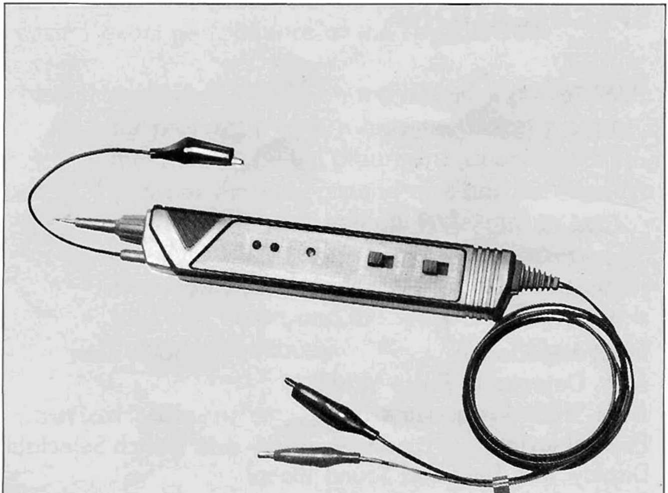
OWNER'S MANUAL

22-303

DIGITAL LOGIC PROBE

PLEASE READ BEFORE USING THIS MACHINE



*TRADEMARKS OF
TANDY CORPORATION

MICRONTA®*

WHAT IS A LOGIC PROBE?

This Logic Probe is an economical and useful device for testing a logic circuit. It displays the HIGH and LOW and a PULSE with different colored LEDs and audible signals at voltage test points of a digital circuit. It lets you "peek inside" the CMOS and TTL/LS ICs.

SPECIFICATIONS

Thresholds

TTL/LS (5V Vcc): LO = 0.8V±0.2V
HI = 2.2V±0.2V

CMOS/MOS (Vcc Range: 4.7V to 15V):
LO = 30% Vcc
HI = 70% Vcc

Input Impedance	: 100k ohm
Min. Detectable Pulse Width	: 50ns
Max. Input Frequency	: 10MHz
Pulse/Normal	: Switch Selectable
Display with Light and Sound (Beep)	
Power Supply Max. Stand-by Current	: 10mA at 5V 30mA at 15V
Max. Operating Current	: 20mA at 5V 80mA at 15V

CONNECTING YOUR LOGIC PROBE

Your Logic Probe has been designed to operate from any power supply from 4.7 to 15 volts. During testing, attach the longer clip leads of the Logic Probe to the power supply. Connect the black lead to the negative (−) and red lead to the positive (+) terminal of the power supply. The short black ground lead should be attached to a ground near the point to be tested to ensure exact performance of the Logic Probe.

Note : A diode is added on the negative power line for protection from a reversed polarity. Since there is a potential difference (approx. 0.6V) between the input ground wire and the negative power lead, measurement is defined to be conducted by using input ground terminal. Thresholds will deviate if the same power supply for Logic Probe and the systems to be tested is used simultaneously.

Caution : Never apply voltage over 15V DC to the Logic Probe.

USING YOUR LOGIC PROBE

1. Connect your Logic Probe as described above.
2. Set the device type switch to CMOS or TTL/LS depending upon which "family" of logic devices you are going to test.
3. Set the mode switch to either NORMAL or PULSE. In the PULSE mode, the Logic Probe will indicate the logic level of the pulse train. In the NORMAL mode, the unit will indicate the DC Logic state.
4. Touch the exposed metal tip of your Logic Probe to the TTL/LS circuit point to be tested. If the LOW (green) LED lights and the unit makes a low tone sound (beep), it indicates a level lower than the threshold voltage of about 0.8 volts. If the HIGH (red) LED lights and a high tone sound (beep), it indicates a level above the threshold of about 2.2 volts. If the circuit to be tested is the CMOS/MOS circuit:

   LOW = 30% Vcc
   HIGH = 70% Vcc

   If there is no LED lit and no sound (beep) emitted, the level is either between the threshold voltages or the circuit is "open". If the PULSE (yellow) LED is blinking, it indicates a pulse train at the testing node. (The mode switch is in PULSE position.)
5. To analyze the duty cycle of a pulse train, you can compare the brightness level of the HIGH (red) LED with the LOW (green) LED.
   If the HIGH (red) LED is brighter than the LOW LED, the pulse form has a longer high-duration. If the LOW (green) LED is brighter than the HIGH (red) LED, the low-duration of the pulse is longer.

Caution : Never apply more voltage to the tip pin of the Logic Probe than the supply voltage.

LED STATES HIGH	LOW	PULSE	BEEP	
○	●	○	●)	Logic "0" no pulse activity
●	○	○	●)))	Logic "1" no pulse activity
○	○	○	○	Test point an open circuit Out of tolerance signal Not powered
●	●	*		Square wave pulse activity
○	●	*		Logic "0" pulse activity
●	○	*		Logic "1" pulse activity

INDICATION

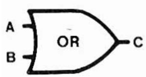
LED	BEEP
○ LED OFF	○ NO BEEP
● LED ON	●))) HIGH TONE
* BLINKING LED	●) LOW TONE
	● TONE

FIG. 1 INTERPRETING THE LEDS AND BEEP

DIGITAL TROUBLESHOOTING

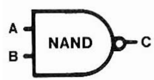
1. Static Gate Analysis

The truth table (a tabulation of the output commands for a given input) must be known for a given type of gate.
The most common logic tables are shown:



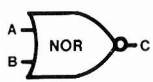
OR

A	B	C
LO	LO	LO
LO	HI	HI
HI	LO	HI
HI	HI	HI



NAND

A	B	C
LO	LO	HI
LO	HI	HI
HI	LO	HI
HI	HI	LO



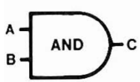
NOR

A	B	C
LO	LO	HI
LO	HI	LO
HI	LO	LO
HI	HI	LO

INVERTER

INVERTER

A	C
LO	HI
	LO



AND

A	B	C
LO	LO	LO
LO	HI	LO
HI	LO	LO
HI	HI	HI

2. Dynamic Gate Analysis

A gate may appear functional when observed statically (constant input DC level) but may fail under actual circuit operation (pulsing input signal). Figure 2 shows how an inverter will change a negative pulse to a positive pulse. All of this information is indicated by your Logic Probe.

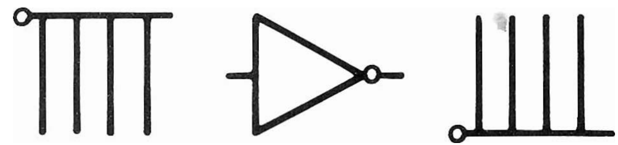


FIG. 2 INVERTER OPERATION

Once a fault is located in the circuit by your Logic Probe, it must next be determined whether the fault is in the IC or in some short external to the node. For example, if an output from a gate is always low, either the gate is bad or the printed circuit track to the node is shorted to the logic low. One method for distinguishing between the two is to free the pin of the IC under test and then use the Logic Probe to analyze the floating output.

Use of a Logic Pulser (such as a MICRONTA Cat. No. 22-304) can make trouble-shooting even easier by allowing you to control the signal flowing the circuit. Complete instructions on using your Logic Probe with a Logic Pulser are included with the Logic Pulser.

HINTS ON DIGITAL TROUBLESHOOTING

1. With CMOS devices, connect all unused inputs to Vcc or ground. "Floating" inputs may cause erratic device operation.
2. With TTL/LS devices, all inputs must be connected to something. If an input should always be high, connect it to Vcc. If an input should always be low, connect it to ground. If the TTL/LS devices contain OR, AND, or NAND gates, connect all unused inputs to a used input on the same device.
3. Power supply problems often cause trouble in digital circuits. Make sure the power supplied to each device is within the limits specified for the device. (A "hot" ground is another common problem.)
4. Often the quickest way to locate a problem in a digital circuit is to start at output and work back. If the circuit is driven by a multivibrator, first check the output of the multivibrator and then go to the output and work back.

TECHNICAL TALK ABOUT DIGITAL ELECTRONICS

Digital circuits are nonlinear devices and operate at saturation levels.

As shown in Fig. 3, if the voltage is increased on A then at some value the state of C will change from a logic 0 to a logic 1. The actual voltage at which this occurs is termed the threshold voltage for the family. (Typically 0.8V for low and 2.2 V for high in the TTL family or 30% for low and 70% for high in the CMOS family, where we define:

$$\% = \frac{V_T}{(+V) - (-V)} \times 100$$

V_T refers to the voltage at which C changes state from logic 0 to logic 1.)

When testing a gate statically, A would be caused to go HIGH (+V) and C monitored (changes from LOW to HIGH). When testing the gate dynamically, A might be pulsed with a square wave and C monitored. The gate is bad if no change occurs, provided the amplitude of the square wave at A passes through the VTL level.

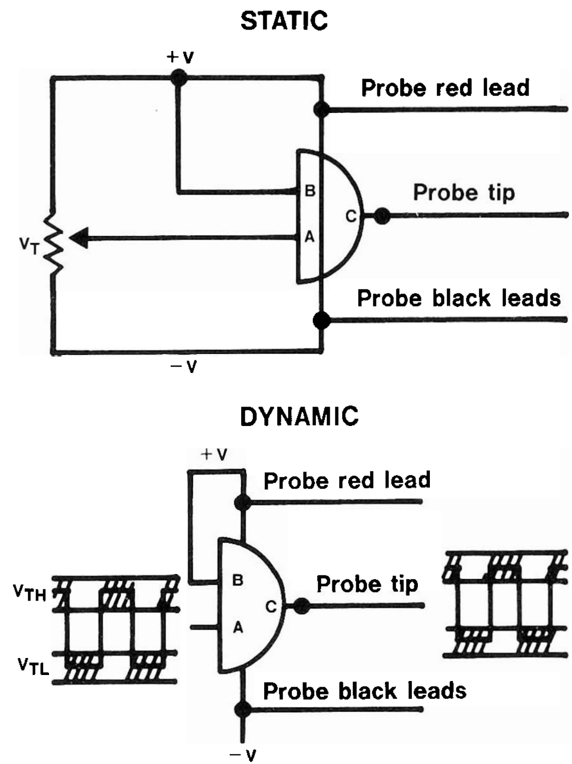


FIG. 3 STATIC AND DYNAMIC TESTING

Within a given family, the gate is bad if it gives rise to transitions that occur in the undefined region. (See Fig. 4 for CMOS.) For example, the HTL has thresholds of 8.5V and 6.5V, which compares favorably to the 70%–30% programming of the CMOS switch position.

Analysis of a wave train incorporates two aspects: the repetition rate and the duration (as shown in Fig. 5). The ratio of the duration to the repetition rate is often called the % duty cycle. For example, in the analysis of a square wave, the duration is half of the repetition rate and consequently has a 50% duty cycle. The repetition rate is the same as the frequency of the wave train. In addition, the pulse is termed as negative (Low) if the logic level remains high for most of the cycle and pulse low as shown in Fig. 5.

The converse is termed a positive (HIGH) pulse as shown in Fig. 6.

The (HIGH, LOW) LEDs will have relative intensities proportional to the duty cycle. For example, if the duty cycle is 10% and a negative exists, then the HIGH LED will have the greatest intensity because the LOW LED is on only 10% of the time. As the frequency becomes lower (below 40 Hz) the actual transitions of the (HIGH, LOW) LEDs can be resolved by the human eye. However, the duration of the HIGH LED with respect to the LOW LED is still proportional to the duty cycle.

A positive pulsing wave train with duty cycle above 50% becomes a negative pulsing wave train with a duty cycle of less than 50%. For example, a positive wave train with a 75% duty cycle is equivalent to a negative wave train with a duty cycle of 25%.

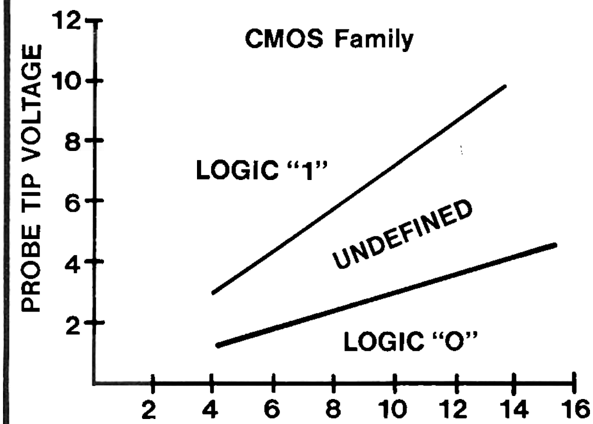


FIG. 4 PROBE TIP VOLTAGE VS POWER SUPPLY VOLTAGE FOR CMOS FAMILY

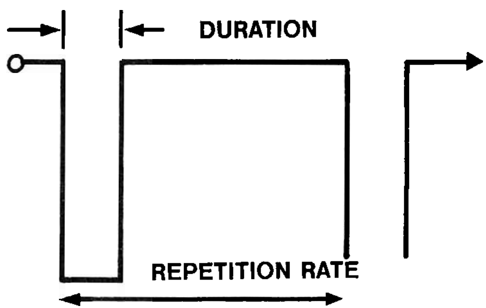


FIG. 5. NEGATIVE-GOING PULSE

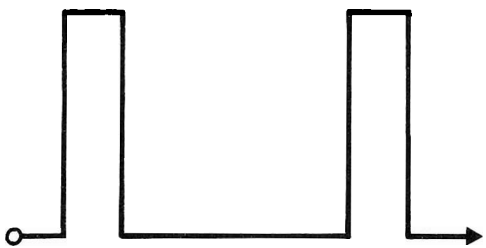


FIG. 6. POSITIVE-GOING PULSE

IN CASE OF PROBLEMS...

If your Logic Probe seems to be working improperly, try these hints:

1. Make sure your Logic Probe is properly connected or grounded.
2. If the PULSE LED blinks continuously for a logic condition, the power supply may require extra filtering. (Too much "noise" is coming from the power supply.)
3. Make sure the problem is not in the circuit you are testing. For example, if the circuit or device is completely "dead", no LEDs will light.