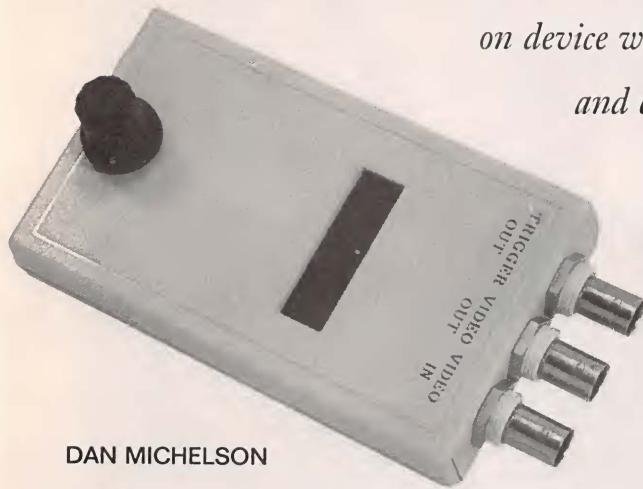*Even if your oscilloscope has a simple video trigger, this add-on device works with different broadcast standards, and can be set to pick out any individual line.*

ADD A VIDEO TRIGGER TO YOUR OSCILLOSCOPE

DAN MICHELSON

One of the most aggravating tasks when working with composite video is getting the oscilloscope to trigger properly. Unless you have an oscilloscope with a video-trigger option, you have probably struggled with just such a problem repeatedly. One option, of course, is to buy a new oscilloscope. Unfortunately, that option is usually too expensive for most of us. Having a simple device that could monitor a video signal and trigger an existing oscilloscope would be a more reasonable choice.

The Video Trigger Module presented here does just that, and then some. The unit is compatible with both NTSC and the several PAL video standards. The output trigger is adjustable on not only a line-by-line basis, but also has a variable offset from the start of any particular line of video. With a single, simple control, it is easy to adjust and choose from the many options available.

Device Description. The Video Trigger is a small hand-held unit that accepts a video signal and generates a trigger pulse. That pulse lets a stable baseband video signal be displayed on an oscilloscope. A 4-digit, 7-segment display is used to show the unit's current setup. A special rotary encoder that has a momentary-contact switch that is activated whenever its shaft is pressed is used to make all of the adjustments and option choices

that are available. Some of the options include the line number to trigger on, how much of a delay from the start of a line before triggering, and which video field to trigger on. Each time that the encoder shaft is pressed, the display shows another item whose options are then selected by rotating the encoder shaft.

To see the location of the trigger position in the video field, the Video Trigger has a video output that will contain a marker showing where in the video field the unit is triggering. That signal can be hooked up to any monitor for easy viewing. The marker can be adjusted between black and white using a potentiometer on the circuit board. The marker can be set to be either a line or a dot by selecting an option with the rotary encoder. Standard BNC connectors are used for easy hookup of the Video Trigger to a video source, a video monitor, and an oscilloscope.

Circuit Description. The circuit is built around two programmable devices: a single-chip microcontroller that controls all of the various functions and a programmable-logic device, or PLD. The PLD replaces almost all of the discrete circuitry that would otherwise be needed for a device such as the

Video Trigger. Within it are several registers that are loaded with data from the microcontroller depending on the various settings and controls. The PLD is the main reason that the unit is so compact in comparison to its features and abilities.

Following the schematic diagram shown in Fig. 1, a video signal that is input through J1 is coupled through C8 to the input of IC1, a video-sync-separator chip. The horizontal, vertical, and odd/even field signals are separated from the video signal and sent to IC5, the PLD. One of the functions located in IC5 is a counter that is decremented on each horizontal-sync signal. The initial value of the counter, which is the video-line number on which the oscilloscope will be triggered, is reloaded at each vertical-sync signal. That value is stored in IC5, and set by microcontroller IC4 according to the options that have been selected from the controls.

When the counter reaches 0 and the selected video field matches, a trigger pulse is generated by IC5. If the offset value is zero, then that pulse becomes the actual trigger signal that is sent to the oscilloscope through J4. With an offset value of zero, triggering will take place at the beginning of the line.
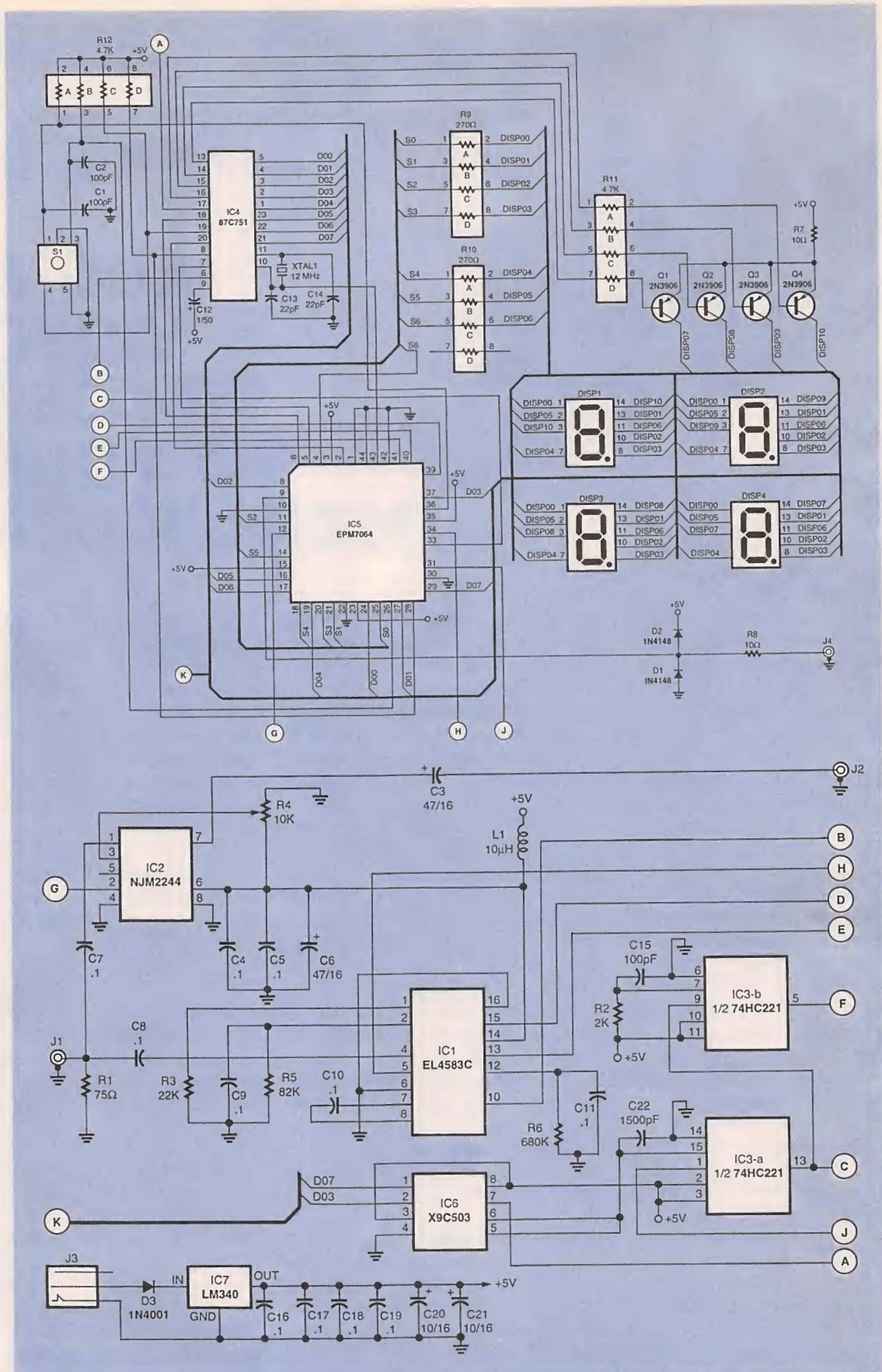
Fig. 1. Although the Video Trigger is a complex device, a programmable-logic device simplifies the design by replacing the equivalent of almost two dozen discrete components.
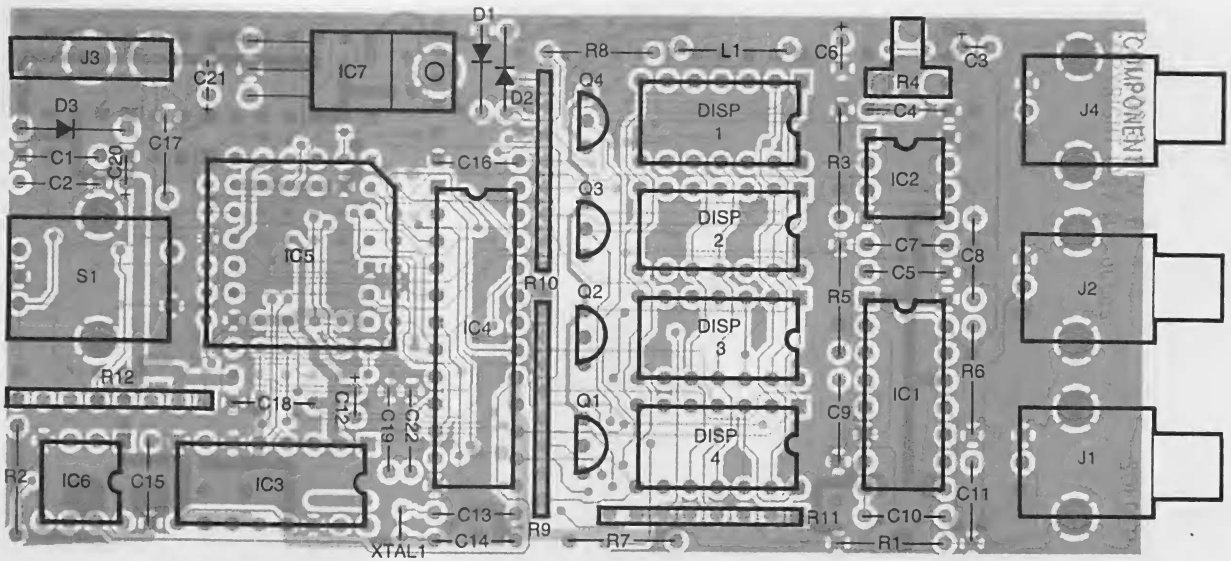
Fig. 2. Careful layout and design of the circuit board makes the Video Trigger a compact unit.

For any other offset, the trigger is sent to the input of IC3-a, a mono-stable multivibrator. That component generates a pulse whose length is set by an RC circuit. The capacitor portion of that circuit is C22, with the resistor portion coming from IC6, an electrically-settable potentiometer. A digital number from IC4 is loaded into IC6 that sets the output resistance of IC6. When the output pulse of IC3-a finishes, IC5 then sends a trigger pulse to J4.

The video signal is passed through video multiplexer IC2 to J2 so that it can be seen on a monitor. The multiplexer superimposes a line or dot on the video signal, giving a visible marker on the monitor. The DC level of the marker is set by R4, making the marker adjustable between the black and white levels.

If the marker display selected is to be a line, the marker voltage is switched in place of the video signal for the duration of that entire video line. A dot, on the other hand, needs to be switched in for only a brief instant at a particular position. The timing for the size of the marker dot itself is generated by IC3-b. The values of R2 and C15 set the output pulse to 200 nanoseconds in length. The dot pulse goes to IC5, which controls the multiplexing of IC2 by selecting whether IC2 will be controlled by the pulse from IC3-b or the horizontal sync from IC1.

Controlling the Video Trigger is done completely through S1, a

combination rotary encoder and momentary-contact switch. The encoder portion of S1 outputs two signals, a position pulse and a direction indicator. Both signals are handled by IC5, which alerts IC4 when S1 has been turned. The switch portion, activated when S1's shaft is pressed, is handled by IC4 directly.

The LED display (DISP1–DISP4) is multiplexed by IC4. The program within the microcontroller updates the display at a rate of four milliseconds per digit. The current source for each digit is supplied by Q1–Q4.

Those transistors are turned on one at a time by IC4. Before they are turned on, the segment pattern for the individual display is loaded into a buffer in IC5.

Construction. Because of the frequencies involved, the Video Trigger should be built on a printed-circuit board. If you want to make your own board, foil patterns have been included. Alternatively, a pre-etched board is available from the source given in the Parts List.

Before beginning construction, both IC1 and IC5 must be pro-

SETTINGS AND OPTIONS

Lxxx—Line xxx is selected as the trigger.
o xx—Offset xx is selected for the trigger.

Fevn—The even field is selected for the trigger.
Fodd—The odd field is selected for the trigger.
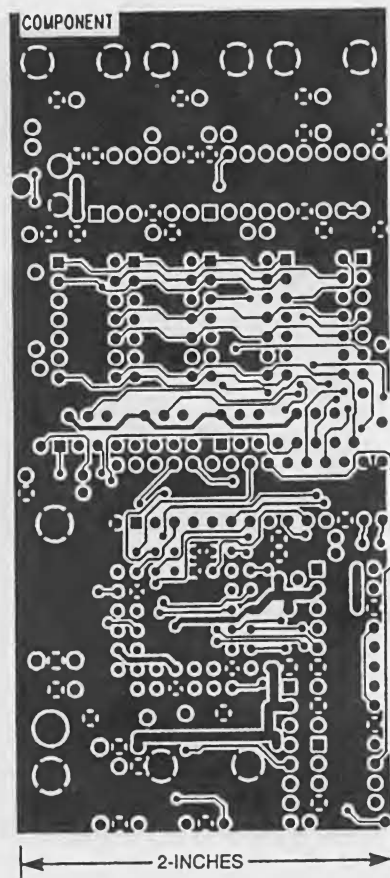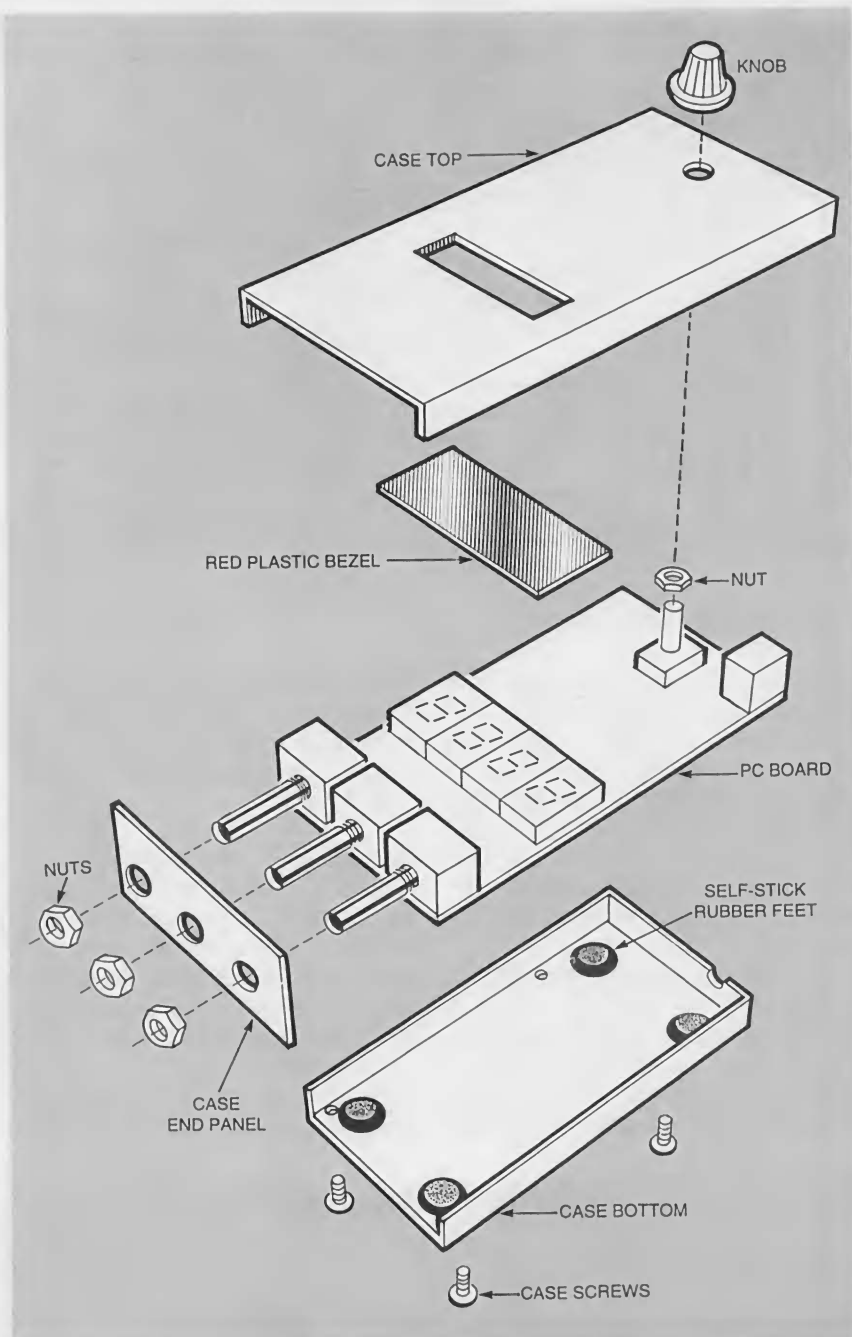**Fo/e**—The odd and even fields are both selected for the trigger.

NtSc—The unit is configured for an NTSC video input.
PALb—The unit is configured for a PAL B video input.
PALd—The unit is configured for a PAL D video input.
PALg—The unit is configured for a PAL G video input.
PALi—The unit is configured for a PAL I video input.
PALn—The unit is configured for a PAL N video input.
PALm—The unit is configured for a PAL M video input.

VLin—A line marker will be overlaid on the Video Output. This marker will move with the Line and Line Offset selection.
Vdot—A dot marker will be overlaid on the Video Output. This marker will move with the Line and Line Offset selection.
VdiS—No marker will be overlaid on the Video Output.

FLASHING (any of the above)—No video input detected.

Fig. 3. The Video Trigger fits neatly into a small hand-held case. A set of self-adhesive rubber feet applied to the inside of the case help lift the LED displays closer to the display window.

Here is the foil pattern for the component side of the Video Trigger.

grammed. The data files for both parts can be downloaded from the Gernsback FTP site at ftp://ftp.gernsback.com/pub/EN/vidtrig.zip. That .zip file contains the two files needed for the programmable parts. The file with the .hex extension is the object code for IC1. That chip should be programmed according to Intel's data sheet. The other file with the .pof extension is for IC5. Programming information for that part is detailed in its data sheet from Altera. If you do not have access to the

equipment needed to program those devices, pre-programmed units can be purchased from the source given in the Parts List.

If you are using a PC board from the Parts List source or the supplied foil patterns, the parts-placement diagram shown in Fig. 2 should be followed. Because of the tightness of the board layout, it is easiest to begin by installing the resistors, capacitors, and inductors first. Note that C19 is extra close to IC3, and might need to be offset a bit in

order for both components to fit on the board. The parts should all be mounted as close to the circuit board as possible.

A socket is required for IC5. Using sockets for DISP1–DISP4 is a good idea—the display will be closer to the viewing window. Although sockets are optional for the other ICs, using them is highly recommended.

Finish the board by mounting the rest of the parts and inserting the ICs into the sockets. If you are using the suggested connector for J3, the pin on the side of the unit should be removed or clipped flush before installation. Voltage regulator IC7 should be mounted flat to the board by bending its leads at a right angle.

Before installing the ICs in their sockets, apply power to the board and check the voltage at the various power-supply pins at each socket. When everything checks out, the ICs can then be installed.

Drill a suitable enclosure for the various controls. Three holes will be needed for the BNC connectors,

PARTS LIST FOR THE VIDEO TRIGGER

SEMICONDUCTORS

IC1—EL4583CN video-sync separator, integrated circuit

IC2—NJM2244D video multiplexer, integrated circuit

IC3—MM74HC221AN dual monostable multivibrator, integrated circuit

IC4—S87C751-1N24 microcontroller, integrated circuit

IC5—EPM7064LC44-15 programmable-logic device, integrated circuit

IC6—X9C503P or DS1804-050 50,000-ohm electronic potentiometer, integrated circuit

IC7—LM340T-5 5-volt regulator, integrated circuit

Q1–Q4—2N3906 silicon transistor, PNP

D1, D2—1N4148 silicon diode

D3—1N4001 silicon diode

DISP1–DISP4—MAN71A 7-segment common-anode light-emitting diode display

RESISTORS

(All resistors are ¼-watt, 5% units unless otherwise noted.)

R1—75-ohm

R2—2000-ohm

R3—22,000-ohm

R4—10,000-ohm potentiometer

R5—82,000-ohm

R6—680,000-ohm

R7, R8—10-ohm

R9, R10—270-ohm 4-element resistor network

R11, R12—4700-ohm 4-element resistor network

CAPACITORS

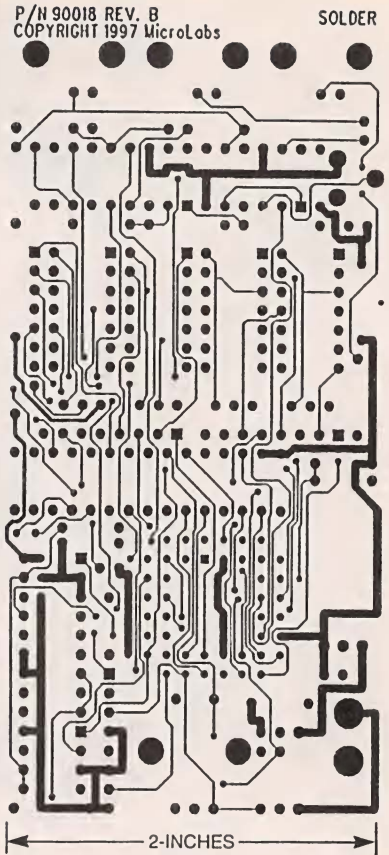C1, C2, C15—100-pF, ceramic-disc

C3, C6—47-µF, 16WVDC, electrolytic

C4, C5, C7–C11, C16–C19—0.1-µF, ceramic-disc

C12—1-µF, 50WVDC, electrolytic

C13, C14—22-pF, ceramic-disc

C20, C21—10-uF, 16WVDC, electrolytic

C22—1500-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

L1—10 µH inductor

XTAL1—12-MHz crystal, CA-301 package (DigiKey SE3424-ND or similar)

J1, J2, J4—right-angle BNC connector, PC mount (Newark 50F979 or similar)

J3—Right-angle male power jack, PC mount (DigiKey CP-002A-ND or similar)

S1—Rotary encoder with switch (DigiKey P80675-ND or similar)

IC sockets, 9-volt 200-mA wall transformer, enclosure, red plastic filter, self-adhesive rubber feet, knob, hardware, etc.

Note: The following items are available from: MicroLabs, Inc., 1036 Marshall Drive, Des Plaines, IL 60016; E-mail: ulabs@ix.netcom.com: IC1 (EL4583CN), $7.05; IC2 (NJM2244D), $2.75, IC6 (X9C503P), $3.65; PC board (TRIG1), $25.00; Programmed IC4, programmed IC5, and PC board (TRIG2), $65.00; Complete kit of all parts and PC board, less case (TRIG3), $125.00. Payment is by check or money order only. Illinois residents must add sales tax. Please add $5.00 to all orders for shipping costs. All orders are shipped via US Priority Mail. Allow 2 to 6 weeks for delivery. The author can be contacted via e-mail at: ulabs@ix.netcom.com.

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2-INCHES

Here is the foil pattern for the solder side of the Video Trigger.

with additional holes for J3 and the shaft of S1. A rectangular hole is also needed for the display. As an option, drill an access hole for adjusting R4. The overall arrangement of the final assembly is shown in Fig. 3. Glue a red plastic bezel over the rectangular hole to protect the display. Depending on the height of the case used, four rubber feet can be placed in the corners of the bottom of the case in order to lift the board up. That will position the displays closer to the plastic bezel if needed for better viewing.

Testing and Using the Video Trigger. When power is applied to the unit, the display will show "L 1," indicating that the trigger is set for the first line of video. Additionally, the unit will trigger on the even field of an NTSC video signal with a line offset of 0 (beginning of the line) and a line video-output marker. A typical test setup is shown in Fig. 4. The oscilloscope should have a high-impedance input that will not load the video input because the Video Trigger already has a 75-ohm termination resistor as a part of the J1 input circuitry. The default line marker will look like the sample video-monitor screen shot shown in Fig. 5A. If the marker is changed to a dot, it will look like the screen shot in Fig. 5B.
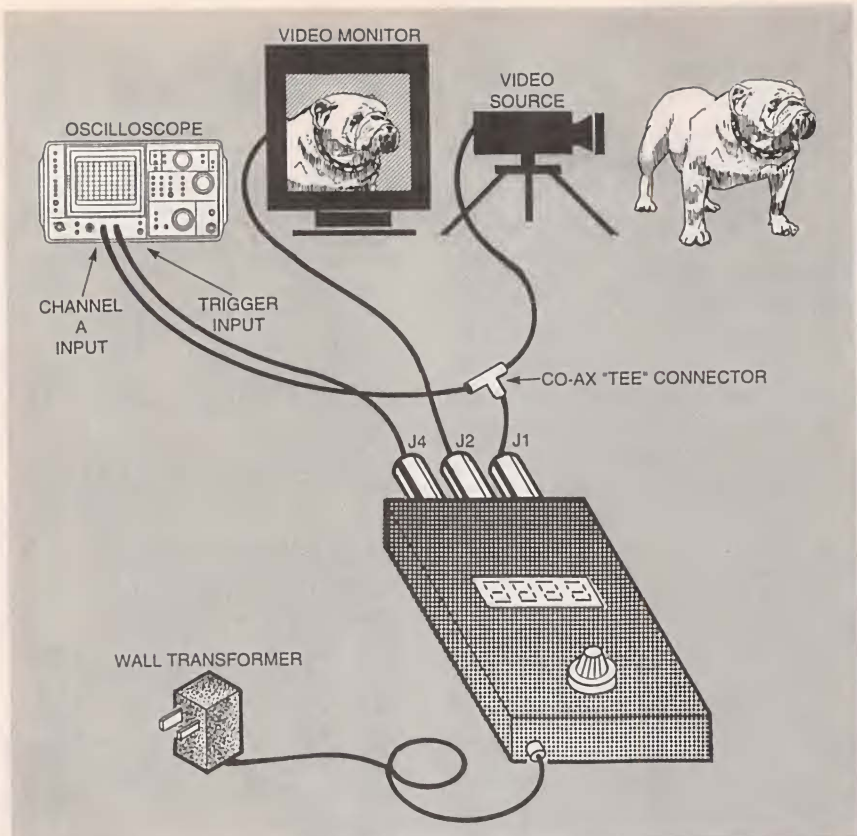
Any video signal that is applied to J1 should be stable with an amplitude of 1 volt peak-to-peak into a 75-ohm load. Either NTSC- or PAL-standard video can be used as long as the Video Trigger is set properly. Information on the various modes and options is shown in the "Settings and Options" box. Note that if there is either too much noise or not enough amplitude in the video signal, IC1 will not properly separate out the horizontal sync, vertical sync, and odd/even-field signals. When no video input is detected, the display will flash.

The trigger output at J4 is a TTL-compatible signal. That output is connected to either the channel input or the trigger input of your oscilloscope, depending on the scope that you will be using with the Video Trigger. In either case, the trigger-input setting on the oscilloscope should be set for activating on a negative-edge signal and DC coupling. If your oscilloscope happens to have an alternate-channel

Fig. 4. Here is a typical setup when using the Video Trigger to view a line of video on an oscillo-scope. All of the settings for the Video trigger are controlled by a single knob.

Fig. 5. The Video Trigger also has a monitor output that marks the position of the trigger on the video signal. You can choose from either a line (A) or a dot (B).

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mode, you can view both the odd and even fields at the same time by setting the Video Trigger to output a trigger on both the odd and even fields. The video signal should then be connected to two oscilloscope channels. The oscilloscope will then alternate between the two inputs on each successive trigger.

The video-output at J2 lets you see the video signal and the marker, if selected, on a monitor. As previously mentioned, the marker can range from white to black as set by R4. Being able to display the video signal with a marker is most useful as an instructional tool for students as it helps relate the actual video on a monitor with the waveform on the oscilloscope.

All of the settings and options available in the Video Trigger are selected with S1 and detailed in the "Settings and Options" box; the current choice is shown on the display. Each time the encoder shaft of S1 is pressed, the next group of options is selected. For any particular group, rotating the knob will change the setting for that option.

Whether it is used for education, troubleshooting, or examination of new circuits, the Video Trigger is a welcome addition to any test bench.   Ω