INSTRUCTION
MANUAL

Serial Number 700-300

D11 / D15
SINGLE BEAM STORAGE DISPLAY UNIT

Tektronix, Inc. ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-1133-01 **1071**

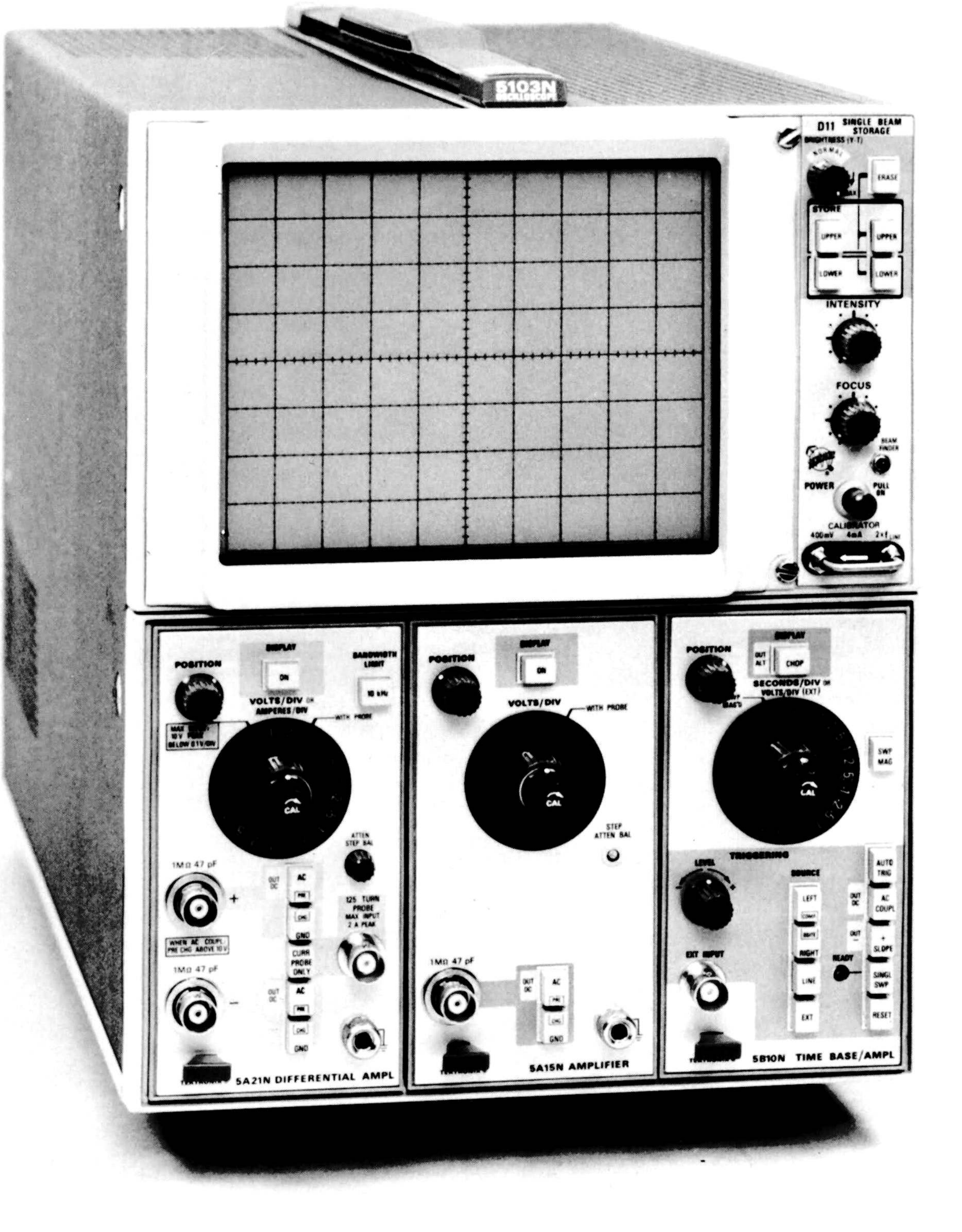


Fig. 1-1. 5103N Oscilloscope with a Single-Beam Storage Display Unit.

SECTION 1
SPECIFICATION

The D11/D15 Single-Beam Storage Display unit provides a single-beam cathode-ray tube (CRT) display for Tektronix 5100-series Oscilloscopes, and can be operated in the storage mode (retention of a display) or the conventional mode (non-store). The display module is operated with a power supply/amplifier module, and comprises one-half of the oscilloscope mainframe. It has a direct-view, bistable storage tube with two 4 X 10 division screens, which can be independently controlled for split-screen applications. A variable Brightness control permits extended storage time and can be used to integrate fast repetitive displays. The CRT also employs electrostatic deflection and has an 8 X 10 division (one-half inch per division) internal black graticule. A bright display is provided by a 3.5-kilovolt accelerating potential. Provision is made for application of Z-axis signals, and a front-panel loop provides a calibration signal.

The following electrical characteristics apply over an ambient temperature range of 0°C to +50°C. Refer to the 5100-series Oscilloscope System manual for environmental characteristics.

TABLE 1-1
ELECTRICAL CHARACTERISTICS

Characteristic	Performance Requirement	Supplemental Information
Cathode-Ray Tube		
Phosphor	Similar to P1.	
CRT Accelerating Voltage		3.5 kilovolts.
Orthogonality		90°, within 1°.
Geometry		0.1 division or less.
Storage Display		
Writing Speed	D11: At least 20 divisions/ millisecond. D15: At least 200 divisions/ millisecond.	D15: At least 800 divisions/ millisecond enhanced.
Storage Time	One hour.	Longer at low brightness.
Erase Time		About 250 milliseconds.
External Intensity Input		
Useful Input Voltage	+5 volts will turn on display to a normal brightness level from an off level; −5 volts will turn display off from a normal brightness level.	
Usable Frequency Range	DC to one megahertz.	
Input R and C		About 10 kilohms, paralleled by about 40 picofarads.
Maximum Safe Input		+50 volts (DC + peak AC).
Calibrator		
Voltage	400 millivolts, within 1%.	
Current	4 milliamperes, within 1%.	
Frequency	Twice the line frequency.	

TABLE 1-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
Power Input		
Line Voltage (RMS)		
With standard transformer	Nominal 110 V, 120 V; within 10%.	
With optional export transformer	Nominal 100 V, 110 V, 120 V, 200 V, 220 V, 240 V; within 10%.	
Line Frequency Range		
With standard transformer		60 hertz and 400 hertz.
With optional export transformer		50 to 60 hertz and 400 hertz.
Power Consumption (including Power Supply/ Amplifier module)		140 watts maximum.

SECTION 3
CIRCUIT DESCRIPTION

Introduction

This section of the manual contains an electrical description of the circuits in the D11 and D15 Single-Beam Display Units. An overall block diagram and complete schematics are given on pullout pages at the rear of this manual.

BLOCK DIAGRAM DESCRIPTION

The Vertical and Horizontal Deflection Amplifiers provide final amplification for the signals from the plug-in units. They produce push-pull outputs suitable to drive the CRT vertical and horizontal deflection plates. Beam-finding circuitry is incorporated to limit the display within the screen area when the front-panel BEAM FINDER button is pressed. A variable capacitor between the output lines of the Vertical Deflection Amplifier permits adjustment of the inherent phase shift between the vertical and horizontal deflection systems to zero degrees.

The CRT Circuit produces the high voltage (about −3.4 kilovolts) and contains the controls necessary for operation of the cathode-ray tube. The CRT Circuit also contains the Z-Axis Amplifier, which provides the drive signal to control the intensity level of the display.

The Storage Circuit provides the voltage levels necessary to operate the storage elements associated with the CRT. The circuit includes the erase-pulse generator for erasing stored information and a multivibrator which permits the flood-gun duty cycle to be varied.

DETAILED CIRCUIT DESCRIPTION

Deflection Amplifiers

Vertical Deflection Amplifier. The Vertical Deflection Amplifier provides the final amplification of signals applied to the vertical plug-in units. It produces a push-pull output sufficient to drive the CRT vertical deflection plates. The amplifier consists of Q104, Q106, Q114, and Q116, connected in a differential configuration.

The input signal arrives via P612 from the plug-in interface circuit (power supply/amplifier module). The output signal is developed across the collector-load resistors, R104 and R114, and is about 50 times the magnitude of the input signal. R116, Vert Gain, provides Q106-Q116 emitter degeneration to set the gain of the stage to provide a calibrated vertical display.

Horizontal Deflection Amplifier. The Horizontal Deflection Amplifier consists of Q124, Q126, Q134, and Q136, and is basically the same as the Vertical Deflection Amplifier just described. It provides final amplification of signals from the horizontal plug-in unit, which arrive via P611. Gain of the stage is set by R136, Horiz Gain, to provide a calibrated horizontal display.

Beam Finder. If a high-amplitude signal or a misadjusted control has deflected the trace or display off screen, it can be located by pressing the front-panel BEAM FINDER pushbutton. This opens S125, allowing current through R125 into the emitter circuits of both deflection amplifiers. R125 limits the current available to the transistors, and hence, to the collector-load resistors. Thus the dynamic range of the deflection plates is limited to an on-screen level, and the display is compressed within the viewing area.

Also, when the BEAM FINDER switch is pressed, the Z Axis Amplifier in the CRT Circuit senses the slight increase in voltage level at the R108-R118-R128-R138 junction. The Z Axis Amplifier produces a slight increase in CRT beam intensity.

X-Y Phasing. Variable capacitor C115, Phase, is connected across the output collectors of the Vertical Deflection Amplifier. This capacitor is adjusted to eliminate the inherent phase difference between the vertical and horizontal deflection systems when operating in the X-Y mode.

CRT Circuit

General. The CRT Circuit produces the high-voltage potential and provides the control circuits necessary for operation of the cathode-ray tube (CRT). This circuit also includes the Z-Axis Amplifier stage to set the intensity of the CRT display.

Z-Axis Amplifier. The Z-Axis Amplifier is a current driven shunt-feedback operational amplifier with a voltage output, and consists of Q222, Q226, and Q234. The feedback path is from the collectors of Q226 and Q234 through

R227-C227 to the base of Q222. Q226 and Q234 are connected as a collector-coupled complementary amplifier to provide a fast, linear output signal while consuming minimum quiescent power. The output voltage provides the drive signal to control the CRT intensity level through the Control-Grid Supply.

The output level of the Z-Axis Amplifier is established by the voltage drop across R227 with reference to virtual ground at the base of Q222 (the operational amplifier summing point). The current through R227 is determined by the input current from any combination of several sources, such as from the front-panel INTENSITY control, plug-in interface (blanking, intensification, etc.), and from Q214. Q214 is an operational amplifier with two inputs; one from the rear-panel EXT INTENSITY INPUT connector and the other from the front-panel BEAM FINDER switch. It sets those input signals to a level suitable for proper response by the Z-Axis Amplifier.

High-Voltage Regulator

High-Voltage Primary. A repetitive, non-sinusoidal signal is produced by a phase-modulated switching circuit in the primary of T240 and induced into the secondaries. Current drive for the primary winding is furnished by Q252 in its conduction state. Q252 is turned on by positive-going feedback applied through C259 and L259 from the feedback winding, and then turned off by switching action from Q262. A sample of the output DC voltage is modulated by the AC from another feedback winding at the gate of Q278 to establish the conduction time of Q252 and thus maintain the proper output level. Q252 delivers energy to T240 only once each cycle.

Assuming Q262 and Q264 are off initially, R262 provides base drive for Q252, causing it to deliver current to T240 primary. As Q252 conducts, the increasing current through the primary winding induces a voltage into the secondaries. The gate of Q278 is driven negative by the voltage from the feedback winding, switching Q264 and Q262 on. With conduction of Q262, base drive for Q252 is removed.

With Q252 off, the transformer field collapses, reversing the polarity of the voltage induced into the secondaries. When the gate of Q278 is driven sufficiently positive to switch Q264 and Q262 off, Q252 is switched on again. Q252 again delivers energy to the primary winding and the action is repeated.

High-Voltage Regulation. Regulation is accomplished as follows: Feedback from the −3400-volt cathode supply is summed with low-voltage level through the voltage divider consisting of resistors R272B-E, R275, and R276 to establish the DC level at the gate of Q278. The AC component, which is the switching signal, is derived from the transformer as described previously. If the output level of the cathode supply drops below the nominal −3400 volts (becomes more positive), the level at the gate of Q278 rises. A new point is selected on the varying AC component to cause switching of Q262-Q264 later and hence increase conduction time of Q252. This allows more energy to be delivered to the primary winding of T240, resulting in an increase of voltage in the secondaries. Conversely, if the output level increases, Q252 is allowed to conduct for a shorter length of time. The DC level at the gate of Q278 is adjusted by R275, H.V. Adj, to set the output at exactly −3400 volts.

High Voltage Outputs

Transformer T240 has two high-voltage output windings which provide the potentials required for the CRT cathode and control grid supplies. The −3400-volt accelerating potential for the cathode is supplied by half-wave rectifier CR247. The cathode heater is elevated to the cathode potential through R273.

Half-wave rectifier CR241 provides about −3450 volts to establish bias voltage on the CRT control grid. This voltage (and hence the CRT beam current) is dynamically controlled by the Z-Axis Amplifier, which contains the INTENSITY control, blanking inputs, and intensification inputs. R245, Int Range, provides a fine adjustment of the quiescent grid voltage to bias the CRT just below cutoff when the Z-Axis Amplifier output is at its minimum quiescent level (INTENSITY control counterclockwise and no intensifying or blanking inputs).

Neon bulbs DS271, DS272, and DS273 provide protection to the CRT if the voltage difference between the control grid and the cathode exceeds about 180 volts.

CRT Control Circuits

In addition to the INTENSITY control discussed previously, front-panel FOCUS and internal astigmatism controls have been incorporated for arriving at an optimum CRT display. FOCUS control R295 provides the correct voltage for the second anode in the CRT. Proper voltage for the third anode is obtained by adjusting Astig control R286. In order to obtain optimum spot size and shape, both the FOCUS and Astig controls are adjusted to provide the proper electrostatic lens configuration in the CRT.

The Geom adjustment R285 varies the positive level on the horizontal deflection plate shields to control the overall geometry of the display. The TRACE ROTATION control, R291, permits adjustment of the DC current through beam-rotation coil L291 to align the display with the horizontal graticule lines.

Storage Circuit

General. The CRT is a direct-view bistable storage cathode-ray tube with a split-screen viewing area that permits each half to be operated individually for stored displays. Only those elements associated with the storage capability of the CRT are shown in the CRT enclosure on the right side of the Storage Circuit schematic diagram. The writing gun, its deflection systems and associated elements have been discussed previously under CRT Circuit.

Storage Operation. Four low-energy electron guns (flood guns) provide full coverage of the large screen area. Each consists of a heated cathode and an anode. The cathode heaters, which receive an unfiltered pulsating DC from full-wave rectifier CR329, are elevated to the cathode potential through R329. Quiescently Q308 is saturated, providing current to the flood-gun cathodes. The anode potential is established by VR396 and supplied via emitter follower Q396.

The collimation electrode is a metallic band around the inner wall of the CRT envelope. It produces an electrostatic field to distribute the flood-gun electrons uniformly over the storage target. R390, CE1, provides adjustment of the flood electron trajectories to cover the extreme rim of the targets and optimize uniformity of the target coverage. Emitter follower Q392 maintains a stable voltage on the collimation electrode, providing a low-impedance current path to absorb current variations.

The storage screen consists of a thin tin oxide layer called the target backplate, which is coated with an insulator material containing finely-ground phosphor particles called the target. A positive voltage potential is applied via Q372 and S372 to the backplage to establish the operating level of the tube, which is the difference in potential between the backplate and the flood-gun cathodes. The CRT screen area is divided into two halves, which are electrically insulated from each other to permit independent operation.

The target operates in a bistable mode because of the secondary-emission properties of the insulator material. The first stable state is the rest potential, at which the target has gathered low-energy flood-gun electrons, causing it to charge down to the flood-gun cathode potential. The second stable state is the stored state, at which the target (or portions of it) is shifted to the backplate potential by increasing the secondary emission. While the flood guns do not have sufficient energy to shift the target to the stored state, they do supply sufficient energy to hold the target in the stored state after it has been shifted by the high-energy writing-gun beam (CRT beam). This is because the landing energy of the flood electrons has increased with the increased potential difference between the flood gun cathode and the target. These higher energy electrons produce a visual display as long as the flood gun beam covers the target.

When the stored display is no longer needed, the information is erased by first shifting the entire target to the stored state, and then removing the charge. A positive-going short-duration pulse is first applied to the backplate, increasing the flood-gun electron landing energy and writing the entire target area. Next, the backplate voltage is pulled well below the rest potential of the target, which follows due to its inherent capacitive coupling. Then, as the backplate is gradually returned to its quiescent potential, the target charges to the rest potential and is ready to write again.

Backplate Supply. A regulated +370-volt DC power supply is incorporated in the Storage Circuit to provide the storage level for the CRT and to ensure a potential sufficient for the erasure process. A winding of high-voltage transformer T240 supplies 400 volts RMS, which is rectified by CR386. Q386 and Q388 are connected as a feedback pair to provide the regulated +370-volt DC output. VR388 establishes the reference voltage, and R387, +370 V Adj, sets the current through Q386 to set the output level. VR387 is a protection device for the transistors, and is normally operated in a region of its characteristic curve below its Zener knee.

Backplate Control. Separate STORE switches, S375A and S375B, are provided for the target backplates to permit each storage screen to be operated individually. In the store mode, the store-level potential for the backplate is supplied by either Q372 or by the erase-generator output operational amplifier, depending upon the setting of the ERASE SELECT switches, S372A and S372B.

A high degree of control of target backplates is maintained by a feedback amplifier system consisting of Q356, Q358, Q362, and Q364. The operational amplifier summing point is at the base of Q356, and the feedback resistor is R355. Variable resistor R350, Store Level, provides an adjustment of the current to the null point and hence, sets the backplate voltage through R355 to an optimum storage level. R370, Store Bal, permits matching the backplate voltages for uniform screen luminance, whether they are selected for erasure or not. When either or both screens are operated in the store mode, the divider network in the high-voltage regulator circuit is modified to shift the high voltage slightly, correcting for the deflection sensitivity changes that occur. The backplate voltage is applied through either R381 or R382 to the base of Q384, removing the ground potential from the Q384 collector. R385, Sens Correct, permits an adjustable sensitivity correction voltage to be applied to the high-voltage regulator.

Erase Generator. The previously discussed operational amplifier is driven by a monostable multivibrator when it is desired to erase a stored display. The multivibrator consists of Q334, which is normally on, and Q336, which is normally off. When ERASE button S330 is pressed, R330 is grounded, producing a negative-going step through C331 to cut Q334 off. Q336 turns on, and the negative-going step produced at its collector causes a corresponding positive-going step at the output of the operational amplifier. This positive-going step is applied to the target backplate, increasing the storage level and "writing" the entire target.

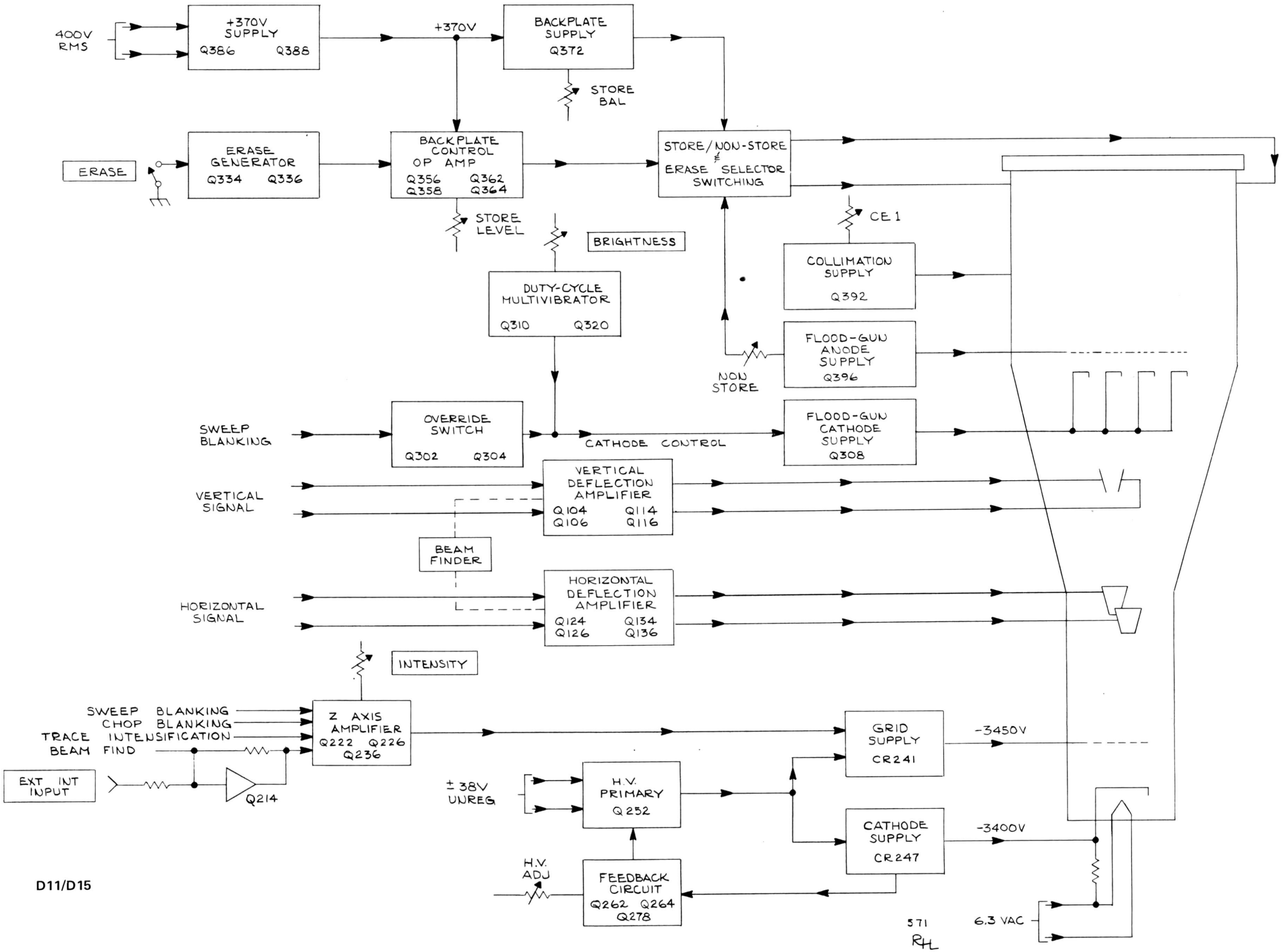
After an RC-controlled time of 10 milliseconds, the multivibrator reverts to its quiescent state, producing a positive-going step at the collector of Q336 as the transistor turns off. This positive-going step is coupled through C342, and the backplate is pulled negative through the action of the operational amplifier. The target is pulled well below its rest potential. As C342 charges, the voltage at the cathode of CR343 decays from about +20 volts toward the −30-volt supply at an RC-controlled rate until it is clamped at ground by conduction of CR343. This action allows the target backplate to be raised slowly to its operating level, while the target remains at the flood-gun cathode potential. The total time from initiation of erasure to the ready-to-write condition is about 250 milliseconds.

Flood-Gun Cathode Control. As previously mentioned, Q308 provides the current for the flood-gun cathodes. It operates at saturation, establishing a cathode potential of nearly −30 volts. Q308 is controlled by two circuits: a transistor switch activated by the sweep gate and a multivibrator. While the sweep is running, Q304 overrides the multivibrator output and holds Q308 in its conduction state. Emitter follower Q302 receives the sweep blanking input from R203 in the Z-Axis Amplifier circuit; however, the level of interest is the zero volts applied to the base of Q302 while the sweep is running. This level permits the base of Q304 to move slightly negative, biasing the transistor into saturation and grounding the collector of Q320. Through R307-R308 divider action, Q308 is held on.

Between sweeps or when the sweep is held off, the +5-volt sweep-blanking level is applied to Q302, raising its emitter positive. This level switches Q304 off, releasing its hold on Q308. In this condition, Q308 is controlled by collector-coupled multivibrator Q310-Q320. When Q320 conducts, Q308 conducts. Symmetry of the multivibrator is controlled by R313 and R325. R325, BRIGHTNESS, is adjustable to allow Q320 to conduct anywhere from 10% to 100% of the time. Thus the duty cycle of the flood-gun cathodes can be varied from 10% to 100%, which has the effect of varying the stored brightness.

Enhance Operation (D15 Only). Writing speed is primarily a function of the writing gun beam current density and physical properties of the storage tube. At very fast sweep speeds, the writing beam of a single sweep does not change the scanned portions of the target enough to shift them to the stored state. Writing beyond the normal writing speed of the CRT is attained through the process of enhancement. Upon termination of the single sweep, a short-duration pulse is applied to the target backplate, which increases the operating level slightly so that less writing current is required to shift the scanned section to the stored state.

When the sweep terminates, the sweep blanking pulse causes the Q302 emitter to snap positive. This positive-going transition is applied via C326 to the base of Q322. Monostable multivibrator Q322-Q328 changes states, producing a negative-going pulse at Q322 collector. The current level applied to the backplate operational amplifier null point (Q356 base) is adjustable by R315, ENHANCE, to control the amplitude of the positive enhance pulse applied to the target backplate.



D11/D15

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BLOCK DIAGRAM

D11/D15

DEFLECTION AMPLIFIER/HIGH-VOLTAGE BOARD
PARTS LOCATION GRID

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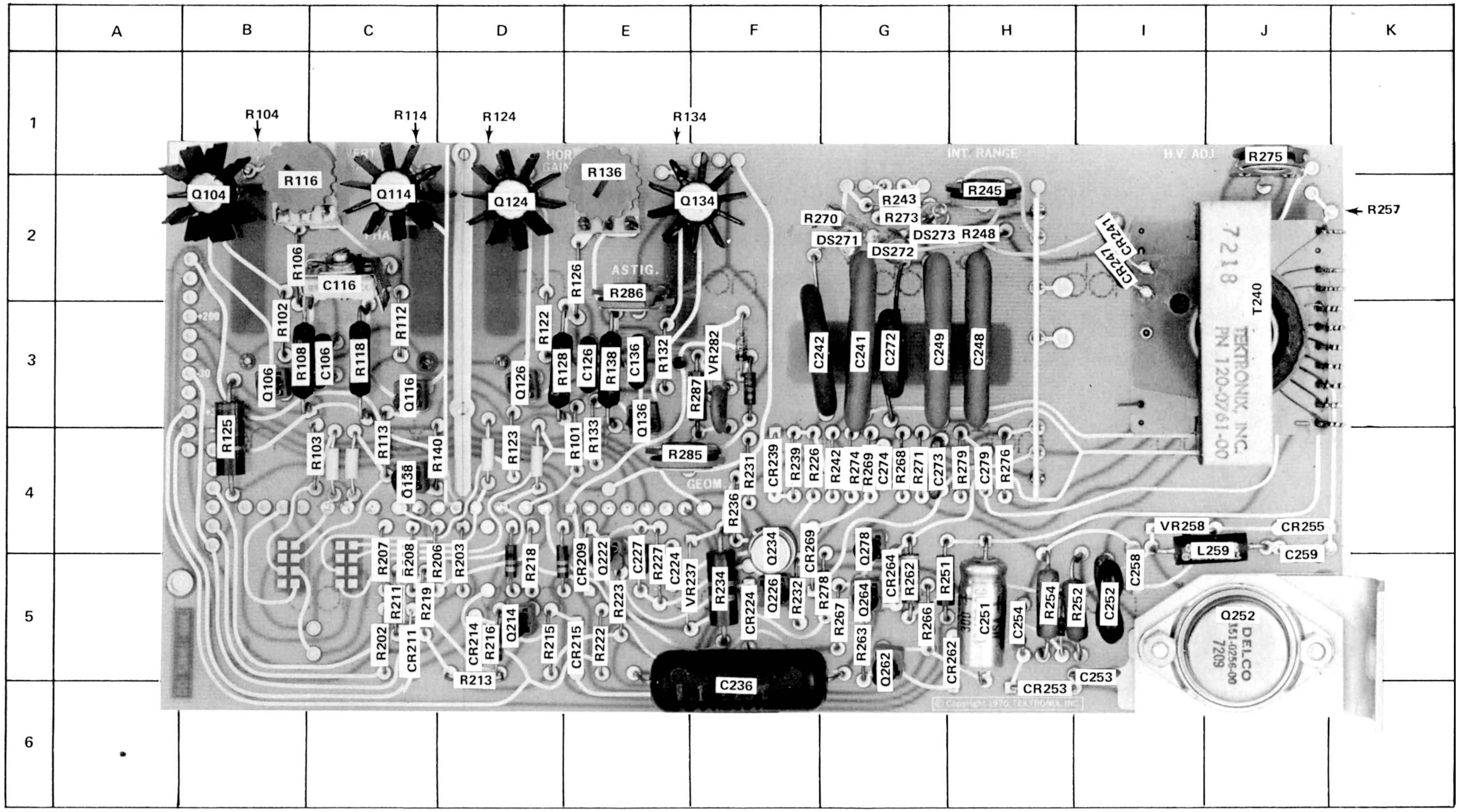

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C106	C-3	C252	I-5	CR209	E-5	CR269	F-4	DS271	G-2	Q104	B-2	Q234	F-4	R101	E-4	R124	D-1	R206	E-5	R223	E-5	R251	G-5	R273	G-2
C116	C-2	C253	I-5	CR211	C-5			DS272	G-2	Q106	B-3	Q252	J-5	R102	B-3	R125	B-4	R207	C-5	R226	F-4	R252	H-5	R274	G-4
C126	E-3	C254	H-5	CR214	D-5			DS273	G-2	Q114	C-2	Q262	G-5	R103	C-4	R126	E-2	R208	C-5	R227	E-5	R254	H-5	R275	J-1
C136	E-3	C258	I-5	CR215	E-5					Q116	C-3	Q264	G-5	R104	B-1	R128	D-3	R209	D-5	R231	F-4	R257	J-2	R276	H-4
C224	E-5	C259	J-4	CR224	F-5					Q124	D-2	Q278	F-4	R106	B-2	R132	E-3	R211	C-5	R232	F-5	R262	G-5	R278	G-5
C227	E-5	C272	G-3	CR239	F-4					Q126	D-3			R108	B-3	R133	E-4	R213	D-5	R234	F-5	R263	G-5	R279	H-4
C236	F-5	C273	G-4	CR241	I-2					Q134	F-2			R112	C-3	R134	E-1	R215	D-5	R236	F-4	R266	G-5	R282	F-3
C241	G-3	C274	G-4	CR247	I-2	VR237	E-5	L259	J-4	Q136	E-3			R113	C-4	R136	E-2	R216	D-5	R239	F-4	R267	G-5	R285	E-4
C242	F-3	C279	H-4	CR253	H-6	VR258	I-4			Q138	C-4			R116	B-2	R138	E-3	R217	D-5	R242	G-4	R268	G-4	R286	E-2
C248	H-3			CR255	J-4	VR281	F-3			Q214	D-5			R118	C-3	R140	C-4	R218	D-5	R243	G-2	R269	G-4	R287	E-3
C249	G-3			CR262	G-5	VR282	F-3			Q222	F-5			R122	D-2	R202	C-5	R219	C-5	R245	H-2	R270	G-2		
C251	H-5			CR264	G-5					Q226	F-5			R123	D-4	R203	D-5	R222	E-5	R248	H-2	R271	G-4		

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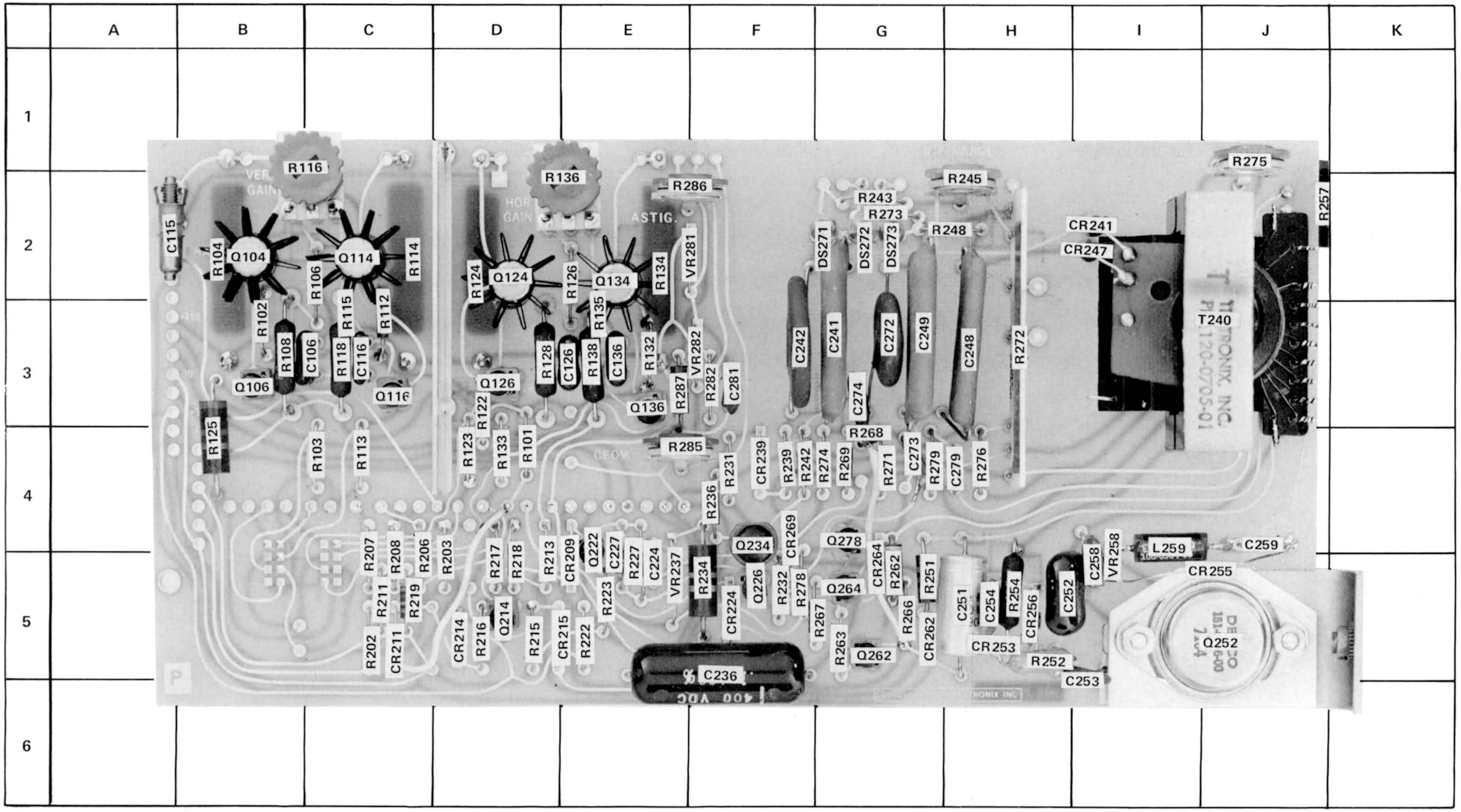
DEFLECTION AMPLIFIER/HIGH-VOLTAGE BOARD
PARTS LOCATION GRID

Below SN B050000



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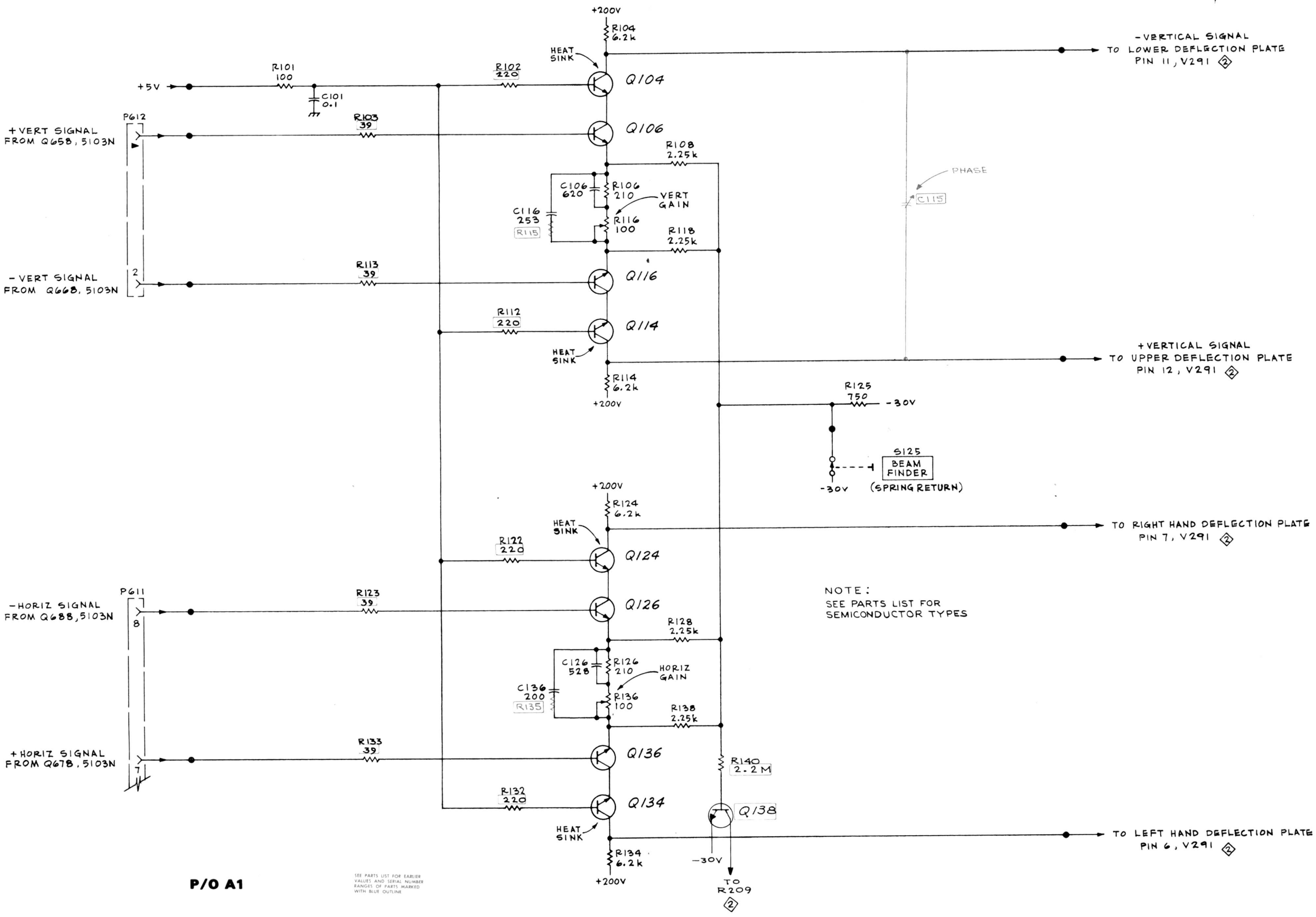
C106	B-3	C251	H-5	CR209	E-5	CR262	G-5	VR237	E-5	DS271	G-2	Q104	B-2	Q252	J-5	R101	D-4	R122	D-3	R202	C-5	R222	E-5	R251	G-5	R273	G-2
C115	A-2	C252	H-5	CR211	C-5	CR264	G-5	VR258	I-5	DS272	G-2	Q106	B-3	Q262	G-5	R102	B-3	R123	D-4	R203	D-5	R223	E-5	R252	H-5	R274	F-4
C116	C-3	C253	I-5	CR214	D-5	CR269	F-4	VR281	F-3	DS273	G-2	Q114	C-2	Q264	G-5	R103	C-4	R124	D-2	R206	C-5	R227	E-5	R254	H-5	R275	J-1
C126	E-3	C254	H-5	CR215	D-5			VR282	F-3			Q116	C-3	Q278	G-4	R104	B-2	R125	B-4	R207	C-5	R231	F-4	R257	J-2	R276	H-4
C136	E-3	C258	I-5	CR224	F-5							Q124	D-2			R106	C-2	R126	E-2	R208	C-5	R232	F-5	R262	G-5	R278	F-5
C224	E-5	C259	J-4	CR239	F-4					L259	I-4	Q126	D-3			R108	B-3	R128	D-3	R211	C-5	R234	F-5	R263	G-5	R279	G-4
C227	E-5	C272	G-3	CR241	I-2							Q134	E-2			R112	C-3	R132	E-3	R213	D-5	R236	F-4	R266	G-5	R282	F-3
C236	F-5	C273	G-4	CR247	I-2							Q136	E-3			R113	C-4	R133	D-4	R215	D-5	R239	F-4	R267	G-5	R285	E-4
C241	G-3	C274	G-3	CR252	H-5							Q214	D-5			R114	C-2	R134	E-2	R216	D-5	R242	F-4	R268	G-4	R286	E-2
C242	F-3	C279	H-4	CR253	H-5							Q222	E-5			R115	C-3	R135	E-3	R217	D-5	R243	G-2	R269	G-4	R287	E-3
C248	H-3	C281	F-3	CR255	J-4							Q226	F-5			R116	B-1	R136	E-2	R218	D-5	R245	H-2	R271	G-4		
C249	G-3			CR256	H-5							Q234	F-4			R118	C-3	R138	E-3	R219	C-5	R248	H-2	R272	H-3	T240	J-3



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

D11/D15

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DEFLECTION AMPLIFIERS ①

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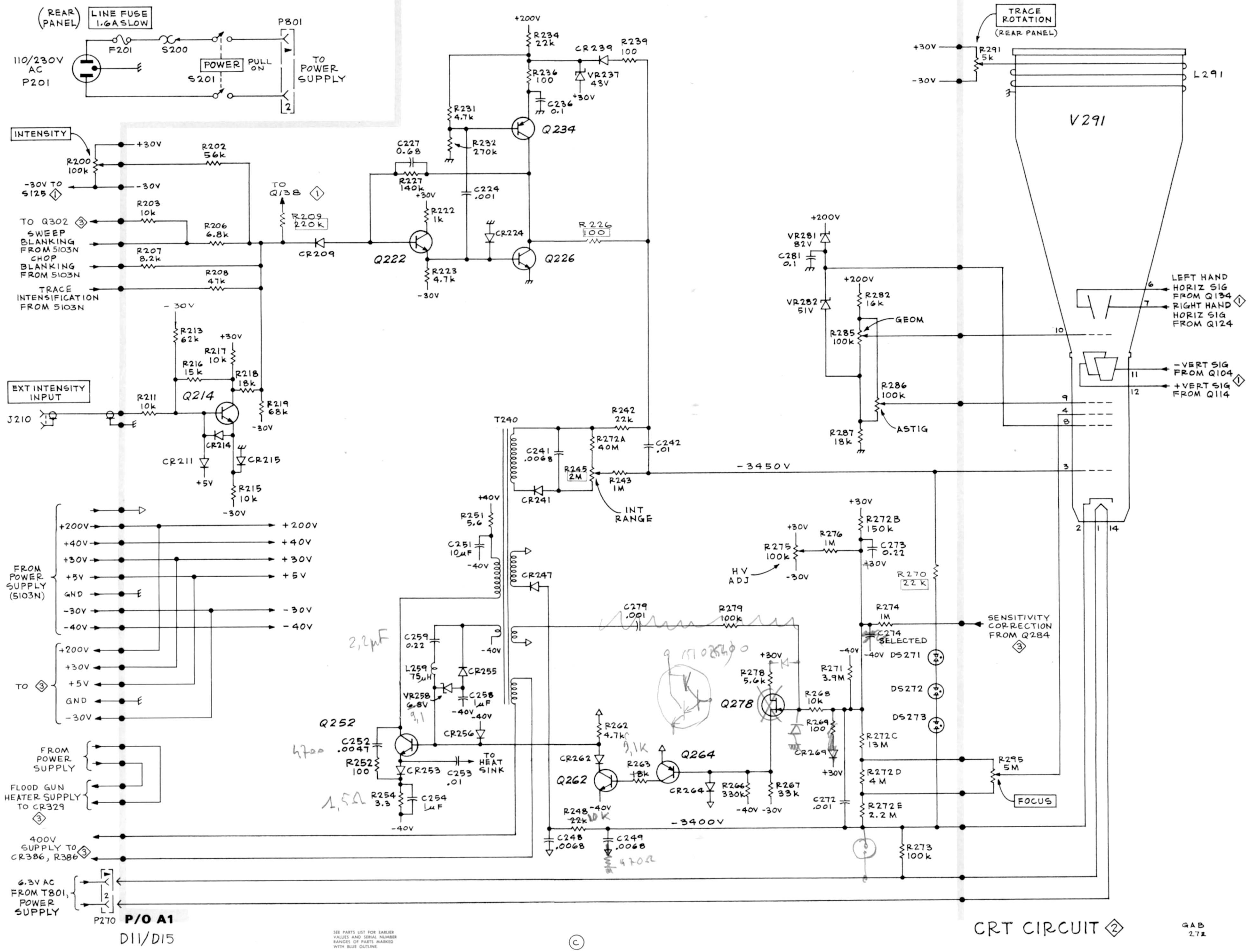

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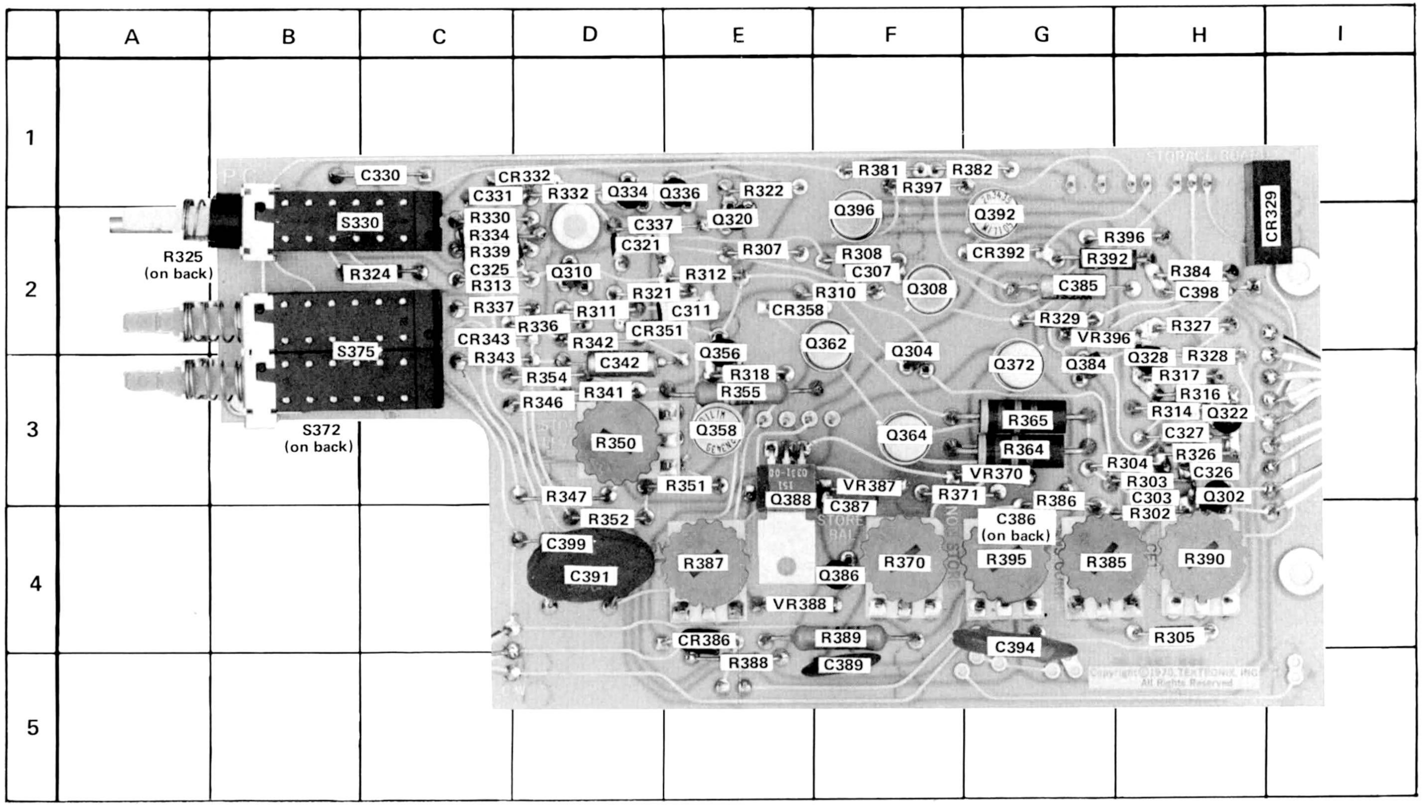
CRT CIRCUIT 2

STORAGE BOARD PARTS LOCATION GRID



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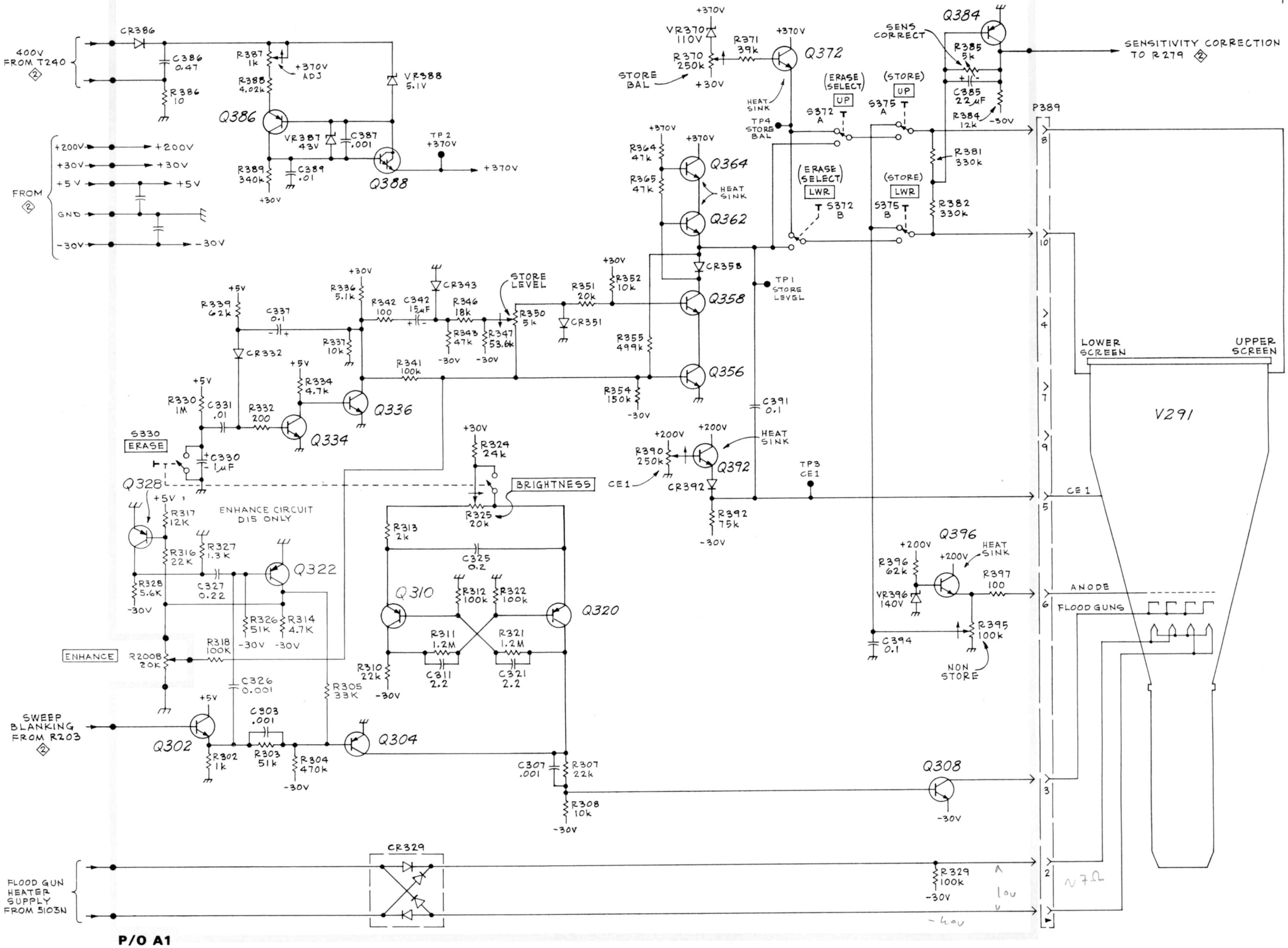
C303	H-3	CR329	I-2	VR370	G-3	Q302	H-3	S330	B-2	R302	H-4	R327	H-2	R364	G-3
C307	F-2	CR332	C-1	VR387	F-3	Q304	F-2	S372	B-3	R303	H-3	R328	H-3	R365	G-3
C311	E-2	CR343	C-2	VR388	E-4	Q308	F-2	S375	B-2	R304	H-3	R329	G-2	R370	F-4
C321	D-2	CR351	D-2	VR396	G-2	Q310	D-2			R305	H-4	R330	C-2	R371	F-3
C325	C-2	CR358	E-2			Q320	E-2			R307	E-2	R332	D-1	R381	F-1
C326	H-3	CR386	E-4			Q322	H-3			R308	F-2	R334	C-2	R382	G-1
C327	H-3	CR392	G-2			Q328	H-3			R310	F-2	R336	D-2	R384	H-2
C330	C-1					Q334	D-1			R311	D-2	R337	C-2	R385	G-4
C331	C-1					Q336	E-1			R312	E-2	R339	C-2	R386	G-4
C337	D-2					Q356	E-2			R313	C-2	R341	D-3	R387	E-4
C342	D-3					Q358	E-3			R314	H-3	R342	D-2	R388	E-5
C385	G-2					Q362	F-2			R316	H-3	R343	C-3	R389	F-4
C386	G-4					Q364	F-3			R317	H-3	R346	D-3	R390	H-4
C387	F-4					Q372	G-3			R318	E-3	R347	D-3	R392	G-2
C389	F-5					Q384	G-3			R321	D-2	R350	D-3	R395	G-4
C391	D-4					Q386	F-4			R322	E-1	R351	C-3	R396	H-2
C394	G-4					Q388	E-3			R324	C-2	R352	D-4	R397	F-1
C398	H-2					Q392	G-2			R325	A-2	R354	D-3		
C399	D-4					Q396	F-2			R326	H-3	R355	C-3		

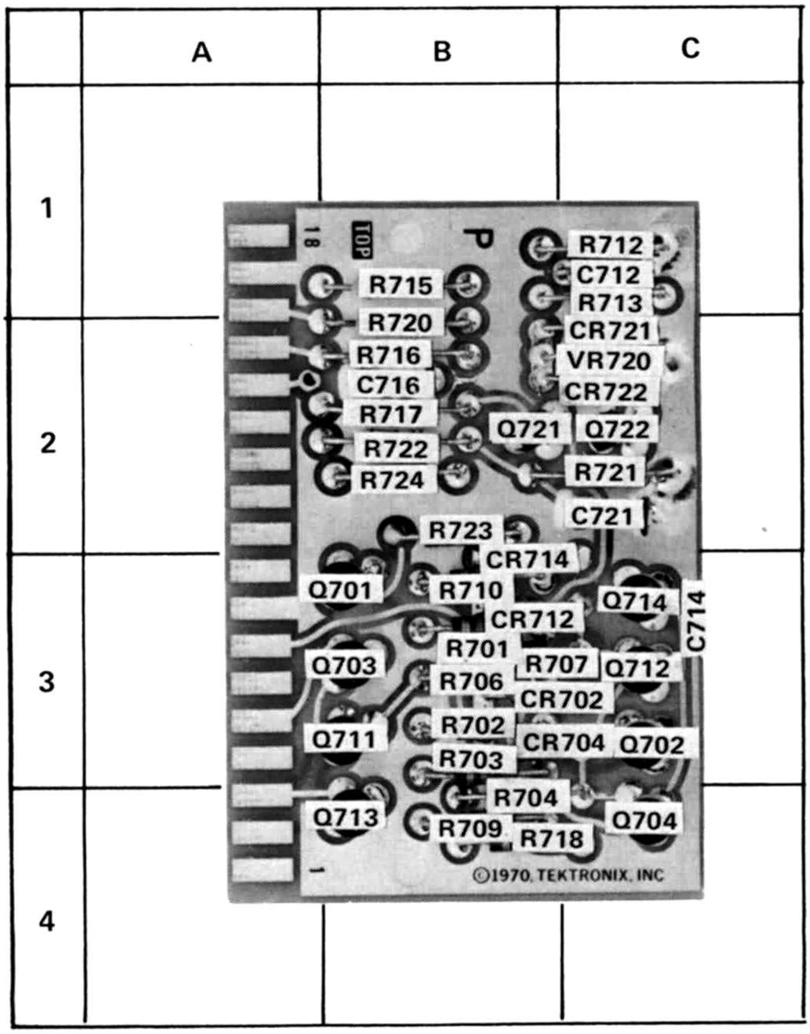


D11/D15

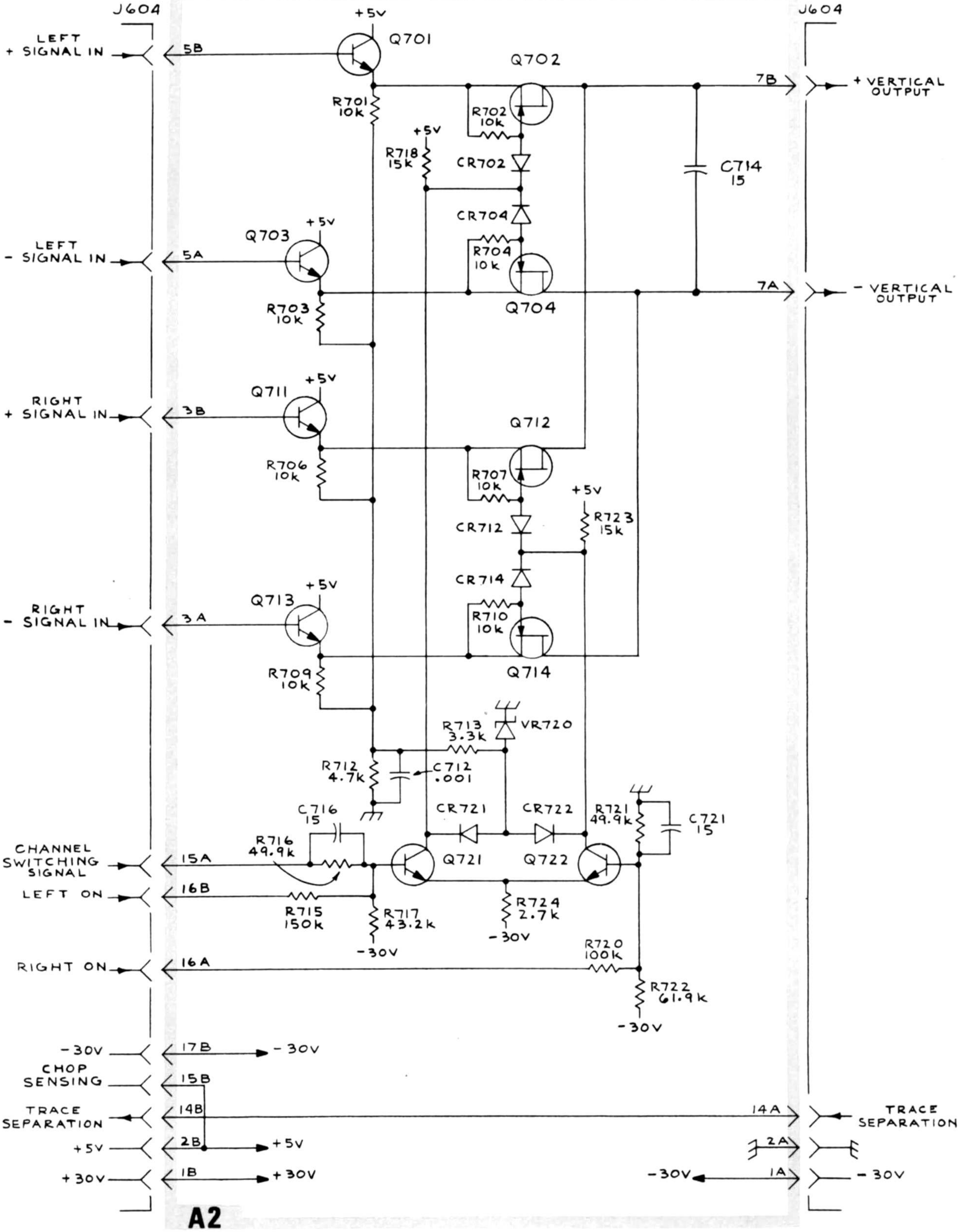
STORAGE CIRCUIT ③

GAB 971

AUXILIARY BOARD PARTS LOCATION GRID



CKT NO	GRID LOC	CKT NO	GRID LOC
C712	C-1	Q721	B-2
C714	C-3	Q722	C-2
C716	B-2		
C721	C-2	R701	B-3
		R702	B-3
CR702	C-3	R703	B-3
CR704	C-3	R704	B-4
CR712	B-3	R706	B-3
CR714	B-3	R707	B-3
CR721	C-2	R709	B-4
CR722	C-2	R710	B-3
		R712	C-1
VR720	C-2	R713	C-1
		R715	B-1
Q701	B-3	R716	B-2
Q702	C-3	R717	B-2
Q703	B-3	R718	B-4
Q704	C-4	R720	B-2
Q711	B-3	R721	C-2
Q712	C-3	R722	B-2
Q713	B-4	R723	B-2
Q714	C-3	R724	B-2



Ⓐ AUXILIARY BOARD ④

ELECTRICAL PARTS LIST CORRECTION

REMOVE:

CR259	152-0185-00	Silicon, selected from 1N4152 or 1N3605

ADD:

CR255	152-0185-00	Silicon, selected from 1N4152 or 1N3605

SCHEMATIC CORRECTION

CRT CIRCUIT 2

CHANGE TO: VR258 9.1 V

R274 goes to Sensitivity Correction From Q384 3

CHANGE: C273 goes to a +30 V

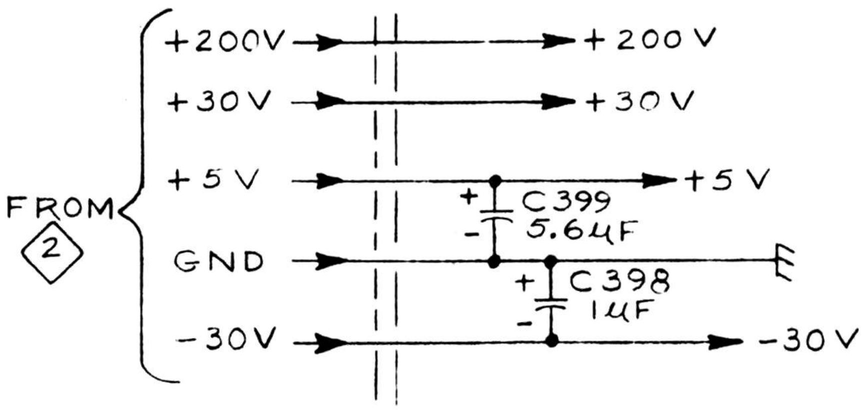
STORAGE CIRCUIT 3

CHANGE TO: R388 5.11 K VR388 6.2 V

Q384 goes to Sensitivity Correction To R274 2

CHANGE TO: R341 75 K

LABEL: Capacitors as shown below:



D10 EFF SN B070000-up

D11 EFF SN B080000-up

D15 EFF SN B040000-up

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

Q106	151-0190-00	Silicon, NPN, replaceable by 2N3904
Q116	151-0190-00	Silicon, NPN, replaceable by 2N3904
Q126	151-0190-00	Silicon, NPN, replaceable by 2N3904
Q136	151-0190-00	Silicon, NPN, replaceable by 2N3904