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Oscilloscope Modification Provides Some Features of Dual Time-Base Units*

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A frequent problem in large systems involves display of two signals from independent sources on the same oscilloscope. If each of the signals is accompanied by a pre-trigger (a trigger signal occurring just before the signal is to be observed) and the signals are asynchronous, the obvious solution is the use of a dual-beam, dual-time base oscilloscope. However, if the two signals cannot occur simultaneously and the same sweep speed is required for both, much of the flexibility of the dual beam unit is wasted. A relatively simple modification to any dual trace oscilloscope will provide the display capability at much lower cost.

The measurement situation referred to above is illustrated in Figure 1. The problem is to display these two signals on an ordinary dual-trace oscilloscope. Of course, the trigger signals could be ignored and the oscilloscope triggered internally, but then the signals marked B_2, C_2, E_2 and D_1 could not be viewed since the scope sweep would be locked out at those times due to the earlier sweep on that channel. Also, the advantages of the coherent pre-trigger have been lost. Clearly another technique should be used. The modification outlined in this article allows full display of all signals.

To understand the nature of the modification, it is first necessary to understand the circuitry of the typical dual-trace amplifier. A simplified block diagram is shown in Figure 2. In single channel mode, the control flip-flop is locked in one of its two states, closing the appropriate analog switch and feeding that signal through to the mixing amplifier. In the "added algebraically" mode both switches are closed and the flip-flop is out of the circuit. In the "chopped" mode, the flip-flop is connected as an astable oscillator running at a high

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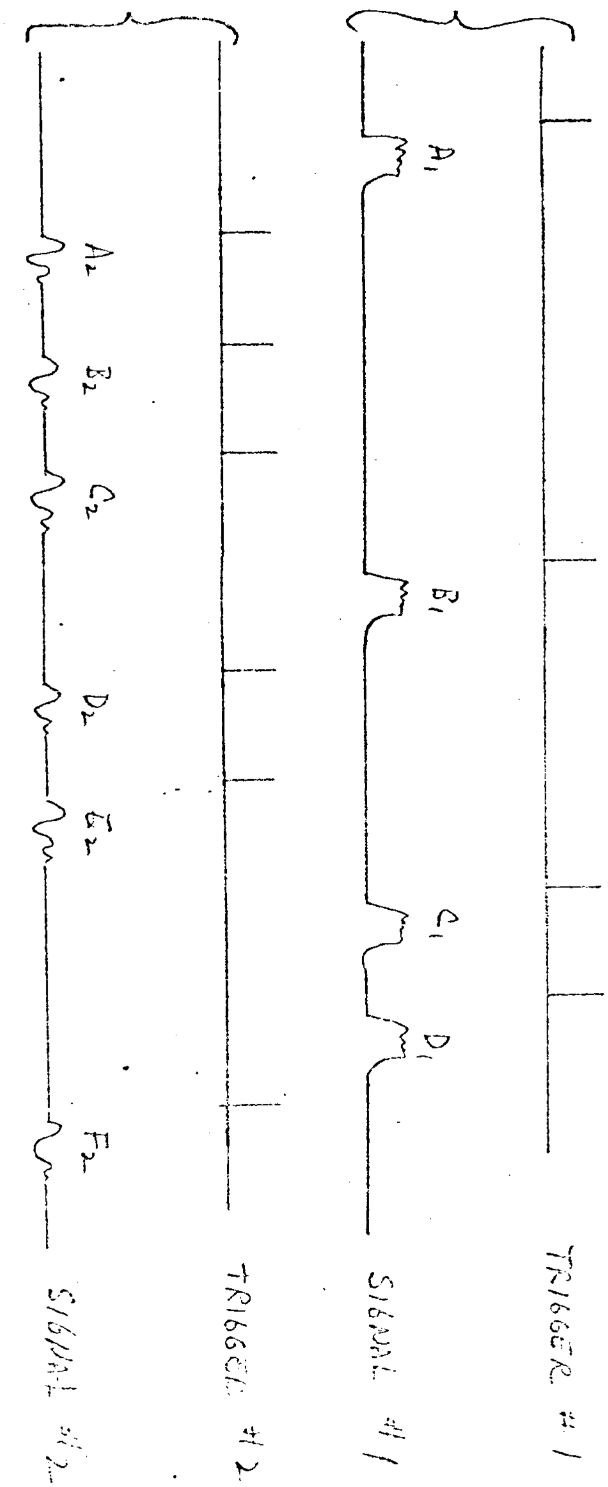
PROJECT—JOB			
TITLE FIGURE 1 — TYPICAL SIGNAL/TRIGGER PATTERNS			



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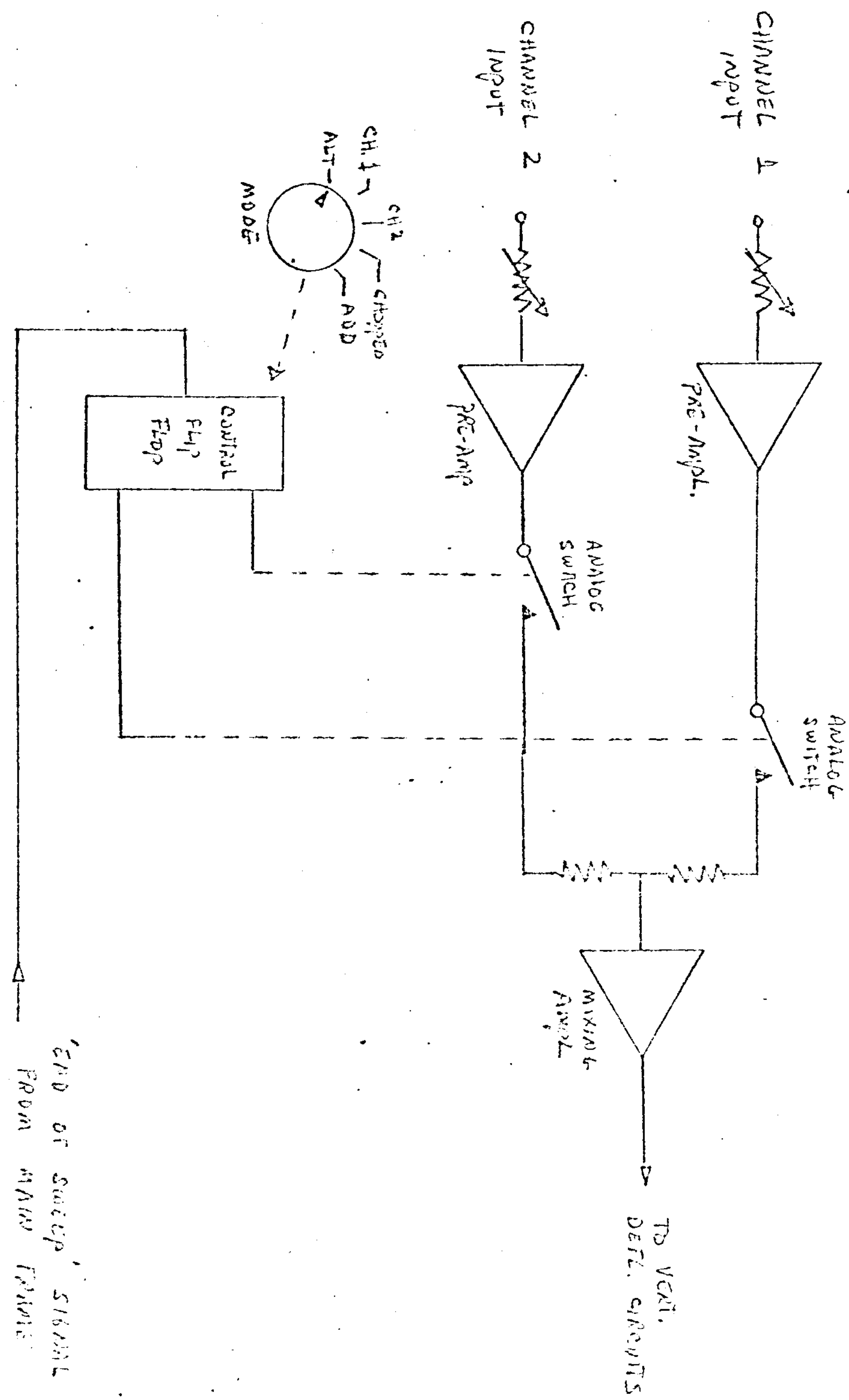
TITLE: FIGURE 2 - DUAL TRACE VERTICAL CIRCUIT



repetition rate. None of these modes concern us here. When the "alternate" mode is selected, the flip-flop acts as a bistable device, changing state at the end of each sweep. Thus the CH.1 and CH.2 signals are displayed alternately. It is this mode which we must modify in order to obtain the measurement capability required. The modification is shown in Figure 3.

The modified vertical circuit now has two trigger inputs which control the state of the control flip-flop; a CH.1 select trigger closes the CH.1 analog switch, and a CH.2 select trigger closes the CH.2 analog switch. If the two trigger channels shown in Figure 1 are now combined as shown in Figure 4, the circuit action will be as follows: when a trigger 1 pulse occurs, the control flip-flop in the vertical circuit is set so that the CH.1 switch is closed. This trigger pulse also passes through the delay line, triggering the oscilloscope sweep. The delay is inserted to allow the analog switch to settle; the delay required is typically 0.1-0.2/sec. The oscilloscope then displays the signal at the CH.1 input. Analogous events occur after a trigger 2 pulse, and the oscilloscope then displays the signal at the Channel 2 input. Obviously, the pre-trigger must occur sufficiently early with respect to the signal to be viewed to allow for the sweep trigger delay. In many large systems this is not a significant problem.

It should be noted that if the trigger channels are selectable, and if it is possible to select the same trigger for both inputs, the flip-flop must be of the J-K type. That is, it must respond to simultaneous signals on both inputs by complementing, or toggling. In this case the oscilloscope will act as a normal "alternate mode" dual-trace unit. This feature allows for restoration of normal operation by connecting the "end of sweep" signal to both inputs to the flip-flop. However, the additional circuitry required is significantly simplified if this feature is not required.

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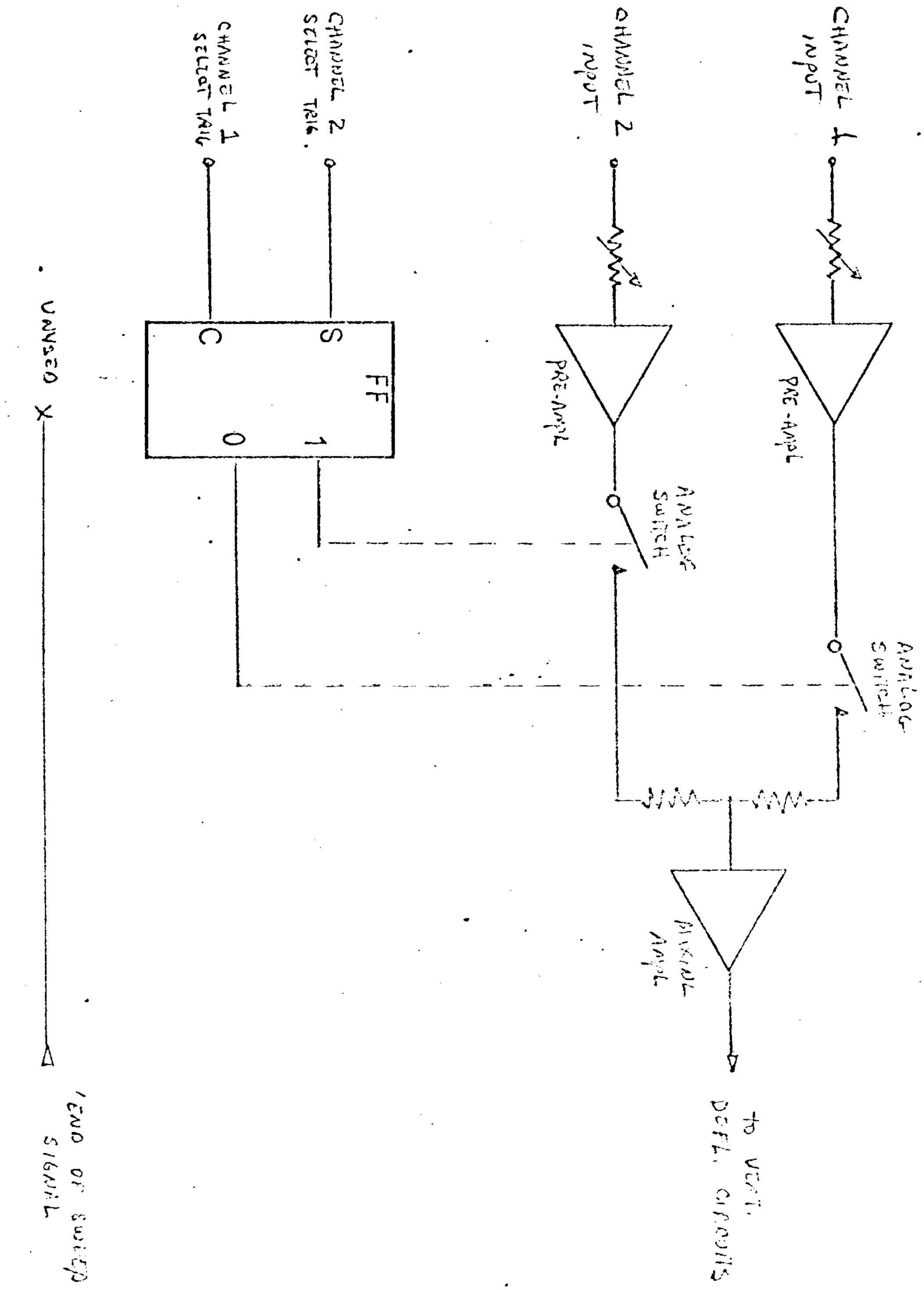
TITLE FIGURE 3 - MODIFIED VERTICAL CIRCUIT



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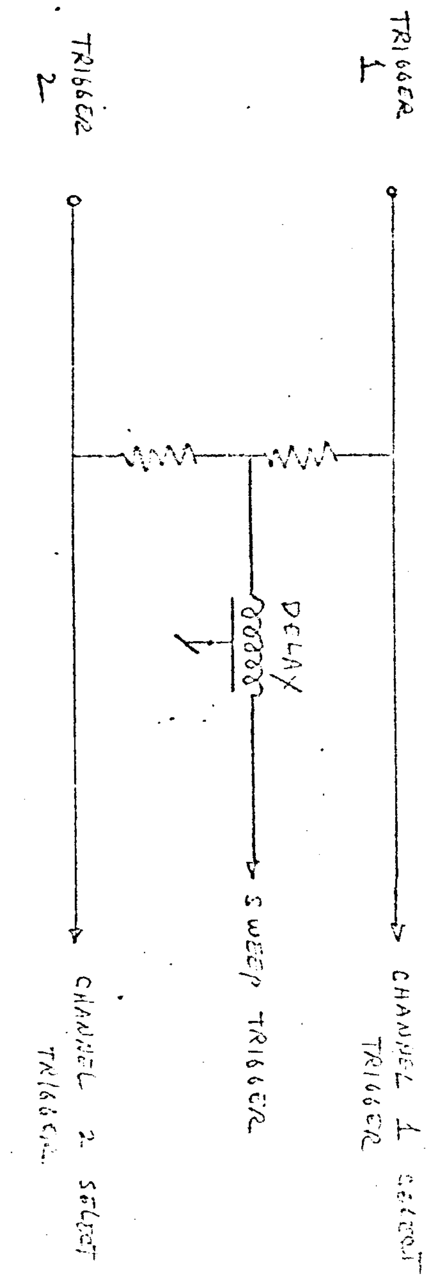
TITLE FIGURE 4 - TRIGGER CIRCUIT DETAILS



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Since each oscilloscope manufacturer uses a different circuit to implement the block diagram shown in Figure 2, it is impossible to describe a single circuit modification appropriate to all. A reasonably universal circuit is given in Figure 5. Circuit action is as follows: if the collector of Q_A is high, Q_1 is turned on, allowing a charge to be built up across C during the trigger pulse -- (note that the trigger source must be able to sink 7 ma when in the "low" state). At the end of the trigger pulse the junction of the capacitor and the two diodes goes negative, turning off Q_2 and turning on Q_3. This pulls the collector of Q_A to ground, triggering the control flip-flop on the trailing edge of the trigger pulse. If the collector of Q_A is already low, however, Q_1 will be turned off when the trigger pulse arrives. With Q_1 open there is no charging path for C_1, and Q_2 remains unaffected. This feature gives the circuit a trigger "steering" capability, allowing J-K action in case the two triggers occur simultaneously. Both channels of the circuitry in Figure 5 were wired on a 2 x 4 inch circuit card which was mounted in a clear space at the rear of the vertical plug-in. Power for the circuit (30 ma from + 15V, 2 ma from - 15V) was obtained from the power buses in the plug-in. Spare pins on the rear connector were used to bring in the trigger cables. Disconnection of the "sweep-end" signal was accomplished by shorting the gating transistor in the plug-in.

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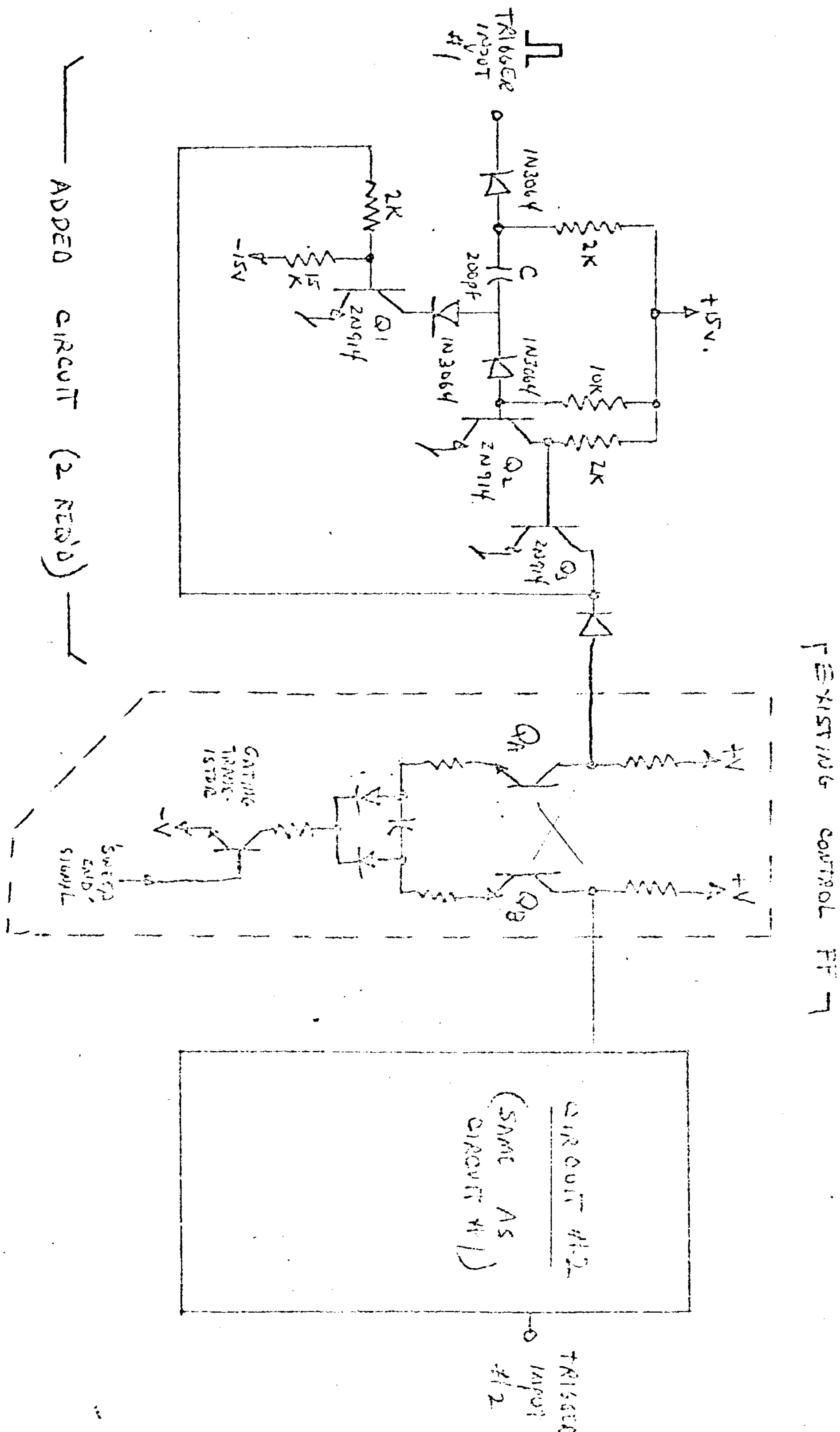
TITLE FIGURE 5 – CIRCUIT DETAILS



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