TEKTRONIX®

1501

SERVICE

INSTRUCTION MANUAL

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TEKTRONIX®

1501

SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.
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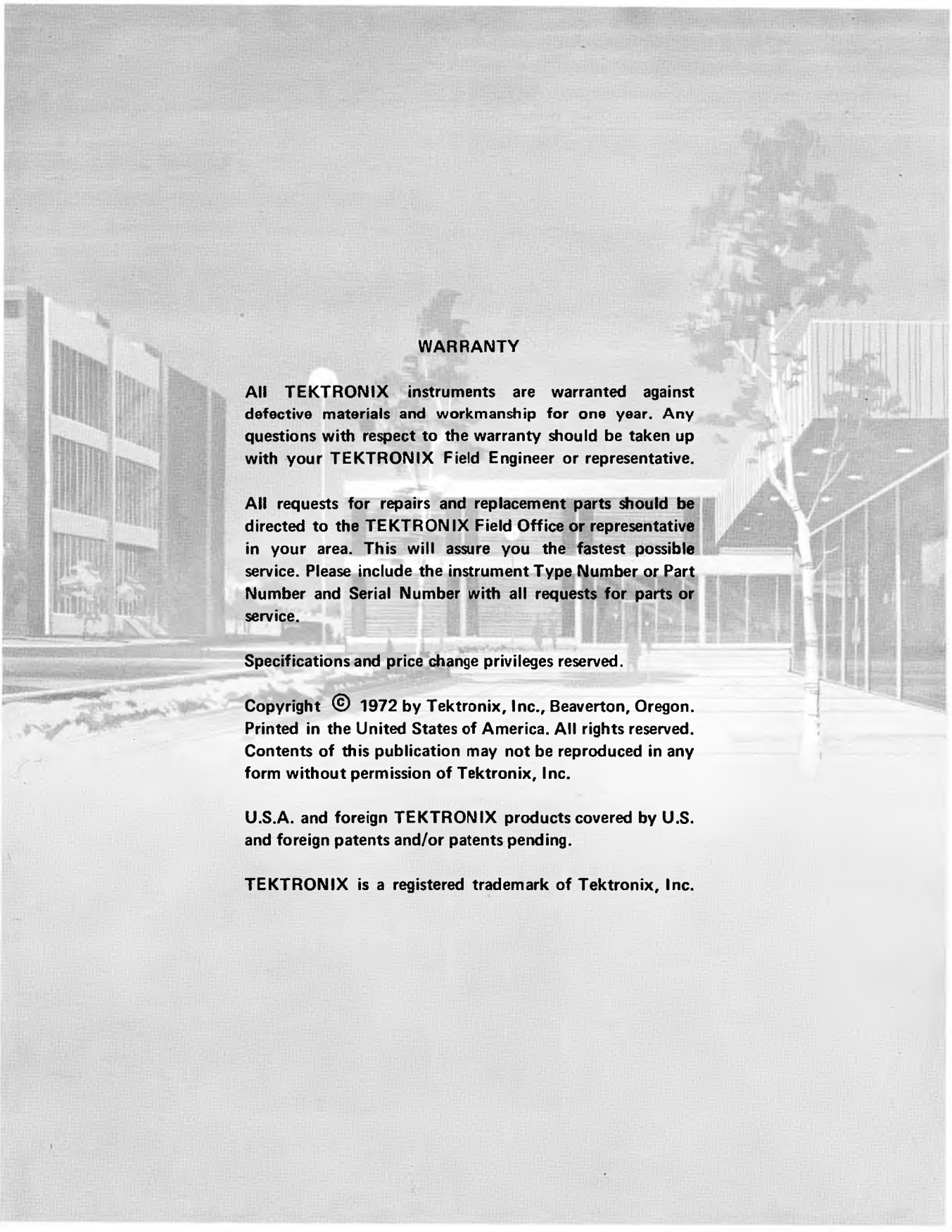

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All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

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CIRCUIT THEORY

The block diagram on the fold-out page near the back of the manual should be used with this description. That diagram provides a key to a thorough understanding of how the 1501 works. Also, it is useful in isolating difficult troubles. Refer to the left side of the block diagram for a listing of specific transistors and integrated circuits and the schematic where each is found. The parts list which precedes each schematic contains all the electrical components shown on that schematic.

BASIC FUNCTIONS

The basic functions of the circuits in the 1501 TDR are (1) to provide test pulses from a TEST PULSE GENERATOR, (2) to provide HORIZONTAL & TIMING or distance information, (3) to provide VERTICAL or amplitude information, (4) to provide oscillograms via a plug-in strip CHART RECORDER, (5) to provide start, stop and timing CONTROL LOGIC for the chart recorder and (6) to provide regulated voltages from a battery power-pack and POWER SUPPLY. These six functions are identified on the block diagram by corresponding sections having like titles.

The 1501 uses many of the basic principles and basic circuits of sampling oscilloscopes. If you already have an understanding of these principles, you may be able to recognize or deduce most of the purposes of the individual blocks and connections within the TIMING & HORIZONTAL and within the VERTICAL sections merely by careful study of the diagrams.

The TEST PULSE GENERATOR section is similar to most other Time-Domain Reflectometers. However, either a short duration pulse or a long duration, fast rise step signal may be selected as a test signal for the transmission line under test. Either kind of test signal is generated in automatic synchronism with the sampling and display process. The information display may be produced on a separate monitor oscilloscope or on a heat sensitive paper strip chart from the plug-in chart recorder.

Power for the chart recorder comes from regulated voltages supplied by the 1501 mainframe. The supply voltages remain disconnected, however, until the CHART POWER pushbutton is pushed. Thus, the motor will not start until the START pushbutton is pushed. Paper begins to emerge immediately, and the stylus begins to heat. After stylus is hot, the sampling and graph making process begins. A 10-division (25 centimeter) chart record is made, then the sampling process stops. The stylus heating voltage is turned off at that instant, but the paper continues to move until the last recorded chart division emerges from the slit at the bottom of the recorder. The paper then stops and the record is available. By lifting the chart paper at an angle against the sharp upper lip, each new chart may be separated from the remainder of the roll of paper. The unrecorded part of each strip chart that appears ahead of the graph is for handwritten data. Each strip should be 32.5 centimeters long, and have 13 heavy vertical lines identifying each major horizontal division.

DETAILED FUNCTIONS

HORIZONTAL & TIMING Section

The SAMPLING RATE GENERATOR is a free-running multivibrator with a frequency of about 10 to 12 kHz. Each cycle initiates a negative-going fast ramp in the FAST RAMP GENERATOR and provides an input to the SWEEP GATING MULTI that occasionally causes it to switch and initiate a new sweep in the SWEEP GENERATOR. At the beginning of each sweep, the nearly simultaneous GATING and BLANKING DRIVER signals occur. Monitor oscilloscope retrace blanking is provided by an approximate −5 volt level from the GATING and BLANKING DRIVER and is mixed through a 10 k ohm resistor (R269) with the VERT OUT signal. When a sweep is in progress, the level of the blanking line floats, following the VERT OUT signal.

The FAST RAMP GENERATOR output goes to two comparators: the SLEWING COMPARATOR and the NON-SLEWING COMPARATOR. Successive outputs from the SLEWING COMPARATOR are increasingly delayed with reference to the beginning of each fast ramp, because of the slowly changing reference level at the other input to that comparator. Since it is slaved to the SWEEP GENERATOR through the SWEEP INVERTER, increasingly delayed signals from the STROBE DRIVER are therefore delivered to the sampling circuits during each sweep. That level changes at a rate proportional to the sweep rate. Thus, samples of the voltage near the TEST LINE connector are taken at later and later instants, (relative to the transmission of each test pulse). Successive samples will be delayed by small or large amounts (to correspond with the dielectric constant and propagation factor of the CABLE selected and the distance to be checked), depending on the FEET/DIV (or METERS/DIV) selected. The first of each successive set of samples taken during any sweep may be delayed, using the START POINT control, by a time corresponding to the two-way propagation time of up to at least 500 feet (or 100 meters) of cable. For measurement of long distances a fast ramp having 10 times longer duration is used, and the START POINT control can be set to delay

the start of sample-taking for a time corresponding to 5000 feet (or 1000 meters) of cable.

Notice the three capacitors between the input and output of the SWEEP GENERATOR. C220, controlled by the NOISE FILTER pushbutton, causes the sweep repetition rate to change from about 40 per second to about 4 per second. C225, controlled by FET Q225, shunts C220 and C222 when the CHART POWER pushbutton is pushed. This reduces the sweep rate to approximate the speed of the chart recorder paper (about 2 seconds per division). The sweep will not free-run in this mode. Instead, the GATING MULTI is locked out by the GATING CONTROL circuits until it receives a go signal from the START-STOP CONTROL in the CONTROL LOGIC section. When grounded, the same input line to FET Q225 also signals the GATING CONTROL circuits, preventing the sweep from repeating until the START pushbutton is pushed.

R216 controls the slope of the sweep ramps. It should be set, using the chart recorder, for minimum correction signal across C202. When the chart paper is properly installed and R216 properly set, the sweep ends within one small minor division of the heavy line corresponding to the last major division. When the step mode is selected, there is an abrupt downward swing of the pen when the sweep stops, corresponding to the beginning of retrace, before it cools off.

R192 controls the current delivered to the sliding contact on the START POINT control. It is used to calibrate the 10-turn START POINT control after the slope of the fast ramps has been properly set with R132.

R132 sets the slope of the fast ramps so that FEET/DIV (or METERS/DIV) will be accurate. One of two fast ramp capacitors (C128 or C129) is selected by the FEET/DIV (or METERS/DIV) switch and determines the start point range. The larger of these capacitors must have precisely 10 times the capacitance of the smaller (including stray circuit capacitance) for the best accuracy at all settings of the FEET/DIV (or METERS/DIV) switch.

VERTICAL Section

The STROBE GENERATOR periodically operates the SAMPLING GATE momentarily, to admit, to the SAMPLING PREAMP, voltage existing at the TEST LINE. That sampling time is on the order of 1 nanosecond. Samples are taken approximately every 100 microseconds, and stored as a partial charge in the capacitors C380 and C390. Positive feedback through adjustable capacitor C394 completes each charge in C380 and C390. The voltage from each charge is applied to the sampling preamplifier.

C394 adjusts the sampling gate to have, in effect, 90% sampling efficiency.

The sampling gate diodes are shunted by capacitance that couples undesired charge to the SAMPLING PREAMP input. The BLOWBY INVERTER produces an equal and opposite signal to nullify the undersired charge. R398 sets the gain of the BLOWBY INVERTER.

The SAMPLING PREAMP drives the VERTICAL AMPLIFIER, which is an operational amplifier, through a part of the gain adjust resistor R442. The resistance connected between the output and the other input of the VERTICAL AMPLIFIER is selected by the %/DIV switch. That switch also controls the gain of the VERTICAL AMPLIFIER. A DC voltage, selectable with the DISPLAY OFFSET control, is applied to the opposite end of R442. The effect of a change in that voltage is to position the display up or down on a monitor oscilloscope or chart recording. The output of the VERTICAL AMPLIFIER normally goes to the PEN DRIVE amplifier via the EXT DRIVE (or EXT SIG) switch. A properly terminated step signal should produce a 1 volt sampled facsimile at the VERT OUT jack when %/DIV is set to 20. When the EXT Drive (or EXT SIG) pushbutton is pushed, any externally supplied signal introduced to the VERT IN jack is routed to the chart recorder and the VERT OUT jack by way of the 1X BUFFER AMPLIFIER. Notice that when the EXT DRIVE (or EXT SIG) pushbutton is pushed, another contact connects the 0 to +5 volt sweep to the SWEEP OUT jack. When that sweep is properly connect to the 1401A or 1401A-1 TEKTRONIX Spectrum Analyzer, and the proper vertical output of the spectrum analyzer is connected to the VERT IN jack on the 1501, a chart recording of a spectrum plot can be made with the 1501.

Notice the two capacitors that may be switched to ground at the input to the VERTICAL AMPLIFIER. One is selected by the NOISE FILTER pushbutton and the other is selected by the CHART POWER pushbutton. These capacitors provide "smoothing" or noise reduction in the display when the sweep rate is slow enough to provide time to average out the random noise.

R442 sets the gain of the VERTICAL AMPLIFIER so that the internally generated step signal produces the correct deflection.

TEST PULSE GENERATOR Section

Either narrow pulses (impulses) or fast rise step-signals may be selected for transmission through the cable under test. The STEP pushbutton selects the step test signal when pushed in, or the impulse test signal when released (out).

The output of the NON-SLEWING COMPARATOR is a pulse edge that causes either the STEP DRIVER or the IMPULSE DRIVER to generate a step or impulse, respectively, for transmission through the transmission line under test, by way of the TEST LINE jack. When the STEP DRIVER is on, the IMPULSE DRIVER is off, and vice versa, depending on the position of the STEP pushbutton. The NON-SLEWING COMPARATOR has a fixed delaying function. It delays the generation of each test pulse, with respect to the beginning of each fast ramp, by a fixed amount of time. The amount of time depends on the slope of the fast ramp and the DC level at the lower input to the NON-SLEWING COMPARATOR. This fixed delay allows strobes, generated during the first part of a sweep, to sample voltage on the line prior to the generation of some test pulses, so that the incident edge of subsequent test pulses may be sampled and displayed later in any sweep.

When the source and line load are matched, the signal delivered to the TEST LINE jack from the STEP GENERATOR has an amplitude of about +1 volt. When the 50 Ω-75 Ω internal slide switch is set to the 75 Ω position, 25 Ω is inserted in series with the output line to make the source impedance 75 Ω and to deliver the same test signal amplitude to a 75 Ω line that is delivered to a 50 Ω line from the basic 50 Ω source impedance.

The INPUT PROTECTOR senses the presense of extraneous voltage on the line that may cause damage to components in the 1501. When more than 5 to 8 volts is on the line, a relay automatically switches a low capacitance blocking capacitor (C346) in series to protect the components. When this happens, a neon light on the front panel flashes periodically. When extraneous voltage on the line must be tolerated, the tests may usually be continued by switching to the IMPULSE mode. Excessive voltage, especially high frequency signal voltage, may produce enough noise in the display to make the tests impractical, however. Once the relay is activated it will hold itself latched while a sweep is in progress, even if voltage on the line goes below 5 volts. At the end of a sweep or chart, however, the relay is unlatched by a signal from the GATING & BLANKING DRIVER. The presense of extraneous voltage on the line that is less than 5 to 8 volts may seriously interfer with the display. In such a case, using the IMPULSE mode may often be a satisfactory solution, providing a blocking capacitor is externally connected in series with the output of the TEST LINE jack.

R148 positions the leading edge of the step signal so it may be visible on the chart or monitor scope at all FEET/DIV (or METERS/DIV) settings in the 5000 foot (or 1000 meter) range. R151 serves a similar purpose for the 500 feet (or 100 meter) range but should be adjusted after R148 has been set, because R148 affects the pulse position in both ranges. Neither adjustment should be made unless the START POINT is first set to 000.

R330 adjusts the position of the leading edge of the impulse to coincide with the leading edge of the step-signal. It should be set using the shortest distance per division.

C366 and R366 are adjusted for the fastest, cleanest step signal.

R347 is adjusted so that the impulse generating avalanche transistor (Q345) does not free-run, but requires very little drive signal to avalanche. It also affects the amplitude of the impulse, so it should be set before IMPULSE amplitude adjustments are made.

C342, R342, and C344 are to minimize aberrations following the impulse. C345 adjusts the amplitude of the impulse delivered to the test line and C378 adjusts the portion of the impulse and reflections that arrive at the sampling gate input.

CONTROL LOGIC Section

The purpose of the control logic section is to provide proper start, stop, and timing information between the CHART RECORDER and HORIZONTAL & TIMING sections of the instrument. When the CHART POWER pushbutton is pushed, an input to the GATING CONTROL circuits is grounded. This prevents the SWEEP GENERATOR from running until the START pushbutton is pushed. The pushbutton also connects a large capacitor (C225) between the input and output of the SWEEP GENERATOR, to assure a long duration sweep closely approximating the paper speed in the chart recorder.

When the START pushbutton is pushed, two outputs from the START-STOP CONTROL circuits immediately turn on the PAPER DRIVE MOTOR and the STYLUS heat by activating the MOTOR VOLTAGE CONTROL circuits and the HEATER VOLTAGE REG circuits. The chart paper then moves, and holes in the left edge (top) of the chart paper periodically admit light from the LED (light emitting diode) to the DETector. The detected light pulses are passed to the PULSE SHAPER circuits, where they are sharpened and passed on to the HOLE COUNTER and ERROR GATE circuits. When the second hole is counted, an output from the START-STOP CONTROL circuit signals the GATING CONTROL circuits and unlocks the SWEEP GATING MULTI. The SWEEP GENERATOR is then started by the SWEEP GATING MULTI as soon as the next pulse arrives from the SAMPLING RATE GENERATOR (less than 100 μs later). By the time the second hole is counted the stylus should be hot and starting to write. If the chart paper has been installed correctly (with the red line visible through a hole in the chart paper set next to a heavy line on the paper), the sweep should commence

precisely as the next heavy line moves across the edge of the hot stylus. After the sweep begins, successive samples are increasingly delayed to correspond with movement of the sweep and movement of the chart paper, and the increasing cable distance that they represent. To ensure precise distance calibration of the chart, the chart speed is monitored by counting holes with a light beam. Each time a hole admits light from the LED to the light DETector a pulse is produced, passed to the PULSE SHAPER and on to the HOLE COUNTER and BINARY TO ANALOG CONVERTER. The voltage level of the sweep is compared with an analagous current stair-step produced by the BINARY TO ANALOG CONVERTER. Any difference in level is then amplified by the SLOPE ERROR AMPLIFIER and gated into the memory capacitor (C202) by the ERROR GATE. The polarity of any error voltage on the capacitor depends on whether the paper tends to move faster or slower than the sweep. The magnitude of the voltage depends on the inherent difference in rate, but tends to be self-cancelling by automatically altering the sweep speed to match the paper speed. When the speeds match perfectly, the heavy line corresponding to the last of 10 major chart divisions is in contact with the stylus edge at the instant the sweep ends. R216 (in the HORIZONTAL & TIMING section) is usually adjusted for a near-exact sweep slope. Otherwise, the error circuits won't operate correctly.

Fifty holes are counted and 50 equal increments of current are supplied by the BINARY TO ANALOG CONVERTER during each sweep. If the sweep rate matches the paper speed, each increment is matched by current supplied by the sweep voltage through the resistor (R526) shown connected to the null point. When R216 at the input to the SWEEP GENERATOR is adjusted properly, the error signal across C202 is minimized.

When the sweep ends, an input to the START-STOP CONTROL circuits from the GATING & BLANKING DRIVER turns off the HEATER VOLTAGE CONTROL. A nearly simultaneous output from the START-STOP CONTROL circuits locks out the SWEEP GATING MULTI through the GATING CONTROL circuits. The paper continues to move, however, until a total of 65 holes are counted. At that instant, the motor is turned off by the START-STOP CONTROL circuits, and the motor is electrically braked by the MOTOR VOLTAGE CONTROL circuit. At the same instant, all counters are reset. The process may then be repeated by pushing the START pushbutton. If the CHART POWER pushbutton is released while the paper is moving, the motor will stop. It will then be necessary, by pulling some paper from the recorder, to re-align a major graticule mark on the paper with the red index line.

CHART RECORDER Section

The chart recorder consumes no power when merely plugged into the 1501. When the CHART POWER pushbutton is pushed, the supply voltages are connected to the recorder circuits and the CONTROL LOGIC circuits, and power dissipation increases to at least 0.6 watts, depending on the position of the stylus. When the START pushbutton is pushed, the stylus HEATER VOLTAGE REGULATOR is turned on and heats the writing stylus. The power required to heat the stylus is about 5 watts, depending on the adjustment of R722, the stylus temperature adjustment. With no paper installed in the recorder, heater voltage will not turn off by itself. Even when paper is installed, the CHART POWER pushbutton should be released immediately after making each record, in order to conserve battery charge. Further, the sweep generator is locked out and the instrument may be thought to be defective if a monitor oscilloscope is connected. If the chart recorder stops running while making a chart, it is likely that the chart paper is depleted. The stylus heater voltage will not turn off, and to avoid excessive battery drain, the CHART POWER pushbutton should be released.

The PEN DRIVE AMPLIFIER is activated whenever the CHART POWER pushbutton is pushed. This amplifier normally receives a signal from the 1501 VERTICAL AMPLIFIER, but may also respond to a signal applied to the VERT IN jack if the EXT DRIVE (or EXT SIG) pushbutton is pushed. Such a signal will need to be slaved to the sweeps generated in the 1501, however, to be of practical use. Those sweeps are available at the SWEEP OUT jack when the EXT DRIVE (or EXT SIG) pushbutton is pushed. If a chart recording is to be made and the CHART POWER pushbutton is pushed, no sweep is available until the START pushbutton is also pressed. These sweeps last about 20 seconds and a complete chart takes about 26 seconds to be completed.

The PEN DRIVE AMPLIFIER must have the correct gain to make an accurate chart record. Gain is controlled by R755 and should be set so a 1 volt P-P low frequency signal at the VERT OUT jack produces five chart divisions of deflection. When the gain of the VERTICAL AMPLIFIER in the 1501 is set correctly, a 1 volt step signal is available at that point when the TEST LINE output is terminated to match the source impedance selected with the internal 50 Ω-75 Ω slide switch. The STYLUS POSITION pot should be set so that, with zero volts at the VERT OUT jack, the stylus is precisely positioned to the center of the chart paper. The stylus is approximately centered but does not respond to rotation of the STYLUS POSITION pot unless CHART POWER is applied. If the paper movement is deliberately stopped by releasing the CHART POWER pushbutton the stylus may tend to stick to the paper because it cooled in one position. In that case, rotation of the STYLUS POSITION pot may not move the STYLUS until the paper is advanced.

PERFORMANCE CHECK AND ADJUSTMENT

Introduction

A complete procedure for verifying proper performance of the 1501 and Chart Recorder (016-0506-00) is contained in this section. Instructions are included for making all internal electrical adjustments. Instructions for making mechanical adjustments are included in the Maintenance section of the manual.

We recommend a complete performance check every six months or 1000 hours of operation if no serious performance problems have occurred in that time. If performance troubles are suspected the Preliminary Checks and Troubleshooting Guide may be followed with a minimum amount of equipment and with little investment of time. It will reveal most abnormal performance conditions and will help locate the trouble rapidly.

A complete performance check is recommended any time a serious trouble has been corrected. Some failures do not warrant a complete performance check, since not all circuits are affected by a given circuit repair.

NOTE

Performance Specifications are listed in the Operation Section of the manual. Tolerances and limits mentioned in Section 2 are adequate to verify the tolerances and limits in the section on operation but may sometimes be tighter than absolutely necessary or pertain to conditions that only indirectly apply to the Performance Specifications.

EQUIPMENT REQUIRED

1. One monitor oscilloscope, such as the SONY/TEKTRONIX 323. The monitor oscilloscope should have a DC-coupled, external horizontal input, with a sensitivity adjustable to 0.5 V per division on a 10-division full screen scale. It should also have a calibrated DC-coupled vertical input with sensitivities of 1 V, 0.5 V, and 0.2 V per division.

2. One DC voltmeter, such as the TEKTRONIX DM 501 (or TEKTRONIX 7000-series oscilloscope and 7A13 plug-in unit). The voltmeter should be accurate to 0.25% or better when reading 5, 7.5, or 75 volts.

3. One variable auto-transformer (with voltmeter), such as General Radio W10MT3WA. The auto-transformer should permit line voltage to be varied from 90 V AC to 130 V AC (or 180 V AC to 260 V AC if the 1501 is wired for 225 V AC).

4. One Time-Mark Generator such as the TEKTRONIX 2901. The generator should have 10 ns, 50 ns, 0.1 μs, 0.5 μs, 1 μs, and 10 μs marker output signals of about 0.5 volts P-P into 50 ohms, and 0.1 μs, 1 μs, and 10 μs synchronous trigger signals of about 0.5 volts into 50 ohms.

5. One six-foot 1X-10X probe, such as TEKTRONIX P6052, or separate six-foot 1X and 10X probes.

6. Three coaxial cables, such as TEKTRONIX 012-0057-01. The cables should be about 42 inches long and have BNC connectors on each end.

7. One BNC to GR adapter such as TEKTRONIX 017-0063-00.

8. One 50 ohm Termination, such as TEKTRONIX 017-0081-00. The termination impedance should be 50 ohms ± 0.5% at DC.

9. One 50 ohm 2X attenuator, such as TEKTRONIX 017-0080-00. The attenuator should provide 2X ± 1% attenuation at DC.

10. One 50 ohm 5X attenuator, such as TEKTRONIX 017-0079-00. The attenuator should provide 5X ± 1% attenuation at DC.

11. One 50 ohm 5X attenuator, such as TEKTRONIX 011-0060-00. The attenuator should have BNC connectors.

12. One 75 ohm Termination, such as TEKTRONIX 011-0102-00. The termination impedance should be 75 ohm ± .25% at DC.

13. One F-to-BNC adapter such as TEKTRONIX 013-0158-00.

14. One insulated adjustment tool such as TEKTRONIX 003-0000-00. The tool should have an insulated shaft.

15. One insulated adjustment tool such as TEKTRONIX 003-0003-00. This tool should have a short thin, narrow, screwdriver-shaped, metalic tip imbedded in an insulating material. Tool 003-0003-00 should be shortened to about 2 inches.

16. One extension cable such as TEKTRONIX 067-0667-00 for troubleshooting the Chart Recorder.

PRELIMINARY CHECKS AND TROUBLESHOOTING GUIDE

All references to the left or right side of the 1501 will mean toward the operator's left or right hand as he views the front panel right side up.

The circuits identified as likely centers of trouble are shown on the block diagram pull-out sheet near the back of the manual. The transistors and integrated circuits associated with each block are identified on the same page.

1. Turn off the POWER switch on the 1501 front panel and remove the 1501 from its case by loosening the thumb screw on the rear panel and pulling on the front panel.

2. Remove the plug-in Chart Recorder by loosening the thumb screw on the front panel and pulling on the thumb screw. Slide the 50 Ω-75 Ω internal slide switch to the 50 Ω position, toward the front of the 1501. It is accessible through the top of the chart recorder compartment on the circuit card to your left.

3. Set the slide switch on the side panel to the FULL CHG position and attach the 1501 power cord between the 1501 and the variable auto transformer. Plug in the auto transformer and turn it on. Set for 120 V AC output to the 1501.

4. Release all pushbuttons on the 1501 front panel and set the POWER switch to ON. The settings of the other controls do not matter yet.

5. Connect a shielded cable (012-0057-01) between the HORIZ OUT connector on the 1501 and the vertical input connector on the monitor oscilloscope. Turn on the power to the oscilloscope, DC-couple the oscilloscope input, set the VOLTS/DIV to 1, the TIME/DIV to 10 ms and measure the sweep voltage. Its indicated amplitude should be 5 volts P-P plus or minus about 0.2 volts. If there is no sweep, look for trouble in the SAMPLING RATE GENERATOR, SWEEP GATING MULTI, GATING CONTROL, or SWEEP GENERATOR circuits. If the sweep voltage is not very close to 5.0 volts, suspect trouble with, or misadjustment of, the power supply voltage.

6. Move the cable from the HORIZ OUT jack to the SWEEP VOLTAGE jack. Push the EXT SIG (or EXT DRIVE) pushbutton. The same sweep signal should appear on the oscilloscope. If not, suspect switch contact troubles.

7. Set TIME/DIV to 1 second. Push the NOISE FILTER button and check for a slower sweep, and that the sweep amplitude does not change. If not, suspect Q255 or switch contact trouble.

8. Release all the pushbuttons then push the STEP pushbutton. Using an F-to-BNC adapter, (013-0158-00), move the shielded cable from the SWEEP VOLTAGE jack to the TEST LINE jack. Change the START POINT control to indicate 100 or more. Set the oscilloscope TIME/DIV to 20 μs and check the interval of one square-wave cycle. It should be about 80 to 100 μs. (Be sure the variable TIME/DIV control is in the CAL position). If no wave form appears, look for trouble in the FAST RAMP GENERATOR, NON-SLEWING COMPARATOR, or STEP GENERATOR circuits.

9. Disconnect the shielded cable from the TEST LINE jack.

10. Release all pushbuttons on the 1501 and set %/DIV to 50. Set the oscilloscope INPUT to GND, free-run the trace and position it to center screen.

NOTE

After this step, the vertical position of the oscilloscope display should be controlled only with the 1501 DISPLAY OFFSET knob. Repeat the ground level check anytime you suspect the vertical position control may have been inadvertently moved.

11. Connect a shielded cable between the 1501 VERT OUT jack and the vertical input to the monitor oscilloscope. DC-couple the oscilloscope input, then set the VOLTS/DIV to 1 and the TIME/DIV to 5 ms.

12. Observe the rectangular wave on the oscilloscope and check that the DISPLAY OFFSET control is able to position the top of the wave more than 1 division above

and below center screen. The negative peaks of the waveform correspond to the 1501 sweep recovery interval and should be about 4 to 7 ms in duration. The upper peaks correspond to the sweep interval and should be about 15 to 30 ms in duration. If no waveform appears, look for trouble in the GATING and BLANKING DRIVER circuits. If you can't move the tops of the waveform, look for trouble in the SLEWING COMPARATOR, STROBE DRIVER, STROBE GENERATOR, SAMPLING GATE, SAMPLING PREAMP, VERTICAL AMPLIFIER or display offset VOLTAGE GENERATOR circuits.

13. Push the STEP pushbutton and check that the top of the rectangular wave moves approximately 0.8 volts. If no movement occurs, suspect trouble in the STEP switch contacts or SAMPLING GATE circuits.

14. Set the distance per division to 20 feet (or 5 meters) and while observing the test scope display rotate the START POINT control counterclockwise to indicate 000. Check that about a +0.8 volt step appears ahead of the top leading corner of each rectangular wave. If not, R148 may have to be pre-adjusted so that it does. R148 is accessible through a hole in the right side panel.

15. Disconnect the shielded cable from the 1501 and release all the pushbuttons.

POWER SUPPLY CHECKS AND ADJUSTMENTS

Follow steps 1 through 3 of the preceding section unless you started with that section.

1. Measure the voltage between ground and the orange test point near the middle of the power supply board, using an accurate volt meter or 7A13 plug-in unit (see Figure 2-1). The voltage should be between +5.6 and +5.8 volts. If not, adjust R806 for a reading of 5.7 volts (see Figure 2-1). If using the 7A13 and oscilloscope, it is normal to see about 50 to 100 mV of ripple.

2. Measure the voltage between ground and the red test point near the right rear corner of the power supply board using the set-up above. The voltage should be within 225 mV of +7.5 volts. If not, adjust R838 (adjacent to that test point) for a reading of +7.5 volts. (See Figure 2-1).

3. Check for +5 volts within ±150 mV at pin 3 of plug P74 (see Figure 2-1).

4. Check for −5 volts within ±150 mV at pin 2 of plug P74 (see Figure 2-1).

5. Check for −75 volts within ±4.0 V at pin 1 of plug P74 (see Figure 2-1).

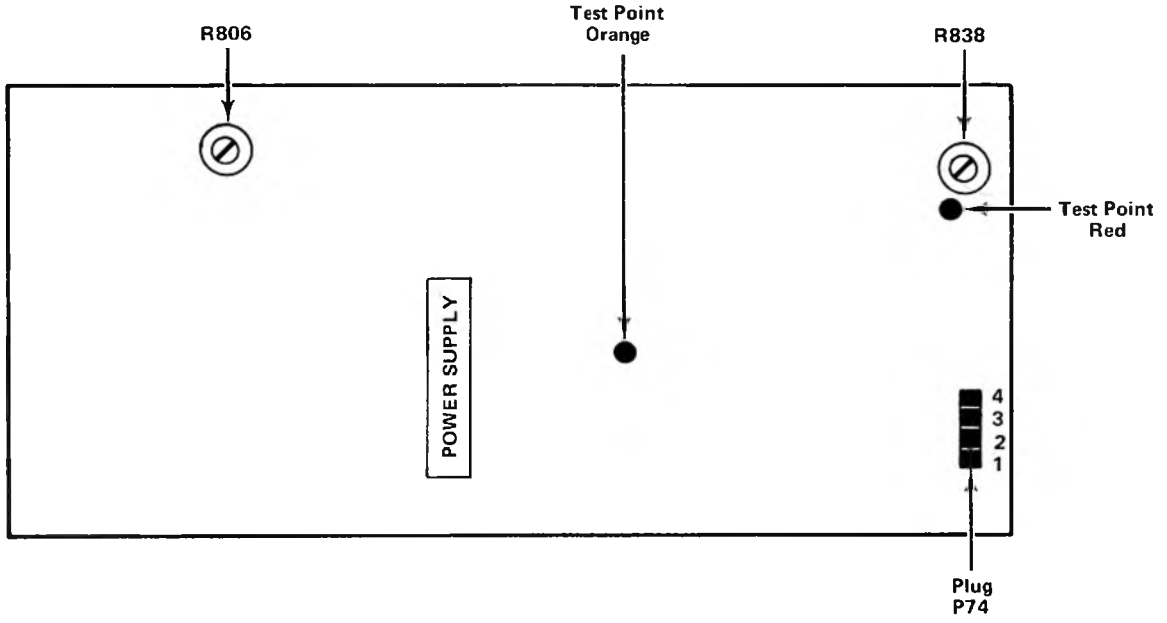


Figure 2-1. Power Supply circuit board showing only test points and adjustment potentiometers. The board is located near the rear of the 1501.

6. Repeat the checks in steps 1 through 5 one at a time while varying the line voltage between 90 and 136 volts AC.

7. Using a 1X probe connected to the monitor oscilloscope vertical input, AC couple the input and check for about 100 mV P-P ripple or less at the orange test point. Vary the line voltage between 90 and 136 volts AC when checking ripple at each point. Check for 15 mV P-P ripple or less on the +7.5 V test point (red), +5 V test point (pin 3) and −5 V test point (pin 2).

8. Check the −75 V test point (pin 1) in the same way for 75 mV P-P ripple or less.

9. Disconnect both ends of the probe.

VERTICAL CHECKS AND ADJUSTMENTS

1. Remove the chart recorder from the 1501 and remove the 1501 from its cabinet if you haven't already done so.

2. Connect a shielded cable (012-0057-01) between the VERT OUT jack of the 1501 and the vertical input to the monitor oscilloscope. Connect a similar cable between the HORIZ OUT jack on the 1501 and the external horizontal input to the monitor oscilloscope.

3. Turn on the POWER switch to the 1501 and oscilloscope and release all pushbuttons on the 1501. Set the %/DIV to 50, the FEET/DIV to 20 (or METERS/DIV to 5) and the START POINT to 000. For ease of adjustment, remove the power cord and operate the 1501 from its internal batteries. Be sure the right side panel slide switch is set for full charge or trickle charge.

4. Set the vertical input coupling of the monitor oscilloscope to GND, free-run the sweep, and center the trace with the vertical position control. DC-couple the horizontal input to the monitor oscilloscope and set its controls to display the 0 to +5 volt sweep from the 1501 across precisely ten divisions. For the most linear sweep while using a SONY/TEKTRONIX 323 or 324 oscilloscope, the left side panel slide switch should be set to 10X, and the X10 front panel MAG switch should be pulled. Also, the front panel trigger selector switch should be all the way down, and the TIME/DIV switch should be set to EXT HORIZ. The VARIABLE knob should be used to set the sweep to be precisely ten divisions long. The bright dot at the beginning of the sweep is normal.

5. Set the monitor oscilloscope VOLTS/DIV to 0.2 and the vertical input coupling to DC.

6. Push the STEP pushbutton on the 1501 and, using only the DISPLAY OFFSET control on the 1501, center the step vertically. It should be 4 divisions in amplitude. If not, preadjust R442 so that it is. R442 is located near the middle of the board that is wired to the %/DIV switch. If no step appears you may have to preadjust R148, accessible through a hole in the right sub-panel.

7. Using an F-to-BNC adapter (103-0158-00) if necessary, connect the precision 75 Ω termination (011-0102-00) to the TEST LINE jack. Slide the internal 50 Ω-75 Ω slide switch, accessible on the left through the top of the chart recorder compartment, to the 75 Ω (rear) position. The step signal should now be 2 divisions in amplitude.

8. Change the %/DIV to 20, distance to 2 feet (or 0.5 meters) per division and center the step with the DISPLAY OFFSET control. Advance R316 fully clockwise and look for a sudden increase in noise in the trace. See Figure 2-2 for the location of R316. Back off about 10 to 20 degrees counterclockwise from the position where the noise disappears. If no noise appears, set R316 about 10 degrees back from the clockwise end of rotation.

9. Set the distance to 500 feet (or 100 meters) per division. Set the START POINT to indicate 020 and adjust R398 for a flat, level trace. Change the %/DIV to 1, recenter the trace with the DISPLAY OFFSET control and fine adjust R398 for a flat, level trace.

NOTE

What appears as a high frequency oscillation may be on the entire trace. Its amplitude should be close to minimum when the trace is flattest. If more than about 1/5 division of oscillation appears when R398 is adjusted for the flattest trace, the sampling gate diodes (CR380 and CR390) may need to be replaced.

10. Change the %/DIV to 50 and set the START POINT to 000. Rotate C394 and notice the amplitude of overshoot and ringing change on the front corner (see Figure 2-3). Set C394 so that the ringing barely disappears (see Figure 2-4).

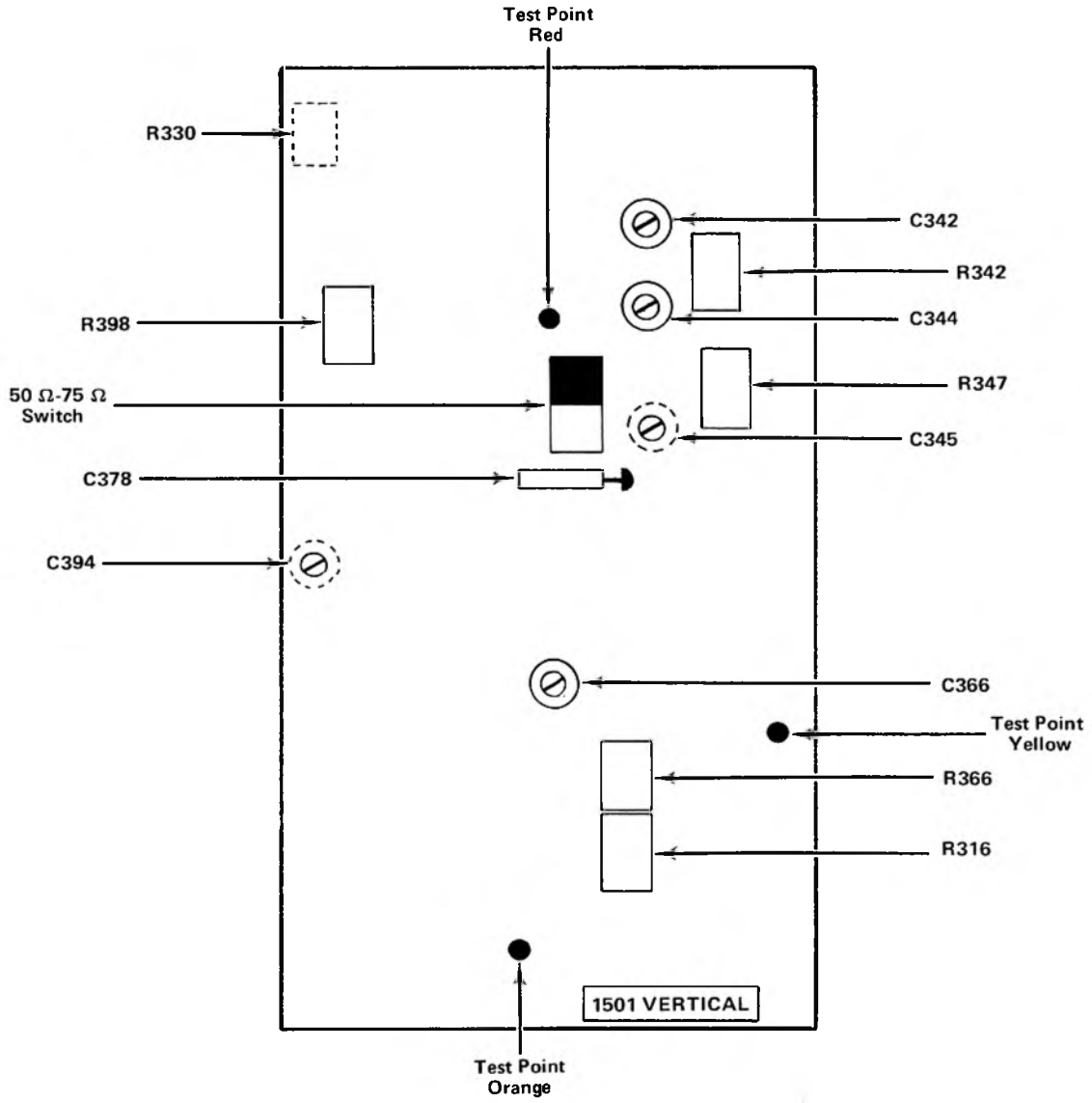


Figure 2-2. Vertical deflection circuit board showing location of test points and adjustable components. Dotted lines indicate locations of components on the left side of the board. The board is mounted in a vertical plane near the DISPLAY OFFSET control.

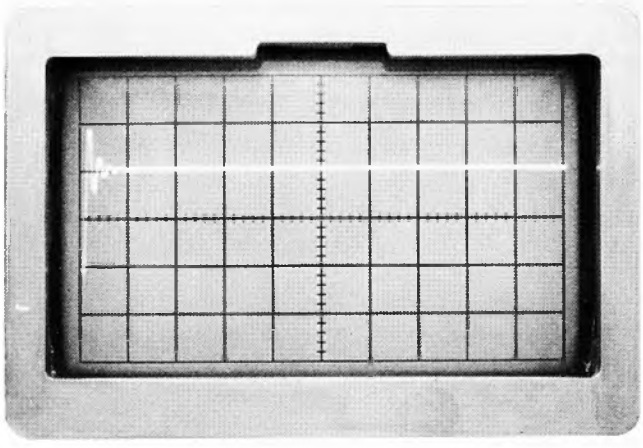


Figure 2-3. Capacitor C394 improperly adjusted.

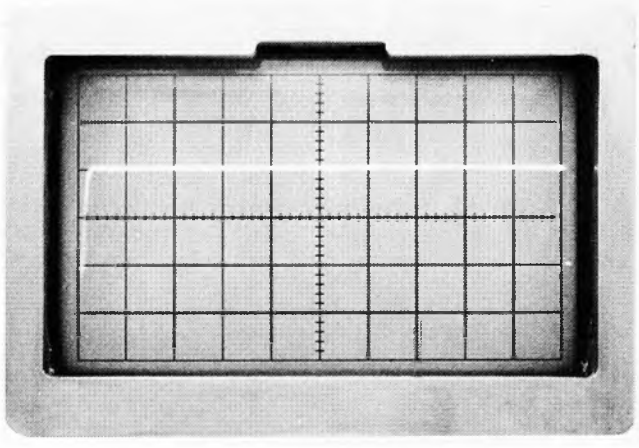


Figure 2-4. Capacitor C394 correctly adjusted.

11. Set the distance per division to 20 feet (or 5 meters) and disconnect the 75 Ω load. Set the internal 50 Ω-75 Ω slide switch to the front (50 Ω) position. Check that the step amplitude measured between the flattest portions is precisely 4 divisions or adjust R442 so that it is. R442 is located near the middle of the board that is wired to the %/DIV switch (see Figure 2-5)..

12. Connect a third 50 Ω coaxial jumper cable (012-0057-01) to the TEST LINE jack. Using the necessary adapters, connect a precision 50 Ω terminating resistor (017-0081-00) to the end of the jumper cable. Check that the amplitude reduces by 2 divisions. Change the %/DIV to 20; using the DISPLAY OFFSET control, position the step on screen and check that the displayed amplitude is 5 divisions ±2%.

13. Disconnect the 50 Ω terminator and in its place connect the 2X attenuator (017-0080-00). Then attach the terminator to the attenuator. The display should be the same as in the previous step.

14. Change the %/DIV to 10; using the DISPLAY OFFSET control, position the end of the top of the waveform 2 1/2 divisions below center screen. Disconnect the terminating resistor from the 2X attenuator and check that the top of the trace moves up 2 1/2 divisions ±3%.

15. Change the %/DIV to 5; using the DISPLAY OFFSET control, position the end of the top of the waveform 3 divisions above center screen. Reconnect the 50 Ω terminator and check that the top of the waveform moves down 5 divisions ±3%.

16. Disconnect the 2X attenuator and terminator from the jumper cable and substitute the 5X attenuator (017-0079-00). Connect the 50 Ω terminator to the 5X attenuator, and change the %/DIV to 2. Using the DISPLAY OFFSET control, position the top of the waveform 2 divisions below center screen. Disconnect the terminator and check that the waveform moves up 2 divisions ±3%.

17. Change the %/DIV to 1; using the DISPLAY OFFSET control, position the top and the end of the waveform 2 divisions above center screen. Connect the terminator and check that the waveform moves down 4 divisions ±3%.

18. Insert the 2X attenuator between the 5X attenuator and the cable. Change the %/DIV to 0.5 and position the end of the waveform precisely two divisions below center screen. Disconnect the 50 Ω terminator and check that the waveform moves up 2 divisions ±3%.

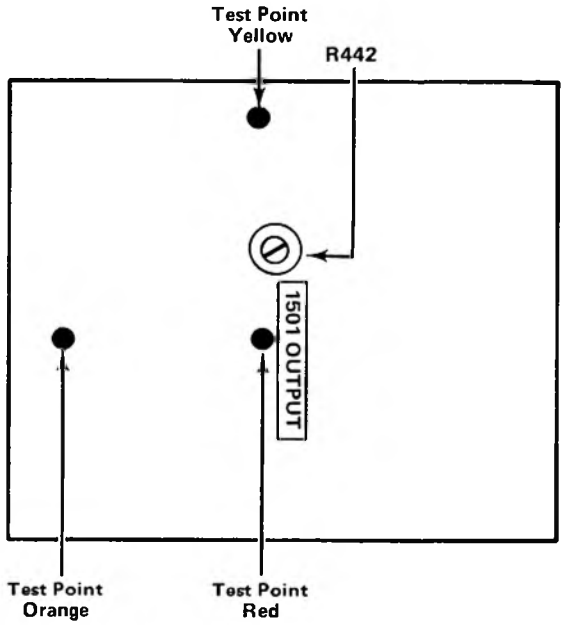


Figure 2-5. Output circuit board showing test points and gain adjustment R442. The board is mounted on a vertical plane directly behind the front panel power switch.

19. Change the %/DIV back to 20%, disconnect the jumper cable from the TEST LINE jack and connect a precision 75 Ω terminating resistor (011-0102-00) to the jack. Slide the 50 Ω-75 Ω internal switch to the rear (75 Ω) position and using the DISPLAY OFFSET control position the waveform and check that the amplitude of the step signal is 5 divisions ±2% between the flattest portions.

TEST PULSE GENERATOR CHECKS AND ADJUSTMENTS

If you have not just completed the preceding section, make the set-up described in steps 1 through 5 of that section. Connect a 75 Ω terminating resistor (011-0102-00) to the TEST LINE jack and set the internal 50 Ω-75 Ω switch to the rear (75 Ω position), then begin here.

1. Set the CABLE dielectric switch to the counterclockwise position and preset the OTHER pot fully CCW. Set the distance per division to 2 feet (or 0.5 meters) and display the step signal. If the step does not appear then preset R148, through the hole on the right side sub-panel, so it does appear.

NOTE

Use an adjustment tool with little or no metal in the tip when adjusting capacitors in the following steps.

2. See Figure 2-2. Adjust R366 and C366 for the shortest risetime, with about 6% but no more than 8% P-P ringing on the top front corner (see Figure 2-6). Check the ringing at 5% per division.

3. Return the %/DIV to 20 and release the STEP pushbutton. Adjust R347 so all evidence of "foot" on the rising edge barely disappears (see Figures 2-7, 2-8, and 2-9).

4. While pushing and releasing the STEP pushbutton, check that the beginning of the rising edge of the impulse coincides with the beginning of the rising edge of the step, or adjust R330 so that it does.

5. Change the distance per division to 5 feet (or 2 meters) and adjust R342 and C342 to minimize the baseline aberrations following the impulse (see Figure 2-10). The average baseline level following the impulse should not be above or below the level preceding the impulse.

6. Change FEET/DIV to 2 (or METERS/DIV to 0.b). Adjust C345 and C378 for 5 divisions of amplitude, with minimum aberrations and a sharp falling edge (see Figure 2-10). Peak-to-peak aberrations should be 8% or less.

7. Check that the width of the impulse at 50% amplitude is no more than 1/3 of a major division. If using a 323 or 324 monitor oscilloscope, the sweep may be expanded ten times with the side panel slide switch and the width checked more accurately at 3.3 major divisions. You may push the NOISE FILTER pushbutton for a more stable display. Position the top of the impulse 2 1/2 divisions above the center line and measure the width at the centerline.

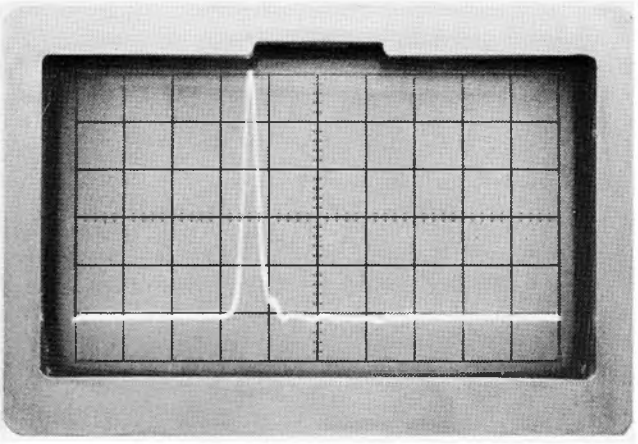


Figure 2-8. R347 adjusted clockwise until "foot" barely but completely disappears.

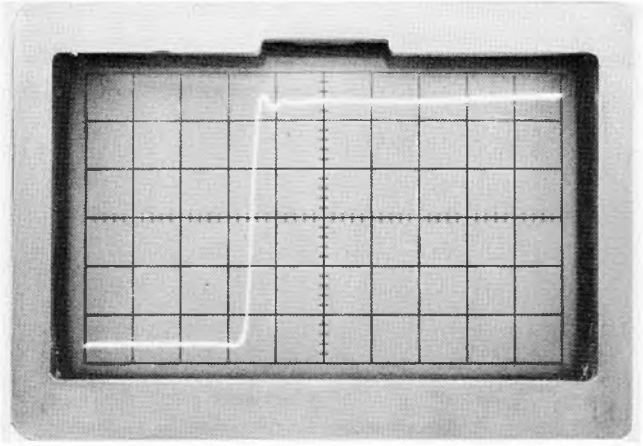


Figure 2-6. Acceptable overshoot and ringing with proper termination.

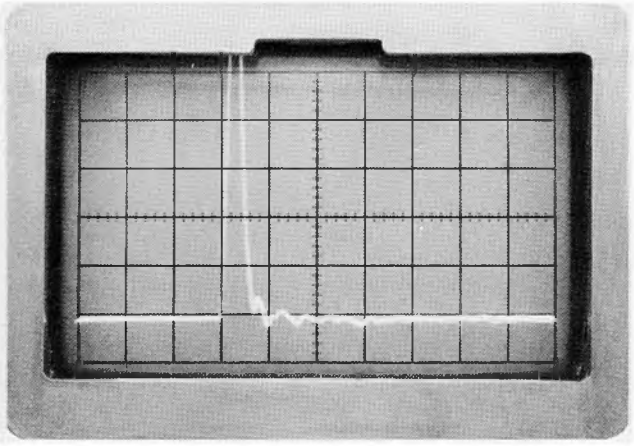


Figure 2-9. R347 adjusted too far clockwise, leading edge moves to the left past the region of the "foot".

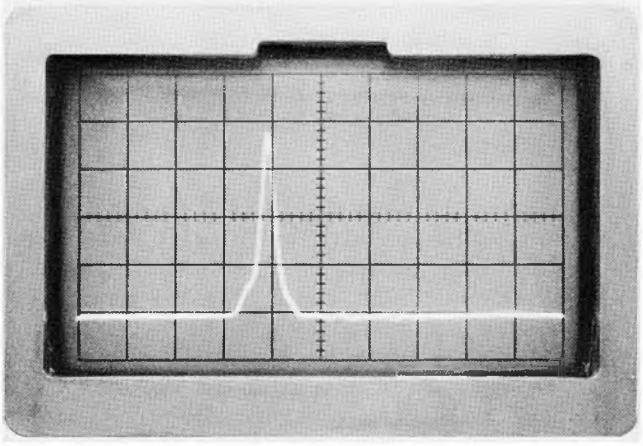


Figure 2-7. "Foot" at beginning of impulse indicating R347 set too far counterclockwise.

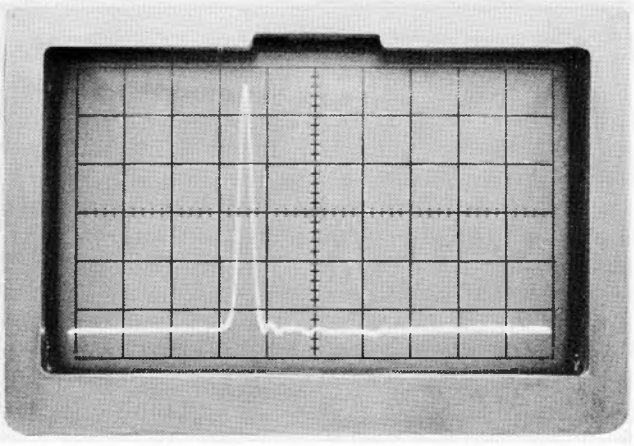


Figure 2-10. Baseline aberrations minimized and amplitude adjusted for 5 divisions.

HORIZONTAL & TIMING CHECKS AND ADJUSTMENTS

If you have not just completed the preceding section, first make the set-up described in steps 1 through 5 of the VERTICAL CHECKS AND ADJUSTMENTS section.

1. Apply power to the 2901 Time-Mark Generator. Set the distance per division to 20 feet (or 5 meters), the %/DIV to 50, and push the STEP pushbutton.

2. With the START POINT control set to 000 and CABLE set to POLY, check that the step or impulse starts between 1 and 2 divisions from the left edge of the trace. If not, adjust R148 so the step begins two divisions from the left edge. R148 is accessible through a hole in the right side panel.

3. Set the FEET/DIV to 2 (or METERS/DIV to 0.5) and check that the step begins between 1 and 4 divisions from the left edge of the trace. If not, adjust R148 as above and check again. If still not within 1 and 4 divisions adjust R151 so that the step begins 2 divisions from the left edge.

NOTE

R151 is located as shown in Figure 2-11. Temporarily turn off power on the 1501 front panel and lift the circuit board 388-2774-00 located under the START POINT control by removing three machine screws near the corners. Being careful not to allow any conductors on the board to contact ground, turn on the power and make the adjustment. Turn off the power, fasten the board in place with the machine screws and re-apply power.

4. Connect the 50 Ω 5X BNC attenuator (011-0060-01) to the MARKER OUT jack on the 2901. Connect a shielded cable (012-0057-01) between the attenuator and the TEST LINE jack on the 1501, using an F-to-BNC adapter. Push the .1 μs button of the 2901 Time Mark Generator. Connect a 10 megohm 10X passible probe to the TRIGGER OUT jack on the 2901 and apply the tip of the probe to the red test point on the Fast Ramp board (see Figure 2-11). It may be important to use a short ground lead on the probe. Turn off the MARKER AMPLIFIER on the 2901 and push the 1 μs TRIGGER SELECTOR pushbutton. Set the internal 50 Ω-75 Ω slide switch to the 50 Ω (forward) position.

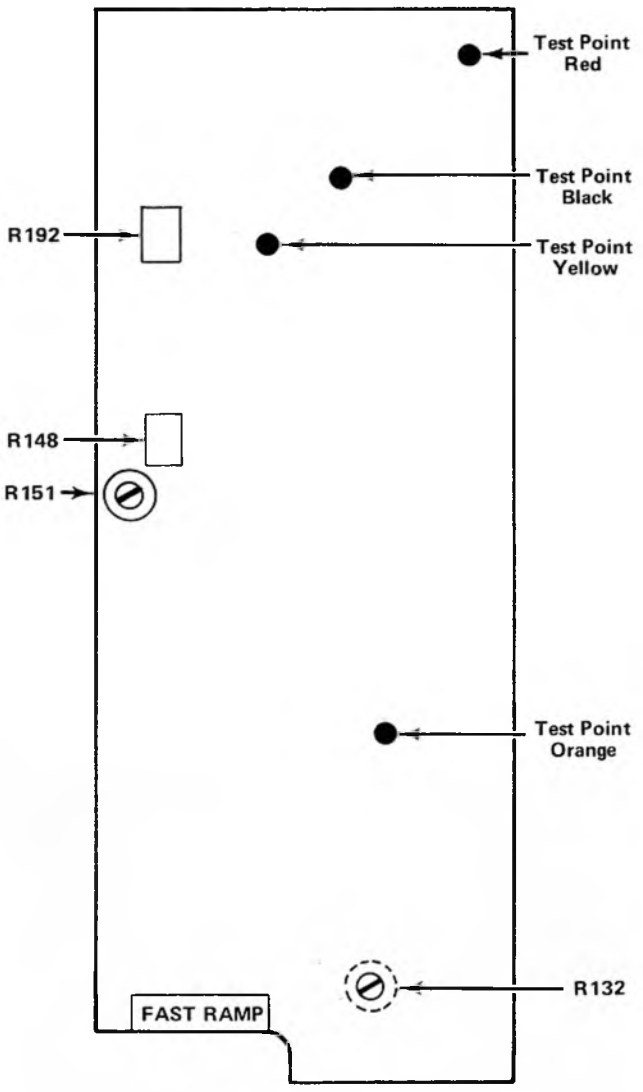


Figure 2-11. Fast Ramp circuit board. Located under and behind the START pushbutton. Mounted in a horizontal plane upside down. R132 is near the START pushbutton. R192 and R148 may be adjusted through holes in the right side panel.

NOTE

For instruments calibrated in METERS/DIV, ignore steps 5 through 15.

5. Set the 1501 FEET/DIV to 50. Set the %/DIV to 50, the START POINT to 000, and the CABLE dielectric to OTHER. Set the OTHER control fully counterclockwise. Check that the trace is still precisely 10 divisions long or adjust the monitor oscilloscope horizontal variable gain so that it is. Center the trace precisely between the left and right hand graticule edges. Move the START POINT control to position the peak of the first clear marker after the step precisely at the beginning of the trace.

NOTE

During the following steps the NOISE FILTER pushbutton may be used to reduce noise in the display. The length and position of the probe ground lead also may affect the noise. Six foot 10X probes work best. Check that there is nearly one marker per division and that the last of the 10 following markers is between about 1/2 minor divisions and 1 1/2 minor division left of the right graticule edge (see Figure 2-12). If not, proceed to the next step and check back later. Counterclockwise rotation of the OTHER control corresponds to air dielectric.

6. Change the CABLE switch to the POLY position and set the START POINT control to position the peak of the first marker following the step precisely at the left edge of the trace. Check that the 15th following marker is between 1 and 2 minor divisions to the left of the right edge of the graticule. If not, adjust R132 so that marker is precisely 1 1/2 minor divisions from the right edge of the graticule. R132 is visible from the top and located on a circuit card just below the OTHER potentiometer. When adjusting R132, the START POINT control may have to be moved to keep the first marker precisely at the beginning of the trace (see Figure 2-13).

7. Change the CABLE switch to the 0.81 FOAM position and set the START POINT control so that the peak of the first marker following the step is again precisely at the beginning of the trace. Check that the last of the twelve following markers is between 1 1/2 and 3 minor divisions left of the right edge of the graticule (see Figure 2-14).

8. Change the CABLE switch back to POLY. Change the FEET/DIV to 20 and position the peak of the first marker to the left edge of the trace with the START POINT control. Check that the peak of the 6th following marker is between 1/2 and 2 1/2 minor divisions from the right edge of the graticule.

9. Change the markers to 50 ns (20 MHz sinewave), the FEET/DIV to 5 and the %/DIV to 20. Using the DISPLAY OFFSET control, center the display and set the START POINT control to position the rising edge of the first clean cycle to intercept the centerline at the left edge of the graticule (see Figure 2-15). Check that the corresponding point on the 3rd cycle crosses the centerline somewhere between the right edge of the graticule and 3 minor divisions left of that edge as shown in Figure 2-15.

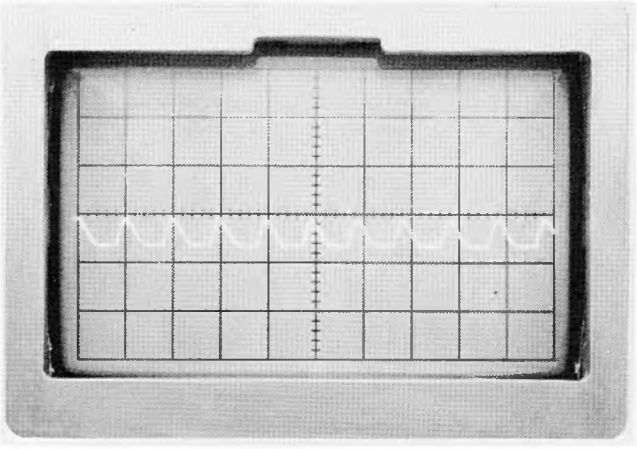


Figure 2-12. 0.1 μs markers at 50 feet/Div; AIR dielectric.

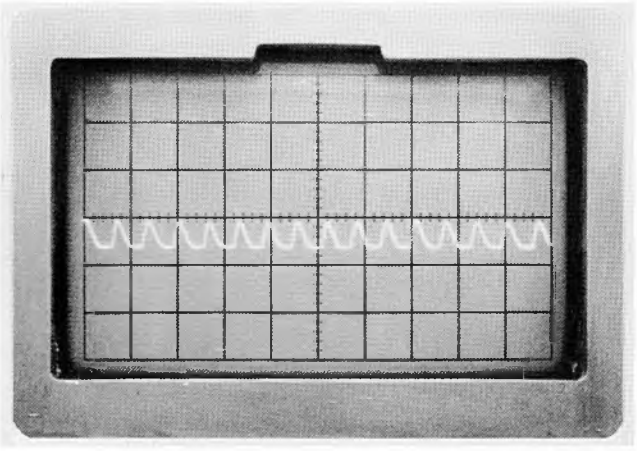


Figure 2-13. 0.1 μs markers at 50 feet/Div; POLY dielectric.

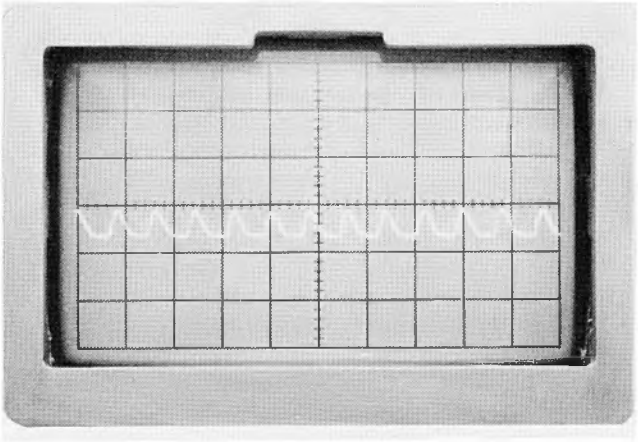


Figure 2-14. 0.1 μs markers at 50 feet/Div; 0.81 FOAM dielectric.

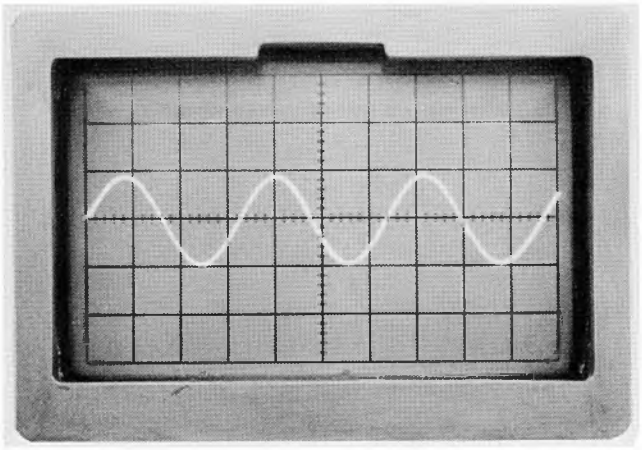


Figure 2-15. 50 ns markers at 5 feet/Div; POLY dielectric.

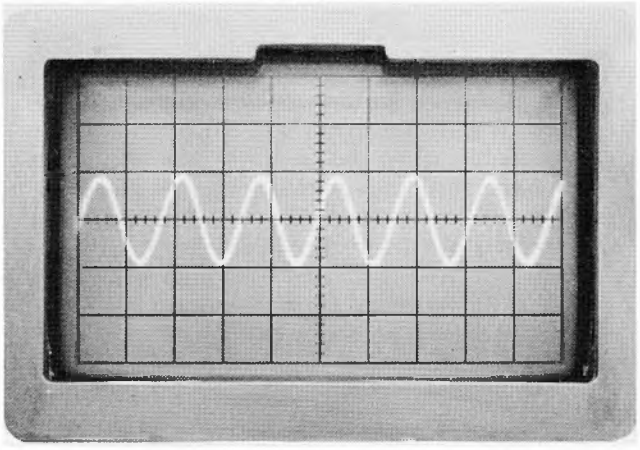


Figure 2-16. 10 ns markers at 2 feet/Div; POLY dielectric.

10. Change the markers to 10 ns and the FEET/DIV to 2. Set the START POINT control as in the previous step and check that the 6th cycle crosses the centerline within 3 minor divisions left of the right edge of the graticule (see Figure 2-16).

11. Change the FEET/DIV to 200, the markers to 1 μs and with the START POINT control, reposition the peak of the first marker to be at the beginning of the left edge of the trace. Check that the peak of the sixth following marker is within three minor divisions left of the right edge of the graticule (see Figure 2-17).

12. Change the FEET/DIV to 500, reposition the peak of the first marker to coincide with the left edge of the trace and check that the 15th following marker is within 3 minor divisions left of the right edge of the graticule (see Figure 2-18).

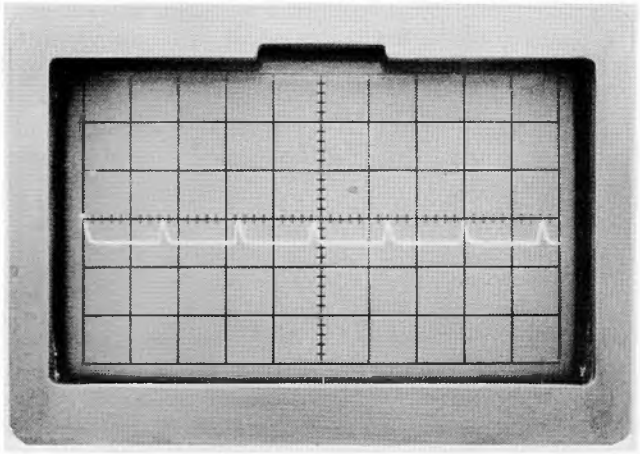


Figure 2-17. 1 μs markers at 200 feet/Div; POLY dielectric.

13. Set the FEET/DIV to 50 and the CABLE dielectric to POLY. Set the START POINT to 000 and set the marker output to 1 μs. Move the horizontal position control on the monitor oscilloscope to position the leading edge of the first marker precisely to center screen. Rotate the START POINT control clockwise and position the 10th following marker to center screen. Check that the START POINT control reads between 3176 and 3304. If not, set R192 (right side panel) so that the edge is in precise alignment when the dial is set to 3240 feet. Check that the zero marker hasn't moved more than about 1 minor division when the START POINT is turned back to 000. If it has, repeat the step.

14. Change the FEET/DIV to 5, the markers to 50 ns and the START POINT to 000. Using the oscilloscope horizontal position control, position the middle of the first

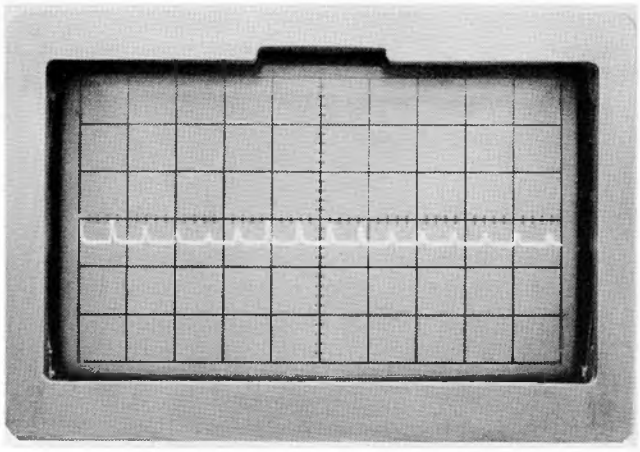


Figure 2-18. 1 μs markers at 500 feet/Div; POLY dielectric.

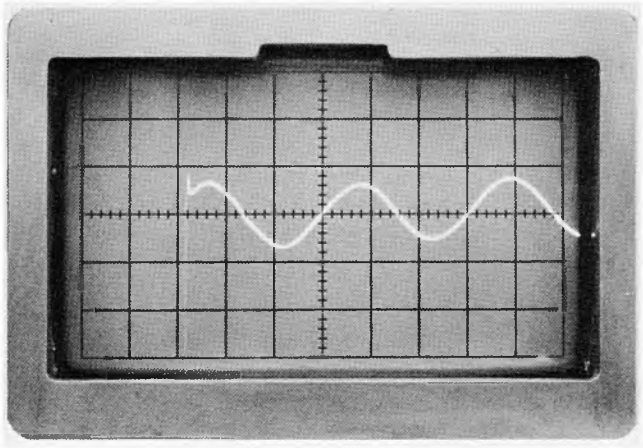


Figure 2-19. 50 ns markers at 5 feet/Div properly positioned for setting of 000 on the START POINT control.

clean rising edge of the sine-wave marker to center screen (see Figure 2-19). Turn the START POINT control and count 20 more sine-waves, finally positioning the 20th with only the START POINT control to intercept center screen as above. Check that the dial reads between 318 and 330. If not, R192 should be adjusted as in the preceding step. If it was already adjusted, it may have to be readjusted again to split the residual error equally between the 5000 and the 500 foot range.

15. Disconnect the probe and cable from the 1501 and marker generator.

The following steps pertain to 1501 instruments calibrated in METERS/DIV.

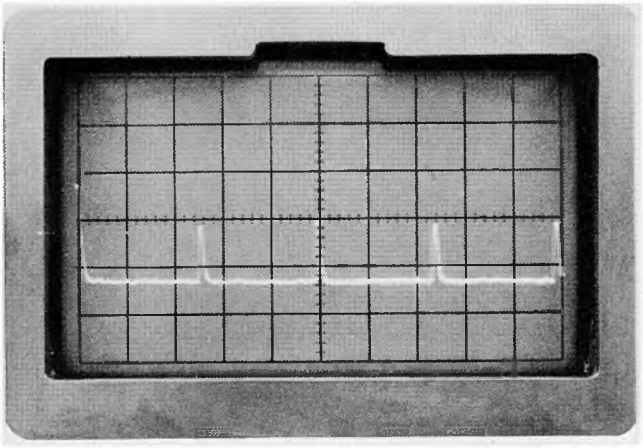


Figure 2-20. 5 μs markers at 200 meters/Div; POLY dielectric.

16. Select 5 μs markers and 10 μs triggers on the 2901. Set the 1501 METERS/DIV to 200 and the %/DIV to 10. Set the CABLE dielectric to POLY and the START POINT control to 000. Check that the trace is still precisely 10 divisions long or adjust the monitor scope horizontal variable gain so that it is. Center the trace precisely between the left and right hand graticule edges. Move the START POINT control to position the peak (of the first clear marker that follows the step) at the beginning of the trace.

NOTE

During the following steps the NOISE FILTER pushbutton may be used to reduce noise in the display. The length and position of the probe ground lead also may affect noise.

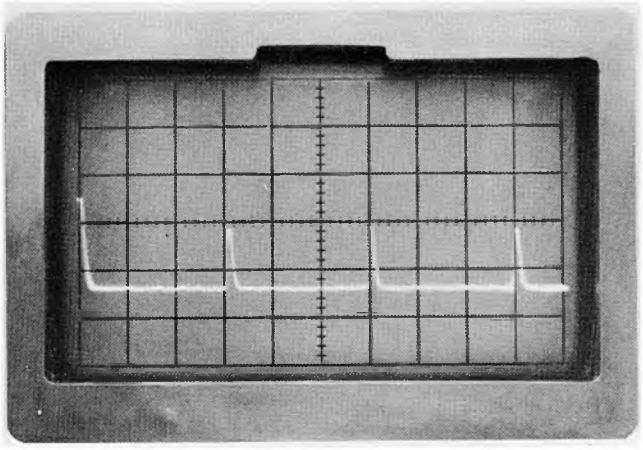


Figure 2-21. 5 μs markers at 200 meters/Div; FOAM .81 dielectric.

Check that the peak of the fourth following marker appears between the right graticule edge and one minor division left of the graticule edge (see Figure 2-20). If not, adjust R132 so that marker is precisely 1/2 minor division left of the right hand graticule edge. When adjusting R132 the START POINT control may have to be moved to keep the peak of the first marker precisely at the beginning of the trace.

17. Change the CABLE switch to the .81 FOAM position and set the START POINT control so the peak of the first marker following the step is again precisely at the beginning of the trace. Check that the third following marker is within ± 1/2 minor division of the 9th major division (see Figure 2-21). If not, adjust R132 as in the preceding step and check again.

18. Change the CABLE switch back to POLY. On the 2901 Time Mark Generator select 1 μs Markers. Change the METERS/DIV to 50 and position the peak of the first marker to the left edge of the trace with the START POINT control. Check that the peak of the 5th following marker is between 0 to 1.5 minor divisions to the left of the right edge of the graticule (see Figure 2-22).

19. Change the Markers to 0.5 μs and the METERS/DIV to 20. Position the peak of the first marker to the left edge of the trace and check that the peak of the 4th following marker is between 0 to 1.5 minor divisions to the left of the right edge of the graticule (see Figure 2-23).

20. Change the Markers to 0.1 μs and the METERS/DIV to 5. Position the peak of the first marker to the left edge of the trace and check that the peak of the 5th following marker is between 0 to 1.5 minor divisions to the left of the right edge of the graticule (see Figure 2-24).

21. Change the Markers to 50 ns and the METERS/DIV to 2. Center the display with the 1501 DISPLAY OFFSET control and position the rising edge of the first clean cycle to intercept the centerline at the left edge of the graticule (see Figure 2-25). Check that the corresponding point on the 4th following cycle crosses the centerline between 0 to 1.5 minor divisions to the left of the right edge of the graticule.

22. Change the Markers to 10 ns and the METERS/DIV to 0.5. Position the display as in the previous step and check that the rising edge of the 5th following cycle crosses the centerline between 0 to 1.5 minor divisions to the left of the right edge of the graticule (see Figure 2-26).

23. Change the Markers to 0.5 μs and the METERS/DIV to 20. Set the START POINT control to 000. Set the horizontal position control on the monitor scope to position the leading edge of the first marker precisely to center screen (see Figure 2-27). Rotate the START POINT control clockwise and position the 20th following marker to center screen. Check that the START POINT control reads between 969 and 1000 meters. If not, set R192 (right side panel) so the edge is in precise alignment when the dial is set to 989. Check that the zero marker hasn't moved more than about 1 minor division when the START POINT control is turned back to 000. If it has, repeat the step.

24. Change the Markers to 50 ns and the METERS/DIV to 2. Set the START POINT control to 000. Center the sine wave with the DISPLAY OFFSET control and, with the monitor scope horizontal position control, set the rising edge of the second or third cycle precisely to center screen (see Figure 2-28). Turn the START POINT control and

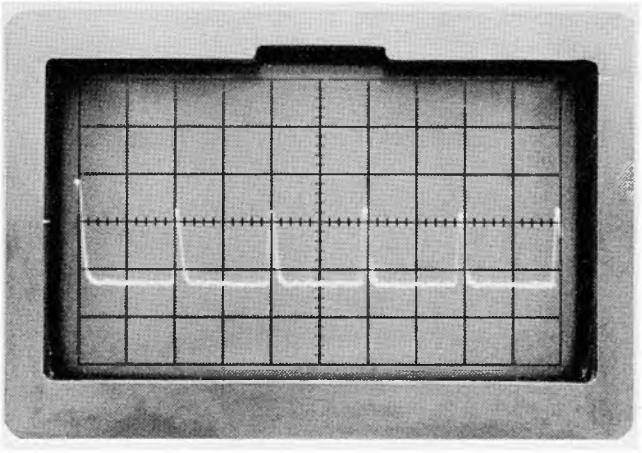


Figure 2-22. 1 μs markers at 50 meters/Div; POLY dielectric.

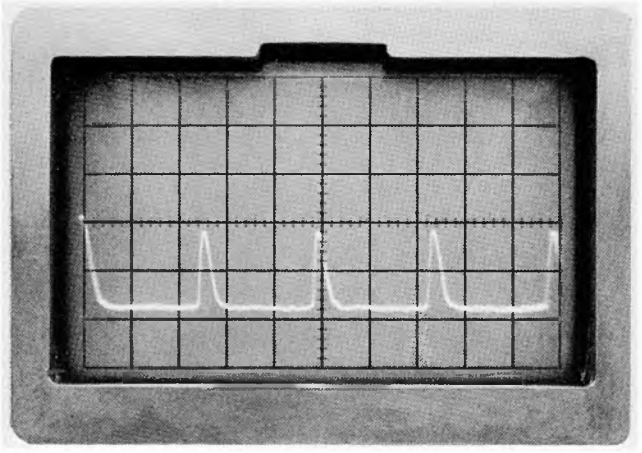


Figure 2-23. 0.5 μs markers at 20 meters/Div; POLY dielectric.

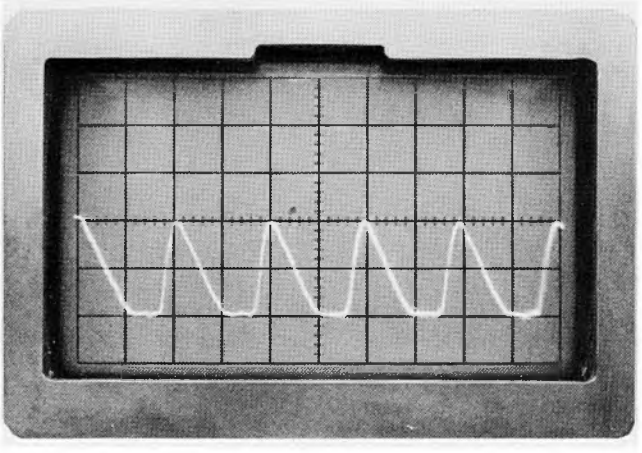


Figure 2-24. 0.1 μs markers at 5 meters/Div; POLY dielectric.

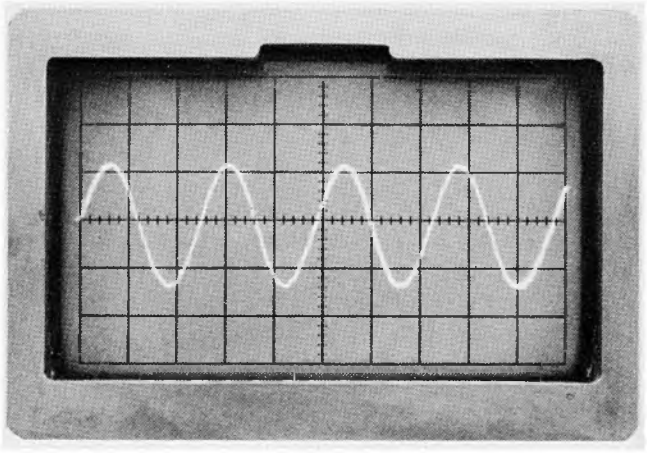


Figure 2-25. 50 ns markers at 2 meters/Div; POLY dielectric.

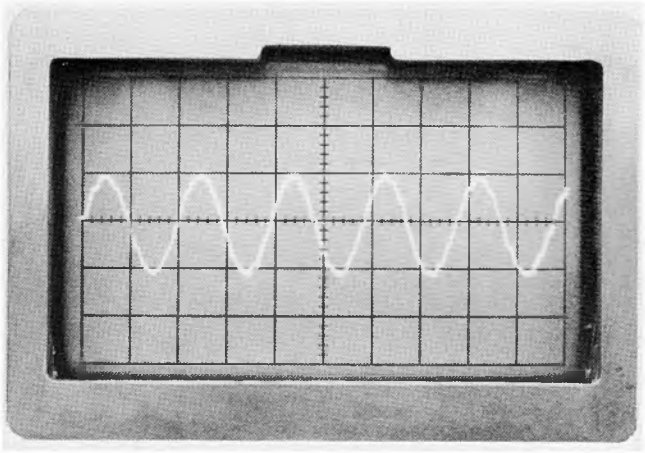


Figure 2-26. 10 ns markers at .5 meters/Div; POLY dielectric.

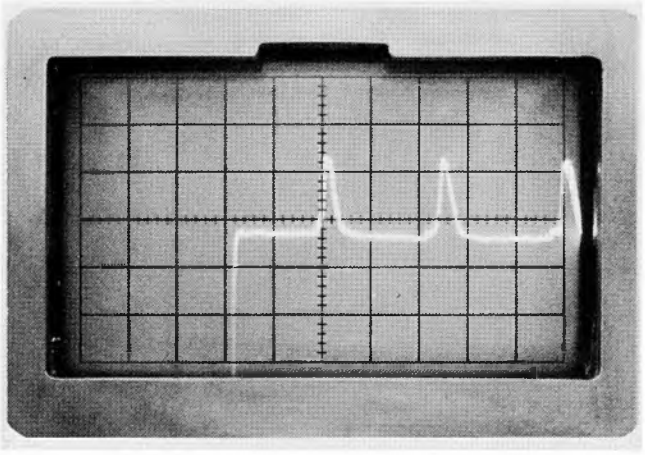


Figure 2-27. 0.5 μs markers at 20 meters/Div properly positioned for setting of 000 on the START POINT control.

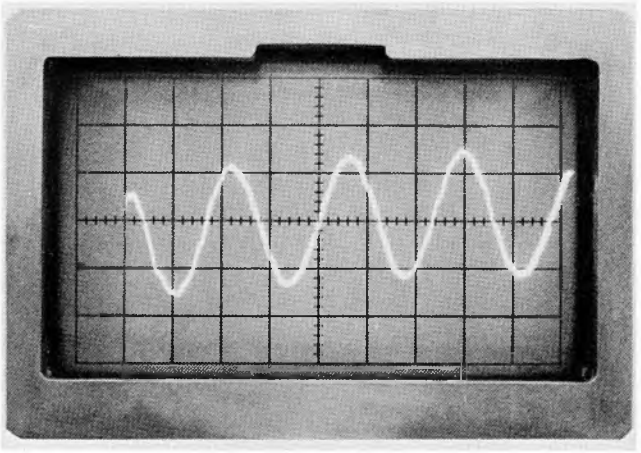


Figure 2-28. 50 ns markers at 2 meters/Div properly positioned for setting of 000 on the START POINT control.

count 20 more cycles, finally positioning the rising edge of the 20th cycle to intercept center screen as before. Check that the dial reads between 969 and 1000 (96.9 to 100 meters). If not, R192 should be adjusted as in the previous step. If it was already adjusted it may have to be readjusted to split the residual error between the 1000 and 100 meter ranges.

25. Disconnect the probe and cable from the 1501 and Marker Generator.

CHART RECORDER CHECKS AND ADJUSTMENTS

There are two internal electrical adjustments in the 016-0506-00 Chart Recorder, and one front panel (STYLUS POSITION) adjustment. The sweep duration adjustment in the 1501 (R216) is unimportant except when using the recorder. Vertical (%/DIV) and horizontal (FEET or METERS) calibration checks described earlier in this procedure should be made before relying on the chart recorder checks. Refer to the Maintenance section of this manual for detailed information on mechanical checks and adjustments of the recorder.

1. Remove the 1501 from its cabinet. With the chart recorder unplugged from the 1501 mainframe and the lid of the recorder closed, check that the writing stylus rests within about 2 millimeters of the middle of the graph paper and that it touches the paper. The stylus edge is near the top of the window and visible from a lower part of the window in front of the recorder.

2. Slide the 50 Ω-75 Ω internal slide switch, accessible through the top of the chart recorder compartment, to the

75 Ω (rear) position. Insert the recorder, properly loaded with paper, into the 1501 mainframe and turn on power. Attach a 75 Ω termination (011-0102-00) to the EXT VERT IN jack and push both the CHART POWER and EXT SIG (or EXT DRIVE) pushbuttons. Check that the stylus is within about 1 millimeter of the center of the chart paper or adjust the STYLUS POSITION screwdriver control to center the stylus.

3. Set the %/DIV to 50, the START POINT to 000 and release all the pushbuttons except CHART POWER. With the DISPLAY OFFSET control, check that the stylus may be moved over the eight vertical divisions of the graph paper. Check also that the stylus moves across the paper smoothly. Excessive pressure against the paper may be indicated by an excessively jerky movement of the stylus. Leave the stylus positioned 5 mm (one major vertical division) to the right of center.

4. Remove the 75 Ω termination from the EXT VERT IN jack and attach it to the TEST LINE jack using an F-to-BNC adapter (103-0158-00). Set the 1501 for 20 feet (or 5 meters) per division.

5. Tear off any chart paper that may be protruding by lifting the paper at a sharp angle against the upper lip of the slot, starting with most pressure against the left edge of the paper. Push the STEP pushbutton then the START pushbutton and make a recording. Tear off the paper and check that the recorder stopped when precisely 32.5 centimeters of paper (65 holes) emerged. Check also that the incident edge of the step signal was recorded and that the step was approximately two major vertical divisions (1 centimeter) in amplitude. If the step does not appear it may be that the stylus doesn't get hot quickly enough. In that case, perform the step 9, then recommence here. A major vertical division is 1/2 centimeter long and a major horizontal division is 2.5 centimeters long.

6. Set the distance per division to 500 feet (or 100 meters) and make another recording, but don't tear off the paper. Check that the baseline ahead of the step is still visible and that the step has about the same amplitude as before. Check whether the red line under the chart paper near the top of the window is visible through one of the holes in the edge of the paper that is in line with a major division. If not, gently and slowly pull the paper straight out from the recorder until the red line lies directly behind a major division.

7. Set %/DIV to 20 and make another recording. Check that the paper stops with the red line directly behind a major division. Also check whether the step is precisely 5 divisions in amplitude. If not, the chart recorder gain (R755) should be adjusted so the amplitude is precisely 5 divisions. To set R755 the chart recorder must be removed from the 1501 mainframe. If an extension cable (067-0667-00) is available, the 1501 may be operated extended from the 1501 while the proper adjustment is made at the rear of the recorder. Without the extender cable, R755 may be adjusted in a series of trials by repetitively removing, adjusting, inserting, recording, and trying again. Clockwise rotation of R755 increases the step amplitude. R755 is the potentiometer located near the rod that is part of the front panel locking screw.

8. Check the recordings to see whether a negative-going step occurs just prior to the end of each trace. If not, adjust R216 fully clockwise and try again (see Figure 2-29). Through a series of trials, adjust R216 so that the ending step occurs within one or two millimeters of the last major division on each chart. This adjustment has a major effect on distance measurement accuracy when using the charts. See Figure 2-30.

9. The only remaining adjustment is R722, stylus temperature. This adjustment must be a compromise between the ability to record very steep waveform edges

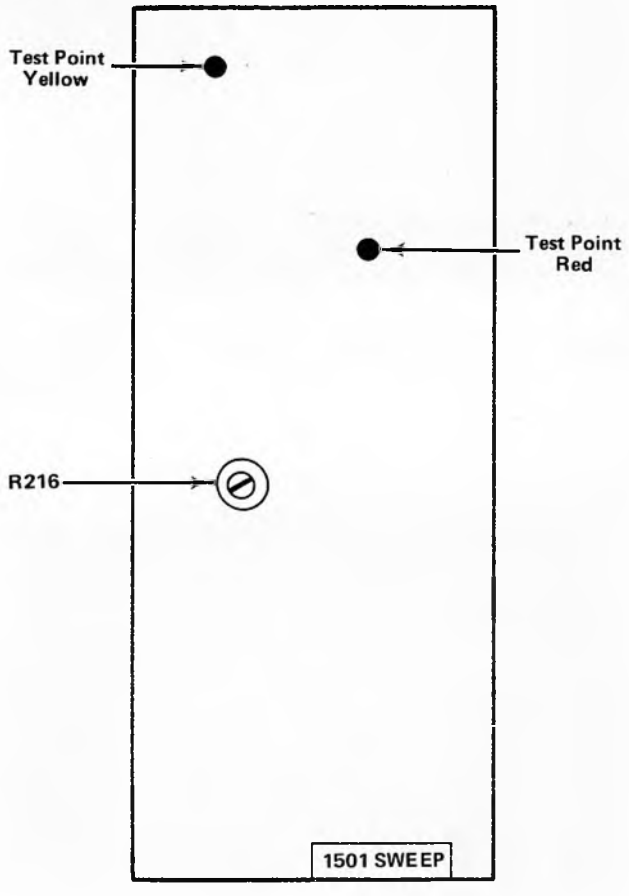


Figure 2-29. Sweep circuit board. Located behind CABLE dielectric switch.

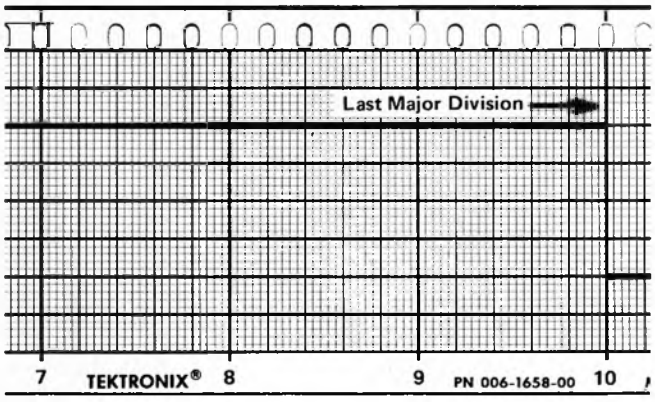


Figure 2-30. Indication of proper adjustment of R216 if paper is properly installed.

(requiring high temperature) and producing reasonably narrow lines over most of the trace. Also, because heating the stylus requires many times more power than all the other functions in the 1501 combined, battery life is shortened and the number of recordings between recharge cycles reduced when the temperature is very high. The usual recommended setting is so that the baseline barely starts to appear as the first major division (zero reference) goes under the stylus. At 500 feet (or 100 meters) per division the incident pulse is very steep and very close to the first major division, so it normally doesn't entirely record. You may conserve battery power greatly, if the points of interest don't extend back to the first major division, by adjusting stylus heat for as light a line as you prefer. R722 is located at the back of the recorder, near the side panel.

POWER PACK CHECKS and ADJUSTMENTS

Excessive charge current may shorten the life of the internal battery. Too little charge current will require excessive time to completely recharge the battery. The battery should charge with a regulated average of 180 mA when AC power is applied if the power pack slide switch is set to the FULL CHG position. The amount of current may be checked by measuring the voltage-drop across the 0.3 ohm precision resistor R615.

The resistor terminals are not accessible, however, until the power pack is removed.

To remove the power pack:

1. Remove the AC power cord.

2. Set the power pack switch to EXT DC.

3. Release the securing clamp and pull the power pack away from its mounting area.

4. Disconnect the three power leads (green, black, and white) which connect the power pack to the 1501.

Resistor R615 is located near the center of the power pack circuit board and is the largest resistor on the board. Set the slide switch to the FULL CHG position and apply AC power through the power cord. Check that the average DC voltage-drop across R615 is 54 mV ± 5 mV. If not, adjust potentiometer R644, also located on the circuit board, for 54 mV.

MAINTENANCE

GENERAL MAINTENANCE

Introduction

The following section includes, maintenance information, circuit diagrams, electrical parts lists, a mechanical parts list and mechanical parts illustrations for the 1501.

Index and Description of Maintenance Aids

Chart Recorder Maintenance. Instructions for replacing and adjusting the chart recorder stylus and for replacing the rubber rollers are given in this section. Instructions for calibrating the chart recorder are given in the Performance Check and Adjustment section of this manual.

Circuit Board Layouts (Back of Foldout Diagrams). A layout of the circuit board related to a particular circuit diagram can be found on the back of the preceding diagram. Circuit numbers are used to indicate the component locations.

Circuit Description (Section 1). A description of the circuit blocks in the 1501 is provided in Section 1, Circuit Theory, of this manual. This section is helpful for understanding the operation of the instrument and for locating malfunctions that cannot be located using the diagrams of the performance check and adjustment procedure.

Cleaning. Instructions for cleaning the interior and exterior of the 1501 are given in this section.

Component Removal and Replacement. Instructions for removing and replacing various components in the 1501 such as: fuses, cam switches, battery cells, and circuit boards are given in this section.

Diagrams (See tabbed foldout pages). A complete set of circuit diagrams is given on foldout pages at the end of this section. Each component in the instrument is shown along with its circuit number and electrical value. Waveforms that can be expected at various points in the circuitry are also included with the diagrams. A block diagram of the major circuits in the instrument can be found at the beginning of the diagram foldouts. Information on the symbols and the logic used in the diagrams is given in this section. The abbreviations and reference designators used in circuit numbers are shown at the beginning of each electrical parts list.

Electrical Parts List (See Related Circuit Diagram). An electrical parts list precedes each circuit diagram. Each parts list contains all the components found on the related diagram, in alpha-numeric order. Instructions for ordering replacement parts are provided at the beginning of each electrical parts list.

Performance Check and Adjustment (Section 2). The performance check and adjustment section of this manual provides a combined adjustment and performance check procedure. This section also includes a troubleshooting procedure.

Transistor and Integrated Circuit Lead Configuration. Fig. 3-2 in this section shows the lead configurations of the transistors and integrated circuits used in the 1501.

Troubleshooting Procedure (Section 2). A troubleshooting procedure, which is helpful for locating the source of a malfunction, is located at the beginning of Section 2.

Mechanical Parts List and Illustrations (See Foldouts Following the Circuit Diagrams.)

Cleaning

The 1501 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown.

Exterior. Loose dust accumulated on the outside of the 1501 can be removed with a soft cloth or small paint brush. The paint brush is particularly useful for dislodging dirt on and around the front-panel controls. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. Abrasive cleaners should not be used.

Interior. Dust in the interior of the instrument should be removed occasionally to prevent electrical conductivity under high-humidity conditions. The best way to clean the interior is to blow out the accumulated dust with dry, low-velocity air. Remove any dirt which remains with a soft paint brush or a cloth dampened with a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces or for cleaning circuit boards.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Avoid chemicals which contain benzene, toluene, xylene, acetone or similar solvents.

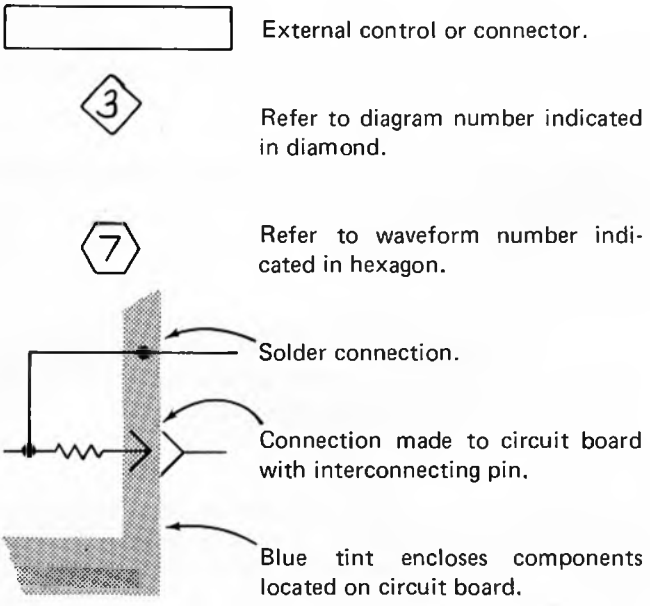
Diagram Symbols

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF). Values less than one are in microfarads (μF).
Resistors = Ohms (Ω).

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

The following special symbols are used on the diagrams.



External control or connector.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

Solder connection.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

Logic

The schematics and block diagrams in this manual which involve digital logic are drawn in terms of positive logic. In positive logic, the true state is the more positive of the two logic levels and the false state is the more negative. The small circles on some of the input or output terminals of the logic symbols indicate a logic negation. Any terminal having a logic negation symbol on it will be at a false level (or low) when the related device is in its activated state. For further information on the logic used in this manual see MIL-STD 806B.

COMPONENT REMOVAL AND REPLACEMENT

Fuses

Replacement of the AC line fuse is covered in the Power Pack section of this manual. To replace the DC fuse (F10) and the chart recorder fuse (F23), remove the instrument from its case. See Fig. 3-1 for location of fuses and spares.

Transistors and Integrated Circuits

See Fig. 3-2 for the lead configurations of the transistors and integrated circuits used in the 1501.

Power Pack

The power pack can be removed from the 1501 by disconnecting three square-pin connectors at the circuit board, and releasing the clamp at the front of the power pack. Switch the power selector switch (at the rear of the power pack) to the EXT DC position before removal. This reduces the number of exposed points to which the internal battery is connected.

WARNING

The battery used in the power pack is capable of delivering a large amount of energy. Rings, watch bands, or other metallic items, which may short-circuit the battery, can rapidly become hot enough to cause severe burns.

Circuit Boards. Components on the battery charger circuit board can be replaced without removing the board. To reach the under-side of the board, remove the three nuts which hold the board in place. Turn the power pack over to permit the washers to fall free of the board. After the nuts and washers have been removed, the outer end of the board can be lifted up, pivoting it on the wiring cable. Be careful that the screw near the transformer does not bind on the corner of the board. If the board must be completely removed, the wire color code should be recorded before any wires are unsoldered.

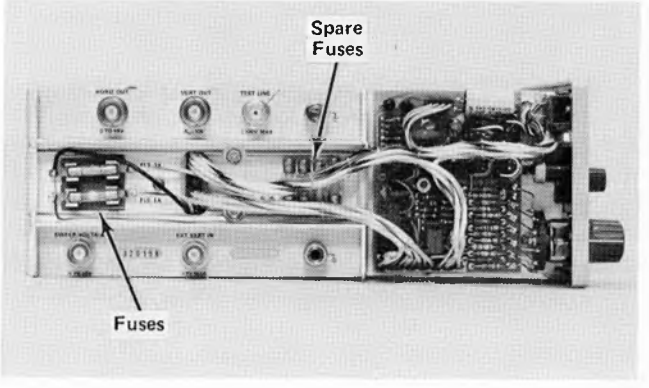


Fig. 3-1. Location of AC line fuses.

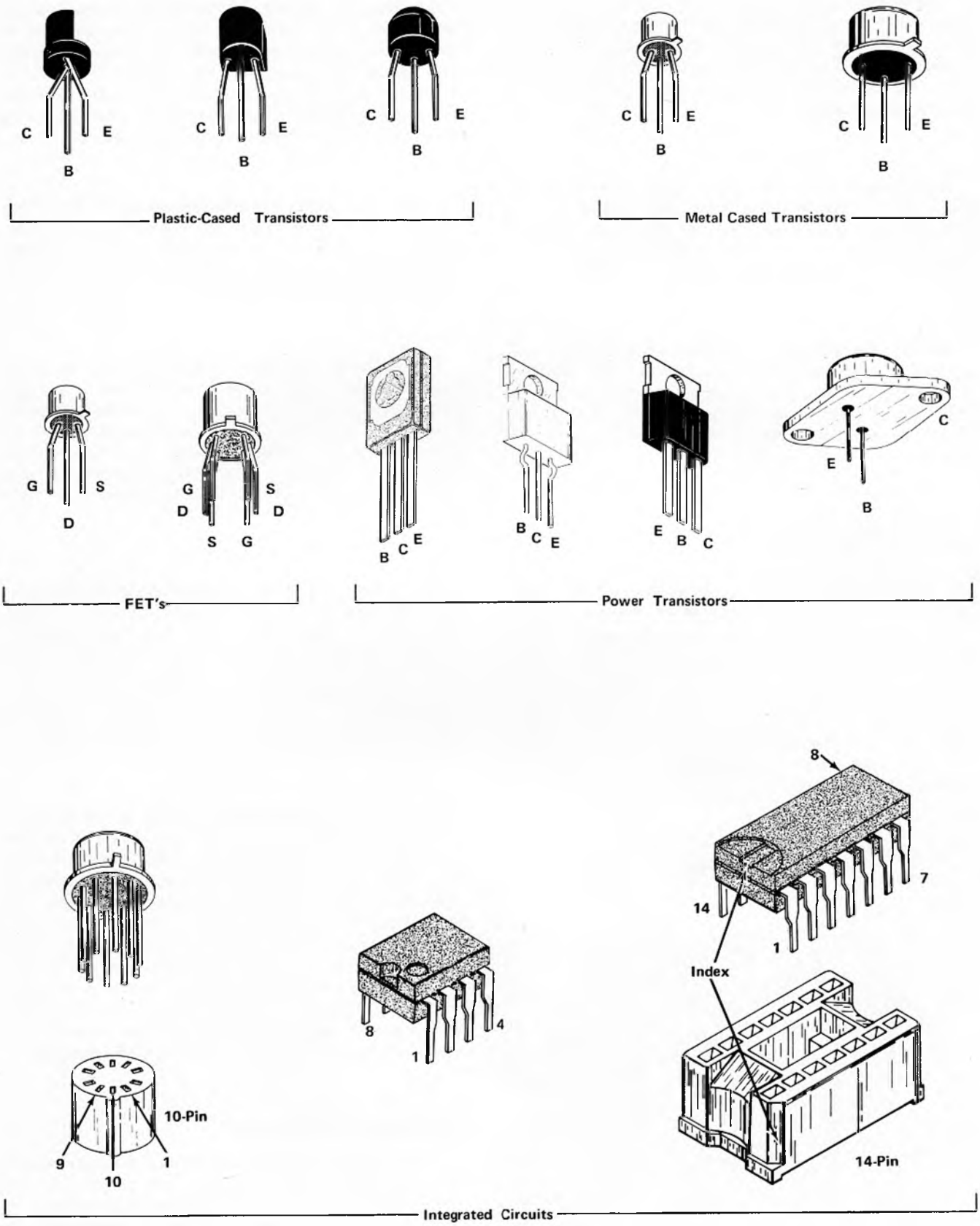


Fig. 3-2. Transistor and Integrated Circuit Lead Configuration.

Transformer. To remove the transformer, unsolder its eight leads from the circuit board. Remove the power pack cover plate, from the opposite side by removing the six screws from it. Then remove the two transformer mounting bolts. The transformer can then be lifted out through the holes in the side plate.

Fuse. Access to the fuse can be obtained by pulling the plastic cap off toward the bottom. When replacing it, be sure that the grooves in the cap align with the fuse mounting board. See Fig. 3-2 for 115-230 V fuse information.

Battery. The battery in the power pack is made up of six 1.25 V nickel-cadmium (NiCd) cells strapped together, series-aiding (see Fig. 3-3). Information regarding care of these cells is given in the Operators Manual section, and should be read before any servicing is performed on the battery.

Battery Pack Removal. Unsolder the two leads which connect the battery pack to terminals 1 and M on the circuit board. Free one lead from the cable clamp. Tape one lead end (creating minimum bulk) so that the two leads cannot come in contact with each other. Remove the nine screws and the cover plate from the power connector side of the power pack. Remove the three battery pack screws through the access holes in the circuit board, freeing the pack. Separate the pack from the rest of the unit, pulling the pack leads through the hole in the circuit board. The battery holding bracket can now be removed by removing one screw from each end. The pack can be re-installed by reversing the procedure.

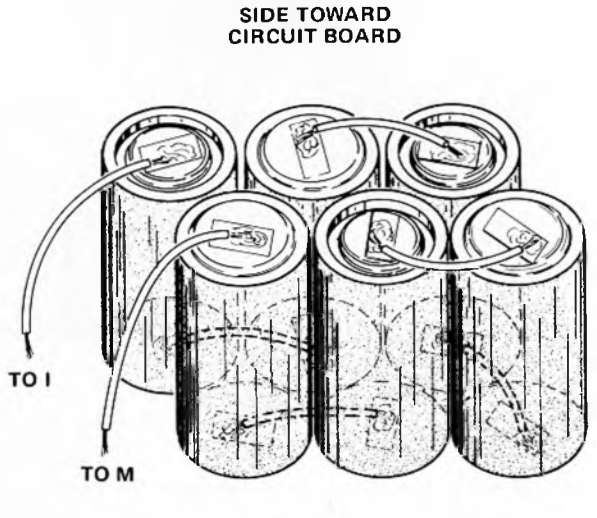


Fig. 3-3. Connection of battery cells in power pack.

Servicing the Battery. The cells which make up the battery have been selected to meet specific performance requirements, and can be expected to maintain relatively equal capabilities throughout the battery operating life. Introducing a strong cell into a weak battery or a weak cell into a strong battery may cause reverse charging of the weaker cells, as explained in the Operators Manual.

If one cell is defective and fails while the rest of the battery is still quite new, that cell may be replaced without concern. The TEKTRONIX Field Representative or Office should be consulted before individual cells are replaced, especially if the warranty is in effect.

Gas evolution and recombination takes place during battery charging. This creates a pressure within the cells which they normally withstand. If a cell becomes defective or a circuit causes the recommended charge rate to be exceeded, excessive pressure builds up. This excessive pressure may rupture a relief vent, exhausting the gas, which may shorten the life of the cell and cause corrosion in the surrounding area.

The battery should be inspected every six months or every 500 operating hours, whichever occurs first. Individual cells or the entire battery should be replaced if venting or corrosion has occurred. The cover plate, on the power connector side, must be removed to expose one side of the battery. Check between the cells for corrosion. If a more thorough check is desired, remove the battery in accordance with the Battery Pack Removal instructions.

Individual Cell Replacement. Individual cells can be removed and replaced by cutting the straps which connect the two ends of the cell to the pack and soldering a new cell in its place (see Fig. 3-3). The replacement cell must be the type specified in the parts list. Other types may not function properly, despite operating claims. Operating time and/or temperature performance may be degraded. However, if a substitution must be made, the cell must be able to withstand a 180 mA charge rate. The cells should only be used as long as it takes to obtain the prescribed replacement. To balance the cells charge the battery for 24 hours at a FULL CHG rate after a cell has been replaced.

Circuit Board Replacement

Most of the components mounted on the circuit boards can be replaced without removing the boards from the instrument. If a circuit board is damaged beyond repair, the entire assembly (including all soldered-on-components) can be replaced. The number is given in the Electrical Parts List for the completely wired board.

Use the following procedure to remove a circuit board.

1. (a) To lift the board for maintenance or access to areas beneath the board, disconnect the pin connectors which might impair lifting.

1. (b) To completely remove the board disconnect all the pin connectors.

2. Remove all screws holding the board to the chassis.

3. Lift the circuit board partially or all the way out of the instrument. Do not force or bend the board.

4. To replace the board, reverse the order of removal. The correct orientation of the "harmonica" pin connectors are printed on the circuit board and on the diagrams. Replace the pin connectors carefully so they mate correctly with the pins. If forced into place incorrectly the pin connectors may be damaged.

Cam Switch Assembly Repair

The cam switch assembly consists of a delrin cam and a set of contacts mounted on an adjacent circuit board. The lobes on the cam activate the contacts; and the cam is rotated with a front panel control labelled FEET/DIV (or METERS/DIV). A switch repair kit, which includes tools, instructions, and replacement contacts, is available from Tektronix, Inc. (TEKTRONIX Part No. 006-1416-00).

CAUTION

Repair of cam switches should be undertaken only by experienced maintenance personnel. For assistance in the repair of cam switches contact your local TEKTRONIX Field Office or representative.

Use the following procedure to disassemble and repair the cam switch assembly:

1. Remove the sweep board (top) and the logic board (bottom) to gain access to the cam switch assembly. Use the procedure as outlined in the circuit board section of this manual.

2. Remove the front panel switch lever knob.

3. Remove the two screws from the top of the metal cover and remove the cover.

4. Separate the cam from the circuit board by removing the four connecting screws from the circuit board.

5. Disconnect the cam from its support blocks by removing the retaining ring from the shaft on the front of the switch and sliding the cam out of the support block.

CAUTION

Be careful not to lose the small detent roller.

6. Replace defective switch contacts by unsoldering the damaged contacts and cleaning the solder from the holes in the circuit board. Next, position the new contacts in the holes so that they are properly aligned with respect to the other contacts and the mating area on the circuit board. (An alignment tool is provided with the cam switch repair kit.) Solder the new contacts into place. Ensure that the spring ends of the contacts have adequate clearance from the circuit board.

CAUTION

The switch alignment and spring tension of the contacts must be carefully maintained for proper operation of the cam switch.

7. Do a continuity check on the newly installed contacts.

8. Reassemble the cam switch assembly by reversing the previous process.

9. Reinstall the sweep and logic circuit boards.

Chart Recorder Repair

Except for the stylus and the rubber rollers, the chart recorder is virtually maintenance free. Instructions for replacing the stylus and the rubber rollers are given in the following procedures. If replacement of other mechanical parts should be necessary, refer to the exploded views which are located in the mechanical parts list section.

Changing the Stylus

1. Disconnect P94 from the circuit board (see Fig. 3-4A).

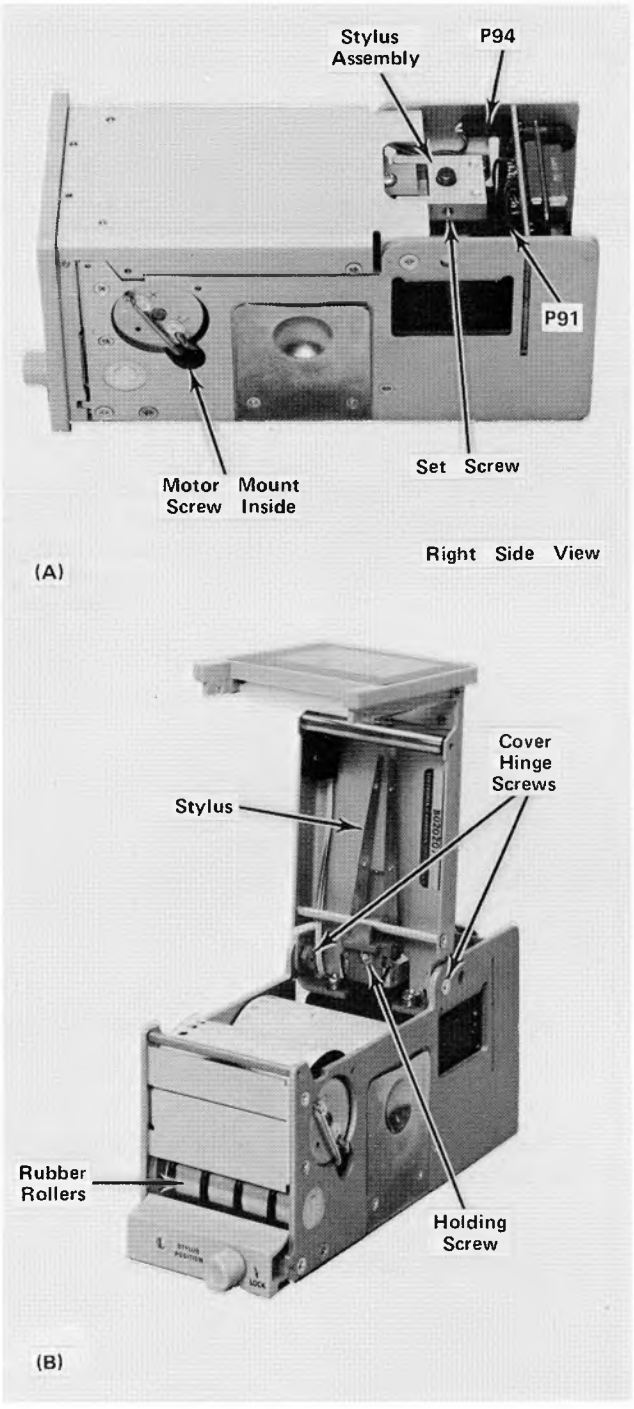


Fig. 3-4A and B. Location of chart recorder components.

2. Remove the two screws from the rear of the cover and carefully remove the cover (see Fig. 3-4B).

3. Disconnect P91 from the circuit board.

4. Using a .05 inch allen wrench, loosen the set screw and lift the assembly off the motor shaft.

5. Remove the holding screw from the stylus assembly.

6. Separate the stylus and the holder.

7. Install a new stylus (TEKTRONIX Part No. 119-0365-00).

8. Loop the stylus wires around the motor shaft as shown in Fig. 3-5. Connect P91.

CAUTION

The recorder will not operate accurately unless step 8 is performed exactly as described.

9. Reinstall the stylus assembly so that approximately 1/16 inch of the motor shaft protrudes through the assembly.

10. Center the writing element on the writing roller.

11. Tighten the set screw; the stylus should now move freely with a light pressure on the writing roller. Adjust as necessary by bending the stylus near the holder.

12. Move the stylus assembly into a vertical position. (Some RTV may be applied to wire where they come out of the stylus holder for additional strain relief.)

13. Reinstall the cover; the stylus should be located between the two metal rollers.

14. With the cover closed and the paper roll removed, check if the stylus holder clears the lift bar. Readjust the height of the stylus holder and stylus pressure as necessary.

Replacing the Rubber Rollers

1. Remove the Chart Recorder from the instrument (1501).

2. Remove the right side (see Fig. 3-4A). The cover must be removed first.)

3. Loosen the motor mount screws.

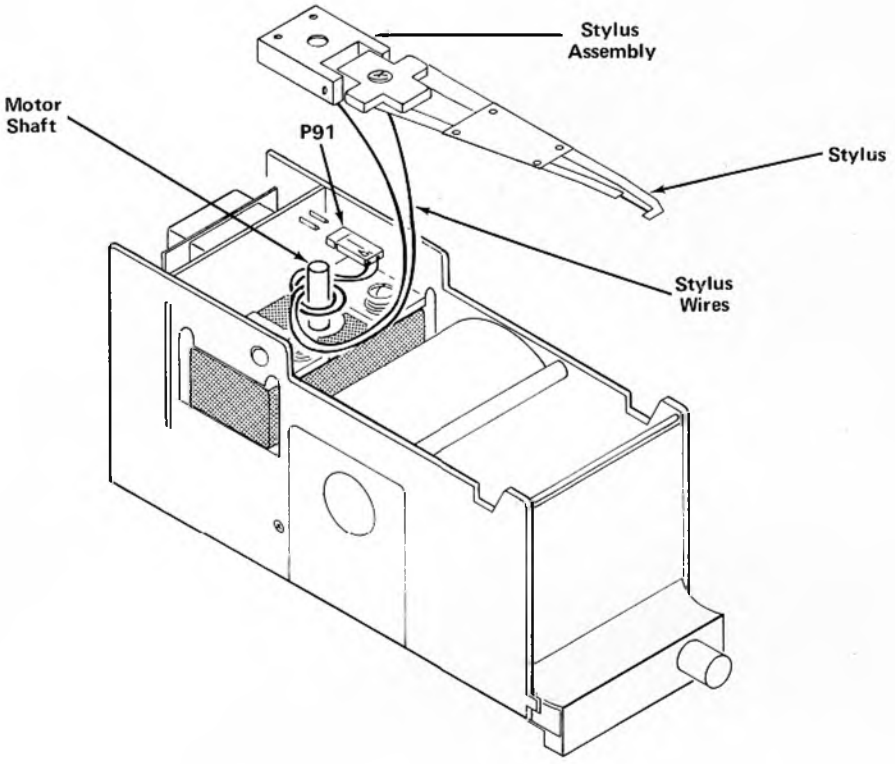


Fig. 3-5. Correct alignment of stylus assembly connecting wire.

4. Remove the metal roller.

5. Remove the old rubber rings and install four new rings.

6. Set the metal roller back into the left bearing. Be sure drive belt is positioned properly.

7. Replace the right side.

8. Move the motor slightly to take up slack in the belt and tighten the motor mount screws.

CAUTION

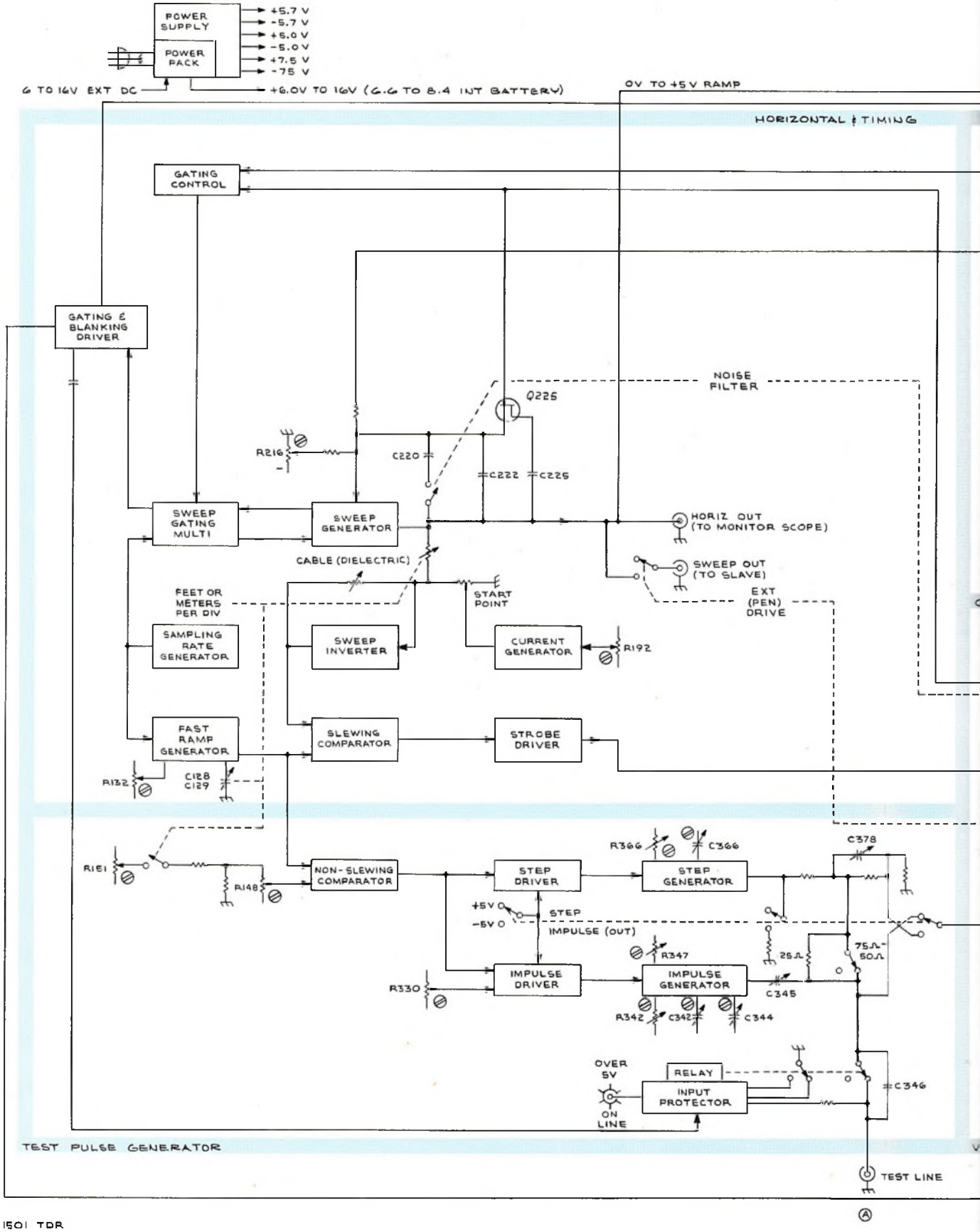
Do NOT overtighten the drive belt.

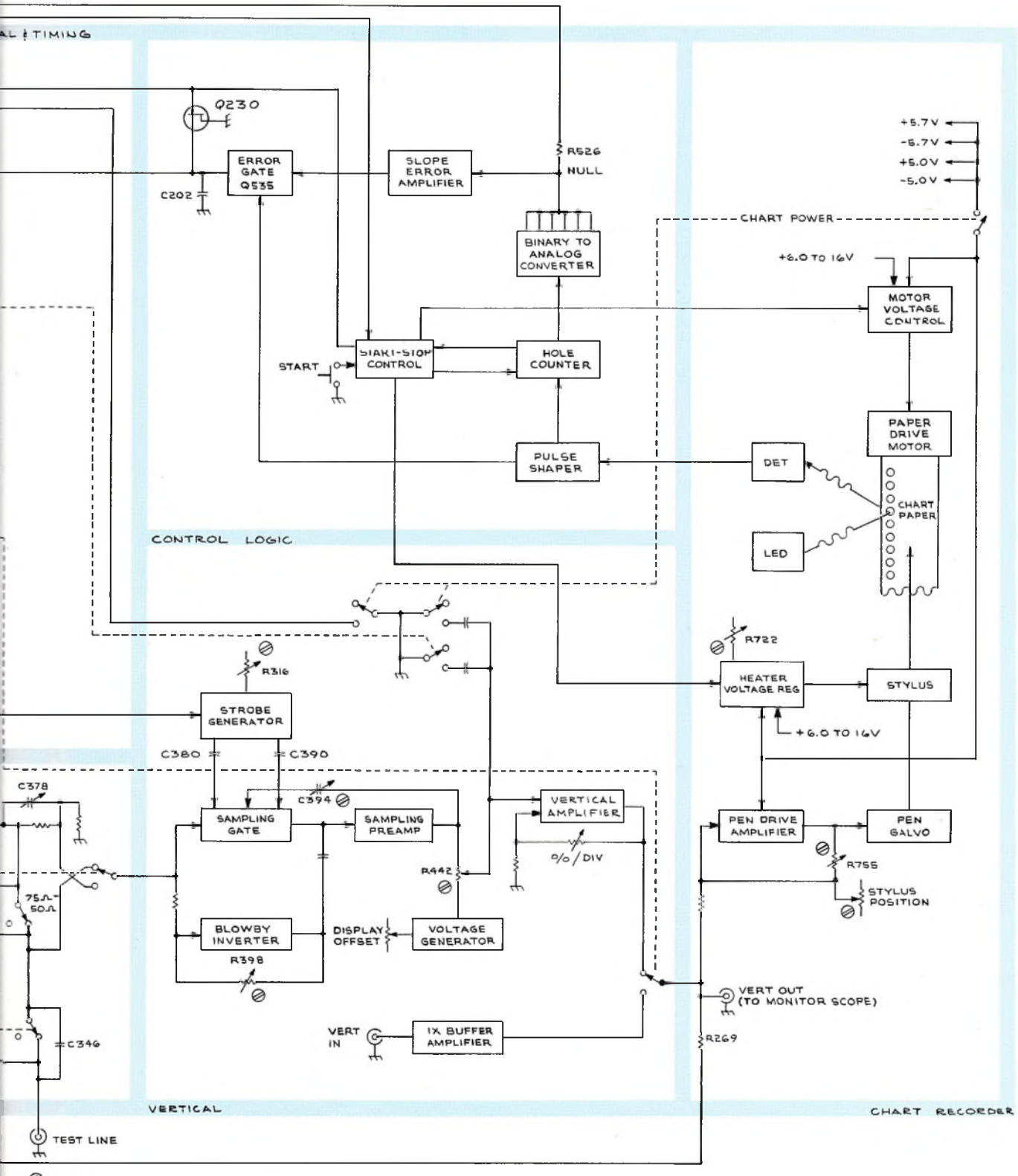
9. Position the motor L-C network to be clear of the paper roll and drive roller.

TRANSISTORS AND IC'S BY BLOCK

BLOCK	SCHEMATIC	TRANSISTORS & I.C.'s
Power Supply	8	Q810, Q812, Q815, Q820, Q825, Q826, Q834,Q835,Q855, U855, Q864, Q865
Power Pack	6	Q617, Q620, Q621, Q634, Q636
Gating Control	2	Q245, Q242
Gating & Blanking Driver	2	Q260, Q268, Q265
Sweep Gating Multi	2	Q238, Q240, Q250
Sweep Generator	2	Q205 A, B, Q206 A, B, Q208, Q222
Sampling Rate Generator	1	U100 A, B, C, D, E
Sweep Inverter	1 and 4	U175
Current Generator	1	Q190, Q188
Fast Ramp Generator	1	Q116, Q120, Q124, Q126, Q125, Q135, Q136
Slewing Comparator	1	Q158, Q160, Q162, Q165, Q166, Q168, Q170, Q172, Q195
Non Slewing Comparator	1	Q138, Q140, Q142, Q145, Q146, Q148, Q155
Strobe Driver	3	Q302, Q310
Step Driver	3	Q355, Q358, Q360
Impulse Driver	3	Q325, Q335, Q338
Step Generator	3	Q365, Q368
Impulse Generator	3	Q345
Strobe Generator	3	Q312
Sampling Gate	3	CR380, CR390
Blowby Inv	3	Q399
Sampling Pre-amp	3	Q385 A, B, U386
Input Protector	4	P410, Q412, Q413, Q420, Q425, Q423, Q421, Q424
Voltage Generator	4	U436
Vertical Amplifier	4	U446
1X Buffer Amp	4	U468
Pen Drive Amp	7	U750
Pen Galvo (motor)	7	B55
Heater Voltage Regulator	7	Q725, Q728, Q734, Q736, Q737, Q738
LED	7	CR40
DET	7	Q40
Paper Drive Motor	7	B20
Motor Voltage Regulator	7	Q705, Q706, Q710, Q715, Q720
Pulse Shaper	5	Q503, Q506, U512, B, D, Q515, Q516
Hole Counter	5	U516, U518
START-STOP Control	5	U520 A, B, U512 C, A, U570 A, B, Q565, Q570, Q566, Q575
Binary to Analog Converter	5	Q545, Q550, Q555, Q540, Q536, Q522, Q525, Q538, Q542, Q548, Q552, Q558
Slope-error Amplifier	5	U525
Error Gate	5	Q535

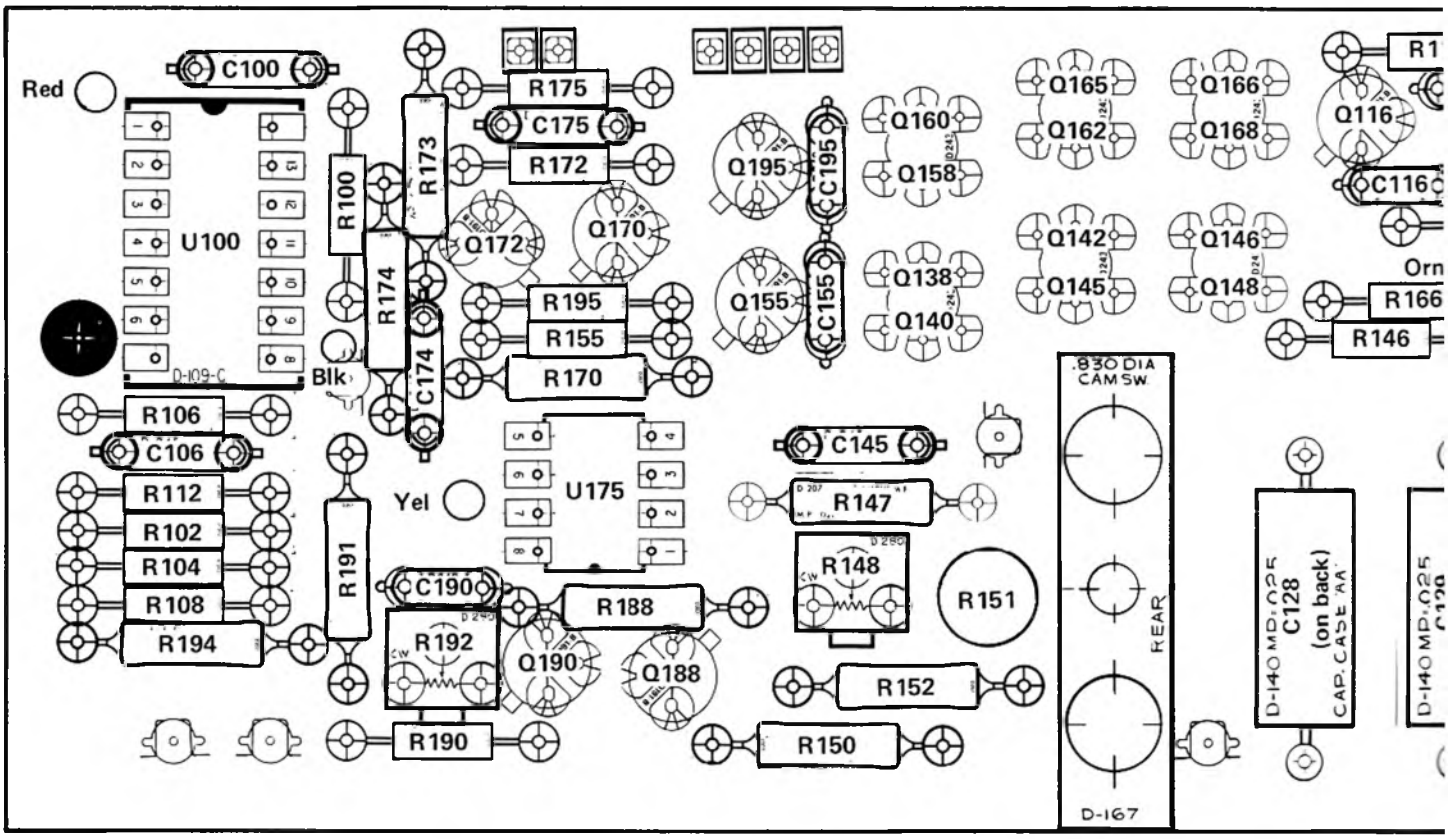
This list serves two functions: (1) It tells on which schematic each block in the block diagram can be found; (2) it identifies the transistors and integrated circuits that make up each block. This list can be used with the Preliminary Checks and Troubleshooting Guide in section 2 to help locate the source of a malfunction.


POWER SUPPLY
POWER PACK
+5.7 V
-5.7 V
+6.0 V
-5.0 V
+7.5 V
-75 V
6 TO 16V EXT DC
+6.0V TO 16V (6.6 TO 8.4 INT BATTERY)
0V TO +5V RAMP
HORIZONTAL & TIMING
GATING CONTROL
GATING & BLANKING DRIVER
NOISE FILTER
Q225
R216
C220
C222
C225
SWEEP GATING MULTI
SWEEP GENERATOR
HORIZ OUT (TO MONITOR SCOPE)
SWEEP OUT (TO SLAVE)
EXT (PEN) DRIVE
CABLE (DIELECTRIC)
START POINT
FEET OR METERS PER DIV
SAMPLING RATE GENERATOR
SWEEP INVERTER
CURRENT GENERATOR
R192
FAST RAMP GENERATOR
SLEWING COMPARATOR
STROBE DRIVER
R132
C128
C129
R161
R148
NON-SLEWING COMPARATOR
STEP DRIVER
R366
C366
STEP GENERATOR
C378
+5V
-5V
STEP
IMPULSE (OUT)
R347
25Ω
75Ω-50Ω
IMPULSE DRIVER
IMPULSE GENERATOR
R330
C345
R342
C342
C344
OVER 5V
ON LINE
RELAY
INPUT PROTECTOR
C346
TEST PULSE GENERATOR
TEST LINE

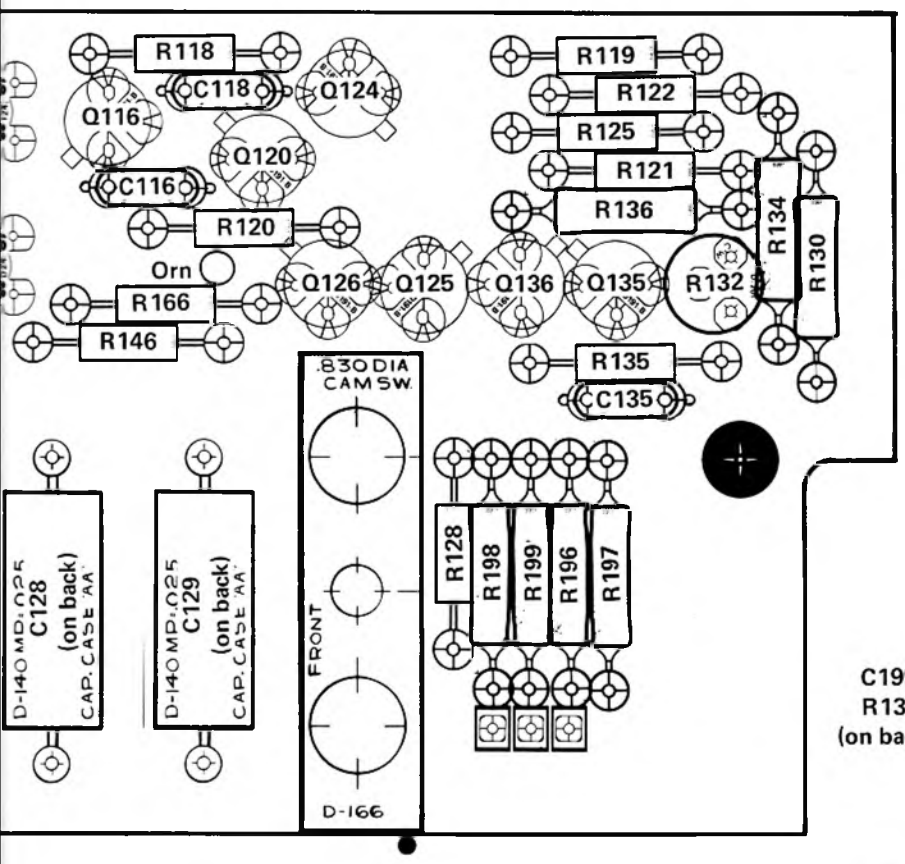


BLOCK DIAGRAM 672 EKP

1501



Fast Ramp circuit board


R118
C118
Q124
Q116
Q120
C116
R120
Orn
R166
R146
Q126
Q125
Q136
Q135
R132
R119
R122
R125
R121
R136
R134
R130
R135
C135
.830 DIA
CAM SW.
FRONT
D-166
R128
R198
R199
R196
R197
D-140 MP .025
C128
(on back)
CAP. CASE AA
D-140 MP .025
C129
(on back)
CAP. CASE AA
C199
R132
(on back)

Ⓐ

ELECTRICAL PARTS LIST

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ABBREVIATIONS AND REFERENCE DESIGNATORS

A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

FAST RAMP ◇1◇

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A1	670-1711-00			FAST RAMP Circuit Board Assembly
A1[1]	670-1711-01			FAST RAMP Circuit Board Assembly
CAPACITORS				
C100	283-0083-00			0.0047 µF, Cer, 500 V, 20%
C106	283-0000-00			0.001 µF, Cer, 500 V, +100%-0%
C116	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C118	283-0175-00			10 pF, Cer, 200 V, 5%
C128, C129 [2]	295-0154-00			0.01 µF, matched to within 1% 990 pF,
C128, C129 [2]	295-0154-00			0.01 µF, matched to within 1% 975 pF,
C135	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C145	283-0000-00			0.001 µF, Cer, 500 V, +100%-0%
C155	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C174	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C175	283-0023-00			0.1 µF, Cer, 10 V, +80%-20%
C190	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C195	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C199	283-0196-00			270 pF, Cer, 50 V, 10%
TRANSISTORS				
Q116	151-0221-00			Silicon, PNP, replaceable by 2N4258
Q120	151-0221-00			Silicon, PNP, replaceable by 2N4258
Q124	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q125	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904

[1] Metric.

[2] Individual timing capacitors in this assembly must be ordered by the 9 digit part number, letter suffix and tolerance printed on the timing capacitor to be replaced. Example:

285-XXXX-XX F-

The letter suffix and the tolerance should be the same of the timing capacitors in the assembly.

FAST RAMP ⟨1⟩ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Description
TRANSISTORS (cont)				
Q126	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q135	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q136	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q138	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q140	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q142	151-0192-00			Silicon, NPN, selected from MPS6521
Q145	151-0192-00			Silicon, NPN, selected from MPS6521
Q146	151-0192-00			Silicon, NPN, selected from MPS6521
Q148	151-0192-00			Silicon, NPN, selected from MPS6521
Q155	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q158	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q160	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q162	151-0192-00			Silicon, NPN, selected from MPS6521
Q165	151-0192-00			Silicon, NPN, selected from MPS6521
Q166	151-0192-00			Silicon, NPN, selected from MPS6521
Q168	151-0192-00			Silicon, NPN, selected from MPS6521
Q170	151-0192-00			Silicon, NPN, selected from MPS6521
Q172	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q188	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q190	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q195	151-0188-00			Silicon, PNP, replaceable by 2N3906
RESISTORS				
R1	311-1361-00			5 kΩ, Var
R1[1]	311-1461-00			5 kΩ, Var
R100	316-0222-00			2.2 kΩ, 1/4 W, 10%
R102	316-0103-00			10 kΩ, 1/4 W, 10%
R104	316-0332-00			3.3 kΩ, 1/4 W, 10%
R106	315-0562-00			5.6 kΩ, 1/4 W, 5%
R108	315-0123-00			12 kΩ, 1/4 W, 5%
R112	316-0102-00			1 kΩ, 1/4 W, 10%
R118	316-0472-00			4.7 kΩ, 1/4 W, 10%
R119	316-0103-00			10 kΩ, 1/4 W, 10%
R120	316-0563-00			56 kΩ, 1/4 W, 10%
R121	316-0392-00			3.9 kΩ, 1/4 W, 10%
R122	316-0473-00			47 kΩ, 1/4 W, 10%
R125	316-0183-00			18 kΩ, 1/4 W, 5%
R128	316-0101-00			100 Ω, 1/4 W, 10%
R130	321-0277-00			7.5 kΩ, 1/8 W, 1%
R132	311-0609-00			2 kΩ, Var
R134	321-0258-00			4.75 kΩ, 1/8 W, 1%
R135	316-0183-00			18 kΩ, 1/4 W, 10%
R136	321-0251-00			4.02 kΩ, 1/8 W, 1%
R136[1]	321-0262-00			5.23 kΩ, 1/8 W, 1%

[1]Metric.

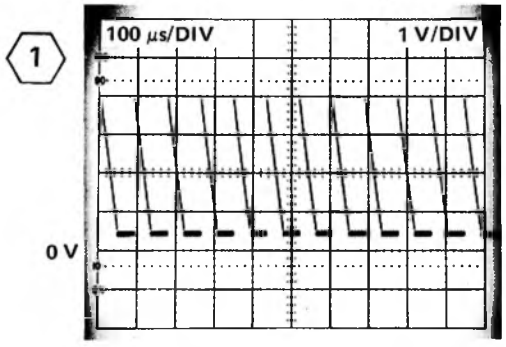
FAST RAMP ⟨1⟩ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R147	321-0289-00			10 kΩ, 1/8 W, 1%
R148	311-1278-00			250 Ω, Var
R150	321-0212-00			1.58 kΩ, 1/8 W, 1%
R151	311-0613-00	B010100	B010138	100 kΩ, Var
R151	311-1287-00	B010139	B020159	100 kΩ, Var
R151	311-0613-00	B020160		100 kΩ, Var
R152	316-0103-00	B010100	B010138	10 kΩ, 1/4 W, 10%
R152	315-0104-00	B010139	-	100 kΩ, 1/4 W, 5%
R155	316-0393-00			39 kΩ, 1/4 W, 10%
R166	315-0682-00			6.8 kΩ, 1/4 W, 5%
R170	321-0236-00			2.8 kΩ, 1/8 W, 1%
R172	316-0472-00			4.7 kΩ, 1/4 W, 10%
R173	321-0335-00			30.1 kΩ, 1/8 W, 1%
R174	321-0318-00			20 kΩ, 1/8 W, 1%
R175	316-0102-00			1 kΩ, 1/4 W, 10%
R188	321-0222-00			2 kΩ, 1/8 W, 1%
R188[1]	321-0251-00			4.02 kΩ, 1/8 W, 1%
R190	316-0682-00			6.8 kΩ, 1/4 W, 10%
R191	321-0342-00			35.7 kΩ, 1/8 W, 1%
R192	311-1283-00			10 kΩ, Var
R194	321-0361-00			56.2 kΩ, 1/8 W, 1%
R195	316-0393-00			39 kΩ, 1/4 W, 10%
R196	321-0260-00			4.99 kΩ, 1/8 W, 1%
R197	321-0298-00			12.4 kΩ, 1/8 W, 1%
R197[1]	321-0318-00			20 kΩ, 1/8 W, 1%
R198	321-0356-00			49.9 kΩ, 1/8 W, 1%
R199	321-0394-00			124 kΩ, 1/8 W, 1%
R199[1]	321-0414-00			20 kΩ, 1/8 W, 1%
SWITCH				
S5	105-0298-00			Actuator assembly, RANGE FEET/DIV
INTEGRATED CIRCUITS				
U100	156-0068-00			Five NPN transistor array, selected from CA3046
U175	156-0067-00			Operational amplifier, replaceable by UA741C

[1]Metric.

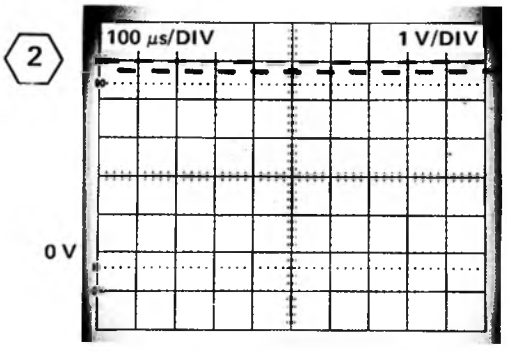
FAST RAMP ①

TEST CONDITIONS



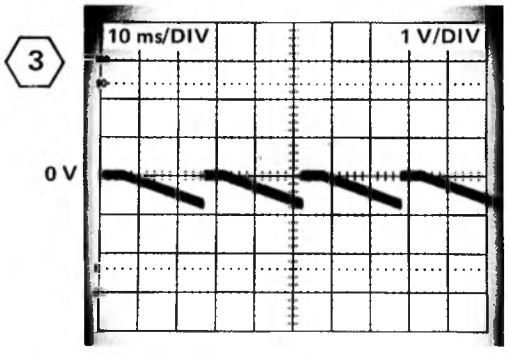
Test Point — RED

1501 — Control Settings Not Important



Test Point — BLACK

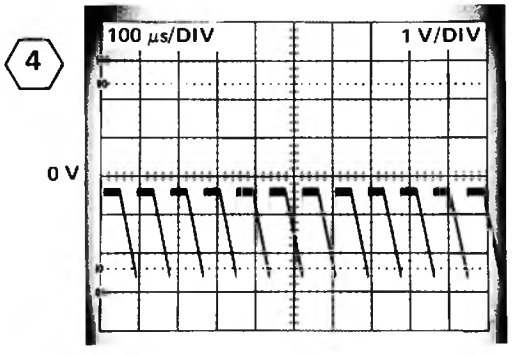
1501 — Control Settings Not Important



Test Point — YELLOW

1501

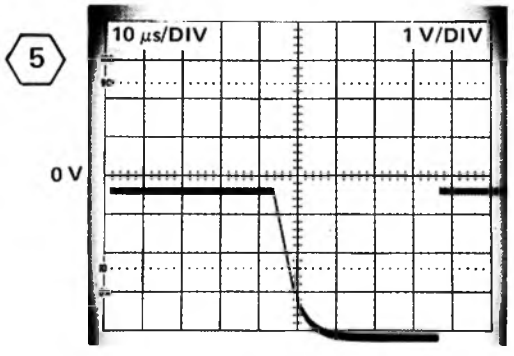
FEET/DIV	500
CABLE	SOLID POLY
NOISE FILTER	Released
Other Controls	Settings Not Important



Test Point - ORANGE

1501

FEET/DIV	500
Other Controls	Settings Not Important

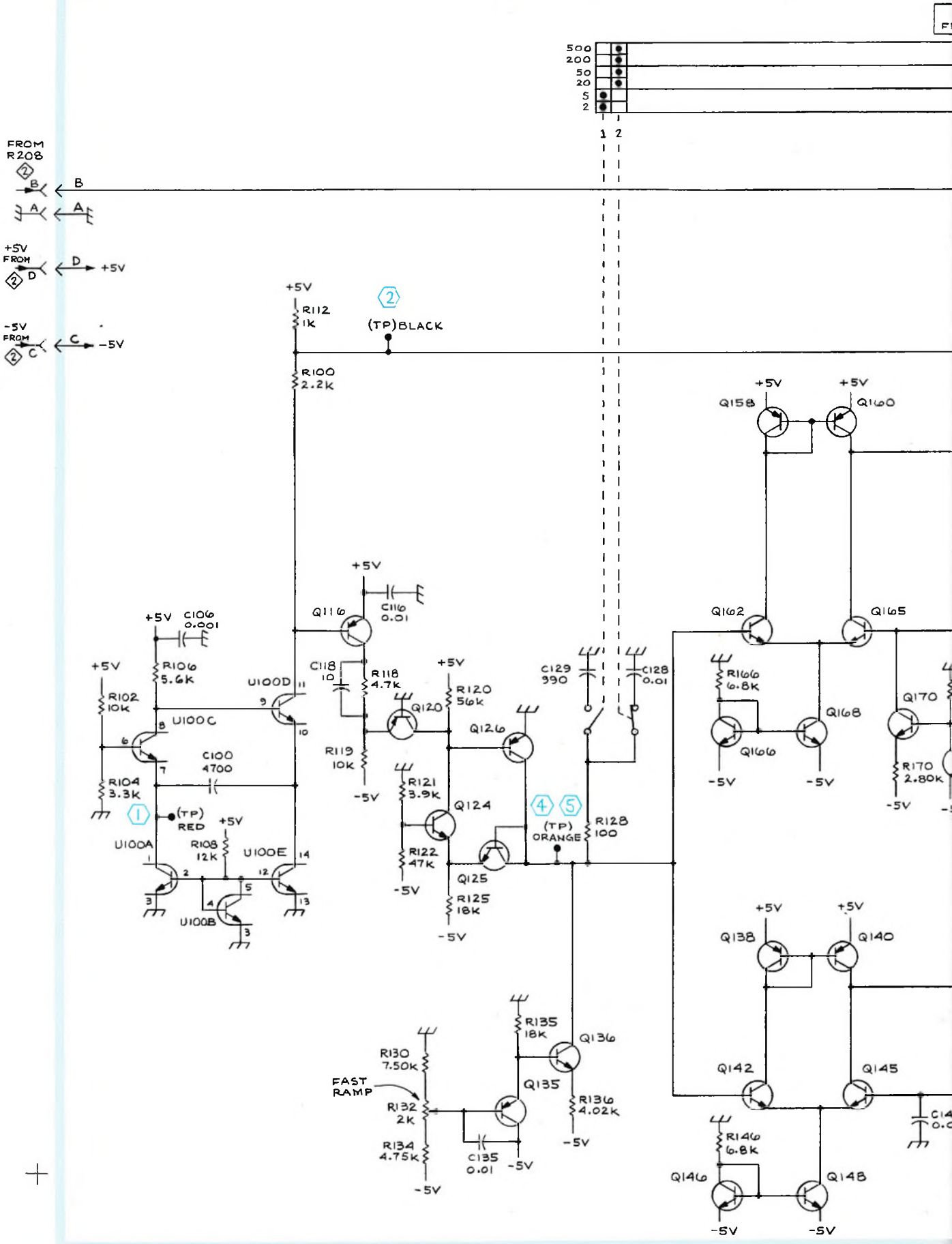


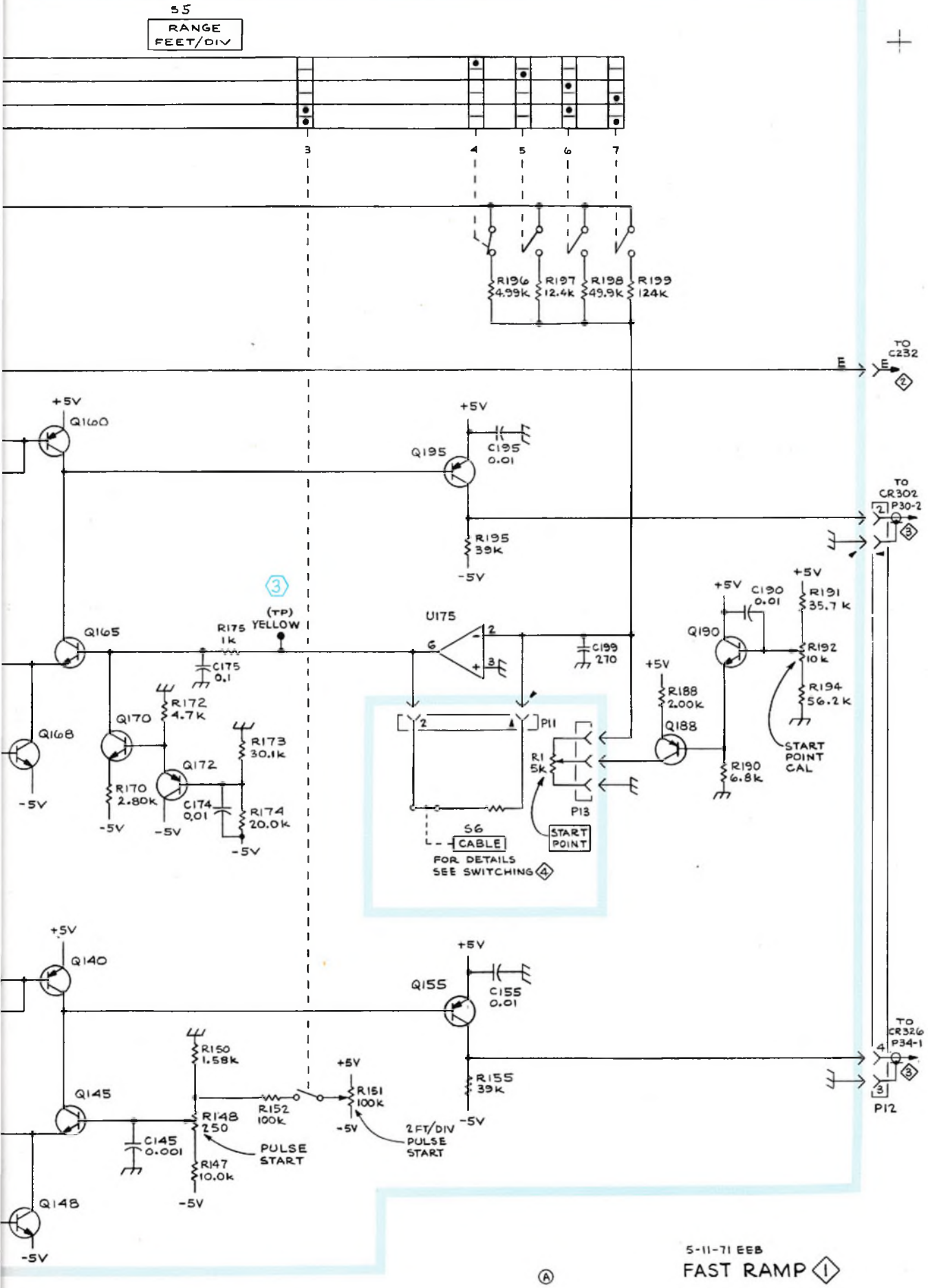
Test Point — ORANGE

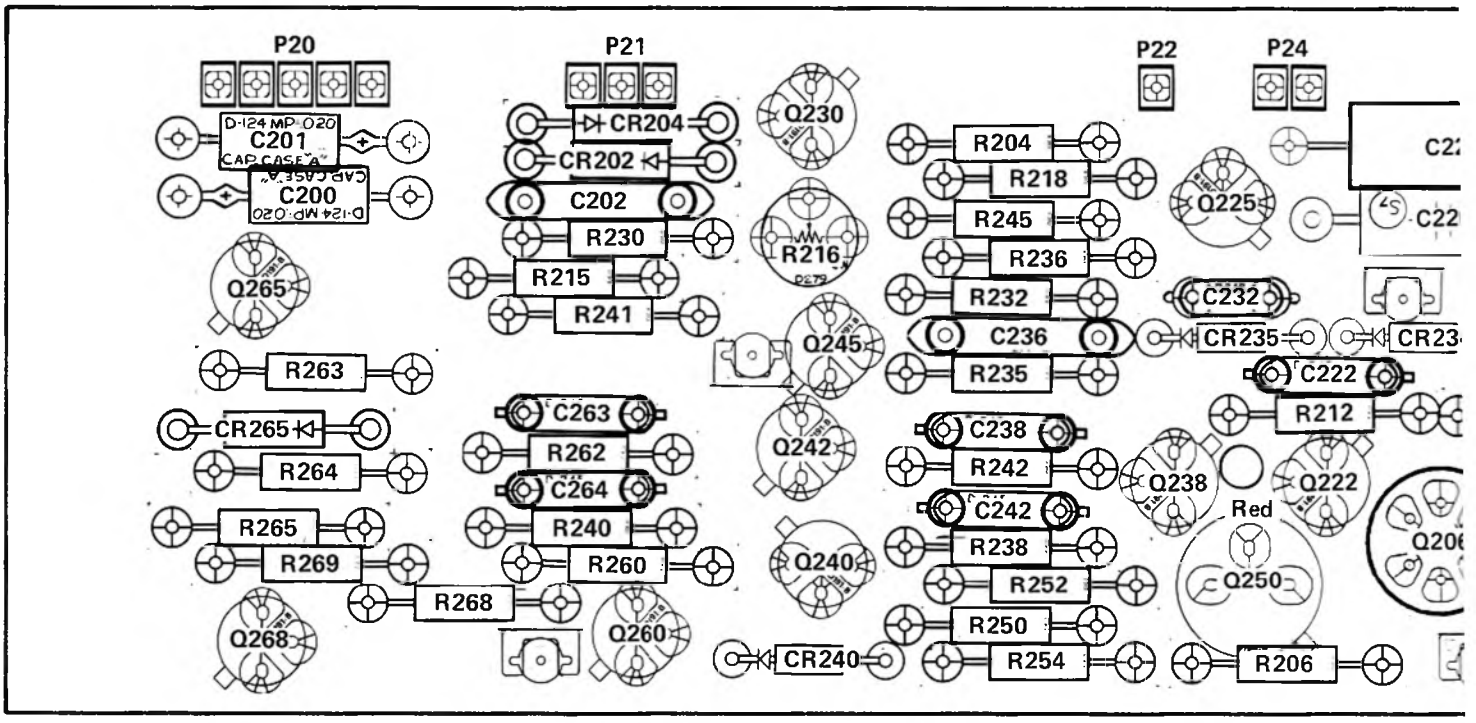
1501

FEET/DIV	5
Other Controls	Settings Not Important

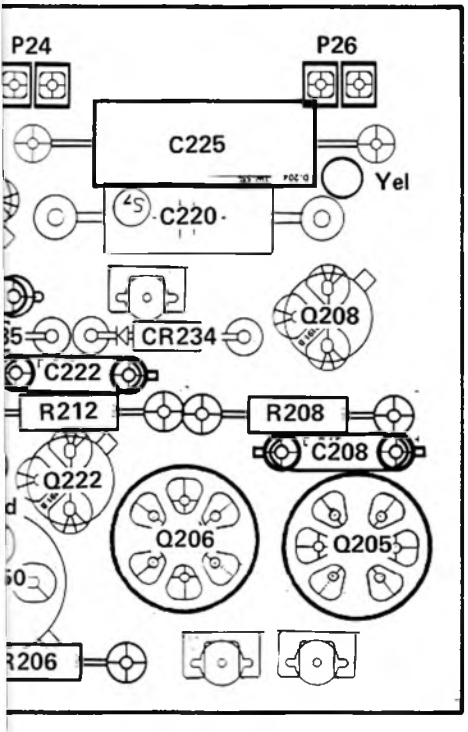
Ⓐ


500
200
50
20
5
2
1 2
FROM R208
B
A
+5V FROM
D
+5V
-5V FROM
C
-5V
+5V
R112 1K
(TP)BLACK
R100 2.2K
+5V
C106 0.001
R106 5.6K
R102 10K
U100D
U100C
C100 4700
R104 3.3K
(TP) RED
U100A
R108 12K
U100E
U100B
Q116
C116 0.01
C118 10
R118 4.7K
R119 10K
Q120
R120 56K
Q126
R121 3.9K
Q124
R122 47K
Q125
R125 18K
C129 990
C128 0.01
(TP) ORANGE
R128 100
R135 18K
Q136
R130 7.50K
FAST RAMP
R132 2K
R134 4.75K
Q135
R136 4.02K
C135 0.01
Q158
Q160
Q162
Q165
R166 6.8K
Q166
Q168
Q170
R170 2.80K
Q138
Q140
Q142
Q145
R146 6.8K
Q146
Q148


55
RANGE FEET/DIV
3
4
5
6
7
R196 4.99k
R197 12.4k
R198 49.9k
R199 124k
E
TO C232
+5V
Q160
Q195
C195 0.01
TO CR302 P30-2
R195 39k
-5V
3
(TP) YELLOW
Q165
R175 1k
C175 0.1
U175
C199 270
+5V
C190 0.01
R191 35.7 k
Q190
R192 10 k
R194 56.2 k
+5V
R188 2.00k
Q188
R190 6.8k
START POINT CAL
Q168
Q170
R172 4.7k
R173 30.1k
Q172
R170 2.80k
C174 0.01
R174 20.0k
-5V
P11
R1 5k
P13
START POINT
56 CABLE
FOR DETAILS SEE SWITCHING 4
+5V
Q140
Q155
C155 0.01
TO CR326 P34-1
P12
R150 1.58k
R151 100k
R152 100k
R155 39k
Q145
R148 250
C145 0.001
R147 10.0k
PULSE START
2 FT/DIV PULSE START
Q148
5-11-71 EEB
FAST RAMP 1
A



Sweep circuit board


P24
P26
C225
Yel
C220
CR234
Q208
C222
R212
R208
C208
Q222
Q206
Q205
R206

Ⓐ

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C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

SWEEP ◇2

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A2	670-1707-00			SWEEP Circuit Board Assembly
CAPACITORS				
C200	290-0177-00			1 µF, Elect., 50 V, 20%
C201	290-0177-00			1 µF, Elect., 50 V, 20%
C202	283-0194-00			4.7 µF, Cer, 50 V, 20%
C208	283-0060-00			100 pF, Cer, 200 V, 5%
C220	285-0569-00			0.01 µF, PTM, 200 V, 20%
C222	283-0156-00	B010100	B020159	1000 pF, Cer, 200 V, +100%-0%
C222	283-0067-00	B020160		0.001 µF, Cer, 200 V, 10%
C225	285-0809-00			1 µF, Plastic, 50 V, 10%
C232	283-0076-00			27 pF, Cer, 500 V, 10%
C236	283-0026-00			0.2 µF, Cer, 25 V, +80%-20%
C238	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C242	283-0115-00			47 pF, Cer, 200 V, 5%
C263	283-0111-00			0.1 µF, Cer, 50 V
C264	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
DIODES				
CR202	152-0246-00			Silicon, replaceable by CD12676 or FD3375
CR204	152-0246-00			Silicon, replaceable by CD12676 or FD3375
CR234	152-0141-02			Silicon, replaceable by 1N4152
CR235	152-0141-02			Silicon, replaceable by 1N4152
CR240	152-0141-02			Silicon, replaceable by 1N4152
CR265	152-0246-00			Silicon, replaceable by CD12676 or FD3375
TRANSISTORS				
Q205A,B	151-0261-00			Silicon, PNP, replaceable by NS7406, dual
Q206A,B	151-1044-00			Silicon, FET, selected from S/2N3684 or replaceable by 2N3955, dual
Q208	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q222	151-1022-00			Silicon, FET, selected from 2N4392
Q225	151-1022-00			Silicon, FET, selected from 2N4392
Q230	151-1022-00			Silicon, FET, selected from 2N4392
Q238	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904

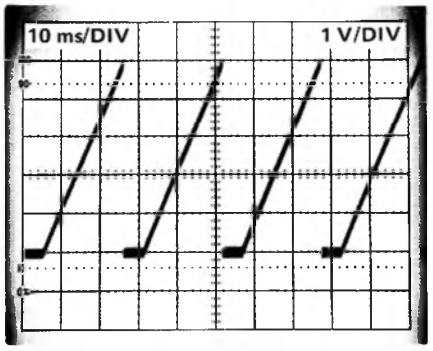
SWEEP ② (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q240	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q242	151-1022-00			Silicon, FET, selected from 2N4392
Q245	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q250	151-0041-00			Germanium, PNP, replaceable by 2N1303
Q260	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q265	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q268	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
RESISTORS				
R204	316-0106-00			10 MΩ, 1/4 W, 10%
R206	316-0123-00			12 kΩ, 1/4 W, 10%
R208	316-0471-00			470 Ω, 1/4 W, 10%
R212	316-0472-00			47 kΩ, 1/4 W, 10%
R215	316-0104-00			100 kΩ, 1/4 W, 10%
R216	311-0613-00			100 kΩ, Var
R218	316-0156-00			15 MΩ, 1/4 W, 10%
R230	316-0103-00			10 kΩ, 1/4 W, 10%
R232	316-0103-00			10 kΩ, 1/4 W, 10%
R235	316-0333-00			33 kΩ, 1/4 W, 10%
R236	316-0333-00			33 kΩ, 1/4 W, 10%
R238	316-0103-00			10 kΩ, 1/4 W, 10%
R240	316-0103-00			10 kΩ, 1/4 W, 10%
R241	316-0224-00			220 kΩ, 1/4 W, 10%
R242	316-0223-00			22 kΩ, 1/4 W, 10%
R245	316-0472-00			4.7 kΩ, 1/4 W, 10%
R250	316-0103-00			10 kΩ, 1/4 W, 5%
R252	316-0152-00			1.5 kΩ, 1/4 W, 10%
R254	316-0473-00			47 kΩ, 1/4 W, 10%
R260	316-0223-00			22 kΩ, 1/4 W, 10%
R262	316-0103-00			10 kΩ, 1/4 W, 10%
R263	316-0104-00			100 kΩ, 1/4 W, 10%
R264	316-0473-00			47 kΩ, 1/4 W, 10%
R265	316-0105-00			1 MΩ, 1/4 W, 10%
R268	316-0104-00			100 kΩ, 1/4 W, 5%
R269	316-0103-00			10 kΩ, 1/4 W, 10%

SWEEP ◇2◇

TEST CONDITIONS

1

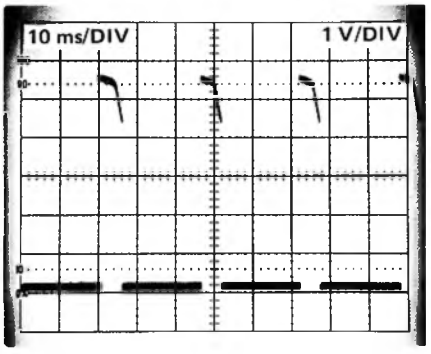


Test Point — YELLOW

1501

All Pushbuttons	Released
Other Controls	Settings Not Important

2

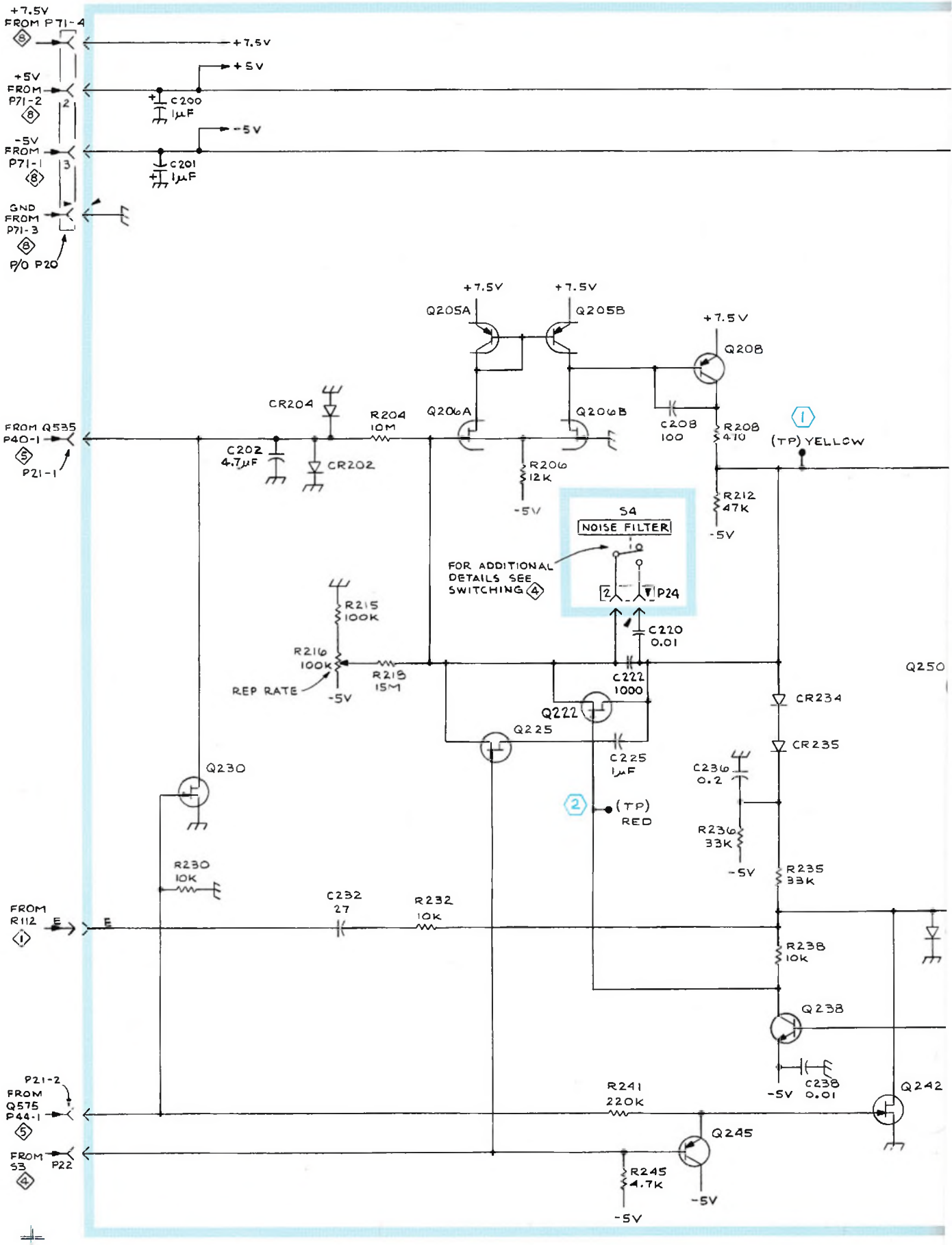


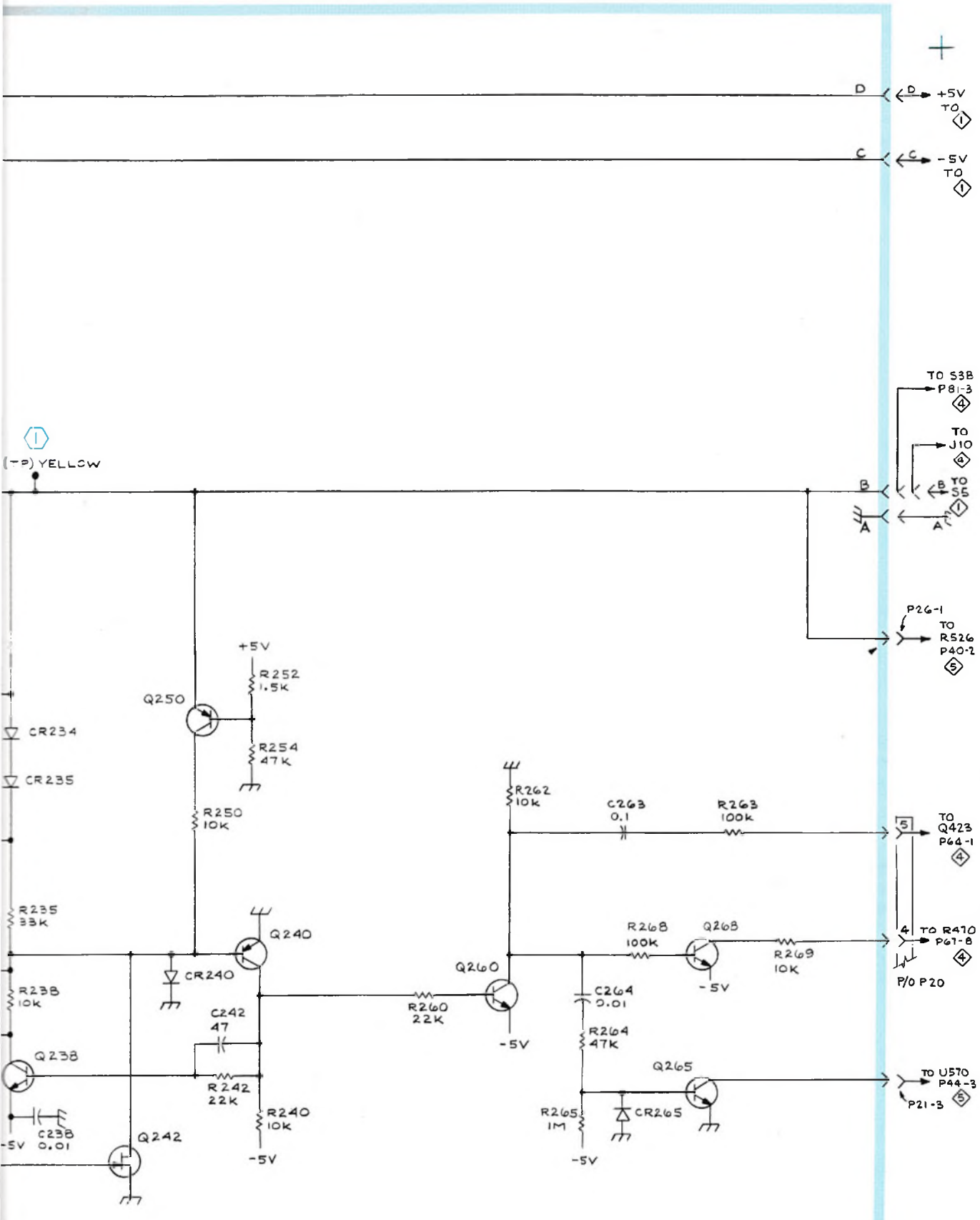
Test Point — RED

1501

All Pushbuttons	Released
Other Controls	Settings Not Important

Ⓐ

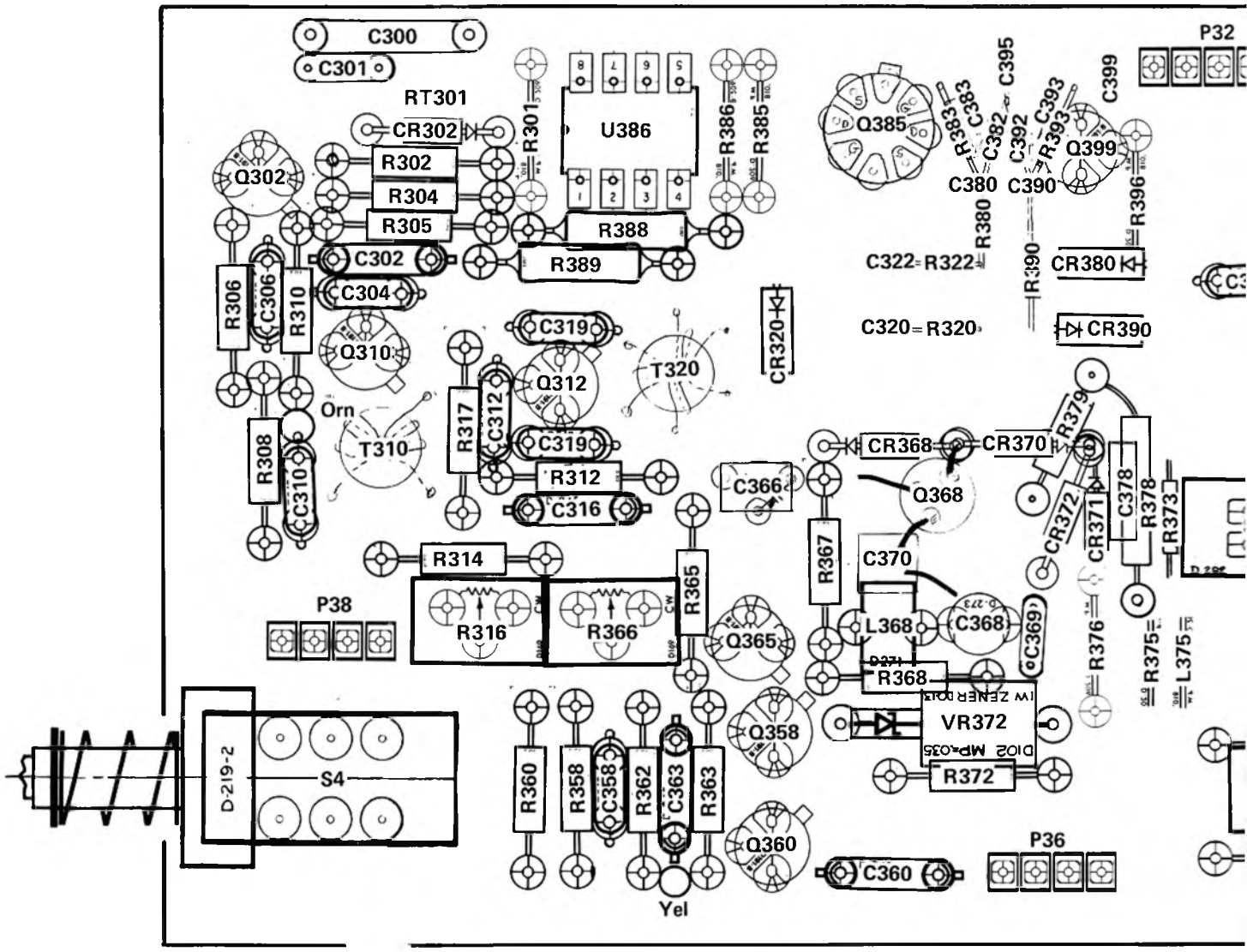

+7.5V FROM P71-4
+7.5V
+5V FROM P71-2
+5V
C200 1µF
-5V FROM P71-1
-5V
C201 1µF
GND FROM P71-3
P/O P20
+7.5V
Q205A
Q205B
+7.5V
Q208
CR204
R204 10M
Q206A
Q206B
C208 100
R208 410
(TP) YELLOW
FROM Q535 P40-1
P21-1
C202 4.7µF
CR202
R206 12K
-5V
R212 47K
-5V
S4 NOISE FILTER
FOR ADDITIONAL DETAILS SEE SWITCHING
P24
R215 100K
R216 100K
REP RATE
R218 15M
-5V
C220 0.01
C222 1000
Q250
CR234
Q222
Q225
CR235
C225 1µF
C236 0.2
(TP) RED
Q230
R236 33K
-5V
R230 10K
R235 33K
FROM R112
C232 27
R232 10K
R238 10K
Q238
P21-2
FROM Q575 P44-1
FROM S3 P22
R241 220K
C238 0.01
-5V
Q242
Q245
R245 4.7K
-5V
-5V
1501



A1

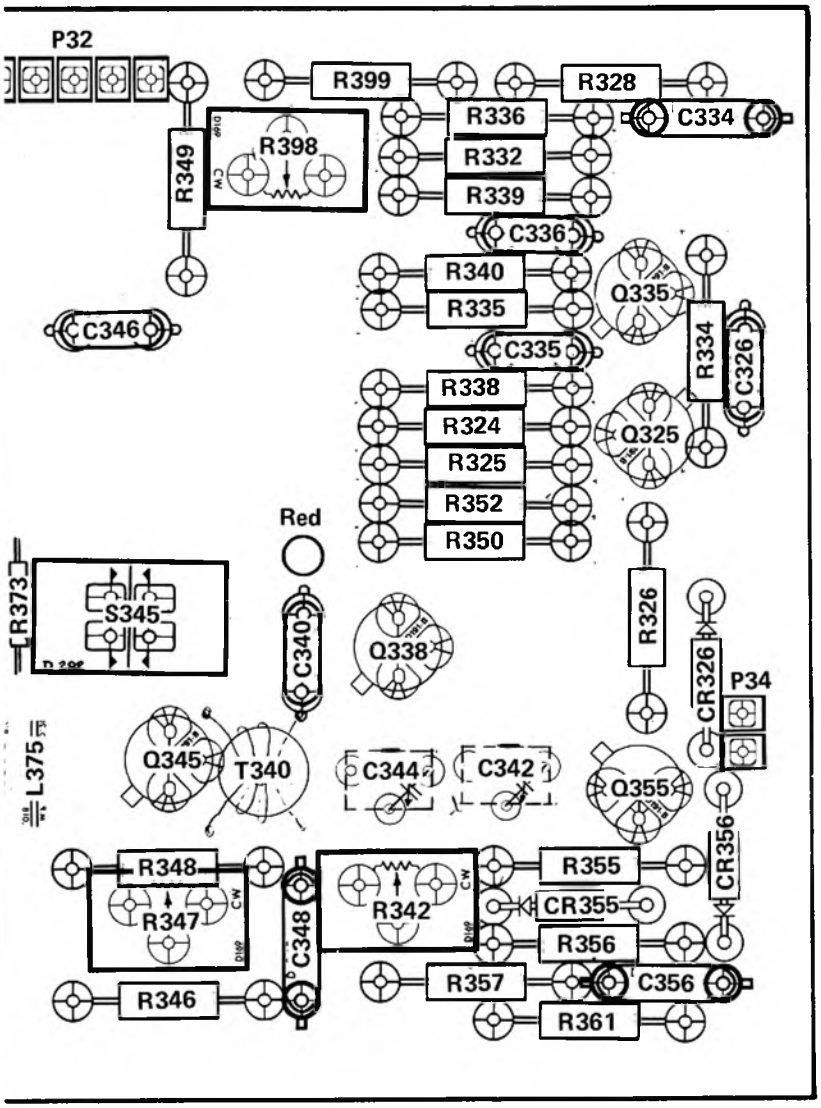
5-14-71 EGB

SWEEP 2



Vertical circuit board

R330, R345, R374, R377
C345, C394, CR345, J346
K345, S1 (on back of board)


P32
R399
R328
R336
C334
R398
R349
R332
R339
C336
R340
R335
Q335
C346
C335
R334
C326
R338
R324
Q325
R325
R352
R350
Red
R373
S345
C340
Q338
R326
CR326
P34
L375
Q345
T340
C344
C342
Q355
CR356
R348
R347
R342
R355
CR355
C348
R356
R357
C356
R346
R361

ELECTRICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS AND REFERENCE DESIGNATORS

A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

VERTICAL ③

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A3	670-1710-00	B010100	B020159	VERTICAL Circuit Board Assembly
A3	670-1710-01	B020160	B029999	VERTICAL Circuit Board Assembly
A3	670-1710-02	B030000		VERTICAL Circuit Board Assembly
CAPACITORS				
C300	283-0010-00			0.05 µF, Cer, 50 V
C301	283-0010-00			0.05 µF, Cer, 50 V
C302	283-0060-00			100 pF, Cer, 200 V, 5%
C304	283-0196-00			270 pF, Cer, 50 V, 10%
C306	283-0201-00			27 pF, Cer, 200 V, 10%
C310	283-0196-00			270 pF, Cer, 50 V, 10%
C312	283-0140-00			4.7 pF, Cer, 50 V, 5%
C316	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C318	283-0140-00			4.7 pF, Cer, 50 V, 5%
C319	283-0140-00			4.7 pF, Cer, 50 V, 5%
C320	283-0069-00			15 pF, Cer, 50 V, 20%
C322	283-0069-00			15 pF, Cer, 50 V, 20%
C326	283-0108-00			220 pF, Cer, 200 V, 10%
C334	283-0060-00			100 pF, Cer, 200 V, 5%
C335	283-0196-00			270 pF, Cer, 50 V, 10%
C336	283-0201-00			27 pF, Cer, 200 V, 10%
C340	283-0196-00			270 pF, Cer, 50 V, 10%
C342	281-0158-00			7-45 pF, Var, Cer, 50 V
C344	281-0151-00			1-3 pF, Var, Cer, 100 V
C345	281-0140-00			5-25 pF, Var, Cer, 100 V
C346	283-0156-00	B010100	B029999	1000 pF, Cer, 200 V, +100%-0%
C346	283-0079-00	B030000		0.01 µF, Cer, 250 V, 20%
C347	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C356	283-0060-00			100 pF, Cer, 200 V, 5%
C358	283-0201-00			27 pF, Cer, 200 V, 10%
C360	283-0000-00			0.001 µF, Cer, 500 V, +100%-0%
C363	283-0060-00			100 pF, Cer, 20 V, 5%

VERTICAL ◇3◇ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
CAPACITORS (cont)				
C366	281-0139-00			2.5-9 pF, Var, Cer, 100 V
C368	290-0530-00			68 µF, Elect., 6 V, 20%
C369	283-0177-00			1 µF, Cer, 25 V, +80%-20%
C370	283-0072-00			0.01 µF, Cer, 20%
C378	281-0095-00			0.2-1.5 pF, Var, Teflon
C380	283-0140-00			4.7 µF, Cer, 50 V, 5%
C382	283-0196-00			270 pF, Cer, 50 V, 10%
C383	283-0196-00			270 pF, Cer, 50 V, 10%
C390	283-0140-00			4.7 pF, Cer, 50 V, 5%
C392	283-0196-00			270 pF, Cer, 50 V, 10%
C393	283-0196-00			270 pF, Cer, 50 V, 10%
C394	281-0140-00			5-25 pF, Var, Cer, 100 V
C395	283-0201-00			27 pF, Cer, 200 V, 10%
C399	283-0157-00			7 pF, Cer, 500 V, 5%
DIODES				
CR302	152-0322-00			Silicon, replaceable by A1108
CR320	152-0322-00			Silicon, replaceable by A1108
CR326	152-0322-00			Silicon, replaceable by A1108
CR345	152-0458-01			Silicon, Schottky barrier
CR355	152-0322-00			Silicon, replaceable by A1108
CR356	152-0322-00			Silicon, replaceable by A1108
CR368	152-0458-01			Silicon, Schottky barrier
CR370	152-0458-01			Silicon, Schottky barrier
CR371	152-0333-00			Silicon, replaceable by FDH6012
CR372	152-0333-00			Silicon, replaceable by FDH6012
CR380	152-0457-00			Silicon, replaceable by MD0288
CR390	152-0457-00			Silicon, replaceable by MD0288
VR372	152-0309-00			Zener, replaceable by 1N3828A, 1 W, 6.2 V, 5%
CONNECTORS				
J15	131-1145-00			Receptacle, electrical, female
J346	131-1003-00			Receptacle, coaxial cable
RELAYS				
K345	148-0078-00			Relay, latch, DPDT, 200 mW
INDUCTORS				
L368	108-0598-00			200 µH
L375	108-0420-00			60 nH
TRANSISTORS				
Q302	151-0269-00	B010100	B059999	Silicon, NPN, replaceable by SE3005
Q302	151-0441-01	B060000		Silicon, NPN, selected from 2N2857
Q310	151-0271-00			Silicon, PNP, replaceable by SAB4113
Q312	153-0556-00			Silicon, NPN, selected from 2N2501
Q325	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q335	151-0269-00	B010100	B059999	Silicon, NPN, replaceable by SE3005
Q335	151-0441-01	B060000		Silicon, NPN, selected from 2N2857

VERTICAL ③ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q338	151-0271-00			Silicon, PNP, replaceable by SAB4113
Q345	153-0556-00			Silicon, NPN, selected from 2N2501
Q355	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q358	151-0269-00	B010100	B059999	Silicon, NPN, replaceable by SE3005
Q358	151-0441-01	B060000		Silicon, NPN, selected from 2N2857
Q360	151-0271-00			Silicon, PNP, replaceable by SAB4113
Q365	151-0269-00	B010100	B059999	Silicon, NPN, replaceable by SE3005
Q365	151-0441-01	B060000		Silicon, NPN, selected from 2N2857
Q368	151-0271-00			Silicon, PNP, replaceable by SAB4113
Q385A,B	151-1044-00			Silicon, FET, selected from D/2N3684 or replaceable by 2N3955
Q399	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
RESISTORS				
R302	316-0473-00			47 kΩ, 1/4 W, 10%
R304	316-0103-00			10 kΩ, 1/4 W, 10%
R305	316-0472-00			4.7 kΩ, 1/4 W, 10%
R306	316-0222-00			2.2 kΩ, 1/4 W, 10%
R308	316-0103-00			10 kΩ, 1/4 W, 10%
R310	316-0103-00			10 kΩ, 1/4 W, 10%
R312	316-0103-00			10 kΩ, 1/4 W, 10%
R314	316-0474-00			470 kΩ, 1/4 W, 10%
R316	311-1243-00			500 kΩ, Var
R317	316-0103-00			10 kΩ, 1/4 W, 10%
R320	317-0151-00			150 Ω, 1/8 W, 5%
R322	317-0151-00			150 Ω, 1/8 W, 5%
R324	316-0333-00			33 kΩ, 1/4 W, 10%
R325	316-0223-00			22 kΩ, 1/4 W, 10%
R326	316-0471-00			470 Ω, 1/4 W, 10%
R328	316-0223-00			22 kΩ, 1/4 W, 10%
R330	311-1240-00			25 kΩ, Var
R332	316-0223-00			22 kΩ, 1/4 W, 10%
R334	316-0473-00			47 kΩ, 1/4 W, 10%
R335	316-0103-00			10 kΩ, 1/4 W, 10%
R336	316-0222-00			2.2 kΩ, 1/4 W, 10%
R338	316-0103-00			10 kΩ, 1/4 W, 10%
R339	316-0472-00			4.7 kΩ, 1/4 W, 10%
R340	316-0103-00			10 kΩ, 1/4 W, 10%
R342	311-1237-00			1 kΩ, Var
R345	316-0105-00			1 MΩ, 1/4 W, 10%
R346	316-0474-00			470 kΩ, 1/4 W, 10%
R347	311-1243-00			500 kΩ, Var
R348	316-0222-00			2.2 kΩ, 1/4 W, 10%
R349	315-0433-00			43 kΩ, 1/4 W, 5%
R350	316-0333-00			33 kΩ, 1/4 W, 10%
R352	316-0223-00			22 kΩ, 1/4 W, 10%
R355	316-0331-00			330 Ω, 1/4 W, 10%
R356	316-0472-00			4.7 kΩ, 1/4 W, 10%
R357	316-0101-00			100 Ω, 1/4 W, 10%

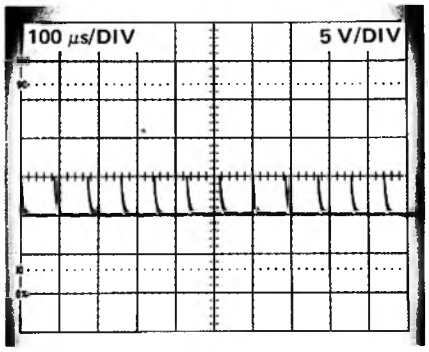
VERTICAL ③ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R358	316-0103-00			10 kΩ, 1/4 W, 10%
R360	316-0103-00			10 kΩ, 1/4 W, 10%
R361	315-0912-00			9.1 kΩ, 1/4 W, 5%
R362	316-0103-00			10 kΩ, 1/4 W, 10%
R363	316-0331-00			330 Ω, 1/4 W, 10%
R365	316-0471-00			470 Ω, 1/4 W, 10%
R366	311-1237-00			1 kΩ, Var
R367	316-0472-00			4.7 kΩ, 1/4 W, 10%
R368	316-0150-00			15 Ω, 1/4 W, 10%
R372	316-0102-00			1 kΩ, 1/4 W, 10%
R373	316-0120-00			12 Ω, 1/4 W, 10%
R374	321-0096-00			97.6 Ω, 1/8 W, 1%
R375	316-0101-00			100 Ω, 1/4 W, 10%
R376	321-0101-00			110 Ω, 1/8 W, 1%
R377	321-0039-00			24.9 Ω, 1/8 W, 1%
R378	321-0164-00			499 Ω, 1/8 W, 1%
R379	321-0072-00			54.9 Ω, 1/8 W, 1%
R380	317-0221-00			220 Ω, 1/8 W, 5%
R383	317-0107-00			100 MΩ, 1/8 W, 5%
R385	316-0223-00			22 kΩ, 1/4 W, 10%
R386	316-0223-00			22 kΩ, 1/4 W, 10%
R388	321-0314-00			18.2 kΩ, 1/8 W, 1%
R389	321-0314-00			18.2 kΩ, 1/8 W, 1%
R390	317-0221-00			220 Ω, 1/8 W, 5%
R393	317-0107-00			100 MΩ, 1/8 W, 5%
R396	317-0103-00			10 kΩ, 1/8 W, 5%
R398	311-1239-00			2.5 kΩ, Var
R399	316-0103-00			10 kΩ, 1/4 W, 10%
SWITCHES				
S1	260-1332-00			Push, CABLE TEST SIG
S345	260-0960-01			Slide, 50 Ω/75 Ω
TRANSFORMERS				
T310	120-0544-00			Toroid, 2 windings
T320	120-0620-00			Toroid, 3 windings
T340	120-0544-00			Toroid, 2 windings
INTEGRATED CIRCUIT				
U386	156-0067-00			Operational amplifier, replaceable by UA741C

VERTICAL ◇3◇

TEST CONDITIONS

1

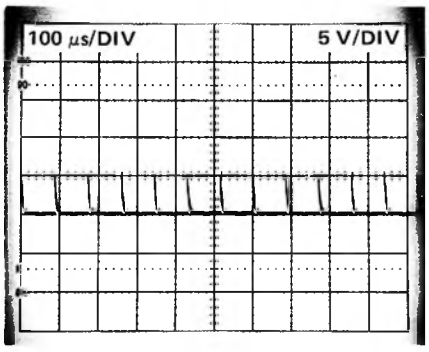


Test Point — RED

1501

All Pushbuttons	Released
Other Controls	Settings Not Important

2

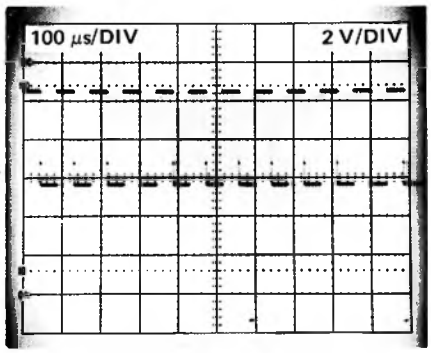


Test Point — ORANGE

1501

All Pushbuttons	Released
Other Controls	Settings Not Important

3

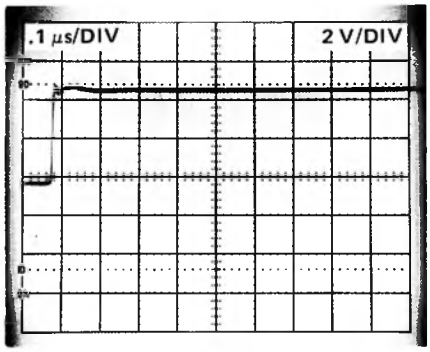


Test Point — YELLOW

1501

CHART POWER	Released
EXT SIG	Released
NOISE FILTER	Released
STEP	Pressed
Other Controls	Settings Not Important

4

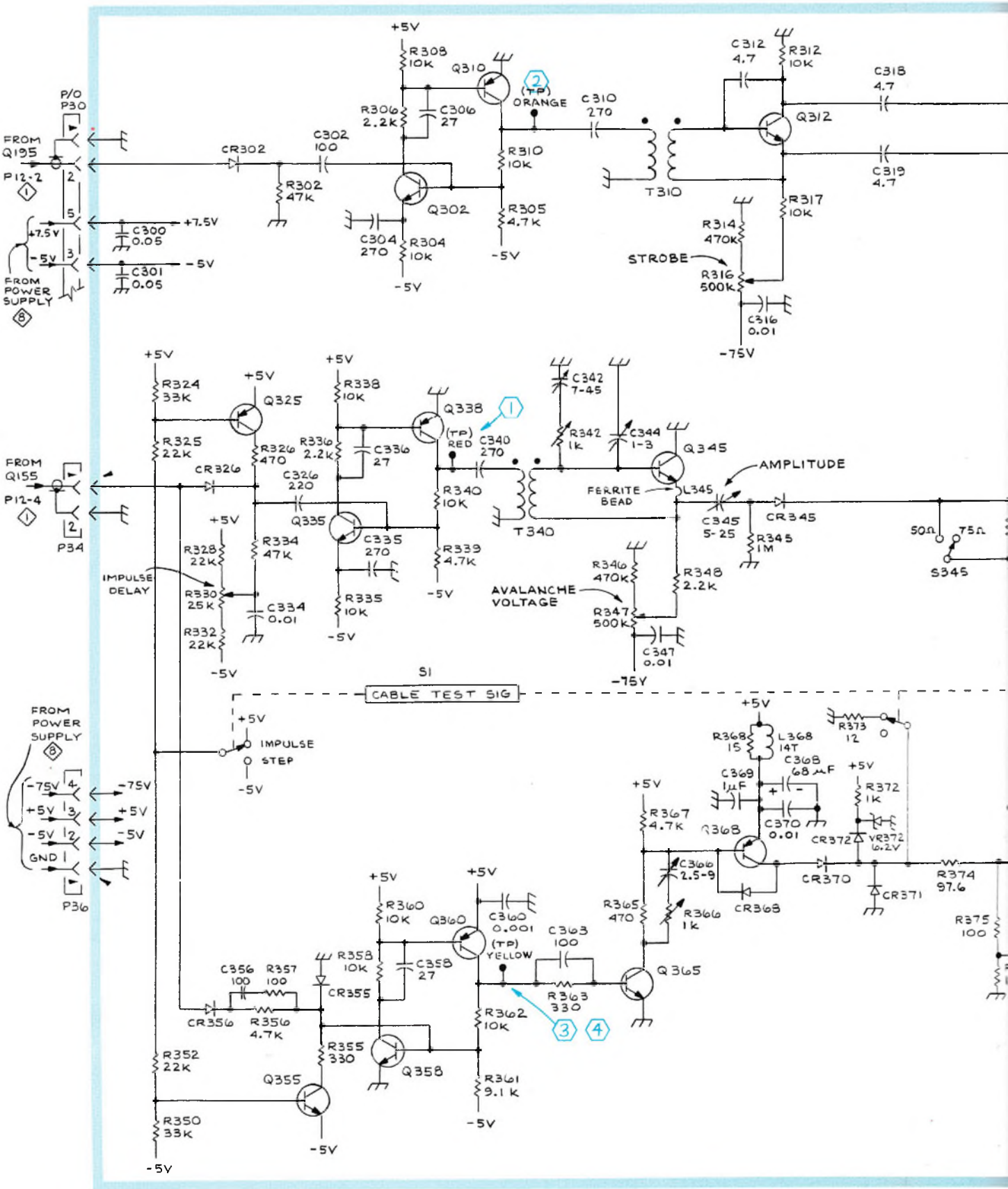


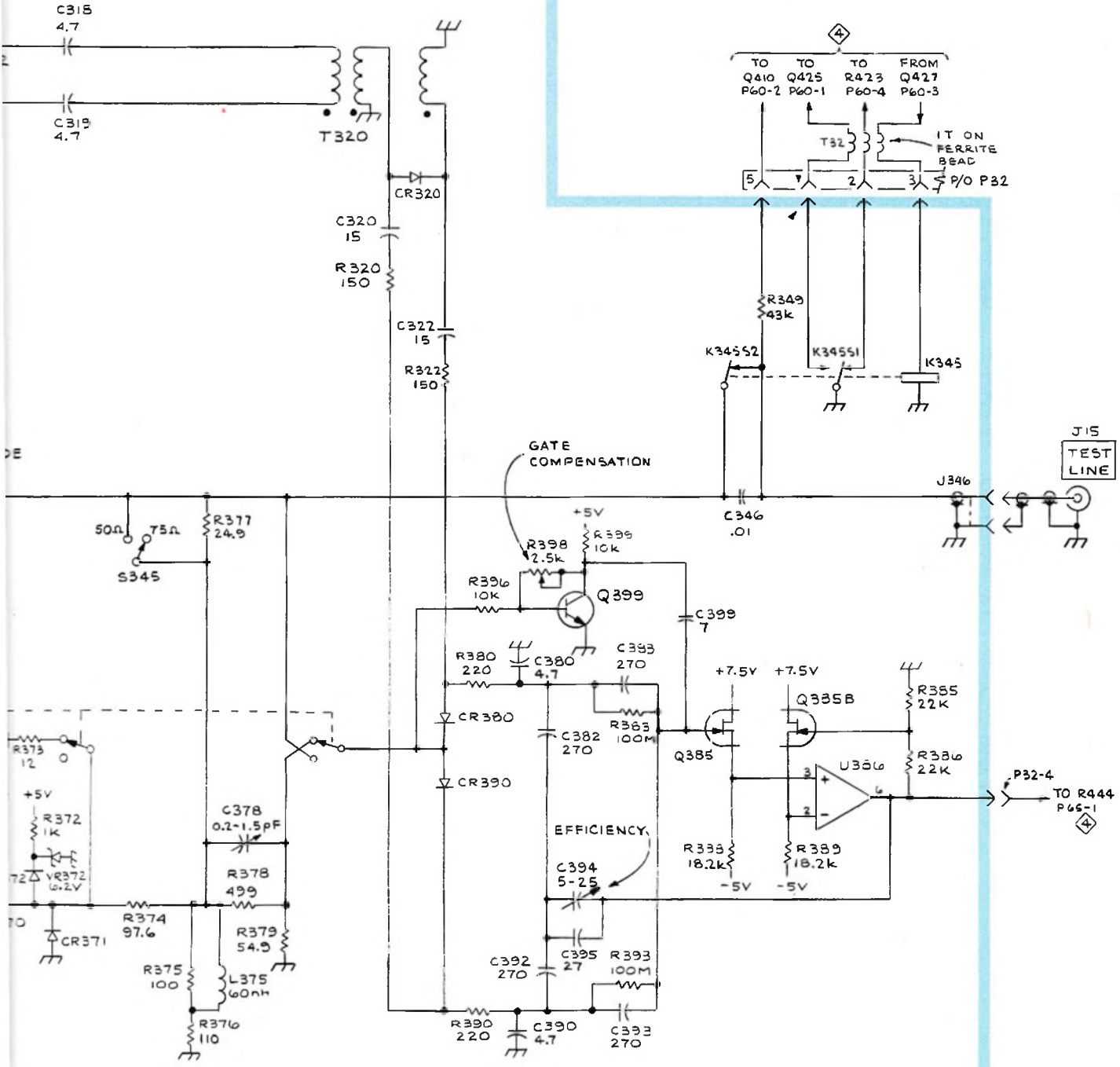
Test Point - YELLOW

1501

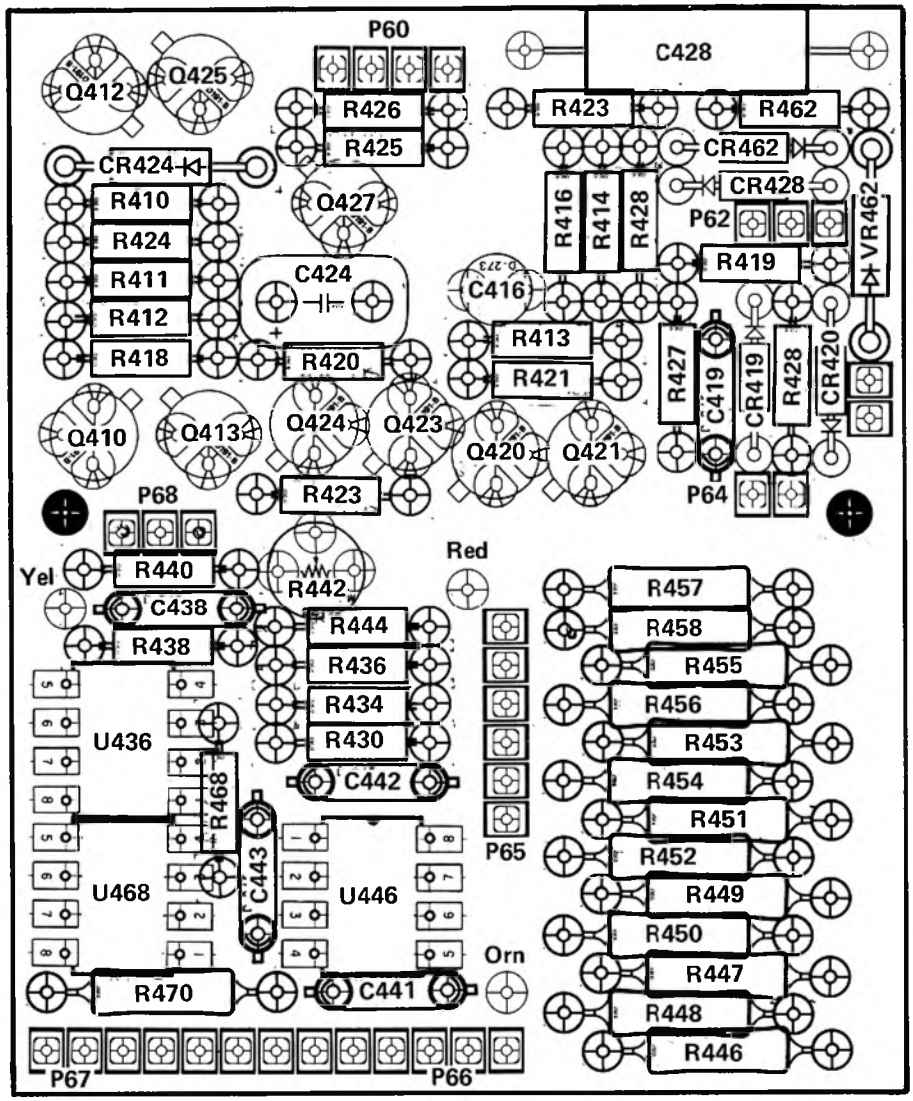
CHART POWER	Released
EXT SIG	Released
NOISE FILTER	Released
STEP	Pressed
Other Controls	Settings Not Important

Ⓐ


FROM Q195
P12-2
P/O P30
FROM POWER SUPPLY
+7.5V
-5V
C300 0.05
C301 0.05
CR302
C302 100
R302 47K
R308 10K
Q310
(TP) ORANGE
R306 2.2K
C306 27
R310 10K
Q302
R305 4.7K
C304 270
R304 10K
C310 270
T310
C312 4.7
R312 10K
Q312
C318 4.7
C319 4.7
R317 10K
R314 470K
STROBE
R316 500K
C316 0.01
-75V
FROM Q155
P12-4
P34
R324 33K
R325 22K
Q325
R326 470
CR326
C326 220
R328 22K
R330 25K
R332 22K
R334 47K
C334 0.01
IMPULSE DELAY
R336 2.2K
C336 27
Q335
C335 270
R335 10K
R338 10K
Q338
(TP) RED
C340 270
R340 10K
R339 4.7K
T340
C342 7-45
R342 1K
C344 1-3
Q345
FERRITE BEAD
L345
AMPLITUDE
C345 5-25
R345 1M
CR345
50Ω
75Ω
S345
R346 470K
R348 2.2K
AVALANCHE VOLTAGE
R347 500K
C347 0.01
S1
CABLE TEST SIG
FROM POWER SUPPLY
P36
IMPULSE
STEP
R352 22K
R350 33K
Q355
R355 330
CR355
R356 4.7K
CR356
C356 100
R357 100
R358 10K
C358 27
Q358
R360 10K
Q360
C360 0.001
(TP) YELLOW
R362 10K
R361 9.1K
C363 100
R363 330
Q365
R365 470
R366 1K
C366 2.5-9
CR368
Q368
R367 4.7K
R368 15
L368 14T
C368 68 μF
C369 1μF
C370 0.01
CR370
CR371
CR372
VR372 16.2V
R372 1K
R373 12
R374 97.6
R375 100


C318
4.7
C319
4.7
T320
CR320
C320
15
R320
150
C322
15
R322
150
TO Q410 P60-2
TO Q425 P60-1
TO R423 P60-4
FROM Q427 P60-3
T32
1T ON FERRITE BEAD
P/O P32
R349
43k
K345S2
K345S1
K345
J15
TEST LINE
J346
GATE COMPENSATION
C346
.01
50Ω
75Ω
S345
R377
24.9
+5V
R398
2.5k
R399
10k
R396
10k
Q399
C399
7
R380
220
C380
4.7
C393
270
CR380
C382
270
R383
100M
+7.5V
+7.5V
Q385B
R385
22k
Q385
U386
R386
22k
P32-4
TO R444
P66-1
R373
12
+5V
R372
1k
VR372
6.2V
CR371
C378
0.2-1.5pF
R378
499
R374
97.6
R379
54.9
R375
100
L375
60nH
R376
110
CR390
EFFICIENCY
C394
5-25
R388
18.2k
R389
18.2k
-5V
-5V
C392
270
C395
27
R393
100M
R390
220
C390
4.7
C393
270

1273 EEB



Output circuit board Ⓐ

ELECTRICAL PARTS LIST

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ABBREVIATIONS AND REFERENCE DESIGNATORS

A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

SIGNAL OUTPUT & SWITCHING ◈4

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A4	670-1712-00			OUTPUT Circuit Board Assembly
CAPACITORS				
C416	290-0522-00			1 µF, Elect., 50 V, 20%
C419	283-0204-00			0.01 µF, Cer, 50 V, 20%
C424	290-0519-00			100 µF, Elect., 20 V, 20%
C428	285-0815-00			1 µF, PTM, 100 V, 5%
C438	283-0023-00			0.1 µF, Cer, 10 V, +80%-20%
C441	283-0111-00			0.1 µF, Cer, 50 V
C442	283-0010-00			0.05 µF, Cer, 50 V
C443	283-0001-00			0.005 µF, Cer, 500 V
DIODES				
CR419	152-0141-02			Silicon, replaceable by 1N4152
CR420	152-0141-02			Silicon, replaceable by 1N4152
CR424	152-0075-00			Germanium, replaceable by GD238 or ED48
CR428	152-0141-02			Silicon, replaceable by 1N4152
CR462	152-0141-02			Silicon, replaceable by 1N4152
VR462	152-0280-00			Zener, replaceable by 1N753A, 0.4 W, 6.2 V, 5%
BULBS				
DS15	150-0035-00			Neon, AID-T, 0.3 mA
CONNECTORS				
J10	131-0106-01			Receptacle, electrical
J11	131-0106-01			Receptacle, electrical
J12	131-0106-01			Receptacle, electrical
J13	131-0106-01			Receptacle, electrical
METER				
M10	149-0031-00			Meter, 0-200 µA, ±15%

SIGNAL OUTPUT & SWITCHING ◇4◇ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS				
Q410	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q412	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q413	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q420	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q421	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q423	151-0254-00			Silicon, NPN, replaceable by 2N5308
Q424	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q425	151-0254-00			Silicon, NPN, replaceable by 2N5308
Q427	151-0301-00			Silicon, PNP, replaceable by 2N2907
RESISTORS				
R2	317-0203-00			20 kΩ, 1/8 W, 5%
R3	315-0470-00			47 Ω, 1/4 W, 10%
R4	321-0183-02			787 Ω, 1/8 W, 1/2%
R5	321-0173-01			619 Ω, 1/8 W, 1/2%
R6	311-1064-00			500 Ω, Var
R7	321-0164-03			499 Ω, 1/8 W, 1/2%
R8	311-1325-00			50 kΩ, Var
R9	315-0103-00	XB040000		10 kΩ, 1/4 W, 5%
R10	315-0103-00	XB040000		10 kΩ, 1/4 W, 5%
R410	315-0512-00			5.1 kΩ, 1/4 W, 5%
R411	316-0103-00			10 kΩ, 1/4 W, 10%
R412	315-0512-00			5.1 kΩ, 1/4 W, 5%
R413	316-0104-00			10 kΩ, 1/4 W, 10%
R414	316-0105-00			1 MΩ, 1/4 W, 10%
R416	316-0102-00			1 kΩ, 1/4 W, 10%
R418	316-0104-00			100 kΩ, 1/4 W, 10%
R419	316-0105-00			1 MΩ, 1/4 W, 10%
R420	316-0102-00			1 kΩ, 1/4 W, 10%
R421	316-0474-00			470 kΩ, 1/4 W, 10%
R422	316-0473-00			47 kΩ, 1/4 W, 10%
R423	316-0105-00			1 MΩ, 1/4 W, 10%
R424	315-0201-00			200 Ω, 1/4 W, 5%
R425	316-0103-00			10 kΩ, 1/4 W, 10%
R426	316-0102-00			1 kΩ, 1/4 W, 10%
R427	316-0105-00			1 MΩ, 1/4 W, 10%
R428	316-0472-00			4.7 kΩ, 1/4 W, 10%
R429	316-0225-00			2.2 MΩ, 1/4 W, 10%
R430	316-0472-00			4.7 kΩ, 1/4 W, 10%
R434	316-0472-00			4.7 kΩ, 1/4 W, 10%
R436	316-0104-00			100 kΩ, 1/4 W, 10%
R438	316-0473-00			47 kΩ, 1/4 W, 10%
R440	316-0103-00			10 kΩ, 1/4 W, 10%
R442	311-0633-00			5 kΩ, Var
R444	315-0393-00			39 kΩ, 1/4 W, 5%
R446	321-0289-00			10 kΩ, 1/8 W, 1%
R447	321-0327-00			24.9 kΩ, 1/8 W, 1%
R448	321-0310-00			16.5 kΩ, 1/8 W, 1%
R449	321-0356-00			49.9 kΩ, 1/8 W, 1%
R450	321-0298-00			12.4 kΩ, 1/8 W, 1%
R451	321-0385-00			100 kΩ, 1/8 W, 1%
R452	321-0293-00			11 kΩ, 1/8 W, 1%

SIGNAL OUTPUT & SWITCHING ④(cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R453	321-0423-00			249 kΩ, 1/8 W, 1%
R454	321-0290-00			10.2 kΩ, 1/8 W, 1%
R455	321-0452-00			499 kΩ, 1/8 W, 1%
R456	321-0289-00			10 kΩ, 1/8 W, 1%
R457	321-0481-00			1 MΩ, 1/8 W, 1%
R458	321-0289-00			10 kΩ, 1/8 W, 1%
R462	315-0432-00			4.3 kΩ, 1/4 W, 5%
R468	316-0105-00			1 MΩ, 1/4 W, 10%
R470	321-0289-00			10 kΩ, 1/4 W, 1%
SWITCHES				
S3A, S3B Wired	262-0960-00	B010100	B039999	Push, CHART POWER EXT SIG
S3A, S3B Wired	262-0960-01	B040000		Push, CHART POWER EXT SIG
S3A, S3B	260-1331-00			Push, CHART POWER EXT SIG
S4	260-1333-00			Push, NOISE FILTER
S6	260-1330-00			Rotary, CABLE
S7	260-1329-00			Rotary, REFLECTION %/DIV
INTEGRATED CIRCUITS				
U436	156-0067-00			Operational amplifier, replaceable by UA741C
U446	156-0067-00			Operational amplifier, replaceable by UA741C
U468	156-0067-00			Operational amplifier, replaceable by UA741C

SIGNAL OUTPUT & SWITCHING ◇4◇

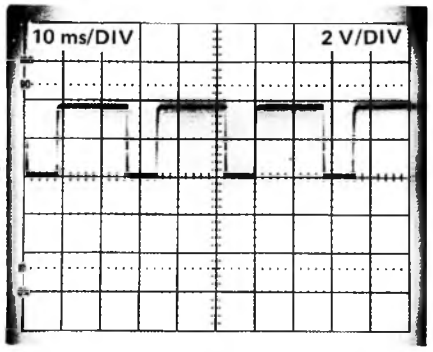
TEST CONDITIONS

Test Point — RED

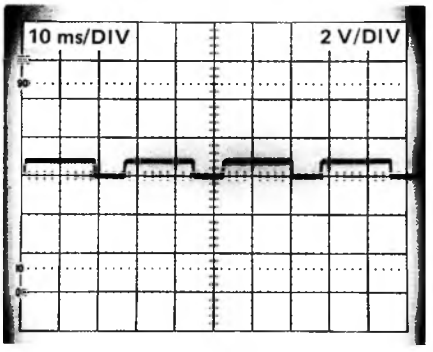
1501

CHART POWER	Released
EXT SIG	Released
NOISE FILTER	Released
FEET/DIV	20
START POINT	000
%/DIV	50
STEP	Pressed
Other Controls	Settings Not Important

⬡1⬡



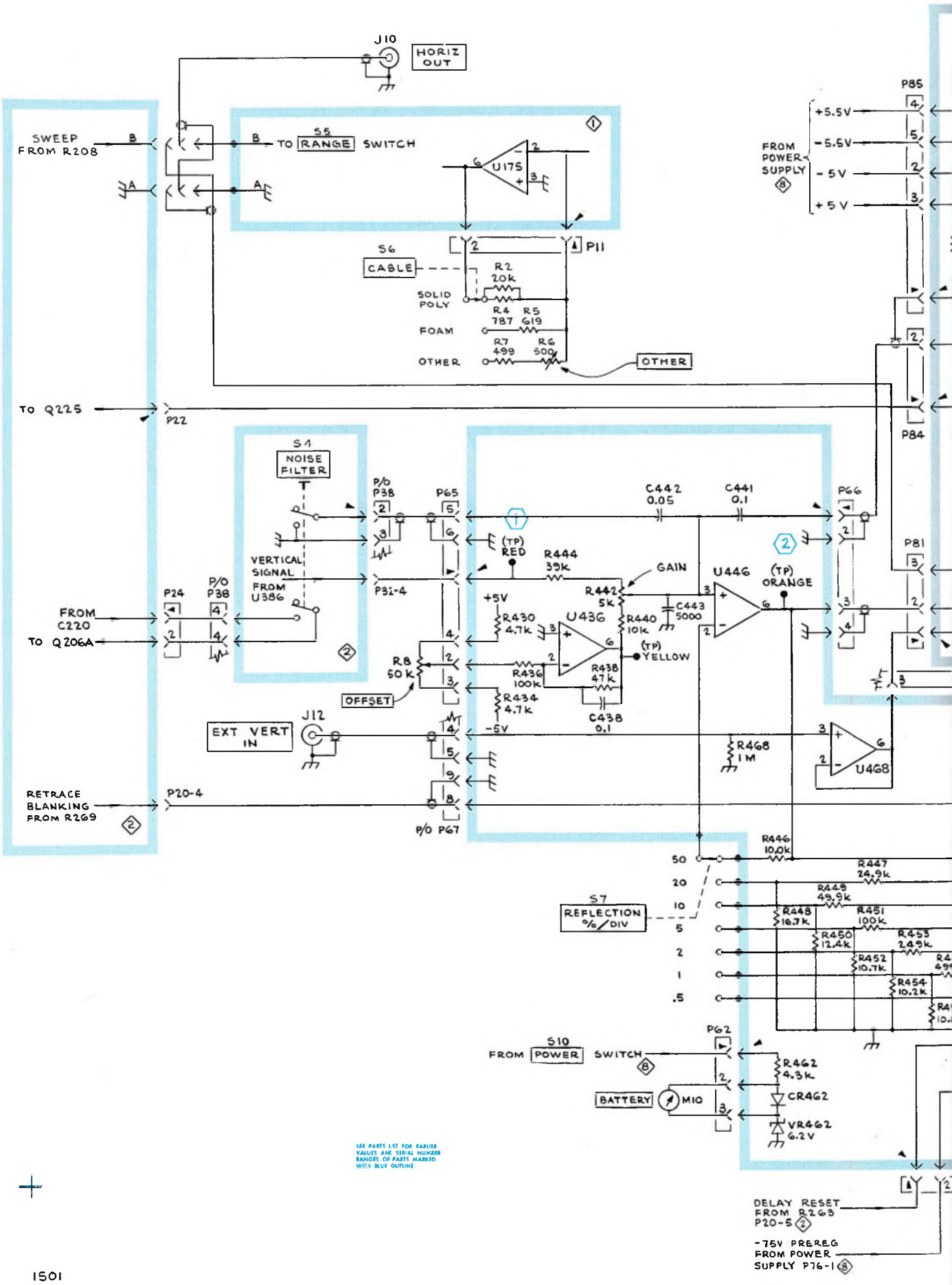
⬡2⬡

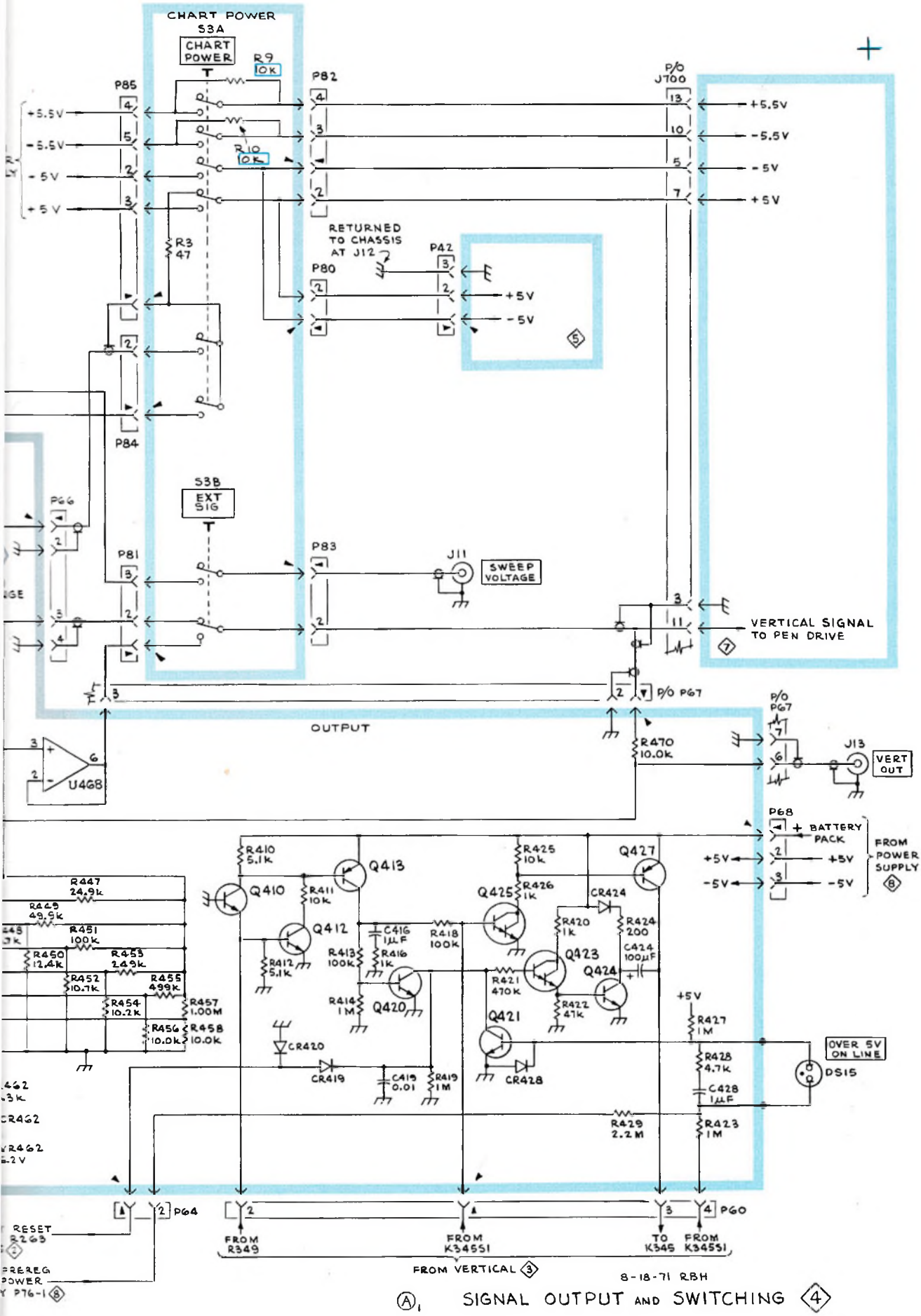


Test Point — ORANGE

1501 — Same as for RED test point except the DC OFFSET control should be centered.

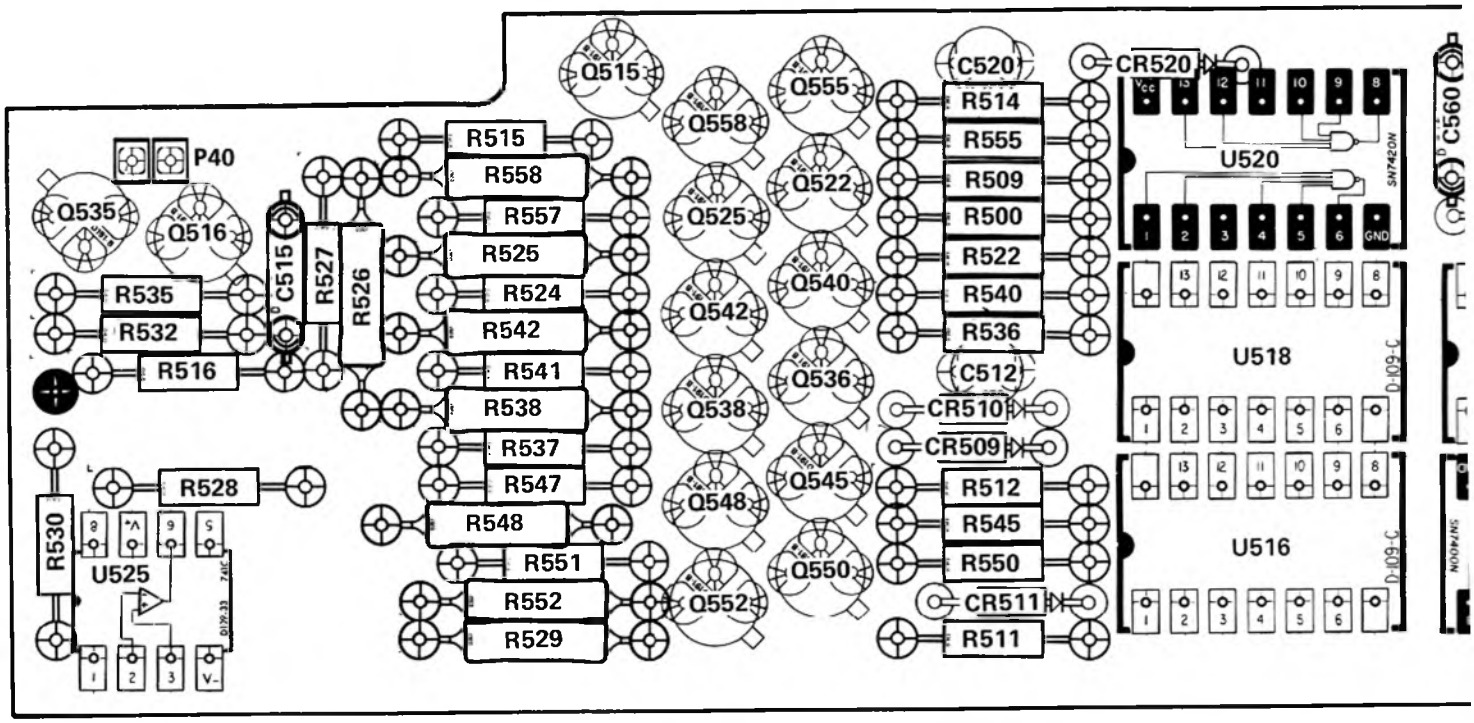
Ⓐ


J10
HORIZ OUT
SWEEP FROM R208
B
A
S5 RANGE SWITCH
U175
S6 CABLE
P11
R2 20k
SOLID POLY
R4 787
R5 619
FOAM
R7 499
R6 500
OTHER
P85
FROM POWER SUPPLY
+5.5V
-5.5V
-5V
+5V
TO Q225
P22
P84
S1 NOISE FILTER
P/O P38
P65
C442 0.05
C441 0.1
P66
VERTICAL SIGNAL FROM U386
P31-4
(TP) RED
R444 39k
GAIN
U446
(TP) ORANGE
P81
FROM C220
TO Q206A
P24
+5V
R430 4.7k
U436
R442 5k
R440 10k
C443 5000
R436 100k
R438 47k
(TP) YELLOW
R8 50k
OFFSET
R434 4.7k
C438 0.1
EXT VERT IN
J12
-5V
R468 1M
U468
RETRACE BLANKING FROM R269
P20-4
P/O P67
R446 10.0k
R447 24.9k
R449 49.9k
R448 16.7k
R451 100k
R450 12.4k
R453 249k
R452 10.7k
R454 10.2k
S7 REFLECTION %/DIV
50
20
10
5
2
1
.5
P62
S10 FROM POWER SWITCH
R462 4.3k
BATTERY
M10
CR462
VR462 6.2V
DELAY RESET FROM R263 P20-5
-75V PREREG FROM POWER SUPPLY P76-1
SEE PARTS LST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



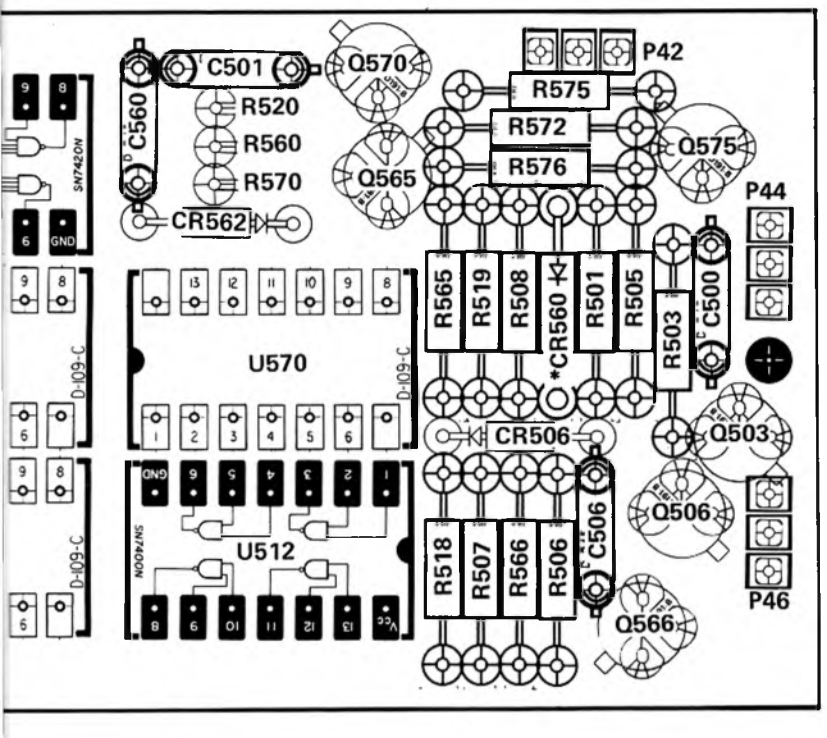
A1 SIGNAL OUTPUT AND SWITCHING 4

1501



Logic circuit board

*See Part List for serial number ranges.


C501
C560
R520
R560
R570
CR562
Q570
Q565
P42
R575
R572
R576
Q575
P44
R565
R519
R508
*CR560
R501
R505
R503
C500
U570
CR506
Q503
Q506
U512
R518
R507
R566
R506
C506
Q566
P46
SN7420N
SN7400N
D-109-C

Ⓑ

ELECTRICAL PARTS LIST

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B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

LOGIC ◇5

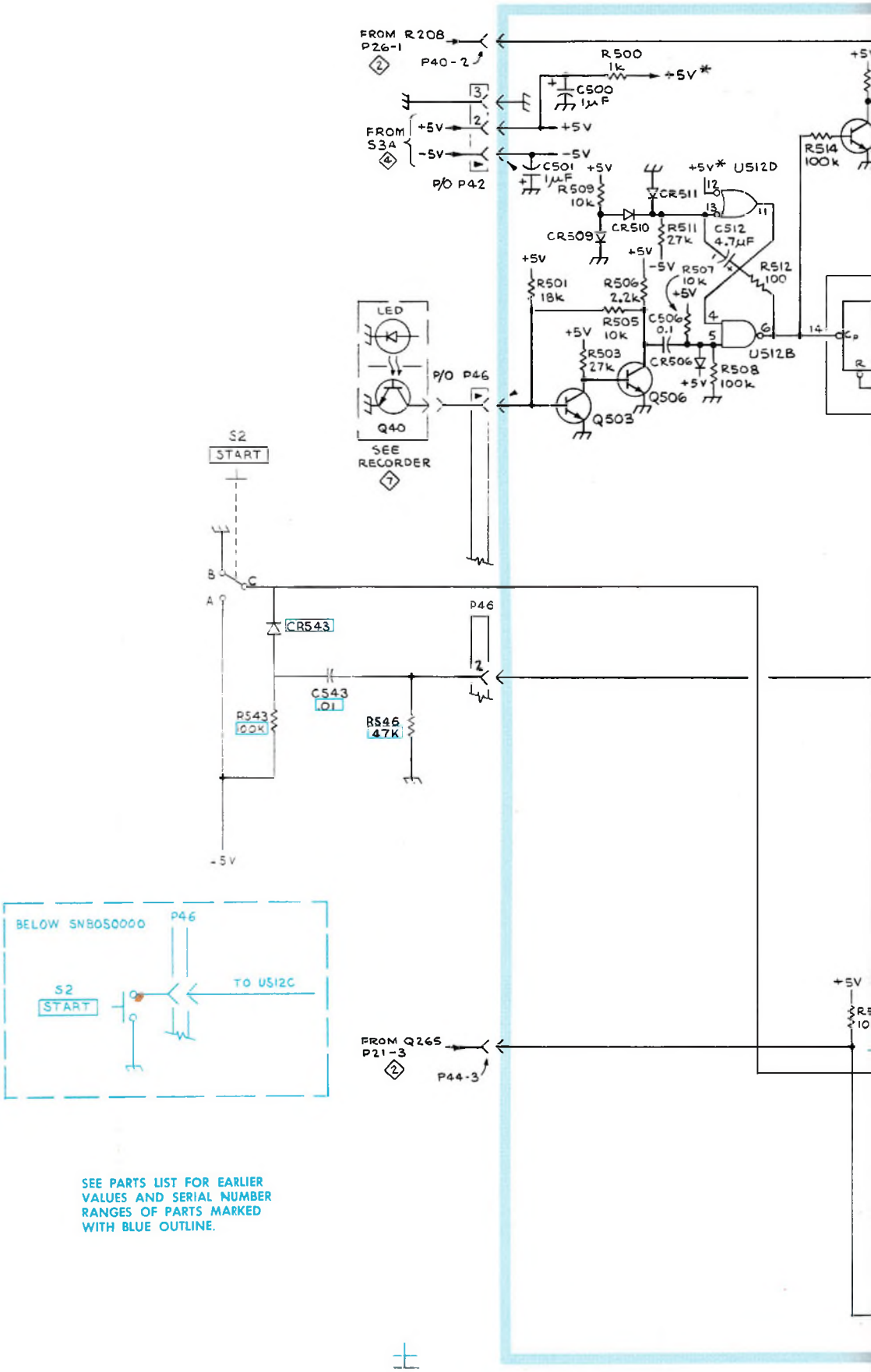
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A5	670-1708-00	B010100	B049999	LOGIC Circuit Board Assembly
A5	670-1708-01	B050000		LOGIC Circuit Board Assembly
CAPACITORS				
C500	290-0534-00			1 µF, Elect., 35 V, 20%
C501	290-0534-00			1 µF, Elect., 35 V, 20%
C506	283-0111-00			0.1 µF, Cer, 50 V
C512	290-0525-00			4.7 µF, Elect., 50 V, 20%
C515	283-0111-00			0.1 µF, Cer, 50 V
C520	290-0525-00			4.7 µF, Elect., 50 V, 20%
C543	283-0204-00	XB050000		0.01 µF, Cer, 50 V, 20%
C560	283-0111-00			0.1 µF, Cer, 50 V
DIODES				
CR506	152-0141-02			Silicon, replaceable by 1N4152
CR509	152-0141-02			Silicon, replaceable by 1N4152
CR510	152-0141-02			Silicon, replaceable by 1N4152
CR511	152-0141-02			Silicon, replaceable by 1N4152
CR520	152-0141-02			Silicon, replaceable by 1N4152
CR528	152-0246-00	B010100	B010159X	Silicon, replaceable by CD12676 or FD3375
CR530	152-0246-00	B010100	B010159X	Silicon, replaceable by CD12676 or FD3375
CR543	152-0075-00	XB050000		Germanium, replaceable by GD238 or ED48
CR560	152-0075-00	B010100	B049999X	Germanium, replaceable by GD238 or ED48
CR562	152-0141-02			Silicon, replaceable by 1N4152
TRANSISTORS				
Q503	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q506	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q515	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q516	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q522	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q525	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q535	151-1022-00			Silicon, FET, selected from 2N4392
Q536	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q538	151-0302-00			Silicon, NPN, replaceable by 2N2222A

LOGIC ⟨5⟩ (cont)

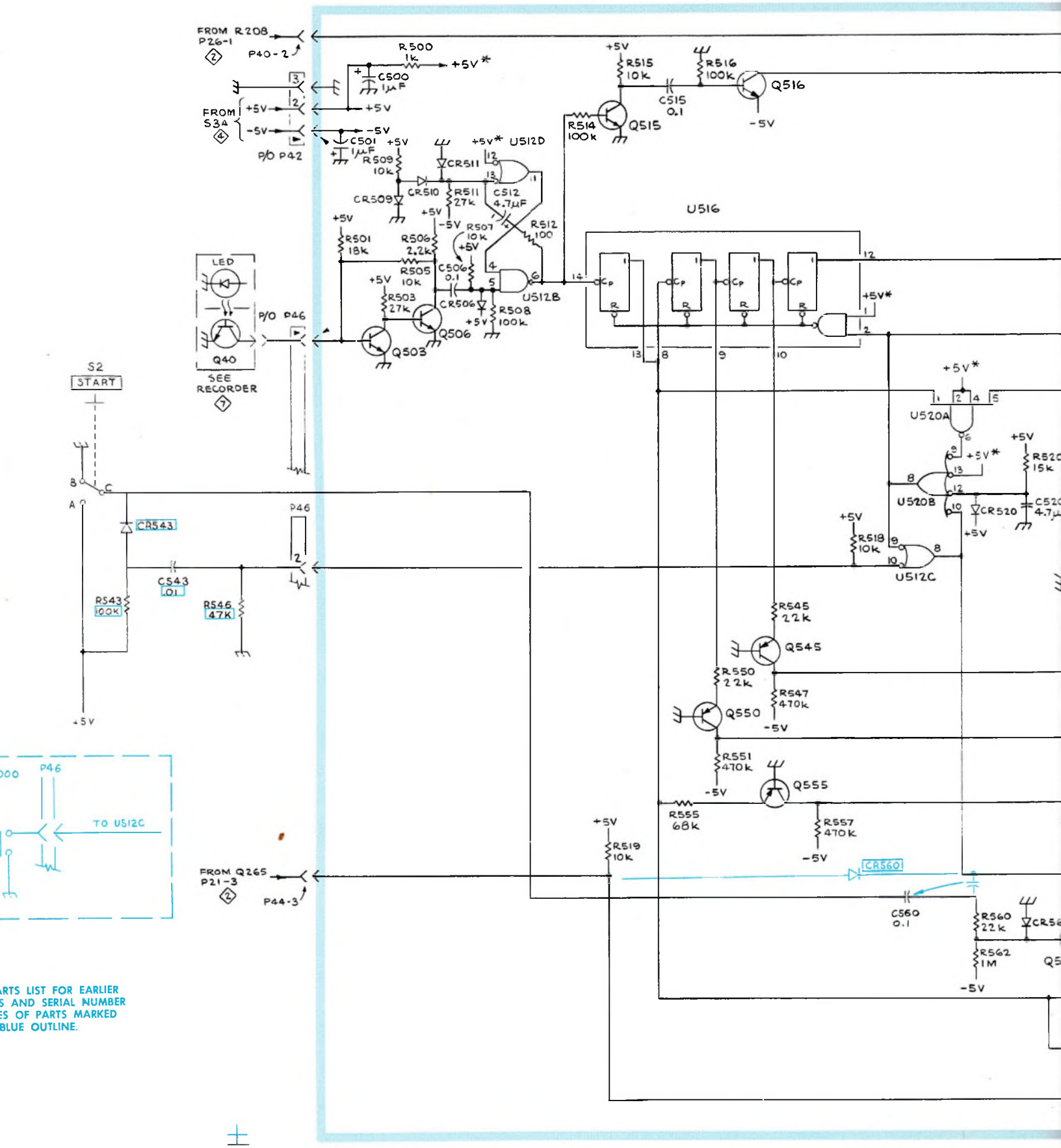
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS (cont)				
Q540	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q542	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q545	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q548	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q550	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q552	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q555	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q558	151-0302-00			Silicon, NPN, replaceable by 2N2222A
Q565	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q566	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q570	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q575	151-0341-00			Silicon, NPN, replaceable by 2N3565
RESISTORS				
R500	316-0102-00			1 kΩ, 1/4 W, 10%
R501	315-0183-00			18 kΩ, 1/4 W, 5%
R503	316-0273-00			27 kΩ, 1/4 W, 10%
R505	316-0103-00			10 kΩ, 1/4 W, 10%
R506	316-0222-00			2.2 kΩ, 1/4 W, 10%
R507	316-0103-00			10 kΩ, 1/4 W, 10%
R508	316-0104-00			100 kΩ, 1/4 W, 10%
R509	316-0103-00			10 kΩ, 1/4 W, 10%
R511	316-0273-00			27 kΩ, 1/4 W, 10%
R512	316-0101-00			100 Ω, 1/4 W, 10%
R514	316-0104-00			100 kΩ, 1/4 W, 10%
R515	316-0103-00			10 kΩ, 1/4 W, 10%
R516	316-0104-00			100 kΩ, 1/4 W, 10%
R518	316-0103-00			10 kΩ, 1/4 W, 10%
R519	316-0103-00			10 kΩ, 1/4 W, 10%
R520	316-0153-00			15 kΩ, 1/4 W, 10%
R522	316-0223-00			22 kΩ, 1/4 W, 10%
R524	316-0474-00			470 kΩ, 1/4 W, 10%
R525	321-0319-02	B010100	B010159	20.5 kΩ, 1/8 W, 1/2%
R525	321-0327-03	B010160		24.9 kΩ, 1/8 W, 1/4%
R526	321-0302-00	B010100	B010159	13.7 kΩ, 1/8 W, 1%
R526	321-0651-00	B010160		15.8 kΩ, 1/8 W, 1/4%
R527	316-0564-00	B010100	B010159	560 kΩ, 1/4 W, 10%
R527	315-0155-00	B010160		1.5 MΩ, 1/4 W, 5%
R528	315-0203-00			20 kΩ, 1/4 W, 5%
R529	321-0465-01	B010100	B010159	681 kΩ, 1/8 W, 1/2%
R529	321-0891-00	B010160		800 kΩ, 1/8 W, 1%
R530	315-0202-00			2 kΩ, 1/4 W, 5%
R532	316-0104-00			100 kΩ, 1/4 W, 10%
R535	316-0102-00			1 kΩ, 1/4 W, 10%
R536	316-0223-00			22 kΩ, 1/4 W, 10%
R537	316-0474-00			470 kΩ, 1/4 W, 10%
R538	321-0726-01	B010100	B010159	42.27 kΩ, 1/8 W, 1/2%
R538	321-0756-03	B010160		50 kΩ, 1/8 W, 1/4%

LOGIC ⑤ (cont)

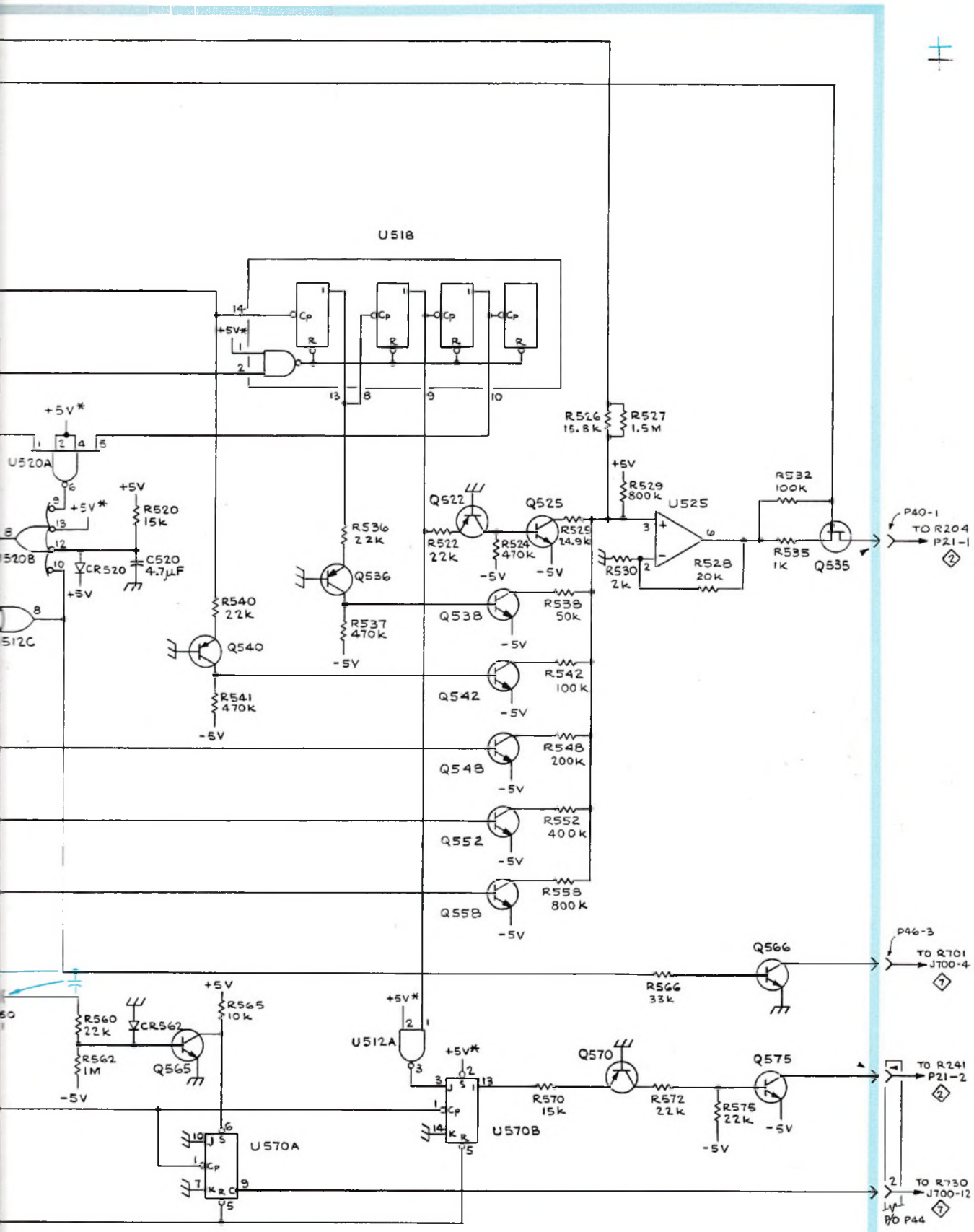
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R540	316-0223-00			22 kΩ, 1/4 W, 10%
R541	316-0474-00			470 kΩ, 1/4 W, 10%
R542	321-0727-01	B010100	B010159	84.54 kΩ, 1/8 W, 1/2%
R542	321-0645-00	B010160		100 kΩ, 1/8 W, 1/2%
R543	316-0104-00	XB050000		100 kΩ, 1/4 W, 10%
R545	316-0223-00			22 kΩ, 1/4 W, 10%
R546	316-0473-00	XB050000		47 kΩ, 1/4 W, 10%
R547	316-0474-00			470 kΩ, 1/4 W, 10%
R548	321-0694-00	B010100	B010159	169 kΩ, 1/8 W, 1/2%
R548	321-0414-00	B010160		200 kΩ, 1/8 W, 1%
R550	316-0223-00			22 kΩ, 1/4 W, 10%
R551	316-0474-00			470 kΩ, 1/4 W, 10%
R552	321-0436-01	B010100	B010159	340 kΩ, 1/8 W, 1/2%
R552	321-0781-06	B010160		400 kΩ, 1/8 W, 1/4%
R555	316-0683-00			68 kΩ, 1/4 W, 10%
R557	316-0474-00			470 kΩ, 1/4 W, 10%
R558	321-0465-01	B010100	B010159	681 kΩ, 1/8 W, 1/2%
R558	321-0891-00	B010160		800 kΩ, 1/8 W, 1%
R560	316-0223-00			22 kΩ, 1/4 W, 10%
R562	315-0105-00			1 MΩ, 1/4 W, 10%
R565	316-0103-00			10 kΩ, 1/4 W, 10%
R566	316-0333-00			33 kΩ, 1/4 W, 10%
R570	316-0153-00			15 kΩ, 1/4 W, 10%
R572	316-0223-00			22 kΩ, 1/4 W, 10%
R575	316-0223-00			22 kΩ, 1/4 W, 10%
SWITCHES				
S2	260-0247-00	B010100	B049999	Pushbutton, START
S2	260-0324-00	B050000		Pushbutton, START
INTEGRATED CIRCUITS				
U512	156-0113-00			Quad 2-input positive nand gate, low power, replaceable by SN74L00N
U516	156-0101-00			Single 3 MHz 1-&-3-bit binary ripple counter, replaceable by SN74L93N
U518	156-0101-00			Single 3 MHz 1-&-3-bit binary ripple counter, replaceable by SN74L93N
U520	156-0160-00			Dual 2-input positive nand gate, low power, replaceable by SN74L20N
U525	156-0067-00			Operational amplifier, replaceable by UA741C
U570	156-0161-00			Dual 3 MHz J-K master-slave flip-flop, low power, replaceable by SN74L78N

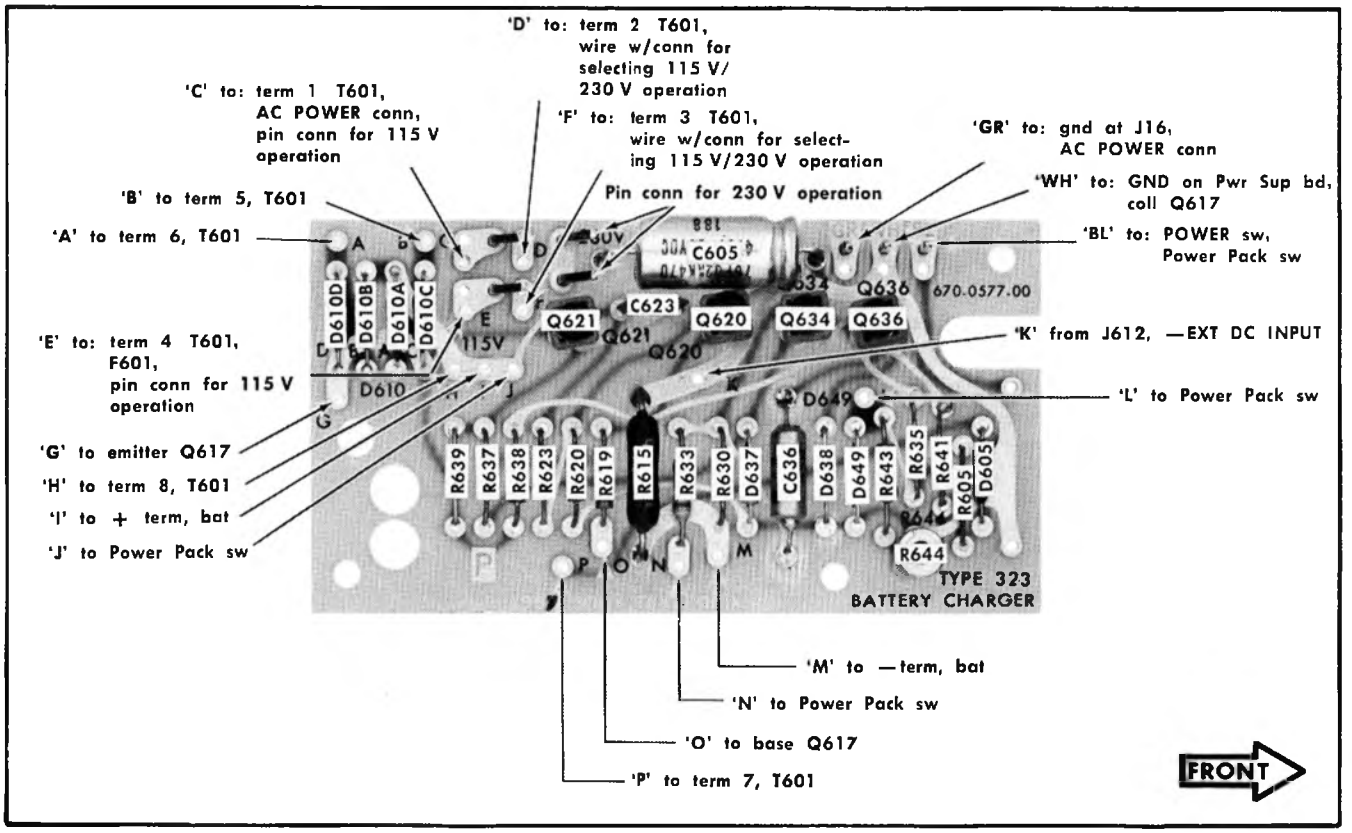


SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



RTS LIST FOR EARLIER
S AND SERIAL NUMBER
ES OF PARTS MARKED
BLUE OUTLINE.


U518
+5V*
U520A
R520 15k
C520 4.7µF
CR520
U520B
U512C
R536 22k
Q536
R537 470k
-5V
R540 22k
Q540
R541 470k
R526 15.8k
R527 1.5M
+5V
R529 800k
U525
R532 100k
Q522
Q525
R522 22k
R524 470k
R525 24.9k
R530 2k
R528 20k
R535 1k
Q535
P40-1
TO R204
P21-1
Q538
R538 50k
Q542
R542 100k
Q548
R548 200k
Q552
R552 400k
Q558
R558 800k
Q566
P46-3
TO R701
J700-4
R566 33k
R560 22k
CR562
R565 10k
R562 1M
Q565
U512A
U570A
U570B
Q570
Q575
R570 15k
R572 22k
R575 22k
TO R241
P21-2
TO R730
J700-12
P/O P44
LOGIC



Power Pack circuit board

ELECTRICAL PARTS LIST

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ABBREVIATIONS AND REFERENCE DESIGNATORS

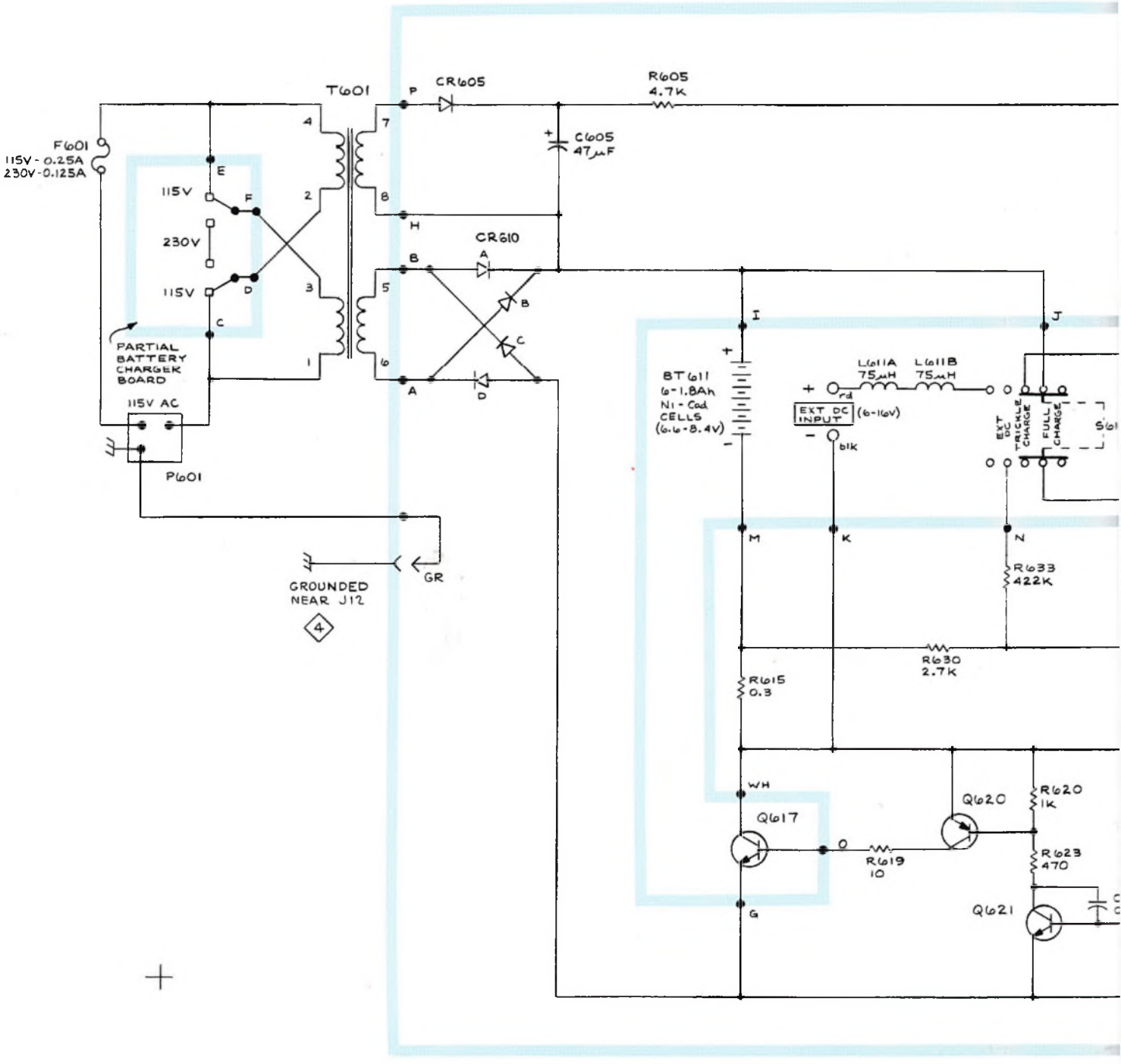
A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

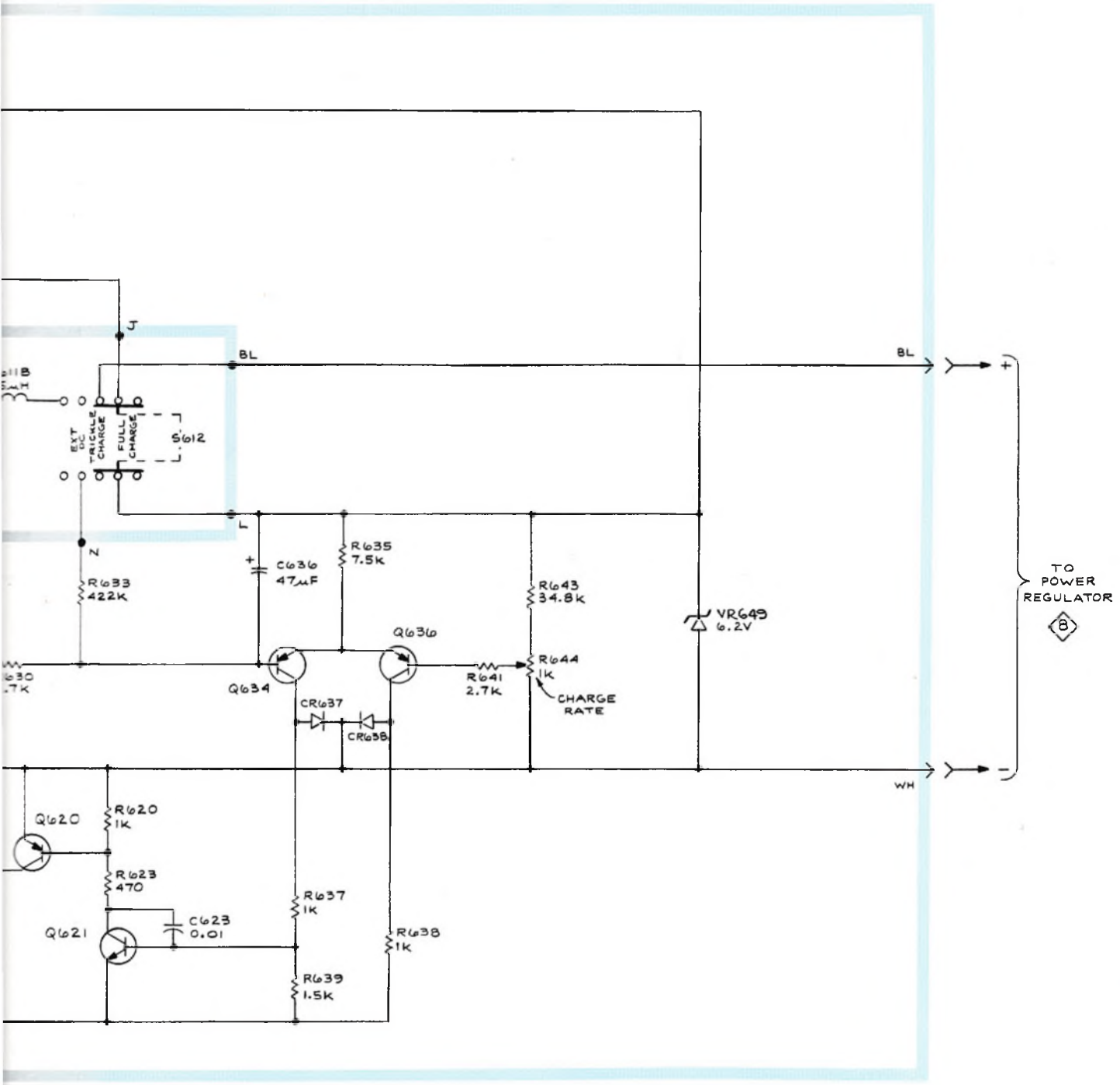
POWER PACK ⑥

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A6	016-0119-02			POWER PACK
BATTERY				
BT611	146-0012-01			Battery set
CAPACITORS				
C605	290-0287-00			47 µF, Elect., 25 V, 20%
C623	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C636	290-0114-01			47 µF, Elect., 6 V
DIODES				
CR605	152-0107-00			Silicon, replaceable by TI60 or 1N647
CR610A,B,C,D(4)	152-0107-00			Silicon, replaceable by TI60 or 1N647
CR637	152-0008-00			Germanium, replaceable by T12G
CR638	152-0008-00			Germanium, replaceable by T12G
VR649	152-0166-00			Zener, selected from 1N753A, 0.4 W, 6.2 V, 5%
FUSES				
F601	159-0074-00			Cartridge, 0.1 A, 250 V, slo-blo, 230 V operation
F601	159-0080-00			Cartridge, 0.2 A, 250 V, slo-blo, 115 V operation
CONNECTORS				
J611	136-0139-00			Socket, banana jack assembly
J612	136-0140-00			Socket, banana jack assembly
P601	131-0552-00			Receptacle, electrical
INDUCTOR				
L611A,B	108-0488-00			150 µH

POWER PACK ⑥ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
TRANSISTORS				
Q617	151-0229-00			Silicon, NPN, replaceable by 2SD28
Q620	151-0219-00			Silicon, PNP, replaceable by 2N4250
Q621	151-0224-00			Silicon, NPN, replaceable by 2N3692
Q634	151-0219-00			Silicon, PNP, replaceable by 2N4250
Q636	151-0219-00			Silicon, PNP, replaceable by 2N4250
RESISTORS				
R605	315-0472-01			4.7 kΩ, 1/4 W, 5%
R615	308-0463-00			0.3 Ω, 3 W, WW, 1%
R619	315-0100-01			10 Ω, 1/4 W, 5%
R620	315-0102-01			1 kΩ, 1/4 W, 5%
R623	315-0471-02			470 Ω, 1/4 W, 5%
R630	315-0272-02			2.7 kΩ, 1/4 W, 5%
R633	321-0445-00			422 kΩ, 1/8 W, 1%
R635	315-0752-00			7.5 kΩ, 1/4 W, 5%
R637	315-0102-01			1 kΩ, 1/4 W, 5%
R638	315-0102-01			1 kΩ, 1/4 W, 5%
R639	315-0152-01			1.5 kΩ, 1/4 W, 5%
R641	315-0272-02			2.7 kΩ, 1/4 W, 5%
R643	321-0341-30			34.8 kΩ, 1/8 W, 1%
R644	311-0635-00			1 kΩ, Var
SWITCH				
S612	260-0902-00			Slide
TRANSFORMER				
T601	120-0503-00			Power


F601
115V - 0.25A
230V - 0.125A
T601
CR605
R605
4.7K
C605
47μF
115V
230V
115V
PARTIAL BATTERY CHARGER BOARD
115V AC
P601
CR610
BT611
6-1.8Ah
Ni-Cad
CELLS
(6.6-8.4V)
L611A
75μH
L611B
75μH
EXT DC INPUT
(6-16V)
EXT DC TRICKLE CHARGE
FULL CHARGE
R633
422K
R630
2.7K
R615
0.3
Q617
R619
10
Q620
R620
1K
R623
470
Q621
GROUNDED
NEAR J12
GR
4



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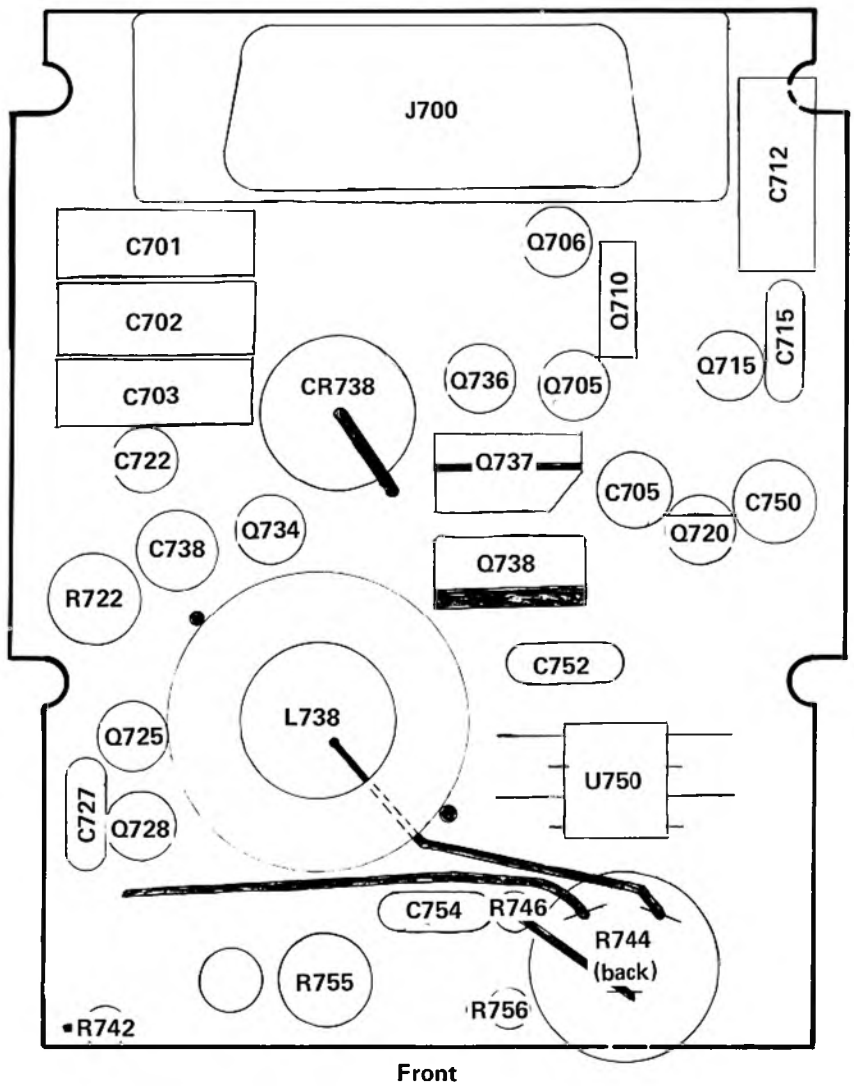
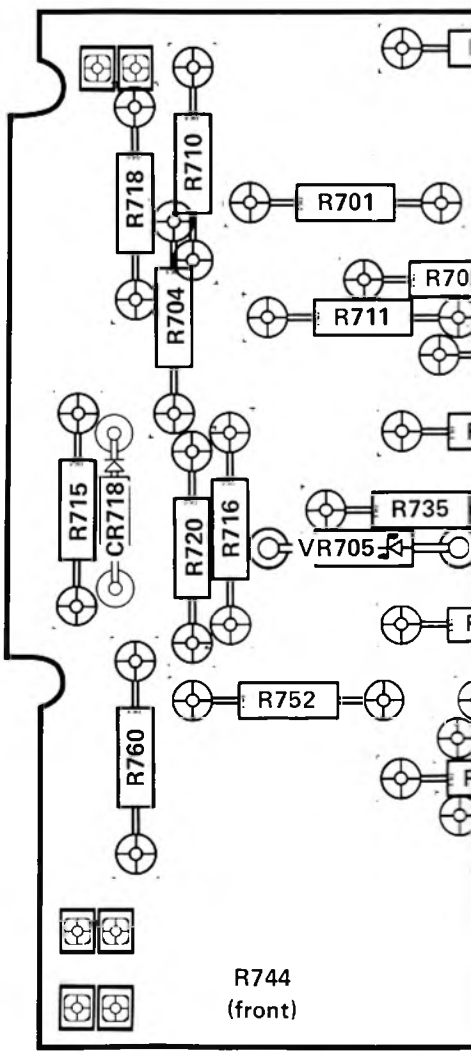
Ⓐ POWER PACK 6



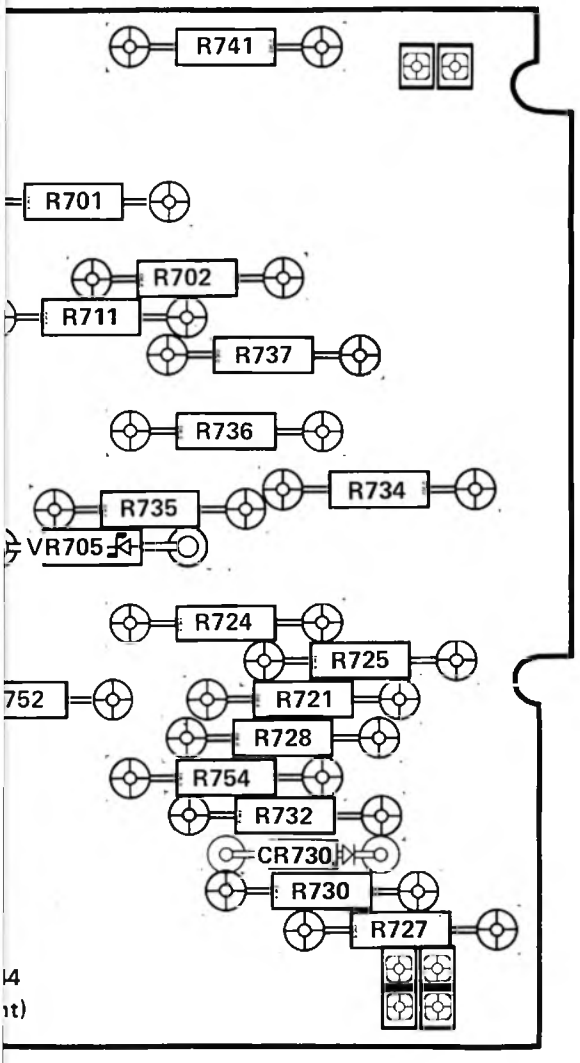
Front



Back

Chart Power circuit board

CHART POWER CIRCUIT BOARD


R741
R701
R702
R711
R737
R736
R735
R734
VR705
R724
R725
752
R721
R728
R754
R732
CR730
R730
R727
Back

ELECTRICAL PARTS LIST

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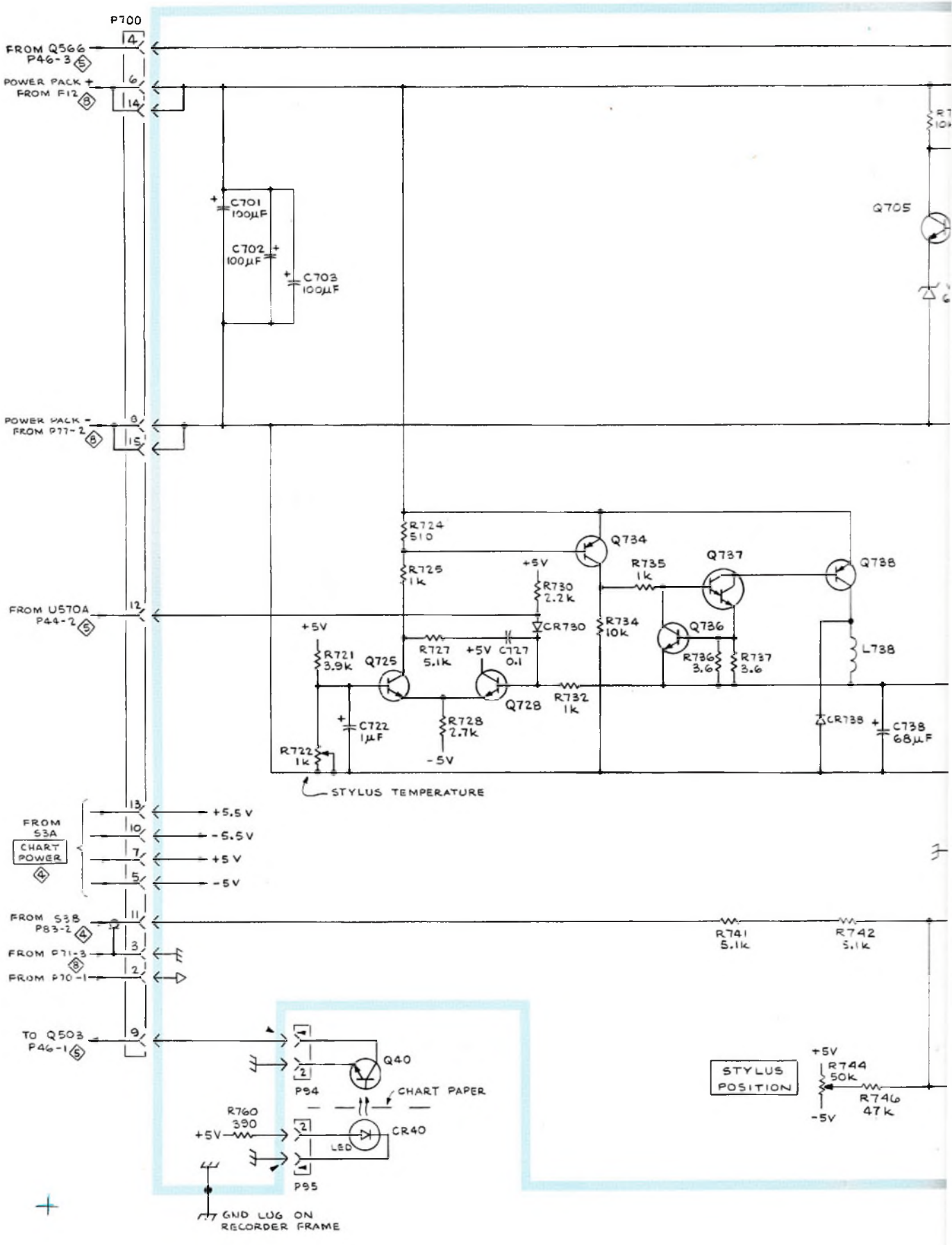
A	Assembly, separable or repairable	FL	Filter	PTM	paper or plastic, tubular molded
AT	Attenuator, fixed or variable	H	Heat dissipating device (heat sink, etc.)	R	Resistor, fixed or variable
B	Motor	HR	Heater	RT	Thermistor
BT	Battery	J	Connector, stationary portion	S	Switch
C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

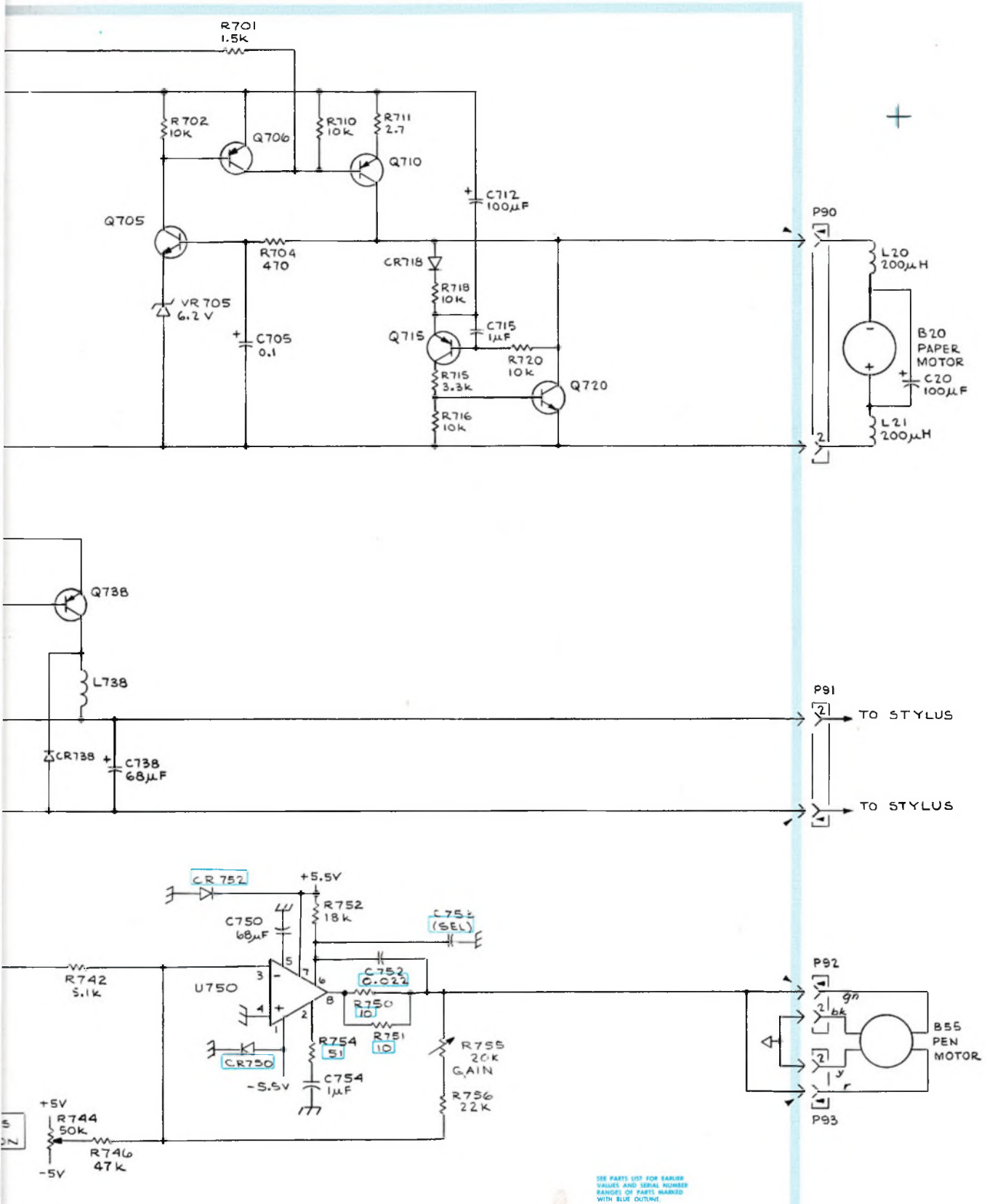
CHART RECORDER ◇1

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A7	670-1742-00	B010100	B039999	CHART CONTROL Circuit Board Assembly
A7	670-1742-01	B040000		CHART CONTROL Circuit Board Assembly
MOTORS				
B20	147-0036-00			Motor, DC, 7.5 V, 420 mV
B55	147-0037-01			Motor, DC, 2 coils, 14 Ω each, 1.5 W
CAPACITORS				
C20	290-0531-00			100 µF, Elect., 10 V, 20%
C701	290-0519-00			100 µF, Elect., 20 V, 20%
C702	290-0519-00			100 µF, Elect., 20 V, 20%
C703	290-0519-00			100 µF, Elect., 20 V, 20%
C605	283-0111-00			0.1 µF, Cer, 50 V
C712	290-0519-00			100 µF, Elect., 20 V, 20%
C715	283-0177-00			1 µF, Cer, 25 V, +80%-20%
C722	290-0522-00			1 µF, Elect., 50 V, 20%
C727	283-0111-00			0.1 µF, Cer, 50 V
C738	290-0530-00			68 µF, Elect., 6 V, 20%
C750	290-0530-00			68 µF, Elect., 6 V, 20%
C752	283-0111-00	B010100	B039999	0.1 µF, Cer, 50 V
C752	283-0191-00	B040000		0.022 µF, Cer, 50 V, 20%
C753	Selected	XB040000		
C754	283-0177-00			1 µF, Cer, 25 V, +80%-20%
DIODES				
CR40	150-1004-01			Diode holder assembly
CR718	152-0141-02			Silicon, replaceable by 1N4152
CR730	152-0141-02			Silicon, replaceable by 1N4152
CR738	152-0502-00			Silicon, replaceable by MBD5300
CR750	152-0333-00	XB040000		Silicon, FDH6012
CR752	152-0333-00	XB040000		Silicon, FDH6012
VR705	152-0280-00			Zener, replaceable by 1N753A, 0.4 W, 6.2 V, 5%
CONNECTORS				
J700	131-1164-00			Receptacle, electrical, 15 pin
P700	131-1165-00			Receptacle, electrical, 15 pin

CHART RECORDER ⓵ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
INDUCTORS				
L20	108-0598-00			200 µH
L21	108-0598-00			200 µH
L738	108-0708-00			75 µH
TRANSISTORS				
Q40	151-0313-01			Silicon, NPN, replaceable by FPT106
Q705	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q706	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q710	151-0335-00			Silicon, PNP, replaceable by MJE370
Q715	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q720	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q725	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q728	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q734	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q736	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q737	151-0331-00			Silicon, NPN, replaceable by D40C8 or selected from D40C5
Q738	151-0366-00			Silicon, PNP, replaceable by X45C277
RESISTORS				
R701	316-0152-00			1.5 kΩ, 1/4 W, 10%
R702	316-0103-00			10 kΩ, 1/4 W, 10%
R704	316-0471-00			470 Ω, 1/4 W, 10%
R710	316-0103-00			10 kΩ, 1/4 W, 10%
R711	307-0103-00			2.7 Ω, 1/4 W, 5%
R715	316-0332-00			3.3 kΩ, 1/4 W, 10%
R716	316-0103-00			10 kΩ, 1/4 W, 10%
R718	316-0103-00			10 kΩ, 1/4 W, 10%
R720	316-0103-00			10 kΩ, 1/4 W, 10%
R721	316-0392-00			3.9 kΩ, 1/4 W, 10%
R722	311-1263-00			1 kΩ, Var
R724	315-0511-00			510 Ω, 1/4 W, 5%
R725	316-0102-00			1 kΩ, 1/4 W, 10%
R727	315-0512-00			5.1 kΩ, 1/4 W, 5%
R728	316-0272-00			2.7 kΩ, 1/4 W, 10%
R730	316-0222-00			2.2 kΩ, 1/4 W, 10%
R732	316-0102-00			1 kΩ, 1/4 W, 10%
R734	316-0103-00			10 kΩ, 1/4 W, 5%
R735	316-0102-00			1 kΩ, 1/4 W, 10%
R736	307-0111-00			3.6 Ω, 1/4 W, 5%
R737	307-0111-00			3.6 Ω, 1/4 W, 5%
R741	315-0512-00			5.1 kΩ, 1/4 W, 5%
R742	315-0512-00			5.1 kΩ, 1/4 W, 5%
R744	311-0580-00			50 kΩ, Var
R746	316-0473-00			47 kΩ, 1/4 W, 10%
R750	315-0100-00	XB040000		10 Ω, 1/4 W, 5%
R751	315-0100-00	XB040000		10 Ω, 1/4 W, 5%
R752	316-0183-00			18 kΩ, 1/4 W, 10%
R754	307-0103-00	B010100	B030000	2.7 Ω, 1/4 W, 5%
R754	315-0510-00	B040000		51 Ω, 1/4 W, 5%
R755	311-0644-00			20 kΩ, Var
R756	316-0223-00			22 kΩ, 1/4 W, 10%
R760	316-0391-00			390 Ω, 1/4 W, 10%
INTEGRATED CIRCUIT				
U750	156-0157-00			Single audio amplifier, replaceable by MFC8010


P700
FROM Q566 P46-3
POWER PACK + FROM F12
POWER PACK - FROM P77-2
FROM U570A P44-2
FROM S3A CHART POWER
FROM S38 P83-2
FROM P71-3
FROM P70-1
TO Q503 P46-1
C701 100µF
C702 100µF
C703 100µF
Q705
R724 510
R725 1k
Q734
+5V
R730 2.2k
R735 1k
Q737
Q738
CR730
R734 10k
Q736
R721 3.9k
Q725
R727 5.1k
+5V
C727 0.1
Q728
R732 1k
R736 3.6
R737 3.6
L738
C722 1µF
R728 2.7k
-5V
R722 1k
CR738
C738 68µF
STYLUS TEMPERATURE
+5.5 V
-5.5 V
+5 V
-5 V
R741 5.1k
R742 5.1k
Q40
P94
CHART PAPER
R760 390
+5V
CR40
LED
P95
GND LUG ON RECORDER FRAME
STYLUS POSITION
+5V
R744 50k
R746 47k
-5V



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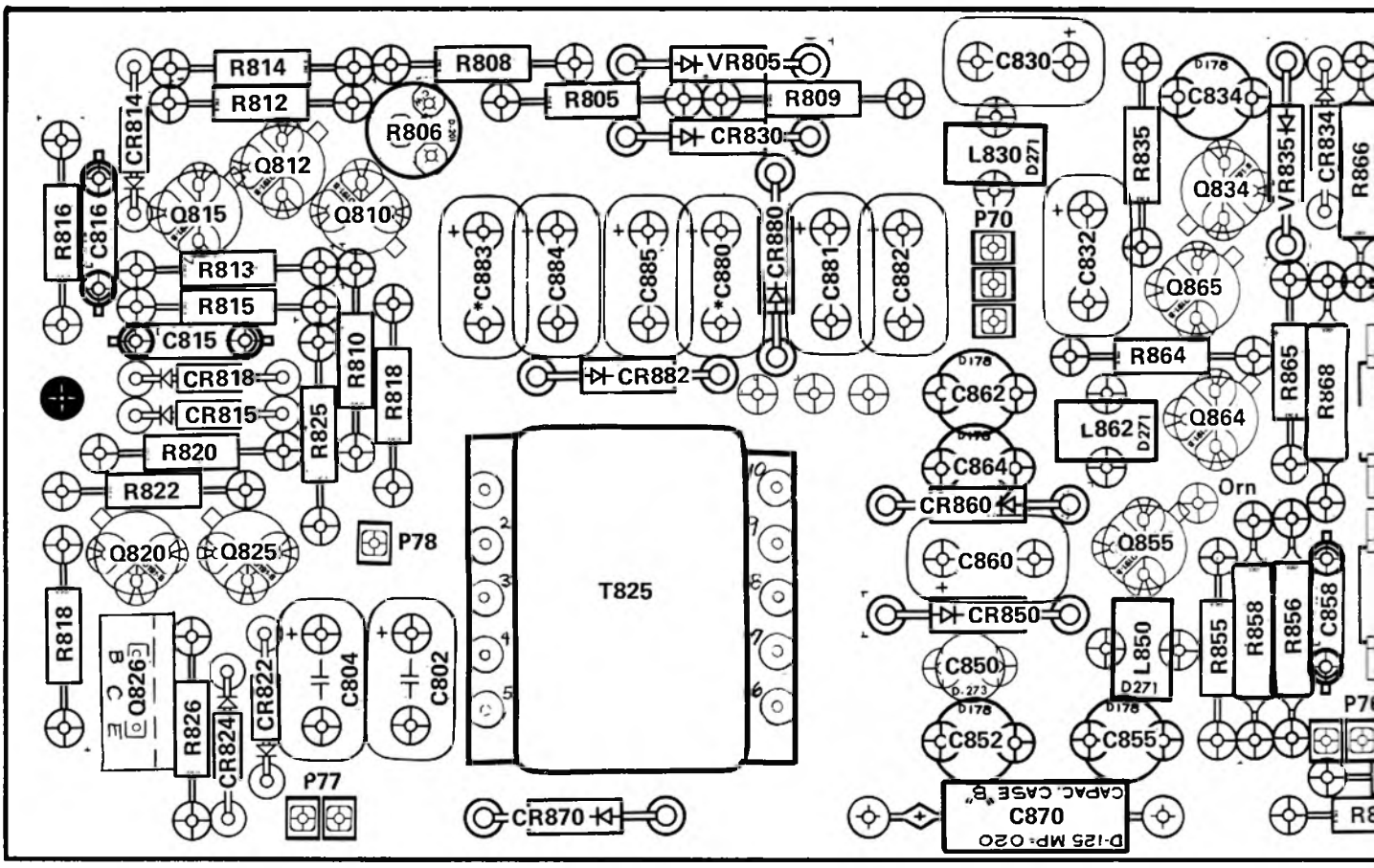
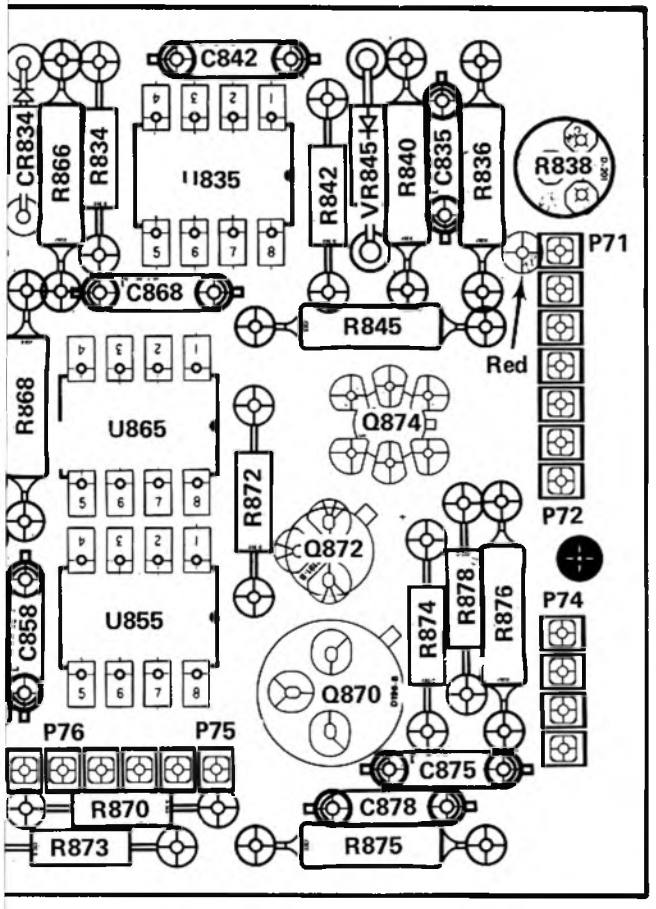
Ⓐ CHART RECORDER 7



*See Parts List for serial number ranges.

Power Supply circuit board

POWER SUPPLY CIRCUIT BOARD


C842
CR834
R866
R834
U835
R842
VR845
R840
C835
R836
R838
P71
C868
R845
Red
R868
U865
Q874
R872
P72
Q872
R878
R876
P74
C858
U855
R874
Q870
P76
P75
C875
R870
C878
R873
R875

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C	Capacitor, fixed or variable	K	Relay	T	Transformer
Cer	Ceramic	L	Inductor, fixed or variable	TP	Test point
CR	Diode, signal or rectifier	LR	Inductor/resistor combination	U	Assembly, inseparable or non-repairable
CRT	cathode-ray tube	M	Meter	V	Electron tube
DL	Delay line	Q	Transistor or silicon-controlled rectifier	Var	Variable
DS	Indicating device (lamp)	P	Connector, movable portion	VR	Voltage regulator (zener diode, etc.)
Elect.	Electrolytic	PMC	Paper, metal cased	WW	wire-wound
EMC	electrolytic, metal cased	PT	paper, tubular	Y	Crystal
EMT	electrolytic, metal tubular				
F	Fuse				

POWER SUPPLY ◈8◈

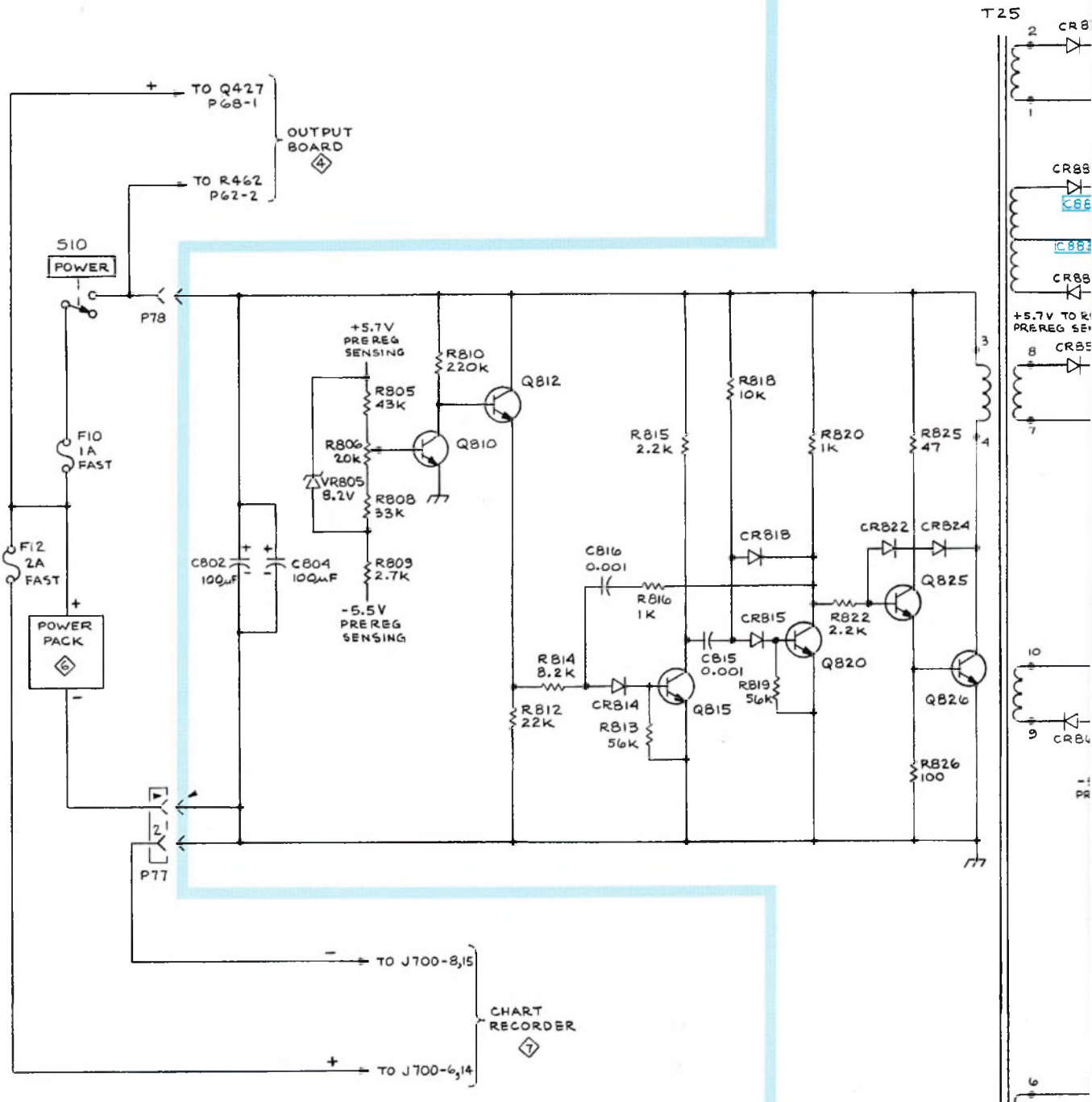
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A8	670-1709-00			POWER SUPPLY Circuit Board Assembly
CAPACITORS				
C802	290-0519-00			100 µF, Elect., 20 V, 20%
C804	290-0519-00			100 µF, Elect., 20 V, 20%
C815	283-0000-00			0.001 µF, Cer, 500 V, 100%-0%
C816	283-0000-00			0.001 µF, Cer, 500 V, 100%-0%
C830	290-0531-00			100 µF, Elect., 10 V, 20%
C832	290-0531-00			100 µF, Elect., 10 V, 20%
C834	290-0529-00			47 µF, Elect., 20 V, 20%
C835	283-0000-00			0.001 µF, Cer, 500 V, +100%-0%
C842	283-0081-00			0.1 µF, Cer, 25 V, +80%-20%
C850	290-0512-00			22 µF, Elect., 15 V, 20%
C852	290-0529-00			47 µF, Elect., 20 V, 20%
C855	290-0529-00			47 µF, Elect., 20 V, 20%
C858	283-0003-00			0.01 µF, Cer, 150 V, +80%-20%
C860	290-0531-00			100 µF, Elect., 10 V, 20%
C862	290-0529-00			47 µF, Elect., 20 V, 20%
C864	290-0529-00			47 µF, Elect., 20 V, 20%
C868	283-0032-00			470 pF, Cer, 500 V, 5%
C870	290-0480-00			0.5 µF, Elect., 200 V
C875	283-0111-00			0.1 µF, Cer, 50 V
C878	283-0111-00			0.1 µF, Cer, 50 V
C880	290-0519-00	B010100	B059999X	100 µF, Elect., 20 V, 20%
C881	290-0519-00	B010100	B059999	100 µF, Elect., 20 V, 20%
C881	290-0671-00	B060000		150 µF, Elect., 15 V, 20%
C882	290-0519-00	B010100	B059999	100 µF, Elect., 20 V, 20%
C882	290-0671-00	B060000		150 µF, Elect., 15 V, 20%
C883	290-0519-00	B010100	B059999X	100 µF, Elect., 20 V, 20%
C884	290-0519-00	B010100	B059999	100 µF, Elect., 20 V, 20%
C884	290-0671-00	B060000		150 µF, Elect., 15 V, 20%
C885	290-0519-00	B010100	B059999	100 µF, Elect., 15 V, 20%
C885	290-0671-00	B060000		150 µF, Elect., 15 V, 20%

POWER SUPPLY ◈8◈ (cont)

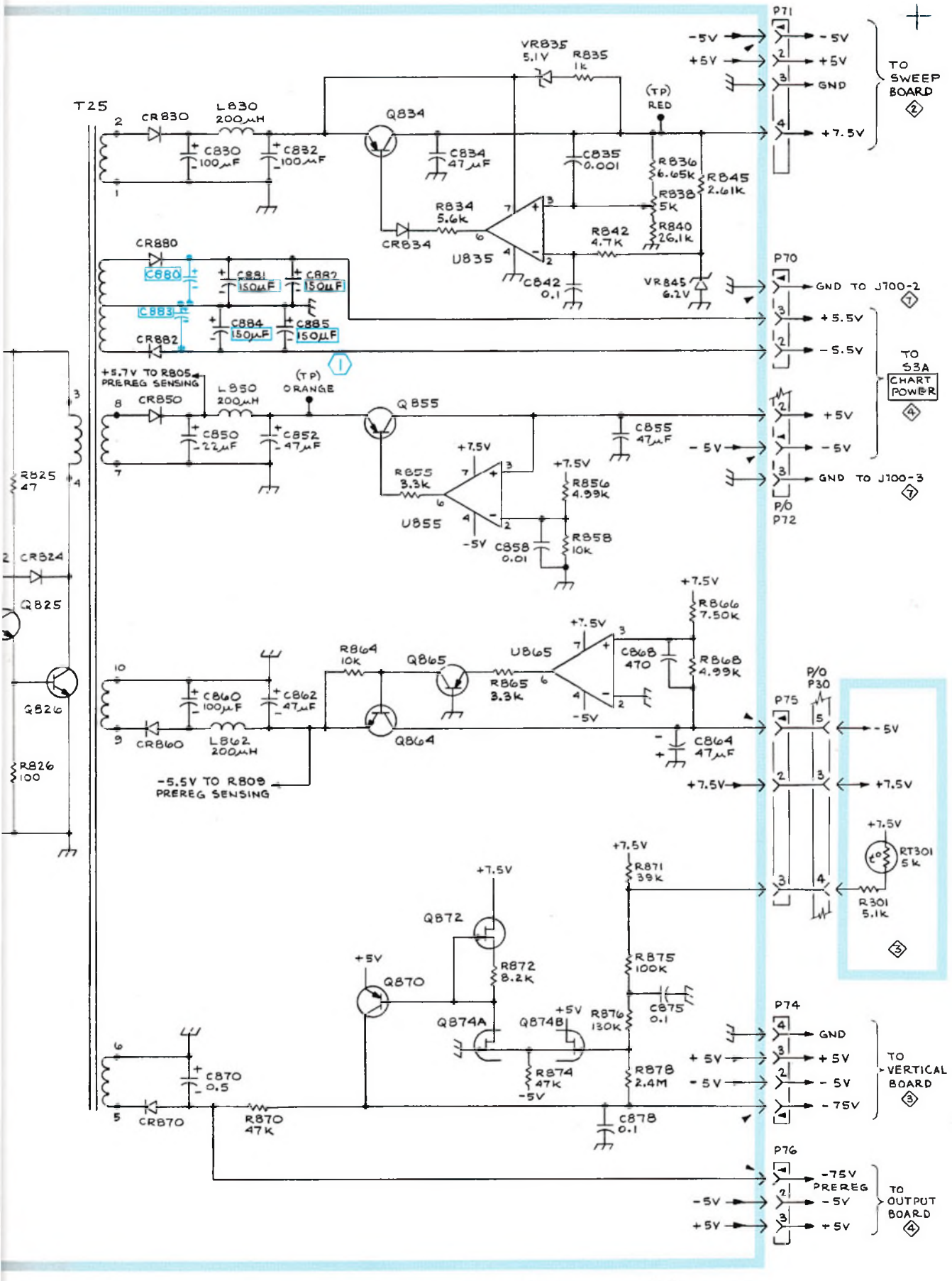
Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
DIODES				
CR814	152-0141-02			Silicon, replaceable by 1N4152
CR815	152-0141-02			Silicon, replaceable by 1N4152
CR818	152-0141-02			Silicon, replaceable by 1N4152
CR822	152-0141-02			Silicon, replaceable by 1N4152
CR824	152-0141-02			Silicon, replaceable by 1N4152
CR830	152-0400-00			Silicon, replaceable by 1N4936
CR834	152-0141-02			Silicon, replaceable by 1N4152
CR850	152-0180-00			Silicon, selected from UTR1112
CR860	152-0180-00			Silicon, selected from UTR1112
CR870	152-0107-00			Silicon, replaceable by TI60 or 1N647
CR880	152-0180-00			Silicon, selected from UTR1112
CR882	152-0180-00			Silicon, selected from UTR1112
VR805	152-0217-00			Zener, selected from 1N756A, 0.4 W, 8.2 V, 5%
VR835	152-0279-00			Zener, replaceable by 1N751A, 0.4 W, 5.1 V, 5%
VR845	152-0280-00			Zener, replaceable by 1N753A, 0.4 W, 6.2 V, 5%
FUSES				
F10	159-0064-00			Cartridge, 1 A, 250 V, fast-blo
F12	159-0107-00			Cartridge, 2 A, 250 V, fast-blo
INDUCTORS				
L830	108-0598-00			200 µH
L850	108-0598-00			200 µH
L862	108-0598-00			200 µH
TRANSISTORS				
Q810	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q812	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q815	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q820	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q825	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q826	151-0352-00			Silicon, NPN, selected from D44C6
Q834	151-0164-00			Silicon, PNP, replaceable by 2N5447 or 2N3702
Q855	151-0164-00			Silicon, PNP, replaceable by 2N5447 or 2N3702
Q864	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q865	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q870	151-0228-00			Silicon, PNP, selected from 2N4888
Q872	151-1004-00			Silicon, FET, selected from 2N4302 or replaceable by U1489
Q874A,B	151-1054-00			Silicon, FET, replaceable by FD1644, dual
RESISTORS				
R301	315-0512-00			5.1 kΩ, 1/4 W, 5%
RT301	307-0124-00			5 kΩ, Thermal
R805	315-0433-00			43 kΩ, 1/4 W, 5%
R806	311-1269-00			20 kΩ, Var
R808	315-0333-00			33 kΩ, 1/4 W, 5%
R809	316-0272-00			2.7 kΩ, 1/4 W, 10%
R810	316-0224-00			220 kΩ, 1/4 W, 10%
R812	316-0223-00			22 kΩ, 1/4 W, 10%
R813	316-0563-00			56 kΩ, 1/4 W, 10%
R814	316-0822-00			8.2 kΩ, 1/4 W, 10%
R815	316-0222-00			2.2 kΩ, 1/4 W, 10%
R816	316-0102-00			1 kΩ, 1/4 W, 10%
R818	316-0103-00			10 kΩ, 1/4 W, 10%

POWER SUPPLY ◈8◈ (cont)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R819	316-0563-00			56 kΩ, 1/4 W, 10%
R820	316-0102-00			1 kΩ, 1/4 W, 10%
R822	316-0222-00			2.2 kΩ, 1/4 W, 10%
R825	316-0470-00			47 Ω, 1/4 W, 10%
R826	316-0101-00			100 Ω, 1/4 W, 10%
R834	316-0562-00			5.6 kΩ, 1/4 W, 10%
R835	316-0102-00			1 kΩ, 1/4 W, 10%
R836	321-0272-00			6.65 kΩ, 1/8 W, 1%
R838	311-0633-00			5 kΩ, Var
R840	321-0329-00			26.1 kΩ, 1/8 W, 1%
R842	316-0472-00			4.7 kΩ, 1/4 W, 10%
R845	321-0233-00			2.61 kΩ, 1/8 W, 1%
R855	316-0332-00			3.3 kΩ, 1/4 W, 10%
R856	321-0260-00			4.99 kΩ, 1/8 W, 1%
R858	321-0289-00			10 kΩ, 1/8 W, 1%
R864	316-0103-00			10 kΩ, 1/4 W, 10%
R865	316-0332-00			3.3 kΩ, 1/4 W, 10%
R866	321-0277-00			7.5 kΩ, 1/8 W, 1%
R868	321-0260-00			4.99 kΩ, 1/8 W, 1%
R870	316-0473-00			47 kΩ, 1/4 W, 10%
R871	315-0393-00			39 kΩ, 1/4 W, 5%
R872	316-0822-00			8.2 kΩ, 1/4 W, 10%
R874	316-0473-00			47 kΩ, 1/4 W, 10%
R875	322-0385-00			100 kΩ, 1/4 W, 1%
R876	322-0396-00			130 kΩ, 1/4 W, 1%
R878	315-0245-00			2.4 MΩ, 1/4 W, 5%
SWITCH				
S10	260-0903-00			Slide, POWER
TRANSFORMER				
T25	120-0745-00			Power, pot core
INTEGRATED CIRCUITS				
U835	156-0067-00			Operational amplifier, replaceable by UA741C
U855	156-0067 00			Operational amplifier, replaceable by UA741C
U865	156-0067-00			Operational amplifier, replaceable by UA741C



SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.



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POWER SUPPLY 8

MECHANICAL PARTS LIST

Replacement parts should be ordered from the Tektronix Field Office or Representative in your area. Changes to Tektronix products give you the benefit of improved circuits and components. Please include the instrument type number and serial number with each order for parts or service.

ABBREVIATIONS

BHB	binding head brass	h	height or high	OHB	oval head brass
BHS	binding head steel	hex.	hexagonal	OHS	oval head steel
CRT	cathode-ray tube	HHB	hex head brass	PHB	pan head brass
csk	countersunk	HHS	hex head steel	PHS	pan head steel
DE	double end	HSB	hex socket brass	RHS	round head steel
FHB	flat head brass	HSS	hex socket steel	SE	single end
FHS	flat head steel	ID	inside diameter	THB	truss head brass
Fil HB	fillister head brass	lg	length or long	THS	truss head steel
Fil HS	fillister head steel	OD	outside diameter	w	wide or width

FIGURE 1 MAIN FRAME

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
1-1	366-1190-00			1	KNOB, gray--REFLECTION %/DIV
	- - - - - -			-	knob includes:
	213-0153-00			2	SETSCREW, 5-40 x 0.125 inch, HSS
-2	366-0494-00			2	KNOB, gray--DISPLAY OFFSET & CABLE
	- - - - - -			-	each knob includes:
	213-0153-00			1	SETSCREW, 5-40 x 0.125 inch, HSS
-3	366-0215-02			1	KNOB, lever switch
-4	366-1257-63			1	PUSHBUTTON--STEP
-5	366-1257-64			1	PUSHBUTTON--NOISE FILTER
-6	366-1257-65			1	PUSHBUTTON--CHART POWER
-7	366-1257-66			1	PUSHBUTTON--EXT SIG
-8	426-0681-00			+ 4	FRAME, pushbutton
-9	- - - - - -			1	RESISTOR, variable (See R8 electrical list)
	- - - - - -			-	mounting hardware: (not included w/resistor)
-10	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-11	210-0940-00			1	WASHER, flat 0.25 ID x 0.375 inch OD
-12	- - - - - -			1	RESISTOR, variable (See R6 electrical list)
	- - - - - -			-	mounting hardware: (not included w/resistor)
-13	358-0342-00			1	BUSHING
-14	210-0046-00			1	WASHER, lock, internal 0.261 ID x 0.40 OD
-15	220-0510-00			1	NUT, hex., 0.25-32 x 0.312 inch
-16	260-0247-00	B010100	B049999	1	SWITCH, push (S2)
	260-0324-00	B050000		1	SWITCH, push (S2)
	- - - - - -			-	mounting hardware: (not included w/switch)
-17	210-0583-00			1	NUT, hex., 0.25-32 x 0.312 inch
-18	210-0940-00			1	WASHER, flat, 0.25 ID x 0.375 inch OD
-19	210-0223-00			1	TERMINAL, lug, 0.25 inch diameter, SE
-20	260-1329-00			1	SWITCH, rotary reel (S7)
	- - - - - -			-	mounting hardware: (not included w/switch)
-21	210-0590-00			1	NUT, hex., 0.375 x 0.437 inch
-22	210-0978-00			1	WASHER, flat, 0.375 ID x 0.50 inch OD

FIGURE 1 MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	Description 1 2 3 4 5
1-23	260-1330-00			1	SWITCH, rotary cable (S6)
	- - - - - -			-	mounting hardware: (not included w/switch)
-24	220-0480-02			1	NUT, dodecagon, black
-25	210-0590-00			1	NUT, hex., 0.375 x 0.437 inch
-26	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--LOGIC (See A5 electrical list)
	- - - - - -			-	circuit board assembly includes:
-27	131-0608-00			11	TERMINAL, pin, 0.365 inch long
-28	136-0252-04			133	SOCKET, pin connector
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-29	211-0116-00			3	SCREW, sems, 4-40 x 0.312 inch, PHB
-30	- - - - - -			1	RESISTOR, variable (See R1 electrical list)
-31	333-1496-00			1	PANEL, front
	333-1496-01			1	PANEL, front (Used on Option 2 & 3 only)
-32	200-0609-00			1	BASE, lampholder
-33	352-0084-00			1	LAMPHOLDER
	149-0031-02			1	METER, battery level ASSEMBLY
	- - - - - -			-	meter includes:
-34	149-0031-00			1	METER, battery level
	131-0708-00			2	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not included w/meter)
-35	352-0243-00			1	HOLDER, indicator
-36	214-0992-00			1	INDICATOR, switch position
-37	260-0903-00			1	SWITCH, slide (S10)
	- - - - - -			-	mounting hardware: (not included w/switch)
-38	210-0586-00			2	NUT, keps, 4-40 x 0.25 inch
-39	211-0005-00			2	SCREW, 4-40 x 0.125 inch, PHS
-40	386-2072-00			1	PLATE, mounting
-41	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--OUTPUT (See A4 electrical list)
	- - - - - -			-	circuit board assembly includes:
-42	131-0608-00			31	TERMINAL, pin, 0.365 inch long
-43	214-0579-00			3	TEST POINT
-44	136-0252-04			45	SOCKET, pin connector
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-45	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB
-46	384-1061-01			1	SHAFT, extension
-47	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--VERTICAL (See A3 electrical list)
	- - - - - -			-	circuit board includes:
-48	136-0252-01			8	SOCKET, pin connector
	136-0252-04			60	SOCKET, pin connector
-49	131-0608-00			20	TERMINAL, pin, 0.365 long
-50	214-0579-00			3	TEST POINT

FIGURE 1 MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description
1-51	344-0061-00	B010100	B010127X	4	CLIP, diode
-52	129-0250-00			1	POST, 0.925 inch long
-53	129-0106-00			2	POST, 0.125 inch long
-54	131-1003-00			1	RECEPTICAL, coaxial (J346)
-55	260-0960-01			1	SWITCH, slide (S345)
-56	260-1333-00			1	SWITCH, push (S4)
-57	361-0384-00			4	SPACER, 0.133 inch long
-58	260-1332-00			1	SWITCH, push (S1)
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-59	211-0007-00			3	SCREW, 4-40 x 0.188 inch, PHS
-60	441-1036-00			1	CHASSIS, vertical & side board
	- - - - - -			-	mounting hardware: (not included w/chassis)
-61	211-0502-00			3	SCREW, 6-32 x 0.188 inch, 100° csk, FHS
-62	211-0504-00			2	SCREW, 6-32 x 0.25 inch, PHS
-63	200-0103-00			2	CAP, binding post
-64	355-0507-00			1	STEM, binding post
	- - - - - -			-	mounting hardware: (not included w/stem)
-65	210-0455-00			1	NUT, hex., 0.25-28 x 0.375 inch
-66	210-0046-00			1	WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-67	355-0507-00			1	STEM, binding post
	- - - - - -			-	mounting hardware: (not included w/stem)
-68	210-0455-00			1	NUT, hex., 0.25-28 x 0.375 inch
-69	210-0223-00			1	TERMINAL, lug, 0.25 inch diameter, SE
-70	131-1145-00			1	CONNECTOR, w/hardware (J15)
	- - - - - -			-	mounting hardware: (not included w/connector)
-71	210-0255-00			1	TERMINAL, lug, 0.391 inch diameter, SE
-72	131-0106-01			2	CONNECTOR, BNC, w/hardware (J11 & J13)
-73	131-0106-01			2	CONNECTOR, BNC, w/hardware (J10 & J12)
	- - - - - -			-	mounting hardware for each: (not included w/connector)
-74	210-0255-00			1	TERMINAL, lug, 0.391 inch diameter, SE
-75	334-1857-00			1	PLATE, identification, upper
-76	334-1858-00			1	PLATE, identification, lower
-77	352-0266-00			2	FUSEHOLDER
	- - - - - -			-	mounting hardware for each: (not included w/fuseholder)
-78	210-0405-00			1	NUT, hex., 2-56 x 0.188 inch
-79	210-0053-00			1	WASHER, lock, .092 ID x 0.175 inch OD
-80	211-0112-00			1	SCREW, 2-56 x 0.375 inch, 100° csk, FHS

FIGURE 1 MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
1-81	352-0135-00			1	FUSEHOLDER, spare
	- - - - - -			-	mounting hardware: (not included w/fuseholder)
-82	361-0007-00			2	SPACER, plastic
-83	386-2219-00			1	PLATE, indexing battery pack
	- - - - - -			-	mounting hardware: (not included w/plate)
-84	213-0012-00			1	SCREW, thread cutting, 4-40 x 0.375 inch 100° csk, FHS
-85	213-0034-00			1	SCREW, thread cutting, 4-40 x 0.312 inch, PHS
-86	361-0501-00			2	SPACER, 0.219 inch long
-87	105-0062-02			1	CATCH, friction
	- - - - - -			-	mounting hardware: (not included w/catch)
-88	211-0192-00			1	SCREW, shouldered, 4-40 x 0.34 inch
-89	210-0907-00			2	WASHER, retaining, 0.25 inch OD
-90	210-0948-00			1	WASHER, plastic, 0.166 ID x 0.216 inch OD
-91	407-0988-00			1	BRACKET
	- - - - - -			-	mounting hardware: (not included w/bracket)
-92	211-0504-00			4	SCREW, 6-32 x 0.25 inch, PHS
-93	386-2116-00			1	SUPPORT, power supply
	- - - - - -			-	mounting hardware: (not included w/support)
-94	211-0502-00			2	SCREW, 6-32 x 0.188 inch, 100° csk, FHS
-95	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--POWER SUPPLY (See A8 electrical list)
	- - - - - -			-	circuit board assembly includes:
-96	131-0608-00			24	TERMINAL, pins, 0.365 inch long
-97	136-0252-04			63	SOCKET, pin connector
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-98	220-0438-00			4	NUT, hex., 4-40 x 0.25 inch long
-99	220-0449-00			4	NUT, sleeve, 4-40 x 0.50 inch long
-100	342-0109-00			1	INSULATOR
-101	441-1034-00			1	CHASSIS, power supply
	- - - - - -			-	mounting hardware: (not included w/chassis)
-102	211-0504-00			2	SCREW, 6-32 x 0.25 inch, PHS
-103	131-1165-00			1	CONNECTOR, receptical (P700)
	- - - - - -			-	mounting hardware: (not included w/connector)
-104	211-0034-00			2	SCREW, 2-56 x 0.50 inch, PHS
-105	166-0024-00			2	SPACER, tube, 0.125 inch long

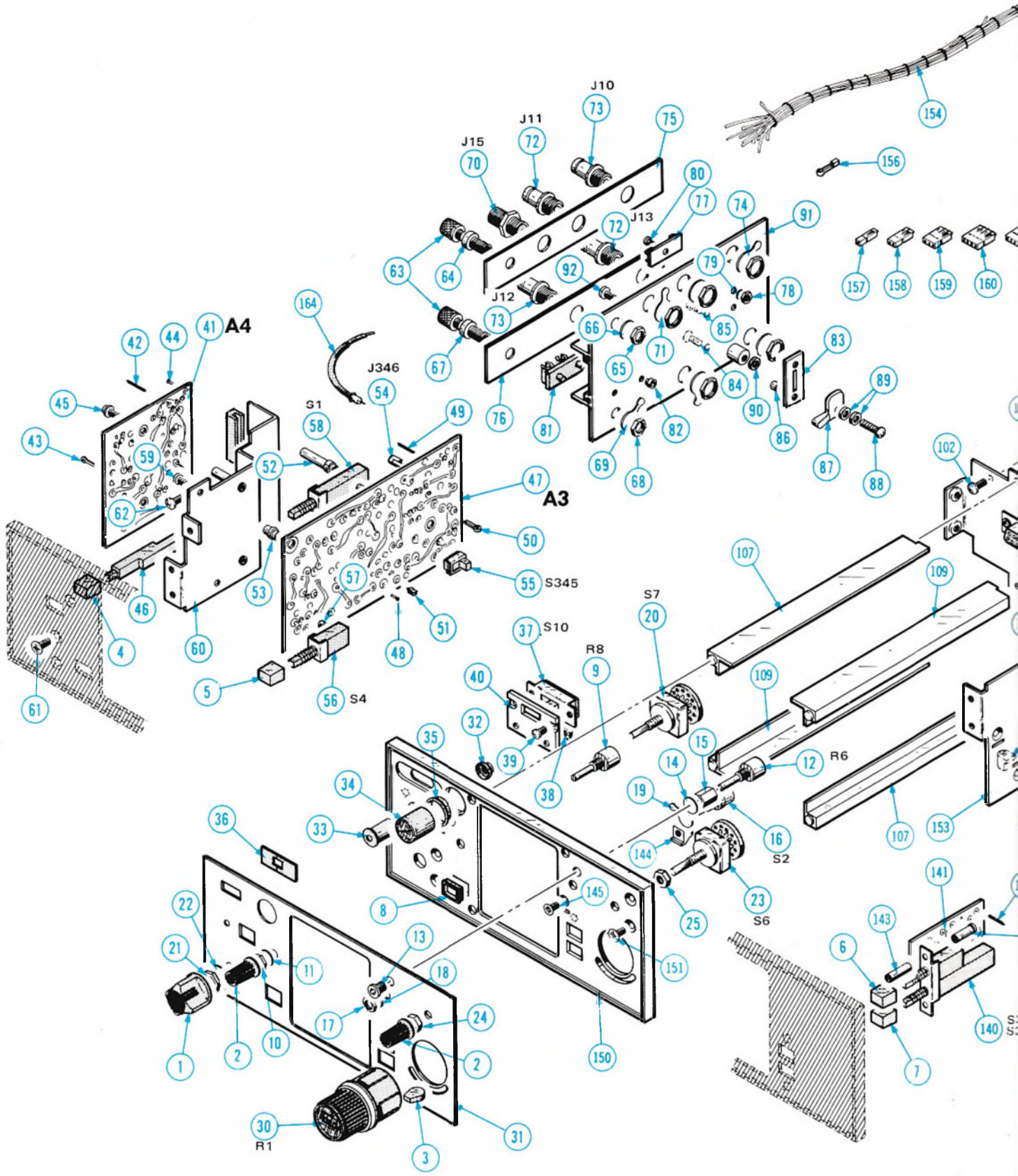
FIGURE 1 MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
1-106	252-0564-00			ft	CHANNEL, plastic, 0.5 foot
-107	351-0315-00			2	GUIDE, plug-in, bottom right & top left
	- - - - - -			-	mounting hardware for each: (not included w/guide)
-108	211-0504-00			1	SCREW, 6-32 x 0.25 inch, PHS
-109	351-0317-00			2	GUIDE, plug-in, bottom left & top right
	- - - - - -			-	mounting hardware for each: (not included w/guide)
-110	211-0504-00			1	SCREW, 6-32 x 0.25 inch, PHS
-111	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--SWEEP (See A2 electrical list)
	- - - - - -			-	circuit board includes:
-112	136-0263-03			5	SOCKET, pin connector
-113	136-0252-04			50	SOCKET, pin connector
-114	131-0608-00			13	TERMINAL, pin, 0.365 inch long
-115	214-0579-00			2	TEST POINT
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-116	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
-117	220-0449-00			2	NUT, sleeve, 4-40 x 0.50 inch long
-118	214-1657-00			1	LEVER, cam switch
	- - - - - -			-	lever includes:
-119	211-0183-00			1	SCREW, 4-40 x 0.50 inch, SHS
-120	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--FAST RAMP (See A1 electrical list)
	- - - - - -			-	circuit board assembly includes:
-121	131-0592-00			5	TERMINAL, pin, 0.885 inch long
	131-0608-00			9	TERMINAL, pin, 0.365 inch long
-122	136-0252-04			97	SOCKET, pin connector
-123	214-0579-00			4	TEST POINT
-124	351-0155-00			2	TERMINAL, lead guide
-125	131-0604-00			7	CONTACT, electrical, cam switch
	105-0298-00			1	CAM SWITCH ASSEMBLY
	- - - - - -			-	cam switch assembly includes:
-126	200-1312-00			1	COVER, cam switch
	- - - - - -			-	mounting hardware: (not included w/cover)
-127	211-0022-00			2	SCREW, 2-56 x 0.188 inch, PHS
-128	210-0001-00			2	WASHER, lock, internal, 0.92 ID x 0.18 inch OD
-129	210-0405-00			2	NUT, hex., 2-56 x 0.187 inch
-130	354-0219-00			1	RING, retainer
-131	401-0057-01			1	BEARING, cam switch, front
-132	214-1139-01[1]			-	SPRING, flat, gold
	214-1139-02[1]			-	SPRING, flat, green
	214-1139-03[1]			-	SPRING, flat, red
-133	214-1127-00			1	ROLLER, detent
-134	105-0295-00			1	DRUM, cam switch
-135	401-0056-00			1	BEARING, cam switch, rear
-136	210-0406-00			4	NUT, hex., 4-40 x 0.187 inch
	- - - - - -			-	mounting hardware: (not included w/cam switch assembly)
-137	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB
	- - - - - -			-	mounting hardware: (not included w/circuit board assembly)
-138	211-0116-00			4	SCREW, sems, 4-40 x 0.312 inch, PHB

[1]Replace only with part bearing the same color code as the original part in your instrument.

FIGURE 1 MAIN FRAME (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-	262-0960-00			1		SWITCH ASSEMBLY
	- - - - - -			-		switch assembly includes:
-139	131-0592-00			7		TERMINAL, pin, 0.885 inch long
	131-0787-00			11		TERMINAL, pin, 0.64 inch long
-140	260-1331-00			1		SWITCH, push (S3A & S3B
-141	388-2742-00			1		CIRCUIT BOARD
	- - - - - -			-		mounting hardware: (not included w/switch assembly)
-142	210-0599-00			2		NUT, sleeve, 4-40 x 0.391 inch long
-143	361-0502-00			2		SPACER, sleeve, 0.469 inch long
-144	220-0547-01			3		NUT, block
	- - - - - -			-		mounting hardware for each: (not included w/nut)
-145	211-0105-00			1		SCREW, 4-40 x 0.188 inch, 100° csk, FHS
-146	220-0547-01			2		NUT, block
	- - - - - -			-		mounting hardware for each: (not included w/nut)
-147	211-0007-00			1		SCREW, 4-40 x 0.188 inch, PHS
-148	220-0547-03			2		NUT, block
	- - - - - -			-		mounting hardware for each: (not included w/nut)
-149	211-0105-00			1		SCREW, 4-40 x 0.188 inch, 100° csk, FHS
-150	426-0824-01			1		FRAME, panel front
	- - - - - -			-		mounting hardware: (not included w/frame)
-151	211-0502-00			2		SCREW, 6-32 x 0.188 inch, 100° csk, FHS
-152	348-0145-00			1		GROMMET, U-shaped
	002-0147-00			SI		SHEET, plastic 1 x 6 inches long (not shown)
-153	441-1035-00			1		CHASSIS
-154	179-1784-00			1		WIRING HARNESS
	- - - - - -			-		wiring harness includes:
-155	131-0707-00			98		CONNECTOR, terminal
	131-0708-00			18		CONNECTOR, terminal
-156	131-0740-01			2		CONNECTOR, terminal
	131-0755-01			2		CONNECTOR, terminal
-157	352-0171-00			1		HOLDER, terminal connector, 1 wire (black)
-158	352-0169-00			9		HOLDER, terminal connector, 2 wire (black)
-159	352-0161-00			9		HOLDER, terminal connector, 3 wire (black)
-160	352-0162-00			7		HOLDER, terminal connector, 4 wire (black)
-161	352-0163-00			4		HOLDER, terminal connector, 5 wire (black)
-162	352-0164-00			1		HOLDER, terminal connector, 6 wire (black)
-163	352-0167-00			1		HOLDER, terminal connector, 9 wire (black)
-164	175-1410-00			1		CABLE ASSEMBLY, coaxial w/connector (J15 to J346)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J11
J15
J13
J12
S345
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S10
R8
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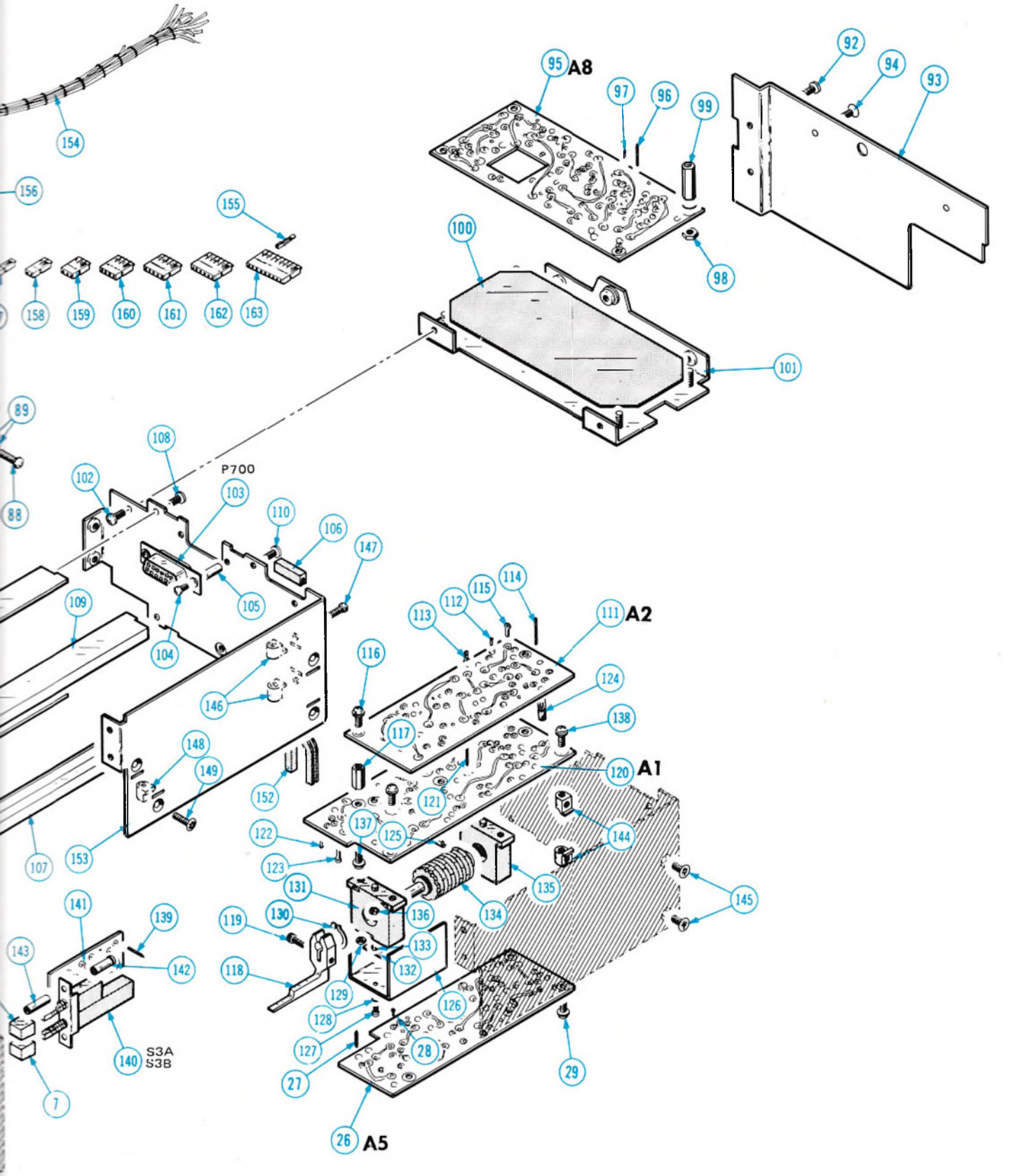
R6
S2
S6
R1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P700
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A2
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S3A
S3B
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FIGURE 2 CHART RECORDER

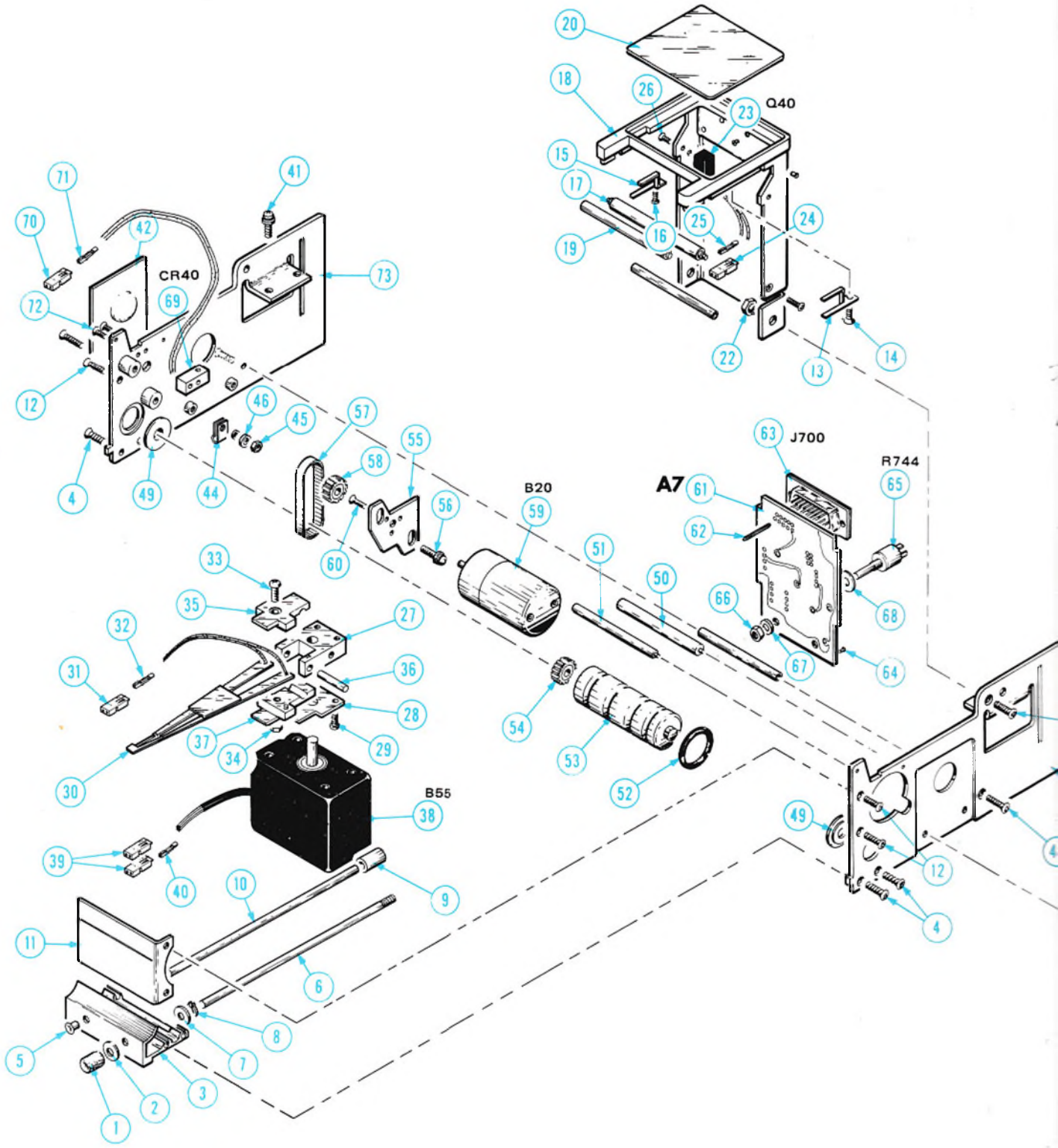
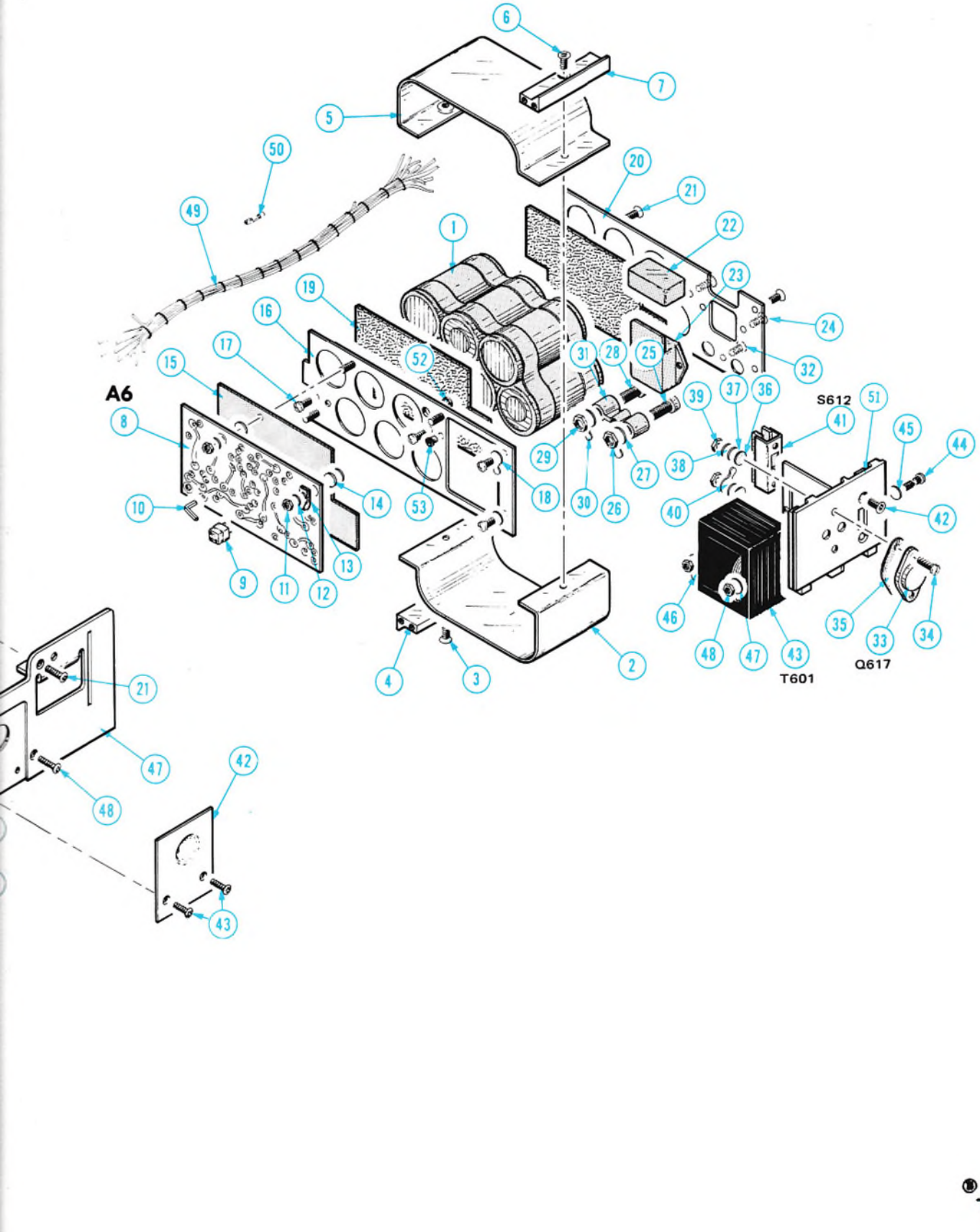
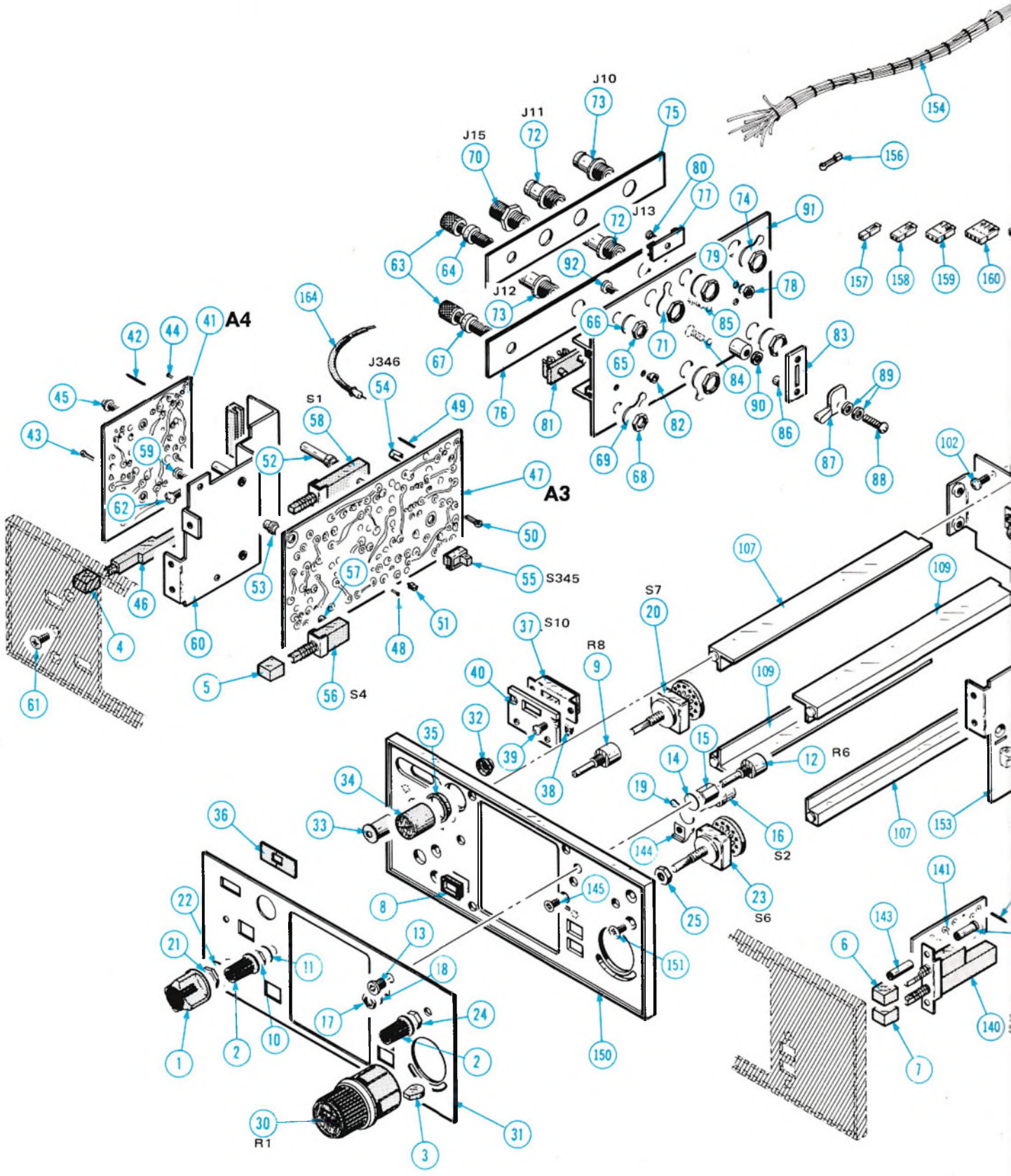


FIGURE 3 POWER PACK

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S345
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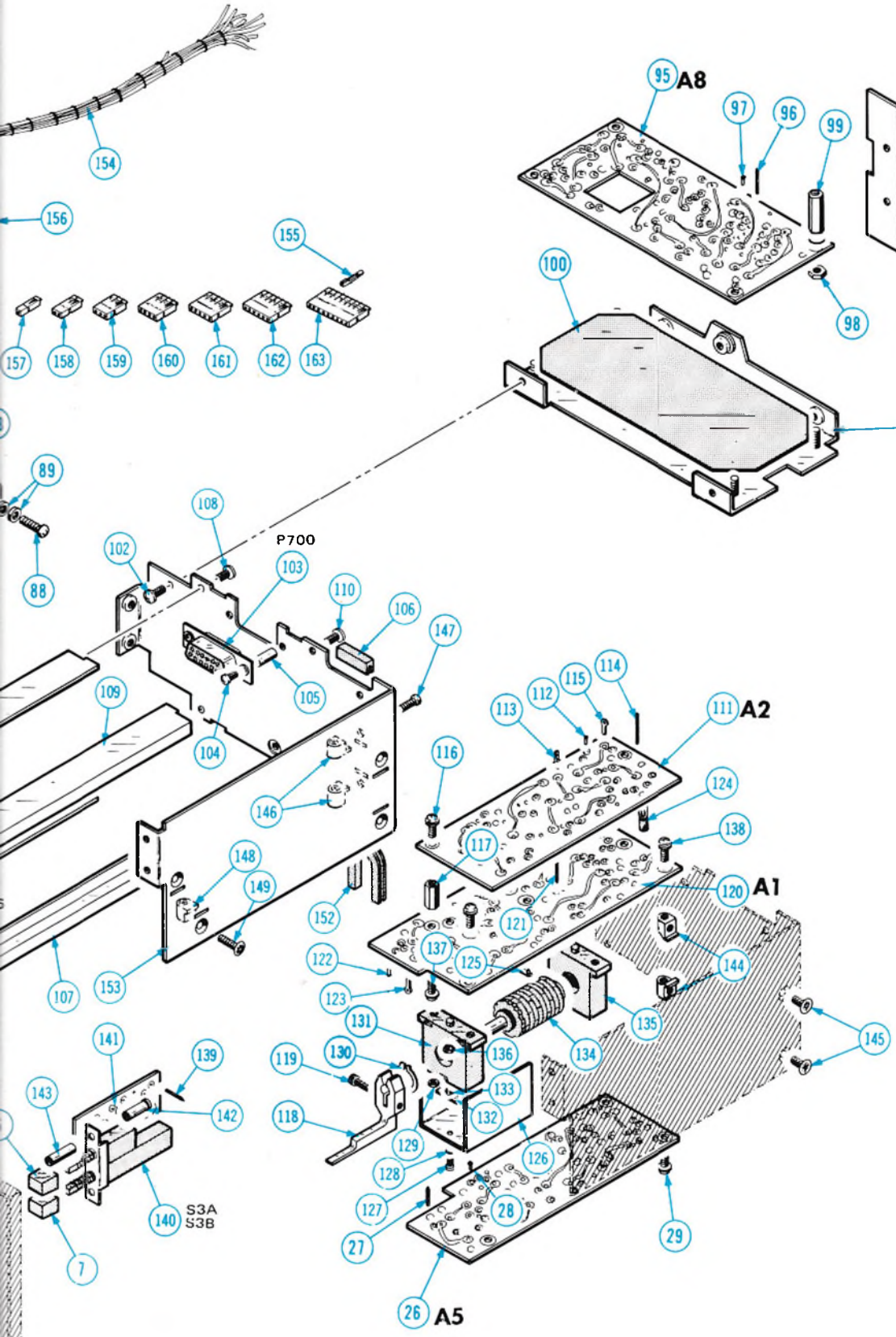
S6
R1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P700
103
110
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147
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111
A2
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138
117
120
A1
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S3A
S3B
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FIGURE 2 CHART RECORDER

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
2-1	366-1368-00			1	KNOB, plug-in, securing
	- - - - - -			-	knob includes:
	213-0076-00			1	SETSCREW, 2-56 x 0.125 inch, HSS
-2	210-1011-00			1	WASHER, plastic, 0.117 ID x 0.375 inch OD
-3	426-0852-00			1	FRAME SECTION, front
	- - - - - -			-	mounting hardware: (not included w/frame section)
-4	211-0101-00			4	SCREW, 4-40 x 0.250 inch, 100° csk, FHS
-5	358-0378-00			1	BUSHING
-6	384-0824-00			1	ROD, securing
-7	210-0803-00			1	WASHER, flat, 0.150 ID x 0.375 inch OD
-8	354-0175-00			1	RING, retainer
-9	376-0029-00			1	COUPLER
	- - - - - -			-	coupler includes:
	213-0075-00			2	SETSCREW, 4-40 x 0.9375 inch, HSS
-10	384-1157-00			1	SHAFT, extension
-11	386-2118-00			1	PLATE, backing
	- - - - - -			-	mounting hardware: (not included w/plate)
-12	211-0030-00			3	SCREW, 2-56 x 0.250 inch, 82° csk, FHS
-13	214-1678-00			1	SPRING, roller tension, right
	- - - - - -			-	mounting hardware: (not included w/spring)
-14	213-0254-00			1	SCREW, thread cutting, 2-56 x 0.250 inch, 100° csk, FHS
-15	214-1679-00			1	SPRING, roller tension, left
	- - - - - -			-	mounting hardware: (not included w/spring)
-16	213-0254-00			1	SCREW, thread cutting, 2-56 x 0.250 inch, 100° csk, FHS
-17	214-1674-00			1	ROLLER, chart paper driven
-18	200-1302-01			1	BEZEL ASSEMBLY
	- - - - - -			-	bezel assembly includes:
-19	214-1663-00			1	ROLLER, chart paper
-20	331-0298-00			1	WINDOW, observation
	- - - - - -			-	mounting hardware: (not included w/bezel assy)
-21	211-0101-00			2	SCREW, 4-40 x 0.250 inch, 100° csk, FHS
-22	220-0629-00			2	NUT, sleeve
-23	- - - - - -			1	TRANSISTOR HOLDER ASSEMBLY (See Q40 electrical list)
	- - - - - -			-	transistor holder assembly includes:
-24	352-0169-00			1	HOLDER, terminal connector, 2 wire
-25	131-0707-00			2	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not included w/transistor holder assy)
-26	213-0254-00			2	SCREW, 2-56 x 0.250 inch, 100° csk, FHS

FIGURE 2 CHART RECORDER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	Description 1 2 3 4 5
2-27	214-1681-00			1	HINGE, half, stationary
	- - - - - -			-	hinge includes:
	213-0205-00			1	SETSCREW, 4-40 x 0.188 inch, HSS
-28	214-1680-00			1	SPRING, pen hinge
	- - - - - -			-	mounting hardware: (not included w/spring)
-29	211-0116-00			2	SCREW, sems, 4-40 x 0.312 inch, PHB
-30	119-0365-01			1	STYLUS
	- - - - - -			-	stylus includes:
-31	352-0169-00			1	HOLDER, terminal connector, 2 wire
-32	131-0708-00			2	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not included w/stylus)
-33	211-0008-00			1	SCREW, 4-40 x 0.187 inch
-34	210-0406-00			1	NUT, hex., 4-40 x 0.187 inch
-35	214-1682-00			1	HINGE, half, upper
-36	214-1749-00			1	PIN, hinge
-37	214-1682-01			1	HINGE, half, lower
-38	147-0037-01			1	MOTOR D.C. (B55)
	- - - - - -			-	motor includes:
-39	352-0169-00			2	HOLDER, terminal connector
-40	131-0707-00			4	CONNECTOR, terminal
	- - - - - -			-	mounting hardware: (not included w/motor)
-41	211-0601-00			4	SCREW, sems, 6-32 x 0.312 inch, PHB
-42	352-0296-00			2	HOLDER, paper
	- - - - - -			-	mounting hardware for each: (not included w/holder)
-43	211-0112-00			2	SCREW, 2-56 x 0.375 inch, 100° csk, FHS
-44	343-0119-00			1	CLAMP, cable, 0.094 inch diameter
	- - - - - -			-	mounting hardware: (not included w/clamp)
-45	210-0405-00			1	NUT, hex., 2-56 x 0.187 inch
	210-0053-00			1	WASHER, lock, split, 0.092 ID x 0.175 inch OD
-46	210-0850-00			1	WASHER, flat, .093 ID x 0.281 inch OD
-47	426-0837-00			1	FRAME SECTION, right slide
	- - - - - -			-	mounting hardware: (not included w/frame)
-48	211-0030-00			1	SCREW, 2-56 x 0.250 inch, 82° csk, FHS

FIGURE 2 CHART RECORDER (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
2-49	401-0147-00			2		BEARING, drive roller
-50	214-1662-00			1		ROLLER, chart paper (stationary)
-51	214-1664-00			1		ROLLER, chart paper (stylus)
-52	354-0429-00			4		RING, rubber
-53	214-1675-01			1		ROLLER, chart paper (drive core)
-54	401-0186-02			1		SPROCKET, wheel
	- - - - - -			-		sprocket includes:
	213-0140-00			1		SETSCREW, 2-56 x 0.094 inch, HSS
-55	386-2084-00			1		PLATE, motor mounting
	- - - - - -			-		mounting hardware: (not included w/motor)
-56	211-0116-00			2		SCREW, sems, 4-40 x 0.312 inch, PHB
-57	214-1709-00			1		BELT, positive drive
-58	401-0186-01			1		SPROCKET, wheel
	- - - - - -			-		sprocket includes:
	213-0076-00			1		SETSCREW, 2-56 x 0.125 inch, HSS
-59	147-0036-00			1		MOTOR, paper drive (B20)
	- - - - - -			-		mounting hardware: (not included w/motor)
-60	211-0202-00			3		SCREW, 1.7 x 5 MM, 90° csk, FHS
-61	- - - - - -			1		CIRCUIT BOARD ASSEMBLY (See A7 electrical list)
	- - - - - -			-		circuit board includes:
-62	131-0608-00			12		TERMINAL, pin, 0.365 inch long
-63	131-1164-00			1		CONNECTOR, receptical electrical (J700)
-64	136-0252-04			15		SOCKET, pin, connector
-65	- - - - - -			1		RESISTOR, variable (See R744 electrical list)
	- - - - - -			-		mounting hardware: (not included w/resistor)
-66	210-0583-00			1		NUT, hex., 0.25-32 x 0.312 inch
-67	210-0940-00			1		WASHER, flat, 0.25 ID x 0.375 inch OD
-68	210-0992-00			1		WASHER, plastic, 0.265 ID x 0.437 inch OD
-69	- - - - - -			1		DIODE HOLDER ASSEMBLY (See CR40 electrical list)
	- - - - - -			-		diode holder assembly includes:
-70	352-0169-00			1		HOLDER, terminal connector, 2 wire
-71	131-0707-00			2		CONNECTOR, terminal
	- - - - - -			-		mounting hardware: (not included w/diode holder assy)
-72	213-0254-00			2		SCREW, thread cutting, 2-56 x 0.250 inch, 100° csk, FHS
-73	426-0838-00			1		FRAME SECTION, left
-74	129-0326-00			1		POST, metalic, 2.10 inches long, 0.125 inch OD
	- - - - - -			-		mounting hardware: (not included w/post)
-75	211-0030-00			2		SCREW, 2-56 x 0.250 inch, 82° csk, FHS
-76	129-0327-00			1		POST, metalic, 2.024 inches long, 0.188 inch OD

FIGURE 3 POWER PACK

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5 Description
3-	016-0119-02			1	POWER PACK, w/batteries
	- - - - - -			-	power pack includes:
-1	146-0012-01			1	BATTERY SET
	- - - - - -			-	battery set includes:
	146-0011-01			6	BATTERY, NiCd, 1.25 V, solder lug type
	016-0119-01			-	POWER PACK, w/o batteries
	- - - - - -			-	power pack includes:
-2	343-0148-00			1	CLAMP, battery retaining
	- - - - - -			-	mounting hardware: (not included w/clamp)
-3	211-0025-00			1	SCREW, 4-40 x 0.375 inch, 100° csk, FHS
-4	105-0063-00			1	STRIKE, post
-5	343-0148-03			1	CLAMP, battery retaining
	- - - - - -			-	mounting hardware: (not included w/clamp)
-6	211-0025-00			1	SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-7	105-0063-00			1	STRIKE, post
-8	- - - - - -			1	CIRCUIT BOARD ASSEMBLY--BATTERY CHARGER (See A6
	- - - - - -			-	electrical parts list)
	- - - - - -			-	circuit board assembly includes:
-9	136-0220-00			4	SOCKET, transistor, 3 pin, square
	214-0506-00			3	CONNECTOR, square pin
-10	214-0507-00			4	CONNECTOR, square pin, angled
	- - - - - -			-	mounting hardware: (not included w/circuit board assy)
-11	210-0406-00			6	NUT, hex., 4-40 x 0.188 inch
-12	210-0004-00			3	WASHER, lock, internal, 0.12 ID x 0.26 inch OD
-13	343-0119-00			1	CLAMP, cable, 0.094 inch diameter
-14	210-0994-00			2	WASHER, flat, 0.125 ID x 0.25 inch OD
-15	214-1059-00			1	INSULATOR
-16	386-1328-00			1	PLATE, battery box, inside
	- - - - - -			-	mounting hardware: (not included w/plate)
-17	211-0008-00			5	SCREW, 4-40 x 0.25 inch, PHS
-18	210-0201-00			1	TERMINAL, lug, 0.12 inch diameter, SE
-19	214-1013-01			2	INSULATOR, plate, foam
-20	386-1327-00			1	PLATE, battery box, outside
	- - - - - -			-	mounting hardware: (not included w/plate)
-21	211-0101-00			6	SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-22	200-0813-00			1	COVER, fuse
-23	131-0552-00			1	CONNECTOR, w/fuseholder
	- - - - - -			-	mounting hardware: (not included w/connector)
-24	211-0101-00			2	SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-25	136-0140-00			1	SOCKET, banana jack, charcoal
	- - - - - -			-	mounting hardware: (not included w/socket)
-26	210-0465-00			1	NUT, hex., 0.25-32 x 0.375 inch
-27	210-0223-00			1	TERMINAL, lug, 0.25 ID x 0.438 inch OD

FIGURE 3 POWER PACK (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
-28	136-0139-00			1		SOCKET, banana jack, red
	- - - - - -			-		mounting hardware: (not included w/socket)
-29	210-0465-00			1		NUT, hex., 0.25-32 x 0.375 inch
-30	210-0223-00			1		TERMINAL, lug, 0.25 ID x 0.438 inch OD
-31	352-0132-00			1		HOLDER, tip jack
	- - - - - -			-		mounting hardware: (not included w/holder)
-32	213-0107-00			1		SCREW, thread forming, 4-40 x 0.25 inch, 100° csk, FHS
-33	- - - - - -			1		TRANSISTOR (See Q617 electrical parts list)
	- - - - - -			-		mounting hardware: (not included w/transistor)
-34	211-0510-00			2		SCREW, 6-32 x 0.375 inch, PHS
-35	214-1025-00			1		INSULATOR, mica
-36	210-0811-00			2		WASHER, fiber, shouldered
-37	210-0802-00			1		WASHER, flat, 0.15 ID x 0.312 inch OD
-38	210-0006-00			2		WASHER, lock, internal, 0.146 ID x 0.283 inch OD
-39	210-0407-00			2		NUT, hex., 6-32 x 0.25 inch
-40	210-0202-00			1		TERMINAL, lug, SE
-41	260-0902-00			1		SWITCH, slide--EXT DC, TRICKLE CHG, Full CHG (S612)
	- - - - - -			-		mounting hardware: (not included w/switch)
-42	211-0119-00			2		SCREW, 4-40 x 0.25 inch, 100° csk, FHS
-43	- - - - - -			1		TRANSFORMER (See T601 electrical parts list)
	- - - - - -			-		mounting hardware: (not inclued w/transformer)
-44	211-0153-00			2		SCREW, 4-40 x 1.281 inches, RHS
-45	210-0906-00			2		WASHER, fiber, 0.125 ID x 0.203 inch OD
-46	210-0201-00			1		TERMINAL, lug, 0.12 inch diameter, SE
-47	210-0004-00			1		WASHER, lock, 0.12 ID x 0.26 inch OD
-48	210-0406-00			2		NUT, hex., 4-40 x 0.188 inch
-49	179-1207-00			1		WIRING HARNESS
-50	131-0371-00			3		CONNECTOR, terminal
-51	214-0993-00			1		HEATSINK, transistor
-52	348-0055-00			1		GROMMET, plastic, 0.25 inch diameter
-53	348-0031-00			1		GROMMET, plastic, 0.156 inch diameter

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
4-	437-0132-00			1		CABINET ASSEMBLY
	- - - - - - - - - -			-		cabinet assembly includes:
-1	334-1544-01			1		PLATE, identification
-2	367-0127-00			1		HANDLE, carrying
	- - - - - - - - - -			-		mounting hardware: (not included w/handle)
-3	213-0179-02			2		SCREW, cap, 6-32 X 0.394 inch, HHS
-4	132-0084-00			2		SPACER, plastic, 0.45 inch diameter
-5	200-0819-00			2		COVER, handle brake assembly
-6	210-1053-00			4		WASHER, spring tension
-7	386-1331-00			2		PLATE, brake, friction, 0.782 inch OD
-8	386-1339-00			2		PLATE, brake, friction, 0.781 inch OD
-9	129-0148-02			2		POST, hex., 6-32 X 0.444 inch
-10	386-2080-00			1		PANEL, rear
-11	426-0824-02			1		FRAME-PANEL, rear
-12	348-0187-00			8		FOOT, cabinet
-13	390-0241-00			1		CABINET SUBASSEMBLY
-14	213-0170-00			1		THUMBSCREW, 8-32 X 0.82 inch
-15	210-1011-00			1		WASHER, plastic, 0.13 ID X 0.375 inch OD
-16	354-0324-00			1		RING, retaining, 0.102 ID X 0.27 inch OD

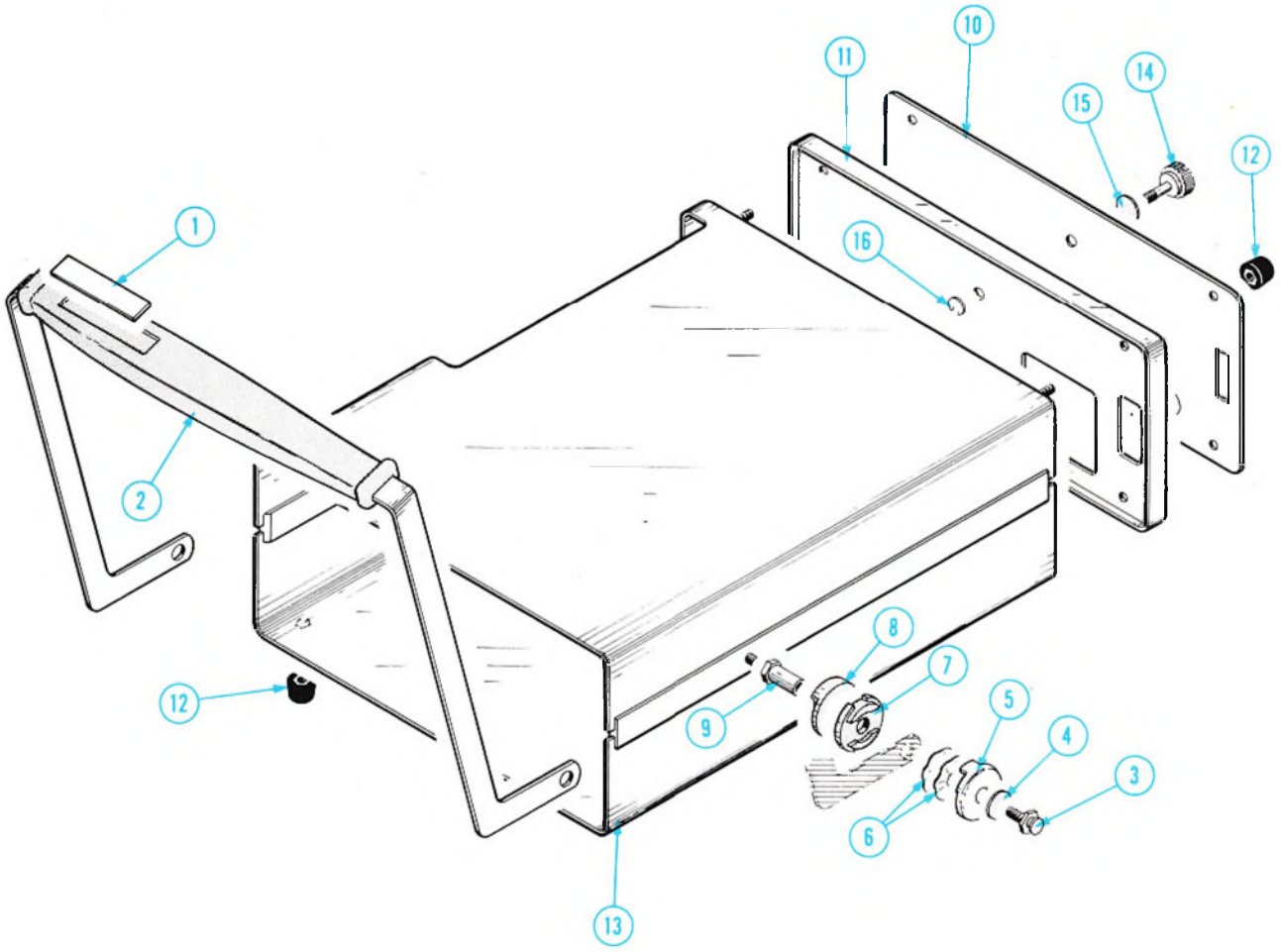

FIG. 4 CABINET

FIGURE 5 ACCESSORIES & INST. OPTIONS

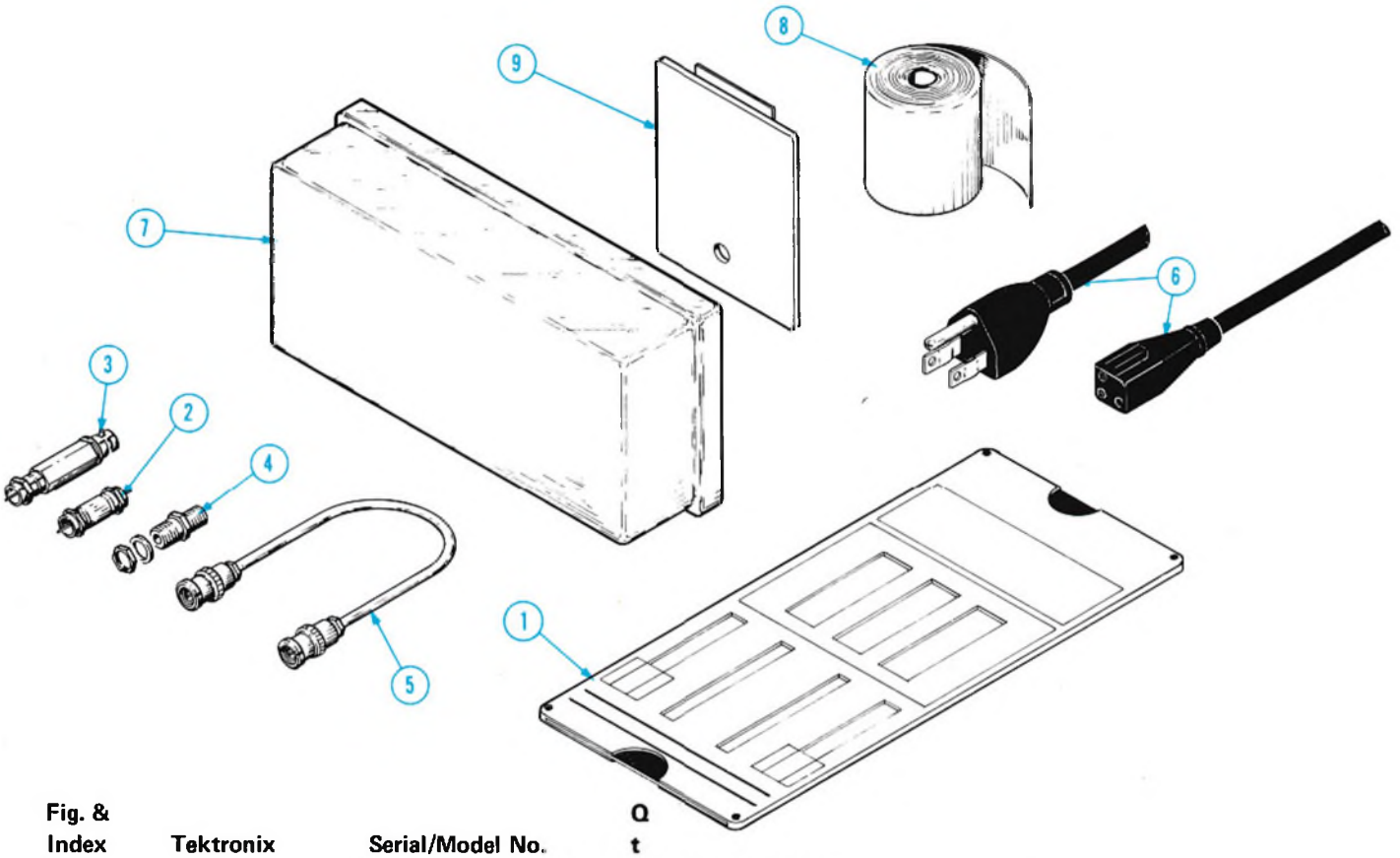

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
						ACCESSORIES
5-1	003-0700-00			1		SLIDE RULE TDR
	062-1538-00			1		BOOKLET, instruction, TDR slide rule (not shown)
-2	103-0157-00			1		ADAPTER, connector F series male to male
-3	103-0158-00			1		ADAPTER, connector BNC female to F series male
-4	103-0159-00			1		ADAPTER, connector F series female to female
-5	012-0214-00			2		CABLE, interconnecting
-6	161-0043-02			1		POWER CABLE, assembly 8 ft.
-7	200-0812-00			1		COVER, front
-8	006-1658-00			2		CHART, paper, roll (not furnished w/option 1 & 3)
	----------			-		1 roll installed in chart recorder
-9	016-0509-00			1		PANEL, chart recorder (furnished w/option 1 & 3 only)
	062-1244-00			1		MANUAL, TDR concept (not shown)
	070-1206-00			1		MANUAL, instruction (not shown)
	070-1368-00			1		MANUAL, operators (not shown)
						INSTRUMENT OPTIONS
	OPTION 1					1501 (without chart recorder)
	OPTION 2					1501 (METRIC VERSION)
	OPTION 3					1501 (METRIC VERSION without chart recorder)

FIGURE 6 REPACKAGING

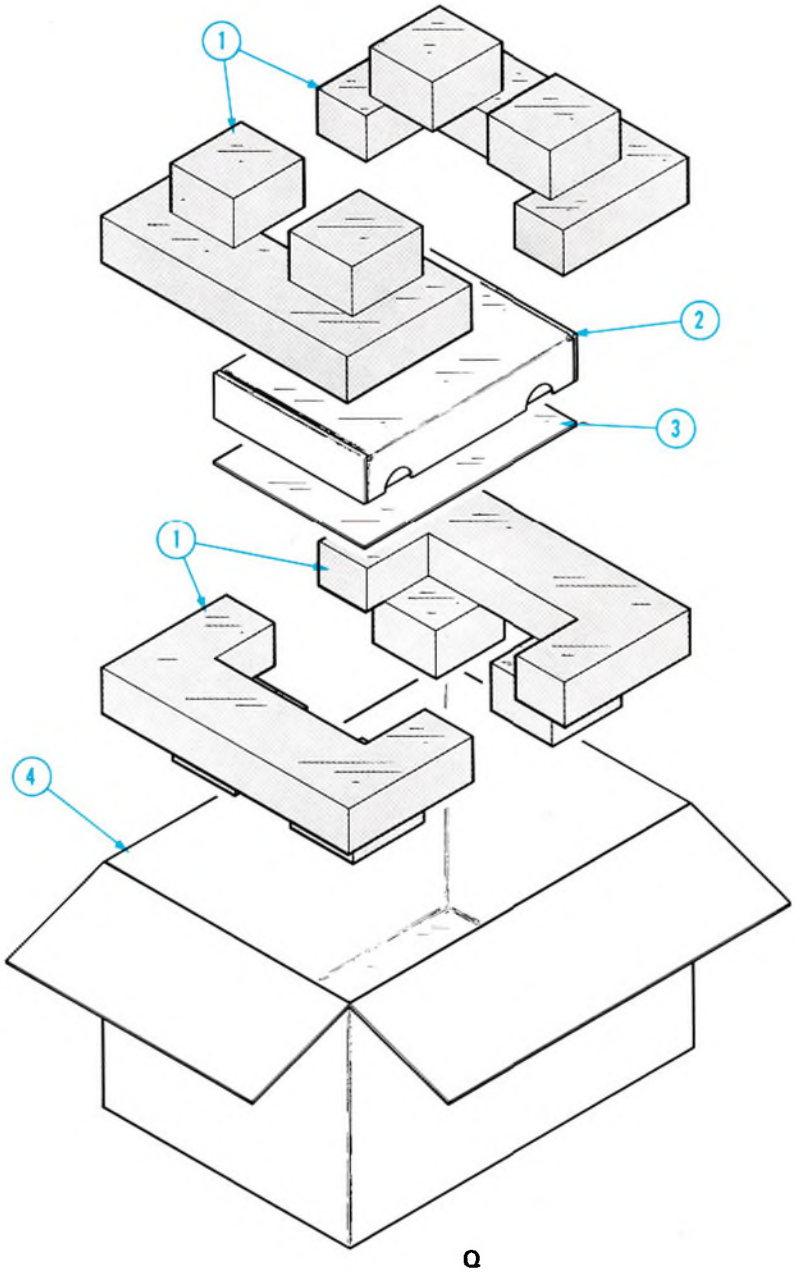

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Qty	1 2 3 4 5	Description
6-	065-0180-00			1		CARTON ASSEMBLY
						carton assembly includes:
-1	004-0259-00			2		FRAME
-2	004-0816-00			1		CARTON, accessory
-3	004-1123-00			1		PAD SET, 1 piece
-4	004-0815-00			1		CARTON

MANUAL CHANGE INFORMATION

At Tektronix, we continual y 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. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. 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 in this section, your manual is correct as printed.

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MANUAL CHANGE INFORMATION

PRODUCT GENERAL

CHANGE REFERENCE S23,351

DATE 6-10-76 REV.

CHANGE:	DESCRIPTION

This applies to all instruments with detachable cord.

WARNING

To avoid electrical shock or equipment damage, be sure to replace the cord set only with another of the same polarity.

Power Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (Line)	Brown	Black
Grounded (Neutral)	Blue	White
Grounding (Earthing)	Green-Yellow	Green-Yellow

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MANUAL CHANGE INFORMATION

PRODUCT 1501 SERVICE
070-1206-00

CHANGE REFERENCE C2/176
DATE 1-9-76

CHANGE:	DESCRIPTION

TEXT CORRECTION

Page 2-14 Column one; step 3.

Change the fourth line of step 3 to read:

be moved over the six vertical divisions of the graph

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MANUAL CHANGE INFORMATION

PRODUCT 1501 Service
EFF SN B070000-up

CHANGE REFERENCE M23,061
DATE 4-1-75

CHANGE:	DESCRIPTION

070-1206-00

ELECTRICAL PARTS LIST AND SCHEMATIC CHANGES

CHANGE TO:

A5	670-1708-02	LOGIC Circuit Board Assembly
R501	316-0683-00	68 kΩ, 1/4 W, 10%
R505	316-0393-00	39 kΩ, 1/4 W, 10%
A7	670-1742-02	CHART CONTROL Circuit Board Assembly

MECHANICAL PARTS LIST CHANGE

ADD:

175-0702-00	1	WIRE STRAP, Teflon Insulated 7/8"