5, and switch the logic indicator +5/+V operating voltage switch to +5. Select the CMOS position on the logic indicator TTL/CMOS threshold select switch. Now the logic indicators should reflect the conditions of the logic switches, that is, red LEDs will indicate switches in the high (logic “1”) position and green LEDs will indicate switches in the low (logic “0”) position. Move each switch between its high and low position to verify proper functioning. Switch the logic switch +5/+V high level switch to +V and the logic indicator +5/+V operating voltage switch to +V; the relationship between the switch positions and the logic indicator display should remain the same, regardless of the setting of the 1.3 - 15 volts +V supply.

By using an ohmmeter, you can check the potentiometers. To do so, select an appropriate range for measuring 10 KΩ and connect the ohmmeter leads to R1-1 and R1-2. With R1 rotated fully counterclockwise a reading of 0Ω ohms should be observed. As the potentiometer is rotated clockwise, the resistance reading will be seen to increase linearly up to 10 KΩ ± 20%. Now move the ohmmeter lead from R1-l to R1-3; with R1 fully clockwise the ohmmeter will read zero ohms, and the resistance will increase linearly to the full value noted previously as the potentiometer is rotated counterclockwise. Select an ohmmeter range appropriate for 1 KΩ and repeat these steps on R2 to verify its function.

To test SPDT switch S9, put S9 in the up position and connect an ohmmeter to S9-1 and S9-2. The ohmmeter should read 0 Ω. When the switch is brought to the down position, an open circuit should be indicated. Move the ohmmeter lead from S9-1 to S9-3 and observe a short circuit with S9 down, and an open with S9 up. These steps can be repeated on S10 to test its functions.

7 BREADBOARDING TECHNIQUES

This section contains information which may prove useful when constructing circuits using the PB-503. While there are no hard and fast rules for breadboarding, the following tips may save time and trouble.

Unless a circuit is being prepared for a demonstration or display, avoid cutting component leads very short. While short wires and leads may look neat, the clipped components will only fit into a limited “span” of connector sockets, limiting the use of the component. It is perfectly permissible to use untrimmed components while exploring different circuit possibilities. The only time short leads may be necessary is when operating at higher frequencies and experiencing mysterious malfunctions. Sometimes the only way to correct high frequency circuit problems is to shorten all circuit connections.

Be cautious when using components which have been removed from a tape reel used in automatic insertion equipment. Suppliers of surplus components often sell components which are taped together in small batches. Removing the components from the tape does not always remove the adhesive from the leads of the components. Placing a formerly taped component into a socket connector may result in a poor electrical connection and, worse still, leave tape adhesive in the socket. Avoid this problem by either carefully cleaning taped component leads, clipping the taped portion of the lead off, or avoiding the use of taped components altogether.

Be especially careful when inserting integrated circuits into the breadboard sockets. Unless the IC pins are straight, it is very easy to crush the pin into a zigzag shape or fold the pins underneath the body of the IC. Either way the result is a bad connection or no connection at all.

Always use solid wire for breadboard connections. When stripping the wire ends, be careful not to strip more than about three-eighths of an inch of insulation from the wire. Too much bare wire may result in unintentional connections near the wire end.

After you have built up a few circuits, you will have a good collection of pre-stripped jumper wires. Save them. By reusing these wires, you can save even more time and effort in assembling future circuits. Pre-formed wires in various sizes are also available from Global Specialties (please visit web site for available options and accessories).

8 Service and Warranty Information

8.1 Limited Three-Year Warranty

Cal Test Electronics warrants this product to be free from defective material or workmanship for a period of 3 years from the date of original purchase. Under this warranty, Cal Test Electronics is limited to repairing the defective device when returned to the factory, shipping charges prepaid, within the warranty period.

Units returned to Cal Test Electronics that have been subject to abuse, misuse, damage or accident, or have been connected, installed or adjusted contrary to the instructions furnished by Cal Test Electronics, or that have been repaired by unauthorized persons, will not be covered by this warranty.

Cal Test Electronics reserves the right to discontinue models, change specifications, price, or design of this device at any time without notice and without incurring any obligation whatsoever.

The purchaser agrees to assume all liabilities for any damages and/or bodily injury which may result from the use or misuse of this device by the purchaser, his employees, or agents.

This warranty is in lieu of all other representations or warranties expressed or implied and no agent or representative of Cal Test Electronics is authorized to assume any other obligation in connection with the sale and purchase of this device.

8.2 Calibration and Repair

If you have a need for any calibration or repair services, please visit us on the web at: globalspecialties.com. See the “Service” tab. Or contact us via the “Contact” tab. You may also contact us at:

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