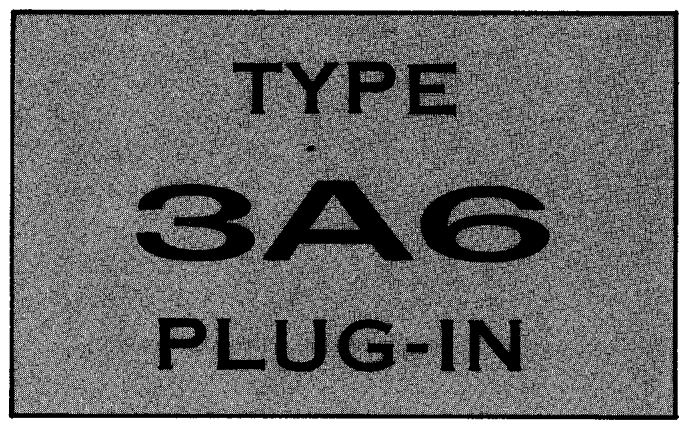
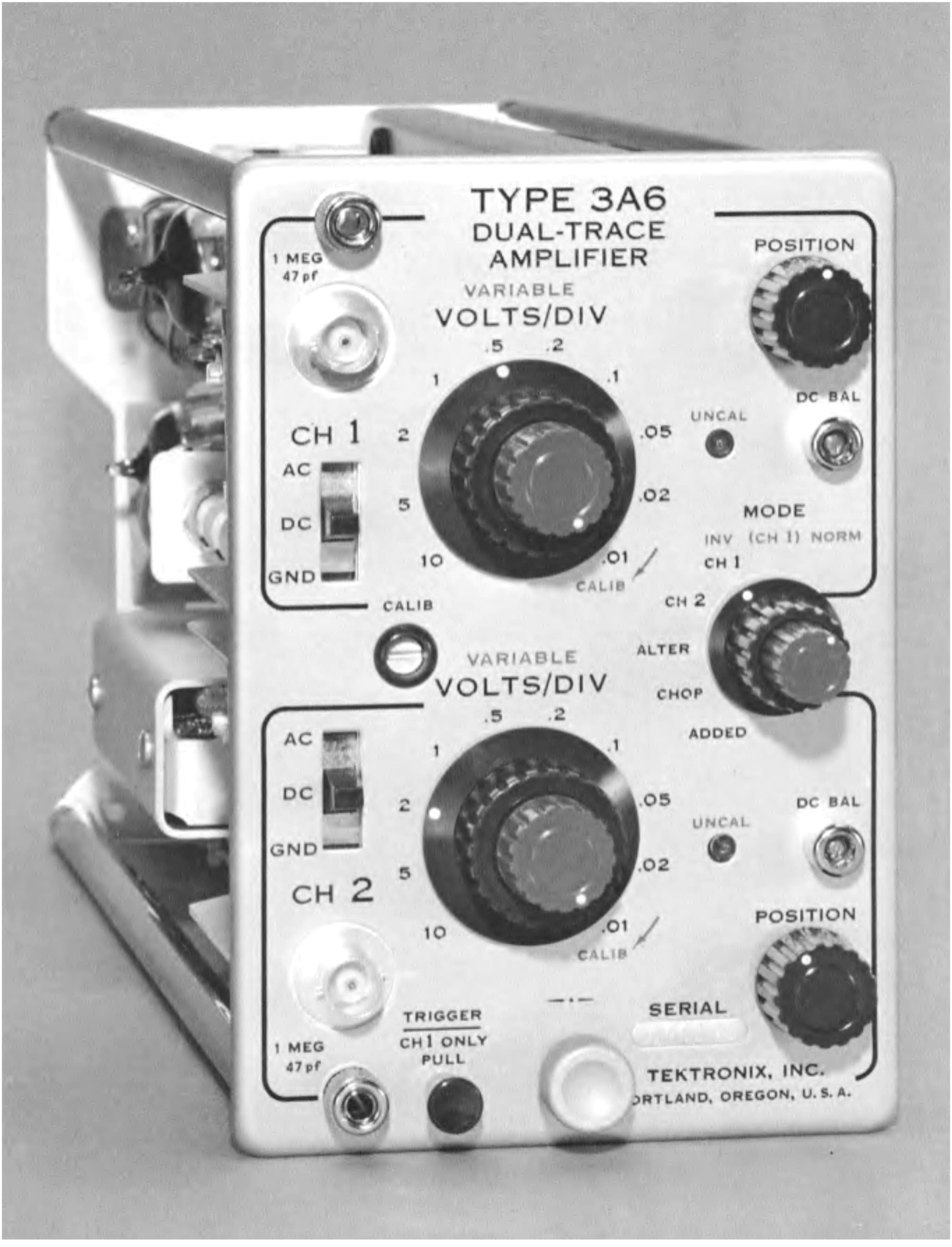
INSTRUCTION MANUAL

Serial Number _



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

070-419


TYPE 3A6
DUAL-TRACE
AMPLIFIER
1 MEG
47 pf
VARIABLE
VOLTS/DIV
.5
.2
1
.1
2
.05
5
.02
10
.01
CALIB
POSITION
DC BAL
UNCAL
CH 1
AC
DC
GND
MODE
INV (CH 1) NORM
CH 1
CH 2
ALTER
CHOP
ADDED
CALIB
VARIABLE
VOLTS/DIV
AC
DC
GND
CH 2
DC BAL
UNCAL
POSITION
TRIGGER
CH1 ONLY
PULL
SERIAL
1 MEG
47 pf
TEKTRONIX, INC.
ORTLAND, OREGON, U. S. A.

SECTION 1

CHARACTERISTICS

Introduction

The Type 3A6 Dual-Trace Amplifier plug-in unit contains two identical amplifier channels. Either channel can be used independently for a single-trace display, or the two channels can be electronically switched for a dual-trace display. Also, the two channels can be added algebraically and the resultant waveform displayed on the indicator unit crt.

A signal delay line in the plug-in unit delays the signal to be displayed while the triggering signal passes to the time base undelayed. This allows the leading edge of the triggering signal to be viewed on the crt.

The Type 3A6 can be used with any of the Tektronix 560-Series Oscilloscopes* or with the Tektronix Type 129 Plug-In Unit Power Supply.

Frequency Response

Dc to 10 mc (not more than 3 db down at 10 mc) with a corresponding risetime of typically 35 nanoseconds.

Deflection Factors

Ten calibrated steps for each channel; .01, .02, .05, .1, .2, .5, 1, 2, 5 and 10 volts/division. Variable control in each channel permits continuous, uncalibrated adjustment from 0.01 to about 25 volts/division in conjunction with the step switch.

Accuracy

Within ±3% of indicated deflection with VARIABLE in the CALIB position.

Input Impedance

1 megohm ±1%, paralled by about 47 pf.

Input Coupling

Ac or dc coupled, selected by front-panel switch. In the AC position low-frequency response is limited to about 2 cps (0.2 cps with 10× passive probe).

Maximum Input Voltage

600 volts combined dc and peak ac; 600 volts peak-to-peak ac.

Polarity Inversion

Polarity of Channel 1 can be changed to provide 180° inversion. No polarity inversion of Channel 2.

Operating Modes

Channel 1 only.

Channel 2 only.

Alternate between channels.

Chopped between channels at approximately 150 kc rate.

Added Algebraically.

Channel Isolation

50,000:1 or greater at 100 kc.

Triggering

Internal triggering signals for time base are provided from both channels or from Channel 1 only, determined by front-panel switch.

Mechanical Features

Input connectors: BNC jacks.

Construction: Aluminum alloy chassis and panel.

Accessories

Information on accessories for use with this instrument is included at the rear of the mechanical parts list.

*Cannot be used with a Type 560. Also, when used with a Type 2B67 or 3B2 time-base plug-in unit or with a Type 565 or RM565, it may not be possible to view the entire leading edge of the triggering waveform due to the delay of these time-base circuits.

SECTION 3

CIRCUIT DESCRIPTION

The Type 3A6 Dual-Trace Amplifier contains two identical input channels, a common output amplifier, a switching circuit, and a trigger amplifier. The output of either or both input channel amplifiers may be fed to the output amplifier, depending on the condition of the switching circuit. Thus, the switching circuit makes it possible to display one signal as a single trace on the crt, two signals alternately in a dual-trace display, or the algebraic sum or difference of two signals as a single trace. Fig. 3-1 shows a block diagram of the Type 3A6.

Input Channel Amplifier

Each input channel consists of an attenuation network, an input cathode-follower, and a two-stage push-pull amplifier with switched outputs. Input cathode followers V113 and V123 (Channel 1) and V213 and V223 (Channel 2) isolate the attenuator input circuitry from emitter followers Q133 and Q143 (Channel 1) and Q233 and Q243 (Channel 2). Q134 and Q144 (Channel 1), and Q234 and Q244 (Channel 2) drive the Output Amplifier.

The gain of the last stage in each input amplifier is set by two internal calibration adjustments: R149 (Channel 1) and R249 (Channel 2) set the gain of the stage in the .01 position of the VOLTS/DIV switches, R147 (Channel 1) and R247 (Channel 2) set the gain of the stage in the remaining positions of the VOLTS/DIV switches. The VARIABLE controls increase emitter degeneration when moved from the CALIB position.

The input attenuators are resistive dividers with capacitive compensation. The attenuators maintain an input impedance of 1 megohm paralleled by about 47 pf. With the VOLTS/DIV switches in the .01 and .02 positions, input signals are fed directly to cathode-follower stages V113 and V213. In the VOLTS/DIV switch positions which provide an input deflection factor greater than 20 mv/div (.05 to 10), the attenuator sections are stacked. In the .05 position, the 2.5× attenuator increases the basic 20 mv/div deflection factor to 50 mv/div. The 5× attenuator is used to increase the deflection factor to 100 mv/div in the .1 position. These three positions (1×, 2.5×, and 5×) are used with the 10× or 100× attenuators in the higher deflection-factor positions of the VOLTS/DIV switch.

The DC BAL controls in the grid circuit of V123 and V223 adjust the balance of each input amplifier so current does not flow through R139 (Channel 1), and R239 (Channel 2) under no-signal conditions. Otherwise, the position of a no-signal trace would shift on the crt as the VARIABLE control was turned or gain adjustments were made.

In the INV position, the INV (CH 1) NORM switch (SW155) inverts the Channel 1 output to the diode gates.

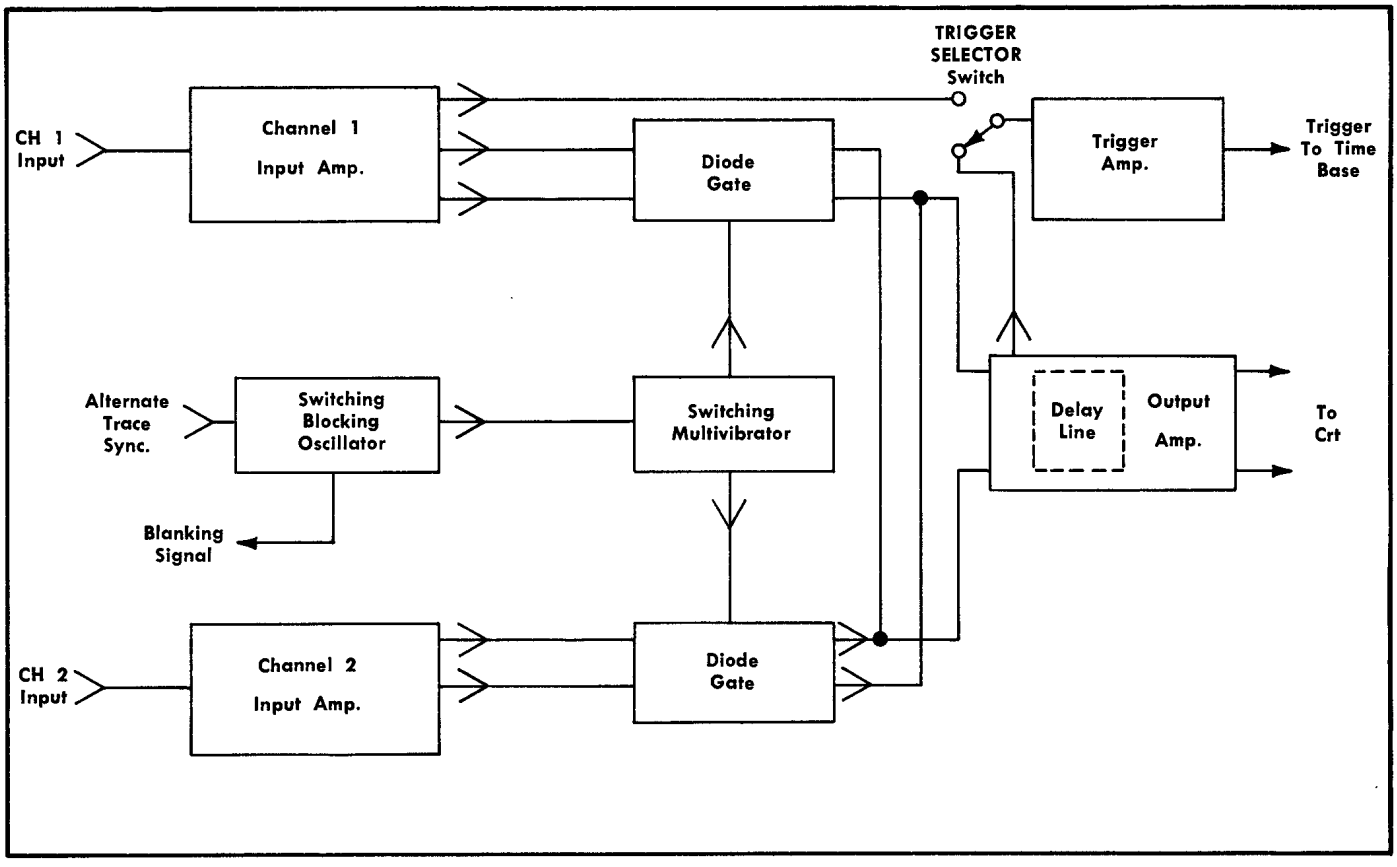


Fig. 3-1. Block diagram of Type 3A6.

Switching Circuit

The switching circuit consists of two diode gates, a switching multivibrator, a switching blocking oscillator, and a blanking emitter follower.

Each diode gate consists of two series diodes and two shunt diodes. In order that a signal can pass through the diode gates to the bases of Q304 and Q314 in the output amplifier, the series diodes must be forward biased, and the shunt diodes must be back biased.

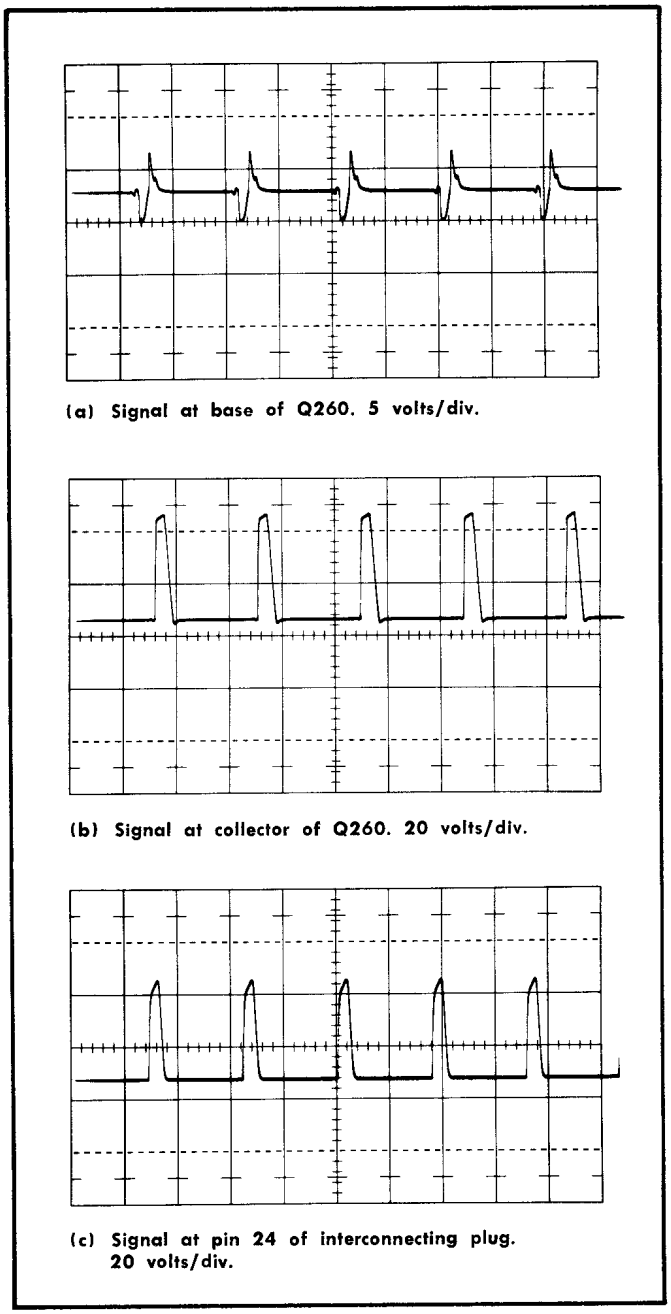
In the CH 1, CH 2, and ADDED positions of the MODE switch, the switching multivibrator is inoperative (i.e. neither transistor is conducting). In the ALTER and CHOP positions of the MODE switch, the switching multivibrator operates as a bistable multivibrator. In this case, the multivibrator is switched by the blocking oscillator. The blocking oscillator operates as either a "triggered" oscillator in the ALTER mode or an "astable" (free running) oscillator in the CHOP mode.

When the MODE switch is in the CH 1 position, collector current of Q134 and Q144 flows through the series diodes. The MODE switch SW290 reverse-biases Q285 and holds it in the "off" state. Q275 is also "off", and holds the junction of D156 and D157 at —2.1 volts. Since the dc level in the signal output from Channel 1 input amplifier is —2.3 volts, the shunt diodes are back biased. The cathodes of the Channel 2 shunt diodes, D256 and D257 are held at about —4.2 volts by Q285. D256 and D257 are conducting and hold the Channel 2 output at about —3.5 volts. Since the output of the diode gates is at about —3 volts, D255 and D258 are back biased. With D255 and D258 cut off, the Channel 2 signal is not transmitted to the output amplifier. In addition, since D256 and D257 are conducting, they form a low-impedance path for any signals coming to the diode gate from the Channel 2 input amplifier.

When the MODE switch is in the CH 2 position, the conditions of the diode gate are reversed. The Channel 2 shunt diodes D256 and D257 and the Channel 1 series diodes D155 and D158 are back biased. Therefore, the signal from the Channel 2 input amplifier passes through D255 and D258 to the output amplifier and the Channel 1 signal is blocked by D155 and D158.

When the MODE switch is in either the ALTER or CHOP positions, Q275 and Q285 operate as a bistable multivibrator. Positive pulses from the switching blocking oscillator, Q260, pass through D278 or D288 to the collector of the "off" state transistor. This pulse is transmitted by either C277 or C287 to the base of the "on" transistor, turning it "off". The collector of this "off" transistor moves toward the —12.2-volt supply, turning the other transistor "on" because of the coupling through either C277 or C287. Resistive dividers R277-R286 and R276-R287 set the levels at the transistor bases. The voltage levels allow switching action to occur when a pulse is received from the blocking oscillator.

Operation of the diode gates in ALTER and CHOP is the same as described in the CH 1 and CH 2 positions of the MODE switch. However, the multivibrator is free to switch states when it receives a trigger signal from the blocking oscillator, and thus operate the diode gates and transmit a signal to the output amplifier from Channel 1 and Channel 2 alternately. Also, in the ALTER and CHOP positions of the MODE switch, R292 is bypassed and the collector loads, R278 and R288, of the multivibrator transistors are connected to the —12.2-volt supply.



(a) Signal at base of Q260. 5 volts/div.

(b) Signal at collector of Q260. 20 volts/div.

(c) Signal at pin 24 of interconnecting plug. 20 volts/div.

Fig. 3-2. Signals in blocking oscillator circuit. Test oscilloscope ac coupled at sweep rate of 2 μsec/division.

In the CHOP and ALTER positions of the MODE switch, Q260 (switching blocking oscillator) is energized and supplies trigger pulses to the switching multivibrator. In the ALTER mode, the emitter of Q260 is connected to the —12.2-volt supply through R261. The collector is connected to the —100-volt supply through the collector winding of blocking oscillator transformer T263. When a positive pulse is fed from the time-base plug-in unit through terminal 3 of the interconnecting plug, the emitter voltage rises. The transistor conducts, drawing current through the collector winding of

blocking oscillator transformer T263, driving Q260 further into conduction. A normal blocking-oscillator cycle occurs, with the backswing cutting the transistor off. The transistor is biased so it does not turn on again until another sync pulse is received.

In the CHOP position of the MODE switch, the emitter of Q260 is connected to ground through R262. Normal free-running blocking oscillator action occurs. The base is forward biased since it is connected to the —12.2-volt supply. Therefore the blocking oscillator is automatically triggered and free runs at about a 300 kc rate. Fig. 3-2 shows the blocking oscillator waveforms with the MODE switch in the CHOP position.

The positive output pulses produced by Q260 in the ALTER or CHOP position of the MODE switch are coupled to the switching multivibrator through D263 and C271. These positive pulses forward bias diode D278 or D288 to switch the multivibrator. Q260 also provides the blanking pulse to blank out the chopping transient. The emitter follower Q263 provides a fast trailing edge on the blanking pulse. Q263 is biased into operation only during the trailing edge of the blanking pulse.

When the MODE switch is in the ADDED position, current is supplied to the output amplifier through R293 and R294, holding the series diodes in both diode gates in conduction. Since the multivibrator transistors are both near cut off, the shunt diodes are back biased and thus inoperative. The signal from both Channel 1 and 2 is allowed to pass to the Output Amplifier and algebraically add or subtract depending on their polarity.

Output Amplifier

The output of the diode gate passes to the bases of Q304 and Q314. These transistors are connected as a common-emitter push-pull amplifier. The feedback networks from collector to base of Q304 and Q314 form an amplifier with low input and output impedance. R300-C300, R303-C303, R305-C305 and R307-C307 boost the gain at high frequencies to compensate for the losses in the delay line. R308 and R318 add to the low output impedance of the amplifier and match the stage to the delay line. However, the output impedance of the stage tends to increase at high frequencies. R309 and C309 are added to the circuit to compensate for this by effectively lowering the output impedance as frequency increases.

The delay line has a characteristic impedance of about 186 Ω. Signal delay through the cable is 260 nsec. The output of the delay line is coupled to the Q324-Q334, V344A-V344B stage. Since this stage has a low input impedance, R320, R321, R330, R331, C321 and C331 are added so that the delay line is terminated in its characteristic impedance.

The T-coils in the plate circuits of V344A and V344B provide high-frequency peaking. The signal from the plates of V344A and V344B are coupled directly to the control grids of the cathode followers V363A and V363B. These cathode followers drive the transistors Q364 and Q374 which in turn drive the output tubes V384 and V394. The feedback from the output stage to the bases of Q364 and Q374 reduces the gain variation due to different tube transconductance (gm). This also increases the linear scan range of the output stage. Diodes D365 and D375 limit the voltage on the collectors of Q364-Q374 and therefore limit the dissipation of the transistors if one or the other of the output tubes (V384 or V394) cut off.

OUTPUT DC LEVEL Adjustment. This adjustment (R346) sets the operating level of the last few stages of the instrument so that the average output voltage to the deflection plates of the crt is +190 volts.

CALIB Adjustment. This adjustment (R389) adjusts the gain of the last stage by changing the cathode degeneration of V384 and V394. This permits the gain of the plug-in unit to be matched to the deflection factor of the indicator unit cathode-ray tube.

Trigger Amplifiers

The Type 3A6 contains a trigger amplifier to supply an internal trigger pulse to the time-base circuitry. The TRIGGER switch selects the triggering signal from either of two similar trigger pickoff amplifiers: Q164-Q174 in Channel 1 or Q404-Q414 in the Output Amplifier. Each of these trigger pickoff amplifiers is an emitter-coupled difference amplifier with double-ended input and single-ended output. The triggering signal from either pickoff amplifier circuit is obtained prior to signal delay. This allows the internal trigger signal to trigger the time-base circuitry before the vertical signal reaches the crt deflection plates.

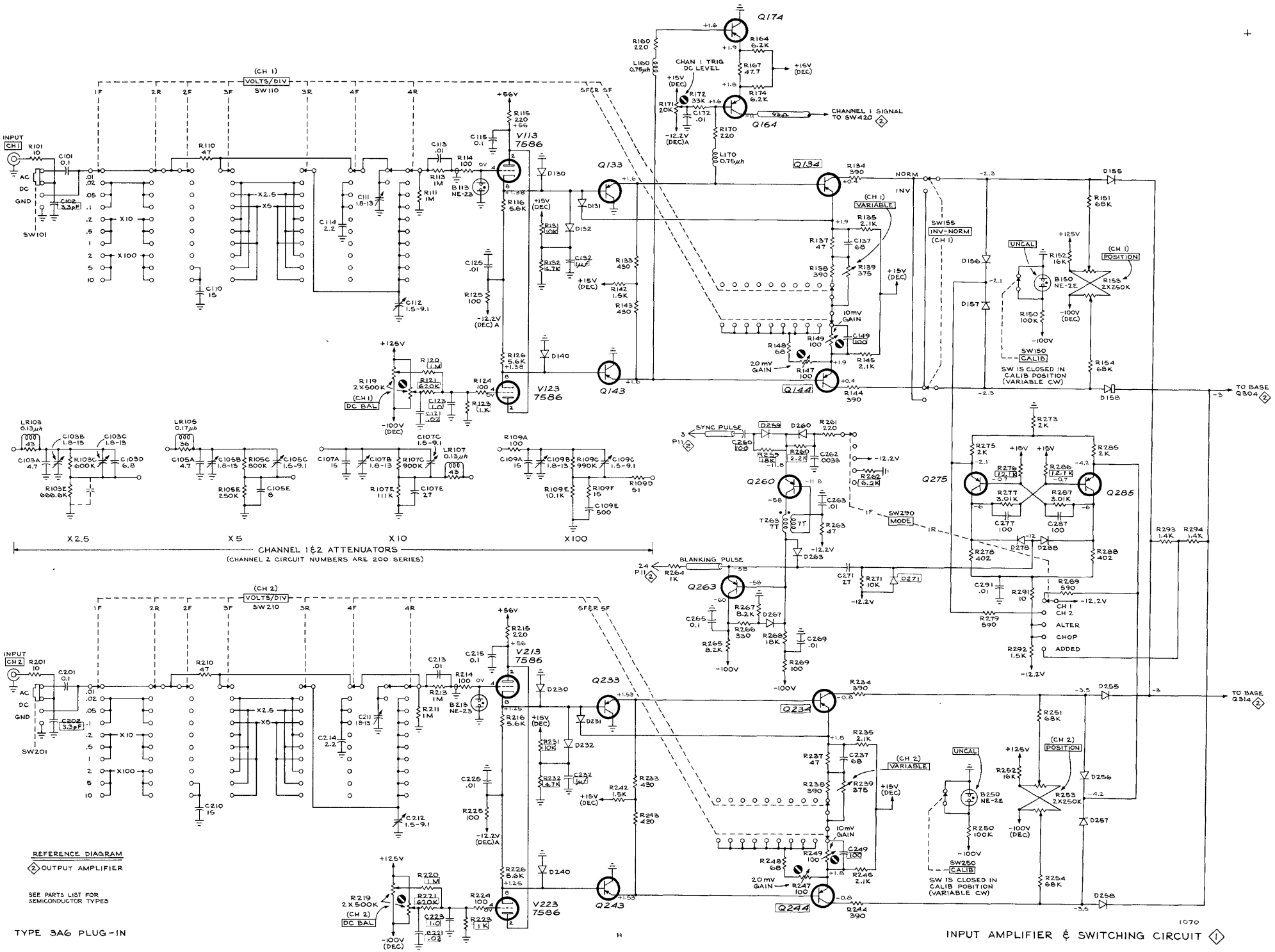
The Channel 1 trigger signal is obtained from the Q133-Q143 stage. The CHAN 1 TRIG DC LEVEL control R171 provides a means of adjusting the dc level of the Channel 1 trigger signal.

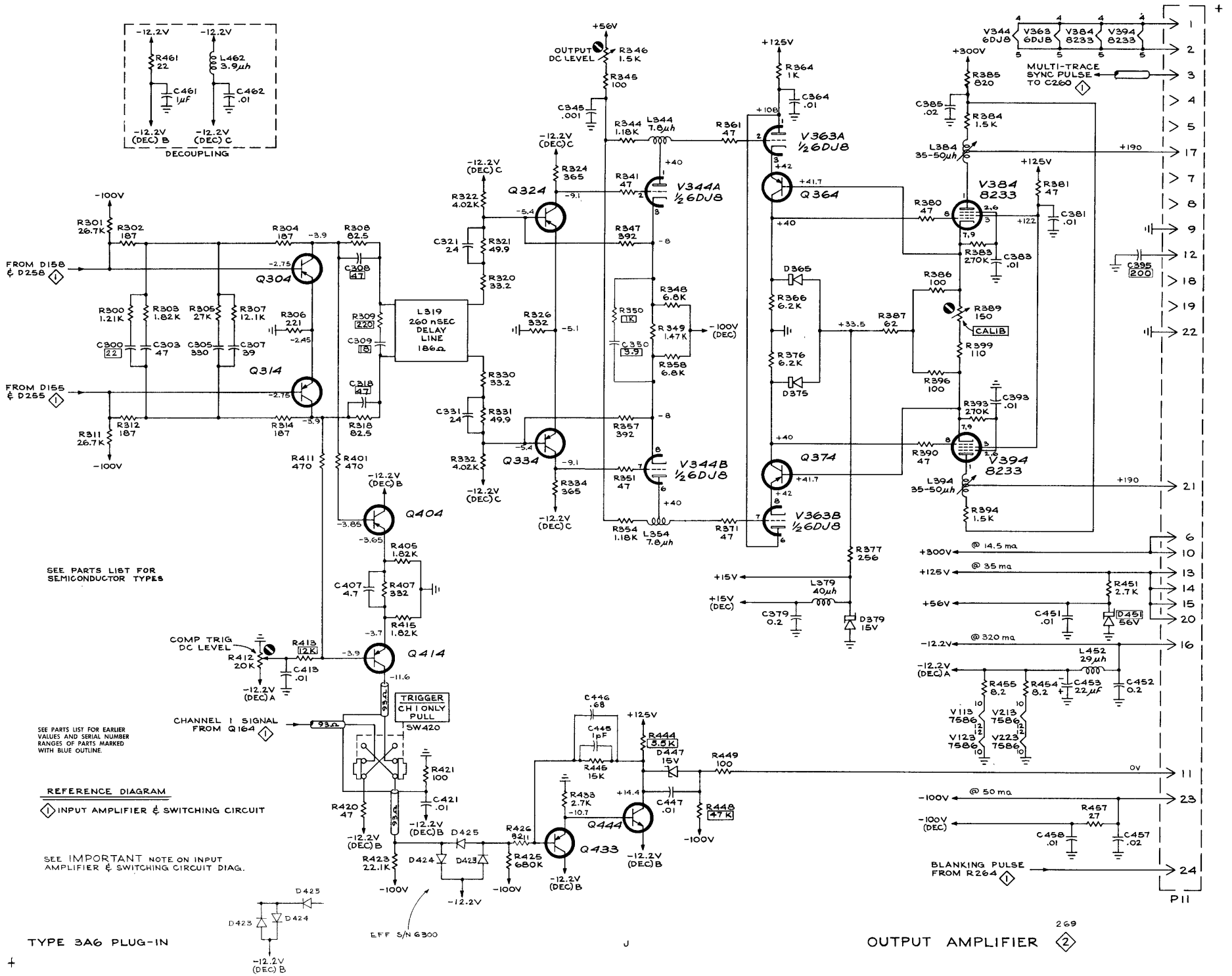
The composite trigger signal is obtained from the Q304-Q314 stage. The COMP TRIG DC LEVEL control R412 provides a means of adjusting the dc level of the composite trigger signal. The dc level of the composite trigger signal is affected by the setting of the POSITION controls. Therefore, the COMP TRIG DC LEVEL adjustment is set with the POSITION controls at midrange.

The TRIGGER switch SW420 selects the triggering signal from the output of either Q164 (Channel 1 only) or Q414 (composite). The output of the unused trigger pickoff amplifier is connected to the —12.2 supply through R420.

The trigger output amplifier is a low input impedance amplifier having a transimpedance of 15 k (Δ3 volt output ÷ Δ.2 milliamp input). D425 prevents Q444 from saturating by limiting the positive input signal. D424 provides a path to the —12.2 supply when D425 limits the positive input signal. Diode D423 limits the negative voltage excursion of the input and prevents overshoot when a large trigger signal is present.

The Zener diode D447 drops the voltage level of the trigger amplifier output signal about 15 volts so that the output to pin 11 of the interconnecting plug is nominally zero volts with a no-signal trace positioned to crt center.


(CH 1)
VOLTS/DIV
SW110
1F
2R
2F
3F
3R
4F
4R
5F&R
5F
INPUT
CH 1
AC
DC
GND
SW101
X10
X100
X2.5
X5
V113
7586
V123
7586
Q133
Q143
Q134
Q144
Q174
Q164
CHAN 1 TRIG DC LEVEL
CHANNEL 1 SIGNAL TO SW420
(CH 1) VARIABLE
10mV GAIN
20 mV GAIN
SW155
INV-NORM
(CH 1)
NORM
INV
UNCAL
(CH 1) POSITION
B150 NE-2E
SW150
CALIB
SW IS CLOSED IN CALIB POSITION (VARIABLE CW)
(CH 1) DC BAL
TO BASE Q304
LR103 0.13μh
LR106 0.17μh
LR107 0.13μh
X2.5
X5
X10
X100
CHANNEL 1&2 ATTENUATORS
(CHANNEL 2 CIRCUIT NUMBERS ARE 200 SERIES)
SYNC PULSE
BLANKING PULSE
Q260
Q263
Q275
Q285
SW290
MODE
CH 1
CH 2
ALTER
CHOP
ADDED
(CH 2)
VOLTS/DIV
SW210
INPUT
CH 2
SW201
V213
7586
V223
7586
Q233
Q243
Q234
Q244
(CH 2) VARIABLE
(CH 2) POSITION
B250 NE-2E
SW250
CALIB
SW IS CLOSED IN CALIB POSITION (VARIABLE CW)
(CH 2) DC BAL
TO BASE Q314
REFERENCE DIAGRAM
2 OUTPUT AMPLIFIER
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
TYPE 3A6 PLUG-IN
1070
INPUT AMPLIFIER & SWITCHING CIRCUIT 1


DECOUPLING
-12.2V
R461 22
C461 1μF
L462 3.9μh
C462 .01
-12.2V (DEC) B
-12.2V (DEC) C
OUTPUT DC LEVEL
R346 1.5K
R345 100
C345 .001
+56V
R344 1.18K
L344 7.8μh
R324 365
Q324
R322 4.02K
C321 24
R321 49.9
R320 33.2
R326 332
R330 33.2
C331 24
R331 49.9
R332 4.02K
Q334
R334 365
R341 47
V344A ½6DJ8
R347 392
R348 6.8K
R350 1K
C350 3.9
R349 1.47K
R358 6.8K
R357 392
R351 47
V344B ½6DJ8
R354 1.18K
L354 7.8μh
R371 47
+125V
R364 1K
C364 .01
V363A ½6DJ8
Q364
R361 47
V363B ½6DJ8
Q374
R377 256
L379 40μh
C379 0.2
D379 15V
+15V
+15V (DEC)
-100V (DEC)
L319 260 nSEC DELAY LINE 186Ω
FROM D158 & D258
FROM D155 & D255
-100V
R301 26.7K
R302 187
R304 187
R308 82.5
C308 47
Q304
R300 1.21K
R303 1.82K
R305 27K
R307 12.1K
R306 221
C300 22
C303 47
C305 330
C307 39
Q314
R309 220
C309 8
C318 47
R318 82.5
R312 187
R311 26.7K
R314 187
R411 470
R401 470
Q404
R405 1.82K
C407 4.7
R407 332
R415 1.82K
COMP TRIG DC LEVEL
R412 20K
R413 12K
C413 .01
Q414
-12.2V (DEC) A
-12.2V (DEC) B
-12.2V (DEC) C
TRIGGER CH 1 ONLY PULL SW420
CHANNEL 1 SIGNAL FROM Q164
93Ω
R421 100
C421 .01
R420 47
R423 22.1K
D424
D423
D425
R426 821
R425 680K
Q433
C446 .68
C445 1pF
R445 15K
R444 5.5K
D447 15V
R433 2.7K
Q444
C447 .01
R448 47K
R449 100
-100V
+14.4
-10.7
V344 6DJ8
V363 6DJ8
V384 8233
V394 8233
+300V
R385 820
C385 .02
R384 1.5K
L384 35-50μh
R381 47
C381 .01
R380 47
R383 270K
C383 .01
C395 200
D365
R366 6.2K
R376 6.2K
D375
R386 100
R389 150
CALIB
R387 62
R399 110
R396 100
C393 .01
R393 270K
R390 47
L394 35-50μh
R394 1.5K
MULTI-TRACE SYNC PULSE TO C260
+190
+122
+33.5
+108
+41.7
+42
+40
+300V @ 14.5 ma
+125V @ 35 ma
+56V
R451 2.7K
C451 .01
D451 56V
-12.2V @ 320 ma
L452 29μh
C452 0.2
C453 22μf
R455 8.2
R454 8.2
V113 7586
V213 7586
V123 7586
V223 7586
0V
-100V @ 50 ma
R457 27
C457 .02
C458 .01
BLANKING PULSE FROM R264
P11
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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23
24
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.
REFERENCE DIAGRAM
① INPUT AMPLIFIER & SWITCHING CIRCUIT
SEE IMPORTANT NOTE ON INPUT AMPLIFIER & SWITCHING CIRCUIT DIAG.
EFF S/N 6300