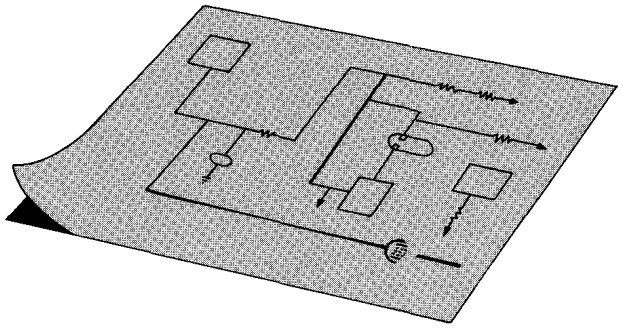
INSTRUCTION MANUAL

Serial Number _____

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

070-358


TYPE 180A TIME-MARK GENERATOR
SERIAL
CANCEL
SINE WAVE
50 MC
10 MC
5 MC
MICROSECONDS
1
5
10
50
100
MARKER OUT
MILLISECONDS
500 µS
1
5
10
50
100
500
SECONDS
1
5
TRIGGER RATE
100 KC 10 µS
10 KC 100 µS
1 KC 1 MS
100 ~ 10 MS
10 ~ 100 MS
1 ~ 1 SEC
TRIGGER OUT
CRYSTAL HEATER
POWER ON
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.



SECTION 1

CHARACTERISTICS

General

The Tektronix Type 180A Time-Mark Generator is a portable laboratory instrument designed to provide accurate time marks, trigger pulses, and sine-wave outputs. The Type 180A may be used in any application where accurate measurement of short time intervals is necessary.

Output Characteristics

Microsecond markers at intervals of 1, 5, 10, 50, 100 and 500 microseconds.

Millisecond markers at intervals of 1, 5, 10, 50, 100 and 500 milliseconds.

One-second and five-second interval markers. Sine-waves of 5 mc, 10 mc, and 50 mc. Trigger pulses at rates of 1 cps, 10 cps, and 100 cps, 1 kc, 10 kc and 100 kc.

The markers are available individually at banana jacks on the front panel and at a front panel connector labeled MARKER OUT. The individual push-button switches connect the markers to a common bus, so that any or all of the markers can be made available simultaneously at the output. Push-button switches are also provided to connect any one of the three sine-wave outputs to the MARKER OUT connector. Only one sine-wave can be used at a time.

Trigger pulses are available at the TRIGGER OUT connector on the front panel of the Type 180A. The trigger pulses are also selected by the operation of a push-button switch.

TABLE 1-1
For Type 180A, S/N 5479 and up
NOMINAL VOLTAGE, IMPEDANCE, AND RISETIME VALUES

	Open Circuit Voltage	Impedance (at half-voltage)	*Risetime	Open Circuit Voltage	Impedance
Markers	3 volt minimum	390 Ω or less	varies from 0.07 μsec at 1 μsec to 1.7 μsec at 5 seconds	25 volts minimum using 10X probe	390 Ω at 1 μsec to 680 Ω at 5 seconds
Trigger Pulses	6 volt minimum 8 volt maximum	56 Ω or less	0.08 μsec at 10 μsec to 0.30 μsec at 1 sec		
Sine Waves	3 volt minimum peak-to-peak across 50-ohms				

*With marker out and trigger out terminated in 93 ohms.

TABLE 1-1 S/N 5001-5478
NOMINAL VOLTAGE, IMPEDANCE AND RISETIME VALUES

	Open Circuit Voltage using 10X Probe	Impedance (at half voltage)	*Risetime	Open Circuit Voltage using 10X Probe	Impedance
Time Markers	1.5 V Min.	390 Ω or less	varies from 0.07 μsec at 1 μsec to 1.7 μsec at 5 sec	8 V Min.	390 Ω at 1 μsec to 680 Ω at 5 sec.
Trigger Pulses	2.0 V Min.	56 Ω or less	0.08 μsec at 10 μsec to 0.3 μsec at 1 sec.		
Sine Waves Using 50 Ω Terminator	5 & 10 MC—2.5 V 50 MC—1.5 V				

Other Characteristics

Crystal Oscillator

Frequency—1 mc ±10 cps. May be accurately set for 1 mc. Stability—within 3 parts per million in 24 hours.

Power Requirements

117 or 234 V Nominal Line Voltage

50 to 60 cps, 240 watts.

Mechanical Specifications

Ventilation—filtered, forced air.

Finish—photoetched, anodized panel. Blue vinyl, perforated cabinet.

Dimensions—13½" high, 9¾" wide, 17" depth.

Weight—31 pounds.

Accessories

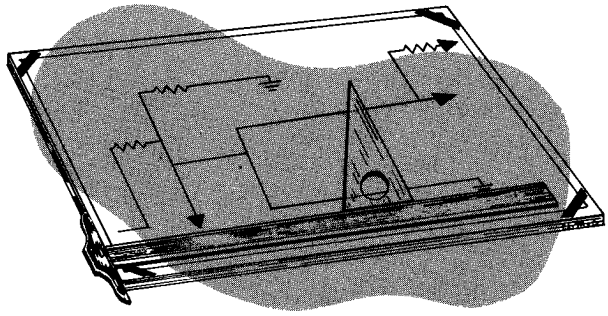
2—93 Ω Cables, BNC both ends, 012-075

1—Clip lead adapter, BNC 013-076

1—3- to 2-Wire adapter, 103-013

1—3-Conductor power cord, 161-010

2—Instruction Manuals, 070-358



SECTION 3

CIRCUIT DESCRIPTION

Block Diagram

In the Type 180A, time-marker and sine-wave outputs are derived from a one-megacycle oscillator. The time-marker signals are available individually at banana-jack connectors or in combination at a coaxial connector. The sine-wave signals are available individually at the coaxial connector. In addition, a triggering signal is available at another coaxial connector. The manner in which the circuits are functionally arranged to achieve these ends is shown in Figure 3-1.

The oscillator is an electron-coupled, crystal-controlled oscillator. Its output signal is coupled to the 1-μsec Amplifier and Cathode Follower and to the Isolating CF. To insure long-term stability, the crystal is housed in a temperature-controlled oven.

In the 1-μsec Amp and CF stage, the signal is amplified for coupling to the front-panel 1-μsec banana jack and push-button switch. The output from this stage is also connected to the input of the 5-mc Multiplier.

In the 5-mc Multiplier, the 1-μsec time markers drive an rf amplifier tuned to 5 megacycles. The resulting 5-mc sine-wave output is coupled to the input of the 10-mc Multiplier, which in turn, drives the 50-mc Multiplier. The 10-mc and 50-mc Multipliers, like the 5-mc Multiplier, are rf amplifiers tuned to the desired output frequency. The sine-wave outputs from all three multipliers are connected to the associated pushbuttons. The pushbuttons are mechanically linked so that only one of the sine-wave signals can be selected at a time. The signal so selected is connected through the pushbutton switches to the MARKER OUT coaxial connector.

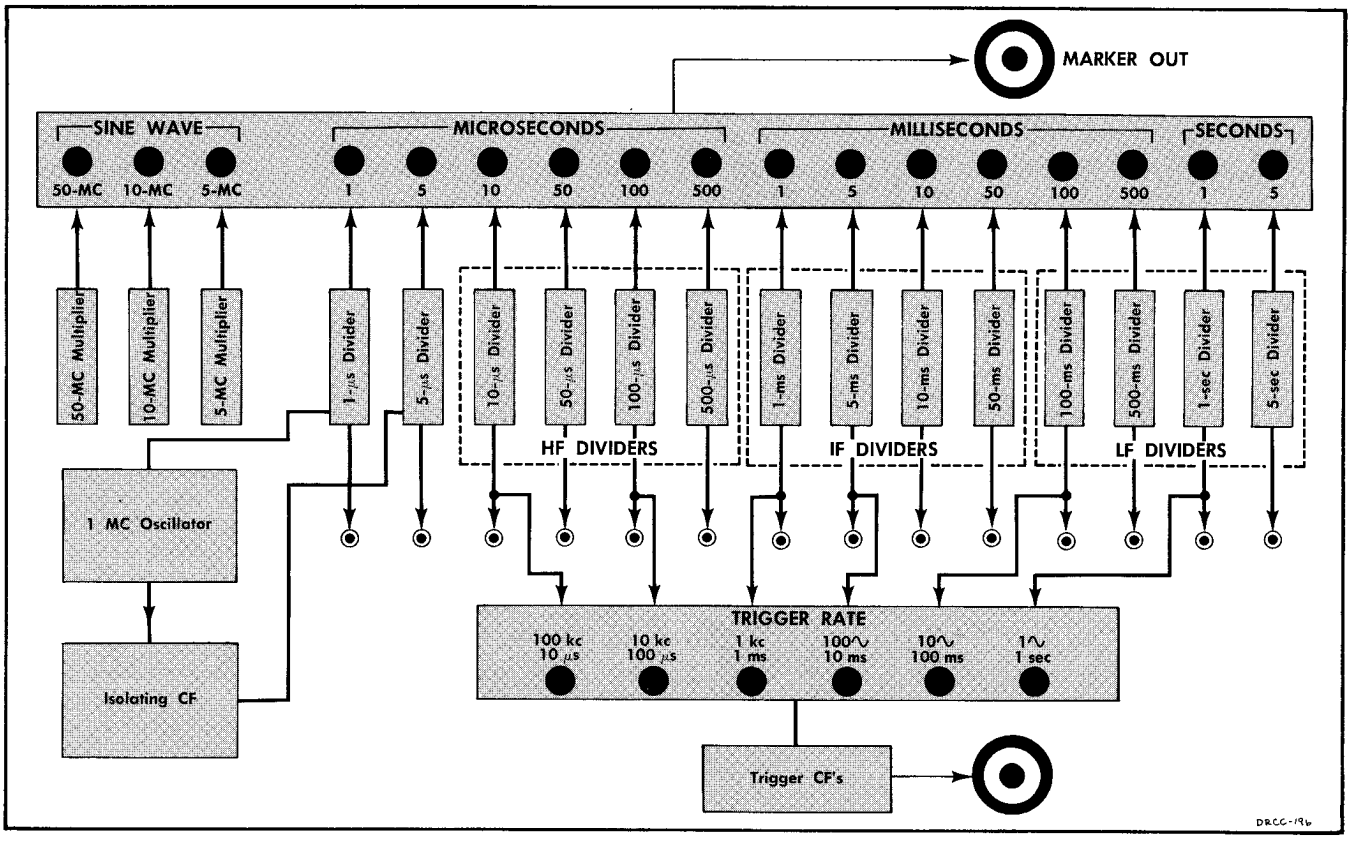


Fig. 3-1 Type 180A functional block diagram.

The oscillator signal connected to the Isolating CF drives the 5-μsec Divider. In this circuit, one output pulse is produced for every five input pulses. Since the input signal consists of 1-microsecond pulses, one output pulse will occur every 5 microseconds. The 5-μsec markers are coupled to the pushbutton switches and banana jacks for external use, and are also connected to the input of the 10-microsecond divider. The 10-μsec divider produces one output pulse for every two input pulses. Hence with 5-μsec markers at the input, the output markers will be spaced 10-microseconds apart.

All of the other dividers are similar to the 5-μsec or 10-μsec divider. They produce one output pulse for every five or every two input pulses. In this manner, the original 1-microsecond time-marker signal is accurately "counted down" to as low as 5 seconds.

The output signals from all of the dividers are connected to an associated banana jack and pushbutton. The pushbuttons are mechanically linked so that any number may be depressed at one time. A cancel button (not shown in Fig. 3-1) is provided to mechanically release all of the depressed buttons.

The signals at the 10-μsec, 100-μsec, 1-msec, 10-msec, 100-msec, and 1-sec banana jacks are also connected to the TRIGGER RATE pushbuttons. Here, any one of the signals may be selected for connection to the TRIGGER OUT connector. The signals are coupled to the coaxial connector through two cathode-followers.

OSCILLATOR AND AMPLIFIER

Oscillator

Circuit details for the oscillator appear on the OSCILLATOR AND MULTIPLIER schematic diagram. The oscillator, V100B, operates as a conventional electron-coupled, crystal-controlled oscillator. The crystal is contained in a temperature-controlled oven. A front-panel lamp, B101, is connected in parallel with the heating element to indicate operation of the thermostat. A variable capacitor, C105, is connected in parallel with the crystal to permit slight adjustments of the crystal resonant frequency.

The output waveform at the plate of V100B is capacitively coupled to the grid of the 1-μsec Amplifier, V104B, and direct coupled to the Isolating Cathode Follower, V100A. The rc network, R103-C103, increases the risetime of the pulse at the grid of V104A (in comparison to the pulse at the grid of V100A) to insure the coincidence of the 1- and 5-μsec markers.

1-μsec Amplifier

The 1-μsec Amplifier is a conventional voltage amplifier with high-frequency peaking in the plate circuit. The gain of the stage is about 2.5. The inductor, L107, serves to improve the risetime of the output waveform.

1-μsec Output CF

The 1-μsec Output CF, V104A, is biased below cutoff through divider R114-R115. This insures that only the fast-rising positive pulses reach the output. The network consisting of C116 and R116 differentiates the rectangular pulses from the plate of V104B, causing sharp, positive-going pulses to appear at the grid of V104A. These pulses appear at the cathode of V104A as 1-μsec time markers. From here, they are coupled to the output switching circuits and to the 5-mc Multiplier.

SINE-WAVE MULTIPLIERS

5-Mc Multiplier

The 5-mc Multiplier, V124, is a conventional grid-leak biased, Class-C amplifier, plate-tuned to 5 megacycles. The exciting 1-μsec (1-megacycle) pulses cause the plate tank circuit to resonate at 5 megacycles. The 5-mc sine-wave is link-coupled from the output tank circuit and fed to the output switch. Plate voltage for the stage is also controlled by the output switch. The switching arrangement is such that V124 will operate only when the 5-, 10- or 50-mc pushbutton is actuated.

10-MC Multiplier

V134 acts as a frequency doubler. The primary and secondary of the rf transformer in the plate circuit of V134 are both tuned to 10 mc. The 10-mc output signal is link-coupled to the output switch, and plate voltage for the stage is also coupled through the output switch. The switching arrangement is such that the stage operates only when the 10- or 50-mc pushbutton is selected.

50-MC Multiplier

The 50-Mc Multiplier, V144, operates as a frequency quintupler. The primary and secondary of the transformer in its plate circuit are tuned to 50 mc. The plate voltage of this stage is turned on only when the 50-mc pushbutton is depressed.

TIME-MARKER DIVIDERS

Basic Multivibrator

There are 13 frequency dividers in the Type 180A, producing thirteen of the fourteen output time markers. (The fourteenth time marker is the original time marker derived from the one-megacycle oscillator output.) The operation of all thirteen dividers is essentially the same. In general, a divider consists of a bistable multivibrator, with diode coupling for triggering pulses, and two cathode-follower output stages. The operation of the 5-μsec multivibrator is described below. The circuit notation of Figure 3-2 is used for simplification.

In the quiescent state, V2 is held in conduction by the grid-clamping action of V4 and V1 is blocked out of conduction by the fixed grid bias. The plates of V1 and V3 rest at about +225 volts. The cathode of V3 is normally at about +225 volts in the absence of a triggering pulse.

The multivibrator is triggered into its unstable state by a negative-going 50-volt pulse at the cathode of V3. The pulse drives the cathode more negative than the plate, per-

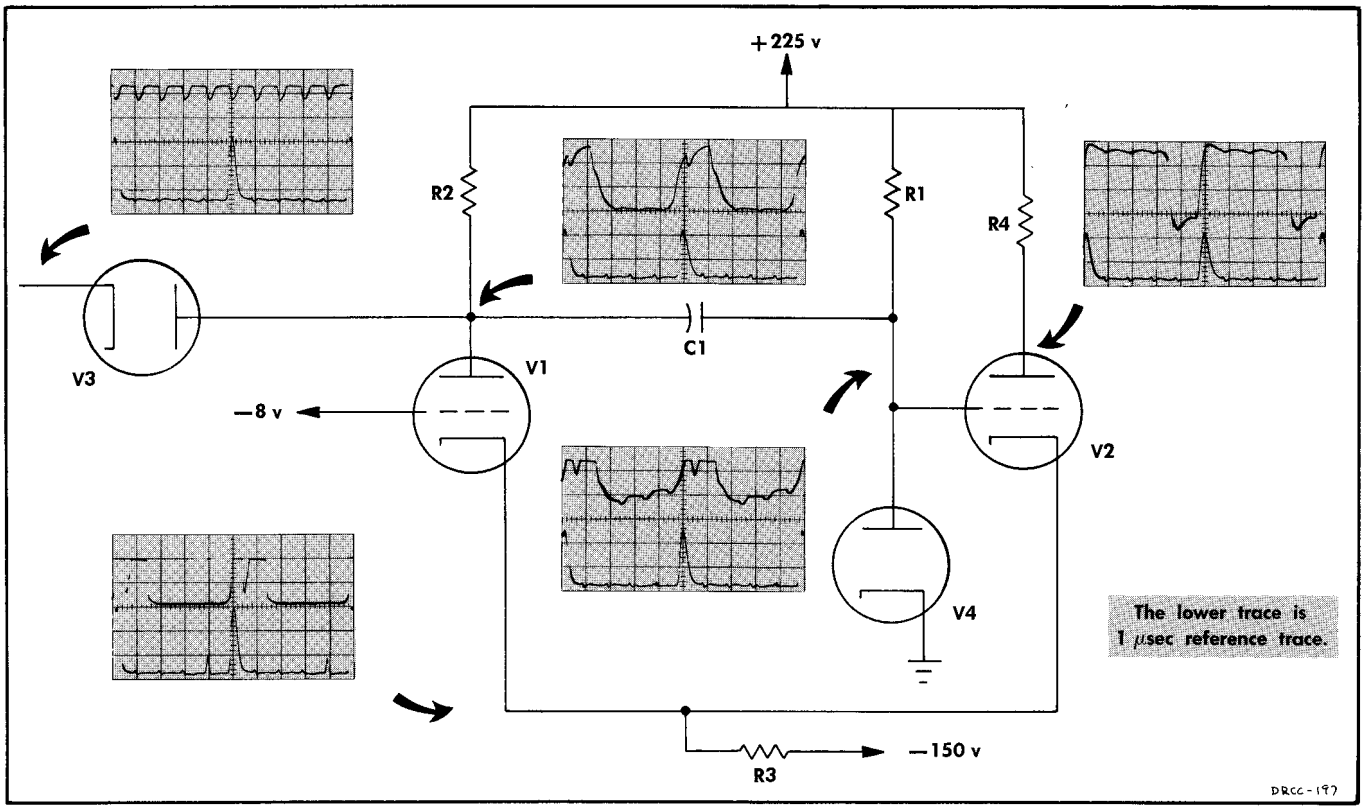


Fig. 3-2 Basic 5-μsec. multivibrator. Circuit numbers have been changed for simplification.

mitting the tube to conduct. As the tube conducts, the pulse is coupled to the grid of V2 through capacitor C1. The negative pulse breaks the clamping action of V4, driving the grid of V2 negative and causing V2 cathode current to decrease. The decreasing cathode current through R3 causes the cathode voltage of V1 to drop also. As the cathode voltage of V1 approaches the fixed bias voltage, V1 starts to conduct, causing a further decrease in the voltage at the plate. This negative-going voltage is coupled to the grid of V2 through C1, reinforcing the switching action.

The plate voltage of V1 drops to approximately 175 volts. With the plate of V3 at 175 volts and the cathode at 225 volts, subsequent trigger pulses cannot reach the grid of V2. As the charge on C1 equalizes, the grid voltage of V2 becomes more positive until the clamping action of V4 is restored and V2 begins to conduct. As V2 goes into conduction, the resulting rise in cathode voltage causes V1 to cut off. As the plate voltage of V1 rises, C1 is charged through R2. In the absence of trigger pulses, this would mark the return of the multivibrator to its stable state. The values of R1, R2 and C1 have been selected to provide a lapsed time of approximately 5 microseconds from the time of triggering to the return to the stable state.

As the multivibrator returns to its stable state, the plate of V3 becomes more positive than the cathode, permitting the next trigger pulse to be coupled to the grid of V2.

Isolating CF

The 1-megacycle waveform at the plate of the oscillator, V100B, is coupled to the 5-μsec Divider through cathode follower V100A. The function of the cathode follower is to isolate the loading effects of the multivibrator triggering circuit from the oscillator.

5 μsec Divider

The operation of the 5 μsec Multivibrator is described in previous paragraphs. Referring to the OSCILLATOR and MULTIPLIER diagram, the 5-μsec adjustment (R168) determines the charging rate of C167, and hence the elapsed time for one cycle of operation. LR171 in the plate circuit of V165B improves the high-frequency response of the circuit and thereby the leading edge of the output waveform.

The waveform at the plate of V165A is coupled to the 10-μsec Divider through the Isolating CF, V173B. The purpose of this cathode follower is to prevent signals generated in the 10-μsec Divider from being coupled back into the 5-μsec divider.

The output waveform at the plate of V165B is differentiated by C177 and R177, and then coupled to the push-button circuits through the OUTPUT CF. Notice that the grid of V173A is biased at −17 volts. Operating the stage in this manner insures that only the fast-rising parts of the multivibrator waveform are coupled to the output.

10 μsec Divider

The circuit configuration and operation of the 10-μsec Divider is essentially the same as the 5-μsec Divider with one exception. Instead of producing one output pulse for every five input pulses, the 10-μsec Divider produces one

output pulse for every two input pulses. This is brought about by the proper selection of circuit time constants.

Other Dividers

All of the dividers in the Type 180A perform in the same manner as the 5-μsec or 10-μsec divider. In each divider, time constants have been selected to provide the appropriate duty cycle. Notice that the last divider, the 5-sec Divider, does not have an Isolating CF. This, of course, is because there is no need for a 5-μsec triggering pulse.

EXTERNAL TRIGGERING

Switching

The manner in which all of the dividers and multiplier output signals are connected to the output terminals is shown on the TRIGGER CF & SWITCHING diagram. Notice that all of the divider Output CFs are connected directly to the banana jacks. Switch connections to the MARKER OUT connector are made through an isolating resistor.

To provide an external triggering signal, switching connections are made directly to the 10-μsec, 100-μsec, 1-ms, 100-ms or 1-second banana jacks. These signals are selected by a pushbutton switch in which only one button may be locked in the depressed position. The selected signal is fed to the input of the first TRIGGER CF, and is available at the TRIGGER OUT terminal.

Trigger CFs

The output signal from the first cathode follower is capacity coupled to the grid of the second CF. The dc level of a time-marker signal coupled in this fashion is a function of the signal repetition rate. To avoid wide excursions in the output-signal dc level, a grid-clamping diode is included in the grid circuit of V553B.

Under no-signal conditions, the diode and its associated voltage divider, R560-R561, maintain the grid voltage at approximately —8 volts. Upon the arrival of a positive-going time-marker pulse, the diode ceases to conduct, permitting the grid, and hence the cathode, to follow the signal excursion. At the completion of the pulse, the diode again clamps the grid at about — 8 volts. This is true regardless of the pulse repetition rate.

With the grid of V553B always clamped at about —8 volts between pulses, the output pulses at the TRIGGER OUT connector will always start at about 6.5 volts. Their amplitude will depend upon the amplitude of the input signal at the grid of V553A.

POWER SUPPLY

Transformers

Plate and filament power for the tubes in the Type 180A is furnished by a single power transformer, T701. The primary has two equal tapped windings; these may be connected in parallel for 105- to 125-volt operation, or in series for 210- to 250-volt operation. Silicon rectifiers are employed for the three separate full-wave, bridge-type, power supplies. The three supplies furnish regulated dc voltages of —150 volts, +225 volts and +350 volts. In addition, —8 volts bias is taken from the —150 volt supply through a voltage divider, and —17 volts bias is taken from the cathode of V433.

A separate transformer, T702, is provided to supply 6.3 volts for the crystal-oven heater. Notice that the primary connections bypass the power switch. This arrangement insures constant crystal-oven temperature even though the power switch may be turned off.

A thermal cut-out is provided in the primary of T701 to open the circuit should the Type 180A internal temperature rise too high. The device is set to open at 137-degrees Fahrenheit. If the cut-out opens, the crystal-oven will operate but the fan and other circuits will not operate. Then, when the internal temperature drops below 137-degrees, the cutout will close, restoring power to the other circuits.

—150 Volt Supply

Reference voltage for the —150-volt supply is established by a gas diode Voltage-Reference Tube V749. This tube, which has a constant voltage drop, establishes a fixed potential of about —84 volts at the grid of V744B, one-half of a Difference Amplifier. The grid potential for the other half of the Difference Amplifier V744A, is obtained from a voltage divider consisting of R742, R743, and R744. R743, the —150 Adj. control, determines the percentage of total voltage that appears at the grid of V744A and thus determines the total voltage across the divider. When this control is properly adjusted, the output voltage is exactly —150 volts.

Should the loading on the supply tend to change the output voltage, the potential at the grid of V744A will change in proportion, and an error voltage will exist between the two grids of the Difference Amplifier. The error signal is amplified by V744B, whose plate is dc-coupled to the grids of the Series Tubes V757 and V767. The error voltage appearing at the grids of the Series Tubes will change the voltage drop across the tubes and hence change the voltage at the plates of the tubes. This change in voltage at the plates of the Series Tubes, which will be in a direction to compensate for the change in the output voltage, is coupled through the rectifiers and C741 to the output and thus returns the output voltage back to its established value of —150 volts. C744 improves the ac gain of the feedback loop, and thus increases the response of the circuit to sudden changes in output voltage.

+225-Volt Supply

The —150-volt supply serves as a reference for the +225 volt supply. The voltage divider R736-R737 establishes a voltage of essentially zero at the grid of the Amplifier V724. (The actual voltage at this grid will be equal to the bias voltage required by the tube.) If the loading should tend to change the output voltage, an error voltage will appear at the grid of the Amplifier. The error voltage will be amplified and will appear at the grid of the Series Tube V707A. The cathode of V707A will follow the grid, and thus the output voltage will be returned to its established value of +225 volts. C736 improves the response of the regulator circuit to sudden changes in output voltage.

A small sample of the unregulated-bus ripple will appear at the screen of V724 through R724. This ripple signal appearing at the screen (which acts as an injector grid) will produce a ripple component at the grid of V707A which will be opposite in polarity to the ripple appearing at the plate of V707A. This tends to cancel the ripple at the cathode of V707A, and hence reduces the ripple on the +225-volt bus. This same circuit also improves the regulation of the circuit in the presence of line-voltage variation.

+350-Volt Supply

The +350-volt supply functions in the same manner as the +225-volt supply. Rectified voltage from terminals 9 and 16 of the power transformer is added to the voltage supplying the +225-volt regulator to supply power for the +350-volt regulator.

Bias-Voltage Supply

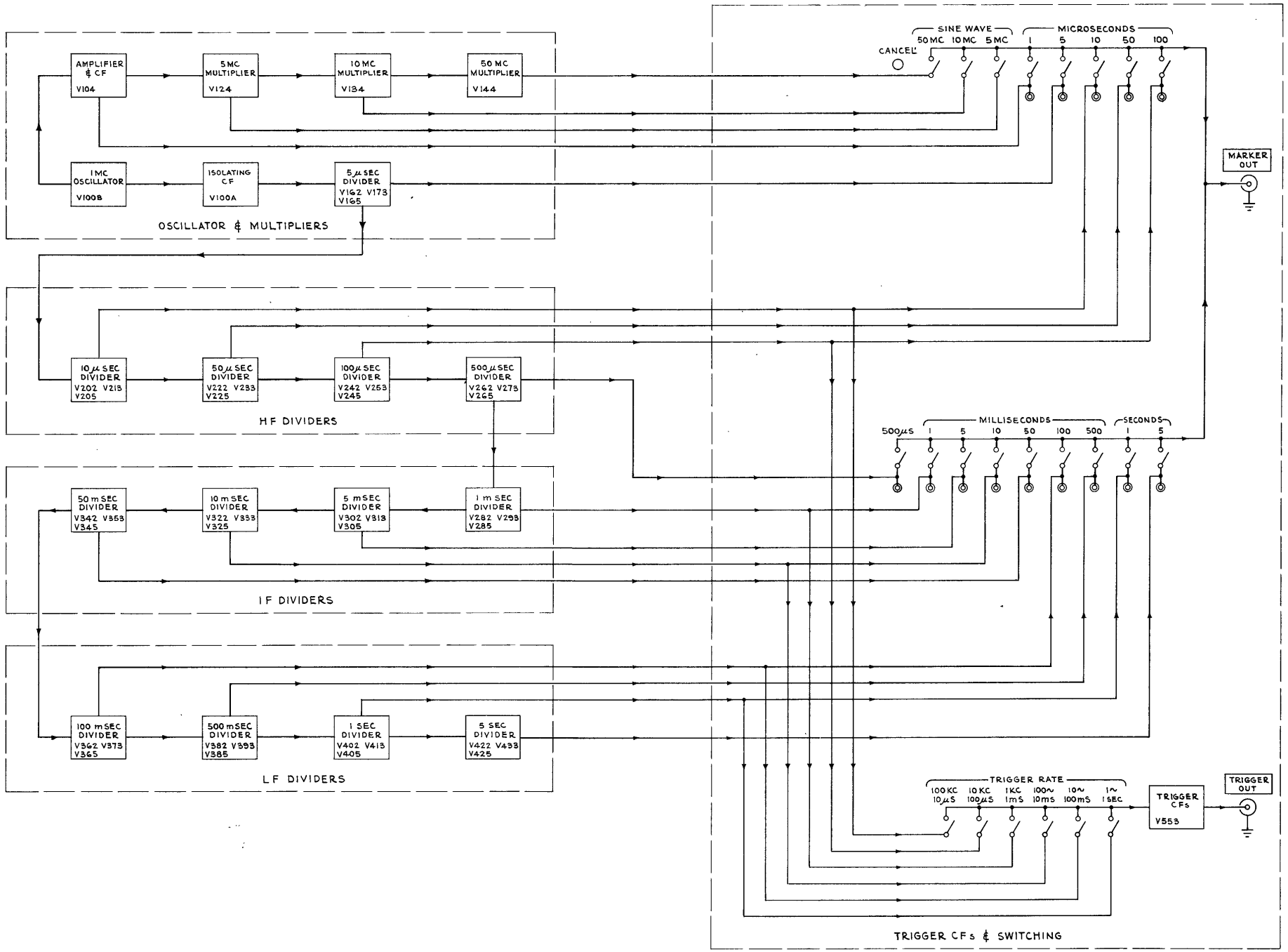
The two bias supply voltages are drawn from separate sources. The —17-volt supply is drawn from the cathode of V433B. C770, connected between the —17-volt supply and ground aids in filtering the output of the supply.

The —8 volts supply is drawn from the R774-R776 divider which is connected across the output of the —150-volt supply.

Color Coding

The power supply circuits can be checked at any point in the instrument by following the color coding of the wires. This coding follows the standard RMA system. Negative voltages from the supply are carried in wires with a black base color while white wires are used for positive voltages. For example, —150 is found on black with a brown and a green tracer stripe while +225 will be found on white with two red tracers. (The last figure is not indicated). The +350 volts will be found on white with an orange and a green tracer.

The bias voltages do not follow the coding system, however. The —8 volt bias will be found on white with a black tracer, and —17 volts will be found on white with grey tracer.



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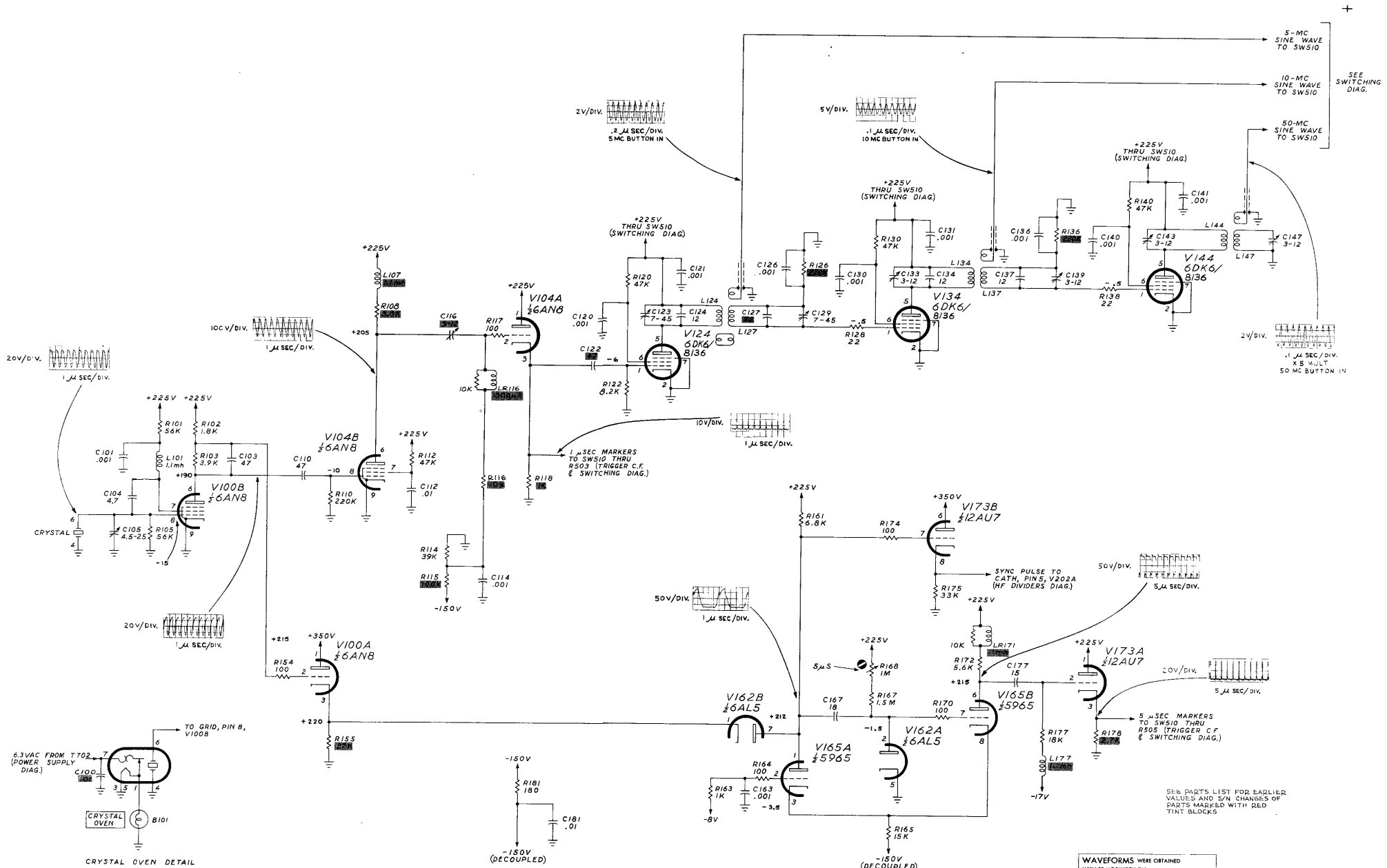
TYPE 180A TIME-MARK GENERATOR

AA

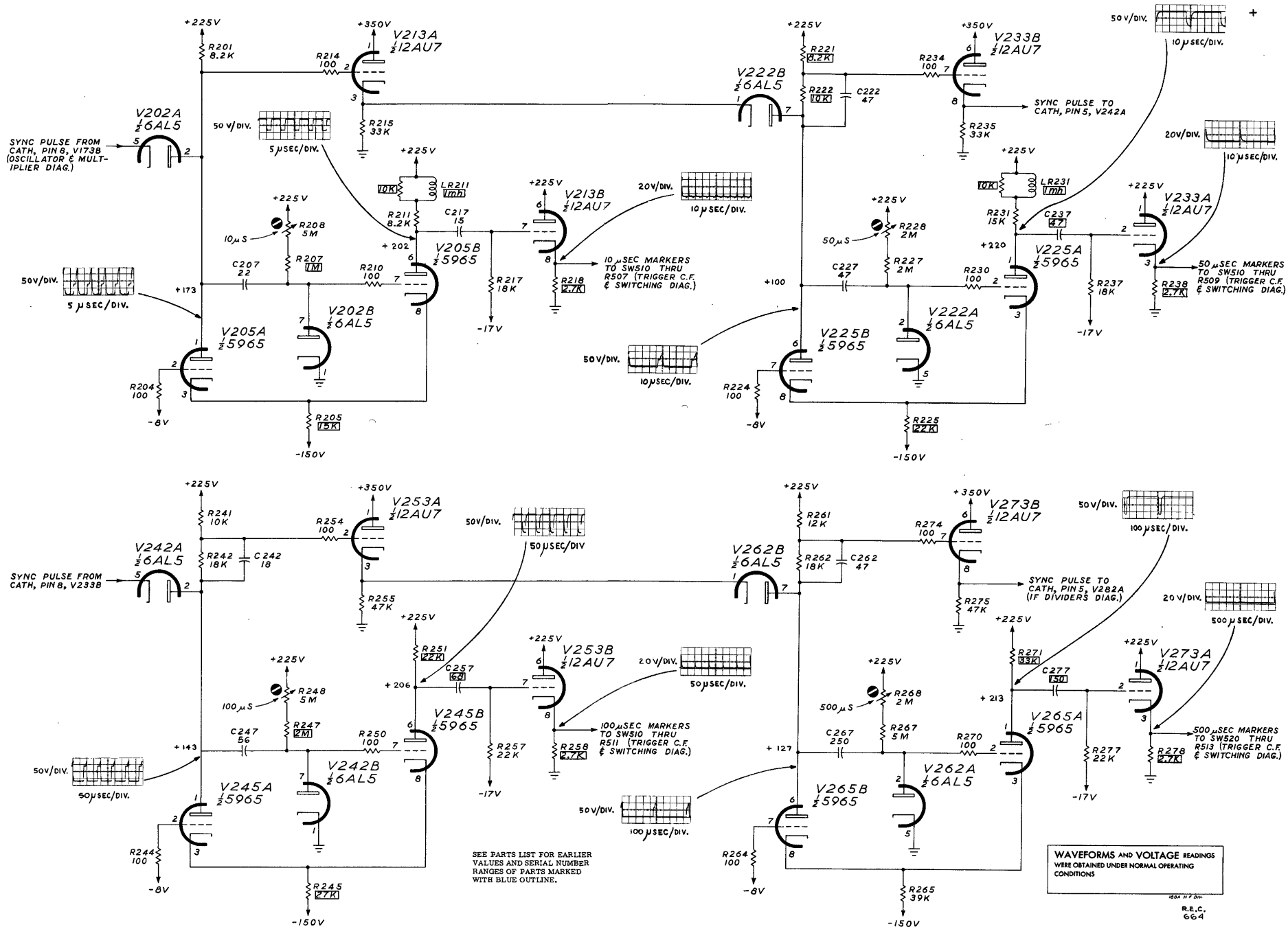
BLOCK DIAGRAM



TYPE 180A TIME-MARK GENERATOR

AA1

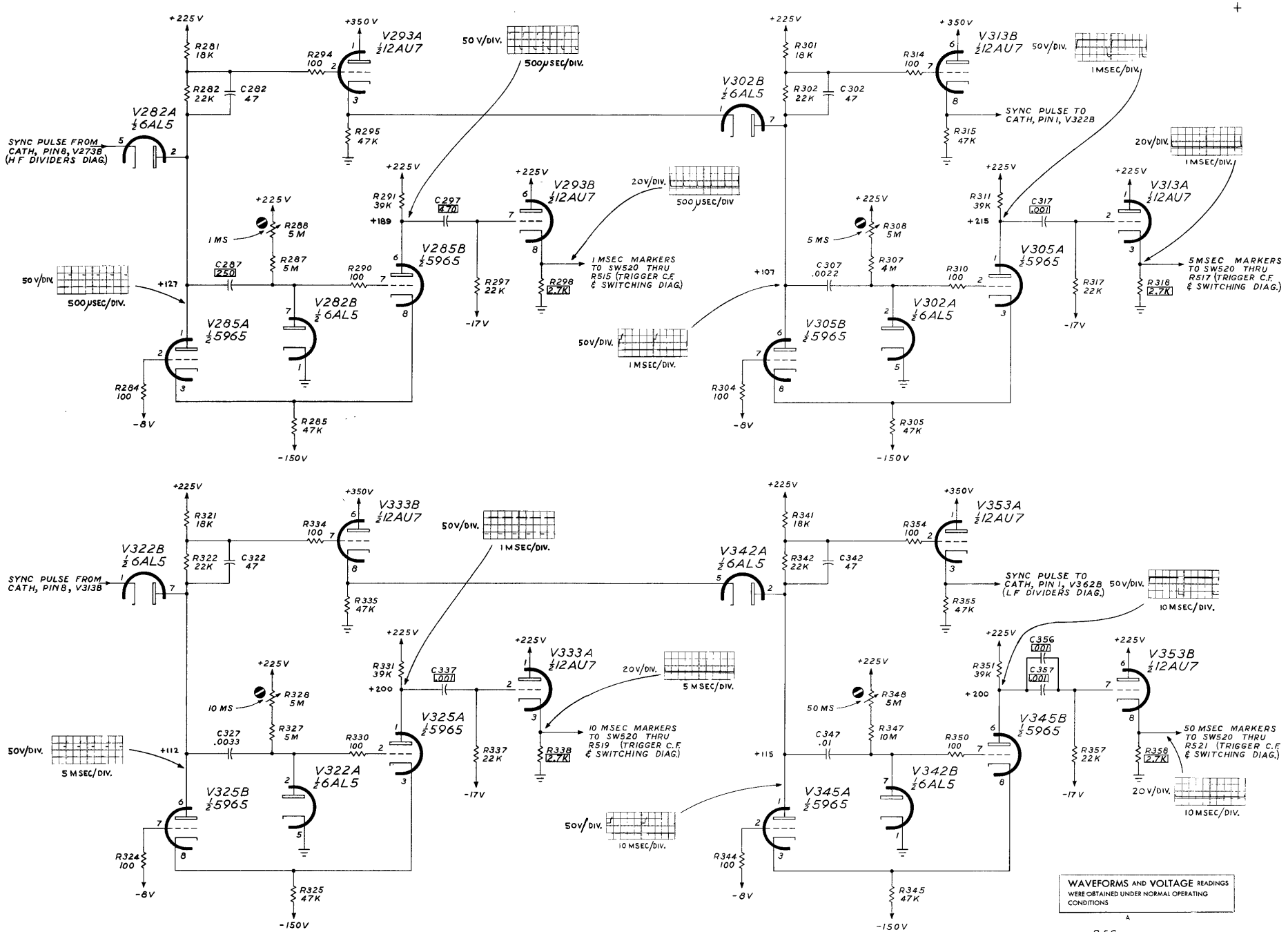
OSCILLATOR & MULTIPLIER



TYPE 180A TIME-MARK GENERATOR

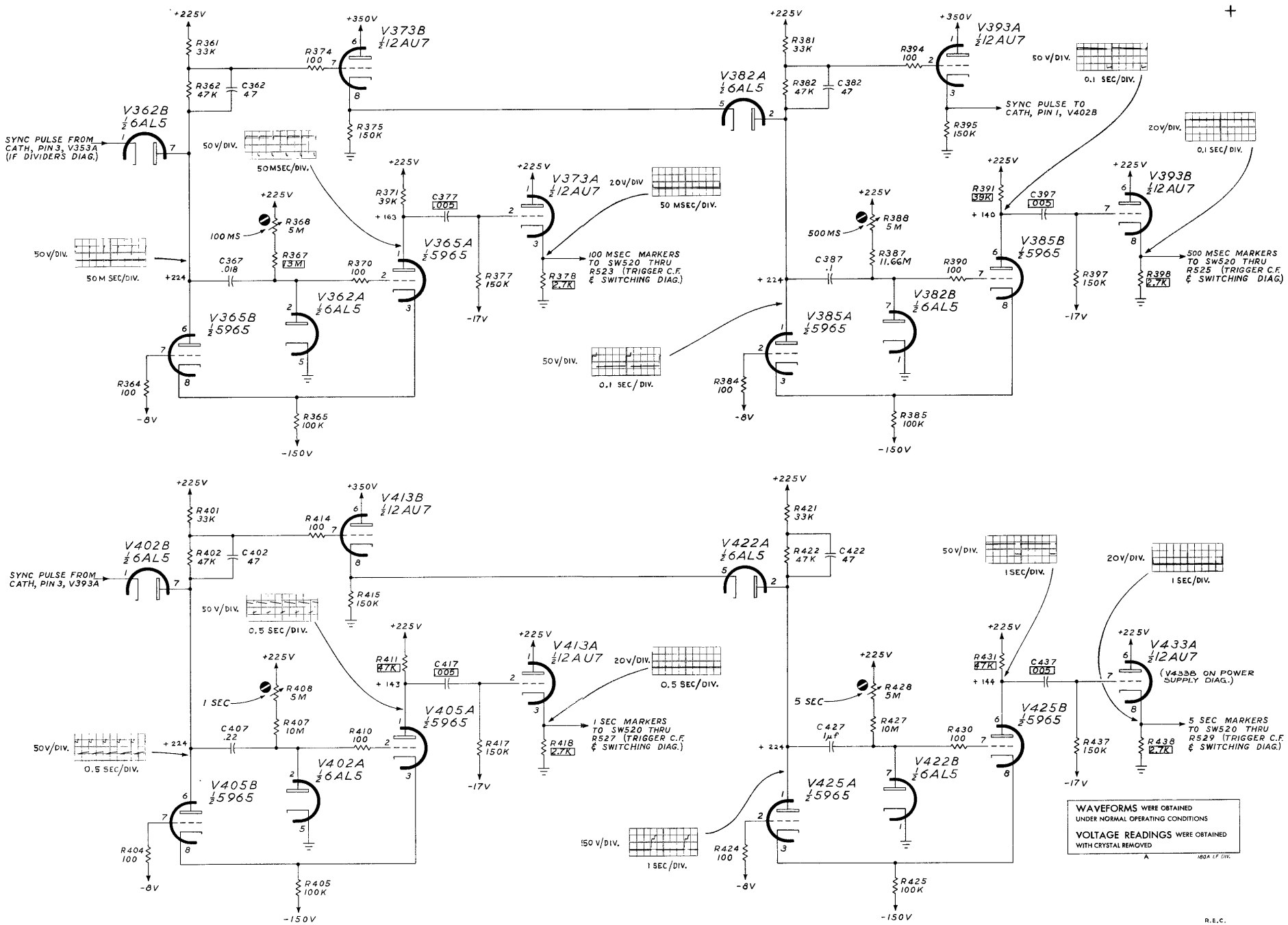
A2

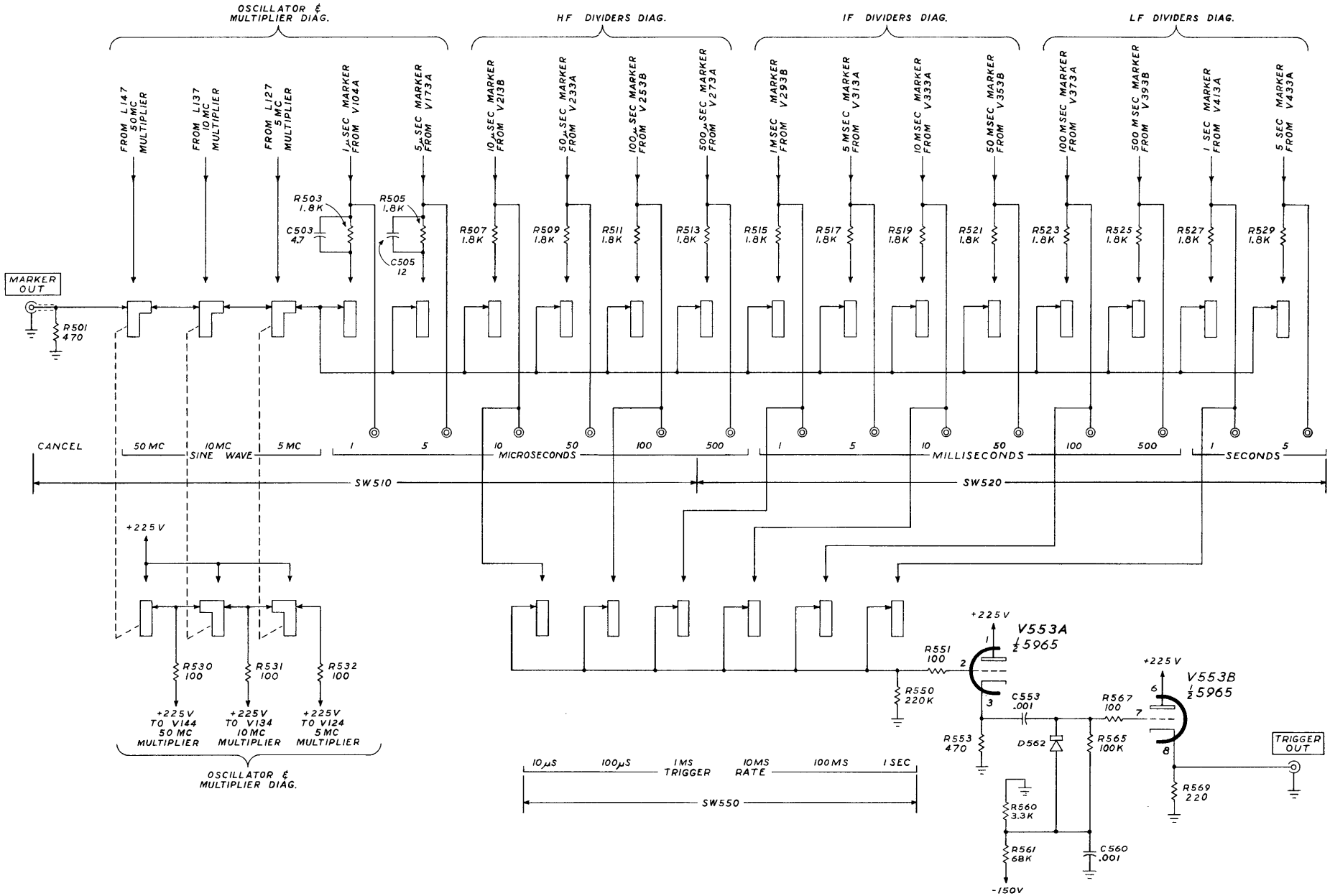
H F DIVIDERS



TYPE 180A TIME-MARK GENERATOR

I F DIVIDERS


+225V
+350V
V373B ½12AU7
R361 33K
R362 47K
C362 47
R374 100
R375 150K
V362B ½6AL5
SYNC PULSE FROM CATH, PIN 3, V353A (IF DIVIDERS DIAG.)
50 V/DIV.
50 MSEC/DIV.
R371 39K
+ 163
C377 .005
V373A ½12AU7
20V/DIV
50 MSEC/DIV.
100 MS
R368 5M
R367 13M
C367 .018
+224
50 V/DIV.
50 M SEC/DIV.
R370 100
V365A ½5965
V362A ½6AL5
V365B ½5965
R377 150K
-17V
100 MSEC MARKERS TO SW520 THRU R523 (TRIGGER C.F. & SWITCHING DIAG.)
R378 2.7K
R364 100
-8V
R365 100K
-150V
V382A ½6AL5
R381 33K
R382 47K
C382 47
R394 100
V393A ½12AU7
50 V/DIV.
0.1 SEC/DIV.
SYNC PULSE TO CATH, PIN 1, V402B
R395 150K
20V/DIV.
0.1 SEC/DIV.
R391 39K
+ 140
C397 .005
V393B ½12AU7
500 MSEC MARKERS TO SW520 THRU R525 (TRIGGER C.F. & SWITCHING DIAG.)
R398 2.7K
500 MS
R388 5M
R387 11.66M
C387 .1
+224
R390 100
V385B ½5965
R397 150K
-17V
V382B ½6AL5
V385A ½5965
50 V/DIV.
0.1 SEC/DIV.
R384 100
-8V
R385 100K
-150V
V413B ½12AU7
R401 33K
R402 47K
C402 47
R414 100
R415 150K
V402B ½6AL5
SYNC PULSE FROM CATH, PIN 3, V393A
50 V/DIV.
0.5 SEC/DIV.
R411 47K
+ 143
C417 .005
V413A ½12AU7
20V/DIV.
0.5 SEC/DIV.
1 SEC
R408 5M
R407 10M
C407 .22
+224
50V/DIV.
0.5 SEC/DIV.
R410 100
V405A ½5965
V402A ½6AL5
V405B ½5965
R417 150K
-17V
1 SEC MARKERS TO SW520 THRU R527 (TRIGGER C.F. & SWITCHING DIAG.)
R418 2.7K
R404 100
-8V
R405 100K
-150V
V422A ½6AL5
R421 33K
R422 47K
C422 47
50V/DIV.
1 SEC/DIV.
20V/DIV.
1 SEC/DIV.
R431 47K
+ 144
C437 .005
V433A ½12AU7
(V433B ON POWER SUPPLY DIAG.)
5 SEC
R428 5M
R427 10M
C427 1μF
+224
R430 100
V425B ½5965
R437 150K
-17V
5 SEC MARKERS TO SW520 THRU R529 (TRIGGER C.F. & SWITCHING DIAG.)
R438 2.7K
V422B ½6AL5
V425A ½5965
150 V/DIV.
1 SEC/DIV.
R424 100
-8V
R425 100K
-150V
WAVEFORMS WERE OBTAINED UNDER NORMAL OPERATING CONDITIONS
VOLTAGE READINGS WERE OBTAINED WITH CRYSTAL REMOVED
180A LF DIV.
R.E.C. 664
CIRCUIT NUMBERS 360 THRU 439
L F DIVIDERS



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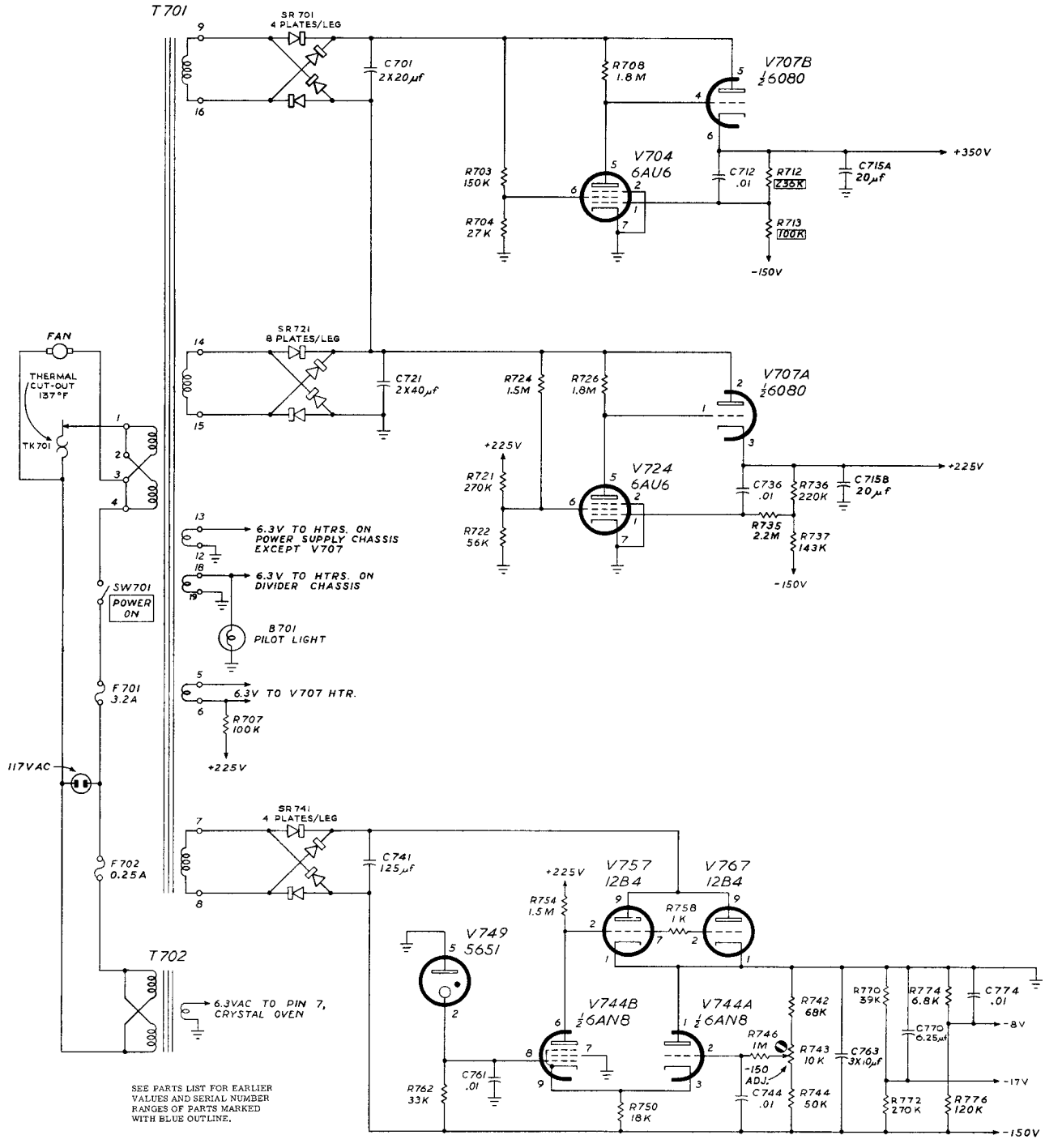
R.E.C.

TYPE 180A TIME-MARK GENERATOR

AA

TRIGGER C.F. & SWITCHING

SN 5001-5478


T701
SR 701
4 PLATES/LEG
C701
2X20μf
R708
1.8 M
V707B
½6080
+350V
R703
150K
V704
6AU6
C712
.01
R712
235K
C715A
20μf
R704
27K
R713
100K
-150V
FAN
THERMAL
CUT-OUT
137°F
TK701
SR 721
8 PLATES/LEG
C721
2X40μf
R724
1.5M
R726
1.8M
V707A
½6080
+225V
R721
270K
V724
6AU6
C736
.01
R736
220K
C715B
20μf
+225V
R722
56K
R735
2.2M
R737
143K
-150V
6.3V TO HTRS. ON
POWER SUPPLY CHASSIS
EXCEPT V707
6.3V TO HTRS. ON
DIVIDER CHASSIS
SW701
POWER
ON
B701
PILOT LIGHT
F701
3.2A
6.3V TO V707 HTR.
R707
100K
+225V
117VAC
F702
0.25A
SR 741
4 PLATES/LEG
C741
125μf
T702
6.3VAC TO PIN 7,
CRYSTAL OVEN
+225V
V757
12B4
V767
12B4
R754
1.5M
R758
1K
V749
5651
V744B
½6AN8
V744A
½6AN8
R742
68K
R746
1M
R743
10K
-150
ADJ.
R762
33K
C761
.01
C744
.01
R744
50K
R750
18K
R770
39K
R774
6.8K
C774
.01
C770
6.25μf
-8V
C763
3X10μf
-17V
R772
270K
R776
120K
-150V
SEE PARTS LIST FOR EARLIER
VALUES AND SERIAL NUMBER
RANGES OF PARTS MARKED
WITH BLUE OUTLINE.