INSTRUCTION MANUAL

Serial Number ______________

TYPE 3A5

AUTOMATIC/PROGRAMMABLE AMPLIFIER

Tektronix, Inc.

S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon ● Phone MI 4-0161 ● Cables: Tektronix

070-0500-00

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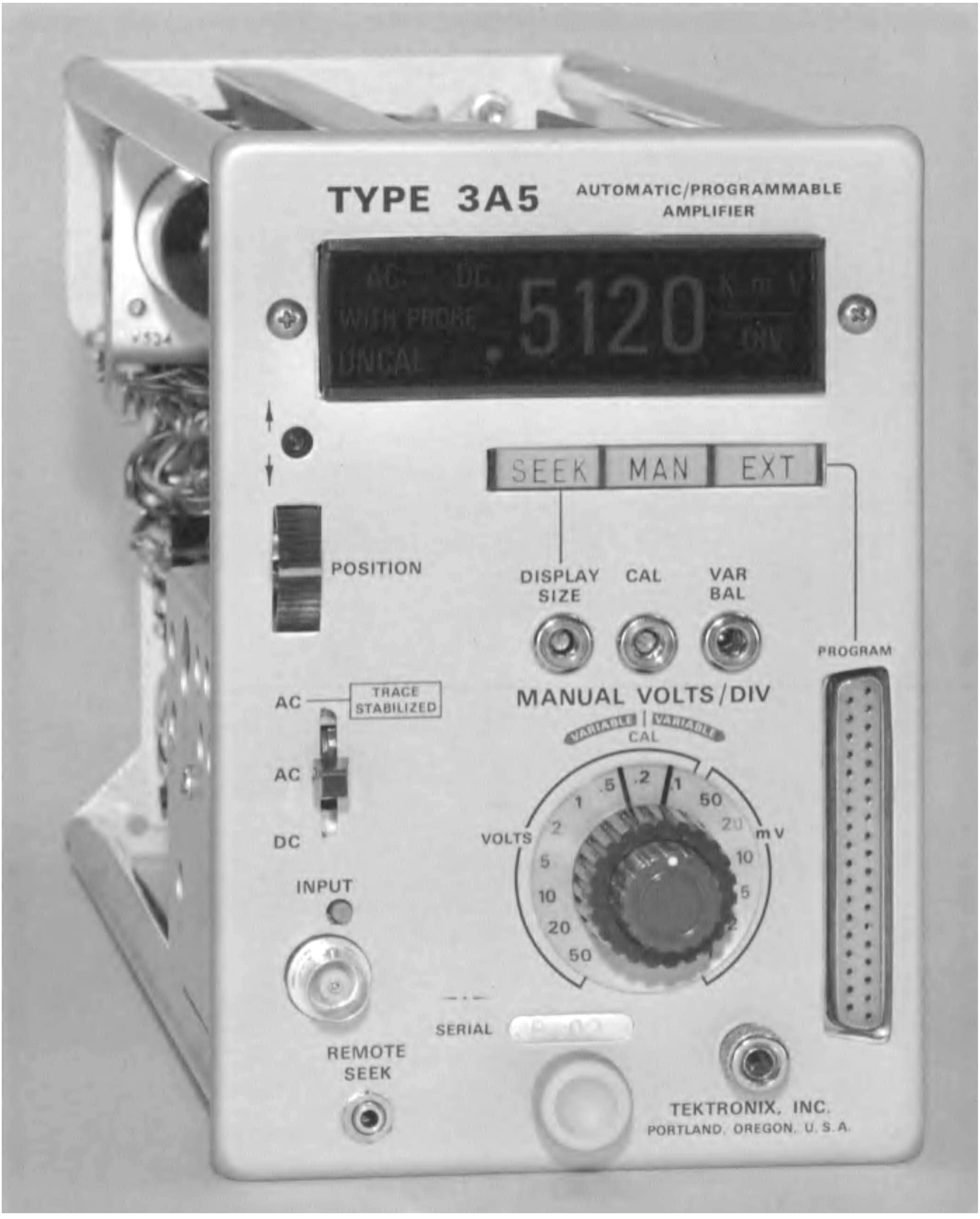

TYPE 3A5
AUTOMATIC/PROGRAMMABLE
AMPLIFIER
AC DC
WITH PROBE
UNCAL
.5120
K m V
DIV
SEEK
MAN
EXT
POSITION
DISPLAY SIZE
CAL
VAR BAL
PROGRAM
TRACE STABILIZED
AC
AC
DC
MANUAL VOLTS/DIV
VARIABLE
VARIABLE
CAL
VOLTS
mV
INPUT
SERIAL
REMOTE SEEK
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.

SECTION 1
CHARACTERISTICS

Introduction

The Tektronix Type 3A5 Automatic/Programmable Amplifier is a wideband oscilloscope vertical amplifier plug-in unit. Its most distinctive feature is the ability to seek and automatically select an appropriate deflection factor for a usable display of an input signal. The Type 3A5 is designed to operate in Tektronix Types 561A, 564, 565 and 567 oscilloscopes (including rack-mount instruments of the same type number), or in the 4-channel Tektronix Type 129 Plug-In Unit Power Supply. It is most often used in the Type 564 or 561A Oscilloscope, with a Type 3B5 Automatic/Programmable Time Base in the horizontal compartment.

Front-panel operated modes include SEEK: automatic deflection factor seeking; MAN: manually selected deflection factor using the MANUAL VOLTS/DIV switch; and EXT: external programming of the deflection factor and input coupling by external circuit closures. The SEEK mode can also be selected by pressing the SEEK button located on the P6030 10× Probe, or by command through the PROGRAM CONNECTOR.

A front-panel illuminated readout indicates the deflection factor (correctly scaled with or without the Tektronix P6030 10× Probe); the input coupling AC or DC; and uncalibrated deflection factor when the VARIABLE control is not at its detent CAL position. Display amplitude is read from the oscilloscope crt by the operator.

ELECTRICAL CHARACTERISTICS

The following characteristics apply over an ambient temperature range of 0°C to +50°C, except as otherwise stated. These characteristics apply only after an instrument warm-up time of at least 20 minutes.

TABLE 1-1

General Characteristics	Performance Requirements	Supplemental Information
Deflection Factors	1 mV/DIV to 50 V/DIV in 15 calibrated steps selectable by MANUAL VOLTS/DIV switch. 10 mV/DIV to 50 V/DIV in 12 calibrated steps selectable by automatic or external circuits.	Steps are in 1, 2, 5 sequence. Steps are in 1, 2, 5 sequence. Both ranges are automatically scaled 10× to maximum of 0.5 kV/DIV when P6030 10× Probe is installed on INPUT connector. Other probes will not scale deflection factor.
Deflection Accuracy	±3% of indicated deflection when VARIABLE control is at CAL detent position.	
Variable Deflection Factor	VARIABLE control reduces display size to between 55.5% and 71.5% of calibrated size as it is rotated from CAL to full ccw position. As control rotates from CAL position clockwise, display size increases. Full display size attenuation ratio as control is rotated throughout its range is $\geq$2.5:1.	Readout V/DIV turns off and red UNCAL turns on when VARIABLE control is at other than CAL.
Input Resistance and Capacitance To Ground	1 MΩ ±0.75% paralleled by 24 pF ±1 pF. Type 3A5 ONLY — With P6030 Probe (Calculated)	Capacitance measured at 140 kHz.
Frequency Response (Amplitude Response not more than —30% from 50 kHz calibrated deflection.) 10 mV/DIV to 50 V/DIV	DC to $\geq$15 MHz — DC to $\geq$14 MHz $\leq$5 Hz to $\geq$15 MHz — $\leq$5 Hz to $\geq$14 MHz $\leq$5 Hz to $\geq$15 MHz — $\leq$5 Hz to $\geq$14 MHz	Response measured at 10 mV/DIV. DC coupled. AC coupled. AC—TRACE STABILIZED.
1 mV/DIV to 5 mV/DIV	DC to $\geq$5 MHz — DC to $\geq$5 MHz $\leq$5 Hz to $\geq$5 MHz — $\leq$5 Hz to $\geq$5 MHz $\leq$30 Hz to $\geq$5 MHz — $\leq$30 Hz to $\geq$5 MHz	Response measured at 1 mV/DIV. DC coupled. AC coupled. AC—TRACE STABILIZED. AC—TRACE STABILIZED operation is recommended.

TABLE 1-1 *(Cont'd)*

General Characteristics	Performance Requirements		Supplemental Information
Risetime (Calculated) 10 mV/DIV to 50 V/DIV	23.2 ns	25 ns	10% to 90%. Related to sine-wave frequency response at 10 mV/DIV.
1 mV/DIV to 5 mV/DIV	70 ns	70 ns	
Transient Response	≤3% overshoot, rounding, ringing or tilt.		Measured at 10 mV/DIV with centered 4 div fast step display.
Attenuator Compensation	≤3% peak-to-peak overshoot, rounding, ringing or tilt.		Measured at 20 mV/DIV to 50 V/DIV using 1 kHz 10 ns risetime square wave, 4 div display through 24 pF time-constant standardizer.
Position Effect On Transient Response	≤±5% overshoot, rounding, ringing or tilt.		While displaying a 400 kHz 6 div step pulse.
Compression or Expansion	±5% compression or expansion of 2 division display from crt top to bottom.		Measured with test oscilloscope at crt pins.
Position Control Range	≥±6 div		AC coupled symmetrical 12 div display top and bottom can be positioned past crt centerline.
Maximum Input Voltage	600 volts combined dc plus peak ac.		500 volts with P6030.
Trace Drift With Line Voltage Change	±0.5 major div from 105 to 125 volts rms.		At 10 mV/DIV and after one minute at each voltage.
Automatic Mode Characteristics			
CRT Displayed Size	1. When the DISPLAY SIZE control is adjusted for the oscilloscope in which the Type 3A5 is operating: The CRT display size will be reduced so that top and bottom are ≤3.5 div above and below the graticule centerline when the SEEK button is pressed.		A dc coupled display peak-to-peak amplitude is dependent upon the signal zero dc level, polarity, amplitude, crt electrical center and the POSITION control.
	2. The crt display size will not be reduced once the deflection factor of 50 V/DIV has been reached.		An ac coupled display peak-to-peak amplitude is dependent upon the signal waveshape, crt electrical center and the POSITION control. A typical sine-wave display peak-to-peak amplitude (when the display zero dc level is at the graticule centerline) will be between 2 and 6 DIV.
Automatic Seeking Time	≤200 ms.		With 100 V, 1 kHz signal.
Automatic Cycling Time	2 to 4 seconds.		When SEEK command is continuous. Slightly faster in first 5 seconds.
Automatic Seeking Circuit Will Respond to Signals:	DC and 30 Hz sinewaves to 20 MHz. 30 Hz sinewaves to 20 MHz.		DC coupled. AC coupled. Waveform does not have to be sinusoidal above 60 Hz. Some signals below 60 Hz will allow proper operation depending upon waveform.

OPERATING CHARACTERISTICS

General

All front panel controls of the Type 3A5 (except the POSITION and VARIABLE controls) operate transistor circuits and internal magnetic reed switches that perform the indicated functions. All functions, including positioning (but not the VARIABLE control), can be performed either manually or programmed externally. The following paragraphs describe which functions operate for each mode.

Manual Mode (No external program connected)

The Type 3A5 operates as a normal oscilloscope vertical amplifier in the manual mode whenever the MAN pushbutton is illuminated. The manual mode operates when the MAN button is pressed, or whenever the MANUAL VOLTS/

DIV switch setting is changed. An external mode command through the PROGRAM connector takes priority over all other modes.

The operating functions available in manual mode, and the corresponding readout panel indications are listed in Table 1-2.

TABLE 1-2

Manual mode functions and readout

Functions	Control Used	Readout
Input Coupling	Three position lever switch	
DC		DC
AC		AC
AC-TRACE STABILIZED		AC
Deflection Factor Selection	MANUAL VOLTS/DIV	$1 \frac{mV}{DIV}$ to $50 \frac{V}{DIV}$
Variable Deflection Factor Selection	VARIABLE control	$\frac{V}{DIV}$ extinguishes and red UNCAL turns on
Deflection Factor 10× probe scaling	P6030 Probe mechanically depresses unlabeled 10× scaling switch	WITH PROBE from $10 \frac{mV}{DIV}$ to $.5 \frac{kV}{DIV}$
Display Positioning	POSITION control	None

Automatic Seeking Mode (No external program connected)

Automatic deflection factor selection is obtained by pressing the front panel SEEK pushbutton. Internal circuitry disables the MANUAL VOLTS/DIV switch; the MAN pushbutton lamp goes out; the automatic circuits cycle through the reed switch-operated attenuators to a point determined by the display amplitude; and the SEEK pushbutton is illuminated. Automatic deflection factor seeking is also operated by the P6030 Probe SEEK button whenever the probe is connected to the front panel INPUT and REMOTE SEEK connectors.

The Type 3A5 will recycle to seek a new deflection factor each 2 to 4 seconds when either SEEK button is held closed longer than 5 seconds. The recycle time is slightly faster during the first 5 seconds.

External Mode

Deflection factor selection can be switched to external programming through the Type 3A5 front panel external PROGRAM connector. Also, the mode will change to external when the EXT pushbutton is held depressed. The mode remains external only by permanent command through the PROGRAM connector. The Type 3A5 deflection factor must be programmed instead of automatically selected when operating in the external mode. Deflection factor selection is by external circuit closures through the external PROGRAM connector. An external mode command through the PROGRAM connector has priority over all other modes. Functions that can be externally operated are listed in Table 1-3.

TABLE 1-3

External Operations Through PROGRAM connector

1. SEEK Mode.
2. EXTernal Mode.
3. Deflection factor, including readout.
4. Input coupling, including readout.
5. WITH PROBE 10× scaling, including readout.
6. Vertical position (adds to POSITION control).

External operation disconnects the front panel input coupling selector switch and the probe 10× scaling switch. The oscilloscope −12.2, −100, and +125-volt power supplies are always available through the external PROGRAM connector. See the Operating Instructions for available current.

The external PROGRAM lead voltage and current ratings required of external programming equipment are given at the back of the Operating Instructions section of this manual.

ENVIRONMENTAL CHARACTERISTICS

Storage

Temperature— −40°C to +65°C.

Altitude—to 50,000 feet.

Operating

Operating temperature—0°C to +50°C.

Operating altitude—to 10,000 feet.

MECHANICAL CHARACTERISTICS

Dimensions—16½ inches x 4¼ inches x 6¼ inches.

Weight—5 pounds, net.

Construction—aluminum alloy chassis.

Finish—anodized and silk screened front panel.

ACCESSORIES

Standard Accessories

	Tektronix Part No.
1—P6030 10× Probe with its accessories.	010-0195-00
1—37 pin Connector, male, to mate with PROGRAM connector.	131-0422-00
1—Connector cover, fits 131-0422-00.	200-0660-02
2—Instruction Manuals.	070-0500-00

SECTION 3
LOGIC AND CIRCUIT DESCRIPTION

Introduction

The Type 3A5 Automatic/Programmable Amplifier circuits provide several ways to obtain a useful crt display easily. The plug-in includes the normal vertical amplifier circuits needed to deflect the crt beam, plus circuits and controls that allow automatic or external control of the deflection factor, input coupling and mode of operation. This section of the manual describes first the system (through block diagrams), then the circuits of the Type 3A5.

LOGIC AND BLOCK DIAGRAM

The system interconnections of the Type 3A5 are shown fully in the complete block diagram at the back of this manual. The logic description begins with simplified block diagrams that show the general vertical and automatic portions of the instrument. Circuit interconnections for seven operating modes follow the simplified block diagrams. The seven mode block diagrams are drawn with the blocks in the same order as the complete block diagram.

A simplified block diagram of the most basic blocks of the Type 3A5 is shown in Fig. 3-1. The Type 3A5 input attenuators are operated by either the MANUAL VOLTS/DIV control or the automatic circuits. Display size information from the vertical amplifier controls the response of the automatic circuits once they have been put into operation. The two connections between the automatic block and the MANUAL VOLTS/DIV switch block (of Fig. 3-1) are power control lines. The automatic control circuits supply —12.2 volts to the MANUAL VOLTS/DIV switch only during manual mode operation. The MANUAL VOLTS/DIV switch will change the mode of operation from SEEK to manual any time the switch is turned (provided an external programmer is not connected and operating). The +6.8 volts to the automatic block is interrupted as the MANUAL VOLTS/DIV switch travels between detent positions, changing the mode to manual.

Fig. 3-2 block diagram shows more basic interconnections between the automatic circuits and the vertical system. The connections added to those of Fig. 3-1 are: (1) "WITH PROBE" switch for 10× scaling of the readout when operating with P6030 10× Probe; (2) two sets of reed-switched attenuators; (3) the AC—TRACE STABILIZED feedback path around the vertical amplifier, and (4) the Input Coupling switch is shown as feeding information to the readout circuits.

The diodes in the lines to the two sets of reed switched attenuators switch out the Automatic circuits when operation is manual; similarly for automatic operation, the MANUAL VOLTS/DIV switch is diode-switched out of operation.

Automatic circuits is the name thus far given to both the mode control circuits and the circuits that set the deflection factor automatically. Before studying any of the control or automatic deflection factor selection circuits, refer to Fig. 3-3 which shows the complete vertical amplifier block diagram. All the front panel controls that affect the vertical system are shown.

Fig. 3-3 shows that several functions of the vertical amplifier can be controlled in more than one manner. The functions and their source of control are:

Function	Controlled By:
Input Coupling	Front-panel three position switch; or external program.
Deflection Factor	MANUAL VOLTS/DIV switch; or SEEK auto selection circuits; or external program.
With Probe 10× scaling of readout	By P6030 10× Probe connector; or by external program.
VARIABLE	Front-Panel only.
UNCAL to readout	Front-Panel only.
POSITION	Front-Panel; or external program override of front-panel control.
CAL	Front-Panel only.
DISPLAY SIZE	From front-panel only. Display size information controls SEEK auto circuit selection of deflection factor.
1, 2, or 5 mV/DIV Deflection Factors	Front-Panel MANUAL VOLTS/DIV switch only, changes Output Amplifier gain 10×.

The seven major operating modes are block diagrammed in Fig. 3-4 through Fig. 3-10. Each figure has all the circuit blocks laid out in the same order as used on the complete block diagram at the back of this manual. Interconnections and readout are shown for only those leads that are active for each mode. (The INT-EXT switch indicates that the input coupling, and "with probe" switching can be front-panel or externally controlled.)

Fig. 3-4 and Fig. 3-5 show two manual operating modes. The major difference between the two diagrams is the 10× probe, the Input Coupling, and the Output Stage 10× gain. Note that the MANUAL VOLTS/DIV switch receives a 10× readout scaling command when the P6030 10× Probe is used.

Fig. 3-6 shows a simple automatic SEEK mode block diagram with an uncalibrated 10 V/DIV deflection factor, and no probe. Note that the Mode Control provides —12.2 volts to the two Ring Counters and the 1×/10× Readout Scaler. The +6.8-volt lead from the MANUAL VOLTS/DIV switch to the Mode Control circuits is the control lead that will change the mode from SEEK to Manual any time the MANUAL VOLTS/DIV switch position is changed (providing there is no external program in operation). The SEEK mode is obtained by pressing the front-panel SEEK pushbutton, or by momentary grounding of the correct external PROGRAM lead (dashed line). A SEEK command pulse goes to the Advance Gate. (Pressing the P6030 SEEK button causes a REMOTE SEEK command pulse to go to both the Advance Gate and the horizontal unit.) The leading edge of the

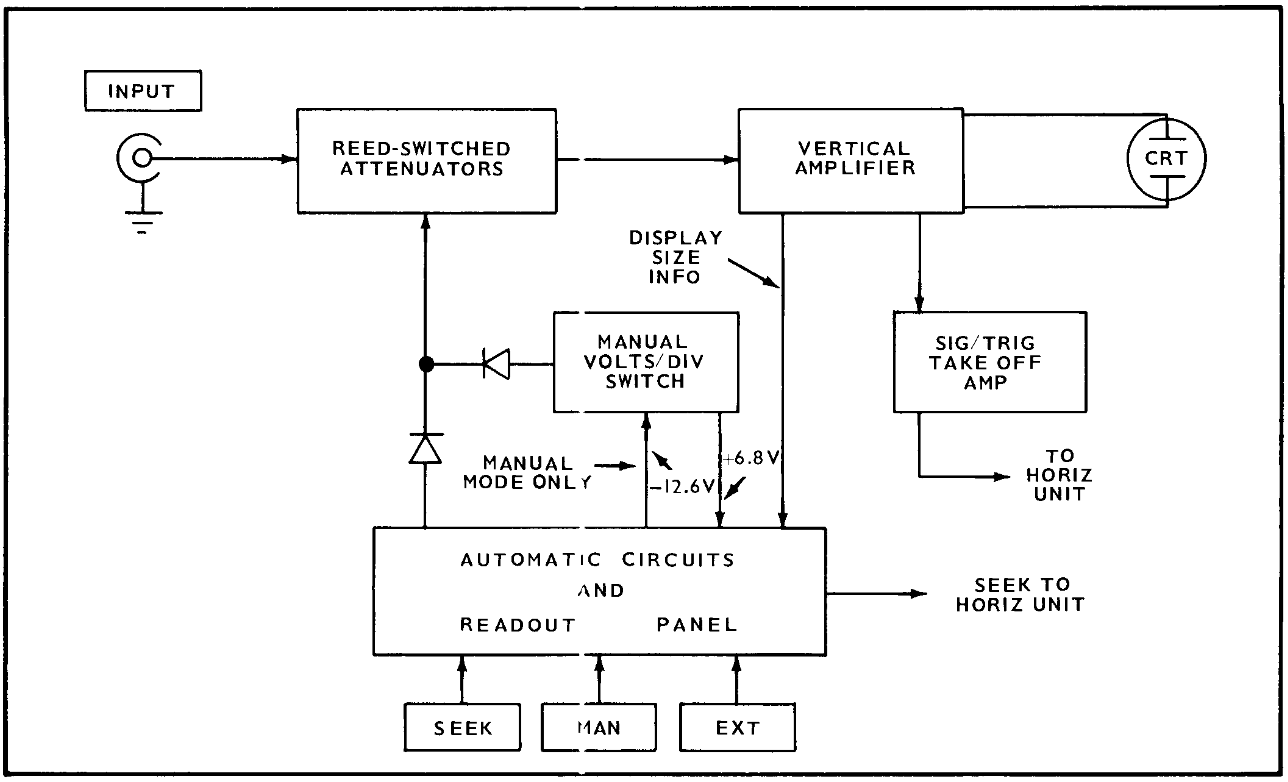


Fig. 3-1. Type 3A5 simplified block diagram.

SEEK command signal is used as a Ring Counter reset pulse to set them both to ÷1. If the vertical signal out of the Driver Amp exceeds the voltage set by the DISPLAY SIZE control, the Display Comparator Multi will send a positive pulse or a series of pulses to the Advance Gate. If the Advance Gate has received a SEEK Command, negative Advance pulses are sent to the ÷3 Ring Counter. Each pulse advances the ÷3 Ring Counter to the next state in its cycle, ÷1 to ÷2 to ÷5, each state corresponding to an input attenuator value. After the ÷3 Ring Counter reaches ÷5, its next step is back to ÷1, and a ÷3 Advance Pulse is sent to the ÷4 Ring Counter. Pulses to the ÷4 Ring Counter advance it one step at a time from ÷1 to ÷10 to ÷100 and to ÷1000. If the Display Comparator Multi sends out enough pulses for the ÷3 Ring Counter to reach ÷5 at the same time the ÷4 Ring Counter reaches ÷1000, a 50 V/DIV Advance Inhibit locks out any more Advance Pulses from leaving the Advance Gate (see Fig. 3-9). If the signal out of the Driver Amp still exceeds the voltage set by the DISPLAY SIZE control, the Display Comparator Multi continues to send out pulses, but they are used only to light the Overscan Lamp. The 10 V/DIV Deflection Factor of Fig. 3-6 required 9 Advance Pulses (after the reset of both ring counters) in order for the Ring Counters to activate the ÷1000 and ÷1 attenuator reed switches.

Fig. 3-7 is a 20 V/DIV SEEK mode WITH PROBE block diagram. The major difference from Fig. 3-6 is the 10X Command to the 1X/10X Readout Scaler, and the ÷1000 and ÷2 attenuators that are activated by the Ring Counters.

Fig. 3-8 connections differ from Fig. 3-7 only in the Input Coupling, and the fact that the VARIABLE control is in its calibrated position. The Deflection Factor is different and shows that the 1X/10X Readout Scaler can turn on more than one readout lamp.

Fig. 3-9 shows signals of the ring counter ÷1000 and ÷5 stages coupled to the Advance Gate at 50 V/DIV. When both Ring Counters reach their maximum count, an inhibit signal to the Advance Gate stops any more Advance Pulses from reaching the ÷3 Ring Counter. If there were no 50 V/DIV inhibit signal, the attenuators next step would be back to 10 mV/DIV (÷1 and ÷1) and the system would not stop cycling until the end of the SEEK command pulse.

Fig. 3-10 is an External Mode block diagram at .5 V/DIV, WITH PROBE, and uncalibrated. Note that the Mode Control sends —12.2 volts to the Ring Counters and the 1X/10X Readout Scaler. Ring Counter input leads are grounded through the External PROGRAM connector, labeled EXT PROGRAM. The Input Coupling is externally controlled, and the 1X/10X Readout Scaler is externally controlled. The POSITION control can receive override current through the PROGRAM connector if desired.

CIRCUIT DESCRIPTION

Attenuators

The attenuators, detailed on diagram number 1, Section 9 are selected by magnetic coil reed switches. Each attenuator

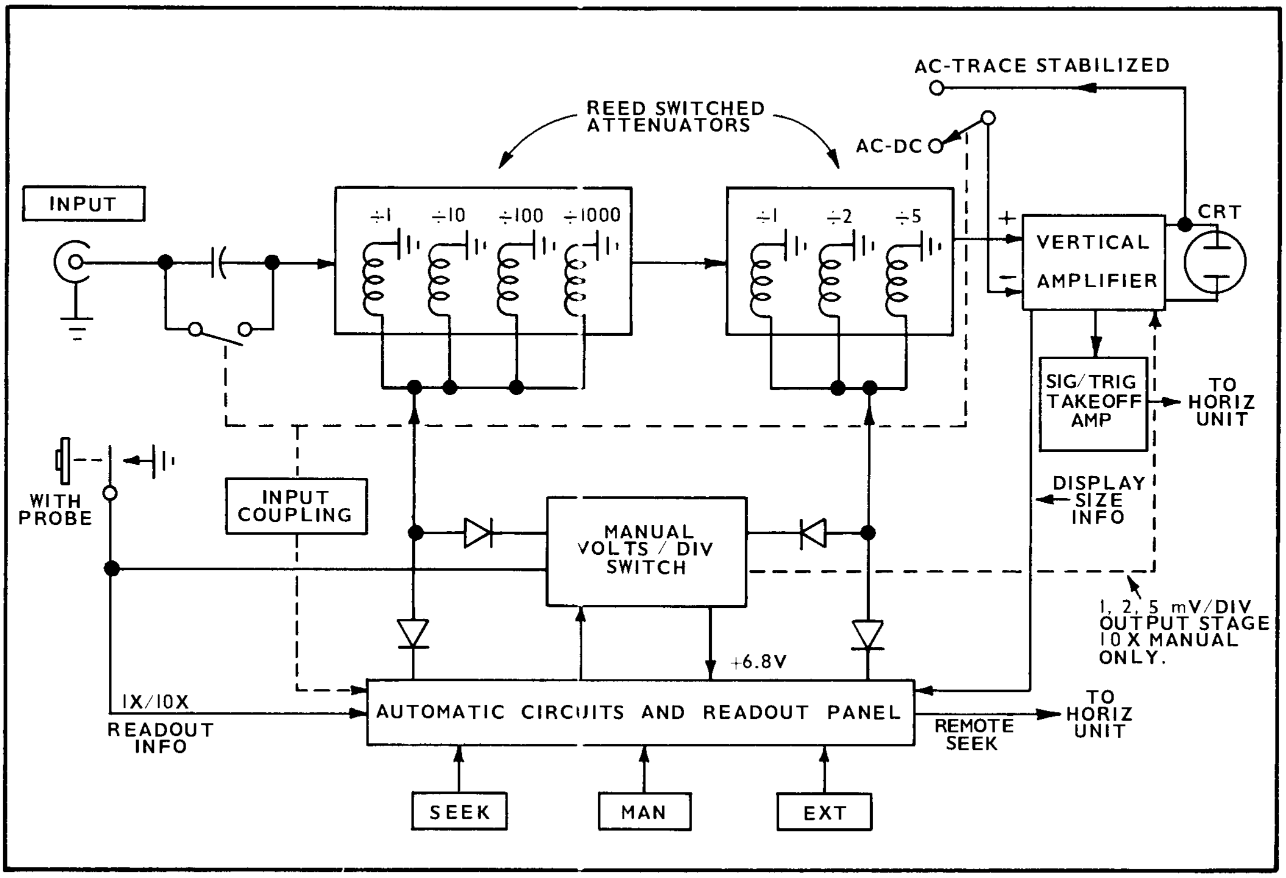


Fig. 3-2. Basic interconnections between vertical system and automatic system.

is a time constant compensated divider that is correctly compensated when its load is 1 MΩ and 24 pF. Fig. 3-11 shows the basic components of an attenuator, assuming no stray capacitance. The output voltage is equal to the input voltage multiplied by the ratio of the resistor values at dc or low frequencies, and by the ratio of the capacitive reactance of the two capacitors at high frequencies. Another way of expressing the same thing is to say the time constant of $R_1 \times C_1$ equals the time constant of $R_2 \times C_2$, and the voltage attenuation is the same for all frequencies.

Fig. 3-12 shows that the ÷2 attenuator output resistor and capacitor (equal to R_2 and C_2 of Fig. 3-11) consist of R55D in parallel with R70, and C70 in parallel with stray lead capacitance and the vertical amplifier input capacitance. R55D and R70 in parallel equals 500 kΩ, which, in turn is equal to R55A. This gives the attenuator a ratio of 2 to 1. Capacitors C55A and C55B serve only to bring the ÷2 attenuator input capacitance up to 24 pF. Without C55A and C55B, the system input would be less than 24 pF with the ÷2 attenuator in use.

The number of components between the INPUT connector and the vertical amplifier input changes considerably, depending upon what deflection factor is required. The attenuator components sequence (without component numbers) is shown in Fig. 3-13. Fig. 3-13 indicates that the input resistance and capacitance (at the INPUT connector) remains the same regardless of deflection factor, and the input capacitance of each attenuator input section is adjustable. An attenuator probe such as the P6030 10× Probe can be used with the Type 3A5 without having to change its compensation as different input attenuators are switched into service.

All attenuator switching is done by magnetic reed switches which are operated remotely by the various circuits. Circuits that can operate the reed switches are shown on the block diagram. They include: (1) the MANUAL VOLTS/DIV switch, (2) the ÷3 and ÷4 Ring Counters, and (3) the external PROGRAM. External control lead voltage and current requirements are given in the Operating Instructions under External Programming.

The input circuit to the attenuators includes the reed-relay operated AC coupling capacitor, C1. Resistor R1 is placed in series with the reed switch and C1 to limit the discharge current through the reed switch in the event C1 is charged to a high voltage.

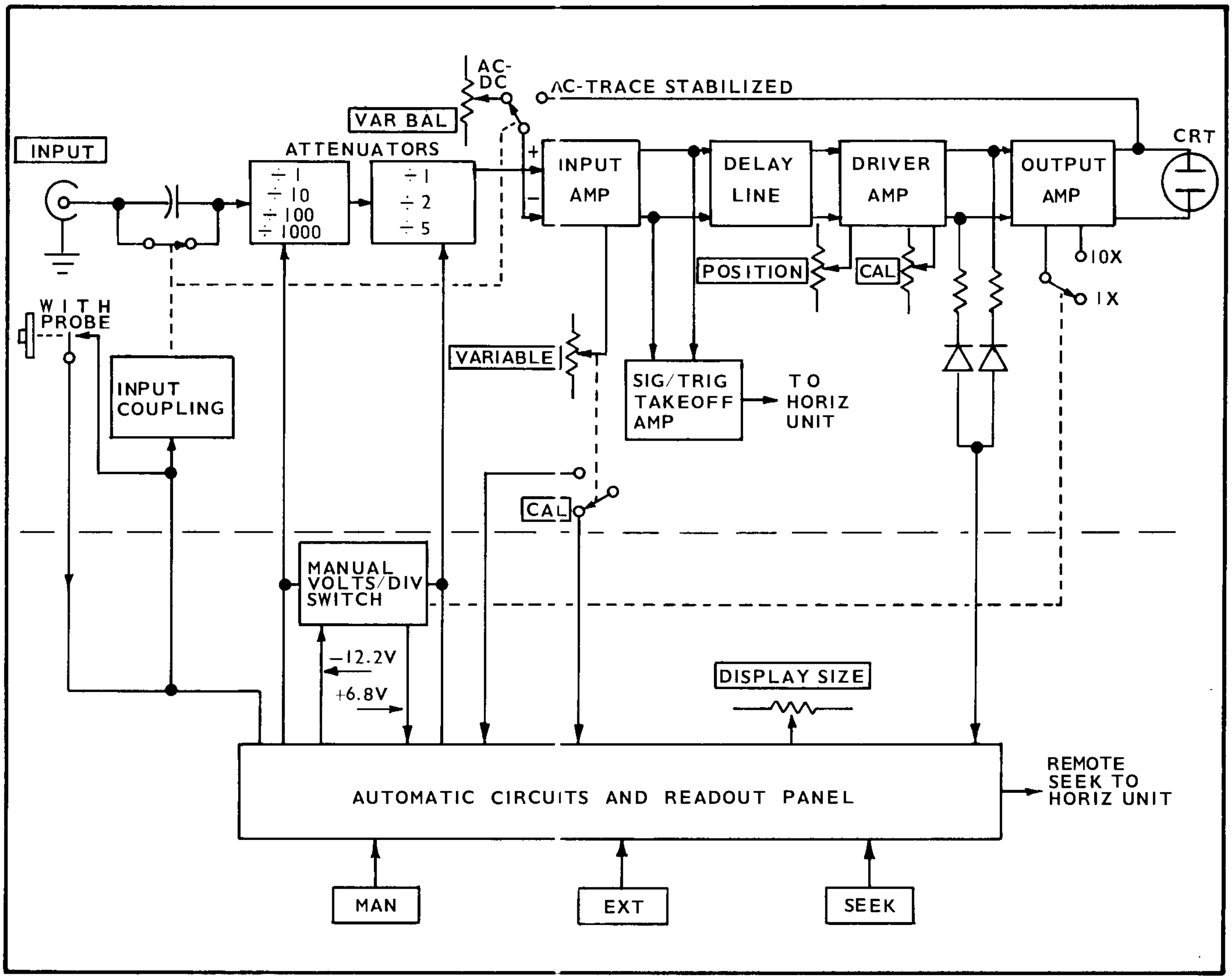


Fig. 3-3. Block diagram of the complete vertical amplifier system with simplified automatic circuits.

Vertical Amplifier

The input grid of the vertical amplifier (at V113) receives a standard signal of 10 mV peak to peak for each major division of vertical deflection. This is true for deflection factors of 10 mV/DIV, through 50 V/DIV. For deflection factors of 1, 2, or 5 mV/DIV, the standard input signal to V113 grid is 1 mV peak to peak for each major division of vertical deflection. The total amplifier is symmetrically balanced, with some sections push-pull and some sections paraphase. The push-pull stages have no common coupling between balanced halves, while the paraphase stages do have common coupling.

Referring to Fig. 3-3 (or the complete block diagram) the Input Amplifier has a single-ended input to push-pull output voltage gain of approximately 9.5 when the VARIABLE control is at CAL. The gain of 9.5 is from the grid of V113 to the two Delay Line input terminals. The gain of the Driver Amplifier is adjustable by the front-panel CAL control. The nominal push-pull voltage gain of the Driver Amplifier (when the crt vertical deflection factor is 20 volts/div) is approximately 5.5. The gain of 5.5 is measured from the two Delay Line output terminals to the two emitters of Q183/Q383. The Output Amplifier push-pull voltage gain is approximately 41 as measured from the emitters of Q183/Q383 to the plates of V524/V534. The total gain from V113 grid to the push-pull output at the crt is approximately 2000.

Input Amplifier. The Input Amplifier consists of five balanced stages. The input is a pair of vacuum tube cathode followers. V113 grid receives the standard signal from the input attenuators. V313 receives either a fixed level dc voltage from the VAR BAL control, or a dc feedback signal from the Output Amplifier at V524 plate. The input tubes have large cathode resistors to the −100-volt supply to stabilize their operation and make their gain nearly unity. R115 and C115 decouple the power supply lead from the input stage cathodes. Since R115 is 47 ohms and C115 is 0.01 μF, the two cathodes have no common signal coupling, and the tubes operate independently.

The cathode output impedance of V113 is not low enough to properly drive the base circuit of Q134, so the second stage is a transistor emitter follower. Q123/Q323 each have relatively large emitter resistors to the decoupled +4.2-volt

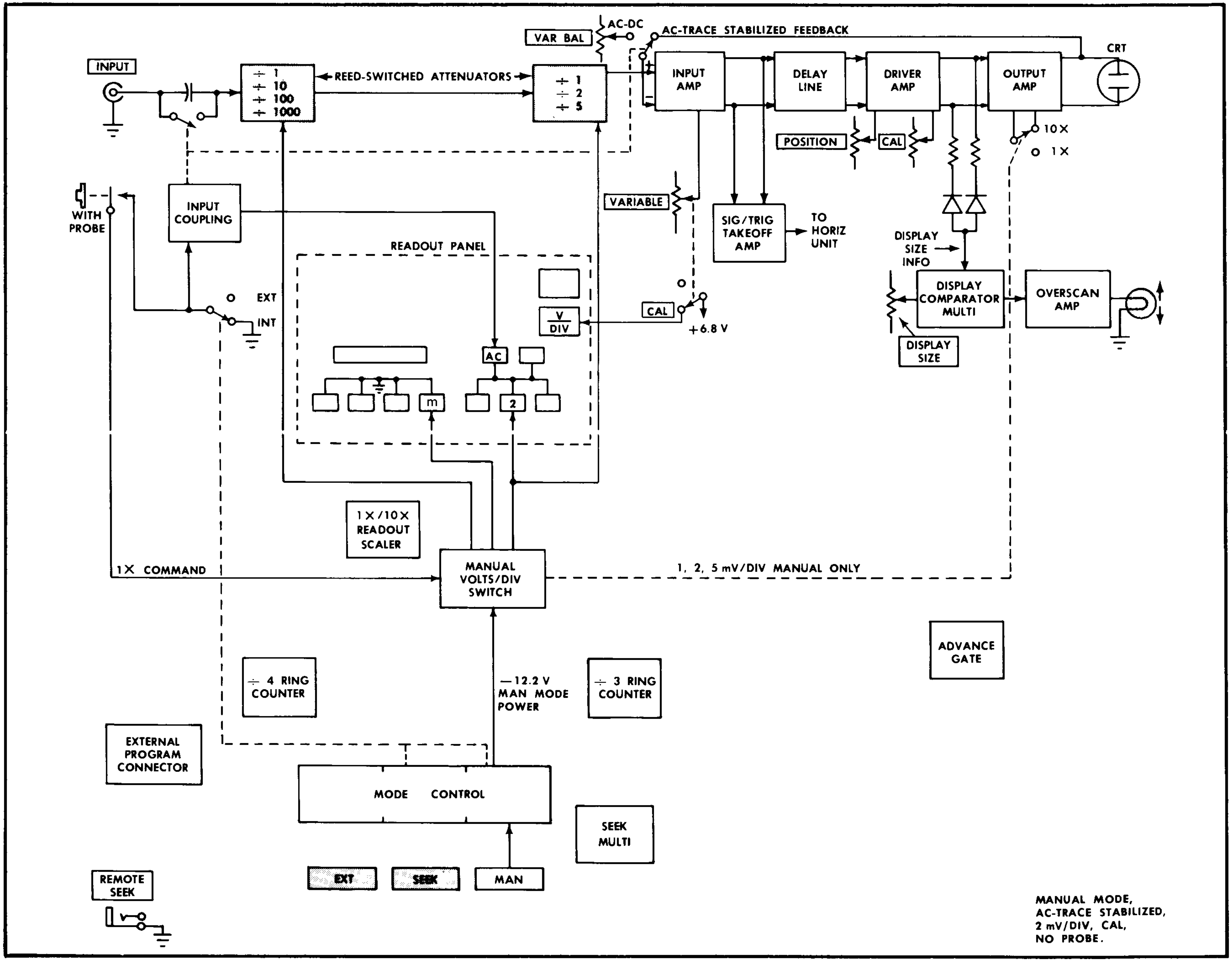
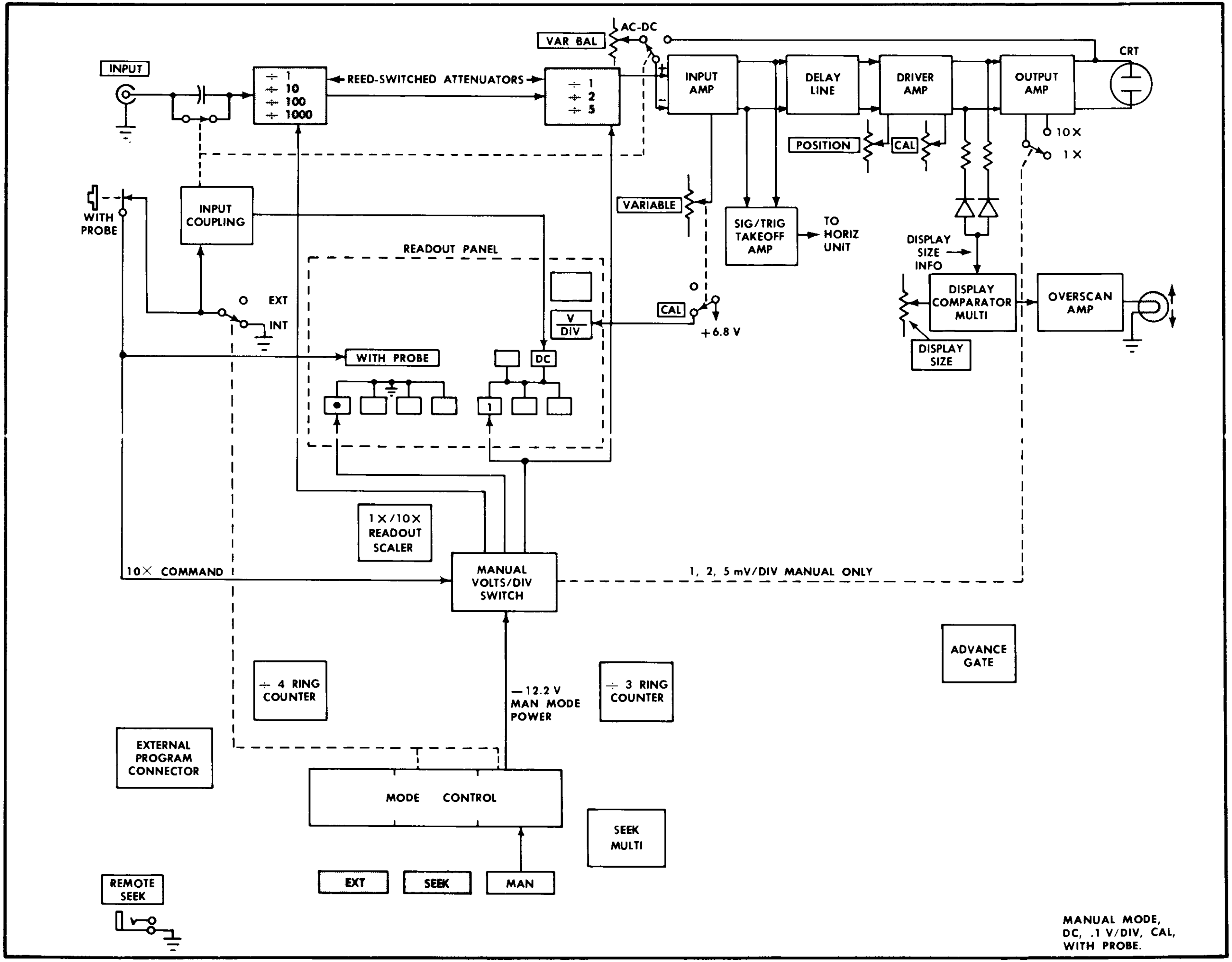

INPUT
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
AC-TRACE STABILIZED FEEDBACK
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10X
1X
WITH PROBE
INPUT COUPLING
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
READOUT PANEL
EXT
INT
AC
m
2
V DIV
CAL
+6.8 V
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
1X/10X READOUT SCALER
1X COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
ADVANCE GATE
÷ 4 RING COUNTER
—12.2 V MAN MODE POWER
÷ 3 RING COUNTER
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK MULTI
REMOTE SEEK
EXT
SEEK
MAN
MANUAL MODE, AC-TRACE STABILIZED, 2 mV/DIV, CAL, NO PROBE.

Fig. 3-4.



INPUT
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
10×
1×
POSITION
CAL
WITH PROBE
INPUT COUPLING
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
READOUT PANEL
EXT
INT
CAL
+6.8 V
V/DIV
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
WITH PROBE
DC
1
1×/10× READOUT SCALER
10× COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
ADVANCE GATE
÷ 4 RING COUNTER
−12.2 V MAN MODE POWER
÷ 3 RING COUNTER
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK MULTI
EXT
SEEK
MAN
REMOTE SEEK
MANUAL MODE, DC, .1 V/DIV, CAL, WITH PROBE.

Fig. 3-5.

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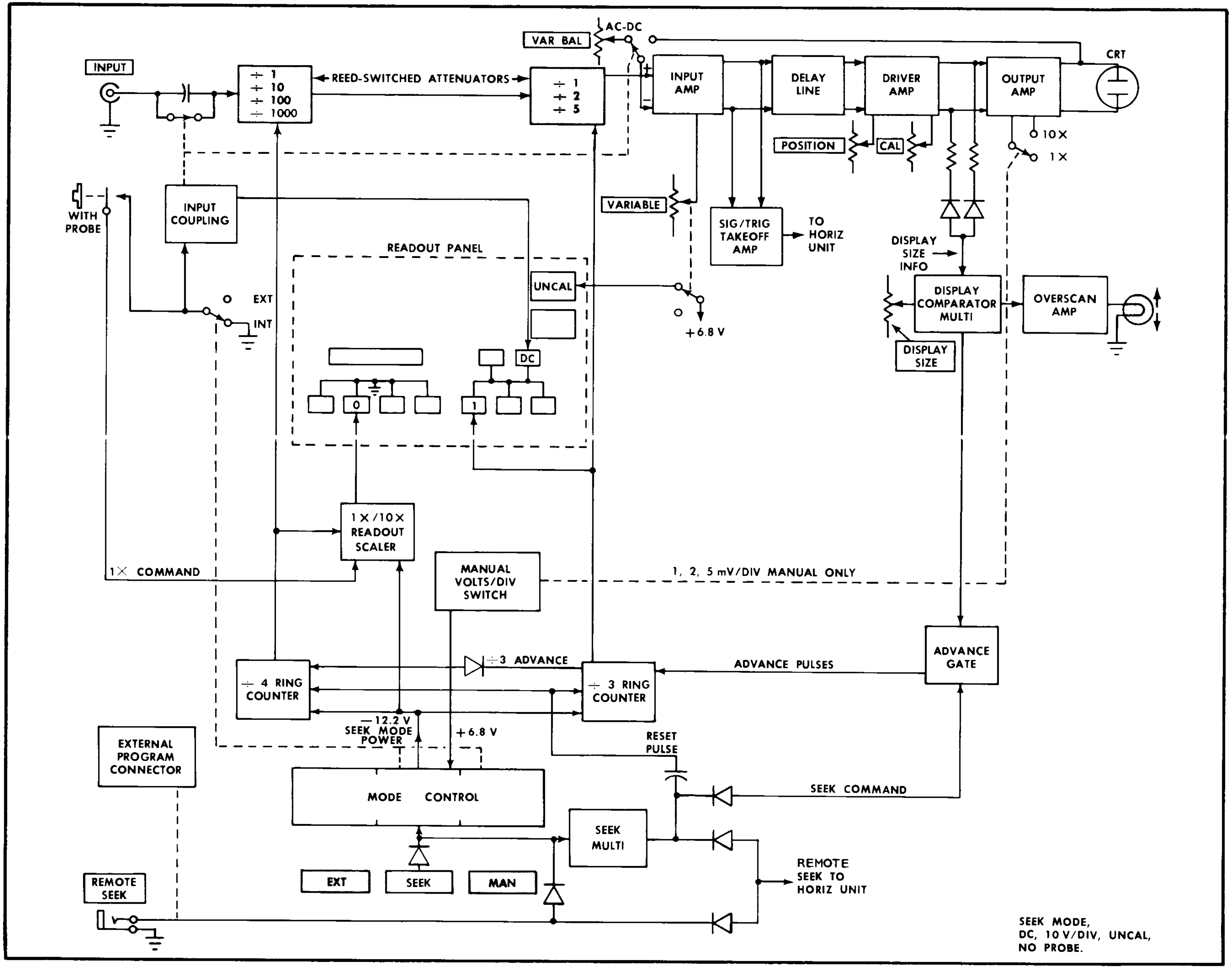
INPUT
VAR BAL
AC-DC
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10 X
1 X
WITH PROBE
INPUT COUPLING
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
READOUT PANEL
UNCAL
DC
0
1
EXT
INT
+6.8 V
DISPLAY SIZE INFO
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
1 X/10 X READOUT SCALER
1 X COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
÷ 3 ADVANCE
÷ 4 RING COUNTER
÷ 3 RING COUNTER
ADVANCE PULSES
ADVANCE GATE
−12.2 V
SEEK MODE POWER
+6.8 V
RESET PULSE
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK COMMAND
SEEK MULTI
EXT
SEEK
MAN
REMOTE SEEK TO HORIZ UNIT
REMOTE SEEK
SEEK MODE, DC, 10 V/DIV, UNCAL, NO PROBE.

Fig. 3-6.

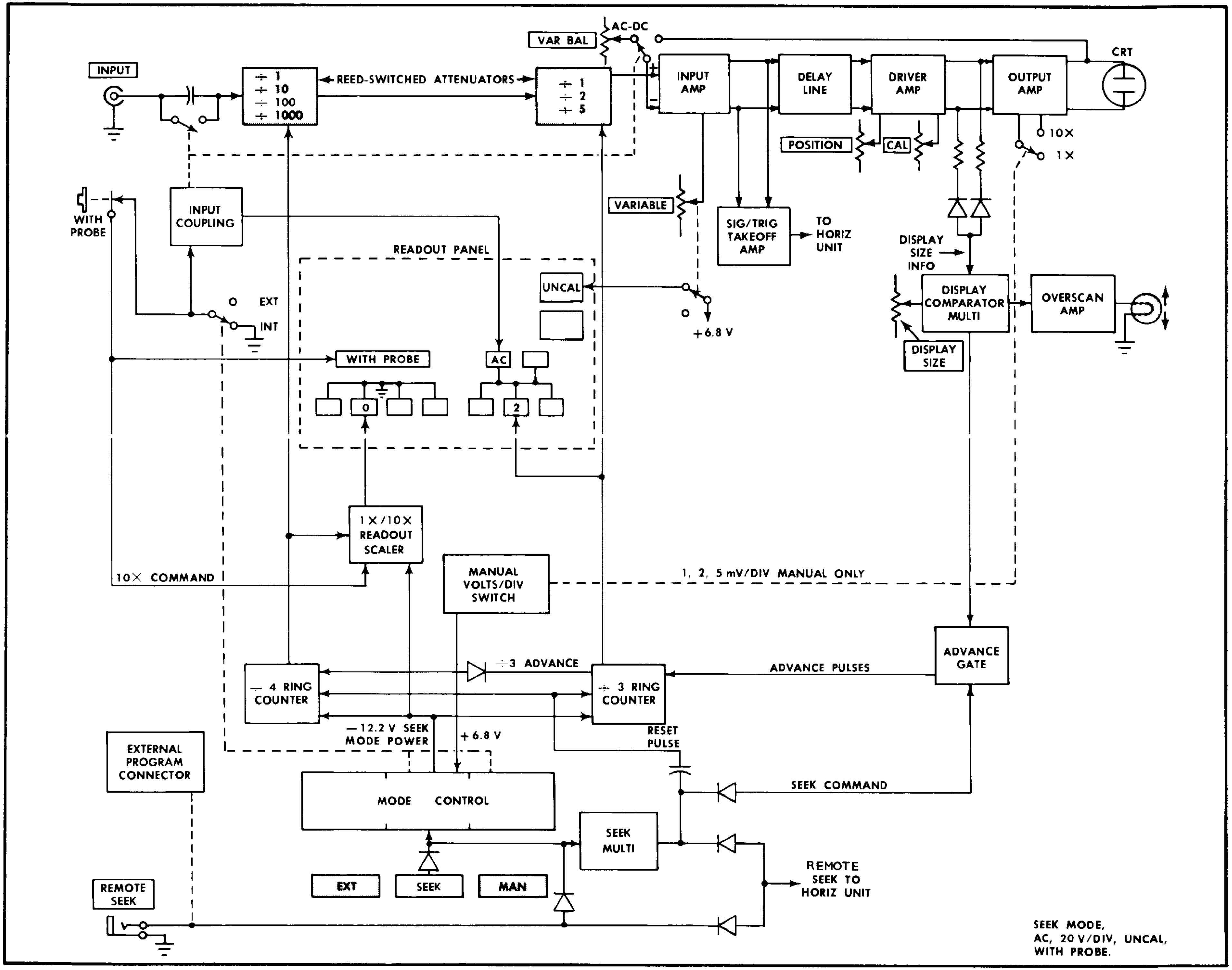
INPUT
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10×
1×
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
WITH PROBE
INPUT COUPLING
EXT
INT
READOUT PANEL
UNCAL
WITH PROBE
AC
0
2
+6.8 V
1×/10× READOUT SCALER
MANUAL VOLTS/DIV SWITCH
10× COMMAND
1, 2, 5 mV/DIV MANUAL ONLY
ADVANCE GATE
÷3 ADVANCE
ADVANCE PULSES
÷ 4 RING COUNTER
÷ 3 RING COUNTER
−12.2 V SEEK MODE POWER
+6.8 V
RESET PULSE
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK COMMAND
SEEK MULTI
REMOTE SEEK TO HORIZ UNIT
REMOTE SEEK
EXT
SEEK
MAN
SEEK MODE,
AC, 20 V/DIV, UNCAL,
WITH PROBE.

Fig. 3-7.

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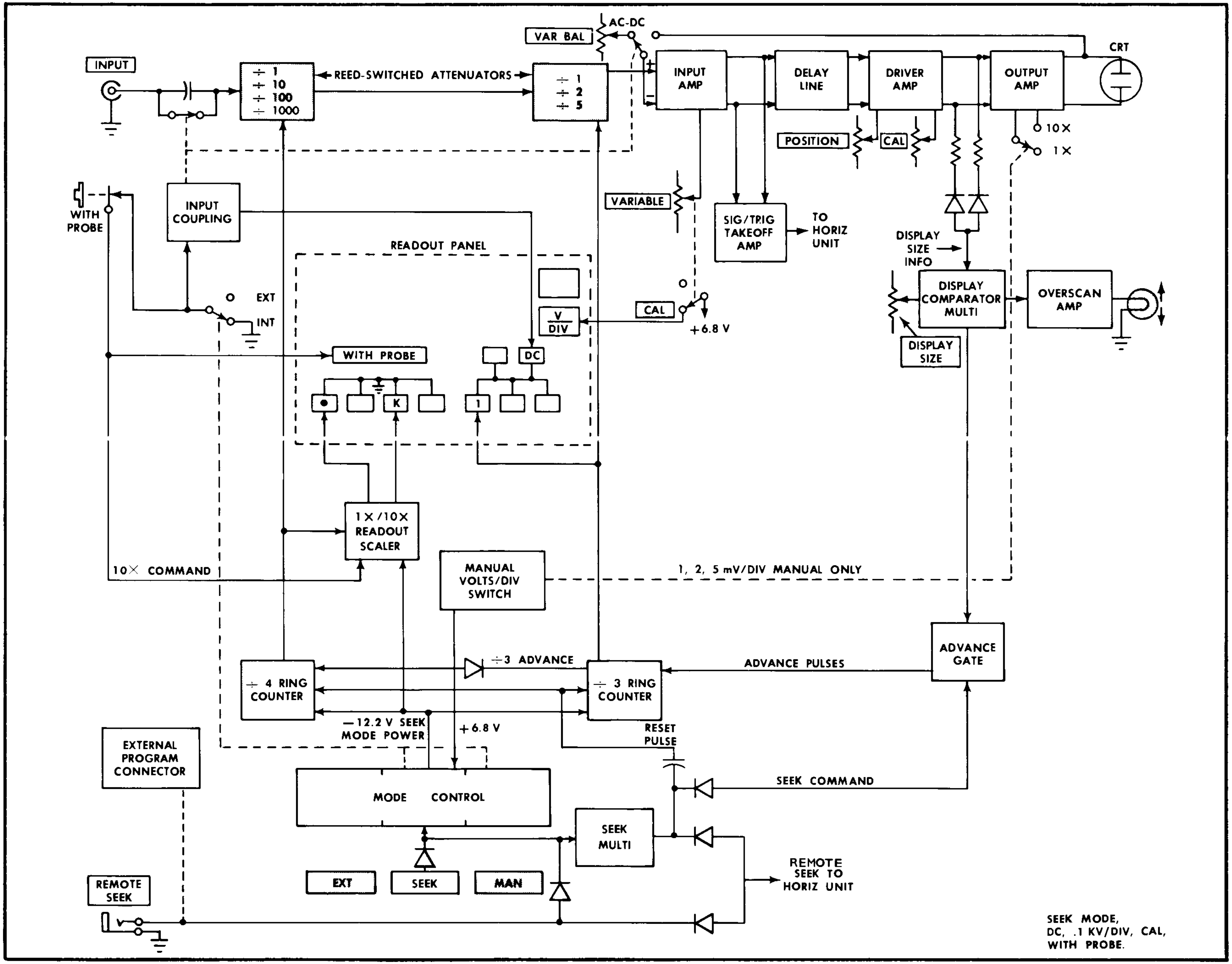
INPUT
INPUT COUPLING
WITH PROBE
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10×
1×
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
READOUT PANEL
EXT
INT
CAL
+6.8 V
V DIV
WITH PROBE
DC
K
1
1×/10× READOUT SCALER
10× COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
ADVANCE GATE
÷ 4 RING COUNTER
÷3 ADVANCE
÷ 3 RING COUNTER
ADVANCE PULSES
−12.2 V SEEK MODE POWER
+6.8 V
RESET PULSE
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK COMMAND
SEEK MULTI
EXT
SEEK
MAN
REMOTE SEEK TO HORIZ UNIT
REMOTE SEEK
SEEK MODE, DC, .1 KV/DIV, CAL, WITH PROBE.

Fig. 3-8.

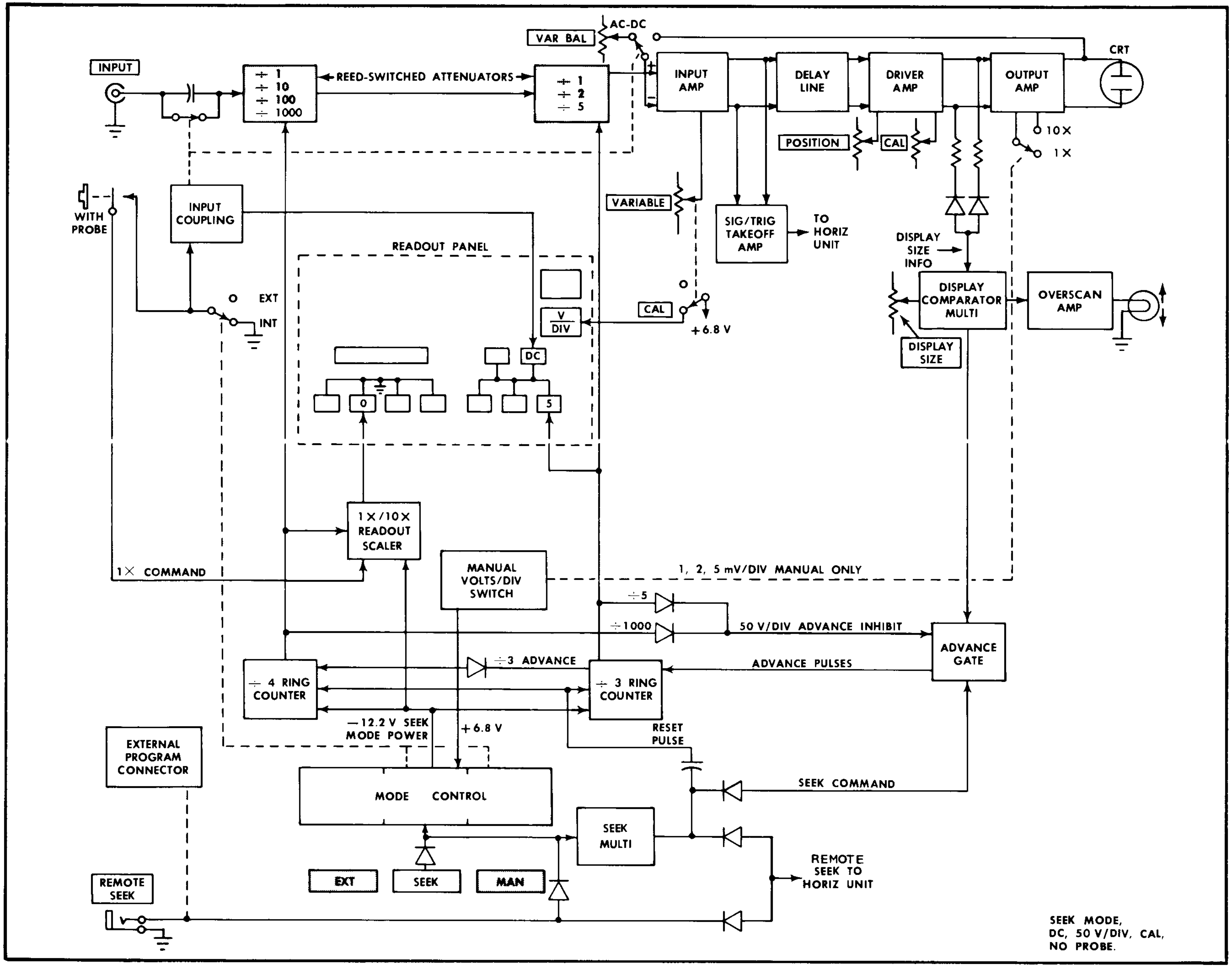
INPUT
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10×
1×
WITH PROBE
INPUT COUPLING
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
READOUT PANEL
EXT
INT
CAL
+6.8 V
V DIV
DC
0
5
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
1×/10× READOUT SCALER
1× COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
÷5
÷1000
50 V/DIV ADVANCE INHIBIT
ADVANCE GATE
÷3 ADVANCE
÷ 4 RING COUNTER
÷ 3 RING COUNTER
ADVANCE PULSES
−12.2 V SEEK MODE POWER
+6.8 V
RESET PULSE
EXTERNAL PROGRAM CONNECTOR
MODE CONTROL
SEEK COMMAND
SEEK MULTI
REMOTE SEEK TO HORIZ UNIT
REMOTE SEEK
EXT
SEEK
MAN
SEEK MODE, DC, 50 V/DIV, CAL, NO PROBE.

Fig. 3-9.

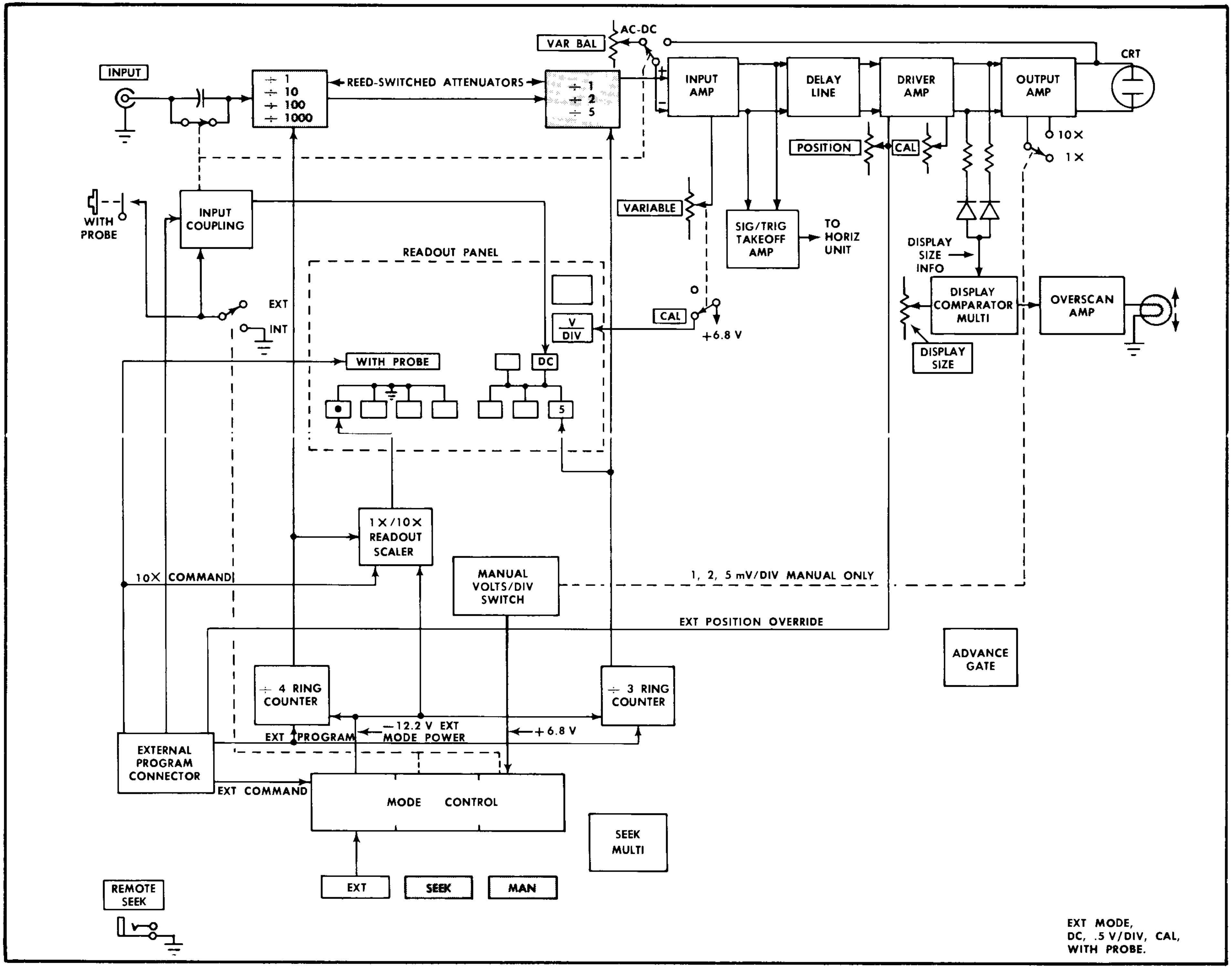
INPUT
÷ 1
÷ 10
÷ 100
÷ 1000
REED-SWITCHED ATTENUATORS
÷ 1
÷ 2
÷ 5
VAR BAL
AC-DC
INPUT AMP
DELAY LINE
DRIVER AMP
OUTPUT AMP
CRT
POSITION
CAL
10 X
1 X
WITH PROBE
INPUT COUPLING
VARIABLE
SIG/TRIG TAKEOFF AMP
TO HORIZ UNIT
DISPLAY SIZE INFO
READOUT PANEL
EXT
INT
CAL
V/DIV
+6.8 V
DISPLAY COMPARATOR MULTI
OVERSCAN AMP
DISPLAY SIZE
WITH PROBE
DC
5
1X/10X READOUT SCALER
10X COMMAND
MANUAL VOLTS/DIV SWITCH
1, 2, 5 mV/DIV MANUAL ONLY
EXT POSITION OVERRIDE
ADVANCE GATE
÷ 4 RING COUNTER
÷ 3 RING COUNTER
EXT PROGRAM
−12.2 V EXT MODE POWER
+6.8 V
EXTERNAL PROGRAM CONNECTOR
EXT COMMAND
MODE CONTROL
SEEK MULTI
EXT
SEEK
MAN
REMOTE SEEK
EXT MODE, DC, .5 V/DIV, CAL, WITH PROBE.

Fig. 3-10.

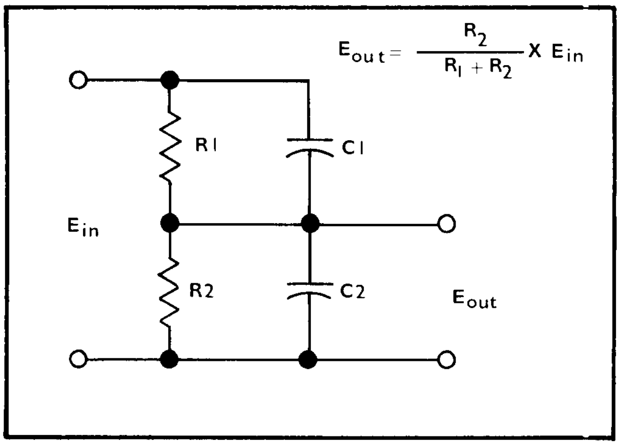

Fig. 3-11. Basic input attenuator.

supply. L122 and C122 decouple the power supply lead from the emitters and provide the low impedance that isolates the emitters. Thus Q123 emitter signal is not coupled to Q323 emitter.

Thus far in the Input Amplifier, signal voltage is applied only to V113 and Q123. There is no signal associated with V313 and Q323. V313 grid is normally fed from the VAR BAL control. The VAR BAL control sets the dc level to V313 grid, which is the minus input to the vertical amplifier. The VAR BAL control adjusts the dc level of Q334 emitter (through V313 and Q323) to exactly the same voltage that is at Q134 emitter. Thus, changing the VARIABLE resistance will not shift the display dc level. The other use of V313/Q323 is discussed under AC-TRACE STABILIZED feedback operation later in this section.

Two diodes located between V313 cathode circuit and Q323 emitter, D315 and D316, protect Q123 and Q134 bases. from large overdrive signals. If V113 cathode voltage rises to about +0.75 volt (about 25 times larger than a normal signal) D316 conducts and places the emitter circuit of Q323 in parallel with V113 cathode. (The output signal of the Input Amplifier reaches its limits before either D316 or D315 conducts.) If V113 cathode voltage falls to about −0.45 volt, D315 conducts and parallels the cathode circuit of V313 across V113 cathode circuit. D315 applies a turn-on signal to Q323 base through R315 (D316 applies a turn-on signal to Q323 emitter) and Q323 then couples some of the overdrive signal to Q334 to limit the unbalanced signal in Q134/Q334 stage.

Q134/Q334 form the first voltage amplifier of the vertical system. The input signal is essentially the same peak-to-peak value through V113/Q123, but is given considerable current gain by the cathode of V113 and the emitter of Q123. Q134/Q334 is a paraphase amplifier with adjustable emitter coupling to allow gain adjustment. The front-panel VARIABLE control is in the signal path between emitters.

As a positive going signal arrives at Q134 base, PNP transistor Q134 conducts less current. Decreased current causes Q134 emitter to go positive and the collector to go negative. As Q134 emitter goes positive, the VARIABLE circuit couples part of the signal to Q334 emitter in a direction to increase its conduction. As Q334 conduction increases, its collector voltage goes positive. Thus the output of Q134/Q334 is push-pull with only single-ended input. Since the VARIABLE circuit attenuates some of the signal from

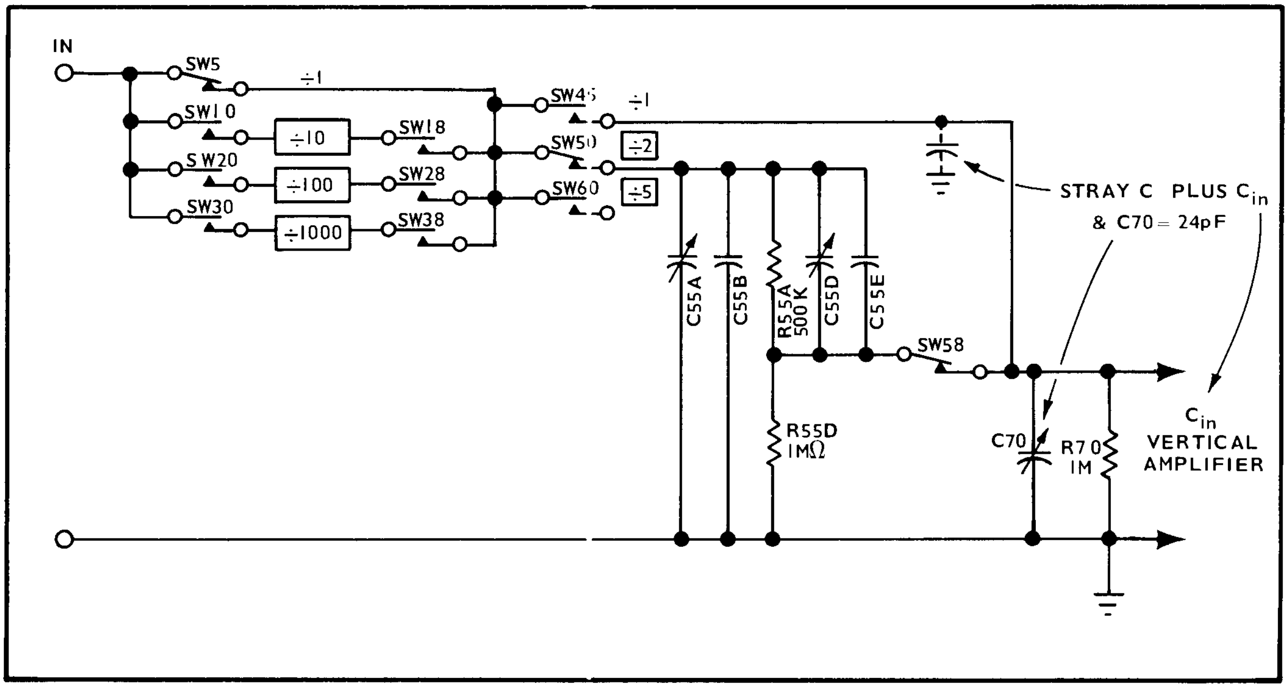

Fig. 3-12. Reed switches and attenuator components at either 2 mV/DIV or 20 mV/DIV.

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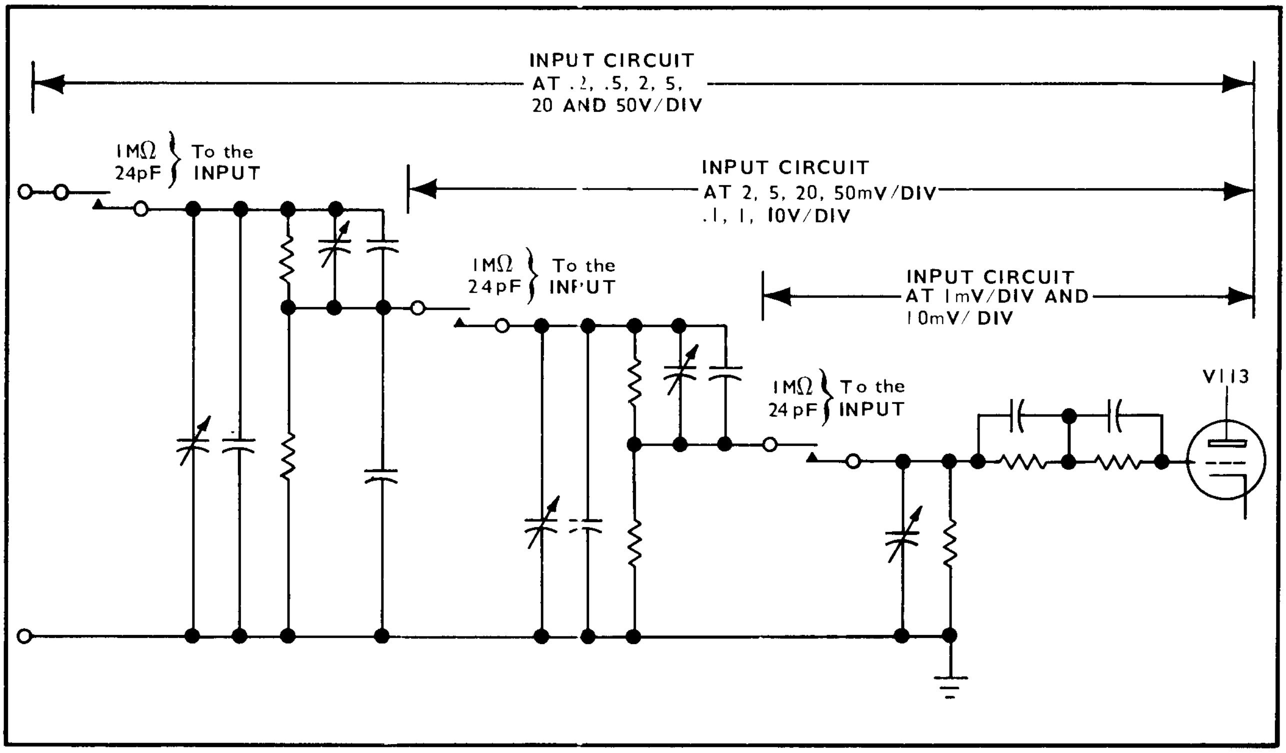

Fig. 3-13. Attenuator sections, single or in cascade, identified for each of the 15 calibrated deflection factors.

Q134 emitter to Q334 emitter, Q334 collector signal amplitude is not quite as great as that of Q134 collector. The difference is not great, because the VARIABLE circuit also provides degeneration to Q134. If the resistance value of the VARIABLE circuit is decreased, the collector signal amplitude of both Q134 and Q334 increases. The two 20 kΩ resistors between Q134/Q334 emitters and the decoupled +125-Volt supply keep the stage current essentially constant. The signal gain is stabilized against transistor β difference by the preceeding stage low driving impedance. Bypassed resistors R124 and R324 in Q134/Q334 collector circuits provide the proper dc and low frequency collector load impedance. R134/R324 allow optimum power dissipation in Q134/Q334 collectors.

C124 and C324 restore the high frequency response that would be lost if pure resistance were placed between the collector (as a signal source) and the next stage base (as a signal load). R140 is a power supply voltage dropping resistor that sets Q143/Q343 base voltage to the correct value.

Q143/Q343 are isolated emitter followers that provide current gain to the signal between Q134/Q334 collector circuits and the bases of amplifier Q154/Q354. These emitter followers are necessary to maintain the overall amplifier high frequency response.

Q154/Q354 is the paraphase output stage of the Input Amplifier. R354 provides dc signal coupling between Q154/Q354 emitters. Several capacitors and series resistance/capacitance networks parallel R354 to provide high frequency compensation to the vertical system. Emitter return resistors R350/R352 assure constant stage current. The collector circuit of Q154/Q354 drives both the Driver Amplifier and the Signal/Trigger Takeoff Amplifier. These amplifiers are driven through power compensating resistors R160/R360. The power compensating resistors keep Q154/Q354 collector junction power dissipation within required limits regardless of signal level.

Delay Line. The delay line is a balanced 186 Ω transmission line. Each end is terminated in 186 Ω. The input end termination is the 186 Ω series value of R194/R394 (at the Signal/Trigger Takeoff Amplifier input) and the low emitter resistance of Q194/Q394. The power compensating resistors, R160/R360 are not in parallel with R194/R394 due to the very high collector resistance of Q154/Q354.

The Delay Line output is terminated by the 186 Ω series resistance of R166/R366 and the virtual ground input resistance of the Driver Amplifier.

Signal/Trigger Takeoff Amplifier. The Signal/Trigger Takeoff Amplifier input is the common-base stage Q194/Q394. The stage effectively isolates the base circuits of paraphase amplifier Q204/Q404 from the delay line input termination, and prevents interaction between the Driver Amplifier and the Signal/Trigger Takeoff Amplifier input.

Q204/Q404 is a non-linear paraphase amplifier that has more gain for low level signals than it does for higher level signals. The stage is designed to have increased low level gain required by the change in standard signal level at V113 input grid. When the deflection factor is 1, 2, or 5 mV/DIV, the Signal/Trigger Takeoff Amplifier receives 1/10 as much signal per crt division as at 10 mV/DIV and up. The stage gain is offset upward at low levels by diodes D204/D404 and C404. Without any signal, D204/D404 are conducting and they place C404 in parallel with the normal emitter signal coupling resistor R202. As a positive 0.5-volt signal is applied to the base of Q204, and a negative 0.5-volt signal the base of Q404, D204 remains in conduction; however, D404 is reverse biased and stops conducting. This is because the charge on C404 takes the cathode of D404 positive while Q404 emitter is going negative. However, if the push-pull signals to the bases of Q204/Q404 are not greater than a total of 0.4 volt, neither diode will cease conducting, and C404 will remain diode-connected across R202, making the stage gain higher than for larger signals.

The collector signal of Q404 is dc coupled to emitter follower Q213. The emitter voltage of Q213 is slightly negative with respect to ground. To bring the output voltage near ground with only small attenuation, R216 and R218 apply a small positive offset to the output signal. C216 couples high frequencies around R216. R214 is a parasitic suppression resistor.

Driver Amplifier. The Driver Amplifier is a paraphase feedback amplifier (usually called an Operational Amplifier) that drives the Output Amplifier and provides Display Size Information to the automatic circuits. The input bases of Q174/Q374 are a virtual signal ground due to negative feedback applied from the output back to the input. The feedback current is nearly equal in magnitude, and is opposite in polarity to the input current. The result is that essentially no signal voltage appears at the input bases, implying a virtual signal ground. Since the input bases are a very low impedance, more than one signal current can be injected or withdrawn to alter the amplifier output voltage. This is done without affecting the amplifier's ability to amplify normal signals. Thus, the POSITION control injects or withdraws current at the Driver Amplifier input to position the crt display.

The input signal current to the Driver Amplifier is applied through the Delay Line and the Delay Line terminating resistors to the base circuit junctions of Q174 and Q374. Assume that a positive voltage signal appears at the Delay Line pin I and a negative voltage signal appears at pin H. Q174 base current increases its collector current. Q374 decreases its collector current. Q174/Q374 emitters are tied directly together to a single return resistor, so the paraphase voltage gain of these two transistors is very high. Q174/Q374 collector signals receive current gain from emitter followers Q183/Q383 and are then metered back to the input base circuit junctions through R179/R183 to Q174, and through R379/R383 to Q374. When the output voltage signal is great enough for the signal current through the feedback resistors to almost equal the input signal current, Q174/Q374 no longer see the signal and they stop changing current. Part of the feedback current is shunted away from Q174/Q374 by the CAL control. The stage gain is adjusted by changing the feedback current by the CAL control which does not change the feedback resistance.

The emitter follower dc return circuit is through R178/R378. These resistors also shunt some of the signal current from the input bases.

Display Size information is diode coupled from the Driver Amplifier output through D188 or D388 to the Display Comparator Multi. Only negative-going signals cause D188 or D388 to conduct; thus, the push-pull Driver Amplifier output signal is converted to single-ended negative-going information. The voltage at which D188 or D388 conduct is set by the Display Size control and the Display Comparator Multi.

Output Amplifier. The Output Amplifier is a combination transistor—vacuum tube amplifier with high voltage gain. The push-pull input signals arrive through T501 to the emitters of common base stages Q504/Q514. T501 assures that the two signals arrive with identical time relationship, even if a minor phase difference exists out of the Driver Amplifier. T501 also inserts a small loss in the signal path, providing parasitic suppression.

Common base amplifiers Q504/Q514 each carry about 17 mA current which passes through the Driver Amplifier output transistors Q183/Q383. Voltage levels are included on the diagram in Section 9. Q504 and Q514 are both feedback amplifiers with feedback applied from the output tube cathodes to the individual transistor bases.

Assume that a negative voltage signal arrives at Q504 and a positive voltage signal arrives at Q514. Q504 reduces its current and Q514 increases its current. As Q504 collector voltage goes negative, the conduction of V524 is reduced. The output voltage to the crt goes positive, and V524 cathode goes negative. V524 cathode is directly coupled to Q504 base, so the negative cathode signal becomes inverse feedback and increases Q504 current again. Q504 current is not increased as much by V524 cathode signal as it was reduced by the Driver Amplifier signal, because the cathode of V524 changes less voltage than the grid changed. Therefore, Q504 receives a turn off signal equal to the difference between its emitter and base voltage changes. D524 (and D534) assure that Q504 (and Q514) have sufficient emitter to collector voltage for proper operation.

V524/V534 are paraphase-connected with about 50 Ω (R518) between cathodes. Thus the Output Stage receives push-pull signals and acts on them in a push-pull balanced fashion. The stage cathode current passes through R521 and R522 to the −12-Volt supply.

When operating at 1, 2, or 5 mV/DIV, the input coupling switch (SW610) causes L515 to close SW515 and parallel less than 3 Ω across R518. Several frequency compensating networks are also placed across R518 to keep the bandwidth as great as possible at the increased gain. SW515 changes the Output Amplifier gain 10X. T524 and T534 are parasitic suppression loss networks.

The plates of V524/V534 include double peaking coils L526 and L536. The plate load resistors are R526 and R536. R528 reduces the +300-Volt supply voltage to limit the plate dissipation in the output tubes. This lowers the output voltage below that which provides proper crt deflection plate voltage (it is low enough to cause defocusing). Therefore, Zener diodes D546 and D556 offset the output voltage (and signal) positively to the required level of about +187 volts at center screen. R546 and R556 provide current to the Zener diodes to assure that they remain at a fixed 62 volts drop. C546 and C556 bypass any Zener diode noise and assure that high frequencies are not attenuated.

AC—TRACE STABILIZED Operation

AC—TRACE STABILIZED operation of the overall vertical amplifier places a dc and low-frequency feedback circuit from the plus output plate circuit of V524 to the minus input grid of V313. The feedback is large in magnitude, causing the whole vertical amplifier to be an operational amplifier with a dc gain much less than unity. Fig. 3-14 is a simplified

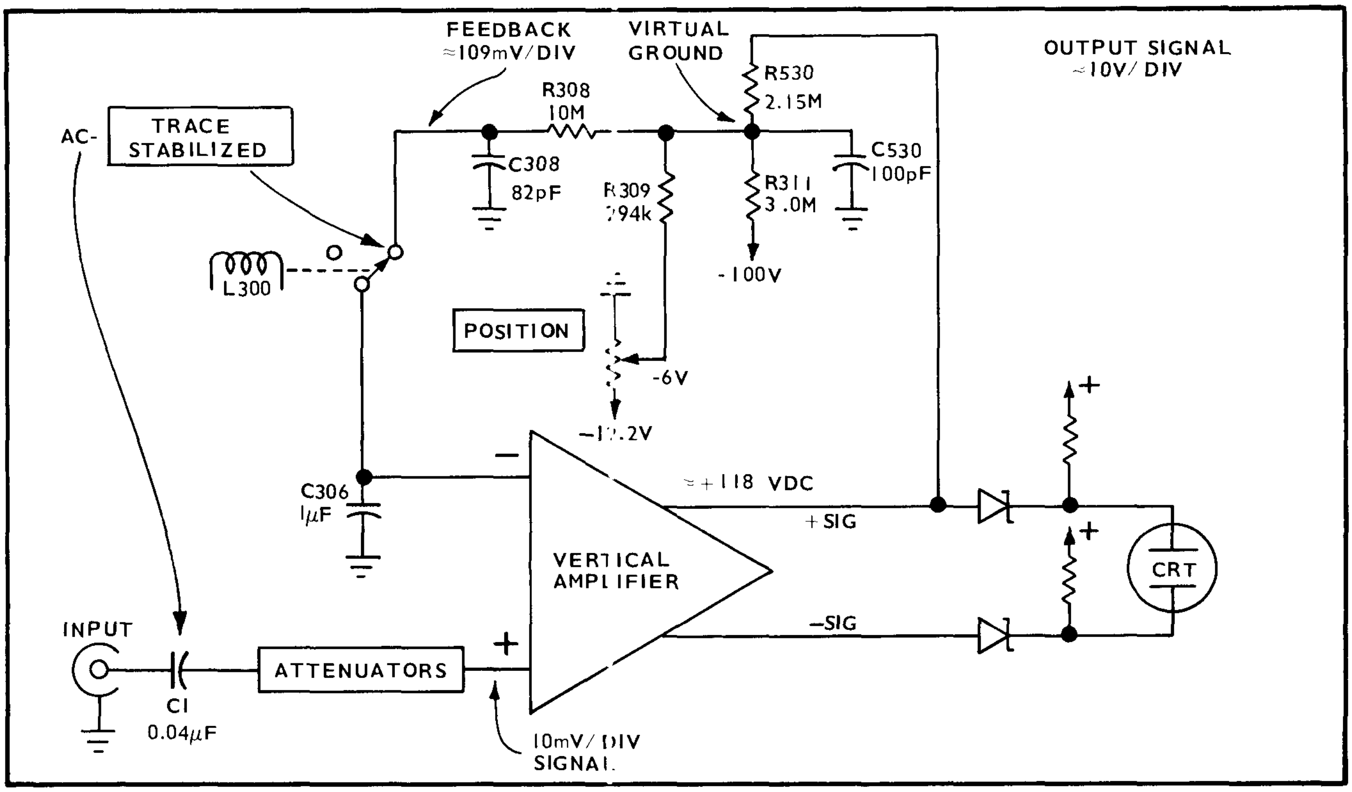

Fig. 3-14. AC-TRACE STABILIZED operational amplifier circuit.

diagram showing the feedback and POSITION control components. Fig. 3-15 shows the circuit connections in greater detail. Feedback resistor R520 is bypassed by C530 to assure that only low frequency signals leave the physical area of the Output Amplifier. The feedback information is cabled to the Control Board for connection with other components. The signal and feedback values included in Fig. 3-14 are for operation at 10 mV/DIV to 50 VOLTS/DIV. Operation at 1 to 5 mV/DIV provides ten times as much feedback due to the Output Amplifier operating at 10× gain.

Feedback current through R530 is equaled by current through R311 and R309 so that their common junction is a virtual signal ground. R308 and C308 in parallel with C306 establish a long time constant to the feedback to assure it is dc and low frequencies only. The feedback network changes the current feedback to about 109 mV/DIV, almost 11 times the standard input signal fed to the amplifier plus input. This amount of feedback would be sufficient to make the overall vertical amplifier dc gain zero, except that the inside loop gain is approximately 2000. Thus the actual dc gain under stabilized feedback conditions is about 0.025 instead of zero. This very low dc gain assures that the crt trace will remain stable for long periods of time regardless of drift signals within the amplifier loop.

With a total vertical amplifier dc closed loop gain of 0.025, normal positioning currents injected at the Driver Amplifier input will not allow control of the crt trace position. Therefore, R309, in addition to opposing R530 feedback signal, also provides offset current to the feedback current so the trace can be positioned. Position affect of the control is approximately one half its normal affect when operation is not feedback-stabilized.

AUTOMATIC CIRCUITS

Some of the automatic circuits have been diagrammed on more than one page of the diagrams in Section 9. The duplication includes interconnections, and is done to help the reader gain understanding of the instrument in the least amount of time.

Mode Control Circuits

The Mode Control Circuits are physically divided between the Automatic Card and the Control board. Drawings Number 4 and 5 in Section 9 show all the control circuits. Number 4 is the MODE CONTROL AND READOUT CONNECTIONS with part of the Control Board and Automatic Card circuits combined in one drawing with the Readout Board bulbs. Number 5 is the complete AUTOMATIC CARD.

The mode of operation is controlled by grounding the proper lead associated with Q624/Q654/Q664 diagrammed on Drawing Number 4. A simplified mode control circuit is shown in Fig. 3-16 joining the physically separated mode control transistors to the proper control relays. The two control relays, L622 and L612 operate as follows:

1. MANUAL operation, both L612 and L622 energized by Q624.
2. SEEK operation, L612 energized by Q664.
3. EXT operation, neither relay energized.

Fig. 3-16 shows that L612/SW612 (the INT-EXT SELECT relay) supplies a ground return circuit for both the Input Coupling switch SW610, and the With Probe switch SW70.

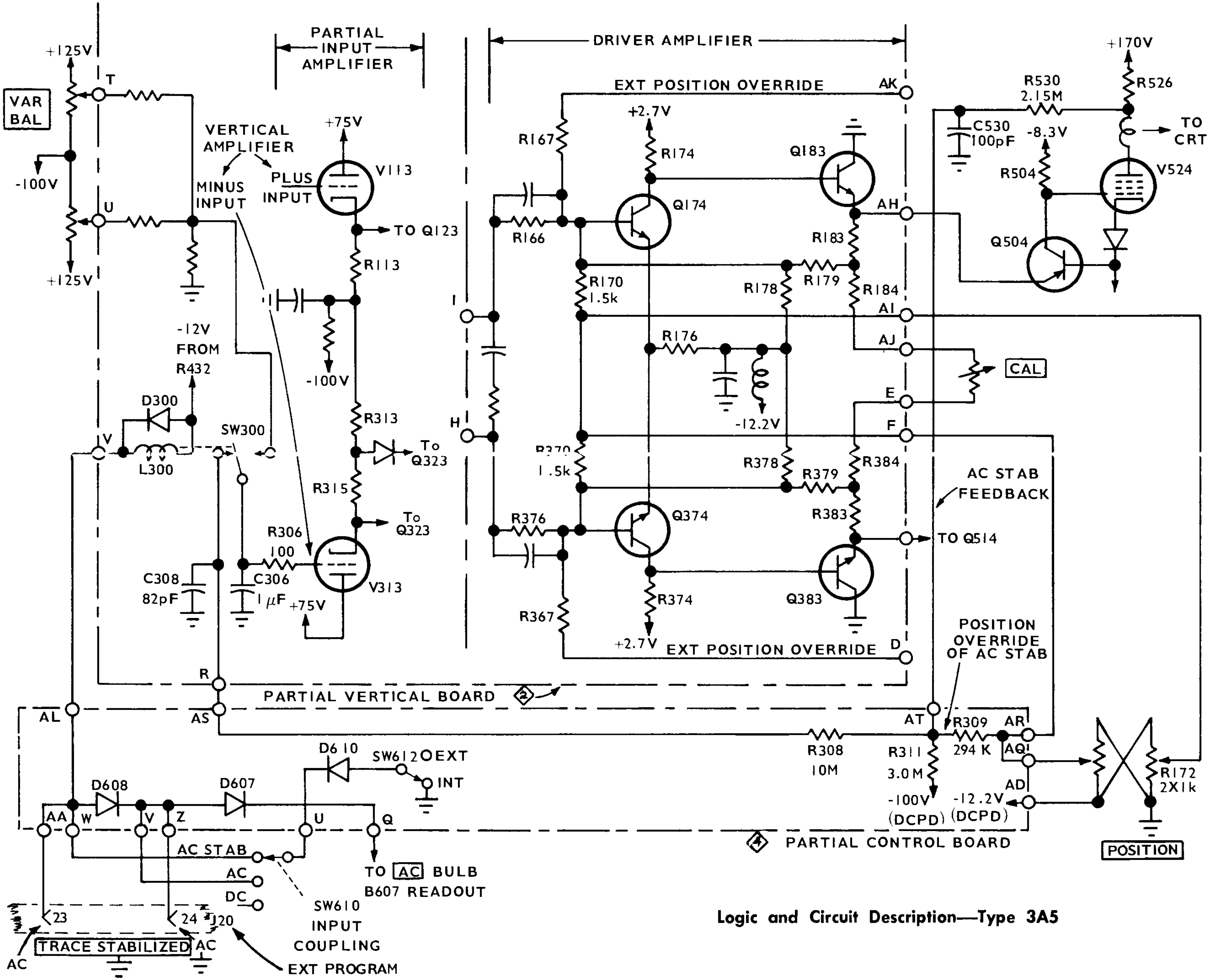

Fig. 3-15. Position control and AC—TRACE STABILIZED connections.

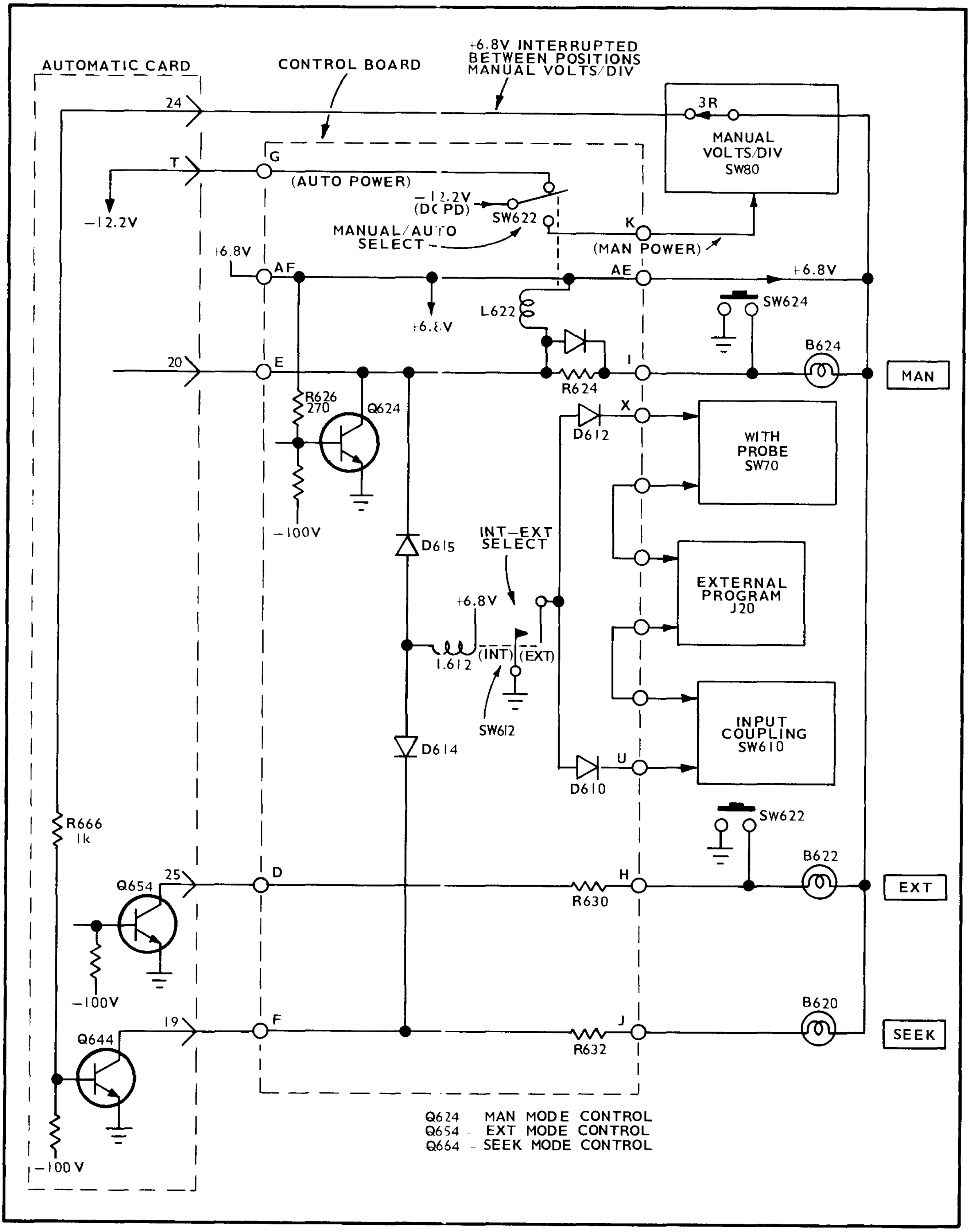

Fig. 3-16. Simplified mode control circuits.

Thus L612 is energized for both SEEK and MAN mode operation. L622/SW622 (the MANUAL POWER or AUTO/EXT POWER relay) supplies —12.2 volts to the MANUAL VOLTS/DIV switch SW80 during MAN mode operation only. It provides —12.2 volts to the Automatic Card for both SEEK and EXT mode operation. Details of each operation mode follow.

SEEK mode operation begins by grounding pin J15-22 or pin J15-21 by either the SEEK button or through the REMOTE SEEK jack or through the external PROGRAM connector J20-34. Momentarily grounding either of these three points will turn Q664 on. See Fig. 3-17. (The same grounding action will operate the SEEK MULTI explained below.) Q664 conducts current through the SEEK bulb and the Internal-External control relay L612, allowing the Input Coupling switch SW610 and the 1×/10× With Probe command switch SW70 to operate normally. Q664 also draws current through the biasing network of Q624 so that Q624 is held cutoff. Q664 is held in saturated conduction by base current through R666/D666/D664; base current is approximately 4.5 mA.

The voltage at the un-operated SEEK button (Fig. 3-17) of —6.0 volts is due to current through the resistance divider R660/R661/R662. As shown, D662 is reverse-biased. Grounding the anode of D661 would let R661/R662 apply turn-on base current to Q664 through D662. Likewise, grounding the anode of D660 will also apply turn-on base current to Q664.

EXT Mode operation requires a continuous ground connection at the base circuit of Q654 through the external PROGRAM connector J20 at pin 21. See Fig. 3-18. Grounding the collector circuit of Q654 (by pressing the EXT pushbutton) allows external mode operation only as long as the button is held depressed. When J20-21 is grounded, Q654 conducts to saturation drawing current through R630 and the EXT readout bulb. Q654 also draws current through R666 and R626 to assure that Q664 and Q624 are held cut off. With only Q654 conducting, neither control relay, L612 nor L622, has any current flow and operation of the Type 3A5 must be controlled through the External PROGRAM connector.

MAN Mode operation begins by first releasing any external program and then grounding the collector circuit of Q624. See Fig. 3-19. Grounding the collector circuit of Q624 is done by pressing the MAN pushbutton. At that time current through D624 and D668 assures that Q664 turns off. With both Q654 and Q664 cut off, Q624 biasing network automatically applies turn-on current to Q624 holding it saturated. Q624 conducts current through the MAN bulb and through both control relays L612 and L622. Q624 also conducts current through R666, biasing Q664 to cutoff. D614 assures that the collector circuit of Q664 is not pulled down by Q624. During internal SEEK operation, MAN MODE operation is assured when changing the MANUAL VOLTS/DIV switch position because its 3R section momentarily interrupts the +6.8-volt power to Q664 biasing network. The result is that Q664 stops conducting and with both Q664/Q654 collector circuits at +6.8 volts (through B620/B621), Q624 is turned on for manual mode operation.

Q664 SEEK Mode bias network is shown in detail in Fig. 3-20. Note that D662 does not conduct when the mode is SEEK and the SEEK button is not pressed. The bias network for Q624 is similar to that shown in Fig. 3-20. D664/D666 provide the necessary voltage drop from the junction of R666/D663 so Q624 conduction assures that Q664 base is reverse biased (Fig. 3-20C).

SEEK Multi

The SEEK multi (See Fig. 3-21) is a monostable multivibrator that drives the Advance Gate and supplies a reset pulse to the Ring Counters. The SEEK multi transistors, Q674 and Q684, do not conduct current in the quiescent state. Quiescent conditions are controlled by six resistors in a multiple divider between ground and minus voltages. Resistors R674/R673/R675/R678 establish —7.5 volts at their junction with germanium diodes D675/D678. D678 conducts 0.42 mA through R679 to the —100-volt supply. D675 conducts 0.933 mA through R676 to the —100-volt supply. The cathode of D678 sets the emitter of Q676 to —7.7 volts, and the cathode of D675 sets the base of Q674 to —7.7 volts. Q674 does not conduct any collector current with the zero bias conditions. Since Q674 does not conduct, R682 in its collector circuit has no voltage drop across it and thus Q684 base emitter junction has zero bias. Q684 does not conduct with the zero bias conditions. All diodes shown in Fig. 3-21 are listed in Table 3-1 with their conduction conditions marked.

TABLE 3-1

SEEK Multi Diode Conduction
(X means conduction)

Diode	Quiescent	SEEK button pressed	Multi conducting	REMOTE SEEK pressed
D660	OFF	OFF	OFF	X
D661	OFF	X	OFF	OFF
D669	X	OFF	OFF	OFF
D672	OFF	X	OFF	X
D673	OFF	X	OFF	X
D674	OFF	OFF	OFF*	OFF
D675	X	OFF	OFF	OFF
D678	X	OFF	OFF	OFF
D684	OFF	X	X	X
D689	OFF	X	OFF	OFF

***D674 protects C674 if Q674 emitter goes positive.**

When either the SEEK button or the REMOTE SEEK button is momentarily pressed, the following action takes place:

1. Q674 base receives turn on current through R671/D672. Q674 collector conducts current and applies several mA of turn on current to Q684 base. Q684 collector rises positive and Q674 base receives regenerative turn on current through R672/R686/C672. Both transistors saturate.

2. Q674 conduction causes its emitter voltage to rise positively and decrease the charge on C674. See Fig. 3-22 and 3-23. As the emitter rises positive, so does the base. C672 signal current to Q674 base increases C672 charge slightly. R672/R686/C672 continue to apply turn on current to Q674 base until Q674 collector voltage rises to about —6.7 volts. (Q674 is still saturated.) At this point the positive side of

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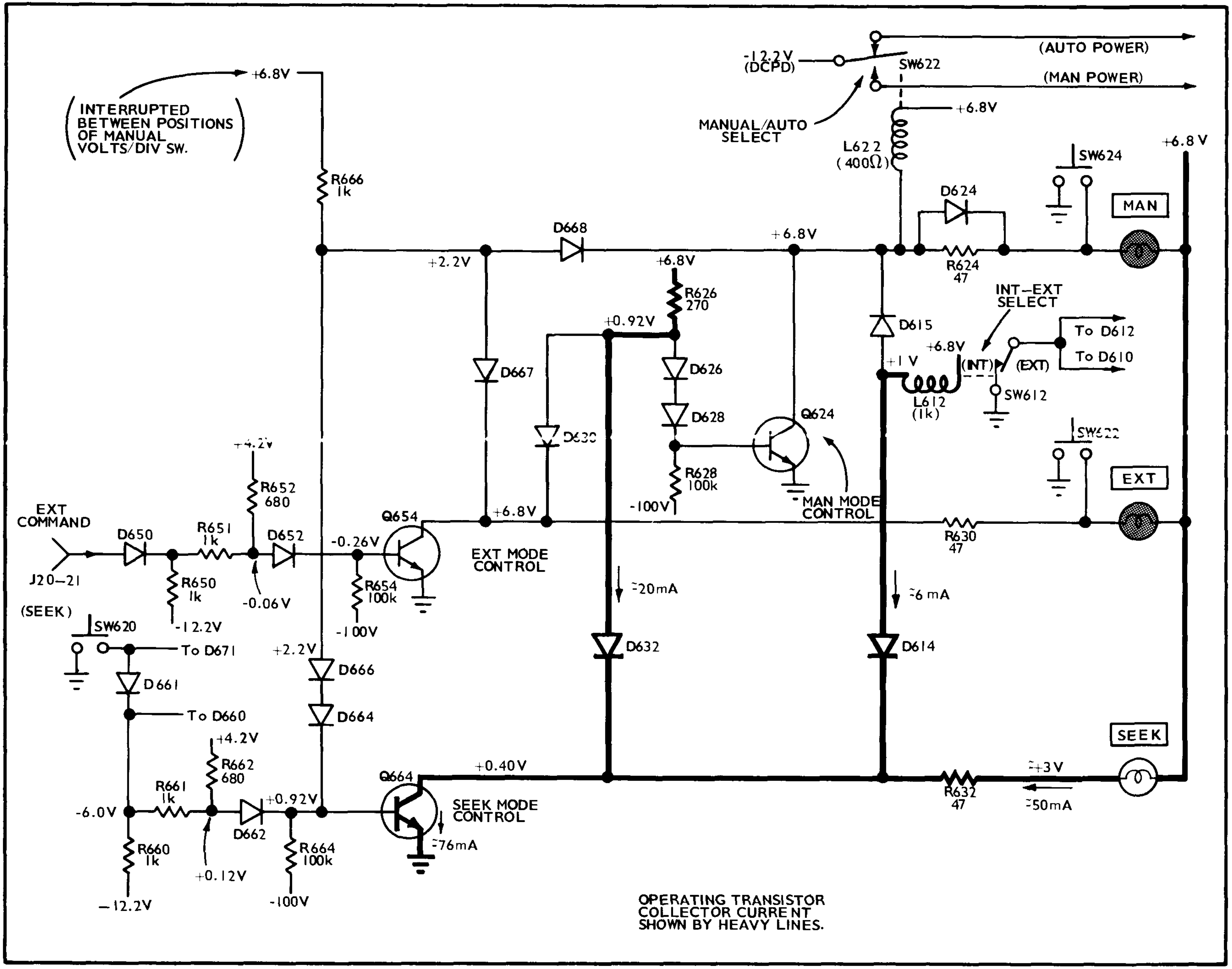

Fig. 3-17. Typical SEEK Mode control circuit conditions.

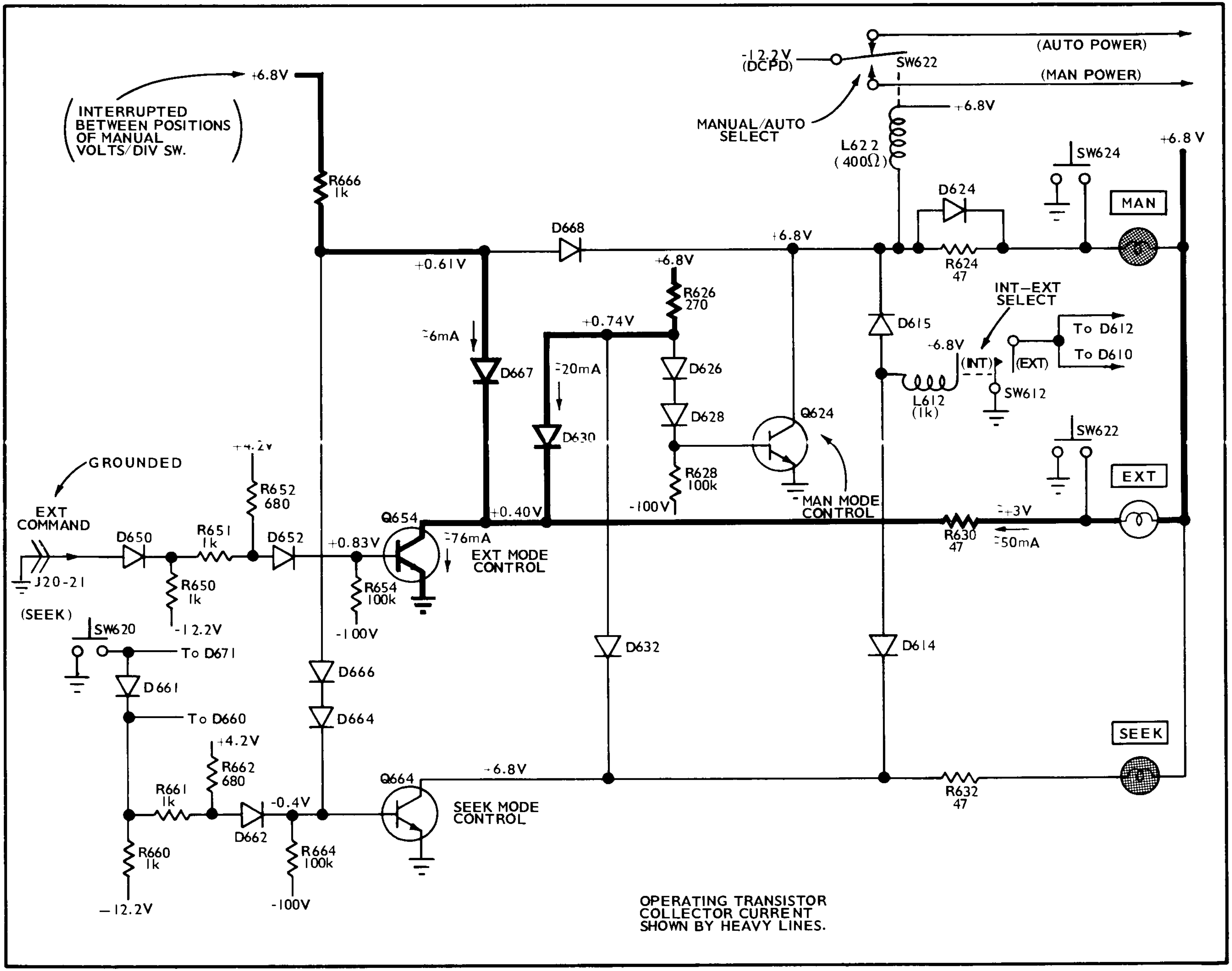

Fig. 3-18. Typical EXT Mode control circuit conditions.

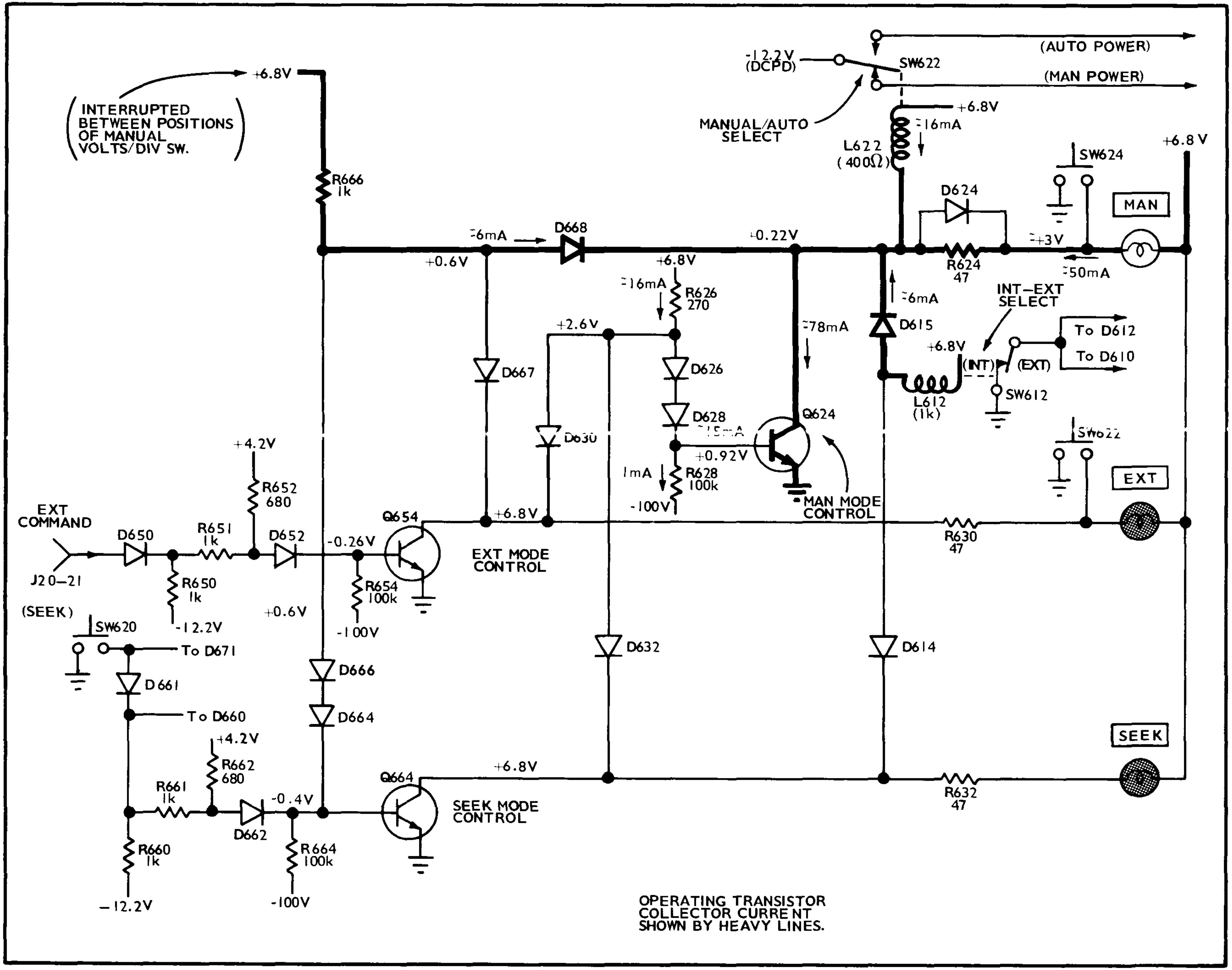

Fig. 3-19. Typical MAN Mode control circuit conditions.

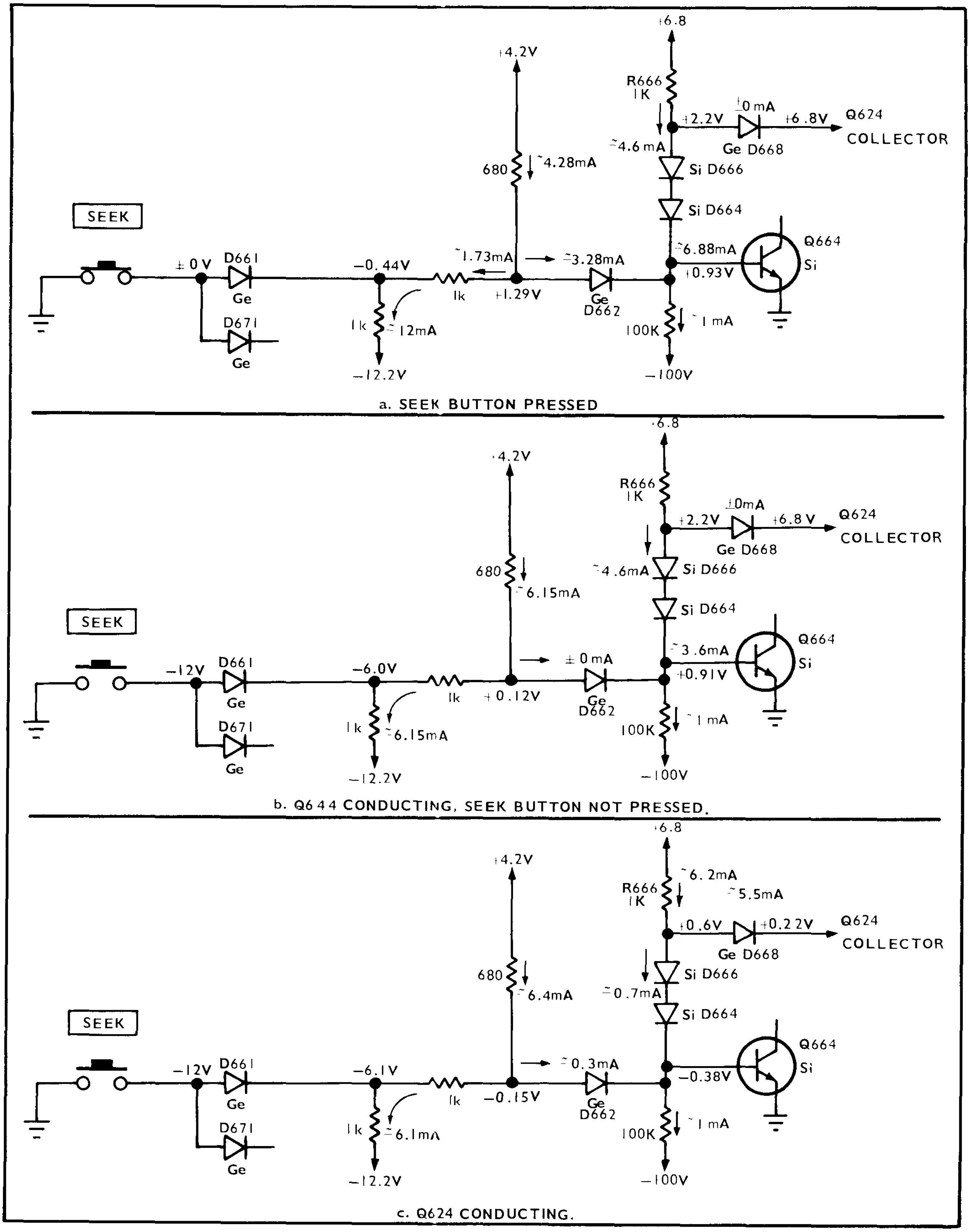

Fig. 3-20. Mode control bias network conditions.

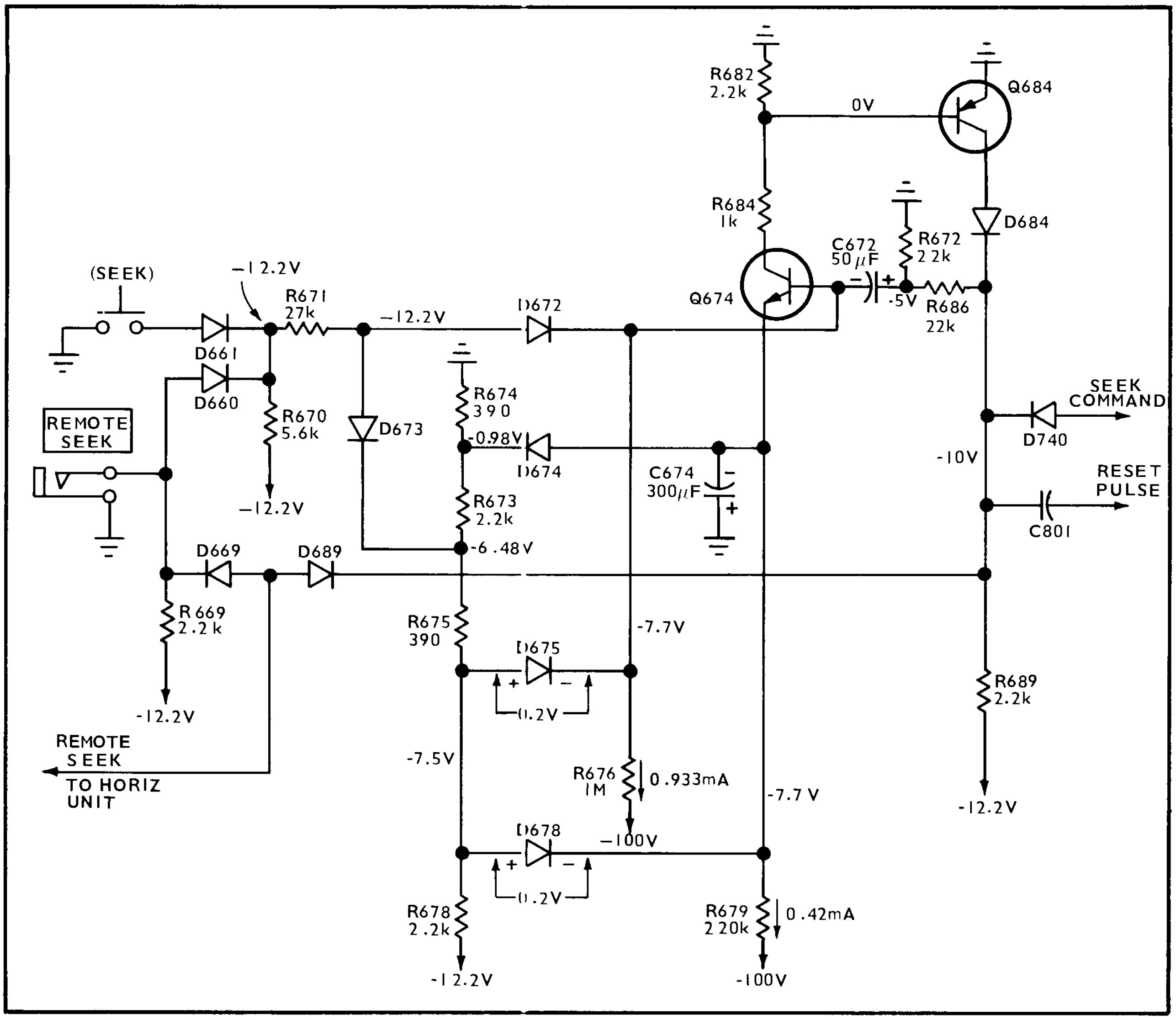

Fig. 3-21. SEEK multivibrator quiescent voltage and current conditions.

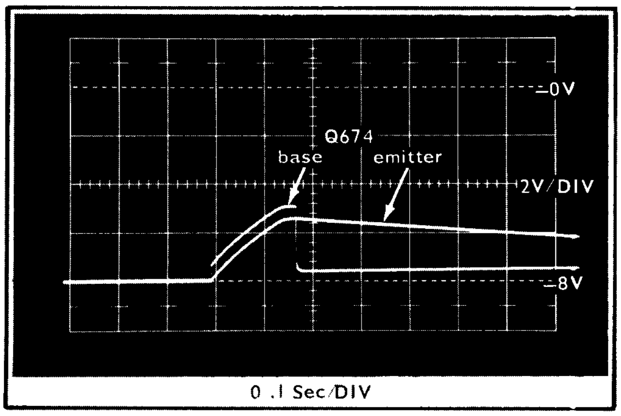

Fig. 3-22. Q674 base and emitter signals when SEEK button is momentarily pressed. (Initial —8-volt level differs from Fig. 3-21 —7.7 volts due to 10X probe loading.)

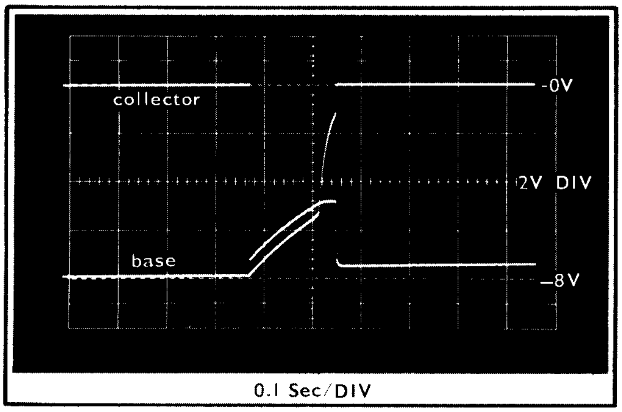

Fig. 3-23. Q674 collector and base signals.

C672 has reached about −1.5 volts and the turn on current to Q674 base through R672/R686 falls below the level where Q674 can remain in saturation.

3. As Q674 comes out of saturation, its collector voltage rises positively until R682/R684 reduce the turn on current to Q684 and it starts to reduce its collector current. As Q684 reduces its current, R689 pulls its collector negative. As the collector goes negative, R686/C672 apply a regenerative turn off signal to Q674 base and both transistors stop conducting.

4. R689 pulls R686/C672 back to their original level and the base of Q675 returns almost to its original level. However, C674 gains its charge back through the large value of R679. This means an interval of about two seconds is required before Q674 emitter returns to its original level, which prevents immediate recycling by the SEEK button. It is the positive signal from Q684 that is the SEEK COMMAND signal to the rest of the automatic circuits.

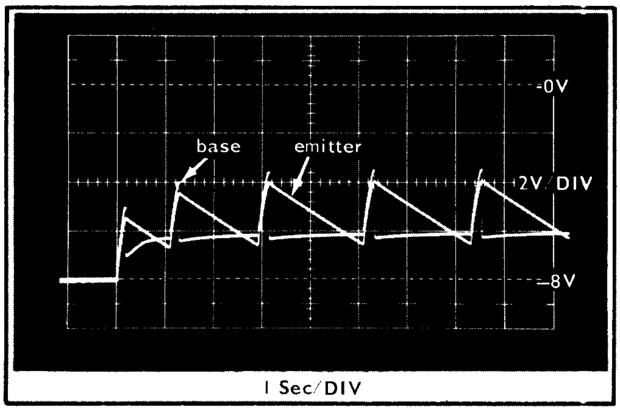

Fig. 3-24. Q674 emitter and base signals over a nine second period. SEEK button was held pressed.

When either the SEEK button or the REMOTE SEEK button is held depressed, the SEEK multi will automatically recycle as shown in Fig. 3-24. Note that the current through R671/D672 causes the base-emitter voltages of Q674 to gradually rise about 2 volts from the single cycle or quiescent values.

Advance Control

The Advance Control circuits are so named because they combine information from several sources to control the number of advance pulses sent to the Ring Counters. When advance pulses are sent to the ring counters from the Advance Control circuits, the reed switched attenuators change the deflection factor.

Sources of information to the Advance Control Circuits

1. SEEK Command pulse from Q684. (See Fig. 3-25 and Diagram 5 in Section 9.)

2. Display Size dc level from the DISPLAY SIZE Control.

3. Display Size information from the vertical Driver Amplifier.

4. 50 V/DIV inhibit signal from the Ring Counter ÷5 and ÷1000 stages.

Quiescent conditions in the circuit are:

1. Q714 and Q724, Display Comparator Multi transistors, are both cut off.

2. The Display Size dc reference level to the Display Comparator Multi is about —2.6 volts at the anode of D706.

3. Q743 emitter follower Advance Gate prevents any signal from turning on Q754 Gated Advance Pulse Amplifier. Q743 is controlled through D740/D743 negative OR gate by either the SEEK Multi or the 50 V/DIV inhibit from the Ring Counters.

4. Q743 Overscan Amplifier is saturated.

5. The Display Size voltage information from the vertical Driver Amplifier depends upon the display. If the crt beam exceeds plus or minus 3.5 divisions from electrical center, the base of Q714 (Display Comparator Multi input) will be taken sufficiently negative to cause Q714 to draw current. The Display Comparator Multi will free run and turn on the Overscan Lamp, but will not pass signals to the Ring Counters until a SEEK Command pulse arrives at Q743. An operation description of each circuit follows:

Display Comparator Multi. The quiescent dc voltage at Q714 emitter is set by current through R714, D705 and D706 and the DISPLAY SIZE control. (See Fig. 3-25.) D706 sets C714 most positive potential, but disconnects the low impedance DISPLAY SIZE control if C714 and the emitter of Q714 try to go more negative than the quiescent level. Both D705 and D706 provide temperature compensation to Q714.

As Q714 starts to conduct current (point #1 of waveforms of Fig. 3-25) its collector voltage begins to rise positive. Q724 base comes out of cutoff after Q714 collector rises about 2 volts. As Q724 starts to conduct, its collector goes negative and couples a negative regenerative turn on signal to Q714 base. Q714 and Q724 both saturate quickly. Q714 remains saturated during the time attenuator reed bounce occurs, and so is insensitive to bounce voltages. Current through R712 and R710 quickly take some of C714 charge and transfer it to C723. As C723 charges, Q714 base becomes reverse biased, and the regenerative action starts in reverse, turning Q714 and Q724 off rapidly. During the time Q714 was conducting, C714 let Q714 emitter fall about —1.5 volts below its quiescent level (point #2 of waveforms of Fig. 3-25). As Q724 collector rises positive to cutoff, C723 drive to Q714 base is limited by D710.

The waveforms of Fig. 3-25 were taken while the Display Comparator Multi was free running. The free run action was caused by positioning the trace 4 divisions from the graticule center. Note that Q714 emitter voltage following point #2 rises slowly and the multi is off longer than it is on. The slow rise is due to C714 charging through R714. As soon as Q714 emitter rises to a level where the base-emitter voltage will again cause it to conduct, the Display Comparator Multi flips and both transistors again saturate.

The Display Comparator Multi thus sends positive pulses to Q754, the Gated Advance Pulse Amplifier.

Overscan Amplifier. The base of Q734, the Overscan Amplifier, is directly coupled to Q724 collector. When Q724 is cut off, R726 applies about 0.125 mA turn-on current to

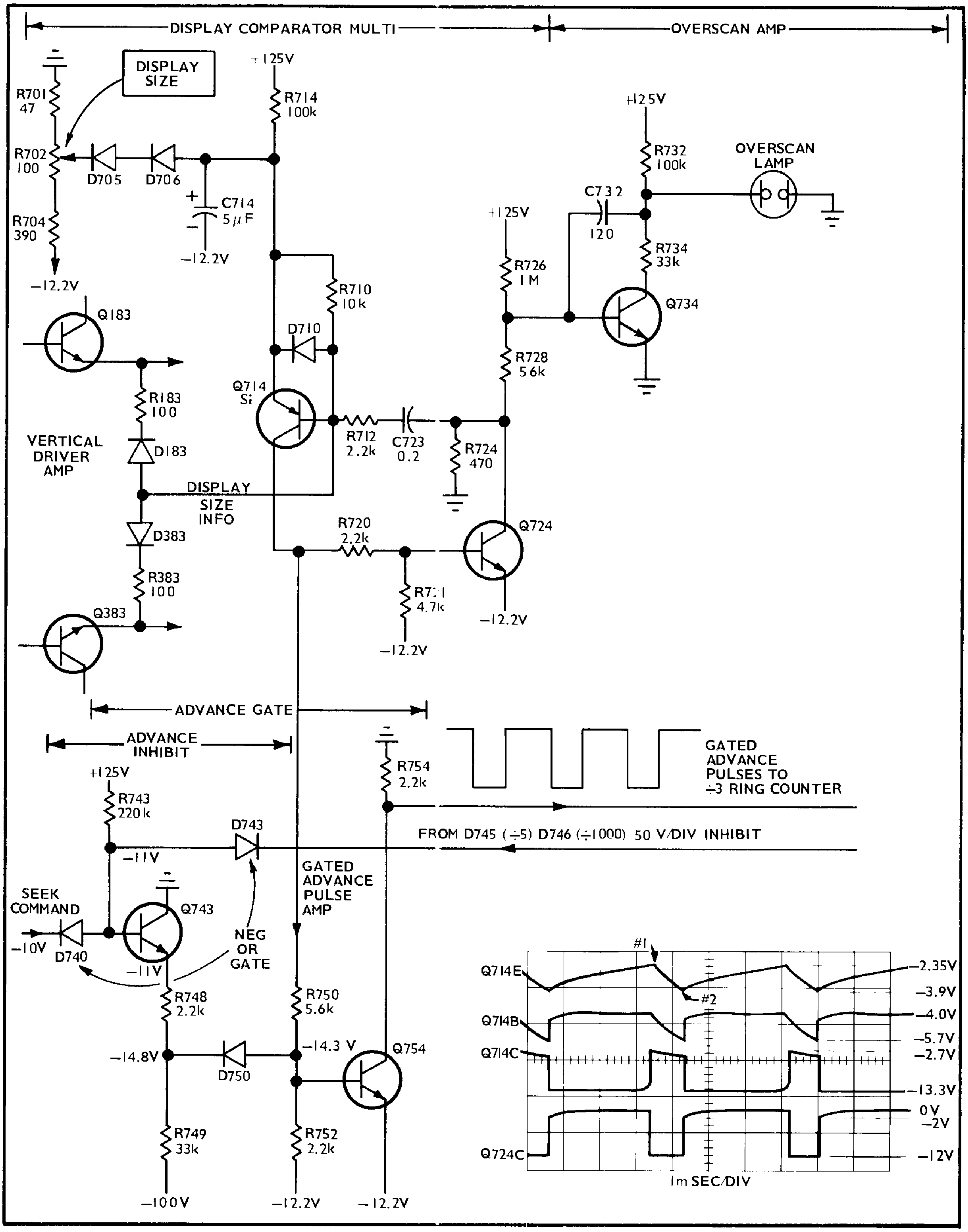

Fig. 3-25. Advance control circuits.

Q734 base. Q734 is thus quiescently saturated. Whenever the Display Comparator Multi develops Advance Pulses, Q734 is turned off during the time Q724 is conducting. The collector circuit of Q734 rises positive toward +125 volts. At about +75 volts B736 the Overscan Lamp fires and immediately returns the voltage level to about +55 volts, the normal holding potential for the neon bulb. C732 couples part of the output voltage back to Q734 base to limit the rate of collector voltage rise, and thus limit high frequency signals from being coupled to the input attenuators. Q734 saturates each time Q724 turns off. Thus the Overscan Lamp is pulsed on and off whenever it is illuminated.

Advance Gate. The Advance Gate (see Fig. 3-26) consists of Q743, Q754 and associated diodes. It is the Advance Gate that permits Advance Pulses to pass to the Ring Counters whenever the SEEK button is pressed.

Assume the deflection factor is 50 V/DIV; that a signal of 10 volts peak to peak is applied to the INPUT connector; and that the input coupling is AC. The display will be 1/5 division peak to peak and cannot be read with any accuracy. Press the SEEK button and the display will change to 5 divisions peak to peak. The sequence of events that takes place to set the deflection factor to 2 V/DIV is:

1. The SEEK multi output step raised the emitter of Q743 from —11 volts to —0.9 volt. The leading edge of the SEEK Command was used as a reset pulse to the Ring Counters, and they changed the deflection factor to 10 mV/DIV. The signal to the vertical amplifier input is now 200 times the value it will be.

2. The Display Comparator Multi changes state immediately. The Overscan Lamp lights. The base of Q754 receives enough turn-on current through R570 to cause it to saturate and send a —12.2 volt Advance Pulse to the ÷3 Ring Counter. The ÷3 Ring Counter does not respond to the first advance pulse because the ac coupled Reset Pulse energy lasts long enough to override the Advance pulse.

3. The Display Comparator Multi and Q754 put out another advance pulse. This time the ÷3 Ring Counter advances to its ÷2 state and actuates the 20 mV/DIV deflection factor. The signal to the vertical amplifier is now 100 times what it will be.

4. The Display Comparator Multi continues to cycle until the ÷3 and ÷4 Ring Counters set the deflection factor to 2 V/DIV. At that time the signal to the vertical amplifier is such that the Display Comparator Multi stops sending pulses to Q754 and the Ring Counters. The SEEK Command remains up for several more milliseconds, and then drops to inhibit Q743/Q754.

50 V/DIV Inhibit. The conditions are slightly different if the display zero dc level is above or below the Display Comparator Multi trip level. If the Display Comparator multi receives a constant turn-on signal it continues to send positive pulses to Q754 and the deflection factor will cycle to 50 VOLTS/DIV whenever the SEEK or REMOTE SEEK buttons are pressed. To prevent advancing the Ring Counters past 50 VOLTS/DIV back to 10 mV/DIV, two Ring Counter output signals are diode-connected back to the Advance Gate through D745 and D746. The signals are the ÷3 Ring Counter ÷5 state output and the ÷4 Ring Counter ÷1000 state output.

The 50 V/DIV Inhibit diode switching operates in the following manner (see Fig. 3-26). When the attenuator ÷1000 and ÷5 coils, L30 and L60, are not energized, D745 and D746 anodes rest at zero volts. A small current (½ mA per diode) flows through them and the coils to the —100-volt supply through R745. If one of the two attenuators is energized, the current through R745 switches to pass 1 mA through one diode and the other diode is reverse-biased. If both attenuators are energized, the anodes of both diodes drop to —12.2 volts and R745 current passes through D743 taking the base of Q743 sufficiently negative to inhibit Q745 from sending any more advance pulses to the ÷3 Ring Counter. Thus D740 and D743 form a negative AND gate such that either diode can couple a turn-off signal to Q743 and inhibit advance pulses.

Another diode, D684 in the collector lead of SEEK Multi transistor Q684 (see Fig. 3-26) assures proper deflection factor selection when there is no signal and the trace is at a position that will not trip the Display Comparator Multi. D684 sets the SEEK COMMAND pulse plus voltage to —0.9 volt. This sets the anode of D740 (by current through R743) and the base of Q743 to —0.3 volt, sufficiently negative that D743 is not turned on. If D743 were to turn on and change the ½ mA current in either D745 or D746, L30 or L60 magnetic flux change would couple enough energy to the attenuator reed switch to be seen by the vertical amplifier and cause the no-signal deflection factor to be 20 mV/DIV instead of 10 V/DIV.

Ring Counters

The ÷3 Ring Counter receives Advance Pulses, changes state, directly energizes attenuator reed coils, and sends a ÷3 Advance Pulse to the ÷4 Ring Counter. The ÷4 Ring Counter directly energizes attenuator reed coils and drives the 1×/10× Readout Scaler. Both ring counters will reset to an initial condition whenever a positive reset pulse arrives through C801 to the base circuits of both Q814 and Q854. See Fig. 3-27 and drawing number 5 during the following discussion.

Each ring counter can be described as a set of saturating transistors that are biased and interconnected in a manner that allows only one to conduct at a time. Coupling circuits allow an incoming negative advance pulse to turn off the conducting transistor. The next transistor is turned on by the collector signal from the turned off transistor. All signals are ac coupled.

A cycle of operation begins with the arrival of a reset pulse, and proceeds as follows:

1. The leading edge of the SEEK command signal is ac coupled through C801 to the base circuits of Q814 and Q854. Both transistors turn on to saturation.

2. An advance Pulse arrives at the ÷3 Ring Counter and tries to turn Q814 off, but the reset pulse lasts long enough to leave Q814 on.

3. Diode D826 turns Q824 off and D836 turns Q834 off in the ÷3 Ring Counter. In the ÷4 Ring Counter, D866 turns Q864 off, D876 turns Q874 off and D886 turns Q884 off.

4. Q814 collector current includes current through D814/L45, R814, D815/R841, D826/R826, D836/R836 and R819 through germanium diode D819 and R812/R816. D819 is

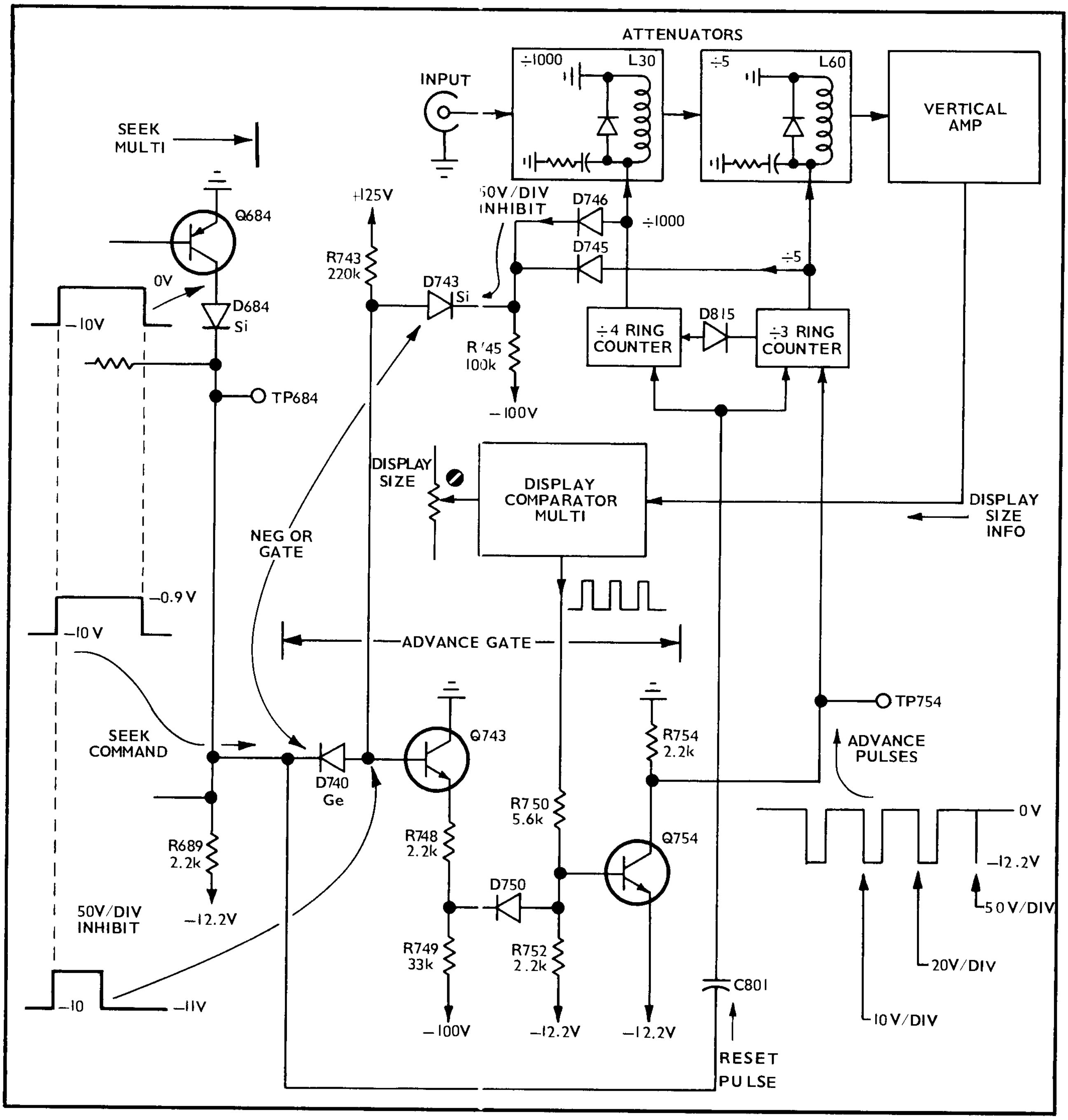

Fig. 3-26. Advance Gate interconnections and signals.

conducting so that the next negative Advance Pulse will turn Q814 off.

5. The base voltage of Q814 is about −11.5 volts; the collector voltage is −12 volts. Base current is through R812/R816. Current through R816 reverse biases D812 and D816. Current through R816 reverse biases D812 and D816. Current through D802/R802 (at reset input) reverse biases D804.

6. The base voltage of the other ÷3 Ring Counter transistors is about −13.3 volts due to Q814 current through D826 and D836. The same conditions exist in the ÷4 Ring Counter. The anode of D826 is at about −11.7 volts; thus, current through R821 and R822 sets Q824 base negative from its emitter and keeps it cut off. With Q824 collector at 0 volts, D829 is reverse biased 13.3 volts so that the −12.2-volt Advance Pulse does not affect Q824 base.

7. After the reset pulse decays, and as the second Advance Pulse arrives, C819 couples the signal to Q814 base and turns it off. As Q814 collector stops conducting current, R814 and L45 pull the collector voltage to ground. D45 clamps L45 inductive backswing. C822 couples the positive going signal to Q824 base and Q824 turns on to saturation. Q824

collector goes to −12 volts and D816 keeps Q814 off and D832 keeps Q834 off.

8. The 3rd Advance Pulse turns Q824 off, and Q824 turns Q834 on.

9. The 4th Advance Pulse turns Q834 off and Q834 turns Q814 on. The signal coupling from Q834 collector to Q814 base is through C812 diagrammed with Q814 biasing network.

10. As Q814 turns on, D815 couples the ÷3 negative Advance signal to Q854 base and turns it off. Q854 then turns Q864 on in the same manner as earlier described when Q814 turned Q824 on.

During manual mode, the MAN/AUTO select switch SW622 turns off the —12.2-volt power to the Ring Counter and the Readout Scaler circuits.

Each Ring Counter transistor can be turned on by external command through the external PROGRAM connector. A positive pulse or a ground connection to the correct pin of J20 will turn on the desired transistor, and thus the desired attenuator. See the Operating Instructions for programming details. The external ground connection applies turn on current to the base of the selected Ring Counter transistors through resistors R810, R820, R830, R850, R860, R870 and R880. External connections must be removed before the Type 3A5 can be operated for the SEEK mode.

Readout Scaler

The Readout Scaler is a set of four saturating emitter follower transistors with diode input control. The emitter followers act as switches to turn on the Readout Board decimal, zero, K and m bulbs. Bulb current is limited by R935 or R939. Whether or not the emitter follower(s) conduct is determined by both the ÷4 Ring Counter and the unlabeled front-panel "with probe" switch SW70.

There are eight possible control conditions shown in Figures 3-28 through 3-35. The figures show the current paths for each possible condition, both bulb current and lockout current. An example of lockout current is shown in Fig. 3-30 where none of the ÷4 Ring Counter current turns on a Readout Scaler emitter follower. All of Q864 is "locked out" and bypasses all scaler emitter followers. When reading Figures 3-27 through 3-34, note that the ÷4 Ring Counter transistors are numbered out of numerical sequence.

Fig. 3-27 is the only figure with voltage included. All other figures will have similar voltages for the portion carrying bulb current, and similar voltages for the portion carrying lockout current.

Power Supplies

Power for the Type 3A5 operation comes from the oscilloscope. Power supply interconnections, and two low voltage supplies within the Type 3A5 are diagrammed on drawing #6 of Section 9.

The oscilloscope power supplies are capable of operating with various current loads, depending upon the plug-in units in use. To keep each supply in regulation, some plug-in units place shunt resistors across the oscilloscope regulator circuits. Diagram #6 indicates which leads of the Type 3A5 are used for supplying regulated current to the Type 3A5 circuits, and which leads are the shunt return circuits for the oscilloscope. P11 pins 10, 15, 16 and 23 are the regulated supply leads to the Type 3A5 circuits. Pins 6, 20 and 22 are the shunt return leads to the oscilloscope power supplies.

Power supply leads that serve more than one part of the Type 3A5 have signal isolation networks to decouple the various circuits. For instance the +125 volt supply enters the Type 3A5 at P11 pin 15, goes directly to the Vertical board and the Output Amplifier. The supply is then cabled to the Control board where R110 and C110 decouple the control and automatic and external circuits from the vertical circuit. R636 is the power supply shunt resistor. The output side of R110/C110, is labeled +125 V (DCPD), indicating the lead is decoupled from the preceding circuits.

Three additional voltages are provided by circuits within the Type 3A5. +75 volts for the Vertical Amplifier Input stage; +6.8 volts for readout lamps, relay coils and some control circuits; and +4.2 volts regulated for the Vertical Amplifier and control circuits.

+75 Volt Regulator. Q108, physically located on the Control board, and diagrammed on drawing #2, is an emitter follower. Q108 collector supply is the +125-volt supply. The base voltage is set at approximately +75 volts by the resistive divider, R106 and R107. Q108 emitter resistance to ground is the plate circuit of V113 and V313. Thus, Q108 emitter provides +75 volts (at a sufficiently low impedance) to the input stage plate circuits.

+6.8-Volt Supply. The +6.8-volt supply is a simple four-diode bridge rectifier and an electrolytic capacitor. D422 A, B, C, and D rectify the oscilloscope 6.3-volt ac voltage, and C422 is the filter capacitor. The supply output voltage is directly related to the power line voltage. It is not regulated, because its major use is for readout lamps and relay coils.

+4.2-Volt Regulator. A stable +4.2 volts is provided by Q423 and Q424 to several of the transistor circuits of the Type 3A5. The regulator source is the unregulated +6.8-volt supply. The circuit consists of an emitter follower (Q423) with an inverse feedback amplifier (Q424). Q423 emitter output voltage is divided by R426 and R427 to provide the feedback signal to Q424 base. The low-voltage end of the divider is the oscilloscope regulated —12.2-volt supply. The —12.2 volts is the reference voltage that sets the +4.2 volts output value.

Assume the circuit to be operating. The load current reduces, causing the output voltage to rise positive. Q424 base receives part of the positive change, Q424 collector current increases changing the voltage drop across R422 and taking Q423 base negative. The negative signal at Q423 base takes the output voltage back to its original value. Thus the supply output voltage remains essentially constant with only a few millivolts of 120 Hz ripple.

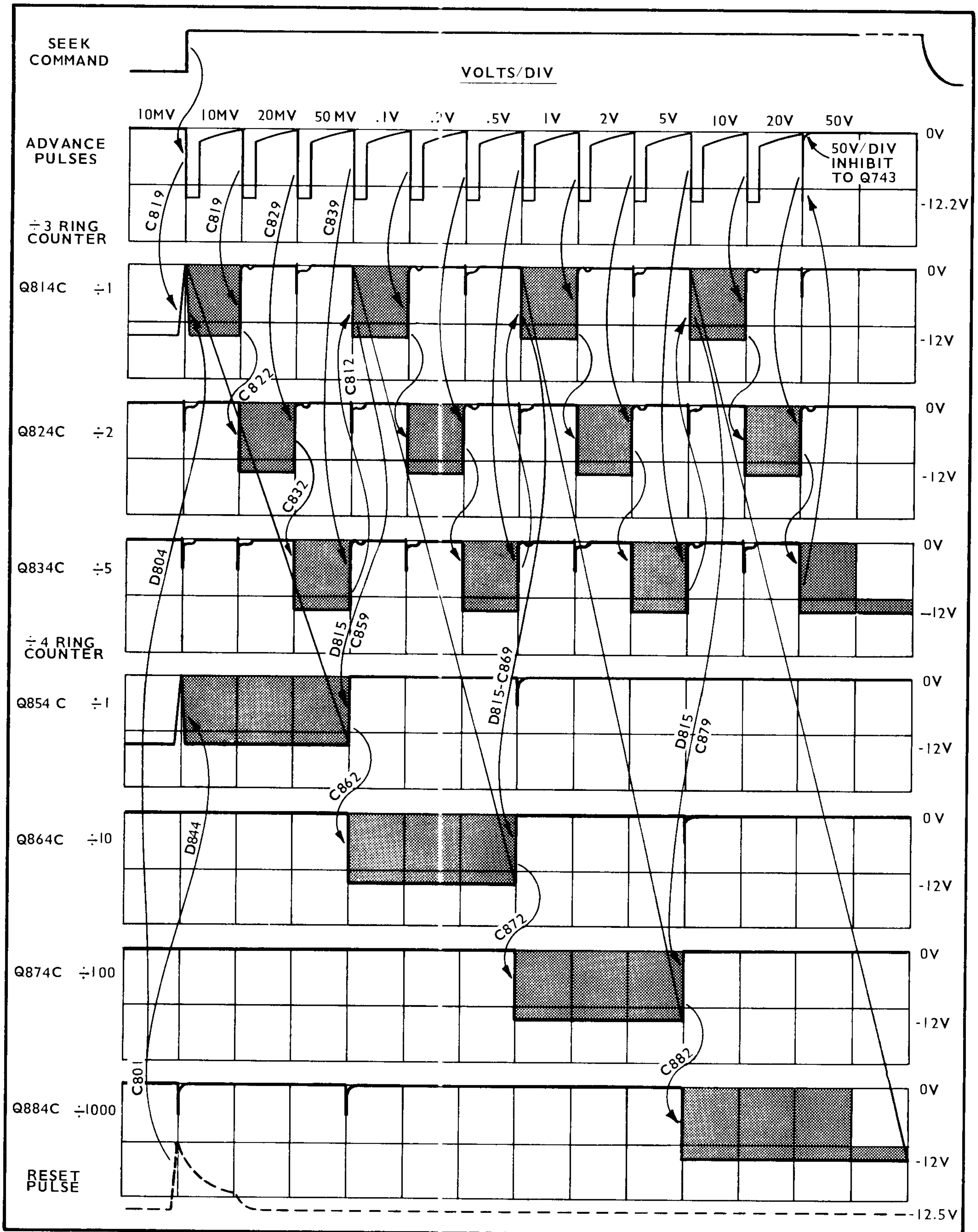

Fig. 3-27. ÷ 3 and ÷ 4 Ring Counter collector voltages related to VOLTS/DIV readout. Coupling sequence and components are identified.

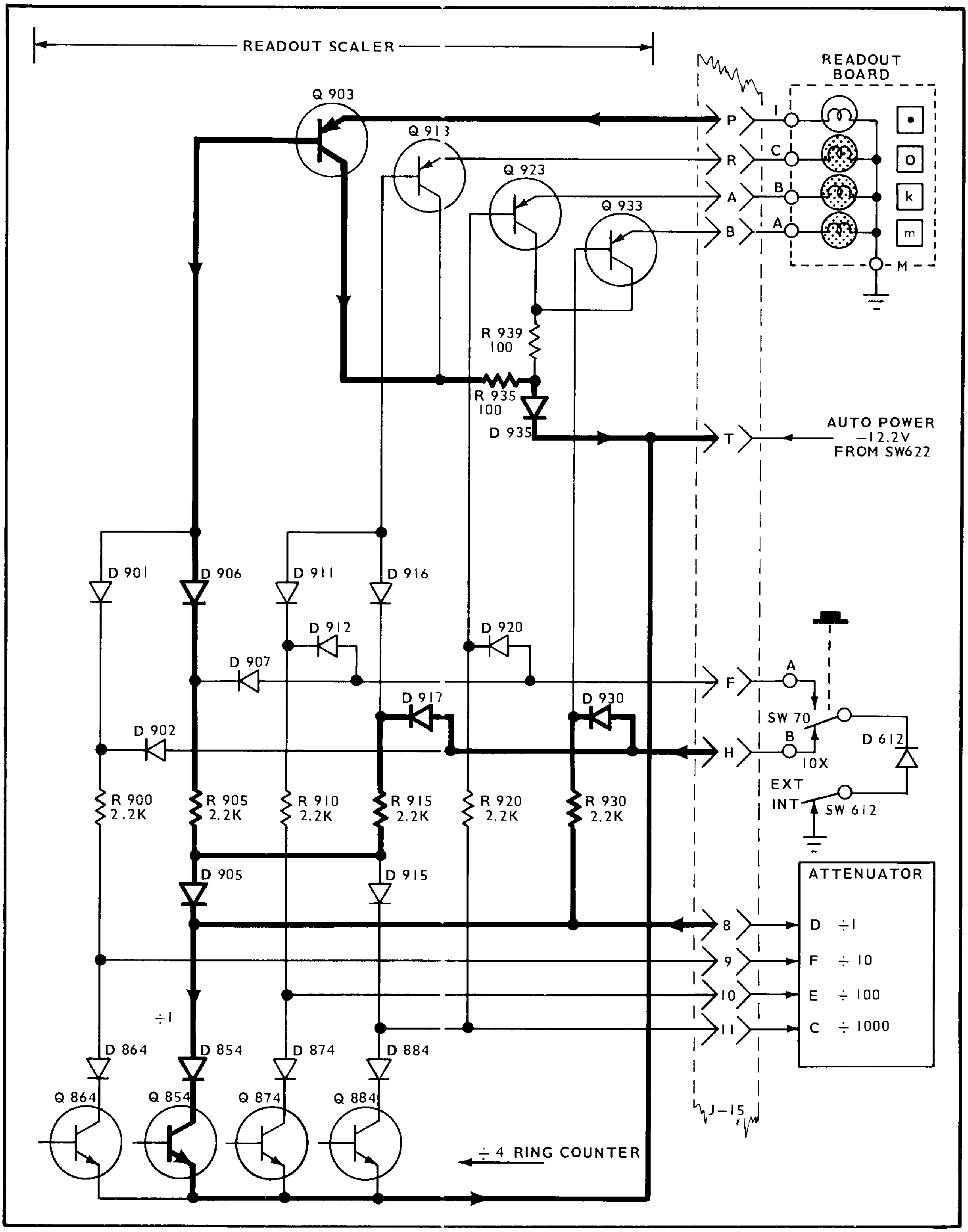

Fig. 3-29. Readout Scaler current paths for .1, .2, .5 V/DIV, with P6030 Probe.

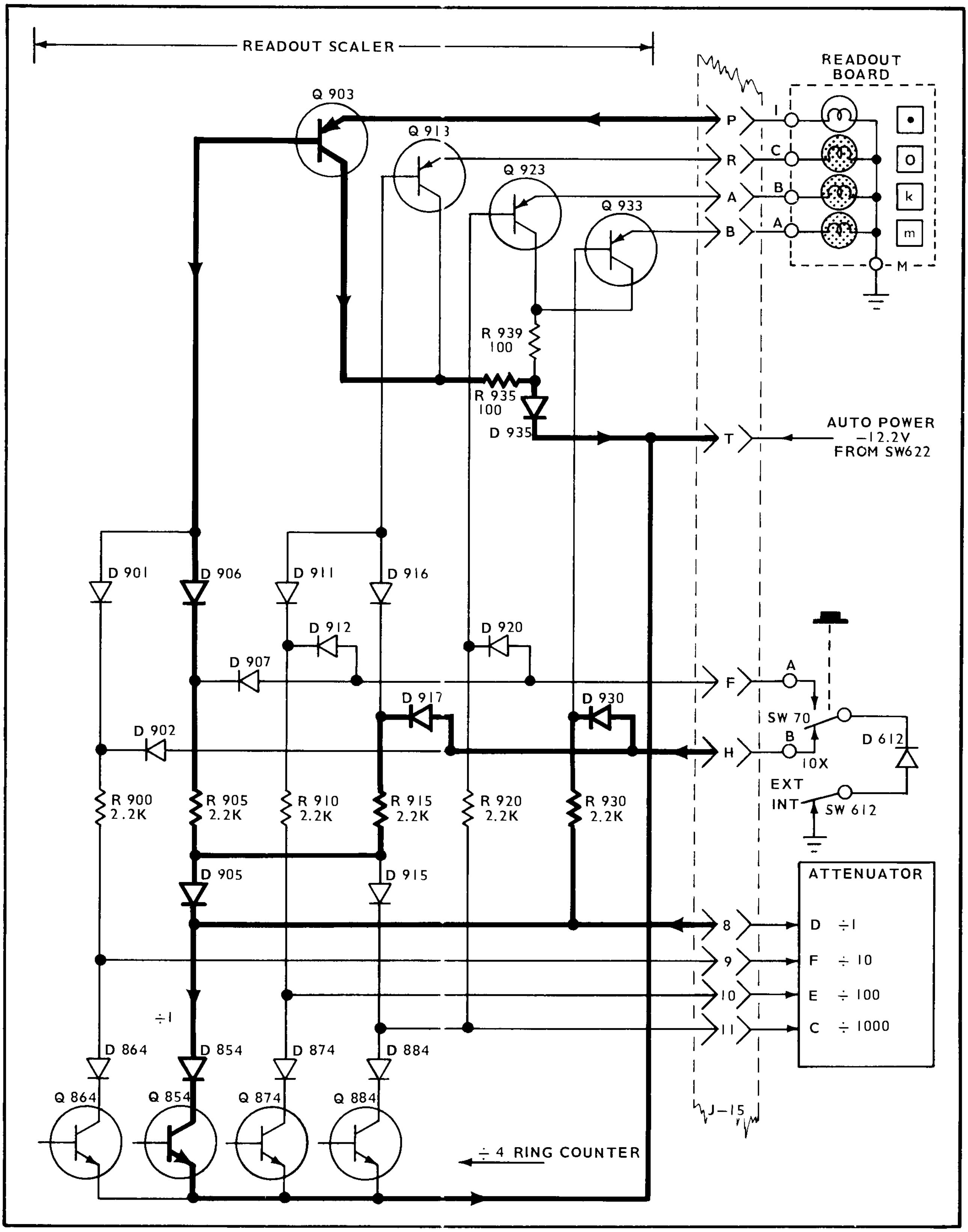

Fig. 3-29. Readout Scaler current paths for .1, .2, .5 V/DIV, with P6030 Probe.

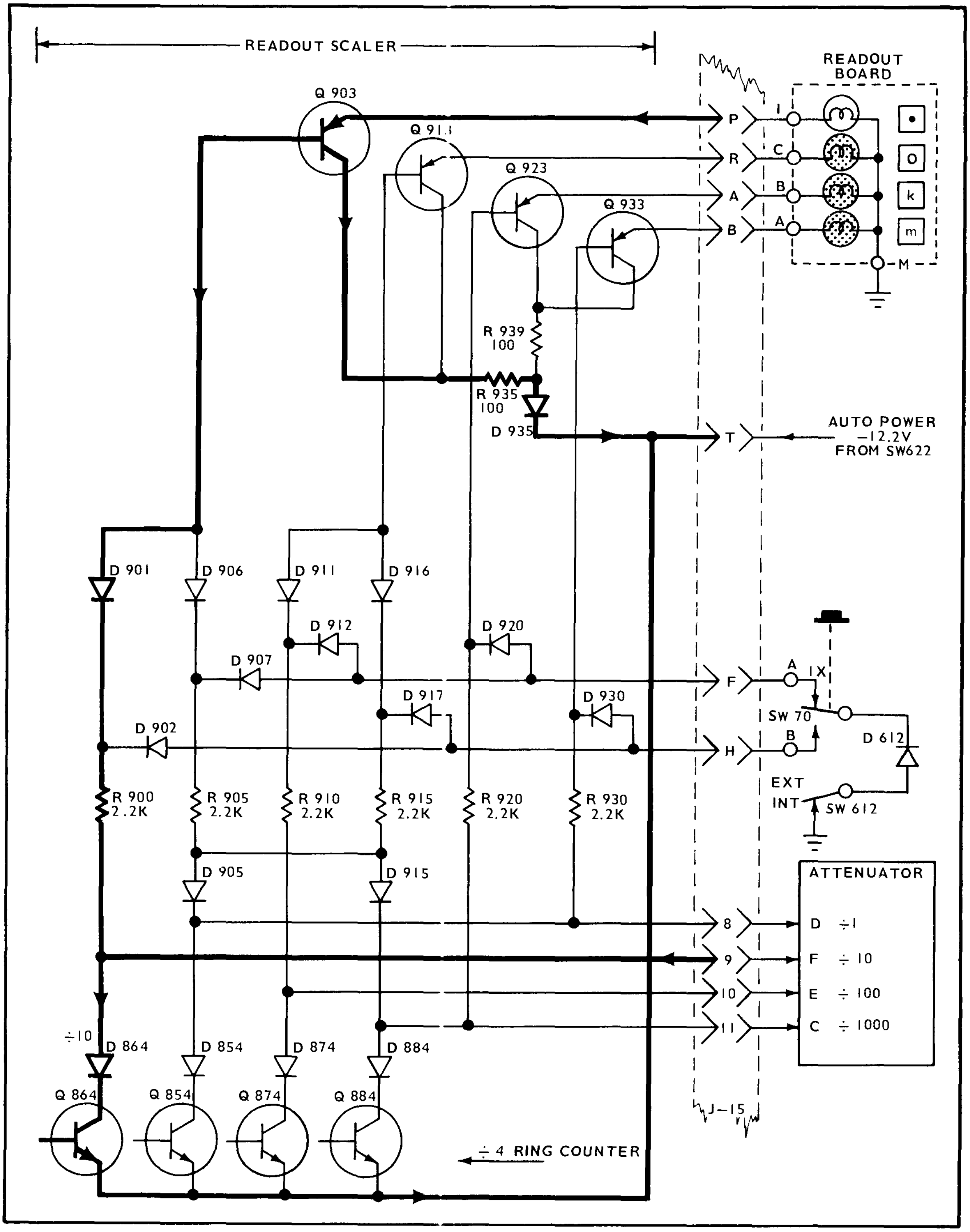

Fig. 3-30. Readout Scaler current paths for .1, .2, .5 V/DIV, no P6030 Probe.

Ⓐ

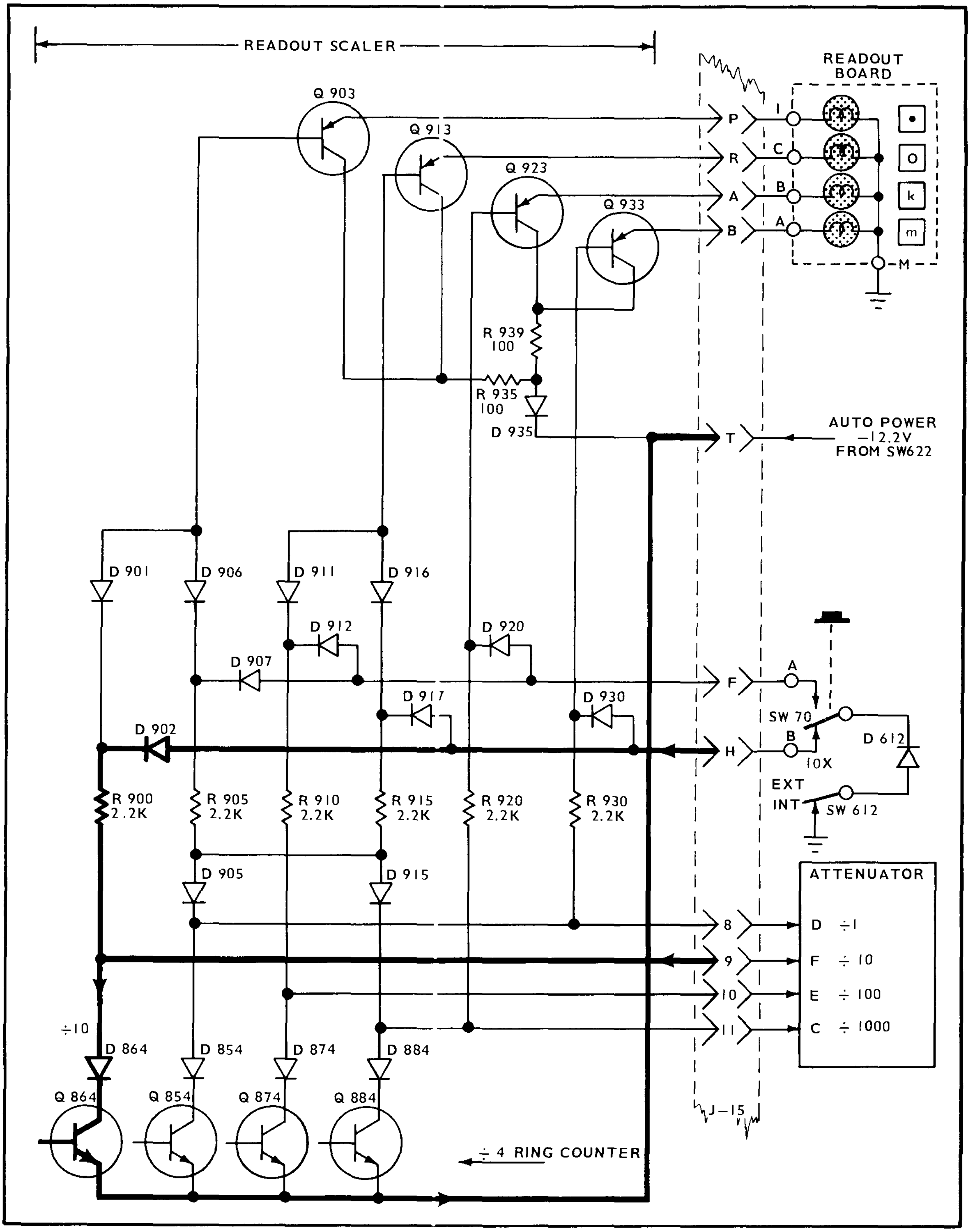

Fig. 3-31. Readout Scaler current paths for 1, 2, 5 V/DIV, with P6030 Probe.

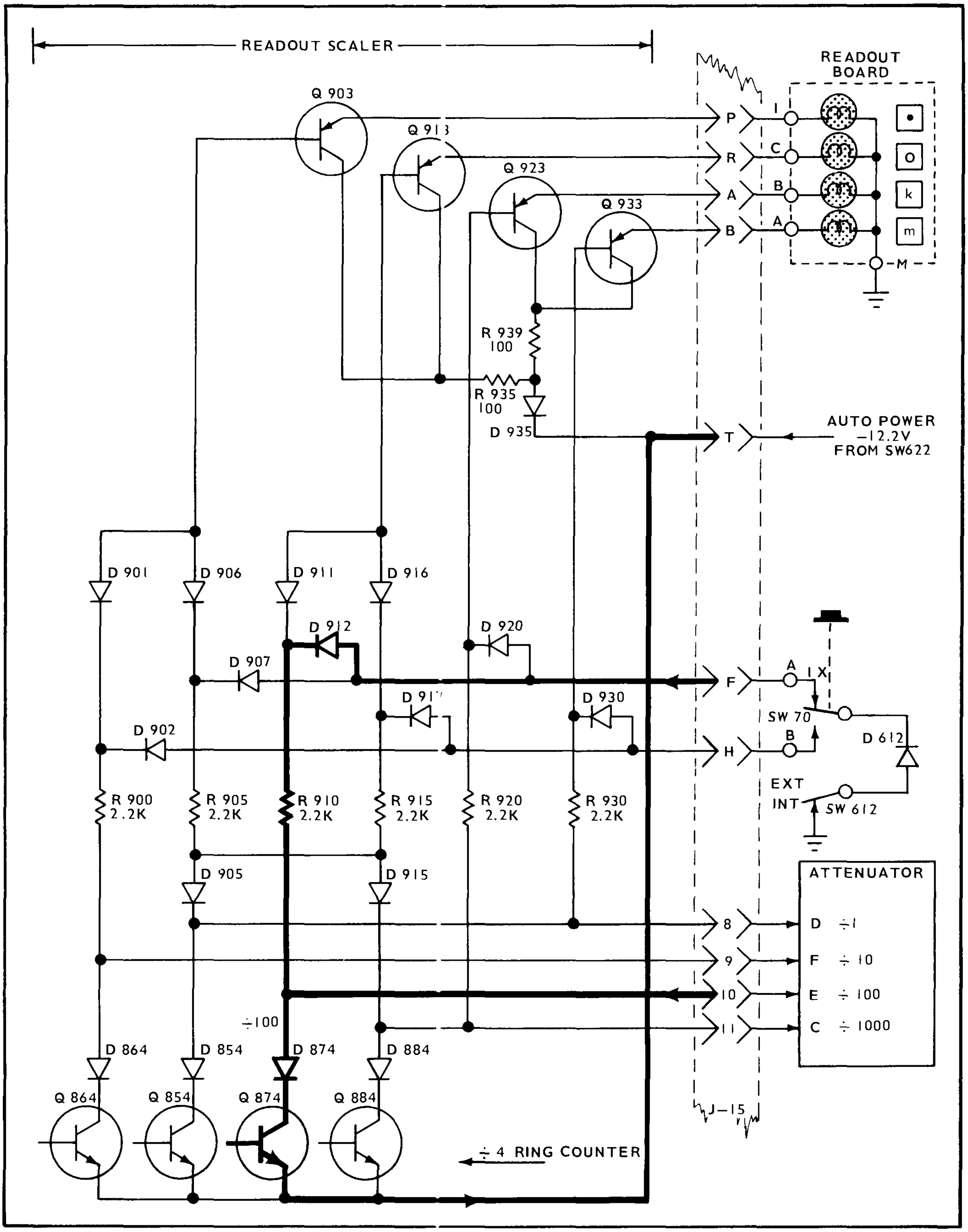

Fig. 3-32. Readout Scaler current paths for 1, 2, 5 V/DIV, no P6030 Probe.

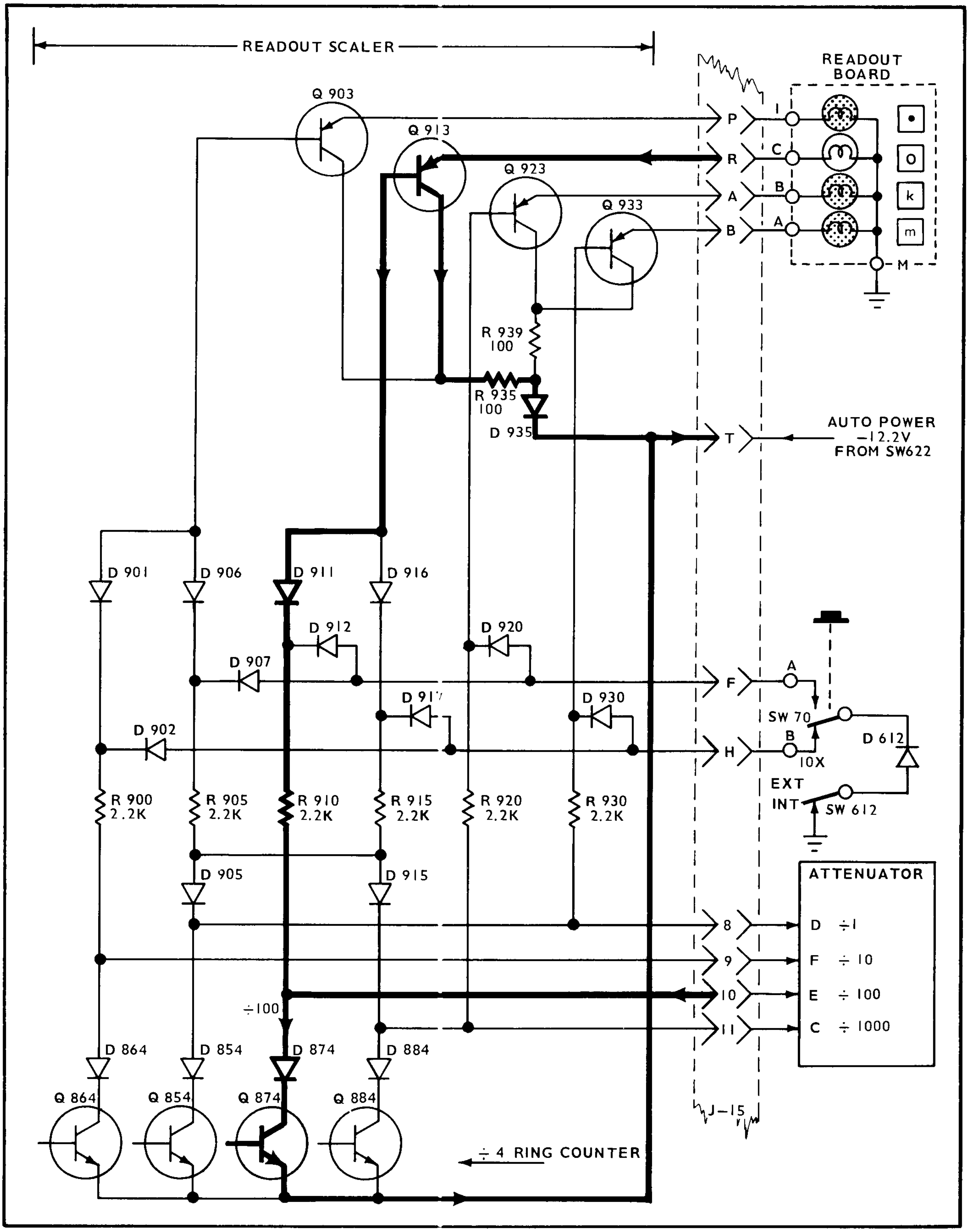

Fig. 3-33. Readout Scaler current paths for 10, 20, 50 V/DIV, with P6030 Probe.

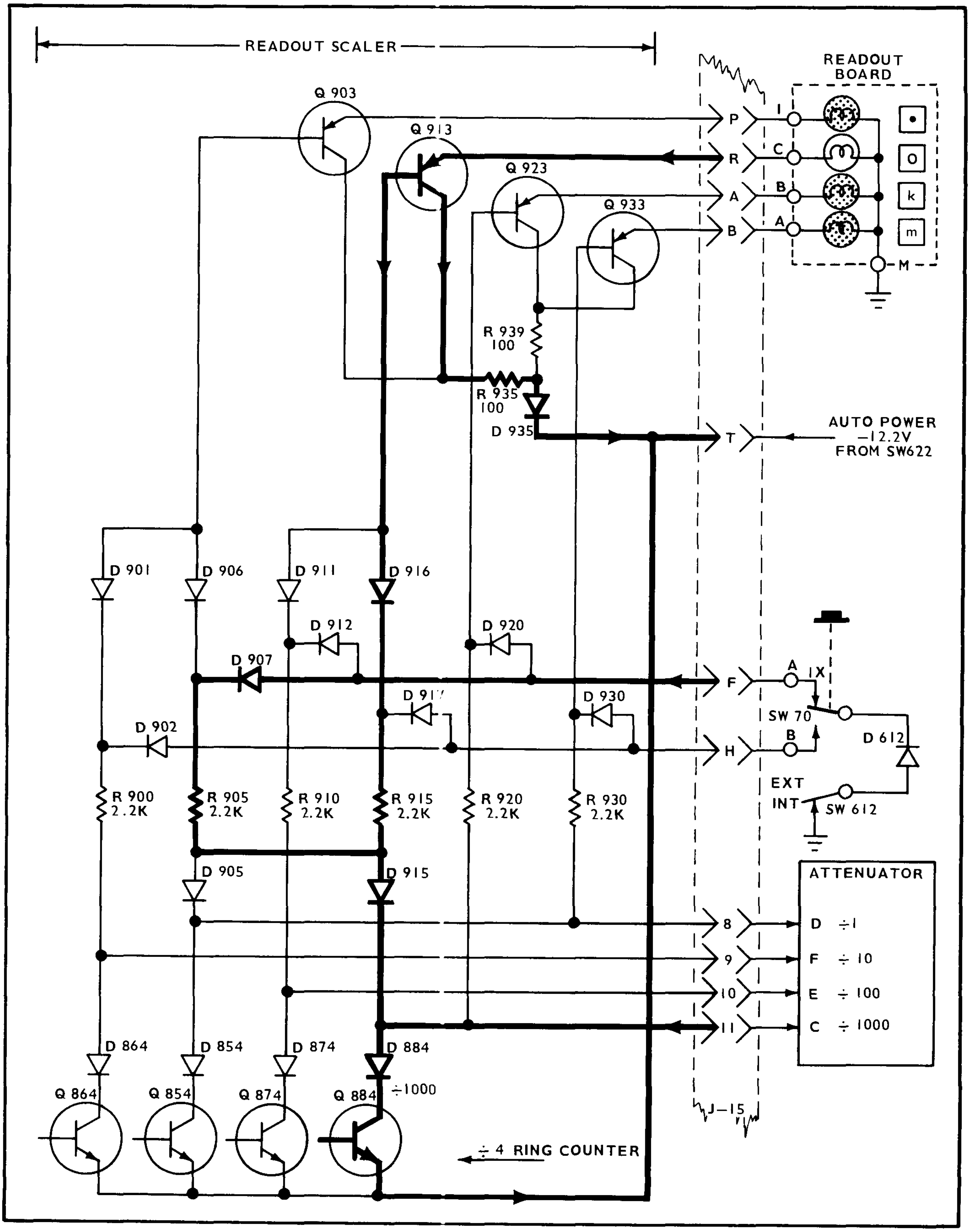

Fig. 3-34. Readout Scaler current paths for 10, 20, 50 V/DIV, no P6030 Probe.

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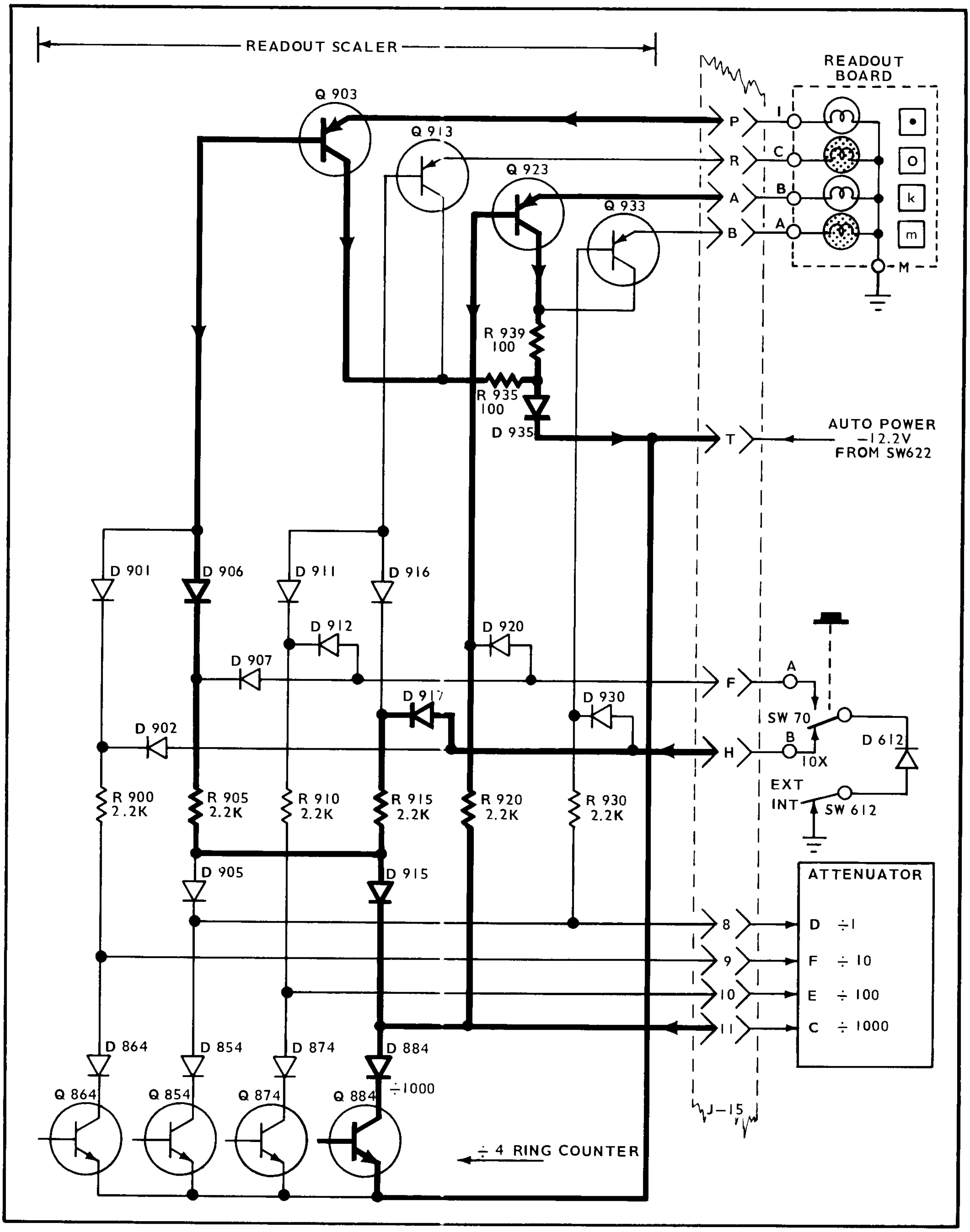
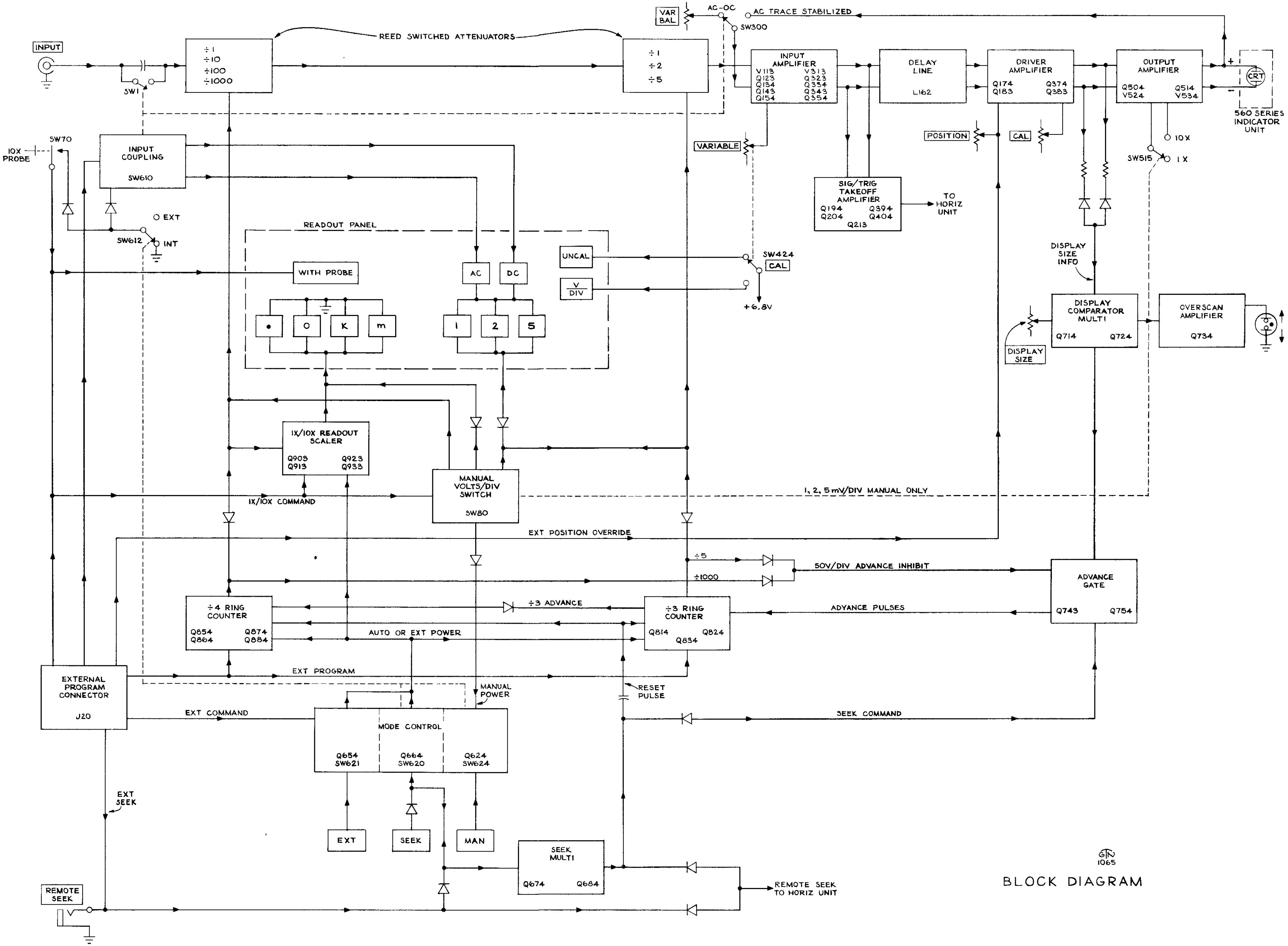
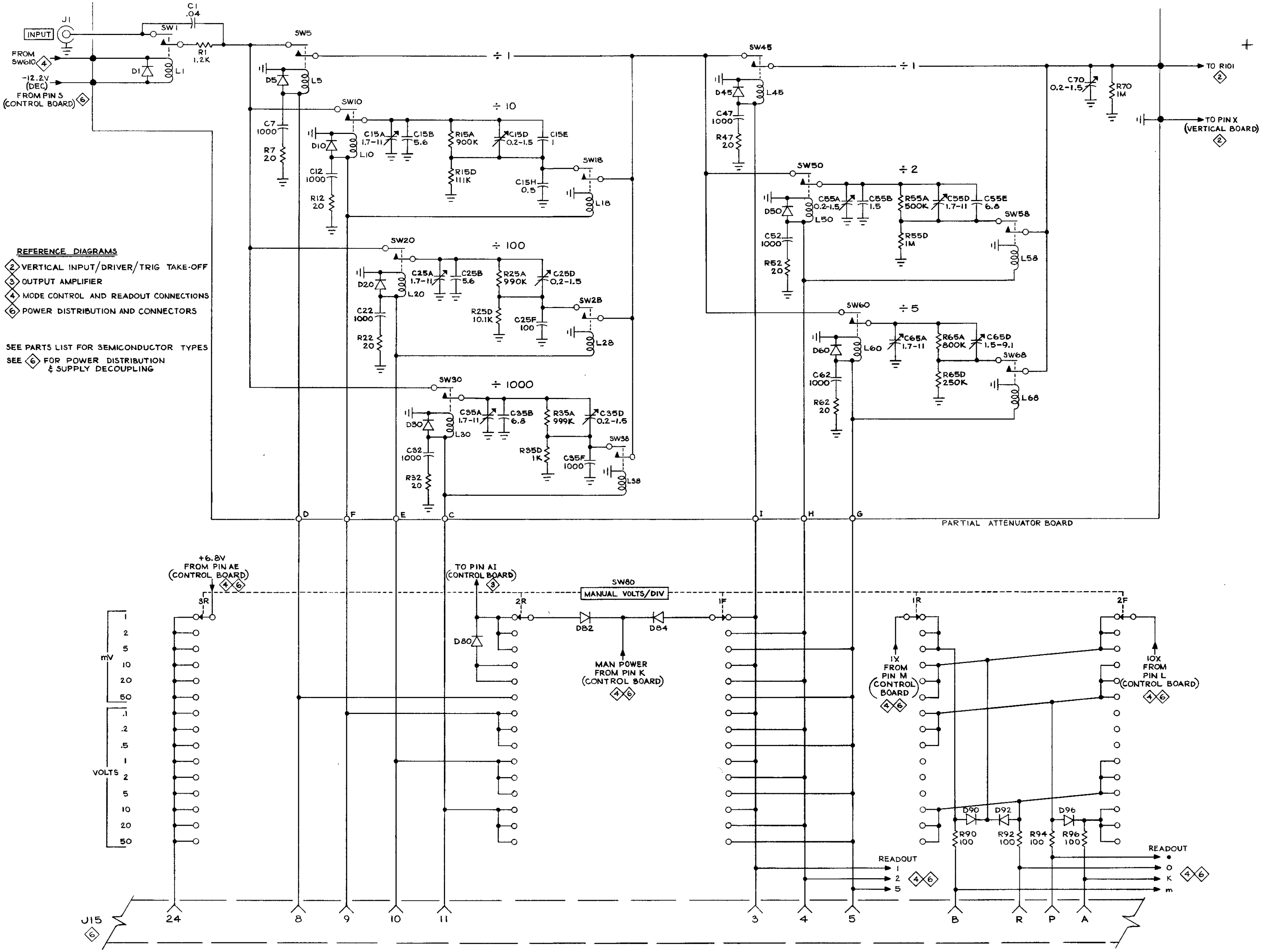


Fig. 3-35. Readout Scaler current paths for .1, .2, .5 kV/DIV, with P6030 Probe.



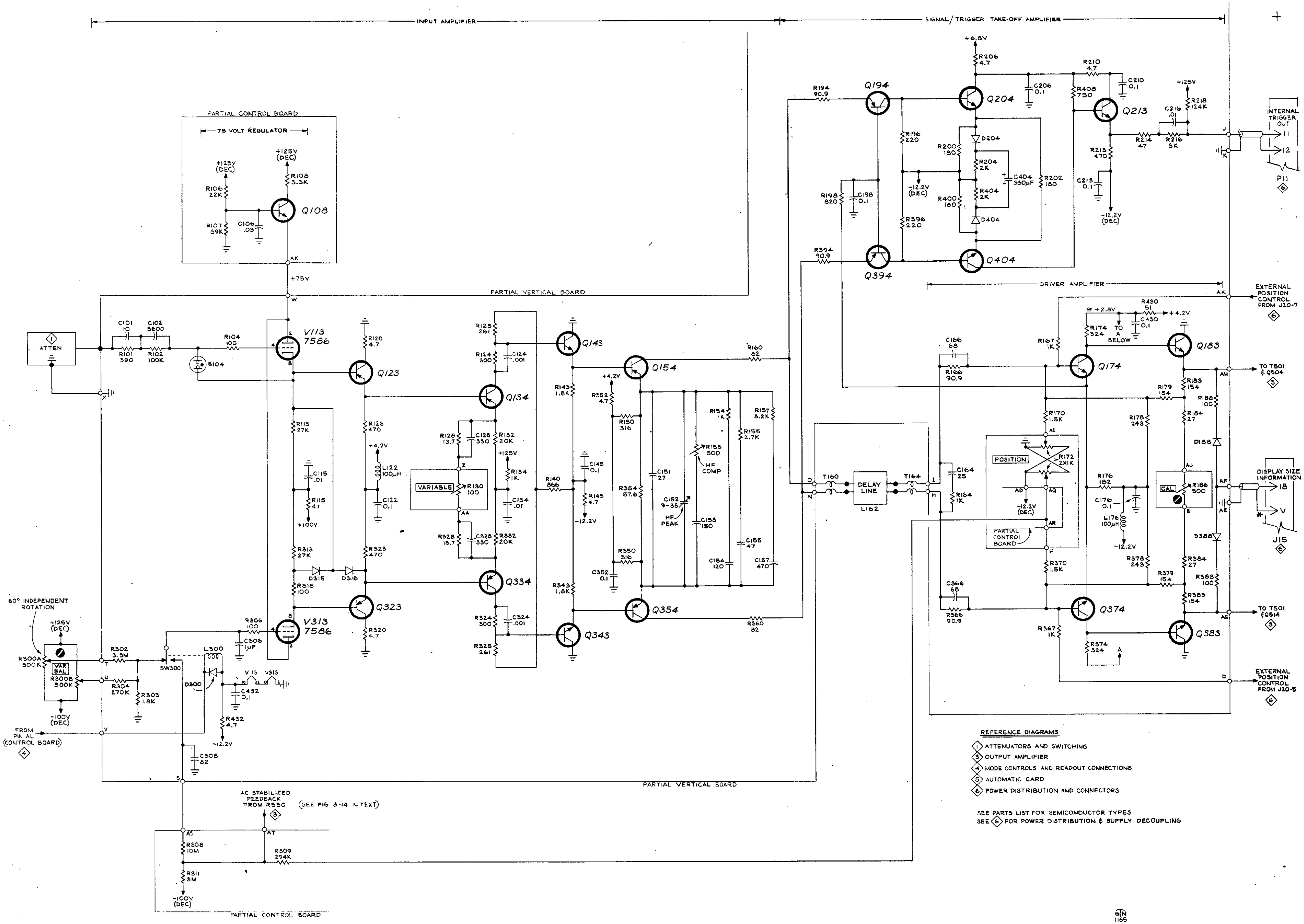
BLOCK DIAGRAM



TYPE 3A5

A

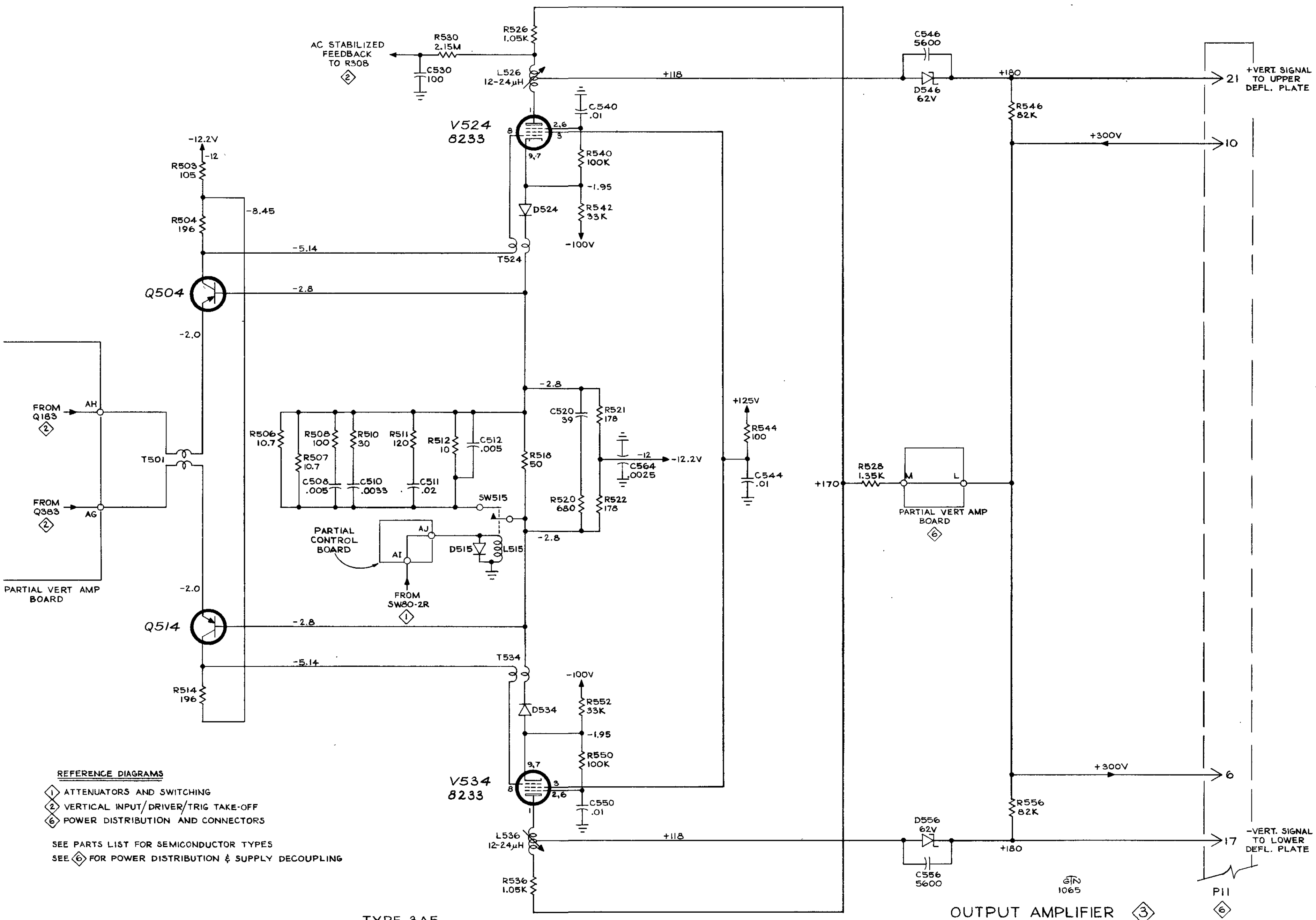
ATTENUATORS AND SWITCHING 1



6N
1165

TYPE 3A5

VERTICAL INPUT/DRIVER/TRIGGER TAKE-OFF ②



REFERENCE DIAGRAMS

① ATTENUATORS AND SWITCHING

② VERTICAL INPUT/DRIVER/TRIG TAKE-OFF

⑥ POWER DISTRIBUTION AND CONNECTORS

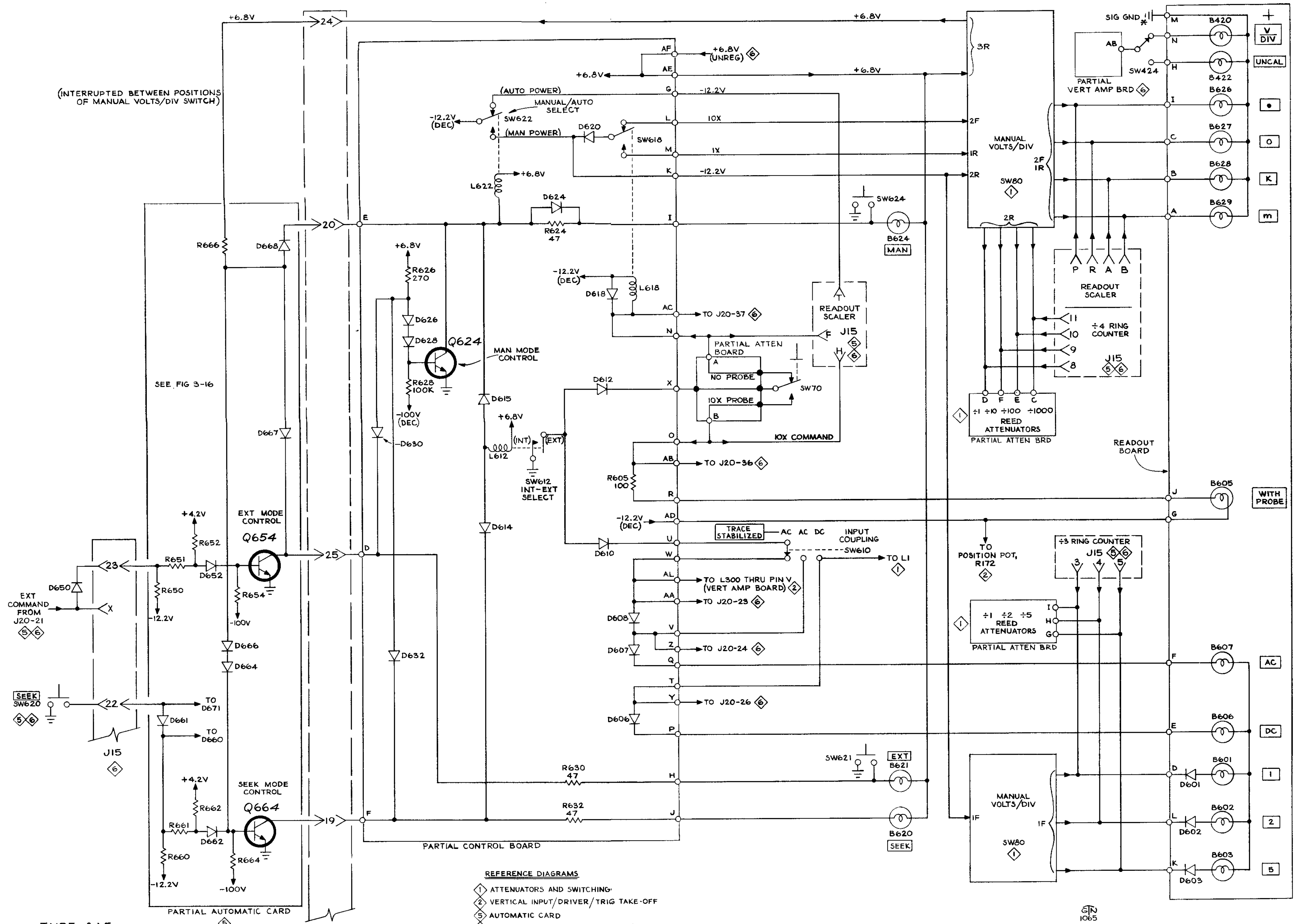
SEE PARTS LIST FOR SEMICONDUCTOR TYPES

SEE ⑥ FOR POWER DISTRIBUTION & SUPPLY DECOUPLING

VOLTAGES MEASURED WITH 20,000 Ω/VOLT METER. TRACE AT CRT ELECTRICAL CENTER.

TYPE 3A5

OUTPUT AMPLIFIER ③



TYPE 3A5

J15 ⑥

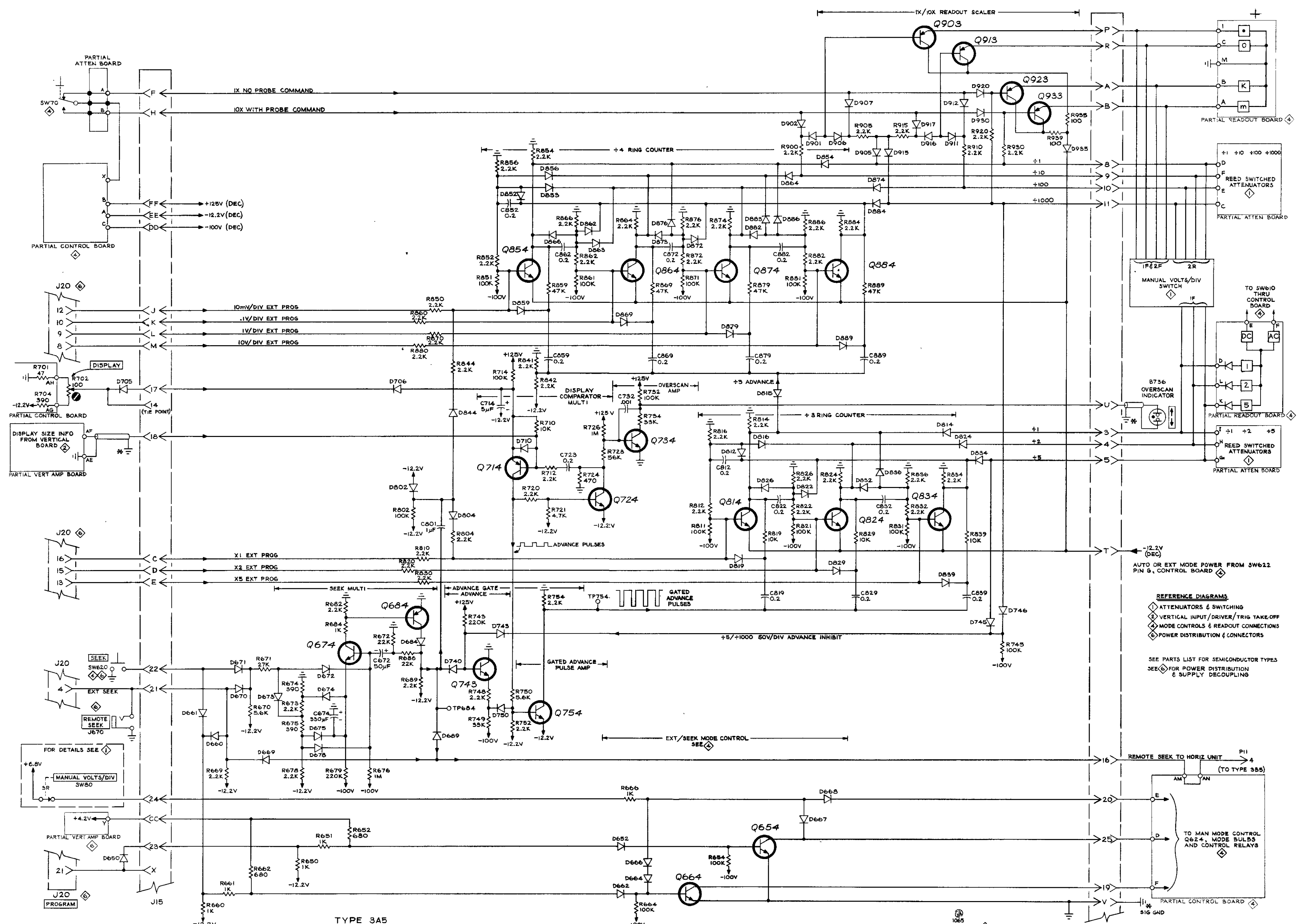
REFERENCE DIAGRAMS

1. ATTENUATORS AND SWITCHING
2. VERTICAL INPUT/DRIVER/TRIG TAKE-OFF
5. AUTOMATIC CARD
6. POWER DISTRIBUTION AND CONNECTORS

SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE ⑥ FOR POWER DISTRIBUTION & SUPPLY DECOUPLING

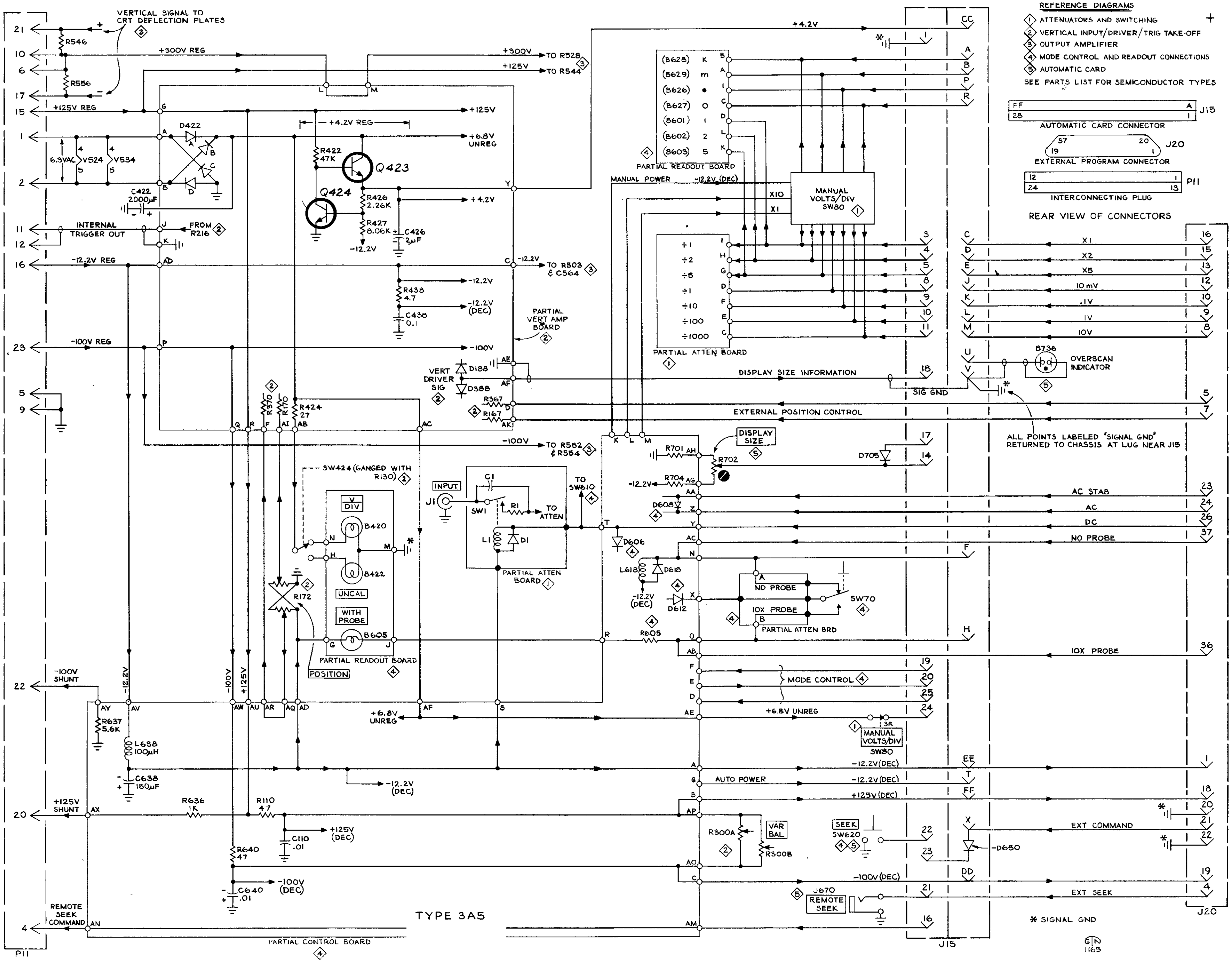
MODE CONTROL AND READOUT CONNECTIONS ④

A



TYPE 3A5

AUTOMATIC CARD 5



POWER DISTRIBUTION AND CONNECTORS ⑥

MANUAL CHANGE INFORMATION

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

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

PARTS LIST CORRECTION

CHANGE TO:

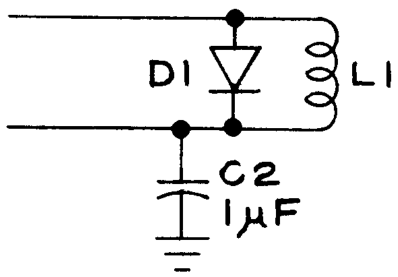
Q143	151-0175-00	Replaceable by 2N3662
Q183	151-0108-00	Silicon Replaceable by 2N2501
Q343	151-0175-00	Replaceable by 2N3662
Q383	151-0108-00	Silicon Replaceable by 2N2501
Q903	151-0188-00	Replaceable by 2N3906
Q913	151-0188-00	Replaceable by 2N3906
Q923	151-0188-00	Replaceable by 2N3906
Q933	151-0188-00	Replaceable by 2N3906

PARTS LIST CORRECTION

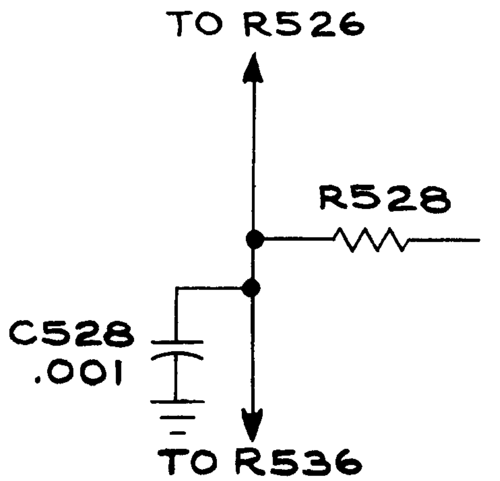
Add:

C2	283-0059-00	1 µF	Cer.	+80%	-20%	25 V
C528	283-0078-00	.001	Cer.	±20%		500 V

SCHEMATIC CORRECTION



PART ATTEN. & SWITCHING



PART OUTPUT AMP.

TYPE 3A5

PARTS LIST CORRECTION

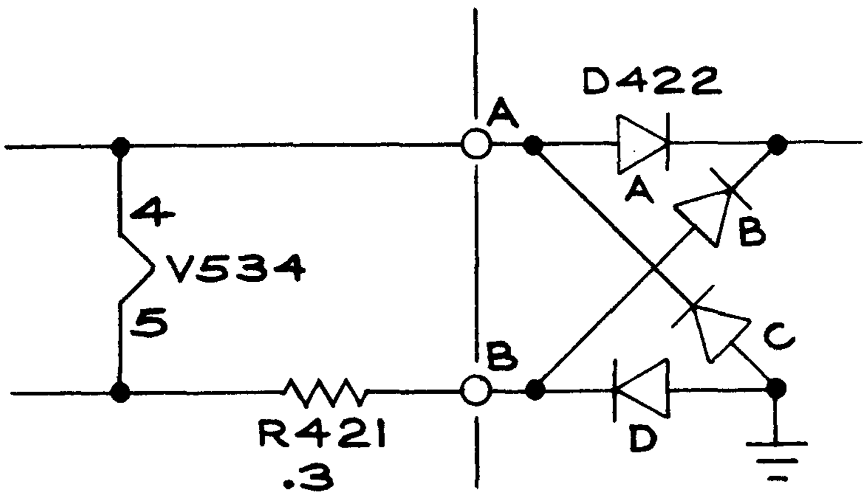
ADD:

R421	308-0244-00	.3 Ω	2W	10%

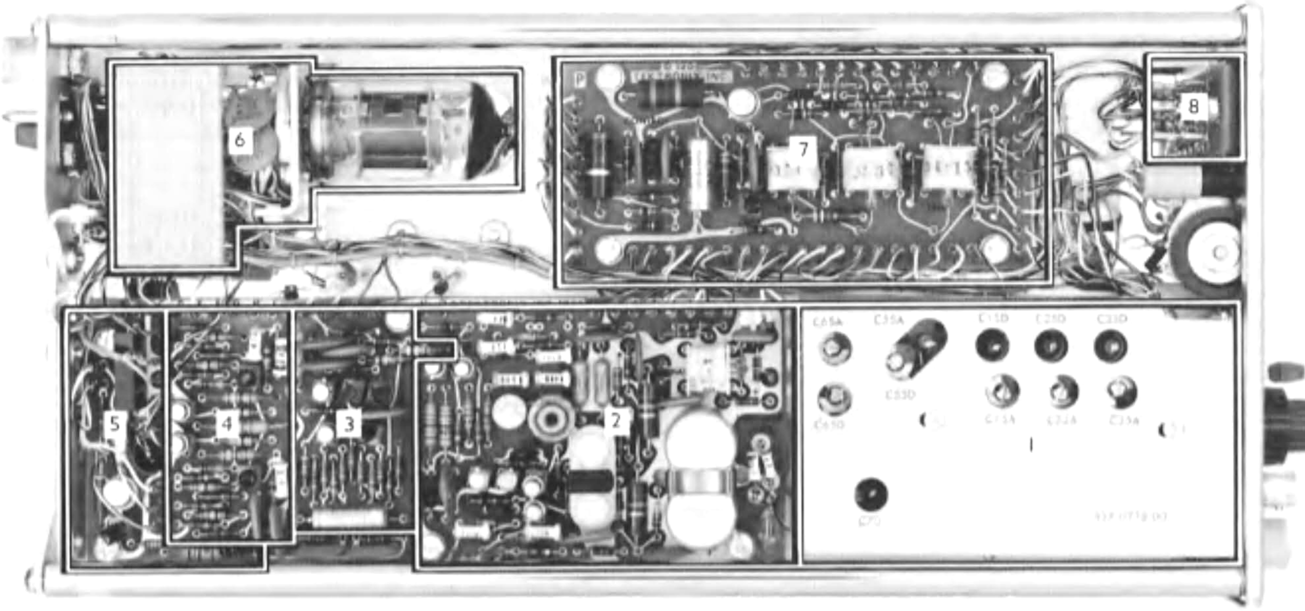
CHANGE TO:

Q724	151-0108-00	Silicon	Replaceable by 2N2501	
R720	315-0103-00	10 k	1/4 W	5%

SCHEMATIC CORRECTION

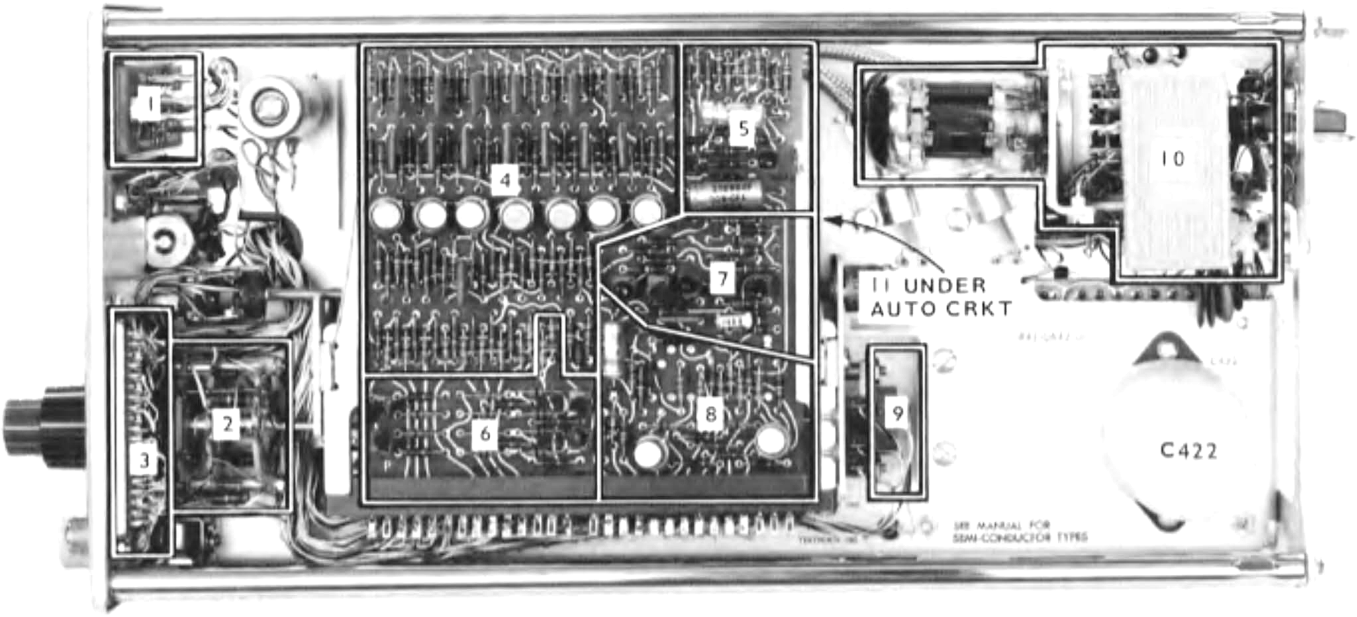


PARTIAL PWR. DISTRIBUTION DIAG.



1. Reed switched attenuators.
2. Vertical amplifier before delay line.
3. Trigger amplifier.
4. Output stage driver amplifier.
5. +6.8V and+4.2V power supplies.
6. Output amplifier.
7. Control circuits.
8. Readout panel.

Fig. 4-7. Left side major circuit locations.



1. Readout panel.
2. MANUAL VOLTS DIV sw.
3. External PROGRAM connector.

Automatic Circuits:

4. ÷ 3 & ÷ 4 Ring counters.
5. SEEK Multi.
6. 1X 10X Readout Scaler.
7. Advance/Comparator.
8. SEEK & EXT Control.

9. VARIABLE control.
10. Output amplifier.
11. Delay line under Auto Crkts.

Fig. 4-8. Right side major circuit locations.

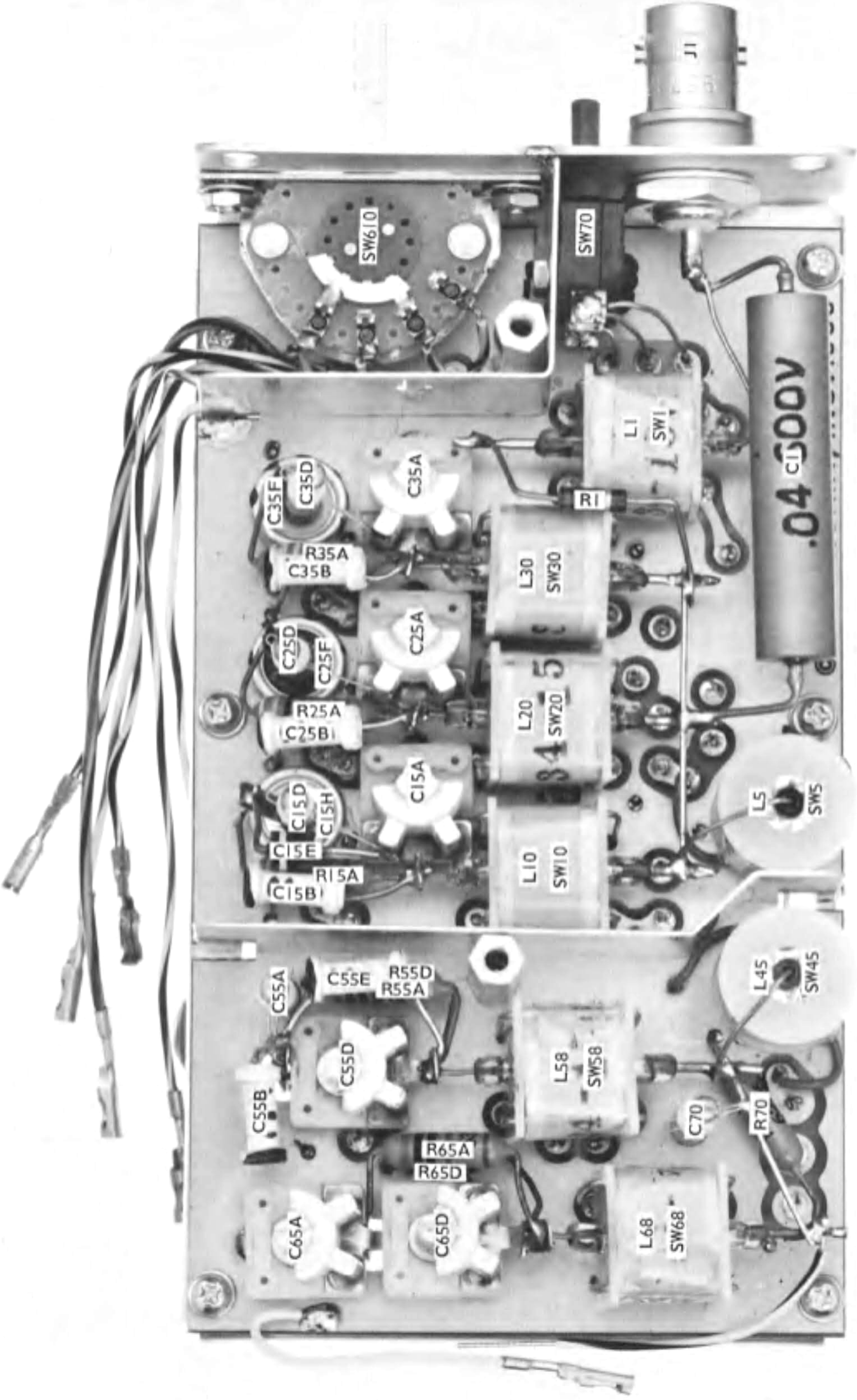


Fig. 4-9. Attenuator left side parts locations and wire color code.

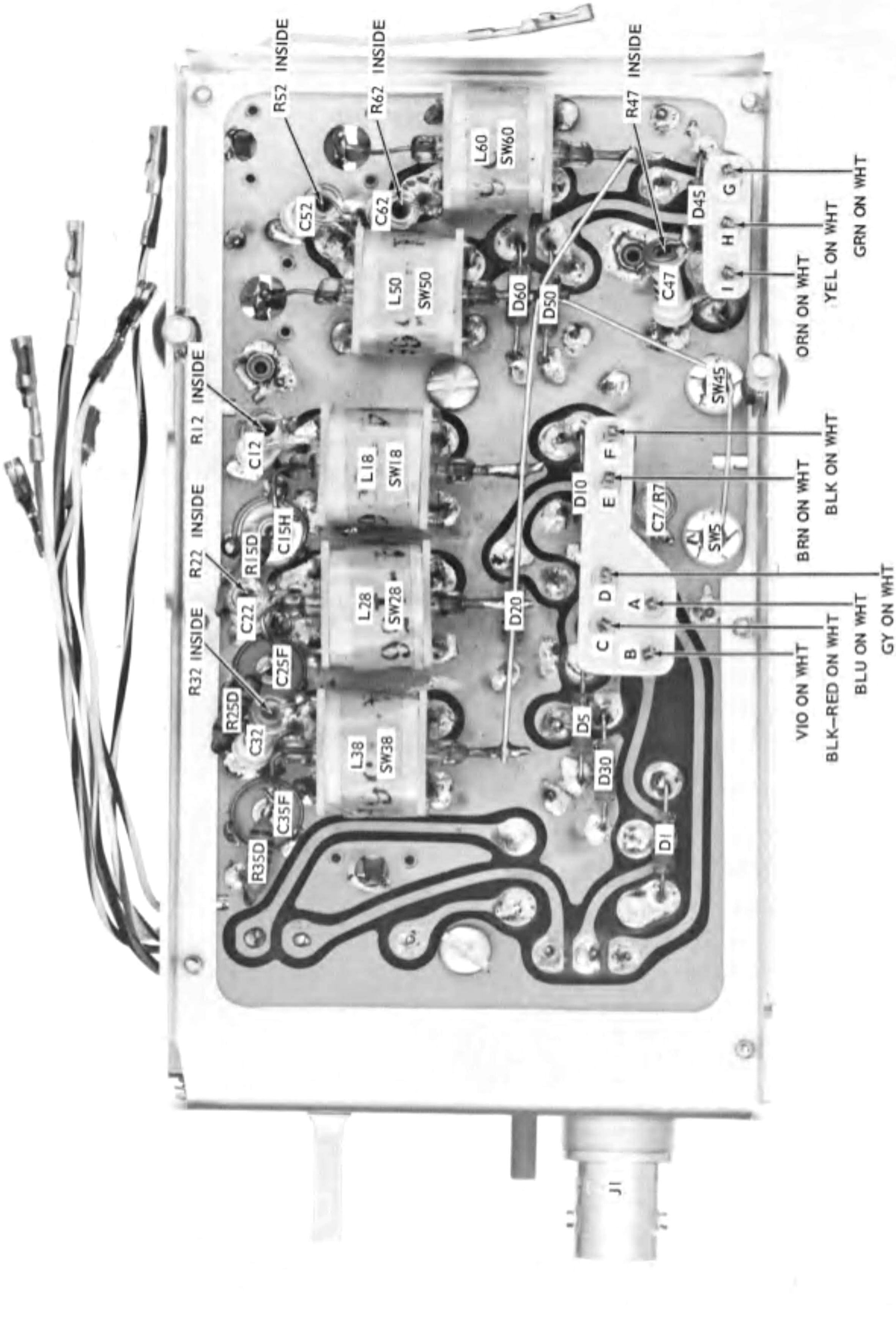


Fig. 4-10. Attenuator right side parts locations and wire color code.

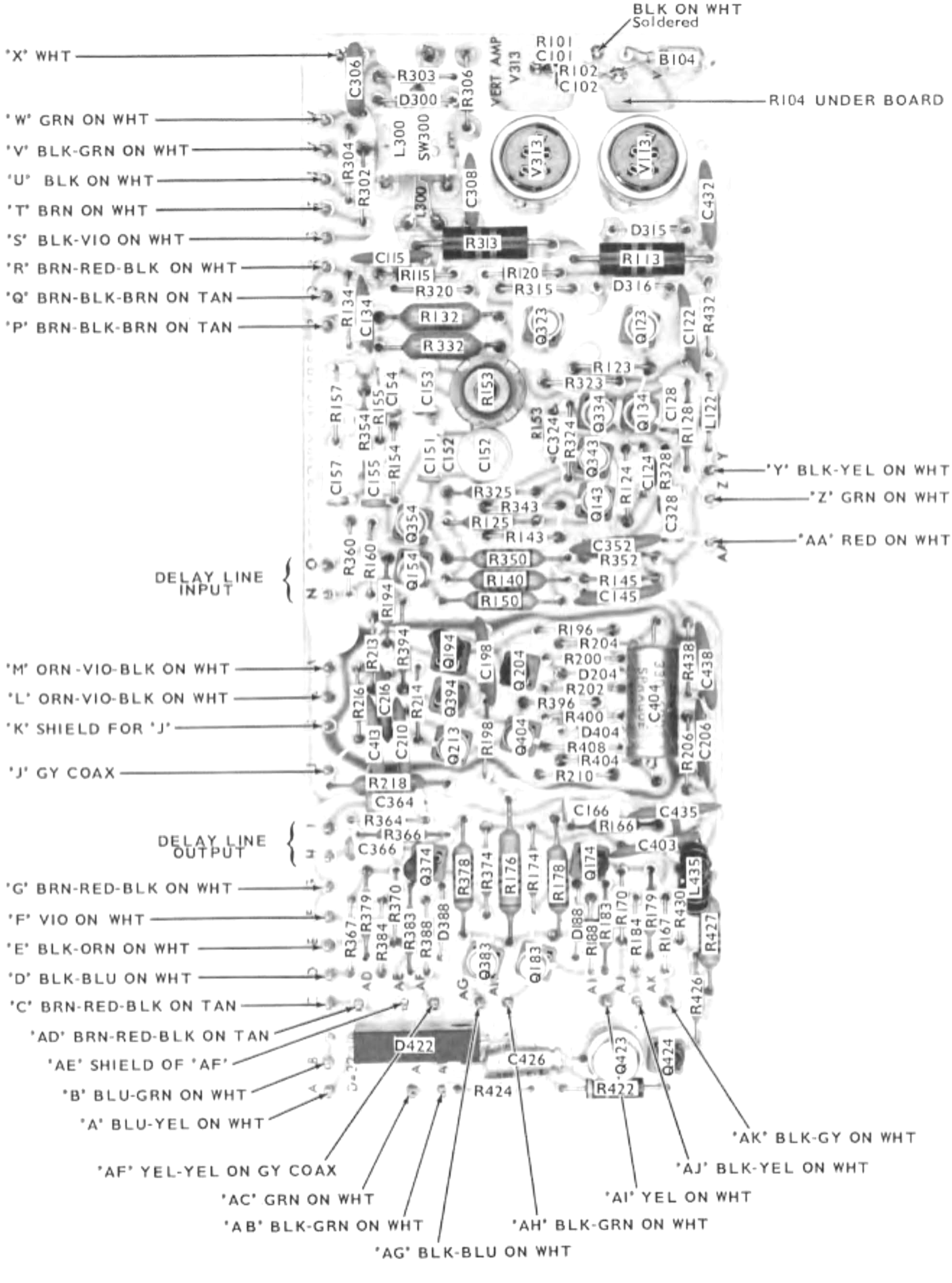


Fig. 4-11. Vertical amplifier board parts locations, and wire color code.

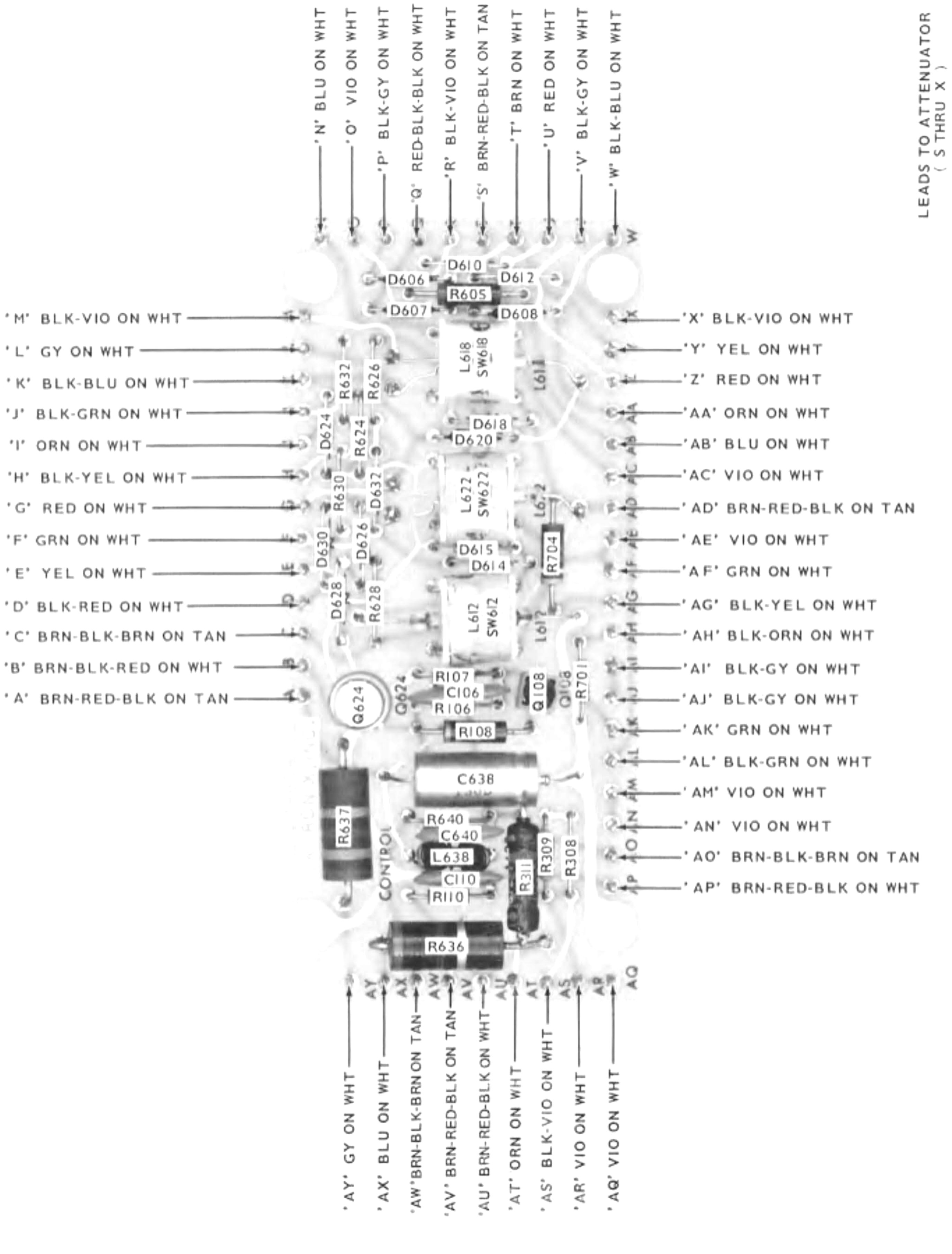
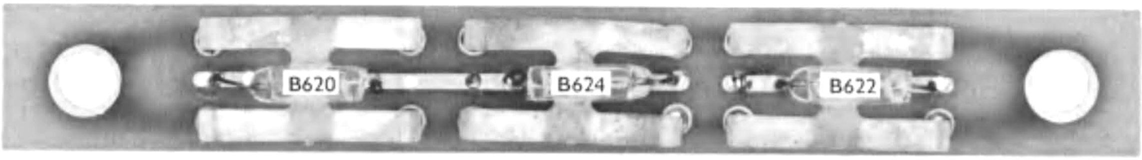
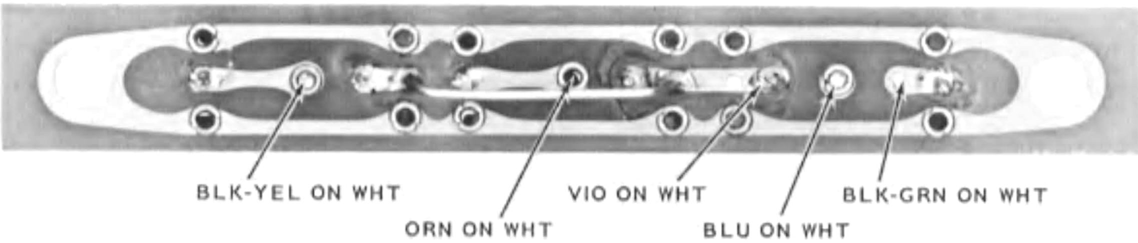


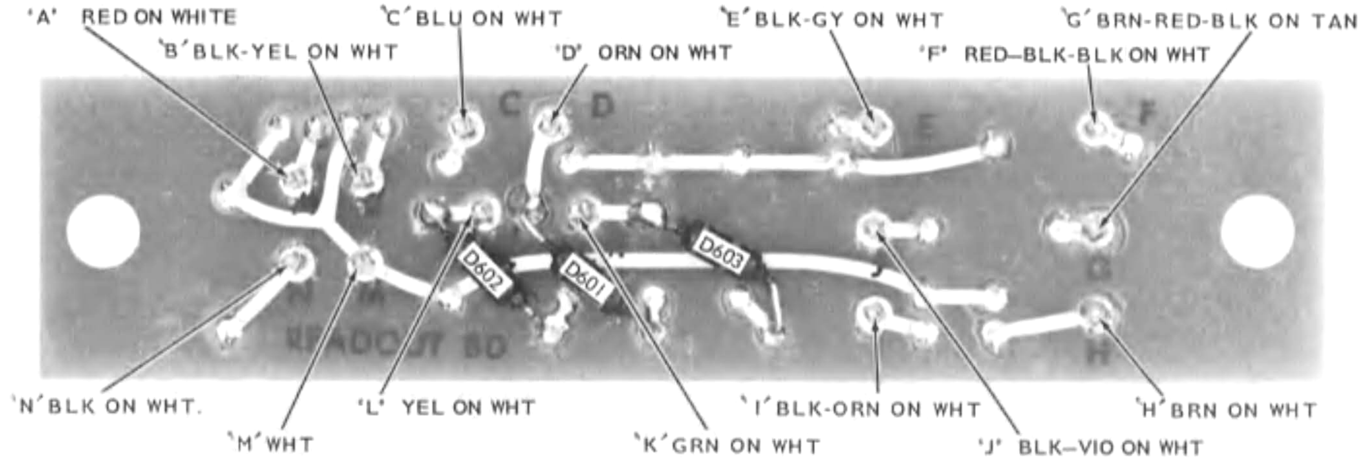
Fig. 4-12. Control circuit board parts locations, and wire color code.



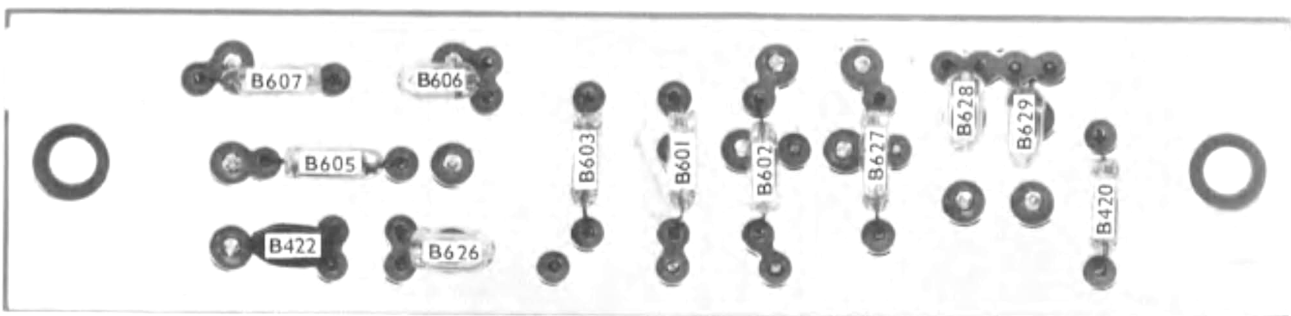
a. Mode switch lamps.



b. Mode switch wiring color code.



c. Readout board diode locations and wiring color code.



d. Readout board lamps.

Fig. 4-13. (A) Mode switch lamps. (B) Mode switch panel wire color code. (C) Readout panel diode locations and wire color code. (D) Readout panel lamps.

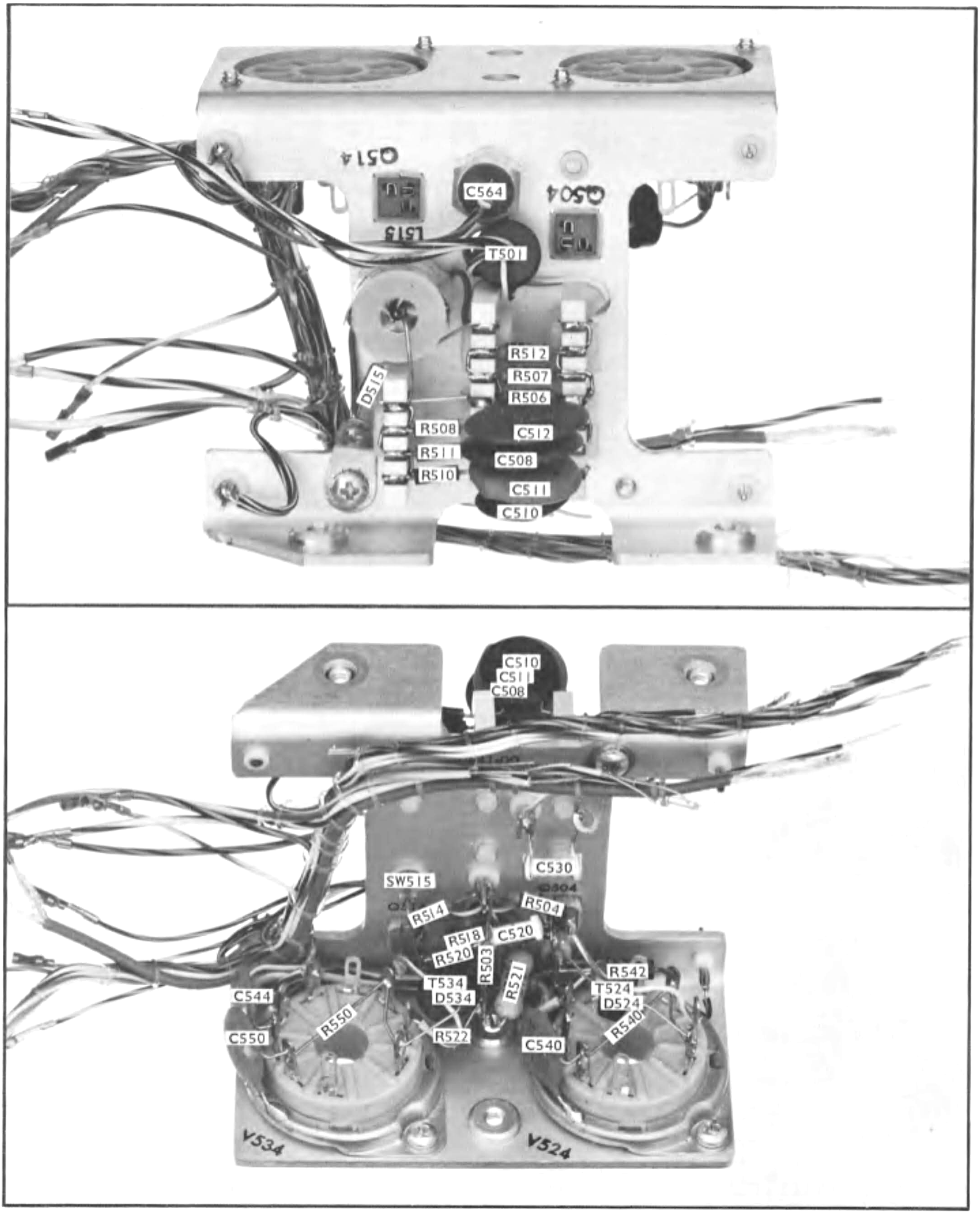


Fig. 4-14. Output amplifier parts locations.

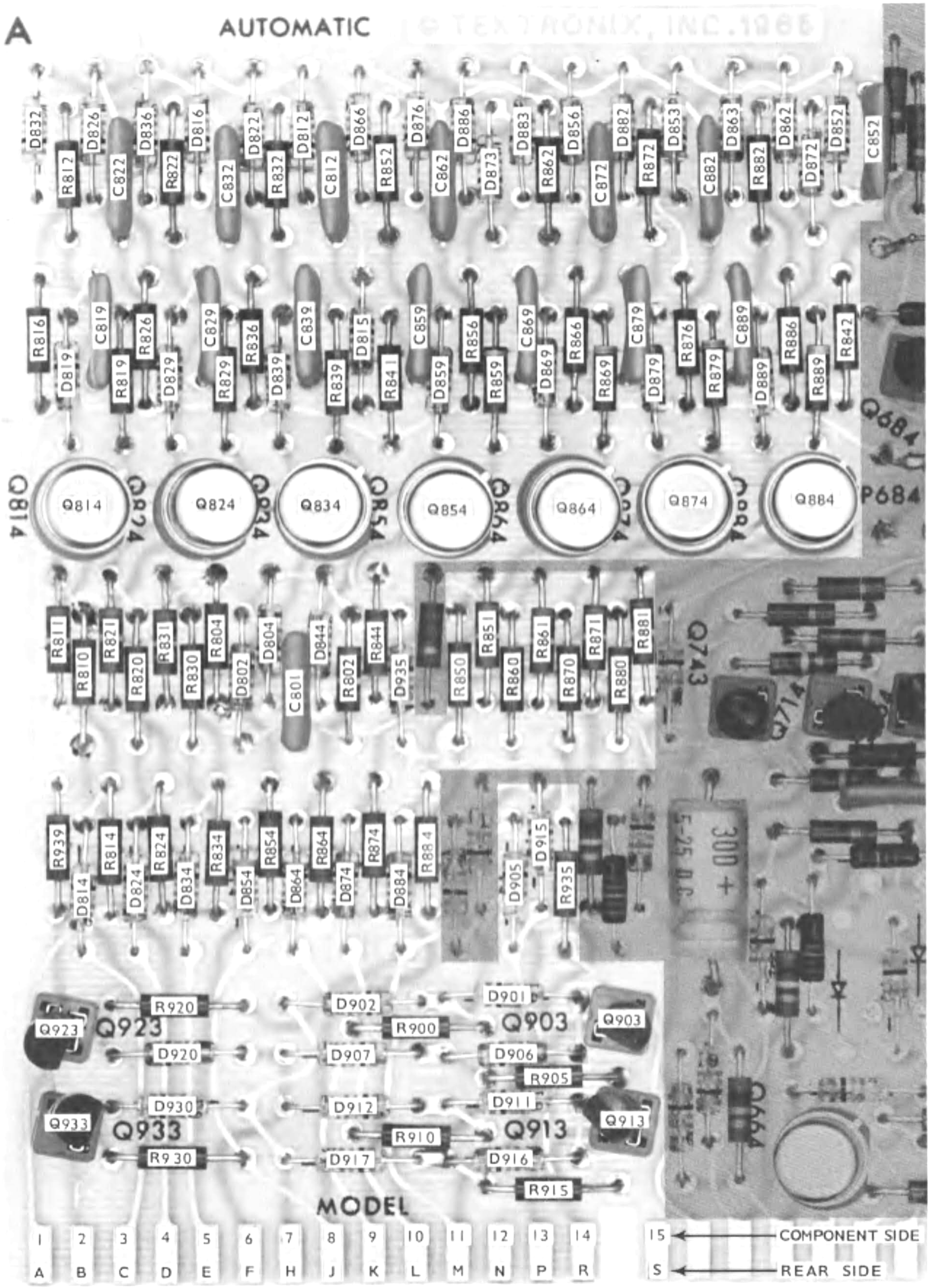


Fig. 4-15. One half automatic card parts locations.

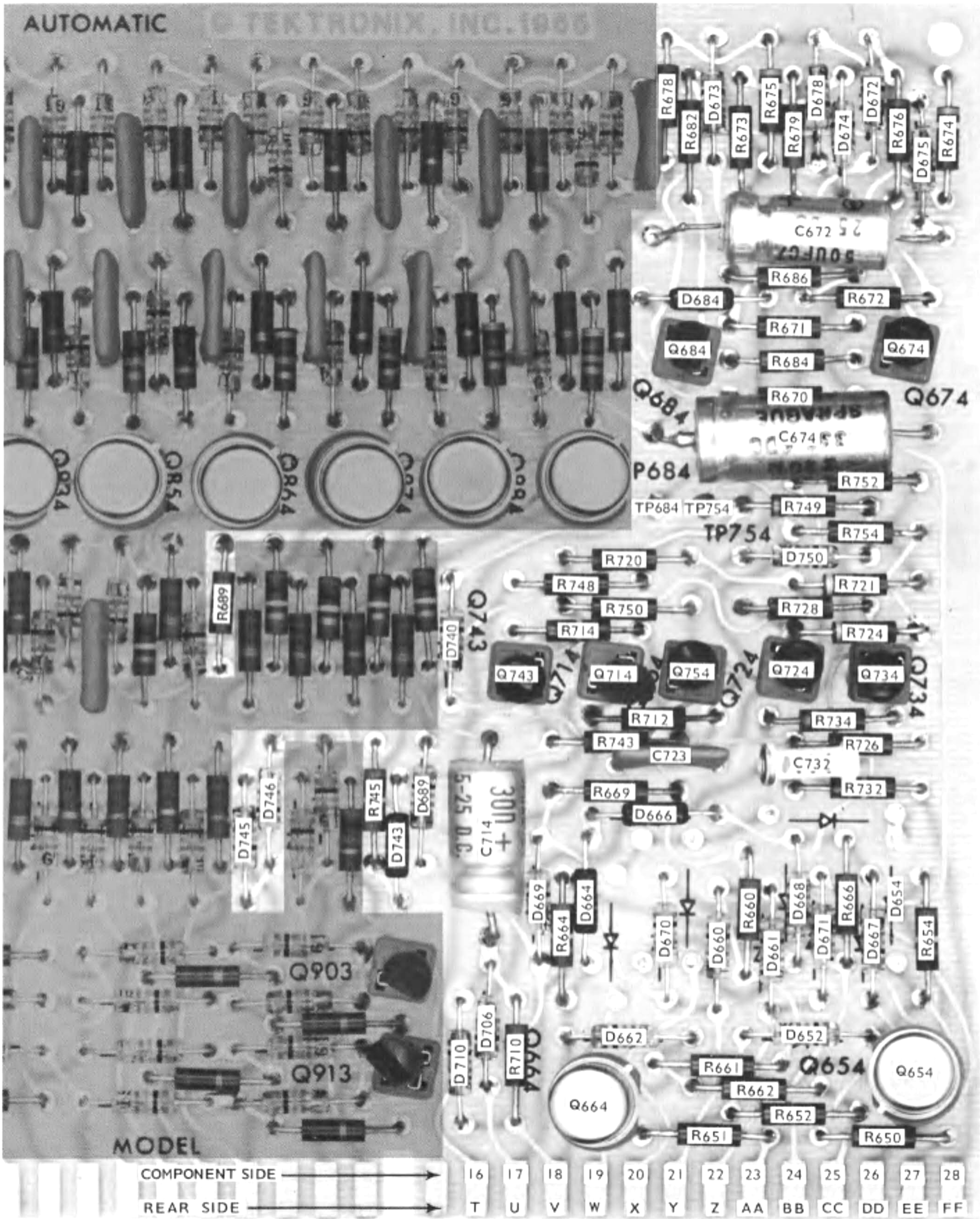


Fig. 4-16. One half automatic card parts locations.