

TEKTRONIX 5403

THEORY OF OPERATION

LOW-VOLTAGE POWER SUPPLY AND CALIBRATOR

The low-voltage power supply circuit provides the operating power for the oscilloscope system. Electronic regulation is used, where necessary, to provide stable, low-ripple output voltages. The circuit also includes the calibrator circuit to produce an accurate square-wave output.

Power Input

Power is applied to the primary of transformer T800/F300/S300 through the display unit (fuse F300, thermal cutout S300, and Power switch S302, and the line-selector block, P800 or P801). The line-selector blocks allow changing the primary-winding taps of T800 to fit different line requirements.

Low-Voltage Rectifiers and Unregulated Outputs

The full-wave bridge rectifiers and associated filter components in the secondaries of T800 provide filtered DC voltages. The unregulated outputs are +200 volts, +18 volts, +38 volts, -18 volts and -38 volts. The +200-volt outputs to the display unit are protected by F800.

Low-Voltage Regulators

-30 Volt Supply. The -30-volt supply, besides providing power to circuitry throughout the instrument, provides a reference-voltage source to establish operating levels for the feedback regulators in the -15-volt, +15-volt, +30-volt and +5-volt supplies. The regulator for the -30-volt supply is a feedback amplifier system which operates between ground and the unregulated -38 volts. Current to the load is delivered by the series-pass transistor, Q940. The supply voltage is established by the drop across R948, R950, and R952, which is compared to the voltage drop across VR950 and the emitter-base junction of Q950. The feedback path is through R949, Q955, and Q958 to the base of Q940. Any variation in output voltage due to ripple, change of current through the load, etc., is immediately transmitted to the base of Q940 and nullified by a change in Q940 conduction, thus maintaining a steady output. The output of the supply is set to exactly -30 volts by adjustment of R950, -30 V adj. This control sets the conduction of Q950, which controls the bias levels of Q958 and Q940. CR955 and Q958 provide short-circuit protection by limiting the current through Q940 when the voltage drop across R940 exceeds 1.1 V.

-15-Volt Supply. The regulator for the -15 volt supply consists of series-pass transistor Q880, error amplifier Q900 and error sensing transistors Q894 and Q896. This is a feedback amplifier system which operates between +30 volts and -20 volts. Current to the load is delivered by the series-pass transistor, Q880. The supply voltage is established by comparing the supply voltage sample at the base of error sensing transistor Q894 with the reference at the base of error sensing transistor Q896. Any differences between the bases of the error sensing transistors causes a change in the Q894 collector. The error sensing circuit change is applied to the base of the error amplifier, Q900. The output of the error amplifier changes the conduction of the series-pass transistor Q880 to correct for any output error. Q885 protects the supply, in the event the output is shorted, by limiting the current demanded from the series-pass transistor under excessive load. During normal operation, Q885 is biased off.

+15-Volt Supply. The regulator for the +15 volt supply consists of series-pass transistor Q850, error amplifier Q870 and error sensing transistors Q864 and Q866. Operation of this feedback amplifier system is similar to that described for the -15-volt supply.

+30-Volt Supply. The regulator for the +30-volt supply consists of series-pass transistor Q910 and error amplifier Q925. This is a feedback amplifier system similar to that just described for the -30-volt supply. R920, +30 V adj, provides an adjustment to set the output of the supply at exactly +30 volts. Q915 protects the supply, if the output is shorted, by limiting the current demanded from the series-pass transistor under excessive load. During normal operation, Q915 is biased off.

+5-Volt Supply. The regulator for the +5-volt supply consists of series-pass transistor Q820, error amplifier Q824-Q832 and error sensing transistor Q838. This is a feedback amplifier system which operates between +5 volts and -30 volts. Current to the load is delivered by the series-pass transistor Q820. The supply voltage is established by the drop across R845 and R846. The error feedback path is through R845 to the base of Q838. Any variation in output voltage is immediately transmitted to the base of Q820 and nullified by a change in the conduction of Q820 which shifts the

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whole supply. Q830 protects the supply, if the output is shorted, by limiting the current demanded by the error amplifier transistor Q824. During normal operation, Q830 is biased off.

Line Trigger

A line-frequency signal is obtained from the secondary of T800 and attenuated by R935, R936, and R937 to provide a line-trigger source for the time-base plug-in unit.

CRT Heater Winding

A separate secondary winding is provided for the CRT writing-gun heaters. The writing-gun heaters are elevated to -3000 volts in the CRT circuit (display unit) to maintain a potential near that of the CRT cathode.

Calibrator

The Calibrator circuit composed of Q982, Q984, and their associated passive components produces a square-wave output with accurate amplitude and at a rate of twice the power-line frequency. This output is available at the probe test loop on the display unit front panel as a 4-milliampere (peak to peak) square-wave current, or as a 400-millivolt (ground to peak) square-wave voltage.

The resistive-capacitive network at the base of Q982 receives a pulsating DC voltage from full-wave rectifier CR980-CR981 and produces a nearly symmetrical switching signal for Q982 and Q984. As Q984 is alternately switched on and off at twice the line frequency, current through R986 is alternately switched through the transistor or through CR986, the probe test loop, and R987, producing the required test signal.

INTERFACE

The interface circuit provides an interconnection of signals, logic levels, and power-supply voltages between plug-in units and the oscilloscope mainframe. It incorporates circuits that determine the vertical display mode and amplify the vertical and horizontal display signals. Functions of interconnections not discussed are labeled on the interface diagram.

Chop Oscillator

The chop oscillator produces a 200-kilohertz square-wave signal for chopping between vertical plug-ins and amplifier channels within the plug-ins. This multivibrator circuit consists of U770A, U770B, and associated passive components. When the multivibrator receives a chop actuate level (+5 volts), it free-runs at a 100 kHz rate. (The chop actuate level is routed through the vertical plug-ins to the time-base unit, and is present at contact A20 of J630 when a multi-trace display is required and the time-base Display switch is set to Chop.) The chop actuate level also disables Q770, locking out alternate-drive pulses. The multivibrator has two outputs; one is sent through buffers to the divider circuit as a timing signal, and the other is sent to the U770D and U770C circuit to blank the chop-switching transients.

Divider Circuit

The divider circuit produces the display switching signal for both the Alternate and Chopped switching modes. This circuit is composed of U780 and its discrete passive components, which is connected as a pair of JK flip-flops. Each flip-flop is a divide-by-two counter, the first one

driving the second. The divider circuit is activated by a negative going transition, which can come from either the chop oscillator or from the time-base plug-in unit via grounded-base amplifier Q770. The chop oscillator input results in chopped-mode vertical switching. The input from the time-base unit coincides with the end of each sweep, and results in alternate-mode vertical switching. The output from the divide-by-two portion of the divider circuit, U780A, is sent via contacts B21 of J610 and J620 to the channel-switching circuits incorporated within multi-trace vertical plug-in units. The outputs from the divide-by-four portion of the divider circuit, U780B, are used for plug-in switching; one output is sent to pin 4 of the vertical integrated switching circuit to produce plug-in switching and the other output is sent via contact B21 of J630 to produce dual-sweep switching in dual-time-base units. The vertical mode switching sequence and some of the display combination possibilities are fully discussed in the General Operating Instructions section of this manual.

Vertical Amplifier and Vertical Integrated Switching Circuit

Emitter followers Q600, Q604, Q610 and Q614 provide a high-impedance input to the vertical amplifier and vertical integrated switching circuit, U620. The vertical amplifier input resistance for the oscilloscope main frame is determined by R601, R605, R611 and R615.

The vertical integrated switching circuit permits only one of the two vertical plug-in signals to pass to the vertical output amplifier, the level at pin 4 of U620 determines the plug-in signal that is passed to the vertical amplifier. When

the Display ON pushbutton on the right-hand vertical plug-in is depressed, -30 V is connected to contact B18 of J620, turning Q680 on. This increases the voltage level on pin 4 of U620, allowing the signal from the right-hand vertical plug-in to pass. If the left-hand vertical plug-in is to be displayed, the voltage on pin 4 of U620 is decreased by applying -30 V through contact B18 of J610 to R688. The signal from the left-hand plug-in now passes through U620. If, however, both plug-ins have an "on" logic level, the two logic levels applied to Q680 cancel each other and the signal from the divider circuit controls the plug-in signal passed. In the chopped switching mode, the switching between pairs of amplifiers occurs at a 50 kHz rate (switching occurs on both the negative- and positive-going transition), and in the alternate mode, switching occurs at the end of every second sweep. If neither plug-in has an "on" logic level, the level at pin 4 of U620 is such that the left plug-in signal passes to the vertical amplifier.

The gain of the vertical amplifier portion of U620 is set by resistors R620 (left plug-in amplifier) and R626 (center plug-in amplifier). The vertical output signal at pins 12 and 13 of U620 goes to a grounded-base stage consisting of Q640 and Q660. Q640 and Q660 change the DC level of the vertical signal so that it is compatible with the vertical amplifier in the display module. Q630 and Q650 act as both a current source for the grounded base stage and an insertion point for the vertical readout and trace separation information.

Trace separation information from contact B16 of J630 is supplied to the emitter of Q650 via Q674. Trace separation information is only available when a dual time base plug-in is used.

The vertical CH switch OFF signal is supplied to Q670 where it causes Q674 to be reverse biased during readout time, thus blocking the trace separation information. The signal also goes to pin 6 of U620 where it is used to prevent any vertical signal output from U620 during readout time.

During the time of the vertical CH switch OFF signal, vertical readout signal information is supplied to the emitter of Q630.

Horizontal Amplifier

The horizontal amplifier consists of an emitter follower stage (Q740, Q744) and a gain stage (Q748, Q752). The gain setting resistor is R750. Thermistor RT754 and resistor R756 provide a temperature compensation network for the amplifier.

Trigger Amplifiers

Left Vertical Plug-In. A nominal 250 mV/division, single-ended, input signal is applied to the input stage of a two stage amplifier from contact A4 of J610. The first stage, a paraphase amplifier, consisting of Q700-Q708 amplifies the signal by 1/4. The second gain stage consists of Q710 and Q715; R713 sets the stage gain. The output signal amplitude of the trigger amplifier depends upon the input impedance of the time-base trigger circuit at contacts A3 and B4 of J630. Time-base plug-ins designed for the 5100-series oscilloscope have a high input impedance, which results in a signal amplitude of 240 mV/division. Time-base plug-ins designed for the 5400-series oscilloscope have a low impedance, which results in a signal amplitude of 50 mV/division.

Right Vertical Plug-In. The right vertical plug-in trigger Amplifier operates the same as described above.

Z-Axis Signal

The gate signal from the A and B sweeps are added on the interface circuit board. The combined A and B gate signal is also summed with the trace intensification and chopped blanking signals before being supplied, via contact 4 of P755, to the display module as the Z-Axis signal. Diode CR761 limits the combined signals on the Z-Axis signal line. C766 and R766, which are in parallel with the input to the Z-Axis amplifier, serve to increase the rise time of the Z-Axis signal.

READOUT SYSTEM

The readout system provides an alphanumeric display of information encoded by the plug-in units. This information is presented on the CRT on a time-shared basis with the analog waveform display. A schematic for the readout system is available at the rear of this manual.

Display Format

Up to eight groups of characters can be displayed on the display unit CRT. The position of each group (word) is fixed and directly related to the originating plug-in. Fig. 2-1 shows the word positions on the display unit CRT.

Each word in the readout display can contain up to ten characters, although a typical display contains between two and seven characters per word. The characters are chosen from a set of fifty.

Developing The Display

Refer to the readout portion of the block diagram during the following discussion.

The key block in the readout system is the timer stage. This stage produces the basic signals that establish the

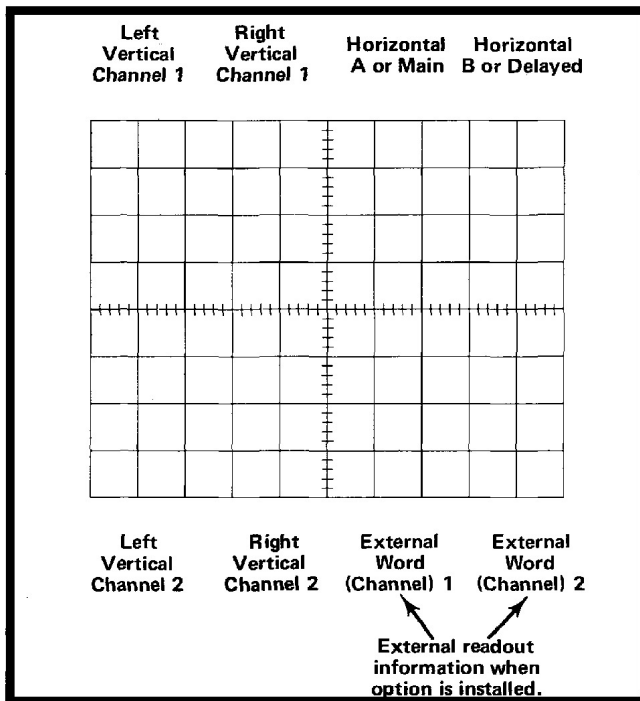


Fig. 2-1. Location of readout words on the CRT, identifying the originating plug-in and channel.

timing sequences within the readout system. The timer stage also produces control signals for other stages within the readout system, and interrupt signals to the vertical amplifier and Z-Axis amplifier to allow a readout display to be presented.

Included in the timer block is the time-slot generator. The time-slot generator has ten outputs, each of which is energized sequentially. After the tenth output is energized, the first is again energized to repeat the cycle. The ten outputs are connected to the vertical and horizontal plug-in compartments as well as to other stages within the readout system. Each time the first time-slot output line is energized, an address counter is incremented by one. The address counter counts to seven, then returns to zero. The address counter's three outputs are connected to various readout system stages.

Within each plug-in are readout coding resistors. The coding resistors are selected by the plug-in control settings, which connect the resistors between the various time-slot lines and one of four plug-in output lines. Two of the plug-in output lines are associated with channel 1 of amplifier plug-ins or the main sweep of sweep plug-ins. The other two output lines are associated with channel 2 of the amplifier plug-ins, or with delayed (or B) sweep of time-base plug-ins.

Each pair of output lines from the plug-ins or external readout (option 3) is connected to the data switches. Currents in these eight pairs (two pairs added with option 3) of lines are transferred to the outputs of the data switches, as selected by the address counter.

The data decoders convert each of the current signals from the data switches to make one of ten logic lines (together with signals from the timer) select the character generated by the character generators.

The output amplifier combines signals from the character generator with positioning signals from the address counter position generator. The combined signals then form the vertical and horizontal components of the readout display.

The vertical component of the readout display is injected directly into the output of the vertical channel switch on the interface board. During the interval when the readout is generated, the vertical channel switch is turned off, so only the readout signal is displayed.

The horizontal component of the readout display is connected to the horizontal channel switch. When the readout is not displayed, signals from the horizontal plug-in pass through the channel switch without change. During the interval when readout is displayed, the horizontal readout signal appears at the output of the horizontal channel switch instead of the horizontal plug-in signal.

CIRCUIT ANALYSIS OF READOUT SYSTEM

The following analysis of the Readout System discusses the operation of each stage in detail. A complete schematic of the readout system is shown on the diagram at the rear of this manual.

The definitions of several terms used in this description of the Readout System follow:

Character—A character is a single number, letter, or symbol that is displayed on the CRT, either alone or in combination with other characters.

Word—A word is made up of a related group of characters. In the readout system, a word can consist of up to ten characters.

Frame—A frame is a display of all words for a given operating mode and plug-in combination. Up to eight words can be displayed in one frame.

Column—One of the vertical groups in the character selection matrix (see Fig. 2-6). Columns C-0 (column zero) to C-10 (column 10) can be addressed in the system.

Row—One of the horizontal groups in the character selection matrix (Fig. 2-6). Row R-1 (row 1) to R-10 (row 10) can be addressed in the system.

Time Slot—A location in a pulse train. In the readout system, the pulse train consists of 10 negative-going pulses. Each of these time-slots is assigned a number between one and ten. For example, the first time-slot is TS-1.

Timer

Time U1000 establishes the timing sequence for all circuits within the readout system. This stage produces seven time-related output waveforms (see Fig. 2-2). The triangle waveform produced at pin 6 forms the basis for the remaining signals. The basic period of this triangle waveform is about 250 microseconds, as controlled by RC network C1021-R1021. The triangle waveform is clipped and amplified by U1000 to form the trapezoidal output signal at pin 10. The amplitude of this output signal is exactly 15 volts as determined by U1000 (exact amplitude necessary to accurately encode data in plug-in units; see Encoding the Data). The trigger output at pin 5 provides the switching signal for the time-slot counter and readout intensity control Q1018.

The signals at pin 12, 13, 14, and 16 are produced only when the triangle waveform is on its negative slope and the trapezoidal waveform has reached the lower level. The timing sequence of these waveforms is very important to the correct operation of the readout system (see expanded waveforms in Fig. 2-3). The Z-Axis blank at pin 14 is produced first. This negative going signal drives Q1015 which removes the current input for the interface to the Z-Axis amplifier to blank the CRT before the display is switched to the readout system. It also produces the strobe pulse through R1010, Q1010 and CR1013 to signal other stages within the readout system to begin the sequence necessary to produce a character. The collector level of Q1010 is also connected to character generator No. 2, U1092 through Q1010-CR1010. This activates U1092 during the quiescent period of the strobe pulse (collector of Q1010 negative) and diverts the output current of row decoder U1035 to row 2. The purpose of this configuration is to prevent the zeros logic and memory stage U1060 from storing incorrect data during the quiescent period of the strobe pulse. When the strobe pulse goes positive, CR1010 is reverse biased to disconnect Q1010 from U1092, and allow the row decoder to operate in the normal manner.

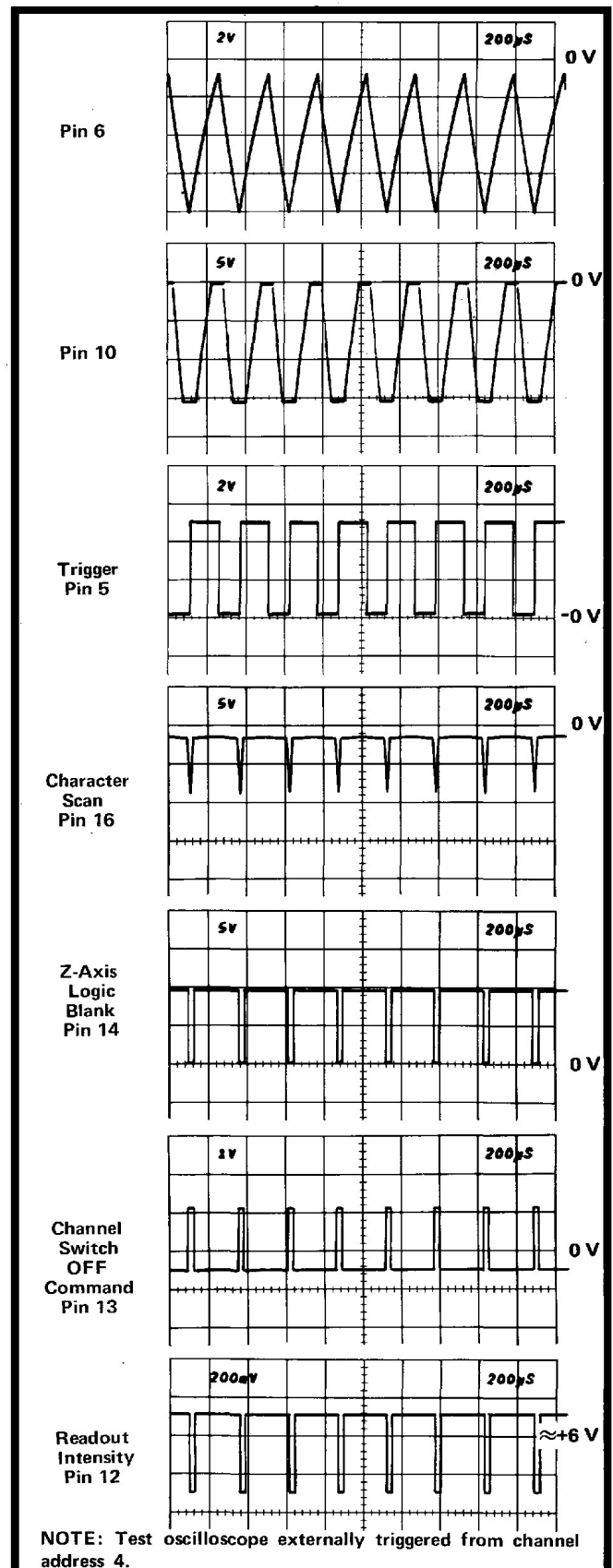


Fig. 2-2. Output waveforms of timer stage.

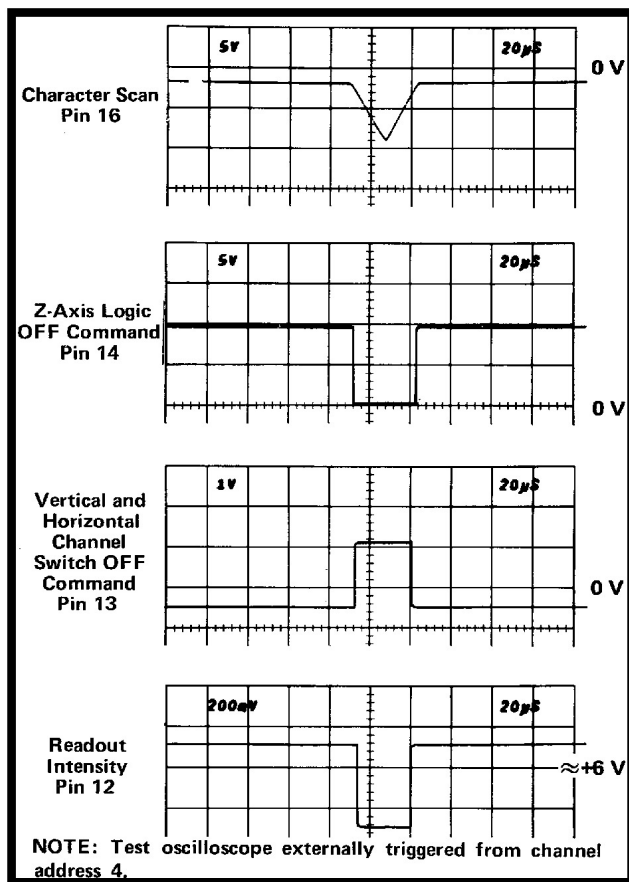


Fig. 2-3. Detail of output at pins 12, 13, 14 and 16 of U1000.

The next signal to be produced is the channel switch off command at pin 13. This positive-going signal disconnects the plug-in signals in the vertical and horizontal deflection system so that the plug-in units do not control the position of the CRT beam during the readout display. This signal is also connected to the decimal point logic and character position counter stage and the format generator stage. The readout unblanking output at pin 12 is produced next. This current is connected to the Z-Axis amplifier to unblank the CRT to the intensity level determined by READOUT intensity control R1000. However, Q1018 prevents the intensity current from reaching the Z-Axis amplifier until the character scan ramp at pin 16 begins its positive slope. The character scan ramp at pin 16 started to go negative as this timing sequence began. The triangular character scan ramp runs negatively from about -2 volts to about -8.5 volts, then returns back to the original level. This waveform provides the scanning signal for the character generator stages. Full character scan adjustment R1006 sets the DC level of the character scan ramp to provide complete characters on the display.

The timer stage operates in one of two modes, as controlled by the display skip level at pin 4. The basic mode just described is a condition that does not occur

unless all ten characters of each word (80 characters total) are displayed on the CRT. Under typical conditions only a few characters are displayed in each word. The display skip level at pin 4 determines the period of the timer output signal. When a character is to be generated, pin 4 is LO and the circuit operates as just described. However, when a character is not to be displayed, a HI level is applied to pin 4 of U1000 through CR1003 from the display skip generator stage. This signal causes the timer to shorten its period of operation to about 210 microseconds. The waveforms in Fig. 2-4 show the operation of the timer stage when the display skip condition occurs for all positions in a word. Notice that there is no output at pins 12, 13, 14, and 16 under this condition. This means that the CRT display is not interrupted to display characters. Also notice that the triangle waveform at pin 6 does not go as far negative and that the negative portion of the trapezoidal waveform at pin 10 is shorter. Complete details on operation of the display-skip generator are given later.

READOUT intensity control R1000 sets the intensity of the readout display independently of the INTENSITY control. The READOUT intensity control also provides a means of turning the readout system off when a readout display is not desired. When R1000 is turned fully counterclockwise, switch S1000 opens. The current to pin 11 of U1000 is interrupted and, at the same time, a positive voltage is applied to pin 4 through R1003 and CR1002. This positive voltage switches the stage to the same condition that were present under the display-skip conditions. Therefore, the CRT display is not interrupted to present characters. However, time-slot pulses continue to be generated.

Time-Slot Counter

Time-Slot counter U1025 is a sequential switch that directs the trapezoidal waveform input at pin 8 to one of its 10 output lines. These time-slot pulses are used to interrogate the plug-in units to obtain data for the readout system. The trigger pulse at pin 15 switches the time-slot counter to the next output line; the output signal is sequenced consecutively from time-slot 1 through time-slot 10. Fig. 2-5 shows the time-relationship of the time-slot pulses. Notice that only one of the lines carries a time-slot pulse at any given time. When time-slot 10 is completed a negative-going end-of-word pulse is produced at pin 2. The end-of-word pulse provides a drive pulse for the channel counter and also provides an enabling level to the display-skip generator during time-slot 1 only. The end-of-word pulse also resets the decimal point logic and zeros logic.

Word Counter

The word counter, made up of three flip flops in integrated circuit U1075, is a binary counter that produces the word address code for the column and row decoder stages.

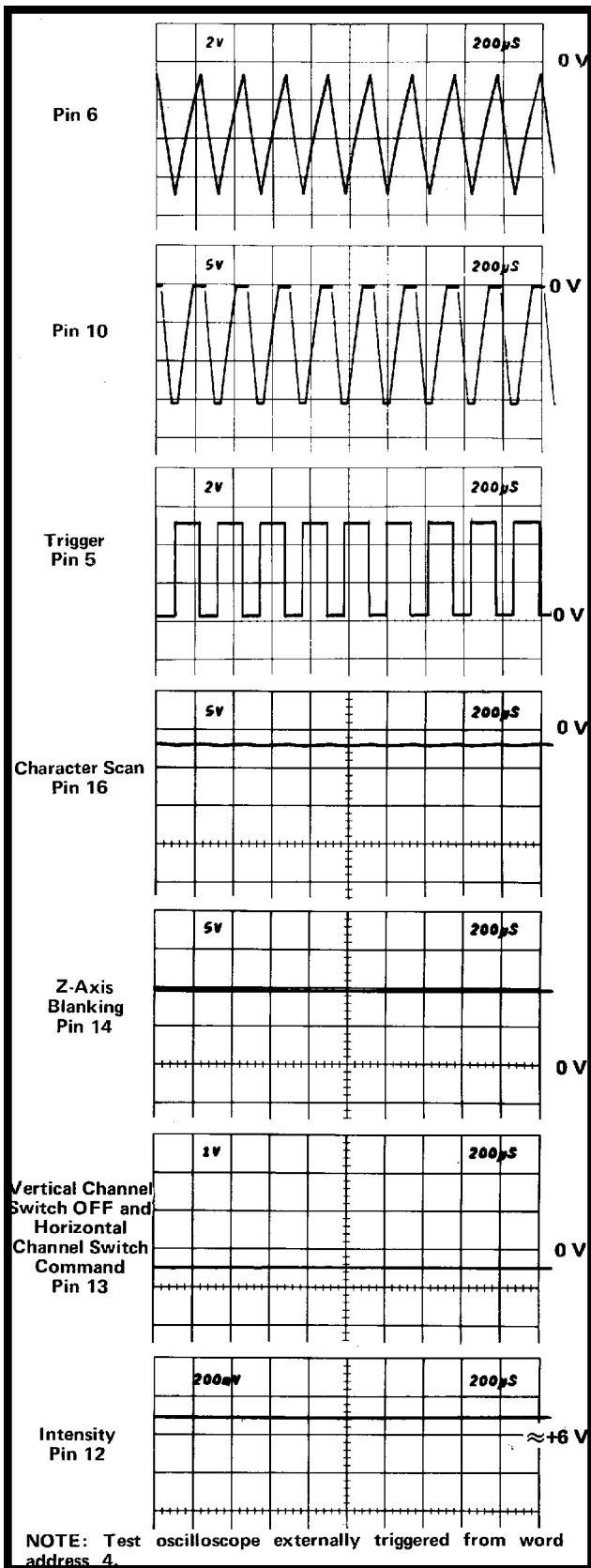


Fig. 2-4. Timer stage operation when display-skip condition occurs.

This code instructs these stages to sequentially select and display the data from the plug-ins. The input channel that is displayed with each combination of the word address code is given in the discussion for the applicable stages.

Encoding The Data

Data is conveyed from the plug-in units to the readout system in the form of an analog code having up to 11 current levels (from zero to one milliamperere in 100 microampere steps). The characters that can be selected by the encoded data are shown on the character selection matrix (see Fig. 2-6). Each character requires two currents to define it; these currents are identified as the column current and the row current which correspond to the column and row of the matrix. The column and row data is encoded by resistive programming in the plug-in units. The resistors are connected between the time-slot lines and the row or column lines.

The amplitude of the time-slot pulses is exactly -15 volts as determined by the timer stage. Therefore, the resultant output from the plug-in units can be accurately controlled by the programming resistors in the plug-in units.

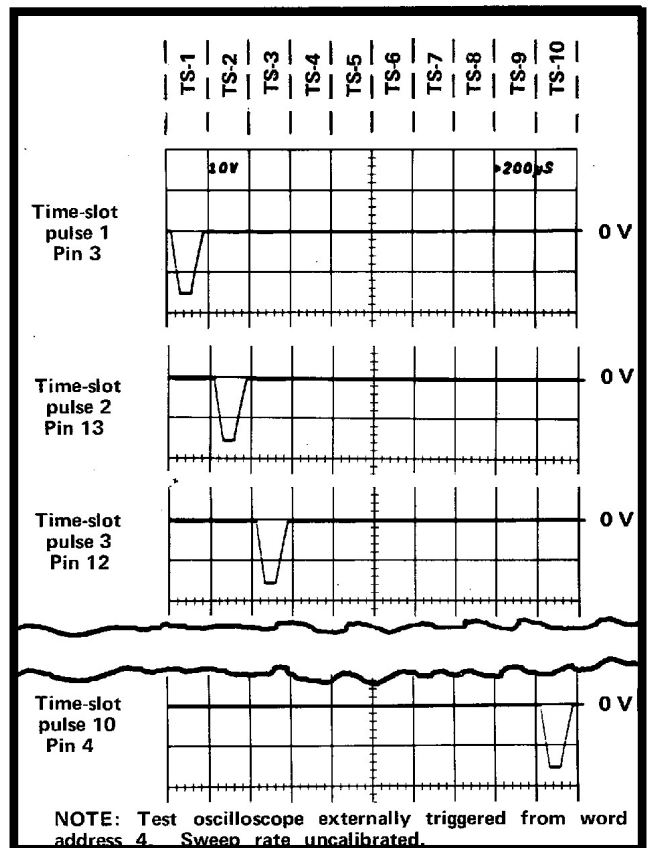


Fig. 2-5. Time relationship of the time-slot (TS) pulses produced by U1025.

COLUMN NUMBER →		C-0	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10
ROW NUMBER ↓	CURRENT (MILLI-AMPERES)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	≥ 1.0
R-1	0	<div>↑</div> <div>SKIP¹</div> <div>↓</div>	0	1	2	3	4	5	6	7	8	9
R-2	0.1		⚡	<	I	/	+	—	+	C	Δ	>
R-3	0.2		ADD ¹ ONE ZERO	ADD ¹ TWO ZEROS	SHIFT ¹ PREFIX ←	SHIFT ¹ PREFIX ← AND ADD ONE ZERO						IDENTIFY ¹
R-4	0.3		m	μ	n	p	X	K	M	G	T	R
R-5	0.4		S	V	A	W	H	d	B	c	Ω	E
R-6	0.5		U	N	L	Z	Y	P	F	J	Q	D
R-7	0.6				DECIMAL ¹ POINT LOCATION NO. 3	DECIMAL ¹ POINT LOCATION NO. 4	DECIMAL ¹ POINT LOCATION NO. 5	DECIMAL ¹ POINT LOCATION NO. 6	DECIMAL ¹ POINT LOCATION NO. 7			
R-8	0.7										DECIMAL ² POINT	
R-9	0.8											
R-10	0.9		ADD SPACE IN DISPLAY ¹									



UNUSED LOCATIONS. AVAILABLE FOR FUTURE EXPANSION OF READOUT SYSTEM

¹ OPERATIONAL ADDRESS.

² DECIMAL POINT CHARACTER. SEE DECIMAL POINT CHARACTER DESCRIPTION IN TEXT.

Fig. 2-6. Character selection matrix for readout system.

Fig. 2-7A shows an idealized current waveform of row analog data, which results from the 10 time-slot pulses. Each of the steps to current shown in these waveforms correspond to 100 microamperes of current. The row numbers on the left-hand side of the waveform correspond to the rows in the character selection matrix shown in Fig. 2-6. The row analog data is connected back to the readout system via contact B28 of the plug-in interface. Idealized column current waveforms at contact A28 of the plug-in interface are shown in Fig. 2-7B.

Referring to the character selection matrix, two units of column current, along with the two units of row current encoded during TS-1, indicates that two zeros should be added to the display. One unit of column current during time-slot 2, along with the one unit of current from the row output, instructs the readout system to add an invert arrow to the display.

No column current output during TS-3 means no display on the CRT (see Display-Skip Generator for further information). Two units of column current are encoded

during TS-4. There is no row current encoded during this time-slot; this results in the numeral 1 being displayed on the CRT. Neither row nor column analog data is encoded during time-slots 5, 6, and 7. During TS-8 two units of column current and three units of row current are encoded. This addresses the μ prefix in the character selection matrix. The final data output is provided from time slot 9: three units of column current and four units of row current cause a V (volts) to be displayed. The resultant CRT readout is 100 μ V.

The column analog data encoded by the plug-in unit can be modified by attenuator probes connected to the input connectors of vertical plug-in units. A special coding ring around the input connector of the plug-in unit senses the attenuation ratio of the probe (with readout-coded probes only). The probe contains a resistor that causes additional column current. For example, if a 10X attenuator probe is connected to a plug-in with the coding for 100 microvolts, an additional unit of current is added to the column analog data during time-slot 1. Since two units of current were encoded in Fig. 2-7, this additional current results in a total of three units of column analog current during this time-slot.

Referring to the character selection matrix, three units of column current, along with the two units of row current, indicates that the prefix should be reduced. Since this instruction occurs in the same time-slot that previously indicated that two zeros should be added to the display, and only one instruction can be encoded during a time-slot, the zeros do not appear in the display. The CRT readout now changes to 1 mV.

Likewise, if a 100X readout-coded probe is connected to the input of the plug-in unit, the column current during time-slot 1 is increased two units for a total of four units of column current. This addresses an instruction in the character selection matrix, which reduces the prefix and adds one zero to the display. The resultant CRT readout with the previous program is 10 mV.

Two other lines of information are connected from each plug-in compartment to the readout system. The column and row analog data from channel 2 of a dual-channel plug-in are connected to the readout system through contacts A24 and B24 of the plug-in interface, respectively.

Column and Row Data Switches

The readout data from the plug-in units is connected to the column and row data switch stages. A column-data line and a row-data line convey analog data from each of the eight data sources (two channels from each of the three plug-in compartments and two external channels, option 3).

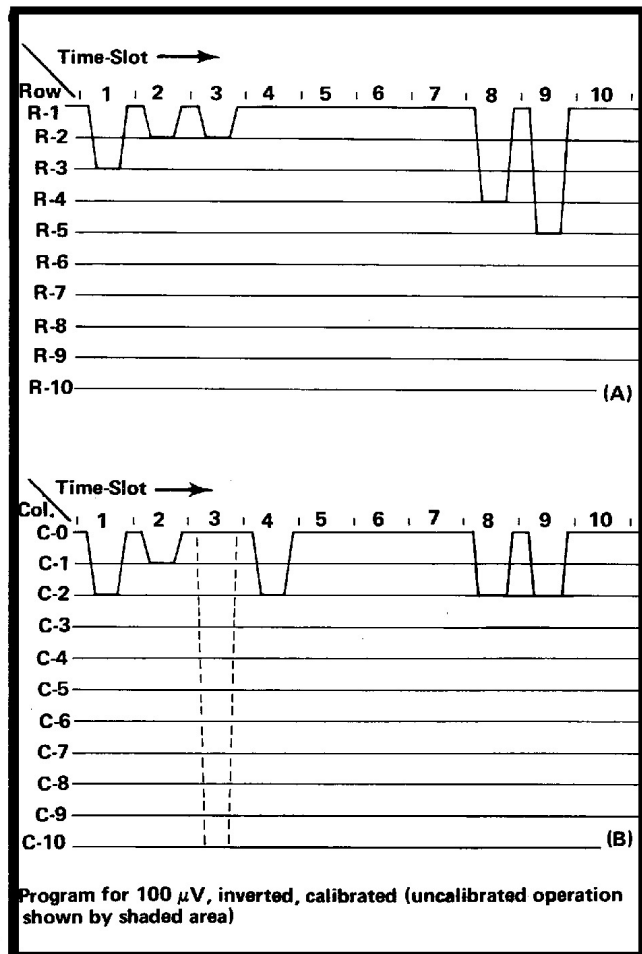


Fig. 2-7. Idealized current waveforms of: (A) Row analog data, (B) Column analog data.

The column data switch U1040 and the row data switch U1030 receive the word address code from the word counter. This binary code directs the column data switch and the row data switch as to which channel should be the source of the readout data. Table 2-1 gives the eight combinations of the word address code and the resultant channel is selected with each combination. These stages have eight inputs and provide a single time-multiplexed output at pin 7, which includes the information from all of the input channels. Six of the eight inputs to each stage originate in the plug-in units; the seventh and eighth inputs come from an optional external access jack.

TABLE 2-1
Word Address Code

Pin 8 U1075	Pin 9 U1075	Pin 12 U1075	Channel Selected
LO	LO	LO	Channel 2 Left Vertical
LO	LO	HI	Channel 1 Left Vertical
LO	HI	LO	Channel 2 Right Vertical
LO	HI	HI	Channel 1 Right Vertical
HI	LO	LO	Channel 2 Horizontal
HI	LO	HI	Channel 1 Horizontal
HI	HI	LO	Channel 2 External Access
HI	HI	HI	Channel 1 External Access

Display-Skip Generator

The display-skip generator, Q1040-Q1048-Q1050-Q1052 monitors the time-multiplexed column data at the output of the column data switch during each time-slot, to determine if the information at this point is valid data that should result in a CRT display. The voltage at the base of Q1040B is set by divider CR1040-CR1041-R1046-R1047-R1048. Quiescently, there is about 100 microamperes of current flowing through R1040 from Q1056 and the zeros logic and memory stage (purpose of this quiescent current will be discussed in connection with the zeros logic and memory stage). This current biases Q1040A so that its base is about 0.2 volt more positive than the base of Q1040B in the absence of column data. Therefore, since Q1040A and Q1040B are connected as a comparator, Q1040A will remain on unless its base is pulled more negative than the base of Q1040B. The analog data output from the column data switch produces a 0.5-volt change at the base of Q1040A for each unit of column current that has been encoded by the plug-in unit. Therefore, whenever any information appears at the output of the column data switch, the base of Q1040A is pulled more negative than the base of Q1040B, resulting in a negative (LO) display-skip output to the timer stage through Q1052. Recall that a LO was necessary at the skip input of the timer so it could perform the complete sequence necessary to display a character.

Q1048-Q1050 also provide display-skip action. The end-of-word level connected to their emitters through R1050 is LO only during time-slot 1. This means that Q1048-Q1050 are enabled only during time-slot 1. These transistors allow the zero logic and memory stage to generate a display-skip signal during time-slot 1 when information that is not to be displayed on the CRT has been stored in memory (further information given under Zeros Logic and Memory discussion).

Column and Row Decoder

The column decoder U1070 and row decoder U1035 sense the magnitude of the analog voltages at their inputs and produce a binary output on one of ten lines corresponding to the column or row data which was encoded by the plug-in unit. These outputs provide the column digital data and row digital data, which is used by the character generator stages to select the desired character for display on the CRT. The column and row data is also used throughout the readout system to perform other functions. The input current at pin 9 of the column decoder stage is steered to only one of the ten column digital data outputs. When a display-skip signal is present (collector of Q1052 HI), pin 9 is pulled HI through CR1052. This ensures that no current is connected to the character generator stage under this condition. Notice the corresponding input on the row decoder. This input is connected to ground and causes one of the ten row outputs to saturate to ground.

Zeros Logic and Memory

The zeros logic and memory stage U1060 stores data encoded by the plug-in units to provide zeros-adding and prefix-shifting logic for the readout system. The strobe pulse at pin 15 goes positive when the data has stabilized and can be inspected. This activates the zeros logic and memory stage so it can store the encoded data. A block representation of the memory sequence is shown in Fig. 2-8. If the plug-in unit encoded data for column 1, 2, 3, 4, or 10 of row 3, the appropriate memory (or memories) is set.

If data is encoded, a negative-going output is produced at pin 7 as the memories are being set. This negative-going pulse is connected to the base of Q1050 in the display-skip generator to produce a display-skip output. Since the information that is encoded is only provided to set the memories and not intended to be displayed on the CRT at this time, the display-skip output prevents a readout display if this encoding occurs in time-slot 1.

During time-slot 5, memory A is interrogated. If information is stored in this memory, a positive-going output is produced at pin 7. This pulse is connected to pin 10 of the column decoder through Q1056 to add one unit

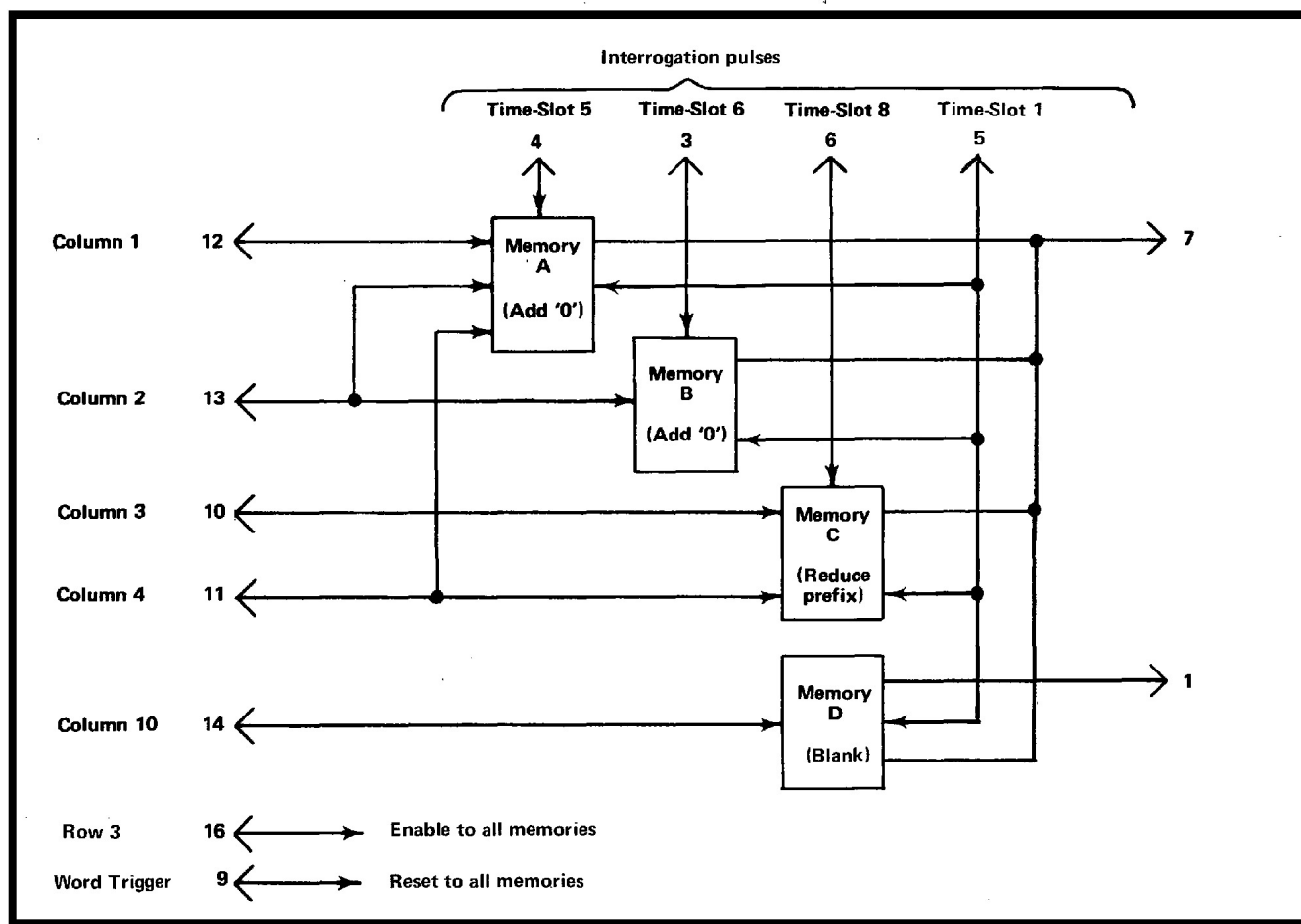


Fig. 2-8. Block representation of memory sequence in U1060.

of current at the input of the column decoder. This produces a zero after the character displayed on the CRT during time-slot 4. During time-slot 6, memory B is interrogated to see if another zero should be added. If another zero is necessary, a second positive output is produced at pin 7, which again results in a column 1 output from the column decoder and a second zero in the CRT display.

Finally, memory C is interrogated during time-slot 8 to obtain information on whether the prefix should be reduced, or left at the value which was encoded. If data has been encoded which calls for a reduction in prefix, a negative-going output level is produced at pin 7. This negative level subtracts one unit of column current from the data at the input to the column decoder. Notice on the character selection matrix of Fig. 2-6 that a reduction of one column when row 4 is programmed results in a one unit reduction of the prefix. For example, with the 100 μ V program, if data was received from the plug-in calling for a reduction in prefix, the CRT readout would be changed to 1 mV (zeros deleted by program; see Encoding the Data).

The 100 microamperes of quiescent current through R1041, provided by Q1056 (see Display-Skip Generator), allows the prefix to be reduced from μ (200 microamperes column current; column 2) to m (100 microamperes column current; column 1). (Notice that if the prefix program is reduced from column 1 to column zero, the readout system does not display a character at this readout location.)

A further function of the zeros logic is the blank function. If ten units of column current are encoded along with two units of row current (row 3, column 10), the zero logic produces a negative-going output pulse at pin 1 of U1060. This pulse lasts until the end of time-slot 10. Pin 1 of U1060 is connected to the base of Q1018 through R1020. When turned on, Q1018 prevents the readout intensity current from reaching the Z-Axis amplifier.

The end-of-word signal from the time-slot counter is connected to pin 9 of U1060 through C1065. At the end of each word of readout information, this pulse goes LO. This

erases the four memories in the zeros logic and memory in preparation for the data to be received from the next channel.

Character Generators

The Character Generator stage consists of five similar integrated circuits U1090-U1098, which generate the X (horizontal) and Y (vertical) outputs at pins 16 and 1 respectively, to produce the character displayed on the CRT. Each integrated circuit can produce 10 individual characters. U1090 which is designated as the "numerals" character generator can produce the numerals 0 through 9 shown in row 1 of the character selection matrix (Fig. 2-6). U1092 can produce the symbols shown in row 2 of the character selection matrix and U1094 produces the prefixes and some letters of the alphabet that are used as prefixes in row 4. U1096 and U1098 produce the remaining letters of the alphabet shown in rows 5 and 6 of the character selection matrix. All of the character-generator stages receive the column digital data from column decoder U1070 in parallel. However, only one of the character generators receives row data at a particular time and only the stage that receives both row and column data is activated. For example, if column 2 is encoded by a plug-in unit, the five character generators are enabled so that either a 1, <, μ , V, or an N can be produced. However, if at the same time row 4 has also been encoded by the plug-in unit, only the prefix character generator U1094 will produce an output to result in a μ displayed on the screen. This integrated circuit provides current outputs to the format generator, which produce the selected character on the CRT. In a similar manner, any of the 50 characters shown in the character selection matrix can be displayed by correct addressing of the row and column.

Decimal Point Logic and Character Position Counter

Decimal point logic and character position counter U1080 performs two functions. The first function is to produce a staircase current, which is added to the X (horizontal) signal to space the characters horizontally on the CRT. After each character is generated, the negative-going edge of the channel switch OFF signal at pin 5 advances the character position counter. This produces a current step output at pin 3 which, when added to the X signal, causes the next character to be displayed one character space to the right. This stage can also be advanced when a space instruction is encoded by the plug-in unit so that a space is left between the displayed characters on the CRT. Row 10 information from the row decoder is connected to pin 4 of U1080 through R1083. When row 10 and column 0 is encoded, the output of this stage advances one step to move the next character another space to the right. However, under this condition, no display is produced on the CRT during this time-slot, since the character generators are not activated.

Time-slot pulses 1, 2, and 3 are also connected to pin 4 of U1080 through VR1080, VR1081, and VR1082 respectively and R1088, R1082. This configuration adds a space to the displayed word during time-slots 1, 2, and 3 even if information is not encoded for display during these time-slots. With this feature, the information that is displayed during time-slot 4 (1-2-5 data) always starts in the fourth character position whether data has been displayed in the previous time-slots or not. Therefore, the resultant CRT display does not shift position as normal/invert or cal/uncal information is encoded by the plug-in. The end-of-word pulse connected to pin 8 of U1080 through C1080 resets the character position counter to the first character position at the end of each word.

The decimal point logic portion of this stage allows decimal points to be added to the CRT display as encoded by the plug-in units. When row 7 is encoded in coincidence with columns 3 through 7 (usually encoded during time-slot 1), a decimal point is placed at one of the five locations on the CRT identified in row 7 of the character selection matrix (Fig. 2-6). This instruction refers to the decimal point location in relation to the total number of characters that can be displayed on the CRT (see Fig. 2-9). For example, if column 3 and row 7 are encoded during time-slot 1, the system is instructed to place a decimal point in location No. 3. As shown in Fig. 2-9, this displays a decimal point before the third character that can be displayed on the CRT (first three time-slots produce a space whether data is encoded or not; see previous paragraph). The simultaneous application of row 7 data to the Y-input of the format generator through R1080 raises the decimal point so it appears between the displayed characters.

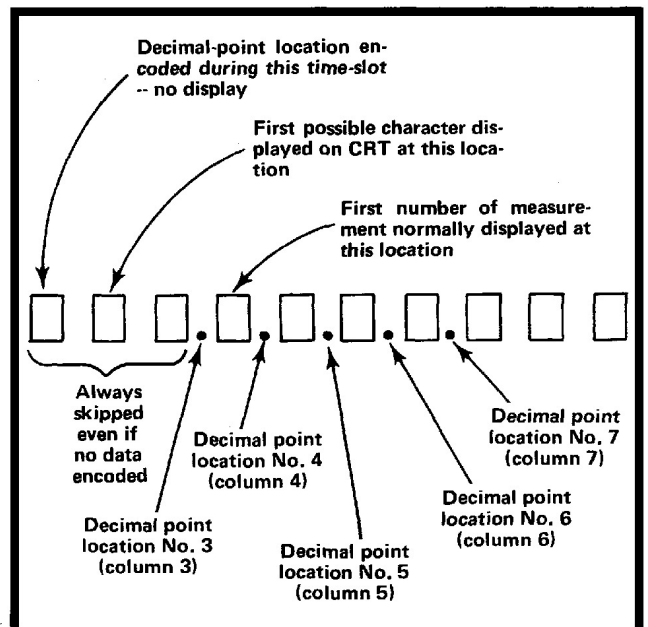


Fig. 2-9. Readout word relating 10 possible character locations to the decimal point instructions that can be encoded, and the resultant CRT display.

When decimal-point data is encoded, the CRT is unblanked so a readout display is presented. However, since row 7 does not activate any of the five character generators, the CRT beam is not deflected but instead remains in a fixed position to display a decimal point between the character along the bottom line of the readout word. After the decimal point is produced in the addressed location, the CRT beam returns to the location indicated by the character position counter to produce the remainder of the display.

Format Generator

The X and Y deflection signals produced by the character generator stage, are connected to pins 2 and 7, respectively, of format generator U1100. The word address code from the word counter is also connected to pins 1, 8, and 15 of this stage. The word address code directs the format generator to add current to the X and Y signals to deflect the CRT beam to the area of the CRT that is associated with the plug-in channel that originated the information (see Fig. 2-1).

In addition, the character position current from the decimal point logic and character position stage is added to the X (horizontal) input signal to space the characters horizontally on the CRT (see previous discussion). The

channel switch OFF signal at pin 13 activates this stage when a character is to be displayed on the CRT. Vertical spacing adjustment, R118, sets the separation between the upper and lower readout displays.

Y-Output Amplifier

The Y-output signal at pin 6 of U1100 is connected to the Y-output amplifier Q1100. This stage provides a low impedance load for the format generator while providing isolation between the readout system and the vertical amplifier.

X-Output Amplifier

The X-output amplifier Q1110 operates similarly to the Y-output amplifier. It provides the horizontal deflection from the readout signal available at pin 4 of U1100. Horizontal position is controlled by R1110, which changes the emitter current of Q1110.

Horizontal channel switch U1130 normally passes signals from the horizontal plug-in connector to the horizontal amplifier with unity gain. When the channel switch OFF signal is generated by timer U1000, the channel switch substitutes the horizontal readout signal for the horizontal plug-in connector signal.

OPTION 3 EXTERNAL READOUT INPUT

The External Readout Input option provides access to the two readout display words which cannot be programmed via plug-ins in the 5403. This option does not alter the display or words that are programmed from plug-ins.

The words that are accessed by this option appear at the bottom of the screen as shown in Fig. 1. These words are designated EXT. 1 and EXT. 2.

LEFT VERT CHAN 1	RIGHT VERT CHAN 1	HORIZ A SWP	HORIZ B SWP
LEFT VERT CHAN 2	RIGHT VERT CHAN 2	EXTERNAL WORD 1	EXTERNAL WORD 2

Fig. 1. Readout Word Location

CONNECTOR DESCRIPTION

The connector provided for the External Readout Input is a 25 pin female connector located on the rear panel of the 5403. The connector mates with an ITT - Cannon DB - 25P or equivalent connector (TEK PN 131-0570-00). Refer to Fig. 2 for connector pin assignments.

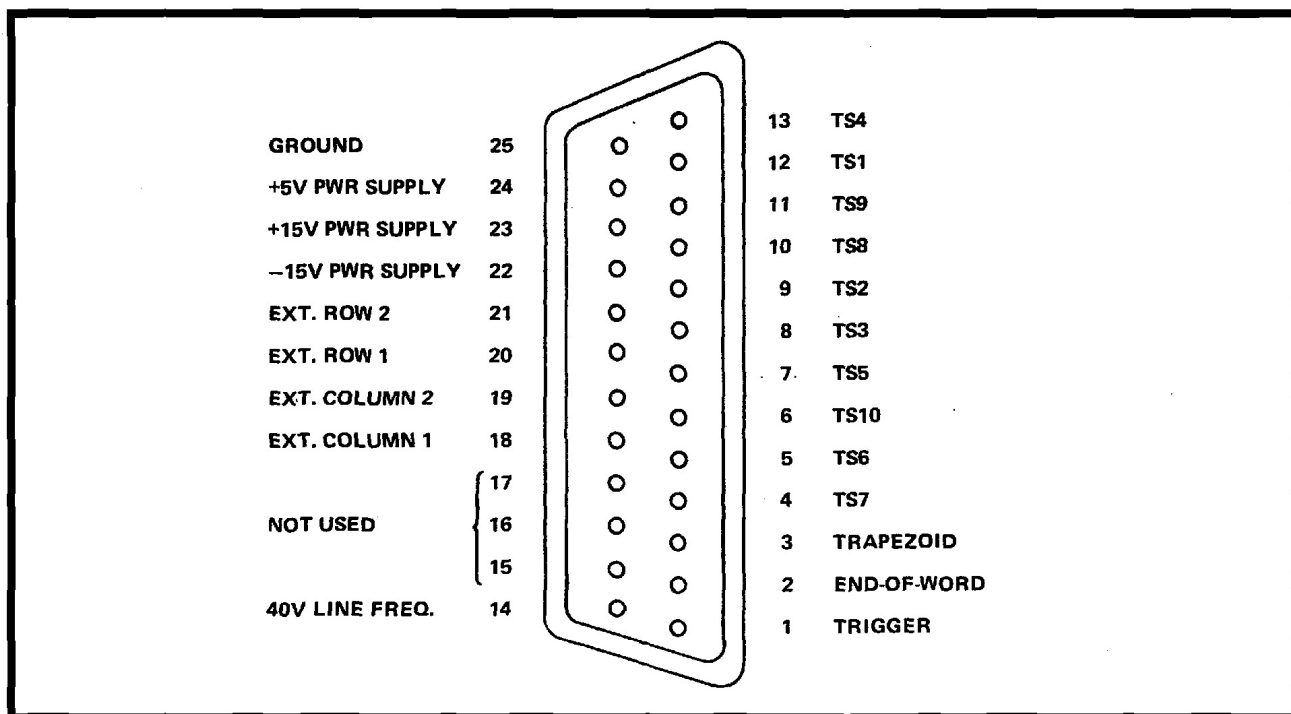


Fig. 2. Connector pin assignments
(View looking at rear panel of 5403)

GROUND	Readout System Ground.
+5 V, +15 V, -15 V	Power supply connections. Maximum allowable currents; +5: 100 mA; +15: 20 mA; -15: 20 mA.
EXT. COLUMN 1	Column data input for External word 1.
EXT. COLUMN 2	Column data input for External word 2.
EXT. Row 1	Row data input for External word 1.
EXT. Row 2	Row data input for External word 2.
40 V Line FREQ	Line frequency signal approx. 40 V P-P. 10 mA maximum.
TS1-TS10	Time Slot signals.
TRAPEZOID	Trapezoid signal from pin 10 of Timer, U1000, on Readout Board.
END-OF-WORD	End-of-word pulse from pin 2 of Time Slot counter, U1025, on Readout Board.
TRIGGER	Pulse from pin 5 of Timer, U1000, on Readout Board.

PROGRAMMING

The 5403 Readout system is programmed by resistors, which are connected between Time Slot lines and Row or Column lines. The resistors are chosen according to the character displayed or the operation performed. For the values of programming resistors, see Fig. 2-6 (the Character Selection Matrix) in the 5403 Manual. All programming resistors smaller than 51K and larger than 13K should be 1% tolerance or better; all others can be 5% or less.

To illustrate resistor selection, consider the display "TEST 1" in EXT. 1. Required resistor values are shown.

CHARACTER	COLUMN	COLUMN RESISTOR	ROW	ROW RESISTOR
T	9	16.5 K	4	51 K
E	10	13 K	5	37.4 K
S	1	150 K	5	37.4 K
T	9	16.5 K	4	51 K
(Space)	0	Open	10	16.5 K
1	2	75 K	1	Open

Fig. 3. RESISTOR PROGRAM for "TEST 1".

In Fig. 3 the Matrix indicates, for example, that the character "T" is programmed by column 9 and Row 4. The Selection Matrix also indicates that a 16.5K resistor is required for column 9 while 51K is required for Row 4. To obtain the space before the "1", the "ADD SPACE" operation is used.

The choice of Time Slots depends on the desired position of the character within the word. Programming the first character from TS1 displays that character in the left-most character position of the display word. Similarly, programming the first character from TS2, TS3, or TS4 displays that character in the second, third, or fourth position within the display word respectively. Programming the first character from TS5 to TS10, however, displays the character as if it is programmed from TS4. To move the character further right requires programming "ADD SPACE" (column 0, Row 10) in Time Slots after TS3.

Once the Time Slot for the first character is chosen, succeeding characters are programmed in succeeding Time Slots. If, however, a Time Slot other than TS1, TS2, or TS3 is left unprogrammed, character position is unchanged during that Time Slot. For example, if TS6 and TS8 are programmed and TS7 is not, then the character displayed in TS8 is displayed in the same position as if it were programmed in TS7.

To further clarify the programming concepts outlined here, a complete circuit diagram for programming a word is given in Fig. 4. This circuit displays "TEST n" where "n" is a number from 0 to 99 selectable by the user. Time Slots TS1 to TS5 are used to program "TEST (space)." Time Slot 6 with Switch S1 and R10 through R19 programs the tens digit of the number. S1 selects the number displayed. Similarly, S2 selects the units digit programmed in TS7. There are several choices for the format of the number when the number is less than 10. If it is desirable to display the number "8" as "08", then R10B is used to program a "0" in the tens digit and R10A is not used. If a space is desired in the tens digit (in addition to the space in TS5) so that the location of the units digit does not shift when changing from "9" to "10", then R10A is used and R10B is not. If neither R10A nor R10B is used, the units digit in numbers less than 10 is displayed in the display location of the tens digit.

Column and Row connections are chosen according to the display location of the word on the screen. Connection of programming resistors of Row 1 and Column 1 displays in the location of EXT 1. Likewise, connection to Row 2 and Column 2 displays in the location of EXT 2.

ADDITIONAL CONSIDERATIONS

The connections to the External Readout Input connector are not short-circuit protected. Shorts may damage the Readout System.

The Trapezoid, End-of-Word, and Trigger signals are for special processing applications. They have very limited driving capability and should be emitter follower buffered if used for any purpose.

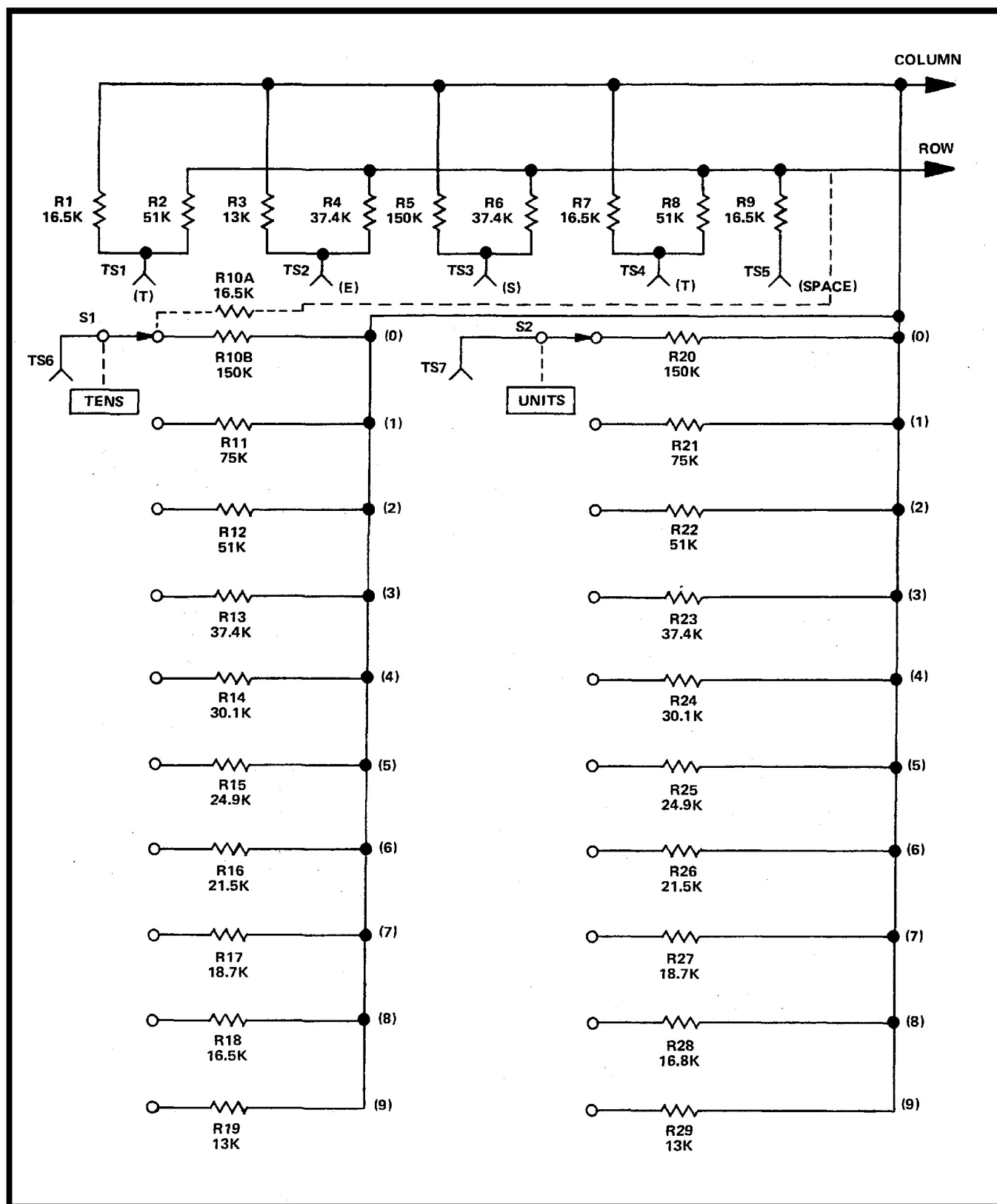


Fig. 4. PROGRAMMING "TEST n"

ADJUSTMENTS

Equipment Required

A display unit must be connected to the 5403. It is not necessary to install any plug-in units.

Preliminary Procedure

a. Remove the cabinet panels covering the 5403 access to the readout circuit board.

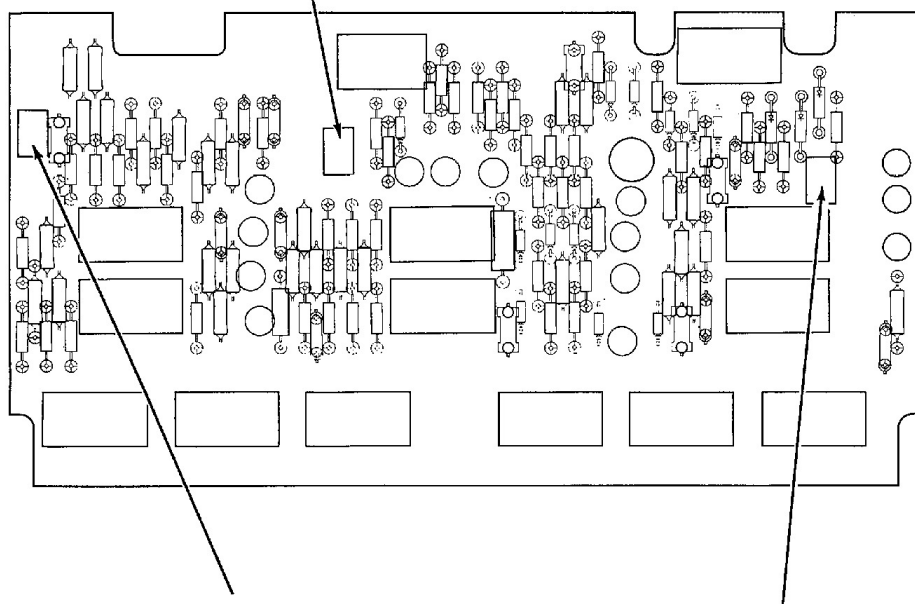
b. With the power to the 5403 turned off, remove Q1052. Turn on the 5403 and display unit.

c. Observe a eight word (four words on bottom graticule and four words on top), ten-characters/word readout.

1. Top Row Vertical Spacing, R1118

Adjust R1118 so all of top row of readout is within the top division of graticule. Now adjust vertical centering R135

(located on display unit vertical circuit board) so all of the bottom row of readout is within the bottom division of the graticule.



2. Horizontal Positioning, R1110

Adjust until the first character of the first and second words, and the last character of the seventh and eight words are just inside the graticule area.

3. Character Scan, R1006

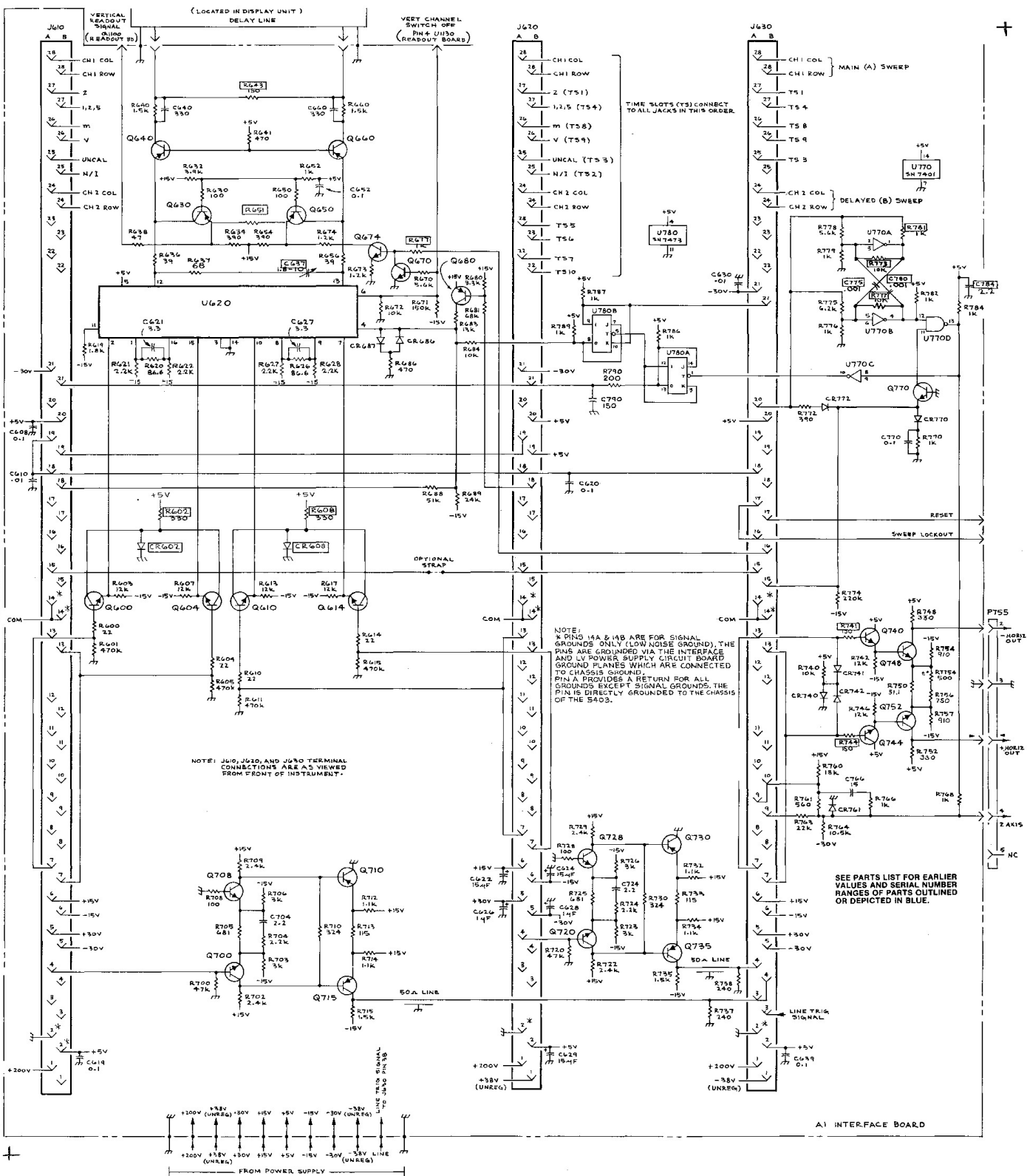
While observing the readout words, adjust R1006 for no blank areas in the characters.

5403

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INTERFACE

DS4



ADJUSTMENTS

Before making adjustments, thoroughly clean and inspect this instrument as outlined in the service information section of this manual.

Services Available

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

NOTE

This procedure facilitates checking and adjusting the Low-Voltage Power Supply ONLY. For complete oscilloscope mainframe calibration (plug-in interface, deflection amplifiers, CRT circuits, etc.), refer to the calibration procedure given in the manual for the display unit.

Equipment Required

For power-supply calibration, proper loading must be established to ensure correct operation and regulation of the low-voltage supplies. For best results, the 5403 should be operated with a display unit and plug-in units as this provides actual operating-condition loads for the supplies.

For measurement of the supply voltages, a precision DC voltmeter is required. The voltmeter must have an accuracy of within $\pm 0.1\%$, and a measurement range from about -35 volts to $+250$ volts. For example, a DM 501 Digital Multimeter (operated in a TM 500-Series Power Module), or any DC voltmeter meeting the listed requirements may be used.

Preliminary Procedure

NOTE

The performance of this instrument can be checked at any temperature within the 0°C to $+50^{\circ}\text{C}$ range. Make any adjustments at a temperature of $+25^{\circ}\text{C}$, $\pm 5^{\circ}\text{C}$.

a. Remove the bottom dust cover of the 5403 to gain access to the LV power supply circuit board.

b. Check that the correct nominal line-selector block (120 VAC or 240 VAC) has been installed on the line-selector pins and that the regulating range selected includes the input line voltage, see Installation section for complete instructions.

c. Connect the 5403 to the line voltage source. Turn the Intensity control on the display unit counterclockwise and pull the Power switch out to turn the instrument on.

d. Allow a 20 minute warm up time before performing the calibration procedure.

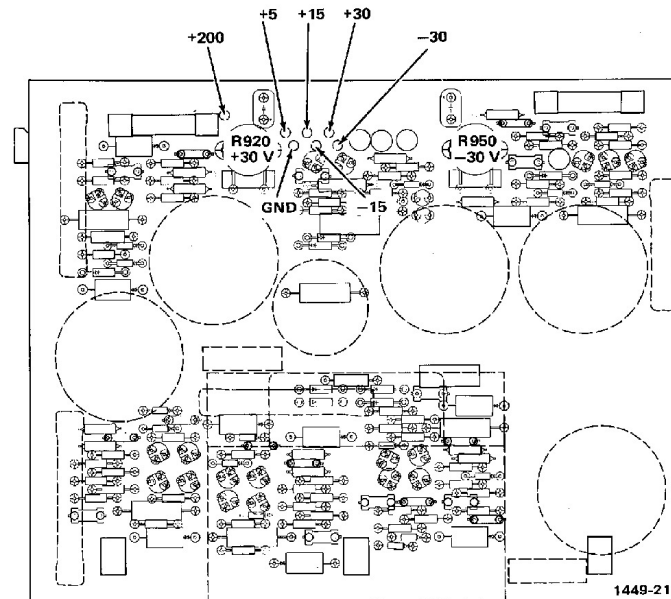
1. LV Power Supply Checks

Connect the precision DC voltmeter between each low-voltage test point and ground. Check that each supply is within the tolerance listed below.

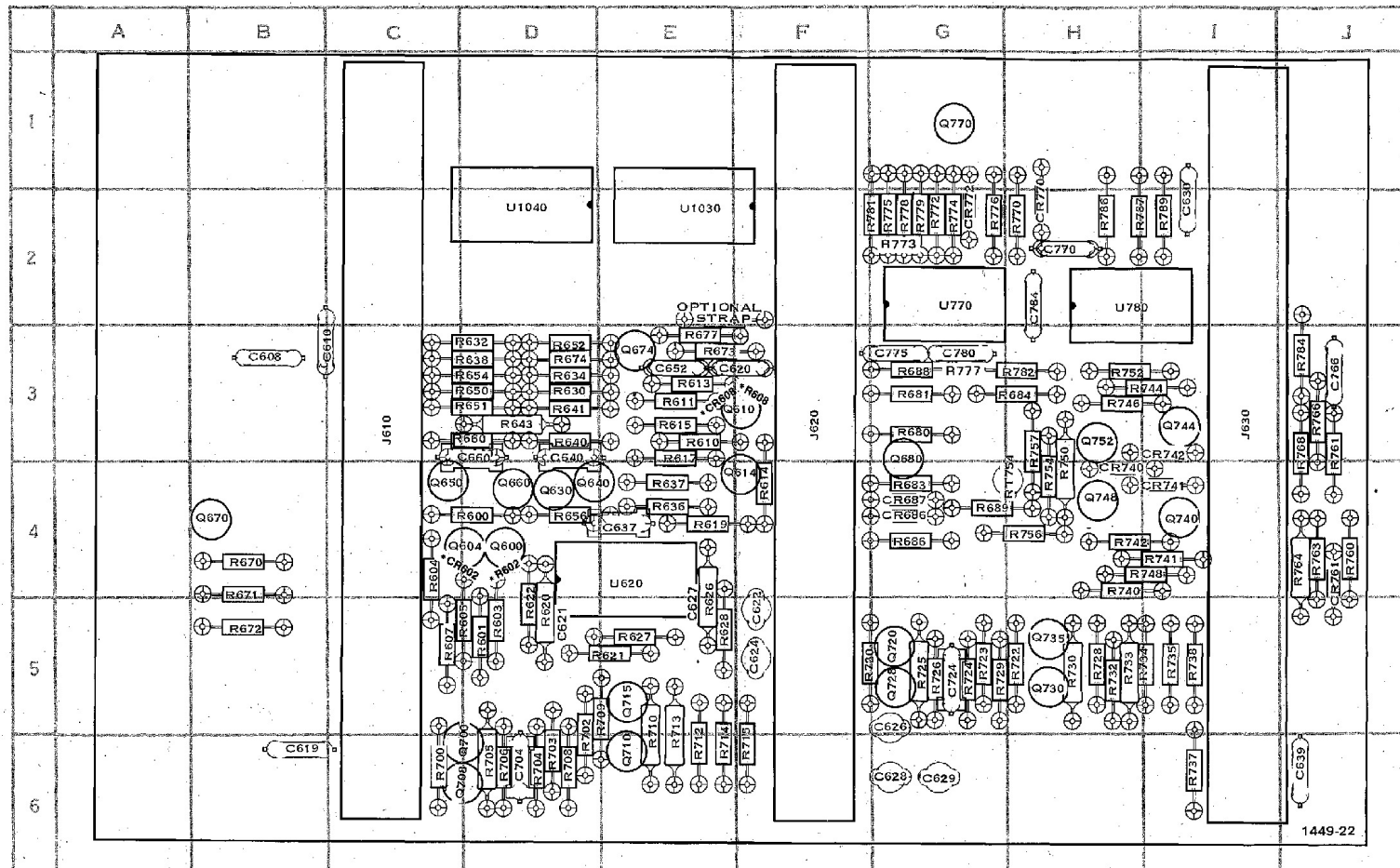
Supply	Tolerance
-30 V	-29.925 V to -30.075 V
-15 V	-14.85 V to -15.15 V
$+5\text{ V}$	$+4.9\text{ V}$ to $+5.1\text{ V}$
$+15\text{ V}$	$+14.85\text{ V}$ to $+15.15\text{ V}$
$+30\text{ V}$	$+29.95\text{ V}$ to $+30.075\text{ V}$
$+200\text{ V}$	$+180\text{ V}$ to $+240\text{ V}$

2. LV Power Supply Voltage Adjustments

Connect the precision DC voltmeter between each test point (-30 V and $+30\text{ V}$) and ground. First, adjust R950, -30 V Adj, and then adjust R920, $+30\text{ V}$ Adj using the appropriate test point for voltmeter readings of exactly 30 volts.



PARTS LOCATION GRID



*See Parts List for
serial number ranges.

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C608	B-3	C704	D-6	J610	C-3	Q710	E-6	R607	C-5	R634	D-3	R674	D-3	R712	E-6	R738	I-5
C610	B-3	C724	G-5	J620	F-3	Q715	E-5	R608	F-3	R636	E-4	R677	E-3	R713	E-6	R740	H-4
C619	B-6	C766	J-3	J630	I-3	Q728	G-5	R610	E-3	R637	E-4	R680	G-3	R714	E-6	R741	H-4
C620	E-3	C770	H-2			Q730	H-5	R611	E-3	R638	D-3	R681	G-3	R715	F-6	R742	H-4
C621	D-5	C775	G-3	Q600	D-4	Q735	H-5	R613	E-3	R640	D-3	R683	G-4	R720	F-5	R744	H-3
C622	F-5	C780	G-3	Q604	D-4	Q740	I-4	R614	F-4	R641	D-3	R684	H-3	R722	G-5	R746	H-3
C624	F-5	C784	H-2	Q610	F-3	Q744	I-3	R615	E-3	R643	D-3	R686	G-4	R723	G-5	R748	H-4
C626	G-5			Q614	F-4	Q748	H-4	R617	E-4	R650	D-3	R688	G-3	R724	G-5	R750	H-3
C627	E-5	CR602	C-4	Q630	D-4	Q752	H-3	R619	E-4	R651	D-3	R689	G-4	R725	G-5	R752	H-3
C628	G-6	CR608	F-3	Q640	D-4	Q758	G-1	R620	D-5	R652	D-3	R700	C-6	R726	G-5	R754	H-3
C629	G-6	CR686	G-4	Q650	C-4			R621	E-5	R654	D-3	R702	D-6	R728	H-5	R756	H-4
C630	I-2	CR687	G-4	Q660	D-4			R622	D-5	R656	D-4	R703	D-6	R729	G-5	R757	H-3
C637	E-4	CR740	H-4	Q670	B-4	R600	D-4	R626	E-4	R660	D-3	R704	D-6	R730	H-5	R760	J-4
C639	J-6	CR741	I-4	Q674	E-3	R601	D-5	R627	E-5	R670	B-4	R705	D-6	R732	H-5	R761	J-4
C640	D-4	CR742	I-3	Q680	G-3	R602	C-4	R628	E-5	R671	B-5	R706	D-6	R733	H-5	R763	J-4
C652	E-3	CR770	H-2	Q700	D-6	R603	D-5	R630	D-3	R672	B-5	R708	D-6	R734	H-5	R764	J-4
C660	D-4	CR772	G-2	Q708	D-6	R604	C-4	R632	D-3	R673	E-3	R709	E-5	R735	I-5	R766	J-3
						R605	D-5					R710	E-6	R737	I-6	R768	J-3

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C1010	F-4	C1180	J-2	LR110	D-4	R1002	F-1	R1023	D-3	R1052	G-4	R1083	D-4	R1110	A-2	R1133	B-2	R1151	C-2	U1000	E-3	U1130	B-3
C1021	F-3	C1181	J-2			R1003	F-2	R1024	D-3	R1053	G-3	R1084	D-4	R1111	A-3	R1134	A-3	R1155	B-4	U1025	H-1		
C1024	F-1	C1182	J-3	Q1015	E-2	R1004	E-3	R1025	G-1	R1056	G-2	R1086	C-4	R1113	B-2	R1136	A-2	R1156	A-4	U1035	I-4		
C1027	G-1			Q1018	E-2	R1005	H-2	R1027	F-2	R1060	G-3	R1088	H-3	R1115	D-3	R1137	B-2	R1157	B-2	U1060	I-3	VR1080	I-2
C1032	H-4	CR1002	F-3	Q1040	G-2	R1006	I-2	R1030	G-2	R1062	H-2	R1092	A-3	R1117	D-3	R1140	C-2			U1070	I-5	VR1081	H-2
C1041	H-2	CR1003	G-3	Q1048	G-3	R1007	F-3	R1032	H-3	R1063	I-2	R1093	A-3	R1118	D-2	R1141	C-2			U1075	E-1	VR1082	I-2
C1065	H-2	CR1005	G-2	Q1050	G-2	R1010	F-2	R1041	H-3	R1064	I-2	R1095	A-4	R1120	C-2	R1142	B-2			U1080	B-4		
C1073	G-1	CR1010	F-4	Q1052	G-4	R1012	F-2	R1043	G-1	R1065	H-2	R1097	C-3	R1122	C-3	R1143	B-2			U1090	C-5		
C1080	C-3	CR1012	F-3	Q1056	G-3	R1015	F-2	R1044	F-2	R1070	E-1	R1098	D-3	R1124	C-4	R1144	B-2			U1092	B-5		
G1083	H-4	CR1013	G-4	Q1100	C-4	R1016	H-2	R1046	G-2	R1071	E-1	R1101	A-3	R1125	B-2	R1146	E-3			U1094	H-5		
C1100	D-4	CR1018	E-2	Q1110	C-3	R1018	F-1	R1047	G-3	R1072	E-1	R1103	J-4	R1127	C-2	R1147	D-3			U1096	F-5		
C1120	J-4	CR1024	G-1	Q1140	C-3	R1018	E-2	R1048	F-3	R1073	G-1	R1105	D-3	R1129	B-1	R1148	D-3			U1098	D-5		
C1134	A-2	CR1040	H-2	Q1150	C-2	R1019	F-2	R1050	G-2	R1080	E-4	R1106	D-4	R1130	A-1	R1150	C-2			U1100	E-4		
C1140	C-2	CR1041	H-2			R1020	H-2			R1082	F-4			R1131	B-1								
C1150	D-2	CR1052	G-4			R1021	E-2							R1132	B-1								

COMPONENTS SHOWN WITH DASHED LINES ARE LOCATED ON BACK SIDE OF BOARD.

***See Parts List for
serial number ranges.**

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C800	E-4	C982	F-2	CR800	F-5	CR982	F-2
C820	G-7	C984	E-2	CR801	F-5	CR986	F-2
C821	H-7			CR802	E-5		
C822	F-5			CR803	E-5	F800	C-1
C825	F-2			CR820	G-7		
C834	F-6			CR821	F-7		
C836	F-6			CR825	G-5		
C845	G-6			CR832	F-7		
C848	I-6			CR838	G-6		
C850	F-2			CR839	F-6		
C860	B-6			CR848	H-7		
C867	C-5			CR850	D-5		
C871	B-7			CR851	C-7		
C875	B-4			CR863	C-5		
C876	C-3			CR864	C-5		
C880	F-2			CR875	D-4		
C890	E-6			CR880	E-6		
C897	D-6			CR881	E-7		
C901	E-7			CR893	D-6		
C910	D-1			CR903	D-7		
C920	C-2			CR910	B-2		
C925	B-2			CR911	B-4		
C930	G-3			CR925	B-3		
C932	I-3			CR927	C-2		
C935	E-3			CR930	G-5		
C944	G-1			CR944	H-3		
C948	H-1			CR950	H-2		
C950	H-2			CR955	I-2		
C953	H-2			CR980	E-3		
C955	H-1			CR981	E-3		
C981	F-3						

CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
Q820	I-7	R800	E-5	R883	E-7	R944	I-3
Q824	F-6	R802	E-4	R885	D-7	R948	G-1
Q830	F-6	R820	G-7	R886	D-7	R949	I-2
Q832	F-6	R822	F-7	R890	E-6	R950	G-2
Q838	F-6	R823	H-7	R891	E-6	R951	H-2
Q850	B-7	R824	F-5	R893	D-6	R952	G-2
Q855	C-6	R827	G-5	R894	D-6	R953	H-2
Q864	C-6	R829	F-5	R896	E-6	R954	I-1
Q866	C-6	R832	F-7	R897	E-6	R955	I-2
Q870	C-6	R833	F-6	R900	E-7	R956	I-1
Q880	E-7	R834	G-6	R901	E-7	R957	I-2
Q885	D-6	R836	F-7	R903	E-6	R980	E-2
Q884	D-6	R838	G-6	R910	B-3	R981	F-2
Q896	D-6	R839	G-6	R911	B-2	R982	F-2
Q900	D-6	R840	F-5	R913	B-2	R984	E-2
Q910	A-2	R842	F-6	R915	C-2	R986	E-2
Q915	B-2	R845	G-6	R917	C-2	R987	F-2
Q925	B-2	R846	G-6	R920	D-2		
Q940	J-2	R850	A-6	R922	C-2		
Q950	I-2	R851	C-7	R924	C-2	VR930	B-3
Q955	I-2	R853	B-6	R925	B-2	VR940	H-1
Q958	I-2	R855	C-6	R927	C-2	VR950	H-2
Q982	E-2	R856	C-7	R929	B-3		
Q984	E-2	R861	B-6	R930	B-3		
		R863	C-6	R935	E-2		
		R866	B-6	R936	F-2		
		R867	B-6	R937	F-2		
		R870	B-6	R940	I-3		
		R871	B-6	R942	I-2		
		R873	B-6	R943	H-2		
		R880	D-5				
		R881	D-7				

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.



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MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M30734
DATE 11-8-77

CHANGE:	DESCRIPTION
---------	-------------

EFF SN B074125 (5440/R) EFF SN B062200 (5441/R)

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A2 670-2335-04 CKT BOARD ASSY:INTERFACE

ADD:

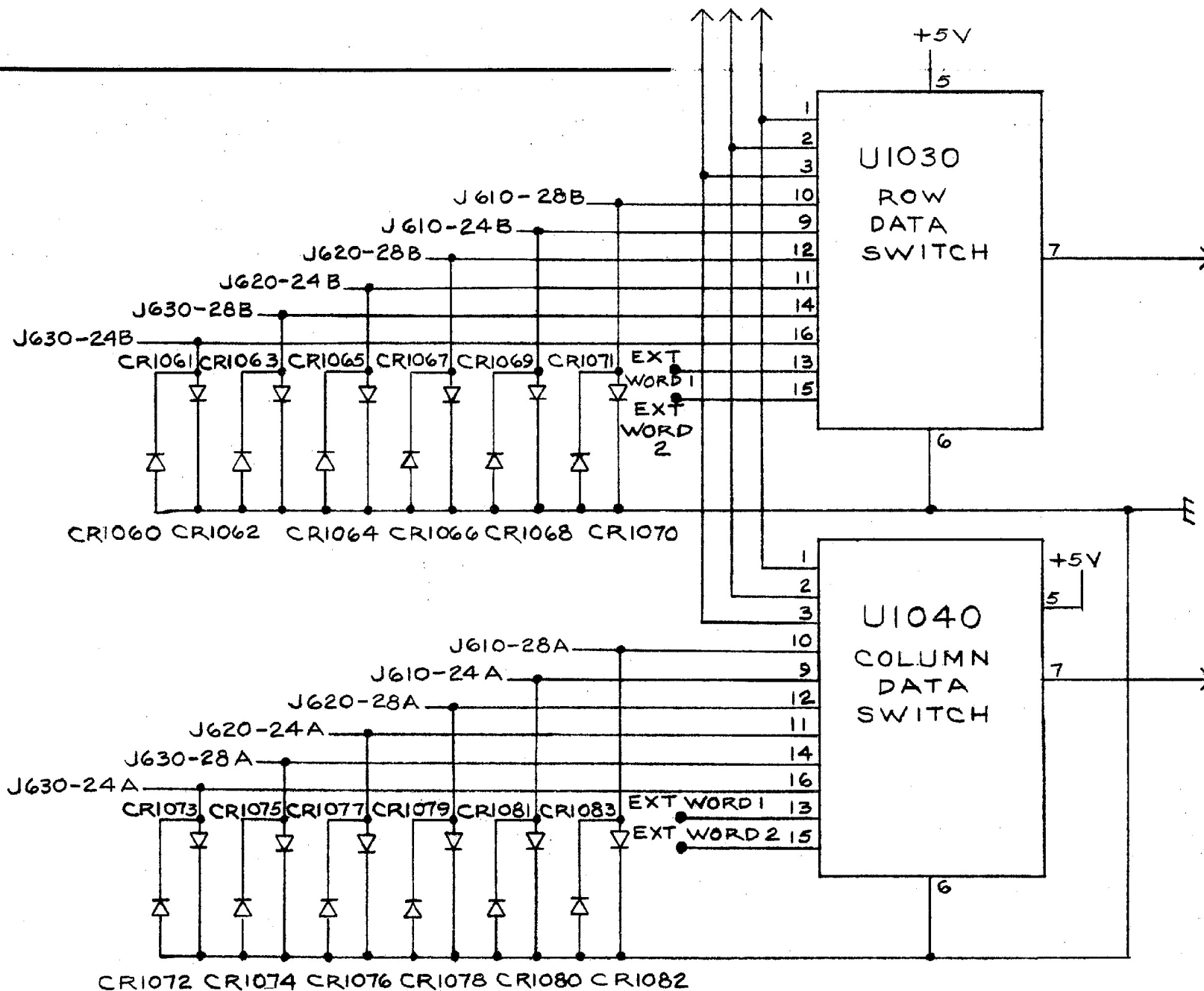
670-5035-00 CKT BOARD ASSY:READOUT PROTECTION

CR1060

thru

CR1083

152-0333-00 SEMICOND DEVICE:SILICON,55V,200MA,1N461D



READOUT PROTECTION

SCHEMATIC CHANGES

CHANGE:

DESCRIPTION

PRODUCT 5440/R, 5441/R

CHANGE REFERENCE M30734

DATE 11-8-77



MANUAL CHANGE INFORMATION

PRODUCT 5440 & 5441

CHANGE REFERENCE M30792

DATE 3-17-77

CHANGE:

DESCRIPTION

EFF SN B073789 (5440) 070-2139-01

EFF SN B061967 (5441) 070-2140-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

DL100 119-0693-00 DELAY LINE, ELEC:

MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R

CHANGE REFERENCE M24,547

DATE 10-8-76

CHANGE:

DESCRIPTION

EFF SN B033100-up (5440) 070-2139-01

EFF SN B021497-up (5441) 070-2140-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

C180	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C192	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C197	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V
C198	283-0111-00	CAP.,FXD,CER DI:0.1UF,20%,50V

The parts listed above are located on the VERTICAL circuit board assembly and shown on diagram 1 VERTICAL AMPLIFIER.



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MANUAL CHANGE INFORMATION

PRODUCT 5441

070-2140-00

CHANGE REFERENCE M22400

DATE 8-3-77 REV.

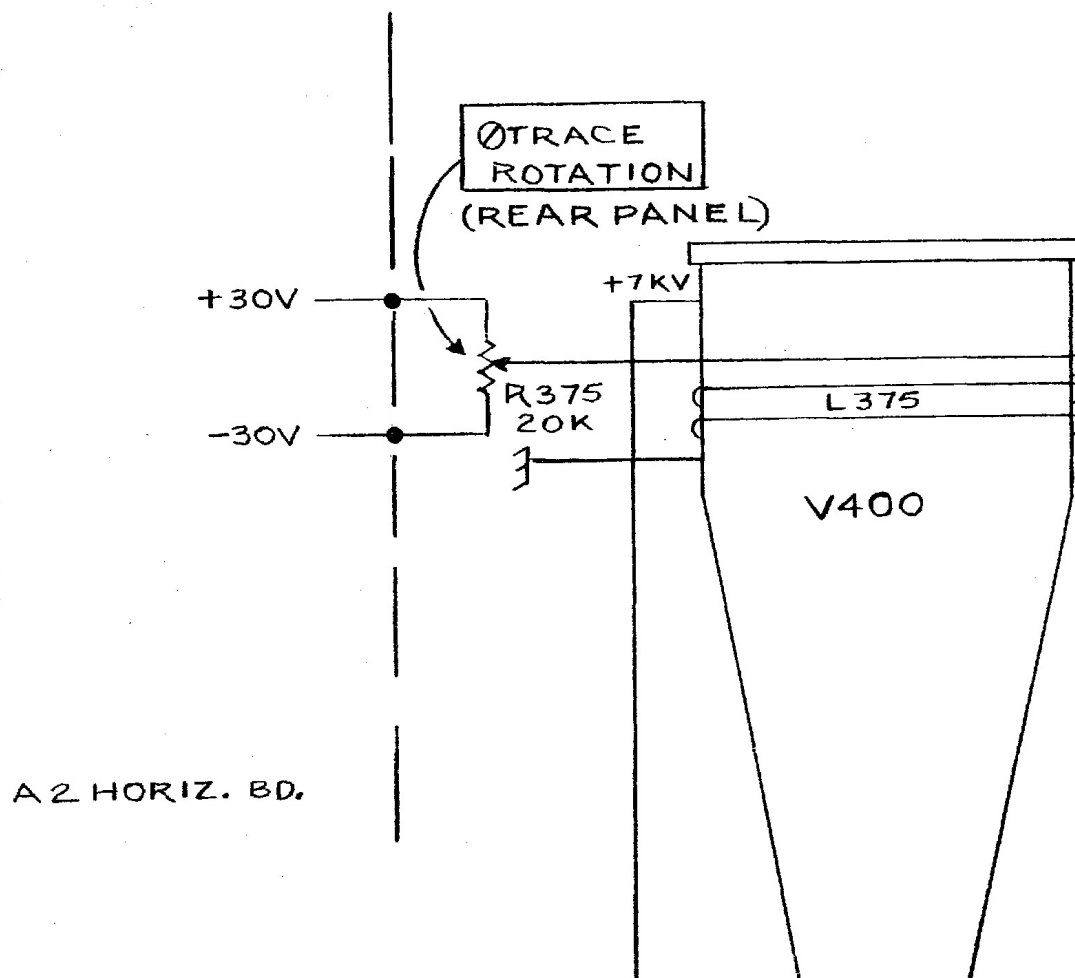
CHANGE:

DESCRIPTION

EFF SN B020000

The Trace Rotation pot R375 is moved from the HORIZONTAL AMPLIFIER circuit board to the top right corner of rear panel. See schematic sketch below.

DIAGRAM 2 Z-AXIS AMPLIFIER & CRT CIRCUIT



MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M24973
DATE 5-24-77 REV. 8-15-77

CHANGE:

DESCRIPTION

EFF SN B080000-up

MECHANICAL PARTS LIST CHANGES

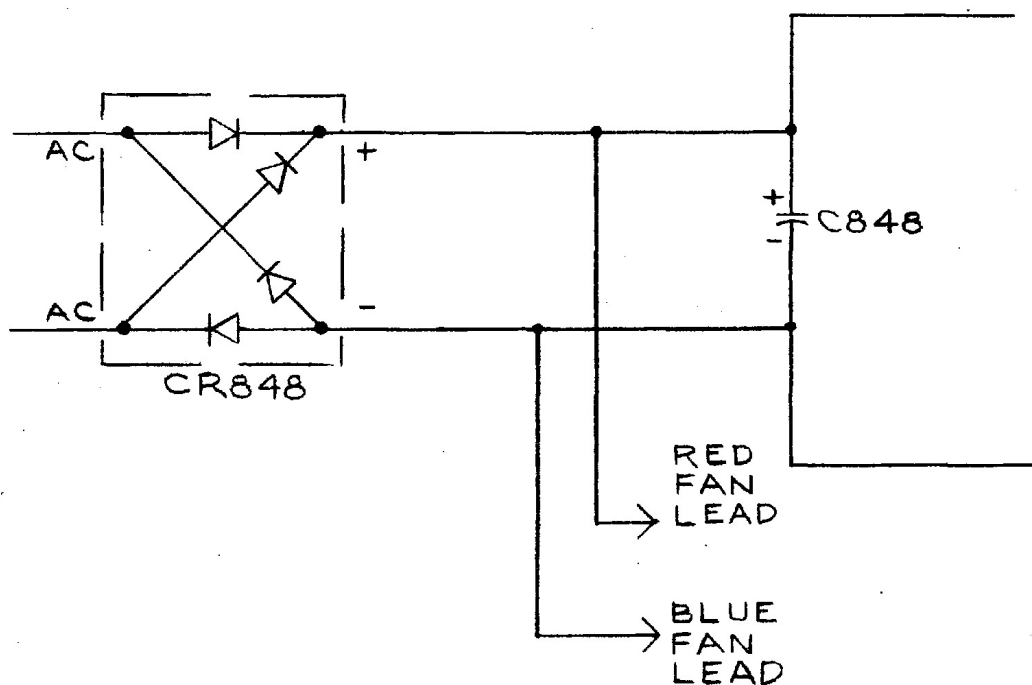
CHANGE TO:

Fig. 2-45	333-1833-02	1	PANEL, REAR
Fig. 2-56	426-0934-01	1	FRAME ASSY, CABINET
	426-0719-24	1	FRAME SECTION
	390-0469-01	2	CABINET SIDE
	390-0470-01	1	CABINET BOTTOM
	390-0502-01	1	CABINET SIDE
	390-0503-01	1	CABINET SIDE
	390-0505-01	2	CABINET BOTTOM
	333-1889-01	1	PANEL, REAR

ADD:

119-0830-00	1	FAN
378-2027-01	1	FAN, GRILL
211-0018-00	2	SCREW, MACHINE: 4-40 X 0.875", PNH
211-0144-00	4	SCREW, MACHINE: 4-40 X 1.312, PNH
380-0490-00	1	HOUSING, FAN
407-1889-00	1	BRACKET, FAN
210-0994-00	4	WASHER, FLAT

DIAGRAM 2 LOW-VOLTAGE SUPPLY AND CALIBRATOR - Partial





MANUAL CHANGE INFORMATION

PRODUCT 5440/R & 5441/R
070-2139-01 & 070-2140-00

CHANGE REFERENCE M31308
DATE 4-5-77

CHANGE:

DESCRIPTION

EFF SN B073840 (5440/R)

EFF SN B062000 (5441/R)

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

VR245 152-0428-00 SEMICOND DEVICE: ZENER, 0.4W, 120V, 5%

VR245 is located on the HORIZONTAL AMPLIFIER board and shown on diagram 4 in the 5440 manual and diagram 2 in the 5441 manual.