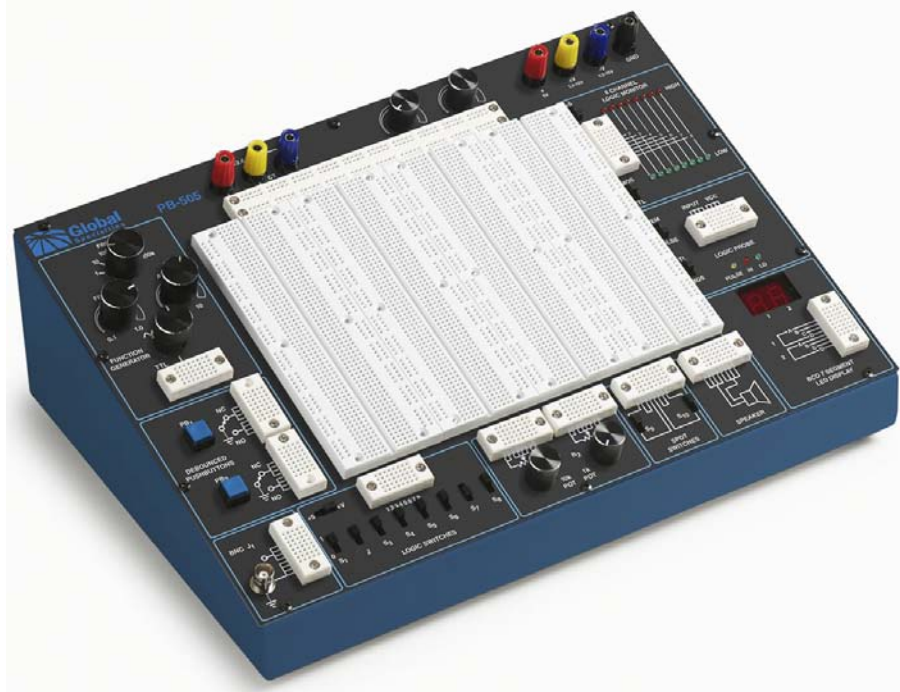


# PB-505

## Advanced Analog & Digital Design Workstation

Instruction Manual



Revision: 2/2011



## Features & Applications

The PB-505 Advanced Circuit Design Workstation is a robust electronics trainer suitable for all levels of electronics instruction and design. Utilizing the PB-505, 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-505 an invaluable instrument, providing a reliable platform for the most advanced and demanding design applications. The PB-505 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-505 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

## **PB-505 COURSEWARE**

Courseware is available separately through our website or as part of the **PB-505 Lab** package.

The PB-505 Lab package offers comprehensive course instruction covering the following areas:

### **Electronic Fundamentals**

Fundamentals of Electricity

Ohm's Law

Series Circuits

Parallel Circuits

Combinational Circuits

Current Control

Closed, open, shorts

Switches

Thevenin's Theorem

Wheatstone Bridge

Capacitors

Inductors

Phase Shift Circuits

Impedance

Resonant Circuits

Transformers

Rectifiers & Filtering

Integrated Circuits

Transistor Amplifiers

Oscillators

Power Control Circuits

### **Digital Electronics**

Number Systems & Codes

Binary, Decimal, Hexadecimal, Octal & ASCII

Logic Gates & Boolean Algebra

Combinational Logic Circuits

Flip-Flops

Digital Arithmetic

Counters & Registers

Integrated Circuit Logic Families

TTL Logic

MOSFETS

CMOS

Interfacing CMOS & TTL

Medium Scale Integration

Decoders

Encoders

Data Conversion & Acquisition

Microcomputer Concepts

## **ABOUT GLOBAL SPECIALTIES**

Thank you for selecting the Model PB-505. Since 1973, Global Specialties has been the recognized leader in technical education courses, training equipment and tutorial materials. Our electronics and microcomputer teaching systems have proven to be effective in secondary schools, technical schools, colleges, universities and industrial training departments throughout the world.

We have been leaders in the development of integrated teaching systems and completely packaged courses which include everything required for effective instruction. Comprehensive textbooks, laboratory manuals and instructor guides have been written in a comfortable, non-intimidating style by experienced professional educators, specifically for use with our equipment. Each course is designed to make selections appropriate for a variety of educational levels and course goals

The central concept upon which we base our entire product line is education through application. We believe that relevant scientific and technical education is best when it involves permitting students to learn by doing.

Global stands behind its products by offering the industry's best warranties. The PB-505 comes with a full three-year parts and labor warranty and can be returned for prompt repair or replacement to our factory in Yorba Linda California.

Low per-student cost, durable and trouble-free hardware and proven tutorial materials combine to make technical and scientific courses from Global Specialties the most effective, economical way to upgrade your lab & curriculum.

Please visit [www.globalspecialties.com](http://www.globalspecialties.com) to explore the many options available for the PB-505, such as courseware, pre-formed jumper wire kits, test probes and prototyping accessories.

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## SPECIFICATIONS

<b>Input Power Source</b>	AC Line: 115VAC @ 60Hz (typical)
<b>Power Supplies</b>	<p><b>Fixed DC:</b> +5VDC 1.0A max, current limited Ripple, &lt;5mV</p> <p><b>Variable DC:</b> +1.3V @150mA to +15VDC @ 500mA Ripple &lt; 5mV</p> <p><b>Variable DC:</b> -1.3VDC @ 150mA to -15VDC @ 500mA Ripple &lt; 5mV</p> <p><b>Fixed AC:</b> 12.6VAC center-tapped @100mA</p>
<b>Binding Posts</b>	(7) Ground, +5VDC, Variable +VDC & Variable -DC Power Supply Outputs, and AC Transformer center-tapped output
<b>Pulsers</b>	(2) Pushbutton-operated, open-collector output pulsers. Each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250mA.
<b>Logic Probe</b>	<p>Detects Logic High, Logic Low and Single Shot events.</p> <p><b>Logic High:</b> 2.2V (nominal) in TTL mode, 70% of Vcc in CMOS mode.</p> <p><b>Logic Low:</b> 0.8V in TTL mode, 30% of Vcc in CMOS mode.</p> <p><b>Memory Mode:</b> Detects single shot events and holds indication until Pulse/Mem switch is toggled</p>
<b>Function Generator</b>	<p><b>Frequency Range:</b> 0.1Hz to 100KHz in six ranges</p> <p><b>Output Voltage:</b> 0 to <math>\pm 10</math>Vp-p into 50 <math>\Omega</math> Load (20Vp-p in open circuit), short circuit protected</p> <p><b>Output Impedance:</b> 600<math>\Omega</math> except TTL</p> <p><b>Output waveforms:</b> Sine, Square, Triangle &amp; TTL</p> <p><b>Sine Wave Distortion:</b> &lt;3% @ 1Khz Typical</p> <p><b>TTL Pulse:</b> Rise &amp; fall time: &lt;25ns, drive 100 TTL Loads <b>**TTL Pulse available when in Square Wave Mode</b></p> <p><b>Square Wave:</b> Rise and fall times &lt;0.5<math>\mu</math>s</p>

<b>Logic Switches</b>	(8) Logic Switches select Logic High and Logic Low <b>Logic Low Level:</b> Ground <b>Logic High Level:</b> Switchable between +5V and the variable positive power supplies.
<b>Switches</b>	(2) Single Pull Double Throw (SPDT) - uncommitted
<b>Logic Indicators</b>	<b>LEDs:</b> 16 LEDs; (8) red to indicate logic high and (8) green to indicate logic low <b>Logic High Threshold:</b> 2.2V (nominal) in TTL/+5V mode, 70% (nominal) of selected operating voltage in CMOS mode <b>Logic Low Threshold:</b> 0.8V (nominal) in TTL/+5V mode, 30% (nominal) of selected operating voltage in CMOS mode
<b>Connectors</b>	(1) BNC - uncommitted
<b>Potentiometer</b>	(2) 1K $\Omega$ and 10K $\Omega$ - uncommitted
<b>Speaker</b>	8 $\Omega$ , 0.25W - uncommitted
<b>Displays</b>	(2) BCD to 7 Segment Display Circuits include (2) red LEDs and decoder/driver circuitry
<b>Breadboards</b>	Removable Aluminum Socket Plate (PB-4) with 3360 Tie points with 200 additional bus strip tie points
<b>Weight</b>	10lbs
<b>Dimensions</b>	6.5" x 19" x 11.5"

***Specifications subject to change without notice***



## INTRODUCTION

The PB-505 Advanced Analog/Digital Electronic Design Workstation, is a versatile, time-saving tool for circuit designers engineers, 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.

The PB-505 is designed to withstand the toughest treatment. It is constructed with the highest quality components available. Durable slide switches are mounted below surface to insure long life. All LED indicators are also sub surface to provide quick indication and durability. Selector switches are high quality rotary type as are all potentiometers. Rugged interface sockets securely bolted to the front panel provide quick connection to the convenient built-in circuits.

Circuit power is provided by three power supplies; two variable, and one fixed. The circuit breadboard area includes over 3300 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. A built-in logic probe is useful in circuit troubleshooting and two BCD to 7 segment decoder/ drivers and LED's may be used in circuit designs.

Two built-in potentiometers and two SPDT switches are provided for circuit control and adjustment. Connections to external test equipment or signal source may be using the BNC connector on the PB-505.

The PB-505 eliminates the clutter and confusion that often results when constructing sophisticated circuits. Alligator clips and similar connectors are seldom needed. Sockets on the PB-505 allow insertion of components of wires of up to 20 gauge.

A detailed panel layout and description of the PB-505 is given in the section "Description of Individual Features".

## DESCRIPTION OF INDIVIDUAL FEATURES

In order to properly use the full capabilities of the PB-505 it is highly recommended that the user become familiar with the panel layout and the features of the components, (see *Figure 1 below*)

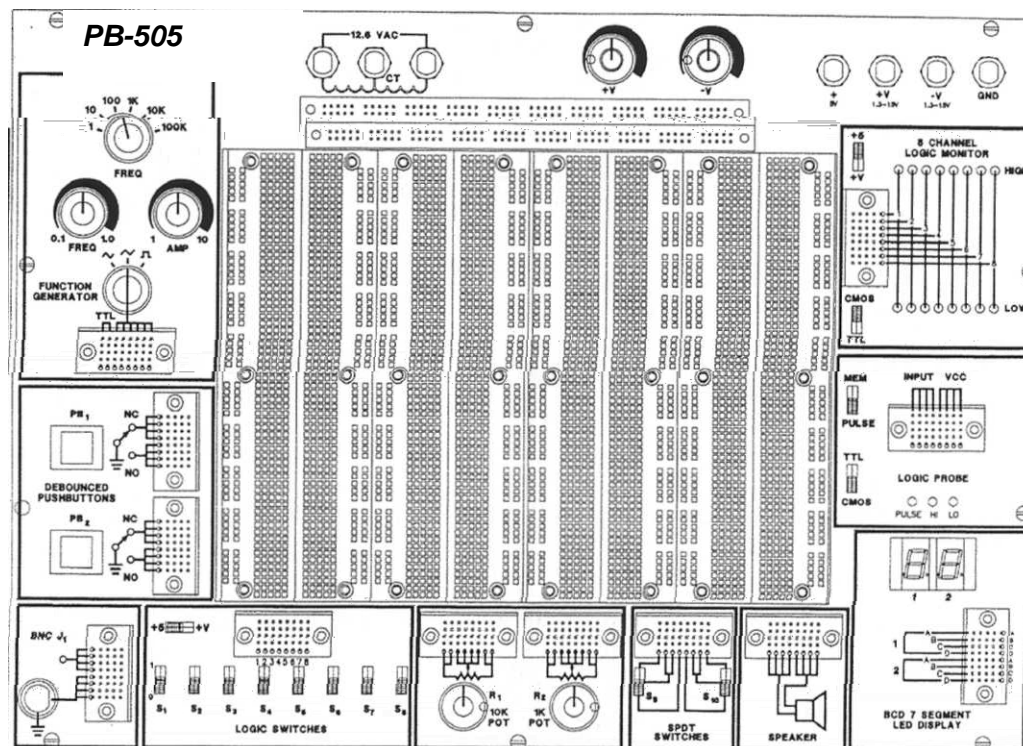


FIGURE 1. PB-505 Front Panel Layout

## POWER SUPPLIES

By combining the three DC power supplies on the PB-505 the user may work with virtually any type of integrated circuit or discrete component. The fixed 5V supply has become an industry standard for powering digital IC's. IC's which require +5V, +12V, and -5V are easily accommodated by the PB-505. The variable supply output voltages may be changed by using the adjustment knobs on the front panel. The positive and negative outputs are continuously variable from +1.3 to +15V and -1.3 to -15V 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).

In addition to the DC power supplies, the PB-505 also provides a 12.6 volt center-tapped AC supply. This allows the user to construct any 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.

### **FUNCTION GENERATOR**

The multi-waveform function generator provides continuously variable frequency signals from 0.1Hz (for extra-low frequency work) to radio frequency signals of 100Hz. The frequency is selected in six decade ranges, with a vernier 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 50% duty cycle. The TTL output (available when the function generator is set to square wave), capable of driving up to 10 TTL loads, is continuously available and in phase with the square wave output. The low output impedance of the sine, square, and triangle waveforms (600 ohms) assures maximum coupling of the output signal to the device being driven. All outputs can withstand a continuous short circuit to ground.

### **LOGIC INDICATORS**

Sixteen LED's, 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 +5V, or at the setting of the +1.3 to +15V supply. This selection should be the same as the operating circuitry that is to be monitored. The red LED's 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 LED's will light when the voltages at the inputs are 0.8 volts or less when in the TTL position, or 30% of the operating voltage or less when in the CMOS position. An unconnected input, or an input not at valid logic level, will cause both LED's to be extinguished. Note that the thresholds determined by the TTL positions are only accurate when the +5V range is selected. The 100K ohm input impedance ensures minimal loading effects of the circuit under test.

### **DEBOUNCED PUSHBUTTON (PULSERS)**

The PB-505 uses clocked flip-flops to provide debounced pushbutton switch functions. The pushbutton circuitry has open-collector outputs switch can sink up to 250mA 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.

### **POTENTIOMETERS**

Two potentiometers are provided on the PB-505. The resistance values chosen (1K and 10K ohms) may be used in common circuit applications such as volume controls. All leads for both potentiometers are available and uncommitted.

## **BNC CONNECTOR**

The PB-505 may be connected to other pieces of equipment via a BNC connector. This allows the use of shielded cable to minimize noise and interference.

## **SWITCHES**

Two single pole, double throw (SPDT) switches are provided for general switching functions. All leads are available and clearly marked on the PB-505 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 +5V or the voltage setting of the +1.3 to +15V supply. The high level is determined by the setting of the +5/+V switch. This arrangement makes connecting special digital circuitry such as an 8-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 IC's. Always insure that the setting of the +5/ +V high-level switch is in the correct position before making connections to any device.

## CHECKING OUT THE PB-505

The PB-505 may be checked out for proper operation by connecting the AC line cord to a suitable receptacle. The two 7-segment displays should light when the power switch is turned on.

Using a DC voltmeter, check for +5 volts between the ground terminal and the +5V 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 knob. 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 volts 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 one of the ground terminal. Switch the function generator range switch to 1KHz. Turn the frequency control pot clockwise. Move the amplitude control clockwise 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 of the frequency control should vary the pitch of the tone. The TTL Pulse is available when the function generator is set to Square Wave.

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

The debounced push-buttons can be checked by connecting one side of a resistor (20 ohms, to 100K) to +5 volts and the other side to PB-1, the NC point. Then connect PB-1 to LED-1 with the Logic Indicator +5/ +V switch in the +5V 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 PB2-1, 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 operating voltage 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 +5/ +V high level switch to +V and

the logic indicator +5/+V operating voltage switch to +V; 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 10K and connect the ohmmeter leads to R1-1 and R1-2. With R1 rotated fully counterclockwise a reading of zero ohms should be observed. As the potentiometer is rotated clockwise, the resistance reading will be seen to increase linearly up to  $10K \pm 20\%$ . Now move the ohmmeter lead from R1-1 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 1K 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 zero ohms. 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.

To test the logic probe, connect a wire from Vcc to +5 terminal. Set mem/pulse switch to pulse and TTL/CMOS switch to TTL. Connect a wire from input to +V terminal. Connect the multimeter between GND and +V. Turn the +V pot fully counter-clockwise, read approx. 1.2V on the meter. Slowly turn the +V pot until the HI LED lights. Read approx. 2.4V on the meter. Set pulse/mem switch to mem. Touch input lead to ground. Observe low LED lighting and pulse LED lighting and staying on. Move pulse/ mem switch to mem and observe pulse LED going out. Move TTL/CMOS switch to CMOS, reconnect input lead to the +V terminal. With the +V pot fully counter clockwise, slowly turn the +V pot clockwise until the low LED goes out. Read approx. 1.6 volts on the DMM. Continue turning the +V pot until the HI LED lights read approx. 3.5 volts on the DMM.

To test the BCD to 7 segment displays, jumper together pins 1A, 1B, and 1C. Connect a jumper wire from these points to ground. Connect a second jumper wire from position 10 to +5V. Observe a number 8 showing on the display. Repeat this test for display number.

## **BREADBOARDING TECHNIQUES**

This section contains information which may prove useful when constructing circuits using the PB-505. 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).

## SERVICE AND WARRANTY INFORMATION

For up-to-date product information, please visit [www.globalspecialties.com](http://www.globalspecialties.com).

For instructions on how to obtain a return merchandise authorization number (RMA), please visit our website, or call our customer service department.

**GLOBAL SPECIALTIES**  
**22820 Savi Ranch Parkway**  
**Yorba Linda, CA 92887**  
**800-572-1028**  
**globalspecialties.com**

Global Specialties will service and repair this instrument free of charge for a period of 3 full years, subject to the warranty conditions below.

### WARRANTY

Global Specialties warrants the PB-505 to be free from defective material or workmanship for a period of 3 full years from date of original purchase. Under this warranty, Global Specialties is limited to repairing the defective device when returned to the factory, shipping charges prepaid, within 3 full years from date of original purchase.

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

Global Specialties 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 functions TD [(s)4( w)16(ar)7(r)7(6(t)2(i)6((s)4(x)6(opy)14( r)7h)