INSTRUCTION MANUAL

Serial Number 1331

type 1L10

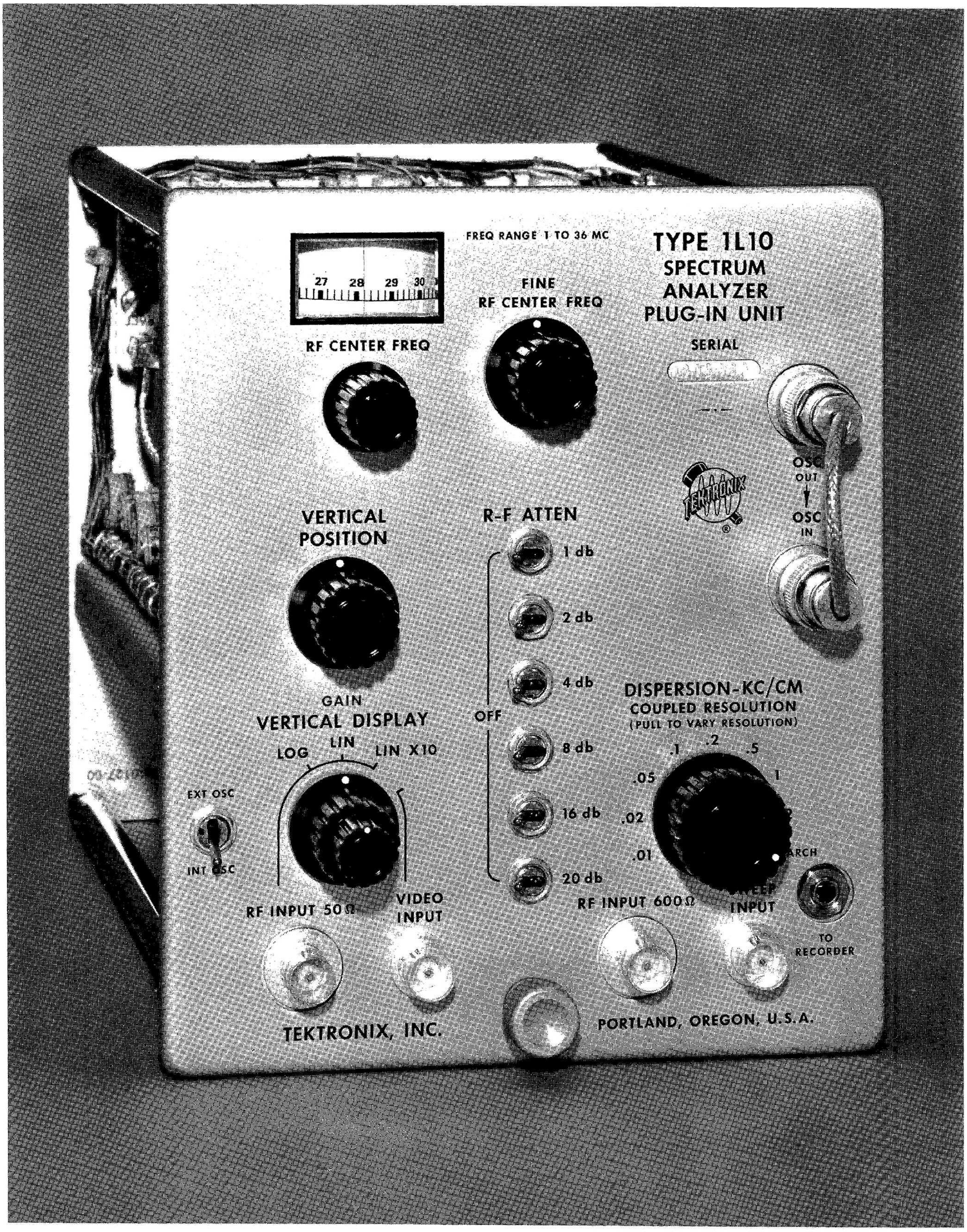
SPECTRUM ANALYZER

Tektronix, Inc.

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

070-0510-00

965



Type 1L10 Spectrum Analyzer Plug-In Unit

SECTION 1
CHARACTERISTICS

Introduction

The Type 1L10 Spectrum Analyzer plug-in unit is designed for use with Tektronix Type 530-, 540-, 550-, and *580-Series Oscilloscopes. The Type 1L10 Spectrum Analyzer is tunable over the frequency range of 1 mc to 36 mc. The frequency "window" (dispersion) of the display is variable in eight calibrated steps of 0.01 to 2 kc/cm in a 1, 2, 5 sequence.

The Type 1L10 displays the frequency distribution of an applied signal (or signals) along the horizontal axis of the crt while the signal energy is displayed on the vertical axis.

Specifications

R-F Center Frequency Range	Continuously tunable from 1 mc to 36 mc.
Dial Accuracy	±(100 kc + 1% of dial reading)
Dispersion (width of frequency "window")	10 cps/cm to 2 kc/cm in eight calibrated steps in a 1, 2, 5 sequence.
Dispersion Accuracy	±3% when the Type 1L10 is calibrated for an individual oscilloscope. Otherwise, accuracy is +13% and —7%.
Sensitivity	—100 dbm minimum at 10 cps resolution. (0 dbm equals 1 milliwatt).
Sweep Rate	Determined by oscilloscope Time/Cm switch. Typically less than 1 Sec/Cm to more than 5 mSec/Cm.
Resolution	10 cps to 1 kc depending on setting of COUPLED RESOLUTION switch.
Maximum Input Power	—20 dbm with all R-F ATTEN switches OFF. +24 dbm with all R-F ATTEN switches ON.
Frequency Stability	Local Oscillator: 150 ppm*/°F. 10 ppm*/volt of line voltage. I-F Amplifier: 2 ppm*/°F. 1 ppm*/volt of line voltage.
Display Flatness	±1 db.
Vertical Display (with 6 cm screen)	LOG: 50 db. LIN: 26 db. LIN ×10: 26 db.
R-F ATTEN	51 db, ±0.1 db/db in 1 db steps.
GAIN Control Range	60 db.
TO RECORDER Output	Dc coupled. Output voltage at least 15 mv/cm when working into a 600 Ω load.

***A plug-in adapter must be used with 580-Series Oscilloscopes.**

Accessories Included

	Tektronix Part No.
2—Instruction Manuals	070-0510-00
1—Plug, Tini-Plug, Red	134-0052-00
1—Cable Assembly, BNC to Banana Plug, 24"	012-0096-00
1—Cable Assembly, BNC to BNC, 2½"	012-0097-00

VIDEO INPUT	Deflection Factor: .1 v/cm. Bandpass: 10 cps to oscilloscope vertical amplifier bandwidth.

***Parts per million.**

SECTION 3
THEORY OF OPERATION

Introduction

A spectrum analyzer is a device that breaks down a complex electronic signal into its various frequency components. The display presented by the spectrum analyzer is a plot of frequency versus signal energy. The Type 1L10 Spectrum Analyzer is very similar to a superheterodyne radio receiver with quadruple conversion (see Fig. 3-1).

R-F Attenuator

The input signal from either the R-F INPUT 50 Ω or R-F INPUT 600 Ω connector is coupled to the R-F Attenuator section. The R-F Attenuator network is composed of 6 pi attenuator sections. Each pi attenuator may be switched in or out of the signal path with the various R-F ATTEN switches. Output of the R-F Attenuator is coupled to the balanced mixer circuit.

Front-End Local Oscillator

The Front-End Local Oscillator runs at a frequency of from 61 mc to 96 mc depending upon the setting of the R-F CENTER FREQ controls (R58 and C50). Upper frequency limit of the oscillator is set by C49 and the lower limit is set by T50. FINE R-F CENTER FREQ control is accomplished with a voltage variable capacitance diode D54. Bias on the capacitance diodes (and hence capacitance) is controlled by R58. The reactance of the D54-L54 combination is coupled by distributed capacity into the tank circuit of the collector of Q40.

The Q40 stage oscillates due to the capacitively coupled positive feedback from its collector to emitter through C48. The base of Q40 is held at R-F ground by C42.

In the SEARCH position of the DISPERSION-KC/CM switch, the sawtooth voltage of the oscilloscope is coupled to the emitter circuit of Q40. This sweeps the oscillator over a small frequency range and widens the effective dispersion. This makes it easier to locate signals on the screen and to use a faster sweep rate.

The EXT OSC-INT OSC switch SW40 removes power from the local oscillator in the EXT OSC position.

Output of the local oscillator is coupled to the Balanced Mixer circuit and is heterodyned with the input signal.

Balanced Mixer and Filter

The mixer circuit is balanced to minimize spurious signals from the local oscillator. The balance adjustments are C71 and C73. Heterodyning with the input signal takes place at the junction of D71-D73-L80-R80.

With no applied signal and with C71 and C73 set for proper balance, the local oscillator signal cancels at the junction of D71 and D73. This reduces spurious signals that might otherwise be produced by the local oscillator. When an applied signal appears at the junction of D71 and D73, it disturbs the balance of the bridge circuit by alternately biasing the diodes in different directions. When this occurs, heterodyning takes place between the applied signal and the local oscillator.

The Filter circuit is a narrowband circuit that is peaked at 60 mc. Whenever the difference frequency between the local oscillator and the applied signal equals 60 mc, signal energy is passed through the filter to the Wideband Amplifier.

Wideband Amplifier

The Wideband Amplifier chassis contains a two-stage 60-mc amplifier, a 49.3-mc oscillator, and a three-stage 10.7-mc amplifier. The 60-mc and 49.3-mc signals are mixed at the input of the 10.7-mc amplifier.

Q110 and Q120 form the two-stage 60-mc amplifier. The stages are transformer coupled through T114 and T124. C114 and C124 tune the coupling transformers for resonance at 60 mc. The emitters of Q110 and Q120 are R-F grounded through C115 and C123.

Q150 is a 49.3-mc crystal-controlled oscillator. The oscillator is peaked with the variable inductor L154. Output of the oscillator passes from the collector of Q150 to the base of Q200 through C150.

The 60-mc signal from the secondary of T124 is also coupled to the base of Q200. The Q200 stage is tuned to the difference frequency of the 60-mc and 49.3-mc signals (10.7 mc). The Q200, Q210 and Q220 stages form a three-stage 10.7-mc I-F amplifier. Between-stage coupling is accomplished with I-F transformers T204, T214 and T224. The 10.7-mc output from the secondary of T224 passes to the Swept I-F Oscillator chassis.

Swept I-F Oscillator

The Sweep Frequency Oscillator (Q360) is swept over a frequency range determined by the setting of the DISPERSION-KC/CM switch SW325A. The DISPERSION-KC/CM switch varies the amplitude of the oscilloscope sawtooth voltage that is applied to the Sweep Frequency Oscillator.

The action of the Swept I-F Oscillator circuit is as follows: The sawtooth voltage from the oscilloscope is connected to the front-panel SWEEP INPUT connector. The sweep voltage is attenuated by an amount determined by the setting of the Sawtooth Selector switch SW320. In the SEARCH position of the DISPERSION-KC/CM switch the sawtooth voltage is applied to the Front-End Local Oscillator rather than to the Sweep Frequency Oscillator. In all other positions of the DISPERSION-KC/CM switch the sawtooth voltage is applied to the sweep-frequency circuit through the attenuating resistors of the DISPERSION-KC/CM switch. The DISPERSION CAL adjustment, R321, sets the amplitude of the sawtooth voltage that appears across the voltage divider network (R322 through R329).

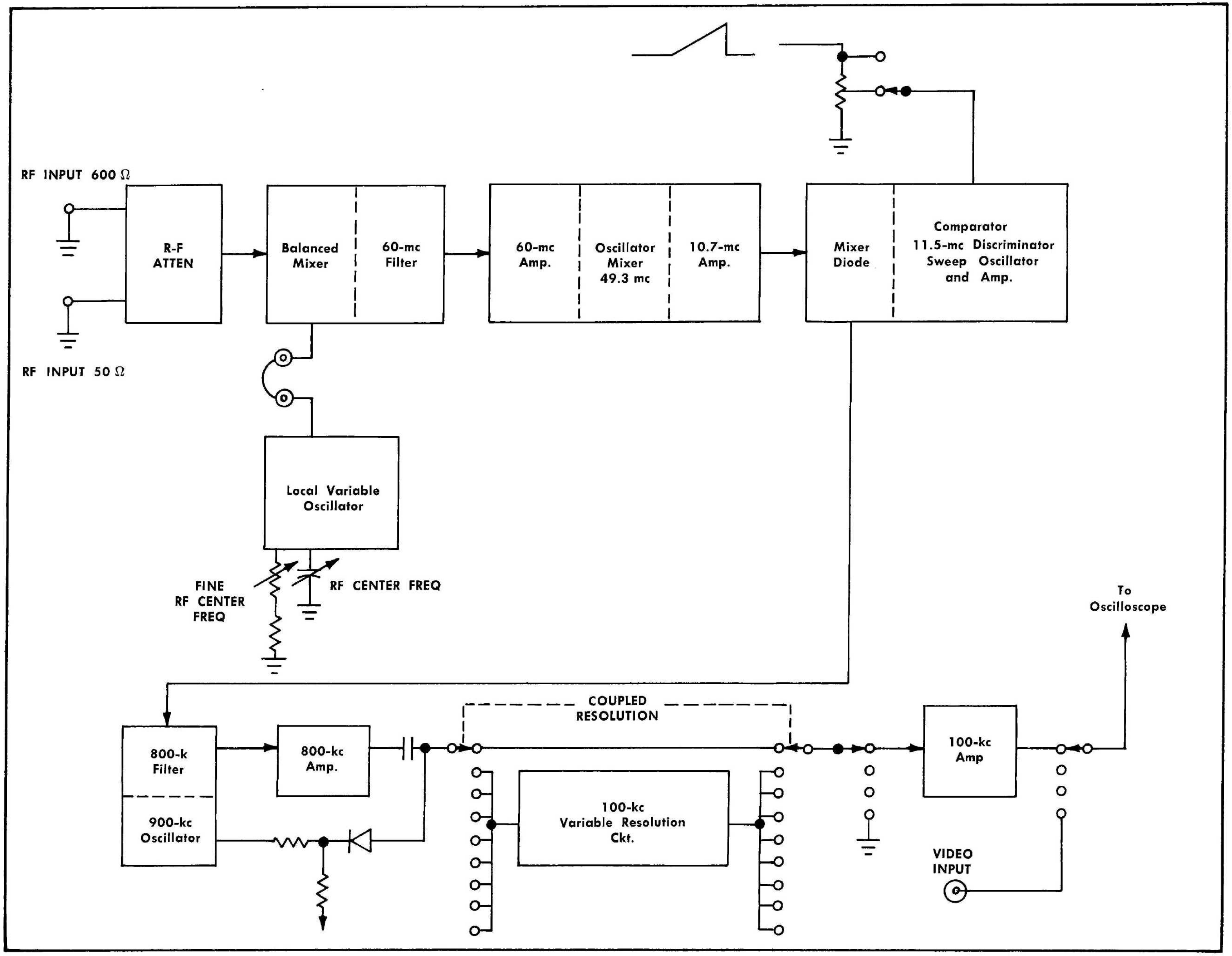


Fig. 3-1 Block diagram of the Type 1L10.

The sawtooth voltage from the voltage divider is applied to the base of emitter follower Q340. The emitter follower has a high input impedance and thus, does not significantly load the voltage divider. Output of the emitter follower is coupled to the base of Q341. Q341 forms one half of a difference amplifier. The purpose of the difference amplifier will be described a little later. For now, consider that the output of the difference amplifier is developed across R354 and applied to the voltage variable capacitance diode D362 through R355.

The sawtooth voltage appearing across D362 causes its capacitance to change in an amount proportional to the sawtooth voltage. D362 forms part of the capacitance of the tank circuit (L364) of the Sweep Frequency Oscillator Q360. The amplitude of the sawtooth voltage applied to the capacitance diode D362 determines the frequency change of the Sweep Frequency Oscillator. Output of the Sweep frequency Oscillator passes through C398 and mixes with the 10.7-mc signal from the Wideband Amplifier. Center frequency of the Sweep Frequency Oscillator is 11.5 mc. This gives a beat frequency of 800 kc.

Part of the output of the Sweep Frequency Oscillator is also coupled back through a closed loop circuit that includes an amplifier, discriminator and the other half of the difference amplifier. This closed-loop system corrects for the inherent non-linearity of the voltage variable capacitance diode D362. This is accomplished as follows: The sweep frequency is amplified by the R-F amplifier Q370 and coupled to the Discriminator circuit Y380. The Discriminator converts the sweep frequency back into a sawtooth signal. The sawtooth signal derived by the Discriminator contains any non-linearity that was introduced by the voltage variable capacitance diode D362. This sawtooth signal is coupled back to the difference amplifier through the emitter follower Q350. Assuming that the oscilloscope sawtooth voltage on the other side of the difference amplifier is linear, only the non-linear portion of the sawtooth will be amplified and coupled to the voltage variable capacitance diode. The result is that a non-linear driving voltage appears on D362. This non-linearity is such that it is equal and opposite to non-linear characteristics of the voltage variable capacitance diode. This, in turn, forces the Sweep Frequency Oscillator to produce a linear sweep frequency.

The mixed output of the Swept I-F Oscillator and the Wideband Amplifier is coupled through an 800-kc filter and then to an amplifier stage (Variable Resolution Amplifier schematic).

Variable Resolution Amplifier

The Variable Resolution Amplifier schematic contains an 800-kc filter, a feedback stabilized amplifier (Q500 and Q510), a 900-kc oscillator and a variable bandwidth circuit.

The filter circuit (L405, L410, L415, etc.) allows only the passage of the 800-kc signal. Output of the filter is coupled to a feedback stabilized amplifier consisting of Q500 and Q510. The 800-kc output of the amplifier is mixed with the output of the 900-kc oscillator giving a beat frequency of 100 kc.

The 900-kc oscillator is a stable crystal-controlled oscillator. Amplitude of the oscillator is peaked with L454. In the SEARCH position of the COUPLED RESOLUTION switch the Variable Resolution circuit (Q520 through Q560) is bypassed. In all other positions of the switch the 100-kc signal passes through the Variable Resolution Amplifier.

The first stage (Q520) of the Variable Resolution Amplifier is a conventional amplifier with the output from the collector applied to the base of Q530 through coupling capacitor C524.

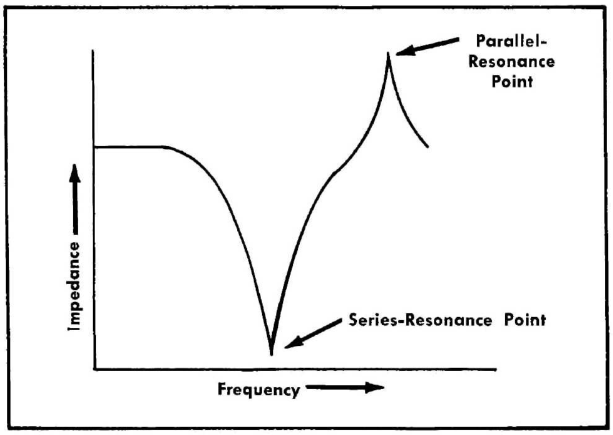


Fig. 3-2. Typical impedance versus frequency graph of a crystal. Note the series- and parallel-resonance points.

Q530 and Q540 form a bandwidth limiting circuit. Bandwidth of the circuit is set by the amount of forward bias on D548. To understand how this circuit operates, first consider the impedance characteristics of a crystal (such as Y530 in the collector circuit of Q530). Fig. 3-2 shows a typical impedance versus frequency curve of a crystal. In examining the curve, from left to right, we first encounter a very low impedance point at the series-resonant frequency point. At some higher frequency, the impedance increases—this is the parallel-resonance point. With a still higher frequency, the impedance drops fairly abruptly because of the inherent parallel capacitance of the crystal mounting.

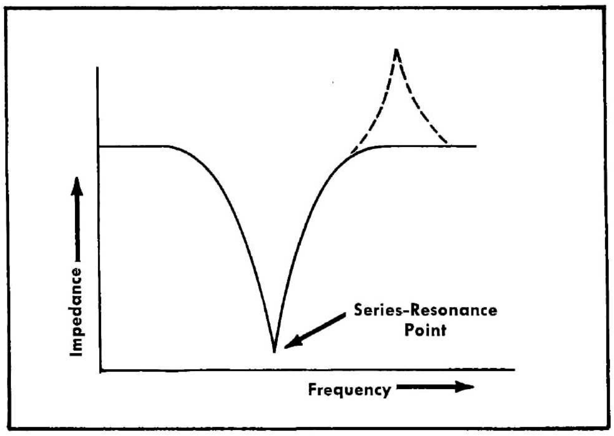


Fig. 3-3. Impedance versus frequency curve of a crystal when the parallel capacitance is effectively cancelled.

If the parallel capacitance is cancelled, the impedance of the crystal exhibits an impedance versus frequency curve that is shown in Fig. 3-3. This cancelling of the shunt capacitance of the crystal is accomplished by C534. Since the voltage on the collector is 180° out of phase with the voltage on the emitter of Q530, the capacity reactance introduced by C534 directly subtracts from the shunt X_c of the crystal. Hence, with C534 properly adjusted, Y530 exhibits no parallel resonance and assumes an impedance versus frequency curve like that shown in Fig. 3-3.

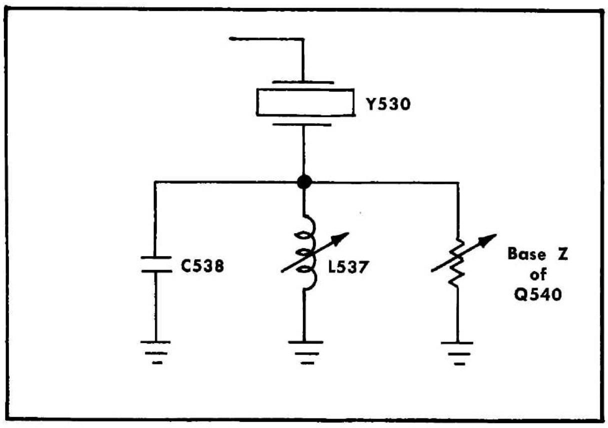


Fig. 3-4. Simplified drawing of the relationship between Y530, C538, L537 and the base impedance of Q540.

The next item to consider in the circuit is the tank circuit consisting of L537 and C538. This tank circuit and the crystal form a voltage divider when considering the voltage at the base of Q540. Also, the base impedance (which is largely resistive at 100 kc) of Q540 shunts the tank circuit of L537 and C538. Fig. 3-4 represents this circuitry in simplified form.

Since the base impedance of Q540 shunts the L537-C538 tank circuit, the 'Q' of the tank circuit can be controlled by changing the base impedance of Q540. This is accomplished by forward biasing D548. The more D548 is forward biased, the closer the emitter of Q540 comes to R-F ground. This, in turn, changes the input impedance at the base of Q540 since:

Input Z of Q540 $= h_{fe} \cdot R_{ee}$

Where: h_{fe} is the Beta of the transistor.

R_{ee} is the external emitter impedance of Q540 at 100 kc. Governed by the amount of forward bias on D548.

Fig. 3-5a shows the impedance versus frequency curve of the L537-C538 tank circuit at two settings of the COUPLED RESOLUTION switch superimposed on the impedance of Y530. Fig. 3-5b shows the resultant bandpass of the circuit at the base of Q540. Note that with a narrow bandpass the signal amplitude is less at the base of Q540. This diminishing amplitude, however, is compensated for by the increase in gain of the Q540 stage. The increased gain results from the decrease in emitter degeneration due to the increased forward bias on D548.

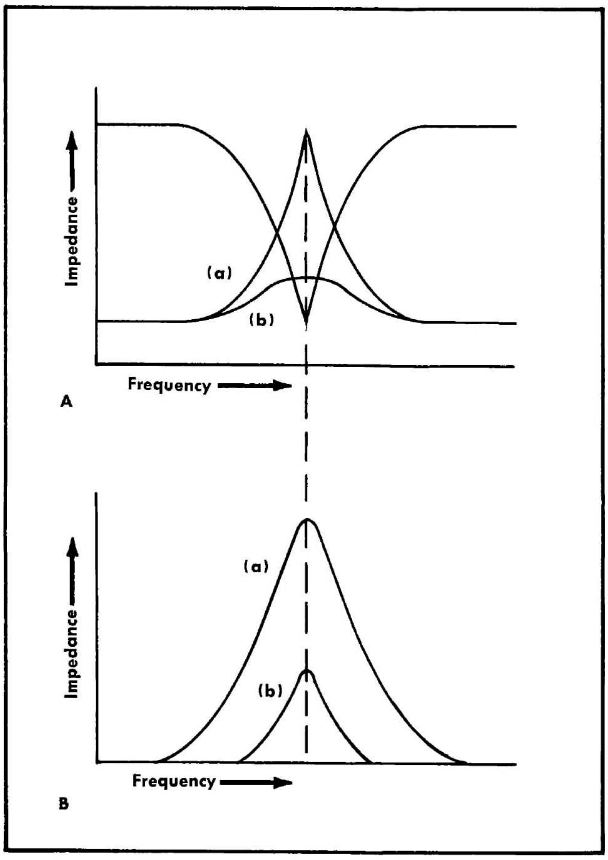


Fig. 3-5. (A) Impedance versus frequency curves of L537-C538 tank circuit at two settings (a and b) of the COUPLED RESOLUTION switch superimposed on the impedance curve of Y530. (B) Resultant voltage division curve derived from A. Notice the narrower bandwidth of curve (b).

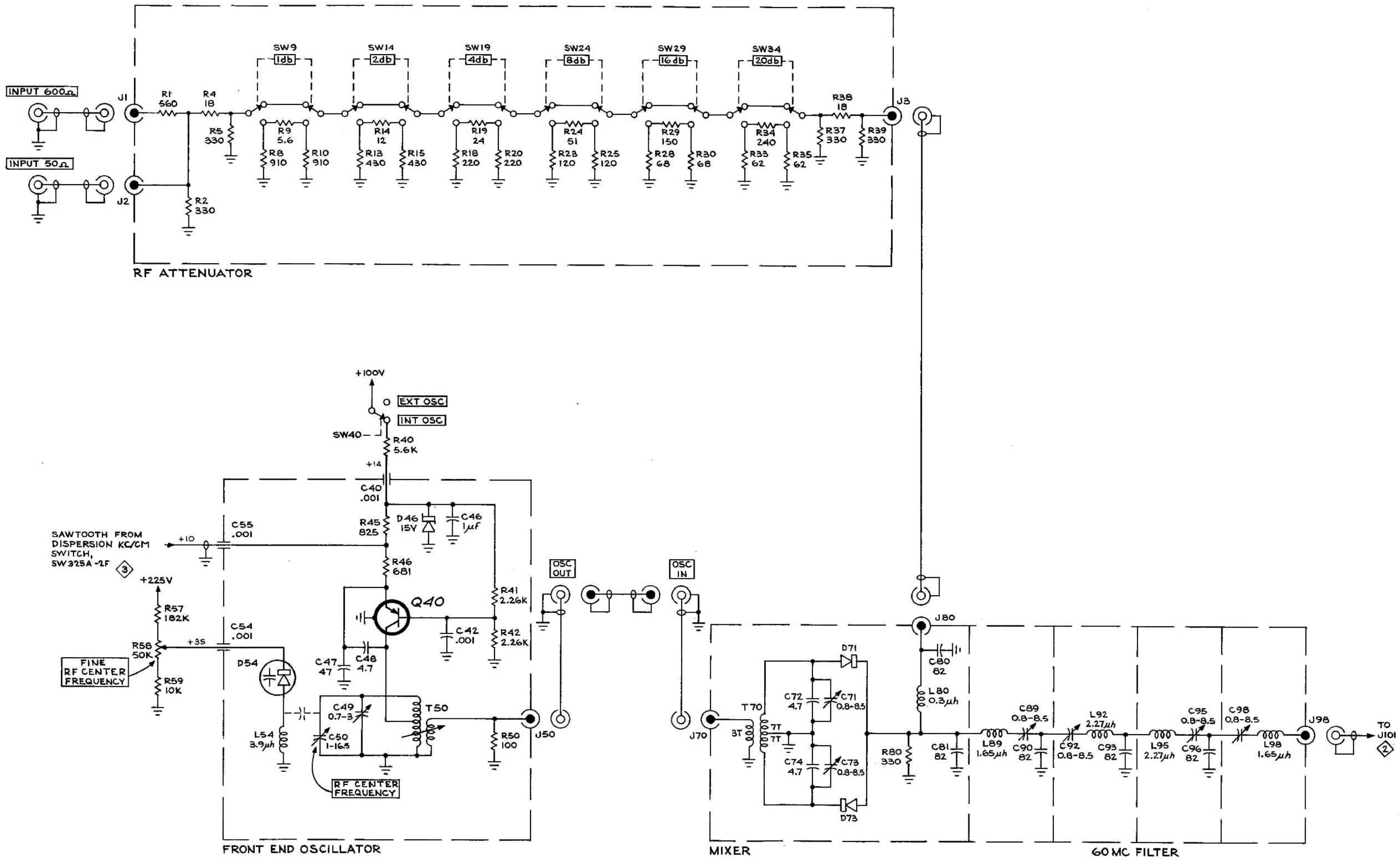
The Q550-Q560 stage of the circuit operates the same as the Q530-Q540 stage. Output of the Variable Resolution Amplifier is coupled to the Output Amplifier and Detector Circuits.

Output Amplifier and Detector

The Output Amplifier circuitry contains an emitter follower (Q600) and two amplifier stages (Q610 and V620). The V620 amplifier stage is tuned to 100 kc with L624.

Diodes D640 and D641 detect the 100-kc output of the output amplifier. Output of the detector is coupled to the junction of R640-R641 and to the VERTICAL DISPLAY switch SW640. In the LIN ×10 position of the VERTICAL DISPLAY switch the signal passes straight through to the input of the oscilloscope with no attenuation. In the LIN position of the VERTICAL DISPLAY switch the output of the detector is attenuated approximately 10 times by the attenuation network. In the LOG position, the signal is attenuated by an amount that is proportional to the log of its amplitude. To small amplitude signals, D646 acts as a comparatively high impedance. To larger signals, D646 becomes increasingly forward biased and acts as a lower impedance. Hence, larger amplitude signals are attenuated more than smaller signals. R646 adjusts the attenuation of this network so that it is more nearly logarithmic.

In the VIDEO INPUT position of the VERTICAL DISPLAY switch the spectrum signal path is blocked and the input to the Output Amplifier is grounded. Also, any signal connected to the VIDEO INPUT connector is coupled to the vertical input of the oscilloscope. The GAIN potentiometer, R109B, sets the attenuation of the signal from the VIDEO INPUT connector. Input R of the VIDEO INPUT connector is approximately 50 Ω.



SEE PARTS LIST FOR SEMICONDUCTOR TYPES

REFERENCE DIAGRAMS

2 WIDE BAND AMPLIFIER

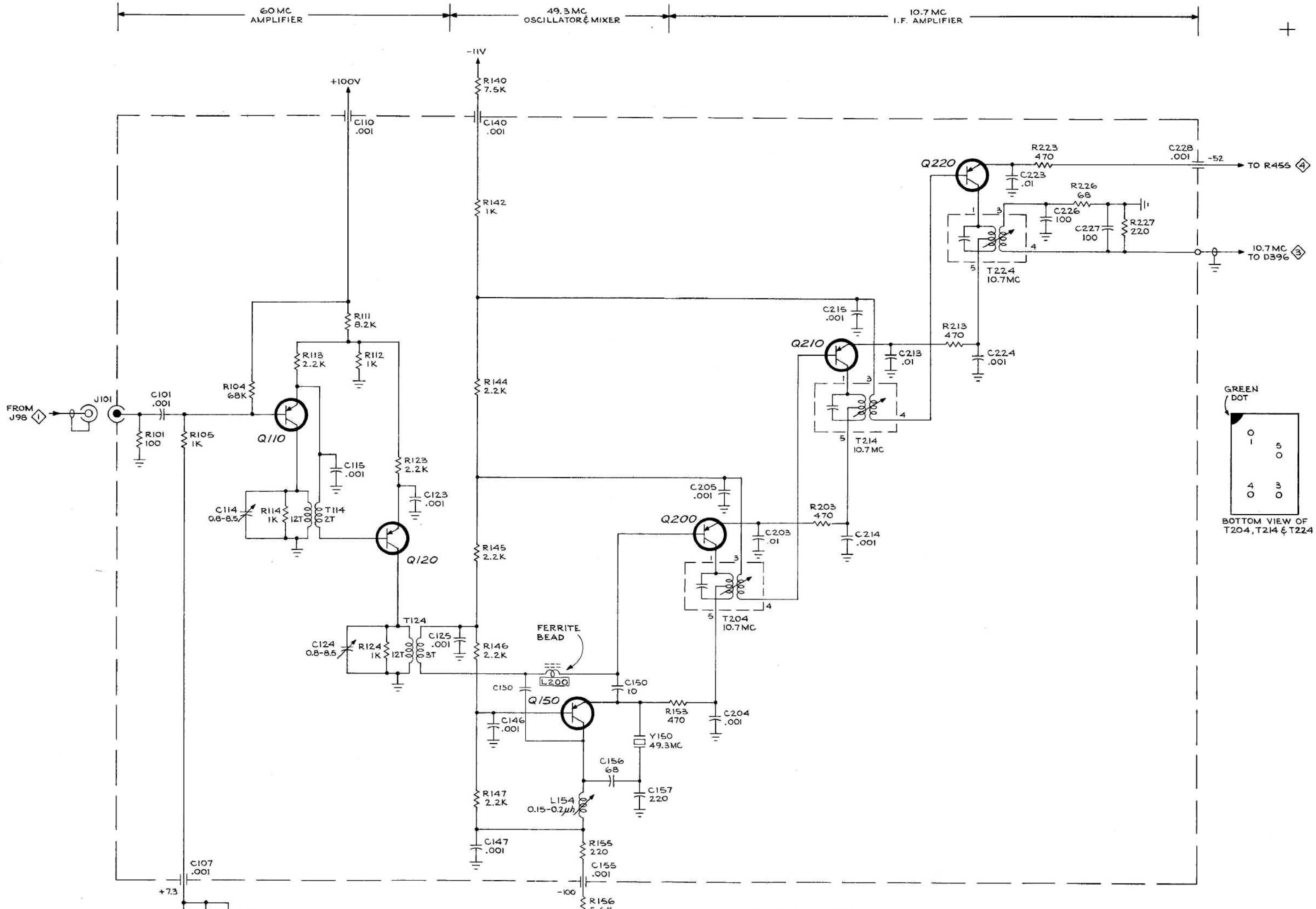
3 SWEPT I.F. OSCILLATOR

DON
565

TYPE 1L10 SPECTRUM ANALYZER

A

VARIABLE OSCILLATOR & MIXER 1



REFERENCE DIAGRAMS
1 VARIABLE OSCILLATOR & MIXER
3 SWEPT I.F. OSCILLATOR
4 VARIABLE RESOLUTION AMPLIFIER
5 OUTPUT AMPLIFIER & DETECTOR

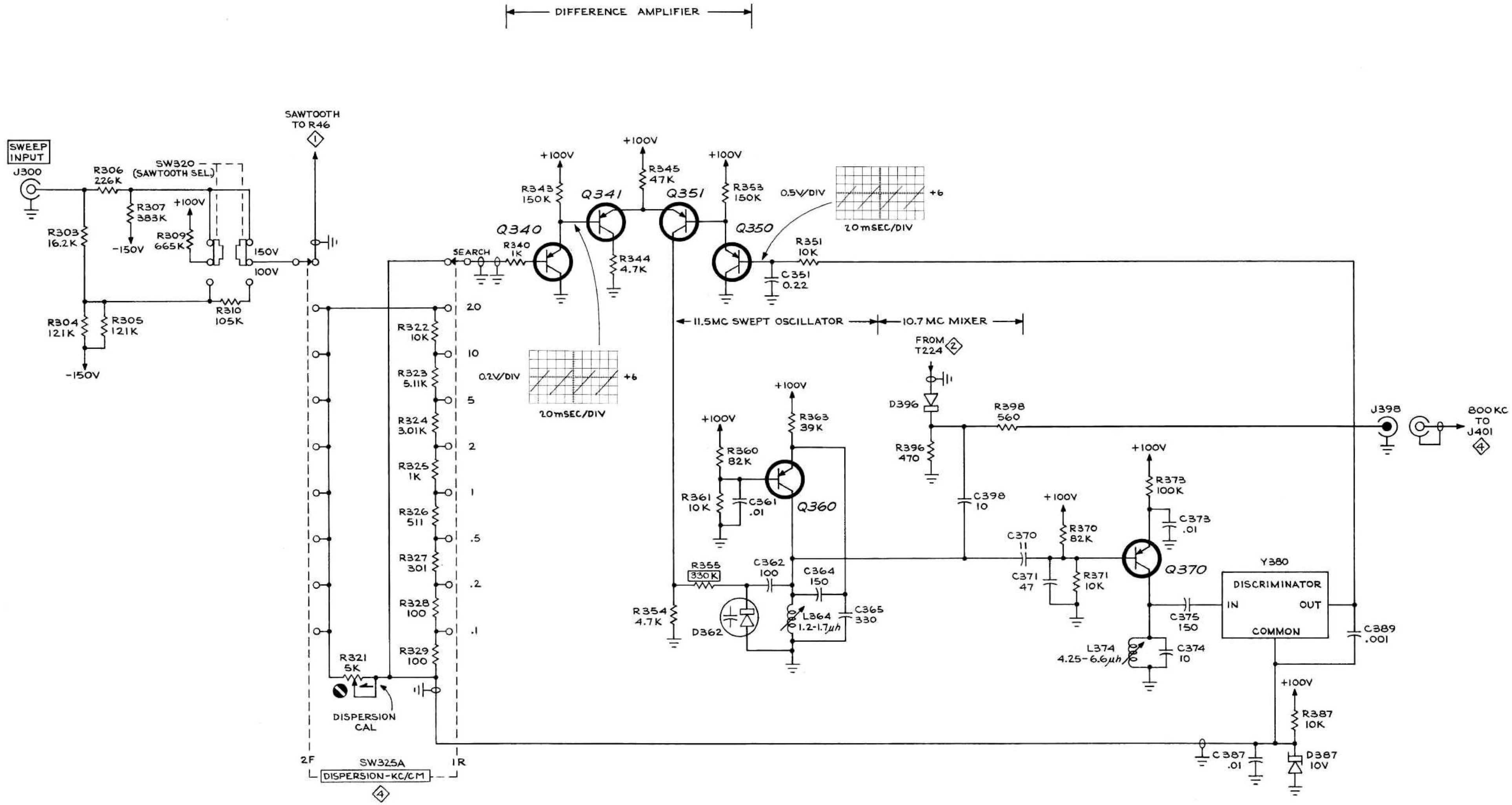
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

DON 166

TYPE 1L10 SPECTRUM ANALYZER

C

WIDE BAND AMPLIFIER 2



REFERENCE DIAGRAMS

1 VARIABLE OSCILLATOR & MIXER

2 WIDE BAND AMPLIFIER

4 VARIABLE RESOLUTION AMPLIFIER

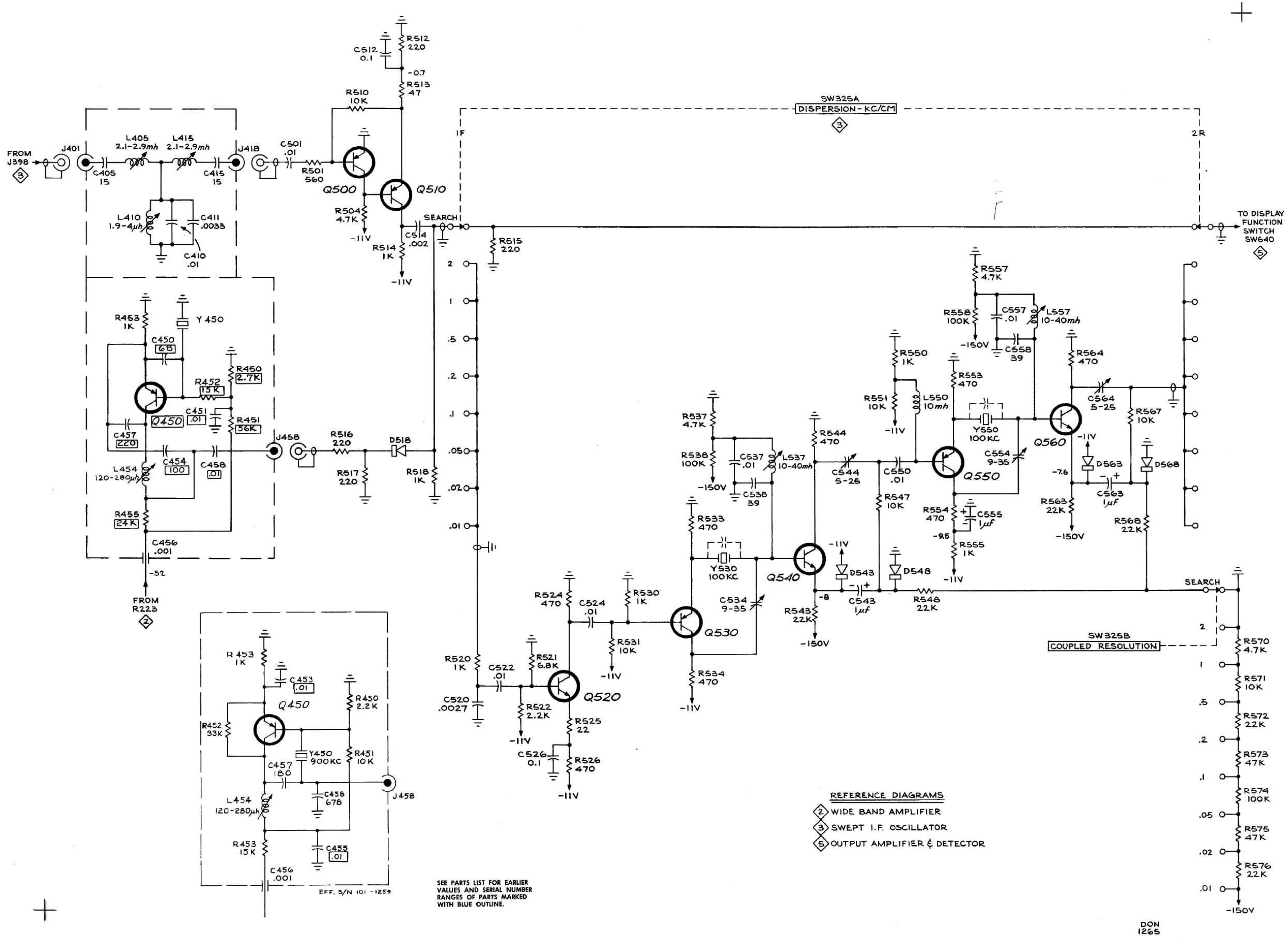
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS MARKED WITH BLUE OUTLINE.

DON 166

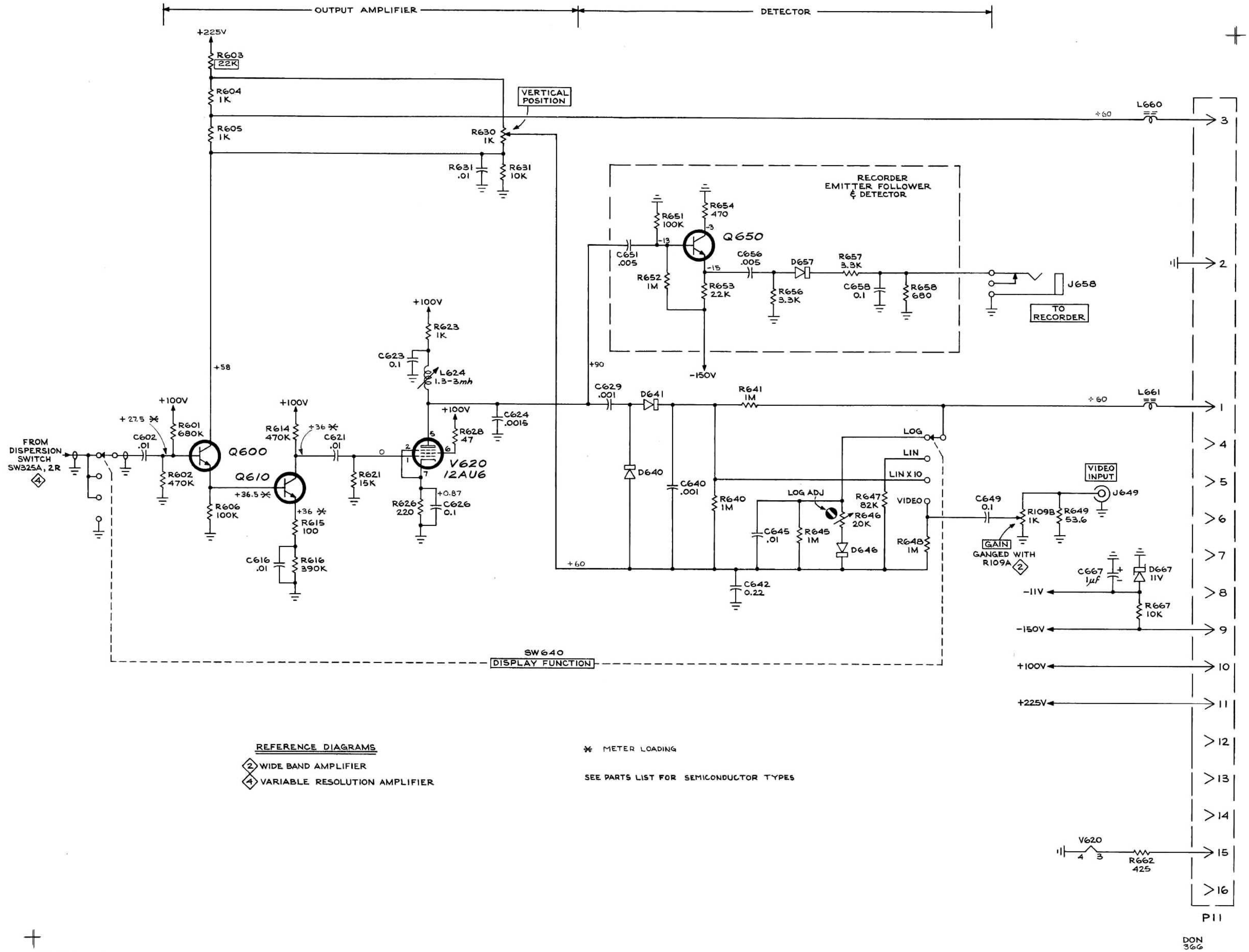
TYPE 1L10 SPECTRUM ANALYZER

B

SWEPT I.F. OSCILLATOR 3



VARIABLE RESOLUTION AMPLIFIER 4


OUTPUT AMPLIFIER
DETECTOR
+225V
R603 22K
R604 1K
R605 1K
VERTICAL POSITION
R630 1K
R631 .01
R631 10K
L660
+60
RECORDER EMITTER FOLLOWER & DETECTOR
R651 100K
R654 470
Q650
C651 .005
R652 1M
R653 22K
C656 .005
D657
R657 3.3K
R656 3.3K
C658 0.1
R658 680
J658
TO RECORDER
-150V
+100V
R623 1K
C623 0.1
L624 1.3-3mh
+58
+90
C629 .001
D641
R641 1M
L661
+100V
R601 680K
+27.5
C602 .01
FROM DISPERSION SWITCH SW325A, 2R
Q600
R602 470K
R606 100K
+100V
R614 470K
+36
C621 .01
Q610
+36.5
R615 100
C616 .01
R616 390K
R621 15K
V620 12AU6
R628 47
C624 .0015
R626 220
C626 0.1
+0.87
D640
C640 .001
R640 1M
+60
LOG
LIN
LIN X 10
VIDEO
LOG ADJ
R647 82K
R646 20K
C645 .01
R645 1M
D646
R648 1M
C642 0.22
C649 0.1
R109B 1K
R649 53.6
VIDEO INPUT
J649
GAIN
GANGED WITH R109A 2
C667 1µf
D667 11V
-11V
R667 10K
-150V
+100V
+225V
V620
R662 425
P11
SW640
DISPLAY FUNCTION
REFERENCE DIAGRAMS
2 WIDE BAND AMPLIFIER
4 VARIABLE RESOLUTION AMPLIFIER
* METER LOADING
SEE PARTS LIST FOR SEMICONDUCTOR TYPES
DON 366

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.

TYPE 1L10/3L10

PARTS LIST CORRECTION

CHANGE TO:

C365	283-0077-00	330 pF	5%	500 V

Parts List Correction

Remove:

C453	283-0079-00	.01 µf	250 V	Cer.
C455	283-0079-00	.01 µf	250 V	Cer.

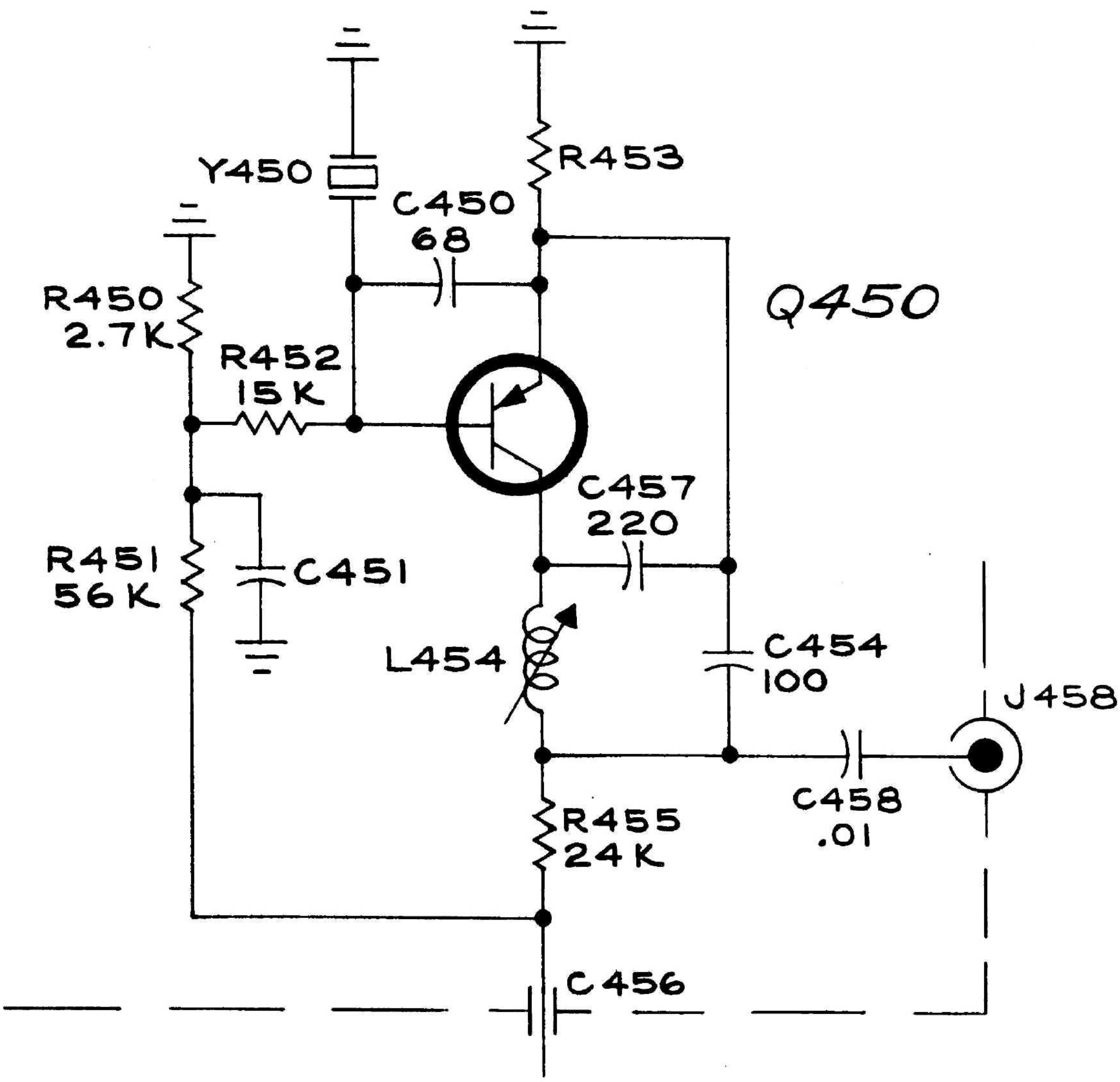
Add:

C450	283-0608-00	68 pf	500 V	Mica
C451	283-0079-00	.01 µf	250 V	Cer
C454	285-0003-00	100 pf		

Change To:

C457	285-0004-00	220 pf		
C458	283-0079-00	.01 µf	250 V	Cer
Q450	151-0164-00	2N3702		
R450	315-0272-00	2.7 K	1/4 W	5%
R451	315-0563-00	56 K	1/4 W	5%
R452	316-0153-00	15 K	1/4 W	10%
R455	315-0243-00	24 K	1/4 W	5%

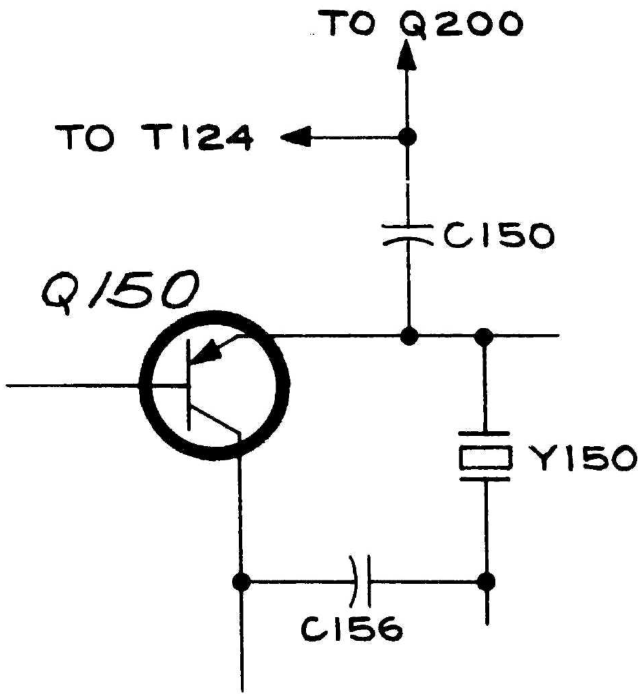
Schematic Correction



PARTIAL VAR. RESOLUTION AMP.

Type: 1L10 Tent S/N 1208
Type: 3L10 Tent S/N 165

Schematic Correction



PARTIAL WIDE-BAND AMP.

M10,399/1265