

UNCLASSIFIED

**TECHNICAL MANUAL  
FOR  
TYPE R-1401/G  
RECEIVER**

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Rockville, Maryland 20852

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M/100/12/10/65

**WARNING**

This equipment employs voltages which are dangerous and may be fatal if contacted. Extreme caution should be exercised in working with the equipment with any of the protective covers removed.



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Table 1-1

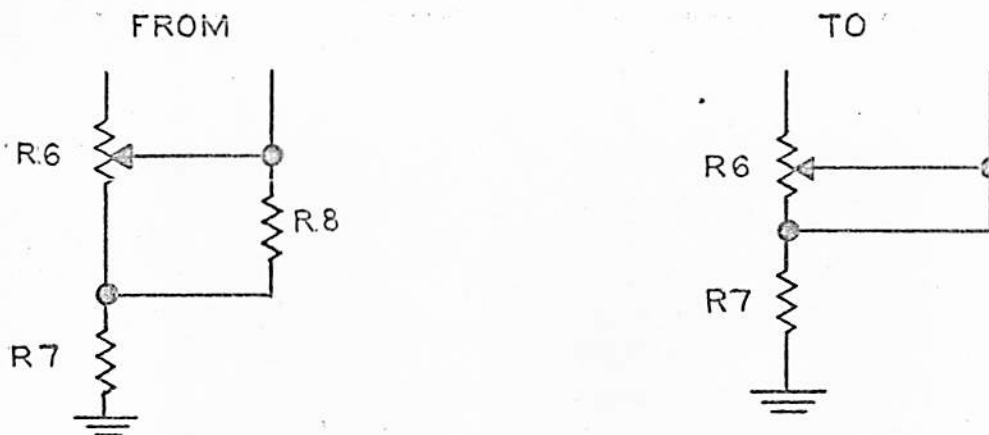
Table 1-1. Type R-1401/G VLF Receiver, Specifications

Frequency Range . . . . .	1 kc to 600 kc (Lower Band limit 500 cps)
Type of Reception . . . . .	AM, SSB, CW, MCW, and FSK
Noise Figure . . . . .	Less than 5 db
Sensitivity (50-ohm input impedance and 1-kc IF bandwidth) . . . . .	CW and FSK, 1 kc to 10 kc: 5 microvolts for 20 db (s plus n)/n CW and FSK, 10 kc to 600 kc: 0.5 microvolt for 20 db (s plus n)/n MCW and AM, 50 kc to 600 kc: 1 microvolt for 10 db (s plus n)/n
Input Impedance. . . . .	50 ohms or 1000 ohms, selectable by rear-panel switch
Input Attenuator. . . . .	0 db, -20 db, -40 db, or -60 db, selectable by front- panel switch
Maximum Input Level . . . . .	1 volt, rms, with input attenuator in -60 db position
IF Bandwidths. . . . .	150 cps, 1 kc, 3 kc, or 6 kc, selectable by front-panel switch
Image Rejection. . . . .	70 db, minimum
IF Rejection . . . . .	60 db, minimum
Dynamic Range . . . . .	AGC or Manual: 55 db, minimum
BFO . . . . .	Five separate BFO's: One variable $\pm 3$ kc by front- panel control and four crystal controlled to provide zero beat with IF frequency, a 1-kc beat note, and upper or lower sideband reception of SSB signals
Incidental FM. . . . .	Less than 10 cps peak deviation
Outputs . . . . .	Five: front-panel phone jack (2000 ohms, nominal); rear-apron audio, 6 milliwatts (600 ohms, balanced); local oscillator output; IF output; and output to feed a signal monitor
Audio Bandwidths . . . . .	Normal (100 cps to 3 kc) or narrow (825 cps to 1175 cps), selectable by front-panel switch
Power . . . . .	115/230 vac, 50-400 cps, approximately 25 watts
Size . . . . .	19-inches wide, 3.5-inches high, and 19.5-inches deep
Weight . . . . .	20 lbs., approximately

ADDENDA

For Types 351 and R1401/G VLF Receivers, the following changes are required on the appropriate parts lists and schematic diagrams:

- (1) Main Chassis: Paragraph 5.4.1 and Figure 6-22, delete R8.



- (2) Type 79108 Input Attenuator: Paragraph 5.4.3 and Figure 6-2, change R1 to 470 ohms, 5%, 1/4W, CB4715, Allen-Bradley.
- (3) Type 7681 +12V Regulated Power Supply: Paragraph 5.4.11 and Figure 6-20, change C2 to Capacitor, Electrolytic, Tantalum: 100  $\mu$ F, 10%, 25V, 109D107X9025F2, Sprague. Change C1 to 450  $\mu$ F, -10% +75%, 39D457G025FJ4, Sprague.
- (4) BFO and Product Detector, Part 11966: Paragraph 5.4.6.4 and Figure 6-8, change C3, C4, C30, and C32 to 47 pF, DM10-470J, Elmenco.
- (5) Type 11937 IF Amplifier and AM Detector, Paragraph 5.4.6.3 and Figure 6-7, change C1, C4, C7, C10, C11, and C14 to Ceramic Disc, .1  $\mu$ F, +80 -20%, UK10-104, Centralab. Change R2 to 15k, 5%, 1/4W, CB1535, Allen-Bradley.
- (6) Type 7981 Input Amplifier and Gate: Paragraph 5.4.9.6 and Figure 6-17, change Q1 through Q6 to 2N3478.
- (7) Type 7680 -12V Regulated Power Supply: Paragraph 5.4.12 and Figure 6-21, change C1 to 450  $\mu$ F, -10% +75%, 39D457G025FJ4, Sprague.
- (8) Type 7835 AGC Amplifier: Paragraph 5.4.7 and Figure 6-9, change C1 to 20V Capacitor P/N 150D106X9020B2.
- (9) Type 79124 Input Amplifier and Balanced Mixer: Part No. 11936/2 Input Amplifier and Balanced Mixer has been replaced by Part No. 12876. A parts list and schematic diagram which supersede paragraph 5.4.4 and Figure 6-3 have been included at the rear of this manual.



Figure 1-1. Type R-1401/G VLF Receiver, Front View

## SECTION I

## GENERAL DESCRIPTION

## 1.1 ELECTRICAL CHARACTERISTICS

The R-1401/G VLF Receiver tunes the frequency range of 1 kc to 600 kc in one band. It may be used for the reception of AM, CW, SSB, MCW, or FSK signals. A direct-reading digital readout is used to indicate the frequency to which the receiver is tuned. The frequency is normally displayed with an accuracy of  $\pm 100$  cps. A front-panel switch permits expanding the readout by a factor of 10, so that the frequency may be read to an accuracy of 10 cycles. A fine-tuning control is provided so that the receiver can be easily tuned this accurately. Four IF bandwidths are provided: 150 cps, 1 kc, 3 kc and 6 kc. Selection of the desired bandwidth is by means of a front-panel switch. The IF frequency is 2 mc. Two audio bandwidths are available: normal, which extends from 100 cps to 3 kc, and narrow, which is restricted to 825 to 1175 cps. Separate audio amplifiers are used to drive the front-panel PHONES jack and 600-ohm balanced output at the rear of the receiver. The front-panel AUDIO GAIN control adjusts only the headphones volume. An internal control is used to adjust the 600-ohm output level. The AM detector, local oscillator, and IF outputs are available at rear-apron BNC connectors. An output is also available for attaching a signal monitor. Other features of the receiver include an adjustable input attenuator to expand the dynamic range of the receiver to permit input signals of up to 1 volt, rms, AGC or manual gain control, switch-selectable antenna input impedances of 50 or 1000 ohms, and an extremely versatile BFO section. There are five separate beat frequency oscillators. One has a variable frequency which may be shifted 3 kc each side of the 2-mc IF center frequency. The other four oscillators are crystal controlled and provide outputs which zero beat with the IF frequency, give a 1-kc beat note, and give upper sideband or lower sideband reception of SSB signals (depending on which sideband is transmitted) when used with the 3-kc IF bandwidth. The desired BFO is selected by means of a front-panel switch. Performance specifications for the receiver are given in Table 1-1.

## 1.2 MECHANICAL CHARACTERISTICS

1.2.1 The front panel of the receiver mounts all controls normally needed for the operation of the unit. These are the DECIMAL SHIFT push-button switch for the frequency display, the FUNCTION, INPUT ATTENUATOR, IF BANDWIDTH, AUDIO BW, and BFO switches, the MAIN and FINE TUNING, AUDIO GAIN, MAIN IF GAIN, and BFO FREQ controls.

1.2.2 Located on the rear apron of the receiver are the RF INPUT jack, A1J1, the DETECTOR LEVEL OUTPUT jack, J1, the BALANCED AUDIO OUTPUT jack, J2, the LO OUTPUT jack, J4, the SM OUTPUT jack J5, the IF OUTPUT jack, J6, the 115/230-vac input power selector switch, the input impedance selector switch, and the line fuses. Jacks J1, J4, J5, and J6 are BNC-type connectors; A1J1 and J2 are twinax-type connectors.

1.2.3 The main chassis, the front panel and the top and bottom dust covers are constructed of aluminum. The IF and BFO assembly, the counter assembly, and the input amplifier and balanced mixer are enclosed in silver-plated brass chassis which have been gold-flashed to prevent tarnishing. The audio and AGC amplifiers, and the power supply regulators are built on etched circuit boards which plug into the main chassis. All the digital circuitry within the counter assembly is also built on plug-in etched circuit cards.

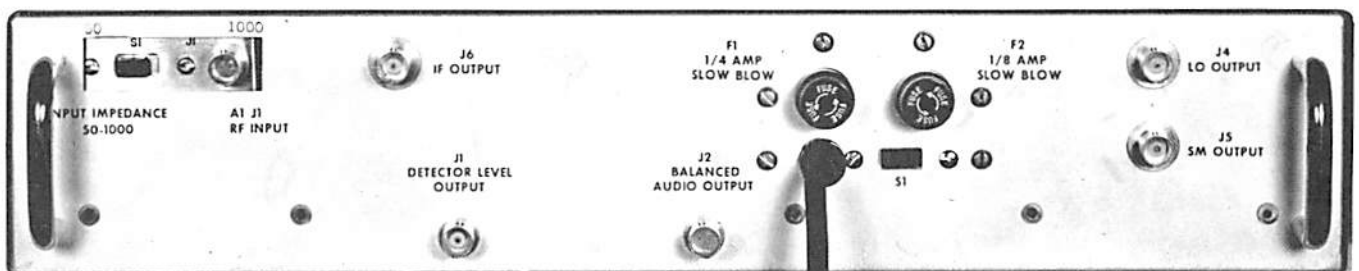


Figure 1-2. Type R-1401/G VLF Receiver, Rear View



Figure 2-1

Courtesy of <http://BlackRadios.terryo.org>

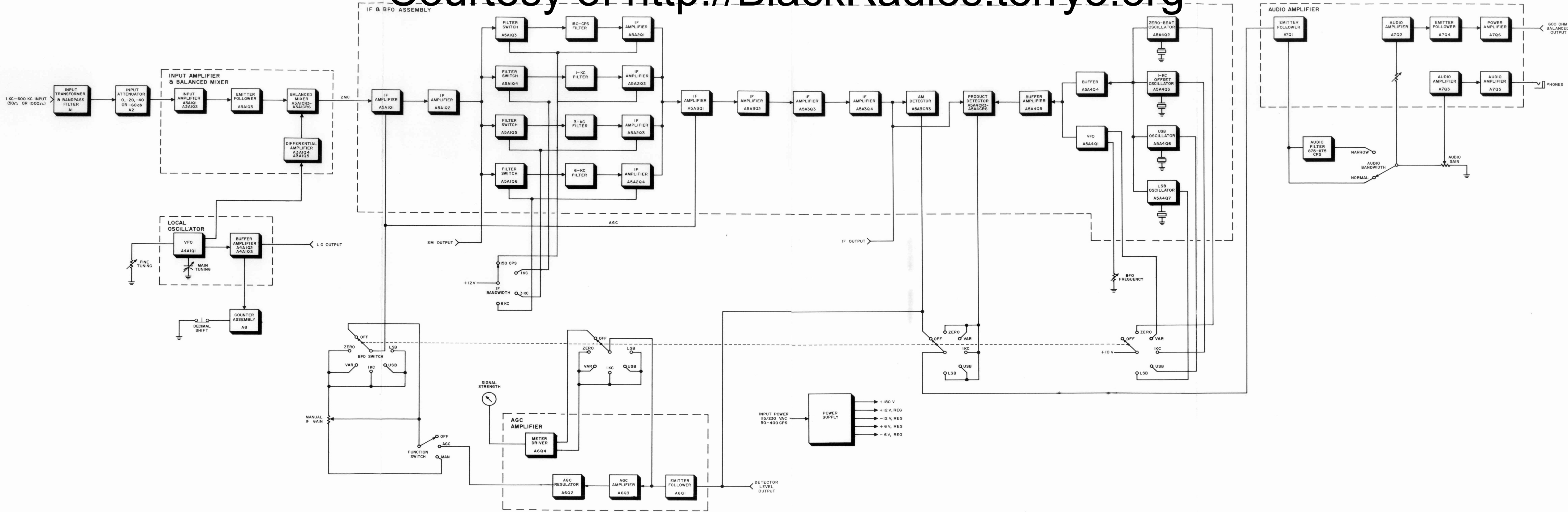


Figure 2-1. Type R-1401/G VLF Receiver, Simplified Functional Block Diagram



Figure 2-2

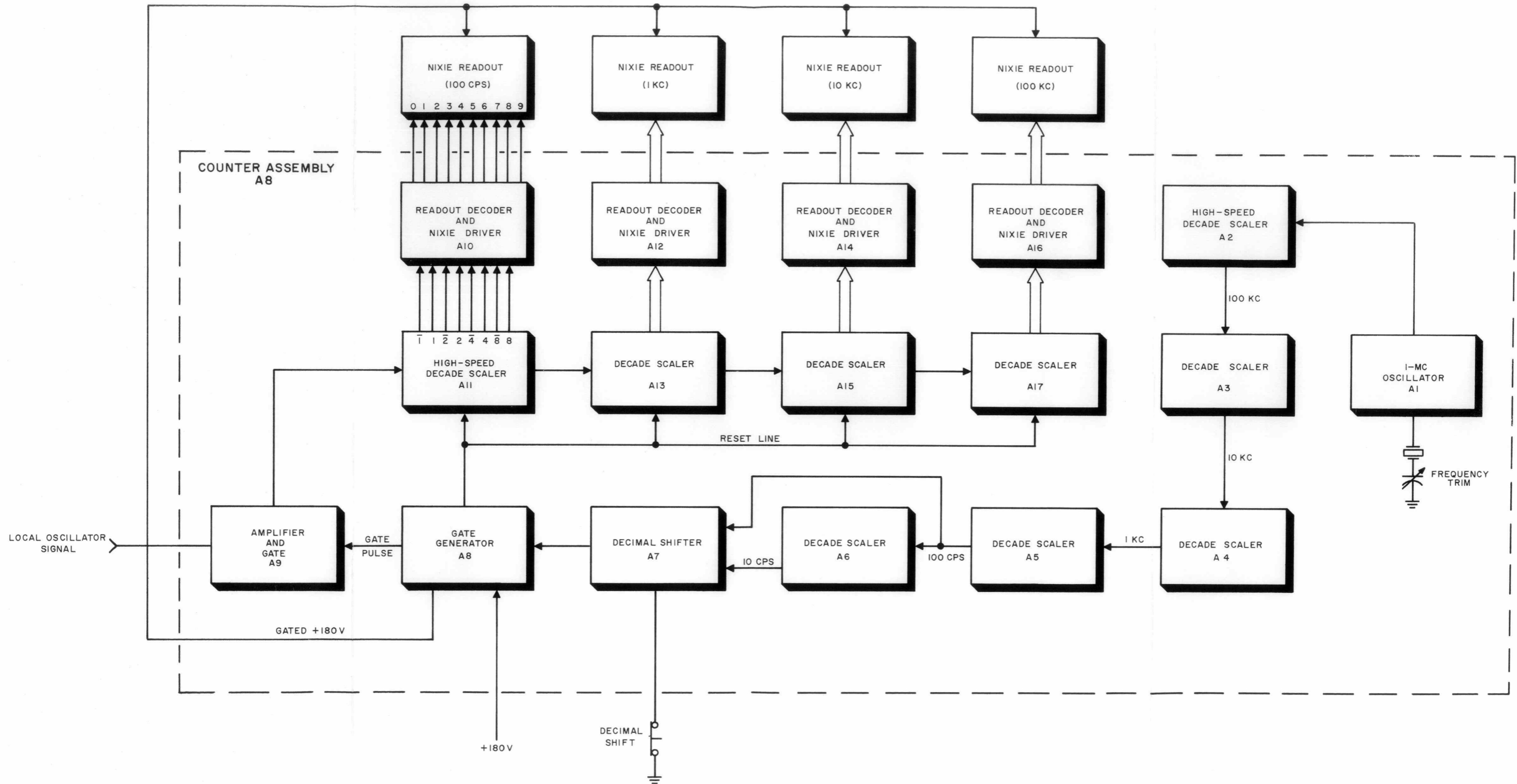


Figure 2-2. VLF Counter Assembly  
Simplified Functional Block Diagram

## SECTION II

## CIRCUIT DESCRIPTION

## 2.1 GENERAL

The operation of the VLF receiver is discussed using the functional block diagrams, Figure 2-1 and 2-2, and the schematic diagrams at the rear of this manual. In the functional analysis which follows, operation of the receiver and the frequency display will be discussed separately. Note that the unit numbering system is used for electrical components. This means that parts of subassemblies and plug-in modules carry a prefix before the usual class letter and number for the item (such as A1C1 and A2R2). These subassembly prefixes are omitted in the text and on illustrations except where confusion might result from their omission.

## 2.2 FUNCTIONAL ANALYSIS, RECEIVER

The VLF receiver is an all-solid state superheterodyne covering the frequency range of 1 to 600 kc in one band. AM, CW, SSB, FSK, or MCW signals may be received. Four IF bandwidths are provided: 150 cps, 1 kc, 3 kc, and 6 kc. A direct-reading digital readout is used which makes it possible to read the frequency to which the receiver is tuned within 10 cycles. The functional operation of the readout is discussed in paragraph 2.3.

2.2.1 Input signals to the receiver are applied to an input transformer which has a tapped primary to provide input impedances of 50 ohms or 1000 ohms. A rear-panel switch is used to select the proper impedance for the antenna being used. From the transformer the signal is passed through a bandpass filter which prevents signals outside the receiver's tuning range from entering the RF circuits. The filter has a pass band extending from 500 cps to 603 kc. A variable attenuator is connected between the filter and input amplifier. It prevents strong signals from overloading the receiver. The input signal may be attenuated by a factor of 0, -20, -40, or -60 db.

2.2.2 The incoming signal is next fed to a two-stage, untuned wideband amplifier made up of transistors A3A1Q1 and A3A1Q2. After amplification the input signal is passed through emitter follower A3A1Q3 to a balanced mixer where it is beat with the local oscillator signal. The 2-mc difference frequency which results from the mixing action is then fed to the IF amplifier assembly. An over-driven differential amplifier, A3A1Q4 and A3A1Q5, amplifies the local oscillator signal and provides a square wave signal to drive the balanced mixer.

2.2.3 The 2-mc output from the balanced mixer is amplified by IF stages A5A1Q1 and A5A1Q2, and applied in parallel to transistors A5A1Q3 through A5A1Q6 which function as switches and to the SM OUTPUT jack. Depending on the position of the IF BANDWIDTH switch one of the switch transistors will be energized, so that the signal passes through it and into the associated bandwidth filter. Crystal filters are used to determine all four IF bandwidths. IF amplifier stages A5A2Q1 through A5A2Q4 are also controlled by the IF BANDWIDTH switch. The outputs of all four stages are connected in parallel and share a common tank circuit. The proper stage is energized to pass the filter output on to the following IF amplifier stages. There are four additional IF amplifier stages before the AM detector A5A3Q1 through A5A3Q4. The IF signal is also taken at the output of A5A3Q4 and fed to the BFO product detector and to the IF OUTPUT jack. The AM detector provides the input to the AGC amplifier, and with the BFO off, the input to the audio amplifier.

2.2.4 The frequency of the local oscillator, A4A1Q1, is maintained 2 mc above the frequency to which the receiver is tuned. Both coarse and fine tuning controls are provided so that the receiver may be tuned with an accuracy of 10 cycles when used with the decimal shift function of the frequency display. The local oscillator signal is fed to the balanced mixer and to buffer-amplifier stages A4A1Q2 and A4A1Q3. These two stages provide the input to the counter assembly and feed the LO OUTPUT jack. They amplify the local oscillator signal and prevent hash generated in the counter from being fed into the balanced mixer.

2.2.5 There are five separate beat frequency oscillators. The desired one is energized by the BFO switch. With a BFO operating the input to the audio amplifier is switched from the AM detector to the BFO balanced mixer and the AGC circuit is defeated, even if the function switch is in the AGC position. Thus the gain of the receiver must be manually controlled when the BFO switch is moved from the OFF position. The variable frequency BFO, A5A4Q1,

## CIRCUIT DESCRIPTION

may be shifted in frequency 3 kc each side of the 2-mc center frequency. Its output is fed through buffer-amplifier stage A5A4Q5 to the product detector where it is heterodyned with the output of IF amplifier stage A5A3Q4. The difference frequency which results is fed to the audio amplifier. The four other beat frequency oscillators are crystal controlled. When used, the output of the one selected is fed through an additional buffer stage, A5A4Q4, before being applied to A5A4Q5. This buffer isolates the variable frequency oscillator from the crystal oscillators to prevent it from locking on a crystal frequency when tuned past one. The crystal-controlled beat oscillators provide upper or lower sideband reception of SSB signals (depending on the sideband transmitter) when used with the 3-kc IF bandwidth, give a 2-mc output to zero beat with the IF frequency, and a 2001-kc signal to provide a 1-kc beat note.

2.2.6 With the AGC-MAN switch in the AGC position, and the BFO off, receiver gain is controlled by the AGC amplifier. AGC action begins when the input signal attains an approximately 10-db (s plus n)/n ratio. Until this signal level is attained the receiver operates at maximum gain. Input to the AGC amplifier is from the AM detector. The AGC circuit consists of an input emitter follower, A6Q1, a dc amplifier, A6Q3, and the AGC regulator, A6Q2. The AGC regulator is connected in series with the +12 volt supply and the base bias circuits of A5A1Q1 and A5A3Q1. Once AGC action begins, as the output from the AM detector becomes more positive with increasing signal strength, the output from the AGC regulator becomes less positive, decreasing the gain of the gain-controlled stages. If the function switch is placed in the MAN position, or if the BFO is turned on, the receiver gain is manually controlled by the front-panel MAN GAIN control. This control varies the base bias of the same two stages controlled by the AGC amplifier. Transistor A6Q4 functions as a driver for the signal strength meter. Its input is derived from A6Q1. When the BFO switch is moved from the OFF position the output of A6Q1 is passed through a fast attack, slow decay network which decreases the sensitivity of the signal strength meter to the on-off characteristics of CW signals. This is to make the response of the meter to CW signals closely resemble the response to AM signals.

2.2.7 Separate audio amplifiers are used for the 600-ohm balanced output and to feed the front-panel PHONES jack. Both share a common input emitter follower, A7Q1. The input to the module is from the AM detector when the BFO is off, and from the BFO balanced mixer when the BFO is on. With the AUDIO BW switch in the NORMAL position, the output is applied directly to the two audio amplifier circuits. Placing the switch in the NARROW position routes the output of A7Q1 through a filter which restricts the audio bandwidths to 350 cps (825 to 1175 cps). The front-panel AUDIO GAIN control adjusts the volume at the PHONES jack only. A potentiometer on the audio amplifier module is used to set the level at the 600-ohm balanced output. The amplifier supplying this output contains a voltage amplifier, A7Q2, an emitter follower, A7Q4, used for impedance matching, and an output power amplifier, A7Q6. The headphones amplifier uses a two-stage circuit consisting of A7Q3 and A7Q5.

2.2.8 All receiver circuits operate from +12 or -12 vdc. The +180, +6, and -6 vdc outputs from the power supply are used by the counter assembly. Input power may be 115 or 230 vac, 50-400 cps. Power consumption is approximately 25 watts.

## 2.3 FUNCTIONAL ANALYSIS, FREQUENCY DISPLAY

The frequency display consists of the counter assembly, A8, the four Nixie display tubes on the front panel of the receiver, and the +180, +6, and -6 vdc power supplies. It displays the frequency to which the receiver is tuned by counting the local oscillator frequency and automatically subtracting the IF frequency. The frequency is normally displayed with an accuracy of  $\pm 100$  cps; however, by depressing the DECIMAL SHIFT switch the display is expanded by a factor of 10 so that the accuracy increases to  $\pm 10$  cps. When the decimal shift function is not used the oscillator frequency is counted for precisely controlled 10-millisecond intervals and displayed 50 times per second. Thus the display appears continuous and without flicker. Use of the decimal shift function increases the counting interval to 100 ms and decreases the display to five times per second. Under these conditions flicker is quite evident. In the functional description of the frequency display which follows it will be assumed that the DECIMAL SHIFT switch is not depressed unless specifically noted. The functional block diagram for this portion of the receiver is Figure 2-2.

2.3.1 Gating pulses are derived from the 1-mc oscillator, A1. A variable capacitor in series with the crystal is used to set the oscillator frequency at exactly 1 mc by zero beating with WWV. The oscillator module output is a train of positive pulses at a 1-mc rate. The pulse train is fed through five decade scalers (counters which count to 10 and then reset) in series (A2 through A6) which divides the 1-mc frequency by a factor of 10,000 or 100,000. Thus the output frequency from A5 is 100 cps and 10 cps from A6. The output from both these modules is fed to the decimal shifter, A7. When the DECIMAL SHIFT switch is not depressed the output of A5 is passed through the

decimal shifter and the 100-cps pulse train is used to control the operation of the gate generator, A8, which, in turn, controls the gating, reset, and display functions of the counter assembly. If the decimal shift function is used the output of A6 passes through the decimal shifter module and the 10-cps pulse train controls the gate generator.

2.3.2 The local oscillator signal output is fed to the amplifier and gate module, A9. The amplifier section of this module amplifies and shapes the input signal so that the output to the high-speed decade scaler, A11, is a train of positive pulses having a very fast rise time. These pulses are gated into A11 in 10-ms bursts at a 50-cps rate. When a gate pulse is received from the gate generator the signal flow is cut off and a 10-ms display and reset interval begins. During the first 8 ms of this interval the gated +180 volts is applied to the Nixie readout so that they can display the count which accumulated during the preceding 10-ms interval. Following the 8-ms display period the gated +180 volts for the Nixies is cut off, extinguishing the display, and a 2-ms reset interval begins. A 0.5-ms reset pulse from the gate generator resets A11, A13, A15, and A17 to all zeros, and 1.5 ms later the next 10-ms counting interval begins. The gate generator timing operations can be summarized as follows: A 10-ms counting interval is followed by a gate pulse which cuts off the flow of the local oscillator signal into the counter. When the gate pulse is generated the +180-vdc Nixie supply is turned on for 8-ms and the count held by the decade scalers is displayed. Following this interval the display is extinguished, and the reset pulse is simultaneously generated. Two ms later another 10-ms counting interval begins. Thus each count and display interval requires 20 ms, so that the local oscillator frequency is updated and displayed at a 50-cps rate.

2.3.3 All decade scalers in the counter assembly contain four flip flops and count in the binary coded decimal (BCD) system. That is, the scaler counts from 0 to 9 for a total count of 10, and then resets itself to 0. The readout decoder and Nixie driver modules continuously decode the contents of their associated decade scalers from binary to its decimal equivalent, but readout cannot occur until the +180 vdc is gated to the Nixies at the beginning of the display period.

2.3.4 Although the local oscillator signal is counted for only a 10 ms (or 100 ms) interval, the frequency is displayed in kilocycles per second. This is done by placing the decimal point in the display where it would appear if the signal were actually counted for a full second, and by not displaying the "2" which would always appear as the most significant digit in the readout. For example, assume the receiver is tuned to 500 kc. The local oscillator frequency will then be 2500 kc. In 10 ms 25,000 cycles will be counted. The "2" is dropped and the decimal point is placed so that the display reads 500.0 kc. When the DECIMAL SHIFT switch is used the counting interval is increased to 100 ms, the two most significant digits are not displayed, and the decimal point is shifted one place to the left. Assuming that the receiver is tuned to 500.55 kc, the oscillator frequency will be 2500.55 kc. Before depressing the DECIMAL SHIFT switch the display will read 500.5 kc. Once the switch is depressed 250,055 cycles will be counted in each 100 ms counting interval. The "2" and "5" are dropped from the display and the readout is 00.55 kc. It is necessary to mentally add the "5" to get the true frequency reading: 500.55 kc.

## 2.4 INPUT TRANSFORMER AND FILTER ASSEMBLY

Figure 6-1 is the schematic diagram for the input transformer and filter assembly. Its reference designation prefix is A1. The incoming signal is fed into the receiver through input transformer T1. The primary of T1 is tapped, providing balanced input impedances of 1000 ohms or 50 ohms, depending on the position of selector switch S1. To prevent ground loops and minimize hum the balanced circuit is maintained through the filter portion of this module, the input attenuator, A2, and into the input amplifier, A3. The entire transformer-filter assembly is encased in a steel inner chassis to prevent the pick up of 60 cps radiation from the receiver's own power transformer and from outside sources. From the secondary of T1 the signal is fed through a bandpass filter which passes only those signals in the 500 cps to 603 kc frequency range. It contains series traps for 1-mc and 2-mc signals. The purpose of the filter is to prevent interference from signals outside the receiver's tuning range, particularly those near the receiver's 2-mc IF frequency, or harmonics of this frequency.

## 2.5 INPUT ATTENUATOR

The input attenuator is used to prevent overloading the receiver on strong signals. It is connected between the input filter and the input amplifier. Figure 6-2 is the schematic diagram for the attenuator; its reference designation prefix is A2. The front-panel INPUT ATTENUATOR switch, A2S1, selects various combinations of resistors to provide attenuations of -20, -40, and -60 db. When the 0 db switch position is selected, the signal is routed through the attenuator without encountering any resistors.



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### 2.6 INPUT AMPLIFIER AND BALANCED MIXER

Figure 6-3 is the schematic diagram for the input amplifier and balanced mixer; A3 is its reference designation prefix.

**2.6.1 Input Amplifier.** - The input amplifier consists of transistors A1Q1 and A1Q2 in a dc-coupled, complementary configuration. A1Q1 is an ultra-low noise, high-gain transistor. Capacitor A1C2 and resistor A1R3 provide a negative feedback path from the collector of A1Q1 to its base. This network is used to cause the input impedance to be approximately 1000 ohms, matching the impedance through the input transformer, filter, and attenuator. A second negative feedback path is from the collector of A1Q2 through A1R6 to the emitter of A1Q1. This feedback is to equalize the response of the input amplifier over the receiver's 1-kc to 600-kc tuning range. Capacitor A1C3 and resistor A1R5 in the emitter of A1Q1 cause the response of the amplifier to roll off rapidly below 500 cps. Silicon diodes A1CR1 and A1CR2 at the input to A1Q1 prevent the incoming signal from exceeding 1.2 volts peak-to-peak and overloading the amplifier. Emitter follower A1Q3 is connected between A1Q2 and the balanced mixer to prevent the modulator from loading down the amplifier. The signal output from A1Q3 is beat with the local oscillator signal in the balanced mixer to produce a 2-mc output.

**2.6.2 Balanced Mixer.** - A balanced mixer is used rather than a conventional mixer, to prevent the local oscillator signal from entering the IF amplifier stages when the receiver is tuned near the end of its low-frequency range. The balanced mixer suppresses the input signal to the receiver and the local oscillator signal, passing the sum and differences of the two signals. Since the following IF stage is tuned to the difference frequency (2 mc), only this frequency is passed. The balanced mixer consists essentially of diodes A1CR3 through A1CR6 connected in a symmetrical lattice configuration, and transformers A1T1 and A1T2. Resistors A1R14, A1R15, A1R21, and A1R22 equalize the current through the diodes. The local oscillator signal is used to switch the diodes in the balanced mixer, and is applied to the mixer circuit through A1T1 which drives an amplifier made up of A1Q4 and A1Q5. The amplifier provides a push-pull output from an unbalanced input. It is overdriven to provide a square-wave output. Using a square wave as the diode switching voltage helps minimize intermodulation products resulting from the mixing action. The signal from A1Q4 is coupled to A1Q5 through A1C13. The positive-going half cycle of the LO signal drives A1Q4 to saturation. This results in a positive-going signal on the emitter of A1Q5 which cuts this transistor off. On the negative-going half cycle of the LO signal A1Q4 is cut off and A1Q5 goes into saturation. Capacitor A1C11 holds the base of A1Q5 at RF ground potential. Its dc base voltage is set by A1R30. This potentiometer is used to adjust the output square wave from the amplifier for maximum symmetry. Resistor A1R32 across the primary of A1T1 damps out an undesirable ringing in the square wave. The LO signal switches the diodes in the mixer circuit at a rate twice the oscillator frequency (once every positive half cycle, and once every negative half cycle). When the LO voltage is positive at the junction of A1R14 and A1R15 diodes A1CR3 and A1CR5 are forward biased. When the voltage reverses, A1CR4 and A1CR6 are forward biased. As a result, the input signal current flowing in the primary of A1T2 changes direction each time the diodes switch. The amount of current flowing will depend on the instantaneous value of the input signal voltage. The output contains the upper and lower sidebands which result from mixing the input and LO signals. Since the following IF stage is tuned to the lower sideband frequency (2 mc) only this frequency will pass. The input and LO signals are cancelled by the balanced mixer. Variable resistors A1R19 and A1R27 are dc balance controls for the mixer and A1C8 is an ac balance control. These controls compensate for any inherent unbalance in the circuit, and are adjusted for maximum suppression of the LO signal.

### 2.7 IF AND BFO ASSEMBLY

The IF and BFO assembly is included on the main chassis schematic diagram, Figure 6-22. It contains five subassemblies, each of which is discussed separately below. A5 is the reference designation prefix for the entire assembly.

**2.7.1 IF Bandswitching Amplifier "A".** - Figure 6-5 is the schematic diagram for this subassembly; its reference designation prefix is A5A1. The input signal from the balanced mixer is applied through dc-blocking capacitor C2 to IF amplifier Q1. The stage is tuned by means of variable inductor L1 in its collector circuit. The inductor resonates with its distributed capacitance, and capacitors C3 and C4. It is tuned to 2 mc. Resistor R3 in the collector circuit is included for parasitic suppression. Unbypassed emitter resistor R5 provides degenerative ac feedback to stabilize the stage. Gain of the stage is controlled by the AGC amplifier when the function switch is in the AGC position and the BFO is off. With the BFO in use or the function switch in the MAN position the gain of Q1 is determined by the front-panel IF GAIN control. The gain control voltage is applied to the base voltage divider, R2-R4, and varies the stage gain by varying the forward bias

on the base-emitter junction of the transistor. The output of the stage is coupled through an impedance-matching capacitive voltage divider made up of C3 and C4 to the second IF amplifier stage, Q2. This stage is identical to the first except that it is not gain controlled. Neutralization of the IF stages is not required due to the use of high-frequency transistors and operating them at nominal gain. The output of Q2 is applied in parallel to Q3 through Q6 and through an impedance-matching resistive pad to the SM OUTPUT jack. These latter four transistors provide no gain, functioning only as switches. They isolate Q2 from the three unused IF bandwidth filters, and provide a closed circuit to the filter being used. The IF BANDWIDTH switch determines which transistor will be turned on by applying +12 vdc to the base voltage divider. This forward biases the base-emitter junction so that the signal can pass through to the bandwidth filter.

**2.7.2 IF Bandwidth Switching Amplifier "B".** - Figure 6-6 is the schematic diagram for this subassembly; its reference designation prefix is A5A2. The subassembly contains four IF amplifiers, Q1 through Q4, which share a common tuned collector circuit. The IF BANDWIDTH switch turns on the proper transistor to receive the output of the selected bandwidth filter by applying a forward bias to its base-emitter junction. Resistive pads are in the base circuit of each transistor to equalize the noise output from each bandwidth filter. In other respects the amplifier stages are quite similar to those in the IF amplifier "A".

**2.7.3 IF Amplifier and AM Detector.** - The schematic diagram for this subassembly is Figure 6-7; A5A3 is its reference designation prefix. The 2-mc input signal is received from the IF amplifier "B", and is fed through four additional IF amplifier stages, Q1 through Q4. Except for Q4 the stages are quite similar to those described in paragraph 2.7.1. Depending on the type of receiver operation, Q1 is gain controlled by the AGC amplifier or the IF GAIN control. A PNP transistor is used in the Q4 position to reference the AM detector, CR3, output level to zero vdc. The IF output for the BFO product detector and IF OUTPUT jack is taken at the junction of capacitors C15 and C16. Silicon diodes CR1 and CR2 clamp the anode of CR3 at approximately 1.2 vdc to keep it forward biased. This is done to improve the linearity of the AM detector output. A low-pass filter made up of R25, C19 and C20 removes RF components which appear in the detector output. This output is fed to the AGC amplifier, the rear-panel DETECTOR LEVEL OUTPUT jack, and when the BFO switch is in the OFF position, to the audio amplifier.

**2.7.4 BFO and Product Detector.** - Figure 6-8 is the schematic diagram for the BFO and product detector; its reference designation prefix is A5A4. There are five separate beat frequency oscillators. Four are crystal controlled: Q2, Q3, Q6, and Q7. The frequency of the other, Q1, may be varied approximately 3 kc each side of the 2-mc center frequency. The oscillator in use depends on the position of the front-panel BFO selector switch. With the switch in the ZERO position Q2 is energized. Placing the switch in the VAR position turns on Q1. Moving it to the 1 KC, USB, or LSB position energizes Q3, Q6, or Q7, respectively. The output from the "on" oscillator is mixed with the output from the IF amplifier in the product detector to produce an audible beat note, or in the case of single sideband reception, to render the transmission intelligible.

**2.7.4.1 Variable Oscillator.** - Transistor Q1 is the variable oscillator. The basic oscillator circuit is a modified Clapp with regenerative emitter-to-base feedback to sustain oscillation taken at the junction of C10 and C11 through R8. The purpose of R8 is to improve the linearity of the oscillator output. Capacitor C16 maintains the collector at RF ground potential. The oscillator frequency is shifted by varying the dc voltage across voltage-variable capacitor CR1 by means of the BFO FREQ control. A voltage-variable capacitor is a semiconductor device whose capacitance varies inversely with the voltage applied across it. Thus, if the voltage across CR1 increases, its capacitance decreases so that the oscillator frequency increases. The output from Q1 is coupled through capacitor C17 to buffer-amplifier Q5. This transistor isolates the variable frequency oscillator from the product detector to prevent the detector from loading the oscillator and affecting its frequency stability. In addition, Q5 amplifies the output signal of the oscillator in use to switch the diodes in the product detector. The collector circuit of Q5 is broadly tuned to 2 mc by a parallel resonant circuit made up of C22 and the primary of T1. Zener diode CR2 regulates the voltage for the selected oscillator at +10 vdc.

**2.7.4.2 Crystal-Controlled Oscillators.** - All four of the crystal-controlled oscillator circuits are identical, therefore only the zero-beat oscillator, Q2, will be discussed. The oscillator circuit is a crystal-controlled Colpitts. Regenerative emitter-to-base feedback is taken at the junction of C12 and C13 through R10. Capacitor C6 holds the collector of Q2 at RF ground potential. The oscillator output is applied directly to the base of buffer stage Q4. This transistor isolates the variable frequency oscillator from the crystal oscillators to prevent the VFO from locking onto a crystal frequency as it is tuned past. The buffer stage has no gain. Its output is coupled through C19 to Q5.

**2.7.4.3 Product Detector.** - The product detector provides an output which is proportional to the product of the IF

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input signal and the injected BFO signal. When either is not present there is no output. This type of detector is used to minimize the intermodulation distortion inherent in the demodulation process. The detector consists essentially of diodes CR3 through CR6 connected in a ring configuration. Resistors R23, R24, R27, and R29 equalize the current through the diodes. Potentiometer R26 is used to adjust the IF signal voltage applied across the detector to obtain maximum cancellation of RF currents in the detector. The switching voltage for the diodes is supplied by the BFO. If, for example, the BFO voltage causes the junction of R23 and R24 to go positive, then CR3 and CR4 will be forward biased. The IF signal will be shorted to ground through CR3 or CR4, depending on the polarity of the IF signal, and there will be no output from the detector. When the BFO voltage reverses so that the junction of R27 and R29 is positive, CR5 and CR6 will be forward biased. Under this condition there will be an output from the detector. When the IF signal is positive current flows through CR5. When the signal reverses polarity the current flows through CR6, and the current through the load is reversed. Capacitors C27 and C28 and resistor R34 form a low-pass filter at the output of the detector to bypass high-frequency signal components.

### 2.8 LOCAL OSCILLATOR

Figure 6-4 is the schematic diagram for the local oscillator; its reference designation prefix is A4. The frequency of the local oscillator A1Q1 is maintained 2 mc above the frequency of the incoming signal. A modified Clapp circuit is used for the oscillator. Regenerative emitter-to-base feedback to sustain oscillation is taken at the junction of A1C6 and A1C7. Variable capacitor C5 is the main tuning control. Fine tuning is accomplished by varying the dc voltage across voltage-variable capacitor A1CR1 which is effectively in parallel with inductor L1. (See paragraph 2.7.4.1 for the operation of a voltage-variable capacitor). Capacitor C6 is a variable temperature compensating trimmer. Its capacitance varies with temperature changes in the direction required to compensate for the shifts in value of the temperature-dependent components to maintain the oscillator frequency constant. Zener diode A1CR2 regulates the oscillator collector voltage at +10 vdc. This same voltage is used by the front-panel FINE TUNING control. The oscillator output is fed through A1C9 to the balanced mixer and LO OUTPUT jack, and through A1C10 to a buffer-amplifier. The primary purpose of this circuit is to prevent hash generated in the counter from feeding through to the balanced mixer. It also amplifies the local oscillator signal to a sufficient level to insure reliable counting. The amplifier consists of a NPN transistor, A1Q2, directly coupled to a PNP transistor, A1Q3, in a complementary configuration. Negative feedback to stabilize the amplifier is fed to the emitter of A1Q2 from the junction of A1R10 and A1R11.

### 2.9 AGC AMPLIFIER

The AGC amplifier is a plug-in module which controls the gain of the receiver when the function switch is in the AGC position and the BFO is off. AGC action begins when the input signal to the receiver attains a  $(s + n)/n$  ratio of approximately 10 db. Figure 6-9 is the schematic diagram for the module; A6 is its reference designation prefix.

2.9.1 The input to the AGC amplifier is obtained from the AM detector. It is applied to an emitter follower, Q1, which drives dc amplifier Q3 and the signal strength meter driver, Q4. Resistor R3 and capacitor C1 form a modulation filter to remove audio variations from the detector output so that the base of Q3 receives a dc voltage which varies in direct proportion to the average value of the input carrier to the receiver. Thus, as the input signal strength increases the AM detector output becomes more positive, as does the base of Q3. As a result, Q3 conducts harder causing its collector, and the base of series regulator Q2, to go less positive due to the voltage drop across R4. Transistor Q2 is connected in series with the +12 volt supply and the base-bias circuits of the AGC-controlled IF stages, so that as its base voltage drops it conducts less, and the AGC output voltage becomes less positive. As a result, the forward bias on the gain-controlled stages decreases so that receiver gain is reduced. Should the input signal strength decrease, the AM detector output also decreases, so that the AGC voltage becomes more positive, increasing the gain of the receiver.

2.9.2 Input to the signal strength meter driver is taken from Q1 before the modulation filter. There are two possible paths for the signal to reach Q4. The path taken depends on the position of the BFO switch. With the switch in the OFF position the signal is fed through R6 to the base of Q4. Placing the switch in any of the BFO positions routes the signal through CR1 and R8 to Q4. This is done to make the response of the meter to CW approximate its response to AM signals. Diode CR1 and resistor R8 provide a low-impedance charge path for C2 so that the capacitor charges rapidly. When there is a break in the signal C2 discharges slowly through R7 so that the meter needle does not drop rapidly back to zero before the next signal burst. Transistor Q4 operates as an emitter follower. Silicon diodes CR2 and CR3 in the emitter circuit protect the meter from damage in the event of an excessively strong signal. If



the output from Q4 exceeds approximately 1.2 volts the diodes conduct and clamp the output at this value. Should the input signal continue to increase no additional current can be forced through the meter.

## 2.10 AUDIO AMPLIFIER

Separate audio amplifiers are used to supply the front-panel PHONES jack and balanced 600-ohm output at the rear of the receiver. The front-panel AUDIO GAIN control affects only the PHONES jack amplifier. Both amplifiers are built on the same plug-in etched circuit board. Figure 6-10 is the schematic diagram for the audio amplifier board; A7 is its reference designation prefix.

2.10.1 Input to the audio amplifier is from the AM detector when the BFO is off, and from the product detector when the BFO is on. The input is fed to an emitter follower, Q1, which is common to both amplifiers. When the audio bandwidth switch, S5, is in the NORMAL position, the output from Q1 is fed directly to the balanced output amplifier and through the AUDIO GAIN control to the PHONES amplifier. Placing S5 in the NARROW position routes the signal through an audio filter before it is fed to the two amplifiers. The filter consists of capacitor C2 on the amplifier board in series with variable inductor L1 on the main chassis. It is tuned to 1 kc. Resistor R15 is shunted across L1 to lower the Q of the inductor sufficiently to attain a 350-cps filter bandwidth.

2.10.2 The headphones amplifier consists of transistors Q3 and Q5 in a direct-coupled complementary configuration. Silicon diode CR1 provides thermal protection for the amplifier. When the base-emitter resistance of silicon transistor Q3 decreases due to an increase in temperature it will conduct harder. The conduction of the diode, which is made of the same material, will also increase by approximately the same amount. This results in a decrease in the forward bias on the transistor so that its conduction drops to a safe value. Negative feedback from the collector of Q5 to the emitter of Q3 is obtained through R15. Resistor R12 and capacitor C5 in the emitter circuit of Q3 cause the amplifier response to fall off rapidly above 3000 cps. Output from the amplifier is fed through R20 and C7 to the PHONES jack.

2.10.3 Gain of the balanced output amplifier is controlled by potentiometer R4 on the amplifier board. Three direct-coupled transistors Q2, Q4, and Q6 are used for the amplifier. The first stage, Q2, is a conventional voltage amplifier in a common emitter configuration. The second stage is an emitter follower used to match the high output impedance of the first stage to the low input impedance of the third stage, a power amplifier. Paralleled capacitor C6 and resistor R18 couples the signal from Q4 to Q6. This arrangement is used to increase the stability of the amplifier. Resistor R21 provides negative feedback from the output stage to the emitter of Q2. Capacitor C1 and resistor R24 in the emitter circuit of Q6 causes the amplifier response to roll off at 3000 cps. Capacitor C8 across the secondary of input transformer T1 is also included to attenuate output signal components above 3 kc. To minimize hum and maintain the proper impedance RG-108A coaxial cable is used to feed the signal to the twinax-type output connector.

## 2.11 COUNTER ASSEMBLY

The counter assembly contains all logic circuitry required for the counting, decoding, and display of the receiver's local oscillator frequency. It is built as a self-contained, shielded assembly to minimize RFI. Figure 6-11 is the schematic diagram for the counter assembly; it carries the reference designation prefix A8.

### 2.11.1 High-Speed Flip Flop. -

2.11.1.1 The counter assembly contains nine decade scalars, each using four steered flip flops. All the flip flops are quite similar, differing primarily in the components added to speed up the switching action in modules A8A2 and A8A11. During the counting operation flip flops are switched by applying a negative trigger pulse through a steering diode to the base of the conducting transistor, cutting it off. Resetting is accomplished by applying a positive pulse directly to the base of the proper transistor so that it turns on if it is not already conducting. The flip flops operate in the saturated mode. When a transistor is off (collector voltage approximately 5.5 vdc) it is considered to be in the binary "one" state; when conducting the transistor is considered to be in the binary "zero" state. Due to the similarity of the flip flops, the operation of only the most complex will be discussed. As the switching speed requirement decreases speed-up components are omitted from this basic circuit.

2.11.1.2 Referring to Figure 2-3 assume that Q1 is conducting, and Q2 is cut off. The positive input pulse is passed through C2 and C4 and differentiated into positive-going and negative-going spikes. Steering diodes CR2 and



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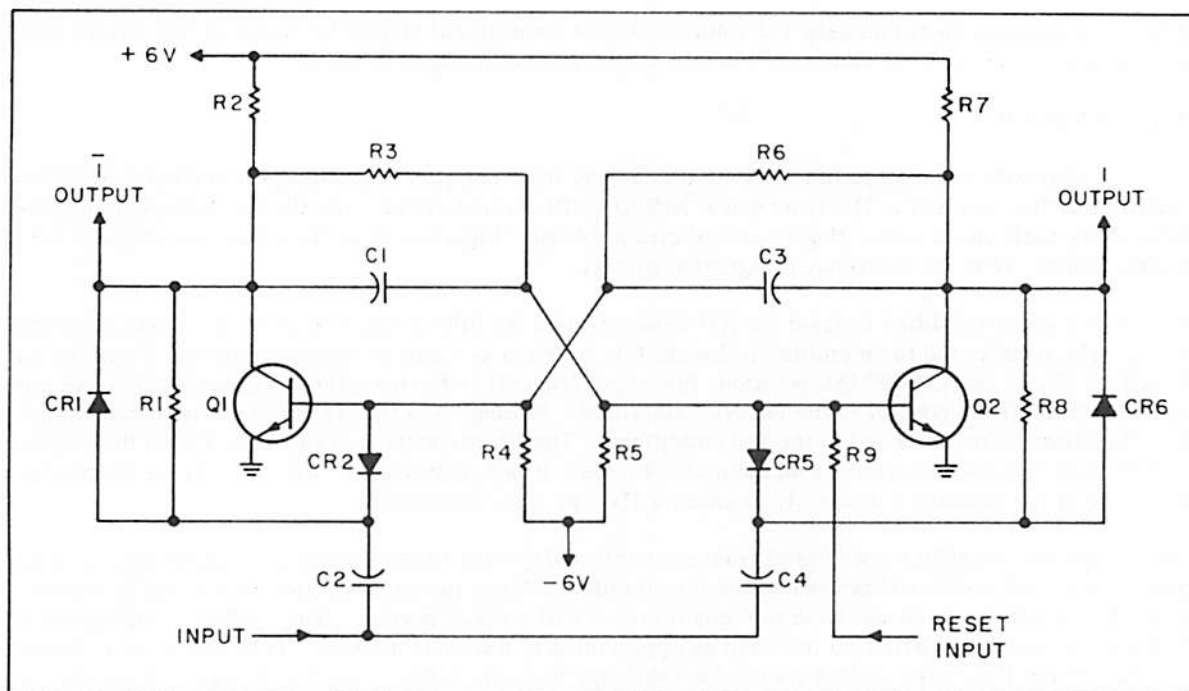


Figure 2-3. High-Speed Flip Flop

and CR5 are connected so that the positive-going spikes can never reach the transistor bases. However, due to the positive base voltage of conducting transistor Q1, diode CR2 is forward biased to the negative-going spike so that it reaches the base of Q1. This transistor will now move toward cut off. The positive-going voltage at its collector is coupled through R3 and C1 to the base of Q2. As Q2 begins to conduct the negative-going voltage at its collector is coupled through R6 and C3 to the base of Q1, assisting the cut off of the latter transistor. This regenerative action continues until a stable condition is reached with Q2 conducting and Q1 held at cut off due to the drop across voltage divider R4 and R6 from the -6 vdc supply. With the flip flop in this condition steering diode CR2 will be reverse biased due to the negative voltage at the base of Q1, and CR5 forward biased due to the positive potential at the base of the conducting transistor. The negative spike resulting from the next input pulse will then be conducted through CR5 to reverse the state of the flip flop. If the flip flop is reset before the next input pulse, the positive reset pulse is applied directly to the base of Q2 through R9. The output of Q2 will then switch to a binary "zero" if it is not already in this state.

2.11.1.3 Diodes CR1 and CR6 speed up the switching time of the transistors by providing low-impedance charging paths for C2 and C4, respectively, on alternate input pulses. If, for example, Q1 is conducting and Q2 is cut off, the cathode of CR1 is at ground potential through the collector of Q1, while the cathode of CR6 will be at approximately +6 vdc. The next input pulse will charge C2 and C4 in the positive direction. Diode CR1 will provide a low-impedance charge path for C2 so that it rapidly charges to the pulse amplitude (less the voltage drop across the diode). Diode CR6 will be reverse biased so that C4 must charge through R8. As a result of the high-impedance charging path C4 never becomes fully charged. When the input pulse is changing in the negative direction on the trailing edge, a negative-going spike of maximum amplitude from C2 will be conducted through CR2 to the base of Q1, starting the cut-off action. Thus by providing a rapid charge path for the input capacitors in the proper sequence, CR1 and CR6 speed up the switching time. Cross-coupling capacitors C1 and C3 speed up the turn-off time of the conducting transistor by forcing a charge into its base to overcome the stored minority carrier charge in the base region due to saturated operation of the transistor. The fall time of the switching cycle cannot begin until this stored charge is depleted. As the input pulse goes negative on the trailing edge, the charge held by C1 (or C3) is discharged into the base of Q2 (or Q1) to cancel the stored charge.

2.11.2 BCD Counting. - Referring to Figure 2-3, each time the input pulse is changing in the negative direction, the collector voltage of Q2 changes. The change in voltage is alternately positive-going and negative-going. If the collector

voltage of Q2 is used as the output pulse, one output pulse is obtained for every two input pulses received. Thus the flip flop divides the number of input pulses by a factor of two. By cascading "n" number of flip flops the over-all dividing factor is  $2^n$ . If four flip flops are connected in cascade ( $n = 4$ ), 16 input pulses are required to produce one output pulse. When decimal operation (BCD) is desired, as in the VLF receiver counter assembly, a means must be provided for automatically resetting of four flip flop counters (a decade scaler) after ten input pulses rather than continuing to count up to 16. That is, on the tenth input pulse the output of the four counter stages must move from 1001 to 0000 rather than moving to 0101. Thus the binary "one" held by the  $2^0$  flip flop must be prevented from moving to the  $2^1$  position, and the  $2^3$  flip flop must be reset to "zero". Figure 2-4 illustrates how this is done. Note the feedback from Q7 to Q4, and that Q7 and Q8 are driven from separate sources. For input pulses 1 through 7 the counter functions in a manner similar to an ordinary cascaded four flip flop counter. Diode CR8 prevents the positive-going transitions at the collector of Q2 (which occur on every odd count) from reaching the base of Q7. Since Q7 is off the negative-going transitions at the collector of Q2 (which occur on even counts) have no effect. On the count of 8 the negative-going transition at the collector of Q6 cuts off Q8 which cuts Q7 on. With Q7 conducting the dc path through R9, CR7 and Q7 results in a forward bias on CR7 so that the junction of CR7 and CR10 is essentially at ground potential. On the count of 9, Q2 is cut off so that the binary output of the counter now stands at 1001. When the tenth input pulse occurs the collector voltage of Q2 moves in the negative direction. Since the anode end of CR10 is clamped to ground potential due to the forward bias on CR7 through the conducting Q7, the negative transition cannot affect Q4, so the  $2^1$  position remains in the "zero" state. However, the negative-going voltage is conducted through CR8, which is forward biased with Q7 conducting, cutting off Q7. The binary output of the decade scaler is now 0000 with a carry passed to the next higher decade when the negative transition at the collector of Q8 occurred on the tenth count. By applying a positive reset pulse to the bases of the even numbered transistors all four stages of the decade scaler will be placed in the binary "zero" state.

2.11.3 1-mc Oscillator. - Figure 6-12 is the schematic diagram for the 1-mc oscillator; A8A1 is its reference designation prefix. The basic oscillator circuit is a crystal-controlled Colpitts. Trimmer capacitor C2 is used to set the oscillator frequency to exactly 1 mc by zero beating with WWV. Emitter-to-base feedback to sustain oscillation is taken at the junction of C4 and C5. Transistor Q2 is biased off so that it conducts only when the collector voltage of Q1 is negative-going. When Q2 conducts positive-going pulses are formed at its collector. These pulses are differentiated and shaped by R5, L1, and C6. The positive spikes bias Q3, which is normally off, to saturation. The voltage drop across R6 thus produces a negative-going pulse. These pulses at a 1-mc rate constitute the output from the module. Diode CR1 damps out the negative spike produced by the differentiating action of L1.

2.11.4 Decimal Shifter. - The schematic diagram for the decimal shifter is Figure 6-15; A8A7 is its reference designation prefix. This module determines if the output from decade scaler A8A5 or A8A6 controls the gate generator. When the DECIMAL SHIFT switch is not depressed the 100-cps output of A8A5 is passed through the decimal shifter to the gate generator. Depressing the switch results in the 10-cps output of A8A6 passing through to the gate generator. The decimal shifter consists of a bistable flip flop, Q2 and Q3, which may be triggered from either of two sources, A8A5 or A8A6. Triggering of the flip flop is accomplished by grounding the collector of the "off" transistor. This is the function of Q1 and Q4. With the DECIMAL SHIFT switch in the normal position the cathodes of CR9 and CR10 are grounded. The diodes are forward biased from the +6 vdc source through R2 and R12, respectively, which effectively grounds the 10-cps input so that it has no effect on the operation of the module. Assume that Q3 is off and Q2 is conducting. When the "not-eight" input at pin 16 goes to the logic "one" level CR7 will be reverse biased, which results in a forward bias on CR6. This causes the base voltage of Q4 to increase in the positive direction, cutting the transistor on. With Q4 conducting the voltage at the junction of R6 and R7 increases in the negative direction, causing Q2 to move toward cut-off. The positive-going collector voltage of Q2 is coupled through C3 and R5 to the base of Q3, which starts this transistor cutting on. This action continues regeneratively until Q2 is cut off and Q3 is conducting to saturation. The "one" at the "not-eight" input now appears at the "not-eight" output, pin 12. The flip flop will remain in this state until the "eight" input at pin 17 switches to the logic "one" level. If the DECIMAL SHIFT switch is depressed, the cathodes of CR11 and CR12 will be grounded which grounds the 100-cps input. The 10-cps input will now trigger the flip flop, and, in turn, control the gate generator.

2.11.5 Gate Generator. - The schematic diagram for the gate generator is Figure 6-5; A8A8 is the reference designation prefix for this module. Operation of this module is best explained by referring to the generator timing chart, Figure 2-5. This chart applies if the DECIMAL SHIFT switch is not depressed. If the switch is used the timing given on the chart must be multiplied by ten. The top line on the chart, the 1-kc pulse train, is included for reference. This is the pulse train entering decade scaler A8A5 whose "eight" and "not-eight" output is the input to the gate generator with the DECIMAL SHIFT switch in the normal position. The "not-eight" pulses occur at a 100-cps rate and control the operation of the gate generator. Operation of the gate in module A1A7 is determined by

Figure 2-4

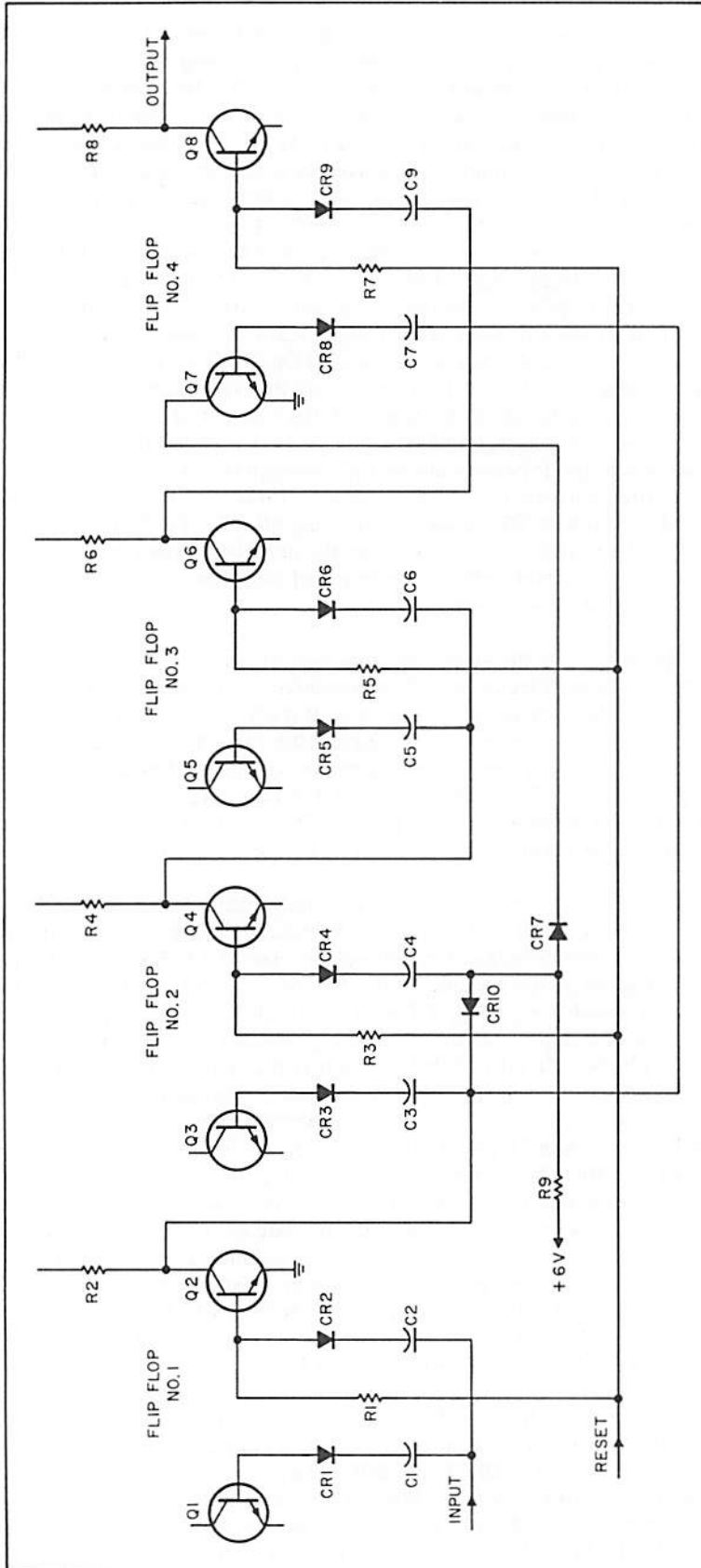


Figure 2-4. BCD Counter, Simplified Schematic Diagram

the collector potential of Q1 in the gate generator. When Q1 is conducting its collector potential is 0 vdc and the gate is closed, permitting the flow of the local oscillator signal into the counter. With Q1 cut off its collector voltage rises to approximately 6 vdc and the gate opens, inhibiting the flow of information into the counter. Referring to Figure 2-5, assume that reset pulse No. 1 has just occurred with the leading edge of the first "eight" pulse. The gate will be open since the collector voltage of Q1 is high. The Nixie display, which is controlled by Q4, goes off at the time the reset pulse is generated. On the negative-going trailing edge of the "eight" pulse Q2 is cut off which cuts Q1 on. This closes the gate and the counting interval begins. The positive-going transition at the collector of Q2 is coupled to Q4 through C5, but can have no effect due to steering diode CR4. Following a 10-ms counting interval, on the trailing edge of the second "eight" pulse, the conducting Q1 is cut off and the gate is opened. During the counting interval Q7 and Q8 are cut off so that the Nixie display is extinguished. Also during this interval Q5 is conducting to saturation and Q6 is biased off. Diode CR5 clamps the reset line at approximately 0.2 vdc except when the reset pulse is generated. The negative transition which occurs at the collector of Q2 when Q1 is cut off is coupled through C5 and CR4 to the base of Q4, cutting this transistor off. At this point the 8-ms display period begins. The positive-going voltage at the collector of Q4 turns on Q7. The voltage drop across R23 turns on Q8, a PNP transistor, so that the 180 vdc is gated out to turn on the Nixie display. With Q4 turned off during the display interval C9 charges from its nominal voltage of 3 vdc up to approximately 6 vdc. Eight ms after the beginning of the display interval the negative-going leading edge of the third "not-eight" pulse is coupled through C8 and CR3 to turn off Q3. This turns on Q4 which, in turn, cuts off Q7 and Q8 so that the Nixie display is extinguished. When the collector voltage of Q4 switches in the negative direction, the voltage at the plus end of C9 suddenly changes from 6 vdc to 3 vdc. Since the voltage across the capacitor cannot change instantaneously, the voltage at its minus end drops to approximately -3 vdc. This pulls Q5 out of saturation, and drives it to cut off. The rise in voltage across R6 cuts on Q6. With Q6 conducting a positive pulse is developed across R20. The width of the pulse, approximately 0.5 ms, is determined by the RC time constant of C9 and R5. When C9 has discharged sufficiently for Q5 to start conducting again, Q6 cuts off and the voltage on the reset line drops back to the clamp level. Two ms after the display is cut off the negative-going trailing edge of the third "eight" pulse cuts off Q2 and another counting interval begins.

2.11.6 Amplifier and Gate. - Figure 6-17 is the schematic diagram for the amplifier and gate; A8A9 is its reference designation prefix. The signal from the input amplifier is fed to a limiter stage formed by Q1 and Q2. The limiter is essentially an emitter follower, Q1, and a grounded-base amplifier, Q2, which share a common emitter resistor, R2. When the input signal goes positive Q1 conducts heavily, causing an increased voltage drop across R2. This results in a reverse bias on Q2 so that it cuts off. On the negative-going half-cycle of the input signal Q1 is cut off so that the voltage across R2 increases in the negative direction. This negative voltage on the emitter of Q2 causes the transistor to conduct to saturation. Thus with Q2 operating between the cut-off and saturated conditions the amplitude of the input signal is limited on both the positive and negative excursions. The limited signal is coupled through C4 to a Schmitt trigger made up of Q3 and Q5. Transistor Q4 functions as the gate. With Q4 conducting the Schmitt trigger is disabled and the input signal cannot reach the counting circuits. The Schmitt trigger squares up the input signal to improve the rise time. With no signal input Q3 is conducting and Q5 is cut off. When the signal goes negative Q3 moves toward cut off. As the collector voltage of Q3 goes positive, the increasing voltage is coupled through R9 and C6 to start turning Q5 on. In addition, as the emitter current of Q3 decreases, the voltage drop across R7 decreases. As a result, the emitter voltage of Q5 moves in the negative direction, increasing the forward bias on the transistor. This regenerative action continues until Q5 is conducting to saturation and Q3 is cut off. The circuit remains in this stable condition until the input to Q3 swings in the positive direction, cutting Q3 back on. The regenerative action which results from turning Q3 on turns Q5 off. This switching action results in negative-going pulses at the collector of Q5 with an extremely fast rise time, and having the same frequency as the input signal to the unit. When the readout interval begins the level at the module gate input rises to approximately +6 vdc. This forward biases Q4 so that it turns on and conducts to saturation. The additional current through R7 causes a voltage drop across the resistor which reverse biases the base-emitter junction of Q3 to the extent that the Schmitt trigger is disabled. When the gate input drops to 0 vdc at the end of the display interval, operation of the circuit returns to normal. Emitter follower Q6 conducts to saturation when Q5 is off, and is cut off when Q5 turns on because of the negative-going voltage drop across R12. The pulse output of Q6 developed across R13 is differentiated into positive and negative spikes by C7 and R14. Transistor Q7, which is normally off, is turned on by the positive spikes. The negative spikes are shorted to ground by CR1. Emitter follower Q8 is turned off by the voltage drop across R15 when Q7 conducts. The resulting output is a train of negative pulses developed across R16. Inductor L2 is a peaking coil to improve the rise time of the leading edge of high-frequency pulses. The leading edges of these pulses trigger the initial flip flop in local oscillator decade scaler A8A11 which follows.

2.11.7 Readout Decoder and Nixie Driver. - There is a readout decoder and Nixie driver module for each of the four decades of the local oscillator counter. Figure 6-18 is the schematic diagram for the module. A diode matrix

Figure 2-5

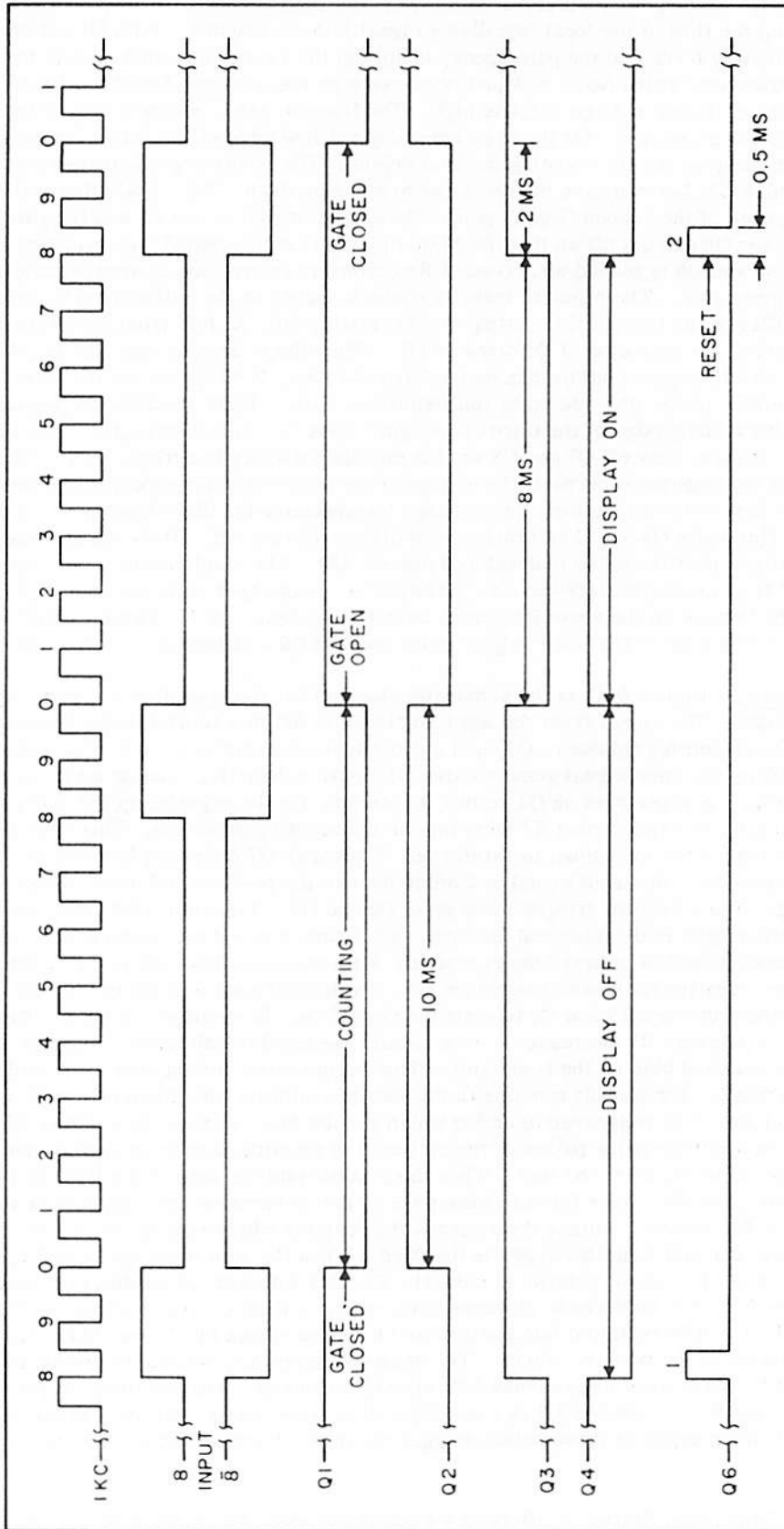


Figure 2-5. Gate Generator Timing Chart



on the module continuously decodes the binary content of the decade scalers during the 10-ms counting interval, but only the count held at the end of the counting interval is displayed when +180 vdc is gated to the Nixie anodes. The output of each side of the four flip flops in a decade scaler is applied to the matrix. The output of the  $2^0$  flip flop controls transistors Q1 and Q2 which determine if an odd or an even digit will be displayed. Assume that a count of 5 is to be displayed. The "one" input to the decoder will be at the logic "one" level, and the "not-one" input will be at the "zero" level. This results in a reverse bias on CR2 so that the base voltage of Q2 can rise, turning the transistor on. A ground return is now provided for the emitters of odd-digit Nixie drivers Q4, Q6, Q8, Q10, and Q12 through the conducting Q2. The "four", "not-two", and "not-eight" inputs to the module are also at the logic "one" level. All other inputs are at the "zero" level. Tracing out the current paths through the diode matrix it will be seen that only the diodes associated with the Q7 and Q8 inputs are all reverse biased so that the base voltage of these two transistors can rise toward the +6 vdc supply. However, since there is no emitter return for Q7 only Q8 will turn on, so the "5" cathode in the Nixie glows.

## 2.12 POWER SUPPLIES

The receiver contains four separate power supplies. Three are built on plug-in etched circuit boards and provide regulated outputs of +6 and -6 vdc, +12 vdc, and -12 vdc. The fourth is built on the main chassis and provides an output of +180 vdc. All operated from a common power transformer. Input power to the unit may be 115 or 230 vac. When switch S1 is in the 115-vac position the two primaries of power transformer T1 are connected in parallel (see main chassis schematic diagram, Figure 6-22). Placing the switch in the 230-vac position connects the primaries in series and adds fuse F2 to the circuit. The decimal points for the Nixie display, DS1 and DS2, are connected across terminals 3 and 4 of the power transformer primary.

**2.12.1 180-vdc Power Supply.** - The 180-vdc power supply provides the anode voltage for the Nixie tubes when they are gated on. Secondary winding 8-10 of T1 provides the ac input to silicon diodes CR1 and CR2 which are connected in a full-wave rectifier circuit. The pulsating dc output from the rectifiers is filtered by electrolytic capacitor C7. Resistor R3 functions as a bleeder to discharge C7 when the unit is turned off.

**2.12.2 +6 and -6 vdc Power Supply.** - Figure 6-19 is the schematic diagram for this power supply; it carries the reference designation prefix A9. Silicon diodes CR1 and CR2 rectify the ac input for the positive output and CR3 and CR4 perform the same function for the negative supply.

**2.12.2.1 Transistor Q1 functions as a series regulator for the negative supply.** Its conduction is controlled by Q3 which senses and responds to fluctuations of the negative output voltage from its nominal -6 vdc value. Transistor Q2 serves as a constant current source for Zener diode CR7 which functions as the reference element for Q3. By providing a constant current for the Zener diode, the Zener voltage is maintained within close limits. This, in turn, improves the regulation of the negative supply. Assuming that the output voltage tends to rise (become more positive), the forward bias on the emitter of Q3 (a PNP transistor) increases since the base voltage is fixed by CR7. This causes Q3 to conduct harder, increasing the voltage drop across R2 and R3 so that the base of Q1 goes more positive. This results in a decrease in the emitter-collector resistance of Q1 since it conducts harder, so that the output voltage returns to its nominal value. Should the output voltage increase in the negative direction the opposite action takes place with Q3 conducting less so that the voltage drop across R2 and R3 decreases. The base voltage of Q1 now becomes more negative resulting in an increase in the emitter-collector resistance, and a decrease in the output voltage back to the nominal value. Resistor R5 provides overload protection for the negative supply. If excessive current is drawn the voltage drop across R5 will reverse bias the base-emitter junction of Q3, cutting it off. The base voltage of Q1 then increases in the negative direction, cutting the transistor off and protecting it from damage. Diodes CR5 and CR6 are used to clamp the base of Q2 at a fixed voltage so that the transistor can function as a current source.

**2.12.2.2 The series regulator for the +6 vdc supply is transistor Q1 located on the main chassis.** Conduction of the transistor is controlled by a feedback loop consisting of a differential amplifier, Q5 and Q6, which drives amplifier Q4, which, in turn, drives an emitter follower, Q7. The output of the emitter follower is connected to the base of the series regulator and directly controls its conduction. The output of the negative supply is used as the reference voltage for the positive supply. It is connected to a sampling network made up of R11, R12, and R13. Potentiometer R12 is used to set the positive output at precisely 6 volts. When properly set the base voltage of both Q5 and Q6 will be 0 vdc. If the output voltage deviates from the set value, the difference voltage is sensed by Q6 as an error signal, and the feedback circuit supplies the series regulator with a compensating voltage to return the output to its normal value. Assuming that the output voltage drops below +6 vdc, the base of Q6 will go negative. This causes

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Q6 to conduct less, so that the voltage drop across R7 increases in the negative direction. The forward bias on Q5 is thus increased so that it conducts harder, increasing the voltage drop across R6. Amplifier Q4, a PNP transistor, now conducts harder so that the voltage drop across it decreases so that its collector voltage more closely approaches the more positive emitter voltage. This results in an increased forward bias on emitter follower Q7 so that it conducts harder, giving a more positive voltage across its load resistor, R9. Since the base-emitter junction of the series regulator is connected across R9, its forward bias increases so that it conducts harder, lowering its collector-emitter resistance. The output voltage now rises back to its nominal 6 vdc value. Should the output voltage rise above 6 vdc the feedback circuit will have the opposite effect, resulting in a decreased forward bias on the series regulator, so that the collector-emitter resistance of the transistor increases and the output voltage drops to the proper value. Overload protection of the positive supply is given by resistor R10 in conjunction with silicon diodes CR8, CR9, and CR10. If excessive current is drawn from the supply the voltage drop across R10 will forward bias the diodes so that the base of Q7 will be pulled down to the voltage at the output terminal. This will result in the base of the series regulator being driven sufficiently negative to limit the current drawn from the transistor to a safe value.

2.12.3 +12 vdc Power Supply. - Figure 6-20 is the schematic diagram for this power supply; its reference designation prefix is A10.

2.12.3.1 The ac input from power transformer T1 is rectified by silicon diodes CR1 and CR2 which are connected as full-wave rectifiers. Initial filtering of the pulsating dc output is by electrolytic capacitor C1. Transistor Q1 functions as a series regulator whose conduction is controlled by Q2. Zener diode CR3 is the emitter reference element for Q2. If, for example, the output voltage from the regulator module tends to rise, the base of Q2 goes more positive, causing it to conduct harder. This increases the voltage drop across R1 and R2 so that the base of Q1 becomes less positive, and the conduction through the transistor decreases. As a result, the voltage output from the module drops to its nominal value. A decrease in the output voltage has the opposite effect, with the base voltage of Q2 decreasing so that it conducts less. The voltage drop across R1 and R2 now decreases, causing the base voltage of Q1 to go more positive. The conduction of the regulator transistor will now increase so that the output voltage rises. Resistor R3 connects the base of the control transistor to the input side of the regulator so that fluctuations at this point can be sensed and compensated for.

2.12.3.2 Transistor Q3 is an overload switch which functions to protect Q1 if excessive current is drawn from the module. Under normal conditions Q3 is cut off. In the event of an overload the voltage drop across R5 will be sufficient to forward bias the base-emitter junction of Q3. Once Q3 conducts it increases the voltage drop across R1 and R2, pulling down the forward bias on Q1. As a result, the conduction through Q1 is limited to a safe value.

2.12.4 -12 vdc Power Supply. - Figure 6-21 is the schematic diagram for this power supply; A11 is its reference designation prefix. The -12 vdc power supply is functionally identical to the +12 vdc power supply except that it does not have the overload protection.

SECTION III

INSTALLATION AND OPERATION

3.1 INSTALLATION

The VLF receiver is designed for mounting in a standard 19-inch rack. It requires 3.5 inches of vertical space and will project 19.5 inches back into the rack. Adequate ventilation should be provided.

3.1.1 Power Connection. - The receiver may be operated from a 115 vac or 230 vac primary power source. Before plugging in the unit be sure that the power selector switch on the rear apron is in the correct position for the line voltage to be used. If the proper line voltage does not appear in the switch window, use a screw driver to slide the switch to the correct position. The third pin of the power cord grounds the unit. If a three-pin power receptacle is not available, use the three-to-two pin adapter provided.

3.1.2 Antenna Connection. - The input signal to the receiver is applied through rear panel jack A1J1. This is a twinax-type connector. Input impedance is 50 ohms, balanced, or 1000 ohms, balanced. The desired impedance is selected by means of the slide switch next to the input connector.

3.1.3 Audio Output Connection. - The balanced 600-ohm audio output from the receiver is obtained at rear-panel jack, J2. This jack is a twinax-type connector.

3.1.4 Detector Level Output. - The AM detector output is available at rear-panel jack J1. This jack is a BNC-type connector.

3.1.5 Local Oscillator Output. - The output from the receiver's local oscillator is fed to J4, LO OUTPUT. This jack is a BNC-type connector.

3.1.6 Signal Monitor Output. - A 2-mc output for use with a signal monitor is available at the SM OUTPUT jack, J5. This jack is a BNC-type connector.

3.1.7 IF Output. - The output of the receiver's IF strip may be obtained at J6, IF OUTPUT. This jack is a BNC-type connector.

3.2 OPERATION

The use of the front-panel operating controls is explained in the following paragraphs. These controls are shown in Figure 1-1, a front view of the unit.

3.2.1 Function Switch. - This switch serves as the power on-off switch and as the AGC-manual control selector switch. With the switch in the AGC position and the BFO switch in the OFF position, receiver gain is controlled by an internal AGC amplifier. Placing the FUNCTION switch in the MAN position transfers control of receiver gain to the MAN IF GAIN control. If the FUNCTION switch is in the AGC position and the BFO switch is moved from the OFF position, then the AGC control is defeated and the MAN IF GAIN control determines the gain of the receiver.

3.2.2 Tuning Control. - The TUNING control is used for coarse tuning of the receiver. Twenty-five turns of the control are required to tune the receiver through its entire frequency range.

3.2.3 Fine Tuning Control. - The FINE TUNING control is used for small adjustments to the receiver's tuning.

3.2.4 Decimal Shift Switch. - Depressing the DECIMAL SHIFT push-button switch expands the digital readout by a factor of ten so that the frequency to which the receiver is tuned can be read to an accuracy of 10 cps. If the receiver is tuned to 100 kc, or higher, the initial digit of the frequency disappears and must be mentally added. The expanded readout is displayed only as long as the DECIMAL SHIFT switch is depressed.

3.2.5 Input Attenuator Switch. - The input attenuator permits the receiver to accept input signals of up to 1-volt rms without overloading. Place the switch in the position which gives the best results.



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3.2.6 IF Bandwidth Switch. - The IF BANDWIDTH switch is used to select one of the receiver's four IF bandwidths: 150 cps, 1 kc, 3 kc, or 6 kc. The position to be used depends on the type of signal to be received.

3.2.7 Audio Bandwidth Switch. - With the AUDIO BW switch in the NORMAL position, the response of the receiver's audio amplifiers extends from 100 to 3000 cps. Placing the switch in the NARROW position restricts the response to 825 to 1175 cps. This switch affects the output both from the front-panel PHONES jack and the balanced 600-ohm output.

3.2.8 Audio Gain Control. - The AUDIO GAIN control varies the level only at the PHONES jack. The level of the balanced 600-ohm output is determined by an internal control.

3.2.9 BFO Selector Switch. - This switch is used to select any one of the five internal beat frequency oscillators. The ZERO position is particularly useful for measuring the frequency of an incoming signal. Turn this BFO on and tune the receiver to zero beat the incoming signal. Press the DECIMAL SHIFT switch and the frequency of the signal is displayed within 10 cps of the actual frequency. The VAR switch position turns on a variable frequency beat oscillator. Its frequency is varied by means of the BFO FREQ control. The 1 KC beat oscillator gives a beat note of exactly 1 kc once the incoming signal has been zero beat using the ZERO BFO. The upper sideband (USB) and lower sideband (LSB) oscillators inject signals of the proper frequency to demodulate single sideband signals. These oscillators must be used in conjunction with the 3-kc IF bandwidth. The oscillator to be used depends on which sideband is transmitted.

3.2.10 BFO Frequency Control. - This control is activated when the BFO selector switch is in the VAR position. It permits varying the BFO beat note from 0 to approximately 3 kc.

3.2.11 Manual IF Gain Control. - The MAN IF GAIN control is used to vary the receiver's gain when the function switch is in the MAN position, or when any of the BFO's are operating.

## SECTION IV

## MAINTENANCE

## 4.1 GENERAL

The VLF receiver is conservatively designed to give trouble-free service. It presents no special maintenance problems, and normally requires no care beyond being kept clean. Should trouble occur, down time will be minimized if the maintenance technician is thoroughly familiar with Section II of this manual in which the circuits are described before beginning the troubleshooting. Field maintenance should be confined to cleaning and the replacement of fuses and plug-in modules. All other maintenance should be carried out in a well-equipped shop and performed only by experienced personnel.

## 4.2 PLUG-IN MODULE REMOVAL

The plug-in modules can be easily removed by simply pulling them upward from the receptacles into which they are fitted. The numbers on the module pins correspond to the numbers indicated on the schematic diagrams at the points where the connecting leads pass through the lines outlining each module. Modules having completely different functions are keyed to prevent them from being damaged as a result of being placed in the wrong receptacle. All plug-in modules have their type numbers etched on the back of the cards. By referring to the schematic diagrams their reference designation prefixes can be found, and thus their proper location in the unit.

## 4.3 TROUBLESHOOTING, RECEIVER SECTION

If the frequency display lights and the reading changes as receiver is tuned the counter assembly is probably working properly. Should the display light up and indicate all zeros, but not change with tuning, the counter is still probably functioning, but not receiving the local oscillator input. Initial troubleshooting should be directed toward localizing the trouble to a specific section of the receiver. In the case of the plug-in modules, a quick check can be made by plugging in a spare module known to be good. If these substitutions do not cure the trouble, then the audio and AGC amplifiers, and the +12 and -12 vdc power supplies can be eliminated from consideration. Note that the +6 and -6 vdc and +180 vdc power supplies are used only by the counter assembly. If the frequency display is indicating properly as the receiver tuning is shifted, then the local oscillator is probably operating properly. This leaves a series chain consisting of subassemblies A1, A2, A3, and A5 as primary suspects. To check out the chain feed a signal within the receiver's tuning range into the antenna input, tune the receiver to the frequency, and trace the signal through the subassemblies using a wideband oscilloscope. Once the malfunctioning stage is known voltage and resistance measurements will usually pin point the defective part. Typical transistor and module pin voltages are given in Table 4-1.

## 4.4 TROUBLESHOOTING, COUNTER ASSEMBLY

If the maintenance technician understands how the counter assembly functions, troubleshooting the unit will be very simple. Should the cause of trouble not be immediately apparent, first determine if the +6 and -6 vdc and +180 vdc power supplies are functioning properly. If they are, the next step is to localize the trouble to a specific module. The input amplifier and local oscillator counting decades are most easily checked by feeding in a signal of known frequency and tracing it using a wideband oscilloscope. The timing and gating circuits can be quickly checked by tracing the signal from the 1-mc oscillator through to the amplifier and gate module, A8A9. Both the functional block diagram, Figure 2-2, and the gate generator timing chart, Figure 2-5, will be of assistance in signal tracing. Once the malfunctioning module is located, voltage and resistance measurements will usually pin point the defective component. Note that with no signal input the display should reset to 000.0 kc, if functioning properly. Depressing the DECIMAL SHIFT switch should change the display to 00.00 kc. If it does not, check the decimal shifter module, A8A7.

## 4.5 ALIGNMENT PROCEDURES

4.5.1 General. - The alignment procedures given here are suitable when making periodic performance checks, or when making adjustments after replacing transistors or components. Only those controls specifically referred to within a series of steps given for aligning a particular circuit affect the alignment of that circuit. Those controls

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not mentioned in any one series of steps may be left in any position. The alignment of this receiver should be performed only with suitable equipments by technicians thoroughly familiar with the receiver. If the limits and tolerances specified in the following procedures cannot be obtained, then a factory alignment is necessary. Both dust covers and the IF and BFO assembly cover must be removed for alignment.

4.5.2 Equipments Required. - The following equipments, or their equivalents, are required to perform the complete receiver alignment:

- (1) Signal Generator, Hewlett-Packard Type 606A
- (2) VTVM, RCA Type WV-98B
- (3) AC VTVM, Hewlett-Packard Type 400H
- (4) Oscilloscope, Tektronix Type 544
- (5) Headphones
- (6) Assorted cables, connectors, and alignment tools

4.5.3 IF Alignment. - Proceed as follows:

- (1) Set up equipment as shown in Figure 4-1.
- (2) Make the following initial control settings:
  - a. Receiver: BFO off, IF BANDWIDTH to 6 KC, FUNCTION to MAN, MAIN IF GAIN set at midrange.
  - b. Signal Generator: Using internal crystal calibration, set for 2-mc output modulated 50% by 400-cps tone.
  - c. VTVM: Set to 1.5-vdc range.
- (3) Adjust signal generator output for 1-vdc reading on VTVM.
- (4) Adjust in the order given A5A3L4, A5A3L3, A5A3L2, A5A3L1, A5A2L1, A5A1L2, and A5A1L1 for maximum reading on VTVM.

NOTE

Reduce signal generator output as necessary to maintain 1-vdc reading on VTVM.

- (5) Reconnect P7 to A5J1.

4.5.4 BFO Alignment. - Proceed as follows:

- (1) Set up equipment as shown in Figure 4-2. Use headphones to monitor receiver output.

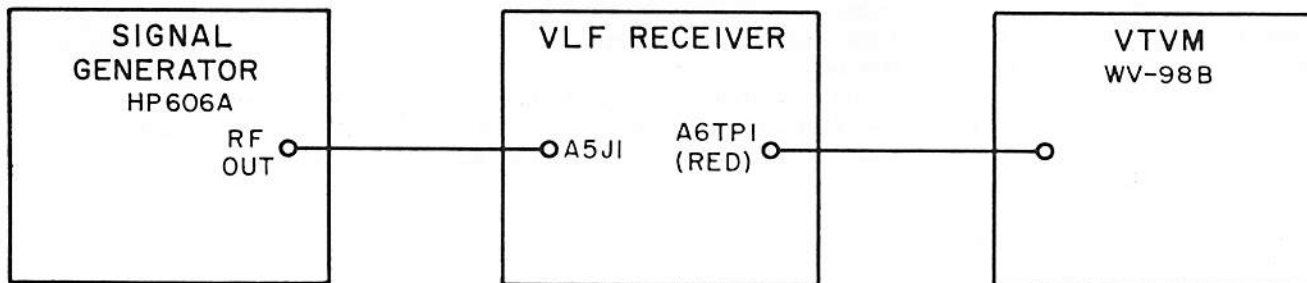


Figure 4-1. Equipment Setup, IF Alignment

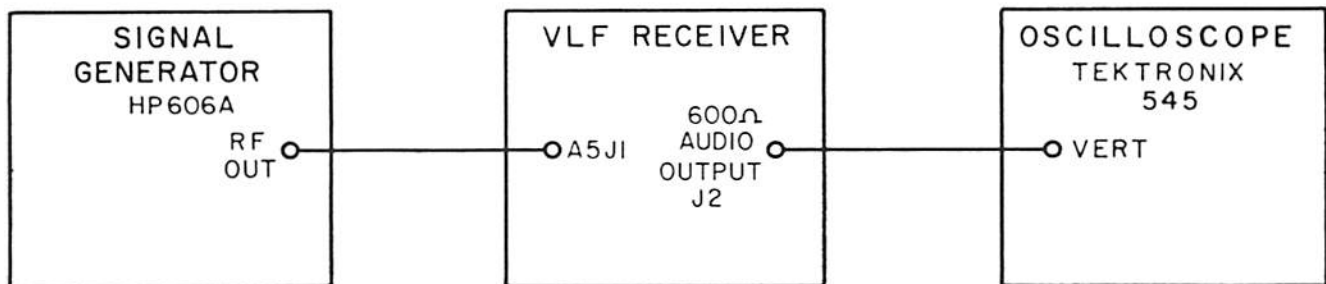


Figure 4-2. Equipment Setup, BFO Alignment

- (2) Make the following initial settings:
  - a. Receiver: BFO switch to ZERO, IF BANDWIDTH to 6 KC, FUNCTION switch to MAN, MAN IF GAIN to midrange, AUDIO BW to NORMAL.
  - b. Signal Generator: Using internal calibration, set for 2-mc CW output.
- (3) Adjust A5A4T1 maximum amplitude as indicated on oscilloscope.
- (4) Modulate signal generator output 50% with 1-kc tone.
- (5) Adjust A5A4R26 for minimum 1-kc audio output in headphones.
- (6) Turn signal generator modulation off.
- (7) Set BFO switch to VAR, BFO FREQ control to midrange.
- (8) Adjust A5L1 for zero-beat indication on oscilloscope.
- (9) Reconnect P7 to A5J1.

4.5.5 Local Oscillator Alignment. - Proceed as follows:

- (1) Turn MAIN TUNING control to low-frequency limit, FINE TUNING control maximum counterclockwise.
- (2) Adjust A4L1 for reading on frequency display of 000.7 to 000.9.
- (3) Turn MAIN TUNING control to high-frequency limit, FINE TUNING control maximum clockwise.
- (4) Frequency display should read in 600 kc to 610 kc range. If not, adjust A4C4 until a reading in this range is obtained.
- (5) Repeat steps (1) through (4) until no further adjustment is necessary.

CAUTION

Do not adjust A4C6. This is a factory adjustment.

4.5.6 Balanced Mixer Adjustment. - Proceed as follows:

- (1) Connect VTVM set to 1.5-vdc range to A6TP1 (the red test point).
- (2) Make the following receiver control settings: IF BANDWIDTH to 1 KC, FUNCTION switch to MAN, MAN IF GAIN control to midrange, BFO off, tune receiver to 3 kc.
- (3) Set A3A1C8, A3A1R19, A3A1R27, and A3A1R30 to midrange.
- (4) Adjust A3A1C8, A3A1R19, and A3A1R27 for minimum reading on VTVM. The adjustment of A3A1C8 is quite critical. If no indication is obtained on VTVM, increase receiver gain slightly or tune to lower frequency and continue adjustment of A3A1C8, A3A1R19, and A3A1R27 until no further decrease is noted on the VTVM.

MAINTENANCE

- (5) Adjust A3A1R30 to see if the null reading on VTVM can be improved. This adjustment is quite critical. Leave control at point which gives minimum reading on VTVM.
- (6) Retouch A3A1C8, A3A1R19, A3A1R27, and A3A1R30 until reading on VTVM does not decrease further.

4.5.7 600-ohm Audio Output Adjustment. - Proceed as follows:

- (1) Set up equipment as shown in Figure 4-3.
- (2) Make the following initial settings:
  - a. Receiver: INPUT ATTENUATOR to 0 db, FUNCTION switch to AGC position, IF BANDWIDTH to 3 KC, BFO off, AUDIO BW in NORMAL position, tune to 100 kc.
  - b. Signal Generator: Set for 100-kc signal modulated 50% by 1000 cps tone. Output level of 300  $\mu$ v.
- (3) Adjust A7R4 for 1.92 volt rms reading (6 mw into 600  $\Omega$  load) on AC VTVM.

4.5.8 Audio Filter Adjustment. - Proceed as follows:

- (1) Set up equipment as shown in Figure 4-3.
- (2) Make initial receiver and signal generator settings as given in paragraph 4.5.7 (2) except AUDIO BW switch is placed in the NARROW position.
- (3) Adjust L1 on main chassis for maximum output as indicated on AC VTVM, then back off adjustment by 10% in the opposite direction. Peak output reading should remain the same.

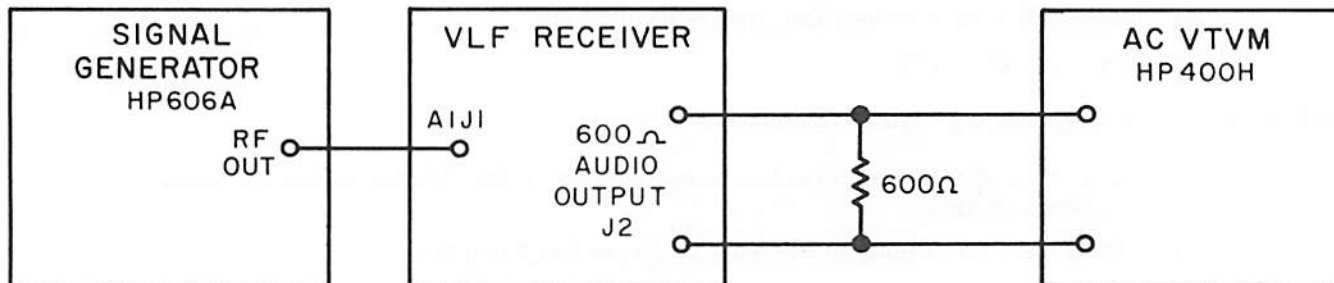


Figure 4-3. Equipment Setup, Audio Output Adjustment

Table 4-1. Typical Transistor Element Voltages

Ref. Desig.	Type	ELEMENT		
		Emitter	Base	Collector
Q1	2N3055	6.2	7.0	10.0
A3A1Q1	2N930	3.18	3.75	9.7
A3A1Q2	2N3251	10.8	9.7	5.4
A3A1Q3	2N3053	4.8	5.4	10.75
A3A1Q4	2N706	8.1	8.6	11.7
A3A1Q5	2N706	7.5	7.9	11.7
A4A1Q1	2N3478	3.3	3.3	9.2
A4A1Q2	2N706	2.9	3.6	7.7
A4A1Q3	2N3251	9.0	7.7	6.1
A5A1Q1	2N3478	1.9	2.7	10.7
A5A1Q2	2N3478	1.6	2.3	10.7
A5A1Q3*	2N706	1.1	1.76	10.7
A5A1Q4*	2N706	1.1	1.74	10.6
A5A1Q5*	2N706	1.1	1.75	10.6
A5A1Q6*	2N706	1.06	1.7	10.6
A5A2Q1*	2N3478	0.8	1.55	10.8
A5A2Q2*	2N3478	0.8	1.55	10.8
A5A2Q3*	2N3478	1.0	1.7	10.6
A5A2Q4*	2N3478	1.0	1.7	10.6
A5A3Q1	2N3478	0.9	1.6	10.8
A5A3Q2	2N3478	0.8	1.5	10.0
A5A3Q3	2N3478	0.75	1.45	10.0
A5A3Q4	2N3251	10.8	10.0	1.43
A5A4Q1#	2N3478	2.35	2.9	8.0
A5A4Q2#	2N706	2.7	3.1	8.7
A5A4Q3#	2N706	4.2	4.55	7.2
A5A4Q4	2N706	1.8	2.45	9.4
A5A4Q5	2N706	2.3	2.9	10.3
A5A4Q6#	2N706	3.85	3.35	7.1
A5A4Q7#	2N706	2.8	3.2	7.6
A6Q1	2N706	0.5	1.1	11.6
A6Q2	2N706	10.8	11.2	11.6
A6Q3	2N929	0.1	0.5	11.2
A6Q4	2N929	0.0	0.5	11.6

Table 4-1

Table 4-1. Typical Transistor Element Voltages (Cont'd.)

Ref. Desig.	Type	ELEMENT		
		Emitter	Base	Collector
A7Q1	2N697	-0.3	0.3	10.5
A7Q2	2N3053	0.4	1.3	11.4
A7Q3	2N697	3.5	4.0	11.4
A7Q4	2N3053	10.8	11.4	11.6
A7Q5	2N1305	11.6	11.4	6.7
A7Q6	2N3053	4.0	4.6	9.5
A9Q1	2N3053	-11.6	-10.9	-7.9
A9Q2	2N3053	-11.0	-10.4	-6.4
A9Q3	2N1305	-6.2	-6.4	-10.4
A9Q4	2N3251	10.0	9.4	7.5
A9Q5	2N929	-0.5	0.0	9.4
A9Q6	2N929	-0.5	0.0	10.0
A9Q7	2N3053	7.0	7.5	10.0
A10Q1	2N3054	12.0	12.6	19.0
A10Q2	2N3053	11.6	12.0	12.6
A10Q3	2N3053	6.0	6.6	12.6
A11Q1	2N2869	-12.2	-12.4	-22.8
A11Q2	2N526	-6.0	-6.2	-12.4

Test Conditions:

1. All voltages dc referenced to ground.
2. Readings taken with RCA WV-98B VTVM with 115 vac power input to receiver. No signal input.
3. AUDIO GAIN and MAN IF GAIN controls in max cw positions.
4. FUNCTION switch in MAN position except when taking readings in AGC module A6. Switch then placed in AGC position.

Notes:

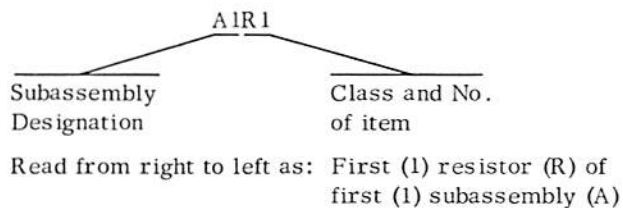
- \* IF BANDWIDTH switch placed in position to energize appropriate transistor.
- # BFO switch placed in position to energize appropriate transistor.

SECTION V

REPLACEMENT PARTS LIST

5.1 UNIT NUMBERING METHOD

The unit numbering method of assigning designations (electrical symbol numbers) has been used to identify assemblies, subassemblies (and modules), and parts. An example of the unit method follows:



As shown on the main chassis schematic, components which are an integral part of the main chassis have no sub-assembly designation.

5.2 REFERENCE DESIGNATION PREFIX

Partial reference designations have been used on the equipment and on the illustrations in this manual. The partial reference designations consist of the class letter(s) and identifying item number. The complete reference designations may be obtained by placing the proper prefix before the partial reference designations. Prefixes are provided on drawings and illustrations following the notation "REF DESIG PREFIX."

5.3 LIST OF MANUFACTURERS

<u>Vendor Code</u>	<u>Name and Address</u>	<u>Vendor Code</u>	<u>Name and Address</u>
00136	Mc Coy Electronics Company Mt. Holly Spring, Pennsylvania	04713	Motorola Semiconductor Prod. Inc. 5005 East Mc Dowell Road Pheonix, Arizona
01121	Allen-Bradley Company 136 West Greenfield Avenue Milwaukee, Wisconsin	05820	Wakefield Engineering, Inc. 139 Foundry Street Wakefield, Massachusetts
01281	T R W Semiconductors, Inc. Lawndale, California	06001	General Electric Company Capacitor Department Irmo, South Carolina
02114	Ferroxcube Corporation of America Saugerties, New York	07688	Joint Electron Device Engineering Council Washington, D. C.
02567	International Electronic Industries Nashville, Tennessee	14632	Communication Electronics, Inc. 6006 Executive Boulevard Rockville, Maryland 20852
04013	Taurus Corporation 8 Coryell Street Lambertville, New Jersey	15605	Cutler Hammer, Incorporated 321 North 12th Street Milwaukee, Wisconsin
04426	Licon Division 6615 West Irving Park Road Chicago, Illinois	21810	Federal Pacific Electric Company Newark, New Jersey



REPLACEMENT PARTS LIST

<u>Vendor Code</u>	<u>Name and Address</u>	<u>Vendor Code</u>	<u>Name and Address</u>
23783	British Radio Electronics, Ltd. 1742 Wisconsin Avenue N.W. Washington, D. C.	75042	International Resistance Company P. O. Box 393 Boone, North Carolina
42190	The Muter Company 1255 South Michigan Avenue Chicago, Illinois	79727	Continental-Wirt Electronics Corp. Philadelphia 44, Pennsylvania
55026	Simpson Electric Company 5200 West Kenzie Street Chicago 44, Illinois	80223	United Transformer Company 150 Varick Street New York, New York
56289	Sprague Electric Company 91 Marshall Street North Adams, Massachusetts	80294	Bourns, Incorporated 6135 Magnolia Avenue Riverside, California
71279	Cambridge Thermionic Corp. 455 Concord Avenue Cambridge, Massachusetts	81349	Military Specifications Promulgated Standardization Div. Directorate of Logistic Services DSA Washington, D. C.
71400	Bussman Manufacturing Company University at Jefferson Street St. Louis, Missouri	81716	Oak Manufacturing Company Crystal Lake, Illinois
71590	Centralab 900 East Keefe Avenue Milwaukee, Wisconsin	82389	Switchcraft, Inc. 5555 North Elston Avenue Chicago, Illinois
71700	Cornish Wire Company 50 Church Street New York, New York	83594	Burroughs Corporation Electronic Components Division Plainfield, New Jersey
72136	Electro Motive Mfg. Company So. Park and John Streets Willimantic, Connecticut	86335	Glenco Corporation 212 Durham Avenue Metuchen, New Jersey
72982	Erie Technological Products, Inc. 644 West 12th Street Erie, Pennsylvania	91418	Radio Materials Corporation 4242 West Bryn Mawr Avenue Chicago 46, Illinois
73899	J. F. D. Electronics Corporation 6101 16th Avenue Brooklyn, New York	91802	Industrial Devices, Inc. Edgewater, New Jersey
74306	Piezo Crystal Company 265 East Pomfret Street Carlisle, Pennsylvania	99848	Wilco Corporation 546 Drover Street Indianapolis, Indiana
74868	Amphenol RF Division 33 East Franklin Street Danbury, Connecticut		

#### 5.4 PARTS LIST

When ordering replacement parts from CEI, specify the type and serial number of the equipment, and the reference designation and description of each part ordered. The Vendors and Vendor Part Numbers listed are included as a guide to the use of the equipment in the field and do not necessarily agree with the parts installed in the equipment. Except in those cases specifically noted, the replacement part may be obtained from any vendor as long as the physical and electrical parameters of the part selected agree with the original part.

#### NOTE

As improved semiconductors become available it is the policy of CEI to incorporate them in proprietary products. For this reason some transistors and diodes installed in an equipment may not agree with those specified in the parts lists and schematic diagrams of this manual. However, the semiconductors designated in the manual may be substituted in every case with satisfactory results.

Figure 5-1

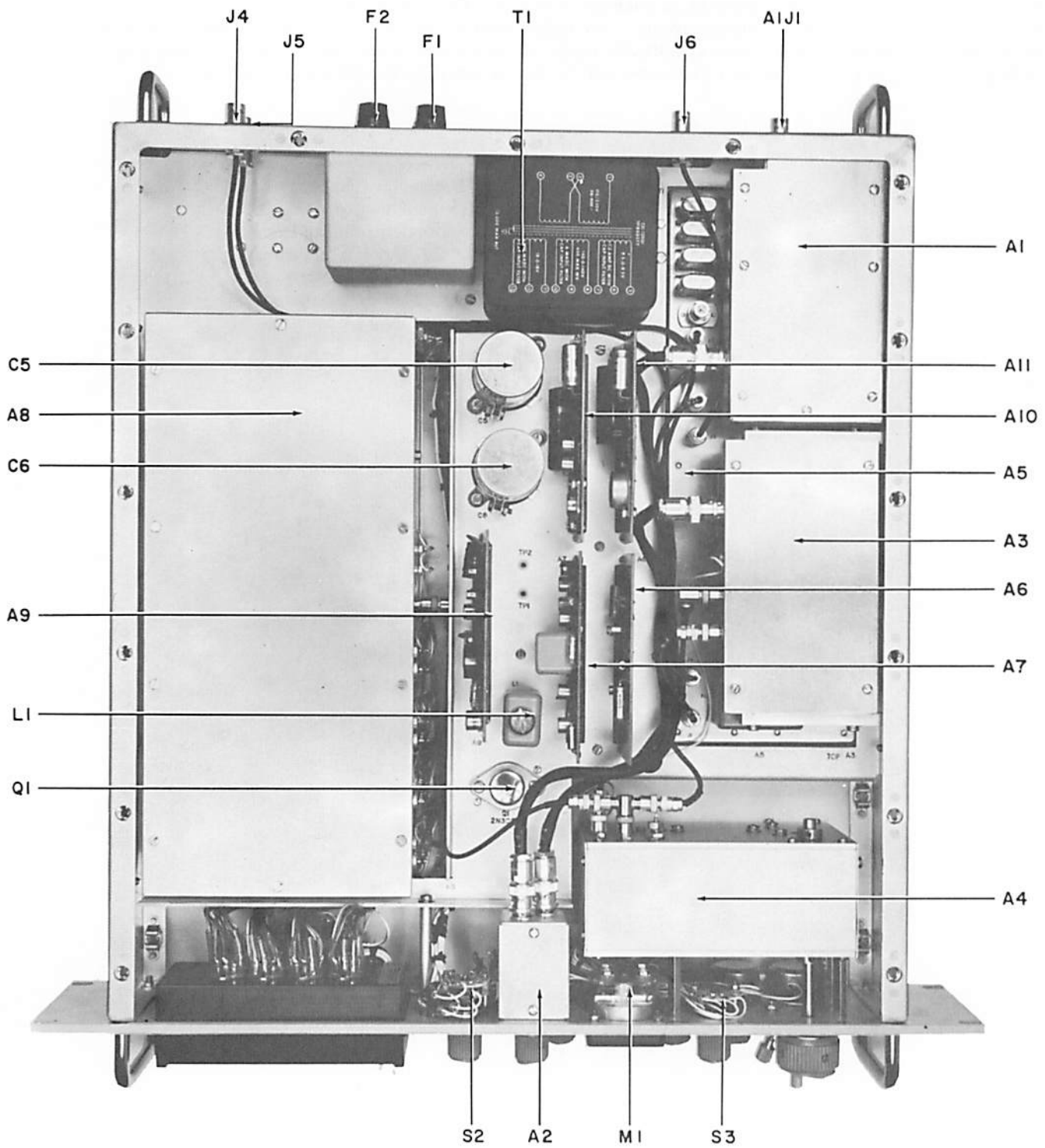


Figure 5-1. Type R-1401/G VLF Receiver, Top View

5.4.1 Main Chassis

Ref. Desig.	Description	Vendor Part No.	Vendor Code
A1	INPUT TRANSFORMER AND FILTER	79123	14632
A2	INPUT ATTENUATOR	79108	14632
A3	INPUT AMPLIFIER AND BALANCED MIXER	79124	14632
A4	LOCAL OSCILLATOR	7713	14632
A5	IF AND BFO ASSEMBLY	72106	14632
A6	AGC AMPLIFIER	7835	14632
A7	AUDIO AMPLIFIER	7411	14632
A8	VLF COUNTER ASSEMBLY	79101	14632
A9	+6VDC and -6VDC POWER SUPPLY	7683	14632
A10	+12V POWER SUPPLY REGULATOR	7681	14632
A11	-12V POWER SUPPLY REGULATOR	7680	14632
C1	CAPACITOR, PAPER, THRU-PASS: .01 $\mu$ f, 600V	102P515	56289
C2	Same as C1		
C3	Same as C1		
C4	Same as C1		
C5	CAPACITOR, ELECTROLYTIC: 3800 $\mu$ f, 15V	43F3019CA4	06001
C6	CAPACITOR, ELECTROLYTIC: 2500 $\mu$ f, 15V	43F3003CA4	06001
C7	CAPACITOR, ELECTROLYTIC: 16 $\mu$ f, 250V	BR16-250	21810
C8	CAPACITOR, CERAMIC, DISC: .05 $\mu$ f, $\pm$ 20%, 50V	55C23A1	56289
CP1	CONNECTOR, ADAPTER, MB SERIES	47325	74868
CR1	DIODE	1N3255	07688
CR2	Same as CR1		
DS1	DECIMAL SHIFT, NEON	21A3-2H	91802
DS2	Same as DS1		
DS3	TUBE, NIXIE	8422	83594
DS4	Same as DS3		
DS5	Same as DS3		
DS6	Same as DS3		
F1	FUSE, 3AG, Slow-Blow, 1/4-Amp.	MDL-1/4	71400
F2	FUSE, 3AG, Slow-Blow, 1/8-Amp.	MDL-1/8	71400
J1	CONNECTOR, RECEPTACLE, BNC	UG1094/U	81349
J2	CONNECTOR, MULTIPIN, BNC	31-2223	74868
J3	JACK, PHONE	C-11	82389
J4	CONNECTOR, JACK, BNC SERIES	17825	74868
J5	Same as J4	Part of W7	

Figure 5-2

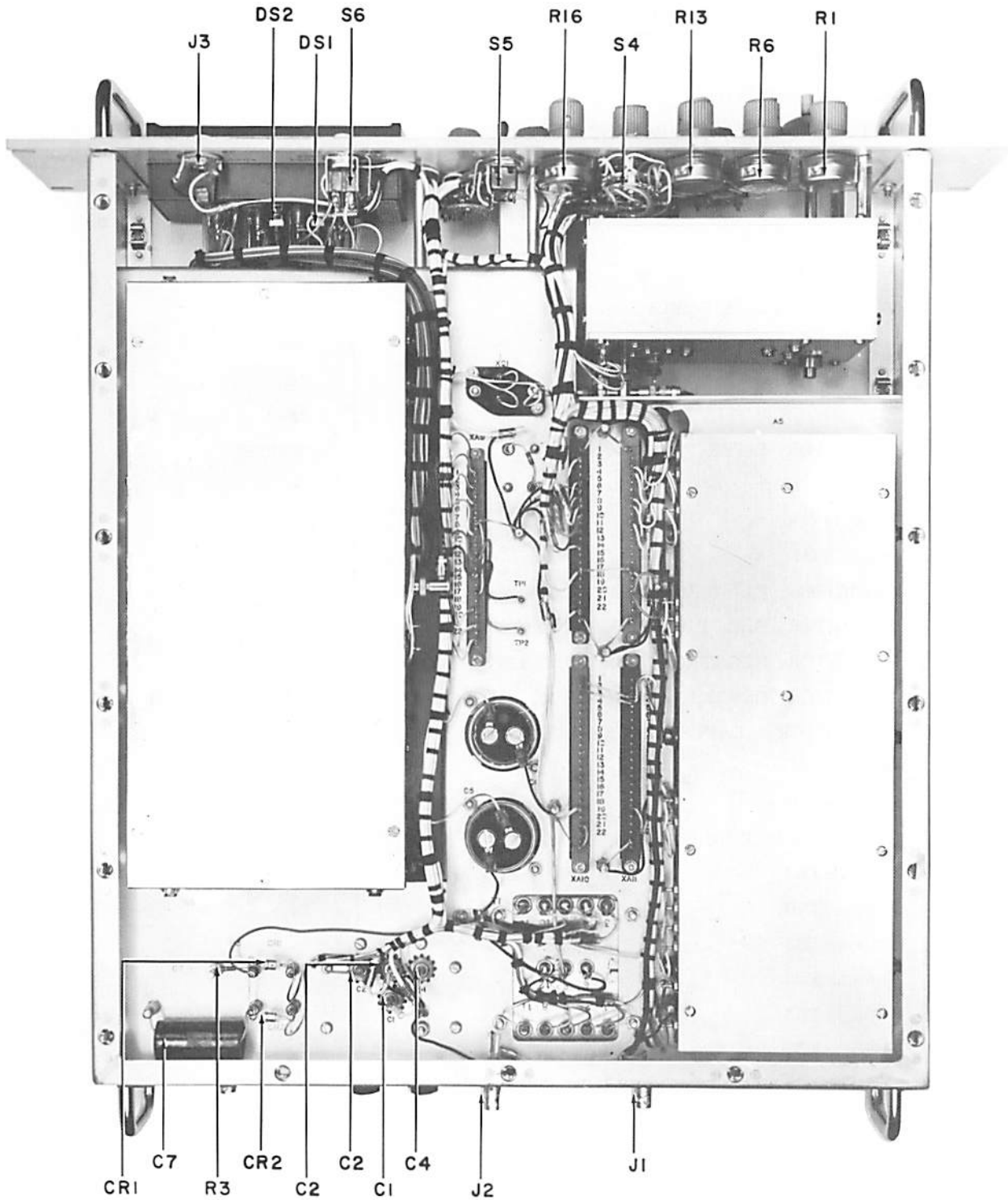


Figure 5-2. Type R-1401/G VLF Receiver, Bottom View

Ref. Desig.	Description	Vendor Part No.	Vendor Code
J6	Same as J4	Part of W8	
J7	CONNECTOR, PLUG, p/o CP1		
J8	CONNECTOR, PLUG, p/o CP1		
L1	COIL, VARIABLE	HVC-8	80223
M1	METER, SIGNAL STRENGTH	1632	14632
P1	PLUG AND POWER CABLE	01753-001	71700
P2	CONNECTOR, PLUG, MULTIPIN, BNC	31-2224	74868
P3	Same as P2	Part of W1	
P4	Same as P2	Part of W2	
P5	Same as P2	Part of W2	
P6	CONNECTOR, PLUG, MB SERIES	45775	74868
P7	CONNECTOR, PLUG, MB SERIES	44950	74868
P8	Same as P6	Part of W4	
P9	Same as P7	Part of W4	
P10	Same as P6	Part of W5	
P11	Same as P6	Part of W5	
P12	Same as P6		
P13	Same as P6		
P14	Same as P6		
P15	CONNECTOR, PLUG, p/o CP1		
P16	Same as P6	Part of W7	
P17	Same as P6	Part of W8	
Q1	TRANSISTOR	2N3055	07688
R1	RESISTOR, VARIABLE, COMPOSITION: 10K, 10%, 2W	RV4NAYSD103A	81349
R2	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R3	RESISTOR, FIXED, COMPOSITION: 1M, 5%, 1/4W	CB1055	01121
R4	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R5	RESISTOR, FIXED, COMPOSITION: 9.1K, 5%, 1/4W	CB9125	01121
R6	RESISTOR, VARIABLE, COMPOSITION: 100K, 10%, 2W	RV4NAYSD104A	81349
R7	RESISTOR, FIXED, COMPOSITION: 3K, 5%, 1/4W	CB3025	01121
R8	RESISTOR, FIXED, COMPOSITION: 9.2K, 5%, 1/4W	CB3925	01121
R9	RESISTOR, FIXED, COMPOSITION: 6.2K, 5%, 1/4W	CB6225	01121
R10	Same as R9		
R11	Same as R9		
R12	Same as R9		



REPLACEMENT PARTS LIST

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R13	Same as R1		
R14	RESISTOR, FIXED, COMPOSITION: 16K, 5%, 1/4W	CB1635	01121
R15	RESISTOR, FIXED, COMPOSITION: 180K, 5%, 1/4W	CB1845	01121
R16	RESISTOR, VARIABLE, COMPOSITION: 2.5K, 10%, 2W	RV4NAYS252A	81349
S1	SWITCH, SLIDE, DPDT	4633	42190
S2	SWITCH, ROTARY: 2-Section, 4-Pole, 2-6 Position	399225A	81716
S3	SWITCH, ROTARY: 1-Section, 1-Pole, 2-12 Position	399217A	81716
S4	Same as S2		
S5	SWITCH, TOGGLE, SPDT	8282-K14	15605
S6	SWITCH, PUSH-BUTTON, DPDT	76-2230/404	04426
T1	TRANSFORMER	12001	14632
TP1	TEST POINT	TJ6	04013
TP2	Same as TP1		
W1	CABLE AND CONNECTOR ASSEMBLY	30020-273	14632
W2	CABLE AND CONNECTOR ASSEMBLY	30020-274	14632
W3	CABLE AND CONNECTOR ASSEMBLY	30020-275	14632
W4	CABLE AND CONNECTOR ASSEMBLY	30020-276	14632
W5	CABLE AND CONNECTOR ASSEMBLY	30020-277	14632
W6	CABLE AND CONNECTOR ASSEMBLY	30020-278	14632
W7	CABLE AND CONNECTOR ASSEMBLY	30020-279	14632
W8	CABLE AND CONNECTOR ASSEMBLY	30020-280	14632

5.4.2 Type 79123 Input Transformer and Filter Assembly

REF DESIG PREFIX A1

Ref Desig	Description	Vendor Part No.	Vendor Code
A1	FILTER BOARD	11922/1	14632
J1	CONNECTOR, RECEPTACLE	31-223	74868
J2	Same as J1		
S1	SWITCH, SLIDE, SPDT	G326	79727
T1	TRANSFORMER	20021-1	14632

REF DESIG PREFIX A1

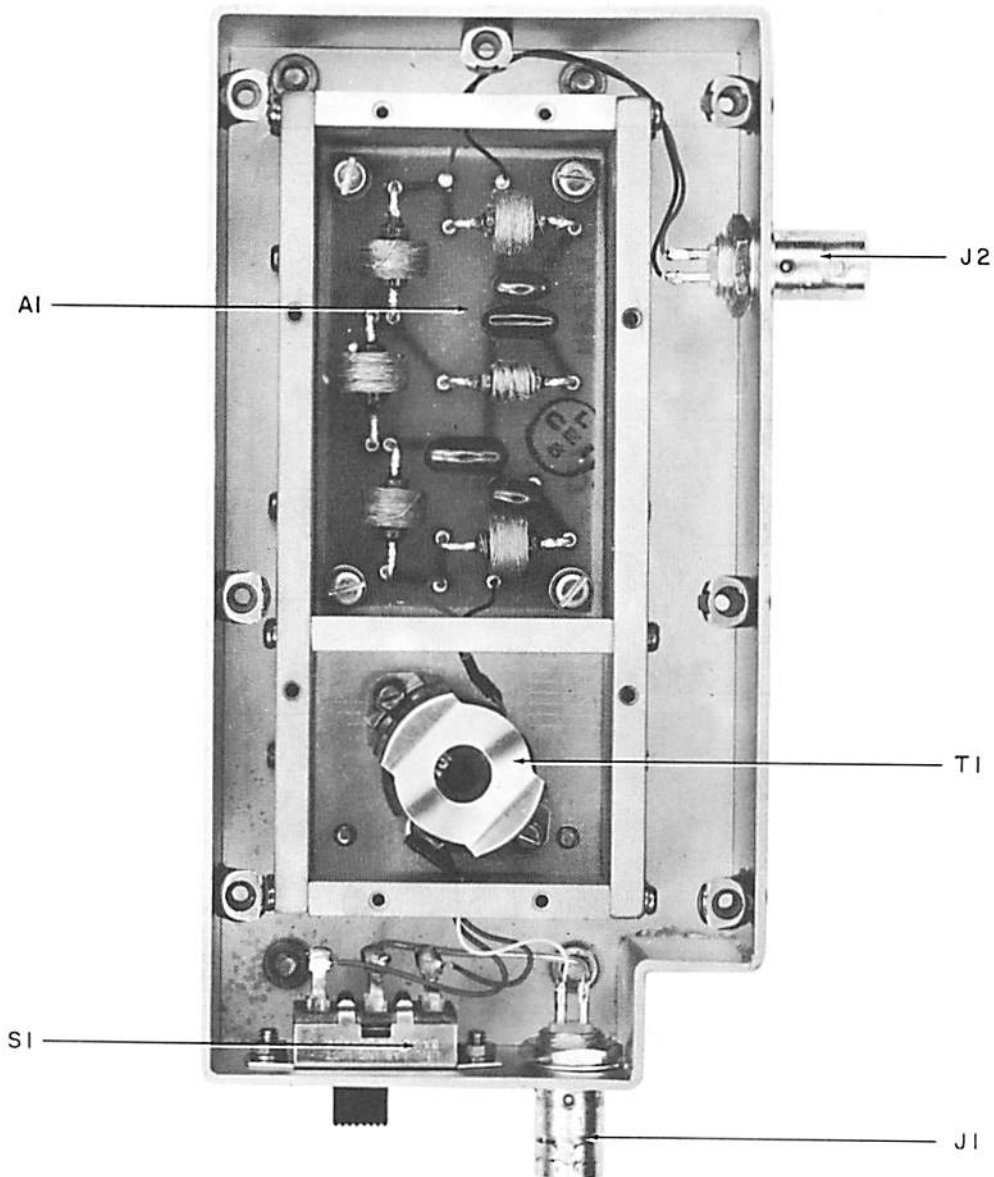


Figure 5-3. Type 79123 Input Transformer and Filter Assembly, Component Locations

REPLACEMENT PARTS LIST

5.4.2.1 Filter Board, Part 11922/1

REF DESIG PREFIX A1A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, DIPPED MICA: 150 pf, 5%, 500V	DM10-151J	72136
C2	CAPACITOR, DIPPED MICA: 390 pf, 5%, 500V	DM15-391J	72136
C3	Same as C2		
C4	CAPACITOR, DIPPED MICA: 100 pf, 5%, 500V	DM10-101J	72136
L1	COIL, FIXED: 200 $\mu$ h	1200-15	99848
L2	COIL, FIXED: 300 $\mu$ h	1300-15	99848
L3	Same as L2		
L4	COIL, FIXED: 15 $\mu$ h	1015-15	99848
L5	Same as L2		
L6	Same as L1		

REF DESIG PREFIX A1A1

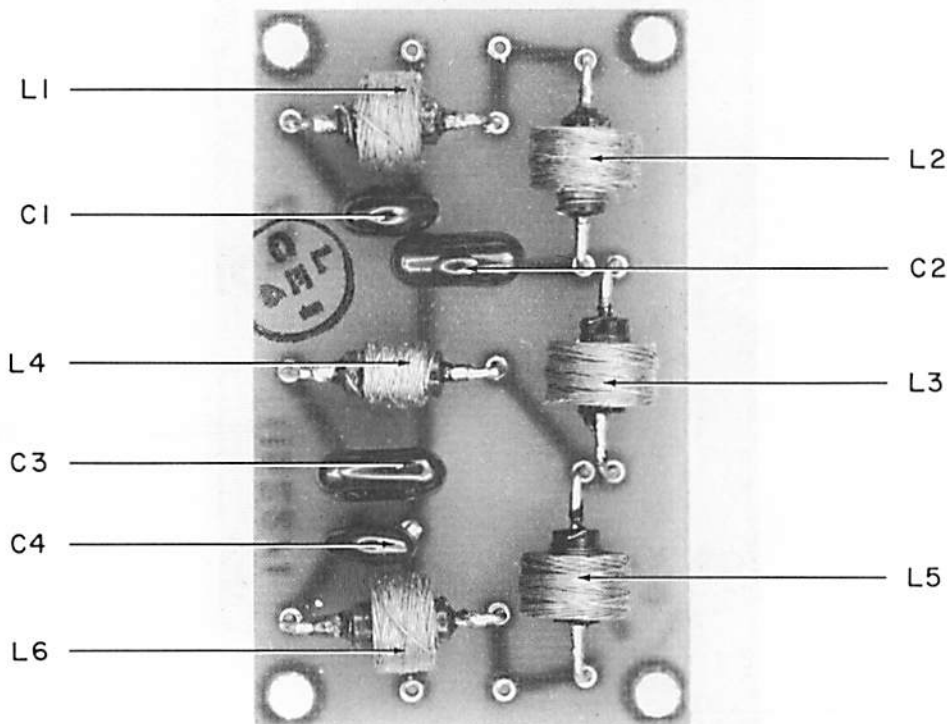


Figure 5-4. Filter Board, Part 11922/1, Component Locations

5.4.3 Type 79108 Input Attenuator

REF DESIG PREFIX A2

Ref. Desig.	Description	Vendor Part No.	Vendor Code
J1	CONNECTOR, JACK	31-2223	74868
J2	Same as J1		
R1	RESISTOR, FIXED, COMPOSITION: 910 $\Omega$ , 5%, 1/4W	CB9115	01121
R2	RESISTOR, FIXED, COMPOSITION: 91 $\Omega$ , 5%, 1/4W	CB9105	01121
R3	RESISTOR, FIXED, COMPOSITION: 11 $\Omega$ , 5%, 1/4W	CB1105	01121
R4	RESISTOR, FIXED, COMPOSITION: 10 $\Omega$ , 5%, 1/4W	CB1005	01121
R5	Same as R2		
S1	SWITCH, ROTARY: 1 Section, 2 Pole, 2-6 Position	399222A	81716

REF DESIG PREFIX A2

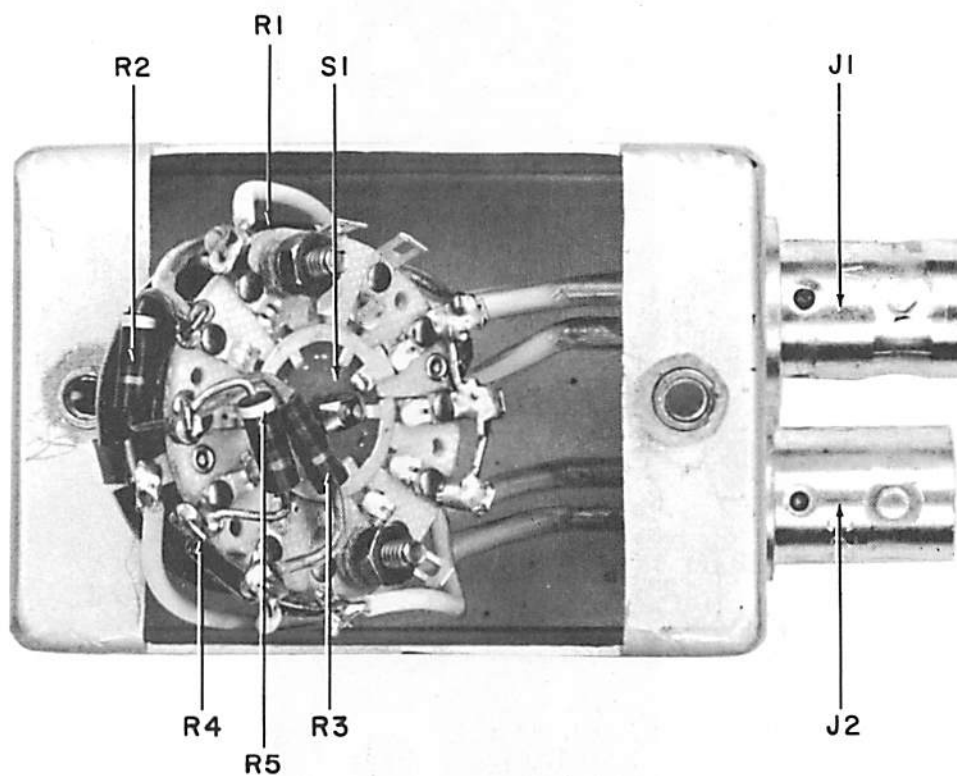


Figure 5-5. Type 79108 Input Attenuator, Component Locations

REPLACEMENT PARTS LIST

5.4.4 Type 79124 Input Amplifier and Balanced Mixer

REF DESIG PREFIX A3

Ref. Desig.	Description	Vendor Part No.	Vendor Code
A1	INPUT AMPLIFIER AND BALANCED MIXER	11936/2	14632
C1	CAPACITOR, CERAMIC, DISC: .05 $\mu$ f, 20%, 50V	55C23A1	56289
C2	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pf, GMV, 500V	FA5C-102W	01121
J1	CONNECTOR, RECEPTACLE, MULTIPIN, BNC SERIES	31-223	74868
J2	CONNECTOR, RECEPTACLE, MB SERIES	46025	74868
J3	CONNECTOR, JACK, MB SERIES	46625	74868

REF DESIG PREFIX A3

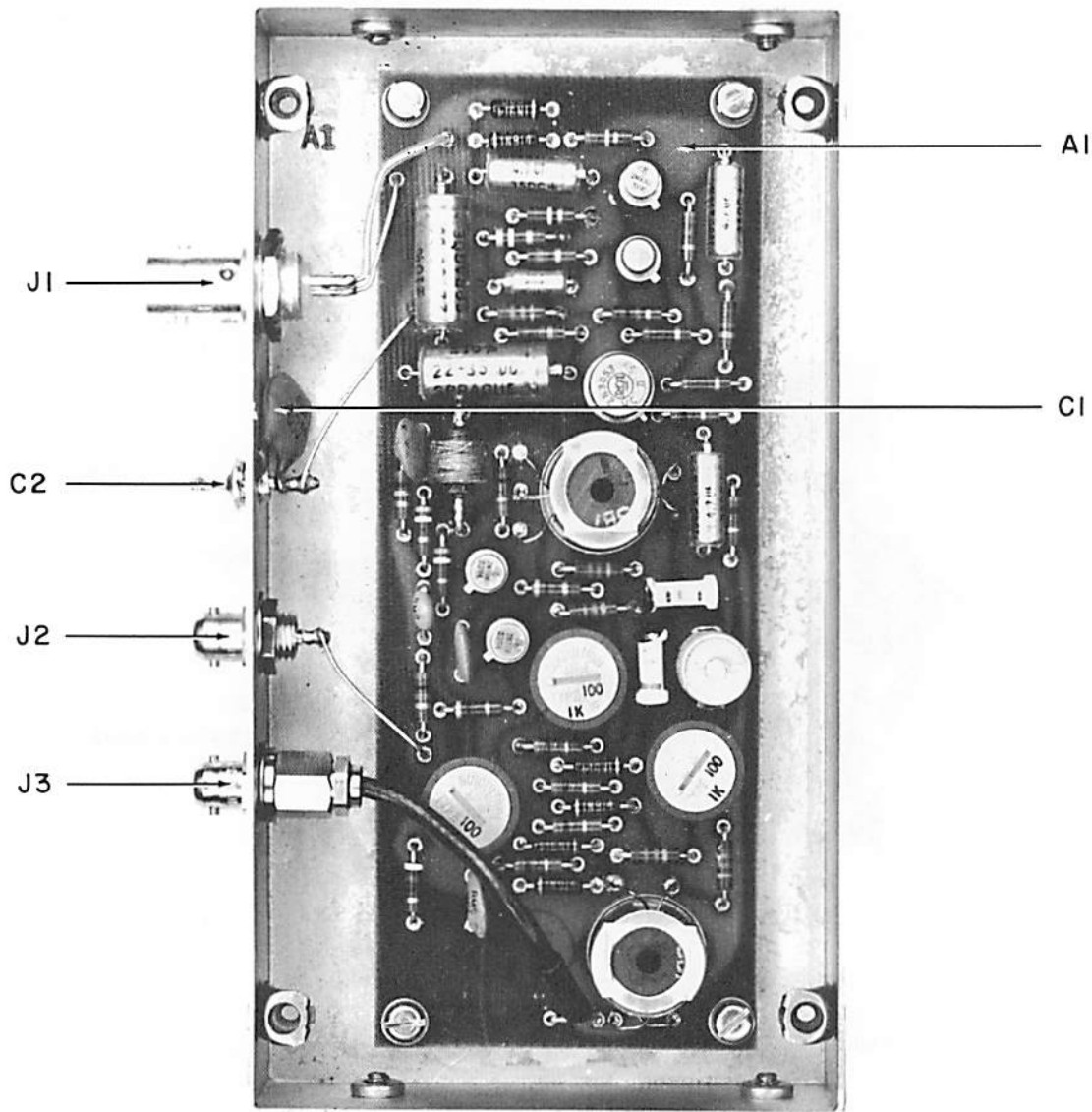


Figure 5-6. Type 79124 Input Amplifier and Balanced Mixer, Component Locations

5.4.4.1 Input Amplifier and Balanced Mixer, Part 11936/2

REF DESIG PREFIX A3A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 $\mu$ f, 10%, 35V	150D475X9035B2	56289
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 1 $\mu$ f, 10%, 35V	150D105X9035A2	56289
C3	Same as C1		
C4	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 $\mu$ f, 10%, 35V	150D226X9035R2	56289
C5	Same as C1		
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 100 $\mu$ f, 20%, 20V	150D107X0020S2	56289
C7	CAPACITOR, CERAMIC, TUBULAR: 3.3 pf $\pm$ .25 pf, 500V	301-000-COHO-339C	72982
C8	CAPACITOR, VARIABLE, CERAMIC: 2.5 - 11 pf, 350V	538-002-90R	72982
C9	CAPACITOR, CERAMIC, TUBULAR: 5.6 pf $\pm$ .5 pf, 500V	301-000-COHO-569D	72982
C10	CAPACITOR, CERAMIC, DISC: 1000 pf, GMV, 500V	SM	91418
C11	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
C12	CAPACITOR, CERAMIC, DISC: .01 $\mu$ f, 20%, 50V	19C214A6	56289
C13	Same as C12		
CR1	DIODE	1N914	07688
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
L1	COIL, FIXED: 120 $\mu$ h	1120-15	99848
Q1	TRANSISTOR	2N930	07688
Q2	TRANSISTOR	2N3251	07688
Q3	TRANSISTOR	2N3053	07688
Q4	TRANSISTOR	2N706	07688
Q5	Same as Q4		
R1	RESISTOR, FIXED, COMPOSITION: 220K, 5%, 1/4W	CB2245	01121
R2	RESISTOR, FIXED, COMPOSITION: 120K, 5%, 1/4W	CB1245	01121
R3	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R4	RESISTOR, FIXED, COMPOSITION: 5.6K, 5%, 1/4W	CB5625	01121
R5	RESISTOR, FIXED, COMPOSITION: 220 $\Omega$ , 5%, 1/4W	CB2215	01121
R6	RESISTOR, FIXED, COMPOSITION: 1.5K, 5%, 1/4W	CB1525	01121
R7	RESISTOR, FIXED, COMPOSITION: 200 $\Omega$ , 5%, 1/4W	CB2015	01121
R8	Same as R6		



Figure 5-7

REF DESIG PREFIX A3A1

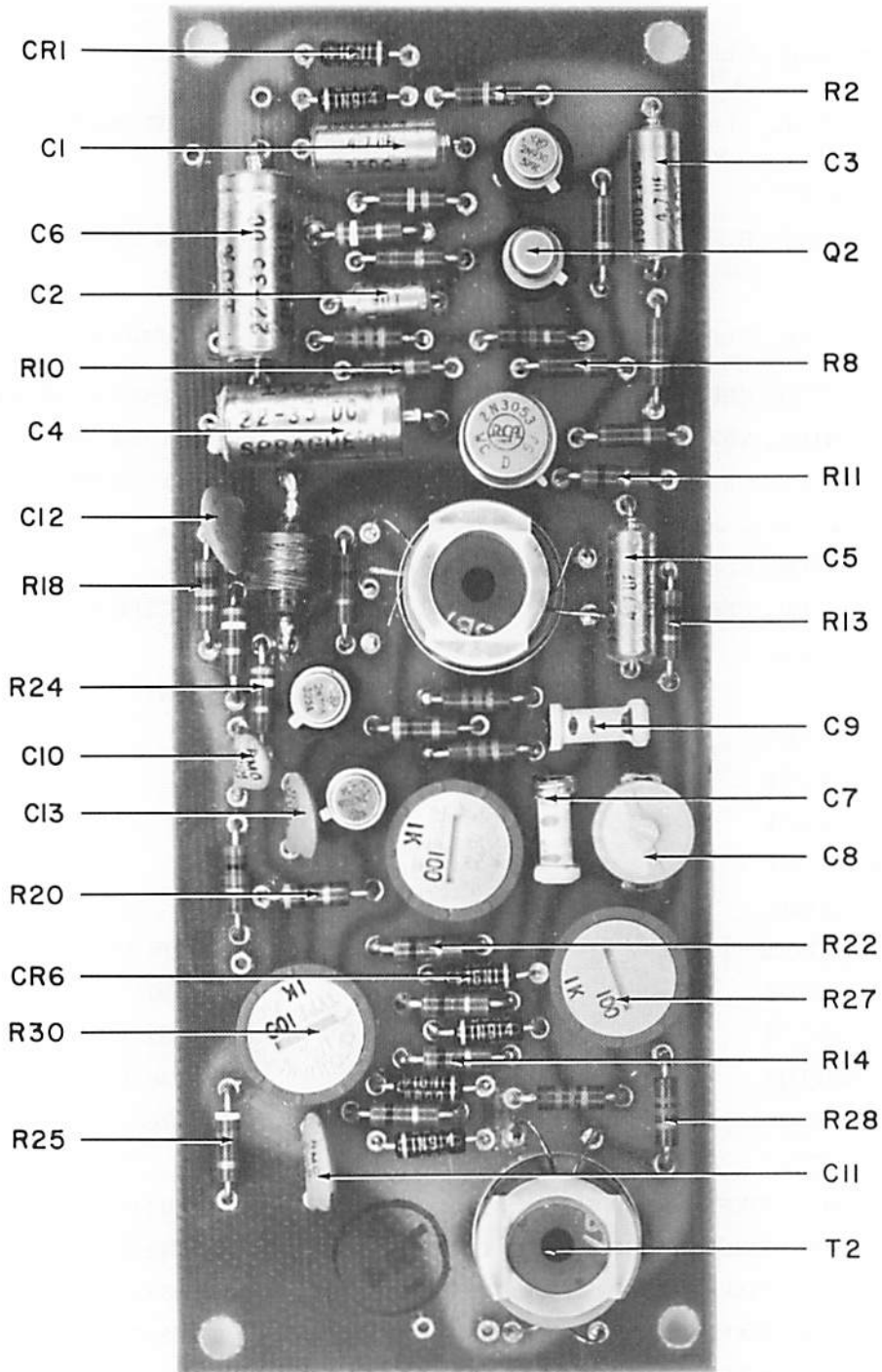


Figure 5-7. Input Amplifier and Balanced Mixer, Part 11936/2, Component Locations

REF DESIG PREFIX A3A1

Ref. Desig .	Description	Vendor Part No.	Vendor Code
R9	Same as R6		
R10	Same as R5		
R11	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R12	Same as R11		
R13	Same as R11		
R14	Same as R11		
R15	Same as R11		
R16	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	CB5115	01121
R17	Same as R3		
R18	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R19	RESISTOR, VARIABLE, WIREWOUND: 1K, 5%, 1W	CT-100	75042
R20	RESISTOR, FIXED, COMPOSITION: 3K, 5%, 1/4W	CB3025	01121
R21	Same as R11		
R22	Same as R11		
R23	Same as R16		
R24	Same as R3		
R25	RESISTOR, FIXED, COMPOSITION: 9.1K, 5%, 1/4W	CB9125	01121
R26	Same as R16		
R27	Same as R19		
R28	Same as R16		
R29	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R30	Same as R19		
R31	Same as R20		
R32	RESISTOR, FIXED, COMPOSITION: 2K, 5%, 1/4W	CB2025	01121
T1	TRANSFORMER	30312-37	14632
T2	TRANSFORMER	30312-38	14632

Figure 5-8

REF DESIG PREFIX A3A1

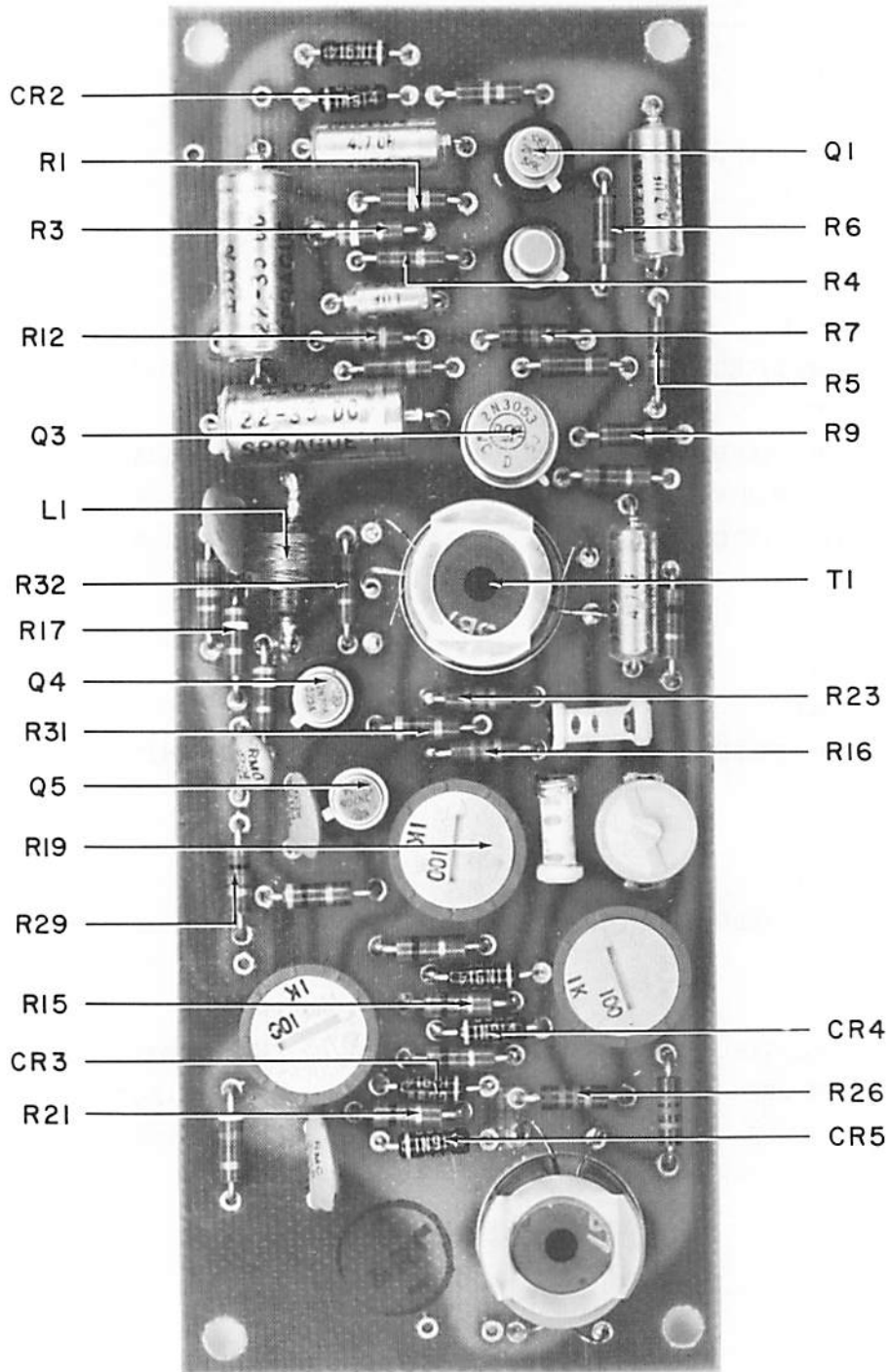


Figure 5-8. Input Amplifier and Balanced Mixer, Part 11936/2, Component Locations

5.4.5 Type 7713 Local Oscillator

REF DESIG PREFIX A4

Ref. Desig.	Description	Vendor Part No.	Vendor Code
A1	LOCAL OSCILLATOR BOARD	11968	14632
C1	CAPACITOR, CERAMIC, FEED-THRU: 1000 pf, 20%, 500V	357-X5U-102M	72982
C2	Same as C1		
C3	Same as C1		
C4	CAPACITOR, VARIABLE, GLASS: 1-38 pf	NBC-24G	73899
C5	CAPACITOR, VARIABLE, AIR: 11-143 pf	RMC-140S	80583
C6	CAPACITOR, VARIABLE, AIR: 6.5 pf (Temp. Comp.)	TC	23783
J1	CONNECTOR, RECEPTACLE, MB SERIES	46025	74868
J2	Same as J1		
L1	COIL, VARIABLE	1505-6	71279

REF DESIG PREFIX A4

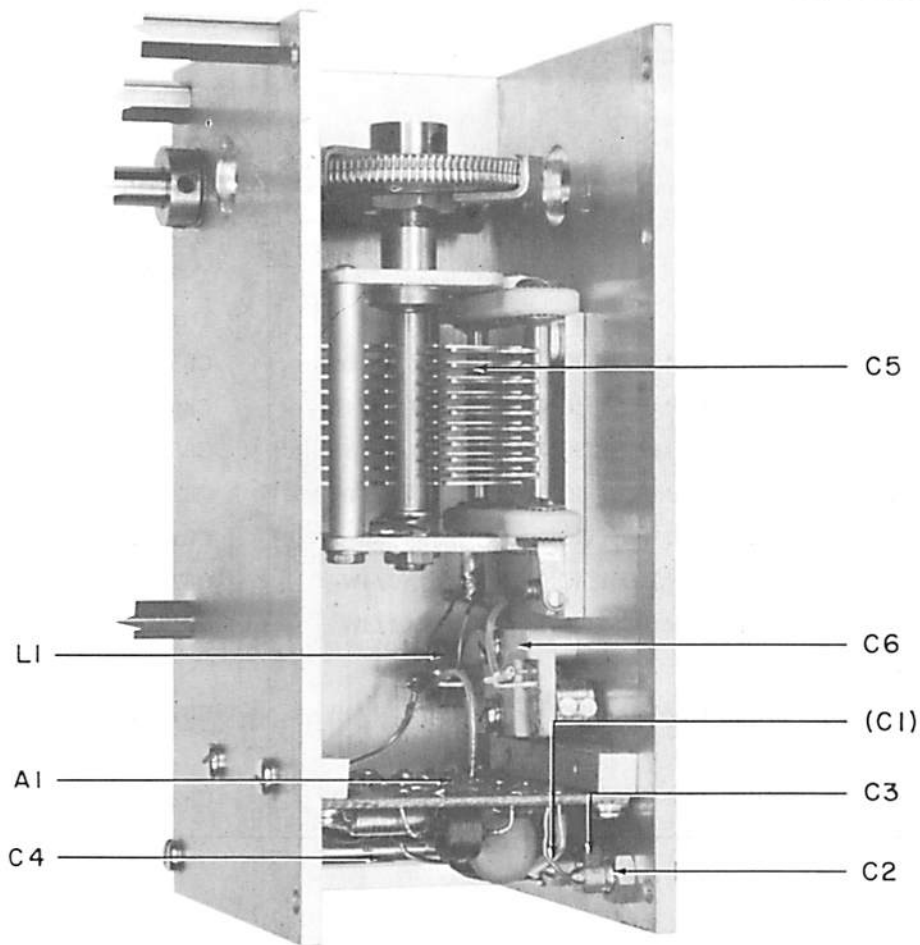


Figure 5-9. Type 7713 Local Oscillator Assembly, Component Locations

REPLACEMENT PARTS LIST

5.4.5.1 Local Oscillator Board, Part 11968

REF DESIG PREFIX A4A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 10 $\mu$ f, 10%, 20V	150D106X9020B2	56289
C2	CAPACITOR, DIPPED MICA: 10 pf, 5%, 500V	DM10-100J	72136
C3	CAPACITOR, CERAMIC, TUBULAR: 18 pf, 5%, 500V (TC-N750)	301-000-U2J0-180J	72982
C4	CAPACITOR, CERAMIC, DISC: .05 $\mu$ f, 20%, 50V	55C23A1	56289
C5	CAPACITOR, DIPPED MICA: 120 pf, 5%, 500V	DM10-121J	72136
C6	CAPACITOR, DIPPED MICA: 1000 pf, 5%, 500V	DM15-102J	72136
C7	Same as C6		
C8	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 $\mu$ f, 10%, 35V	150D475X9035B2	56289
C9	Same as C6		
C10	Same as C6		
C11	Same as C4		
C12	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
CR1	DIODE, CAPACITOR	V27E	01281
CR2	DIODE, ZENER	1N961B	07688
L1	COIL, FIXED: 430 $\mu$ h	3430-15	99848
Q1	TRANSISTOR	2N3478	07688
Q2	TRANSISTOR	2N706	07688
Q3	TRANSISTOR	2N3251	07688
R1	RESISTOR, FIXED, COMPOSITION: 510K, 5%, 1/4W	CB5145	01121
R2	RESISTOR, FIXED, COMPOSITION: 620 $\Omega$ , 5%, 1/4W	CB6215	01121
R3	RESISTOR, FIXED, COMPOSITION: 82K, 5%, 1/4W	CB8235	01121
R4	RESISTOR, FIXED, COMPOSITION: 220K, 5%, 1/4W	CB2245	01121
R5	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R6	RESISTOR, FIXED, COMPOSITION: 20K, 5%, 1/4W	CB2035	01121
R7	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R8	Same as R5		
R9	RESISTOR, FIXED, COMPOSITION: 360 $\Omega$ , 5%, 1/4W	CB3615	01121
R10	Same as R9		
R11	RESISTOR, FIXED, COMPOSITION: 240 $\Omega$ , 5%, 1/4W	CB2415	01121



REF DESIG PREFIX A4A1

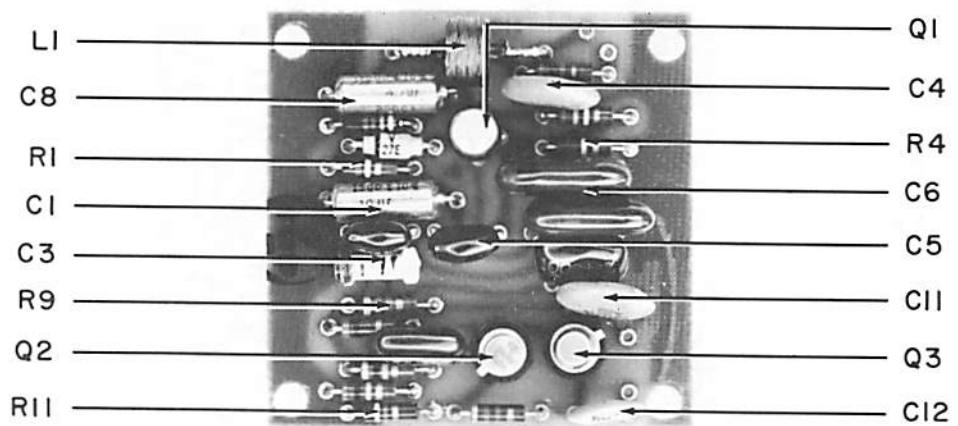
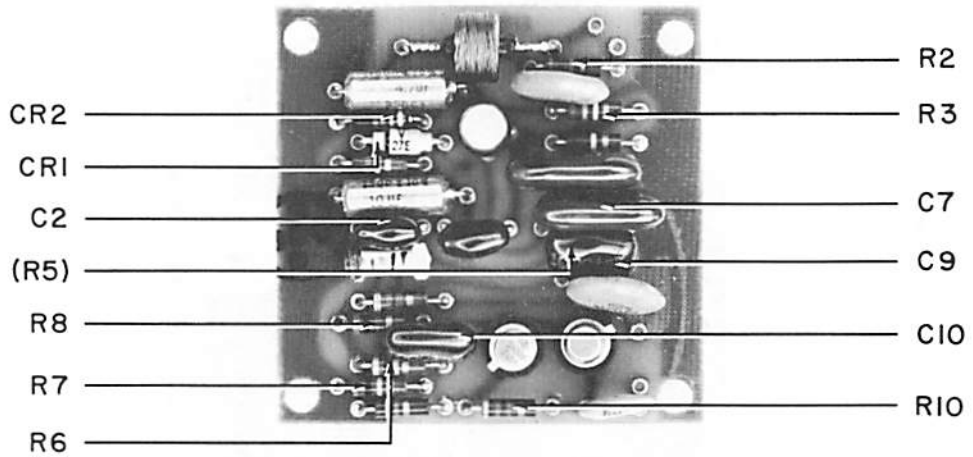


Figure 5-10. Local Oscillator Board, Part 11968, Component Locations

Figure 5-11

REF DESIG PREFIX A5

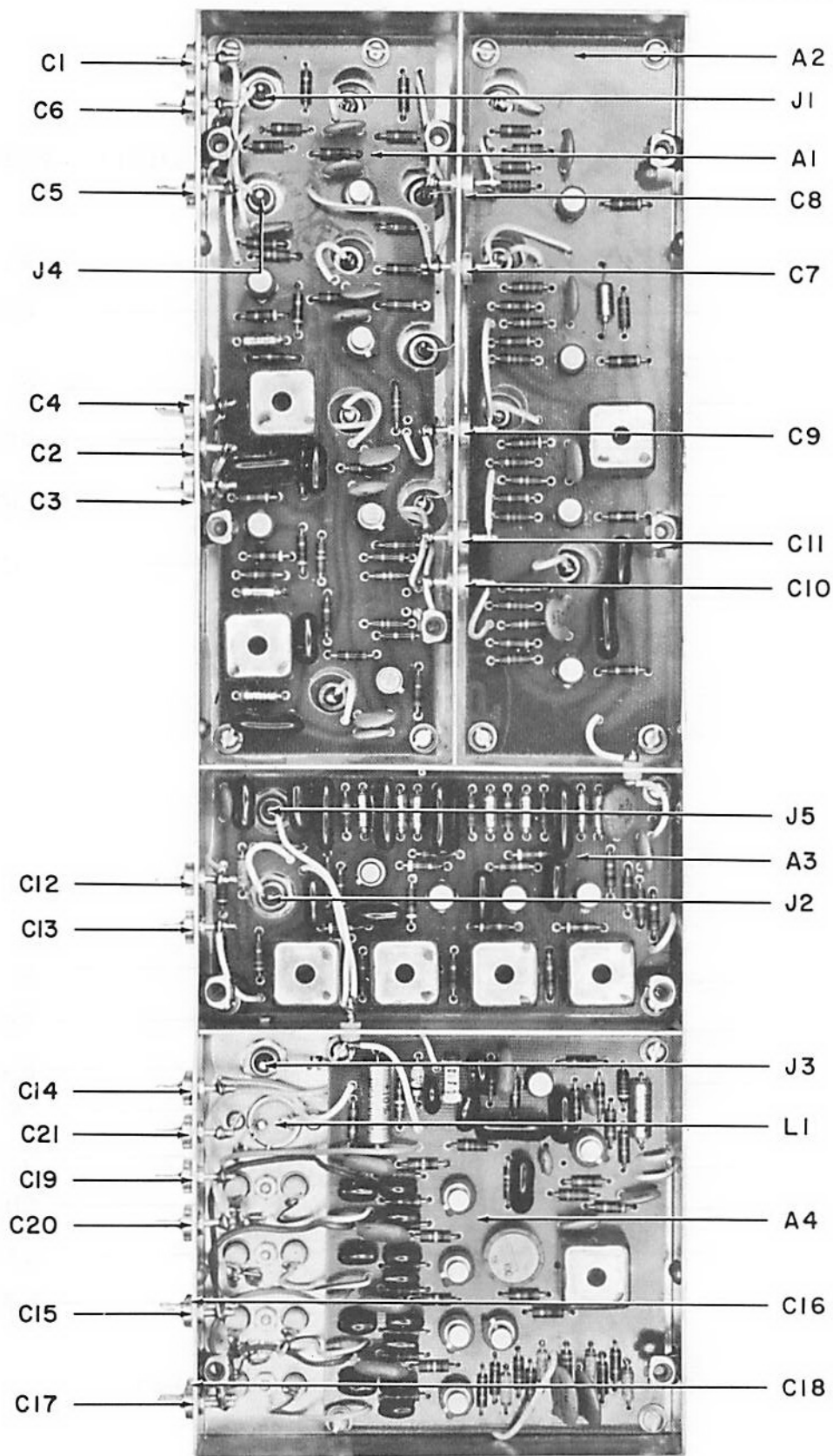


Figure 5-11. Type 72106 IF and BFO Assembly, Component Locations

5.4.6 Type 72106 IF and BFO Assembly

REF DESIG PREFIX A5

Ref. Desig.	Description	Vendor Part No.	Vendor Code
A1	IF BANDWIDTH SWITCHING AMPLIFIER "A"	11962	14632
A2	IF BANDWIDTH SWITCHING AMPLIFIER "B"	11964	14632
A3	IF AMPLIFIER AND AM DETECTOR	11937	14632
A4	BFO AND BALANCED MIXER	11966	14632
C1	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pf, GMV, 500V	FA5C-102W	01121
C2	Same as C1		
C3	Same as C1		
C4	Same as C1		
C5	Same as C1		
C6	Same as C1		
C7	Same as C1		
C8	Same as C1		
C9	Same as C1		
C10	Same as C1		
C11	Same as C1		
C12	Same as C1		
C13	Same as C1		
C14	Same as C1		
C15	Same as C1		
C16	Same as C1		
C17	Same as C1		
C18	Same as C1		
C19	Same as C1		
C20	Same as C1		
E1	TERMINAL, FEEDTHRU	SFU-16	04013
E2	Same as E1		
FL1	FILTER, BAND-PASS: 100 Cycle B-W	40B6	00136
FL2	FILTER, BAND-PASS: 1KC B-W	40B7	00136
FL3	FILTER, BAND-PASS: 3KC B-W	40B8	00136
FL4	FILTER, BAND-PASS: 6KC B-W	40B12	00136
J1	CONNECTOR, RECEPTACLE, MB SERIES	46025	74868
J2	Same as J1		
J3	Same as J1		
J4	Same as J1		
J5	Same as J1		

REPLACEMENT PARTS LIST

REF DESIG PREFIX A5

Ref. Desig.	Description	Vendor Part No.	Vendor Code
L1	COIL, VARIABLE	1505-6	71279
Y1	CRYSTAL, 2,000.000 KC	CR-18/U Except Freq. tol. $\pm 0.001\%$ at room temp. and $\pm 0.002\%$ over temp. range of 0°C to +50°C	74306
Y2	CRYSTAL, 2,001.00 KC	Same as Y1	74306
Y3	CRYSTAL, 1,998.350 KC	Same as Y1	74306
Y4	CRYSTAL, 2,001.650 KC	Same as Y1	74306

5.4.6.1 IF Bandwidth Switching Amplifier "A", Part 11962

REF DESIG PREFIX A5A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: .47 $\mu$ f, 10%, 35V	150D474X9035A2	56289
C2	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
C3	CAPACITOR, DIPPED MICA: 820 pf, 5%, 500V	DM10-821J	72136
C4	CAPACITOR, DIPPED MICA: 1800 pf, 5%, 500V	DM19-182J	72136
C5	Same as C1		
C6	Same as C1		
C7	Same as C1		
C8	Same as C3		
C9	Same as C4		
C10	Same as C2		
C11	Same as C2		
C12	Same as C2		
C13	Same as C2		
C14	Same as C2		
C15	Same as C2		
C16	Same as C2		
C17	Same as C2		
L1	COIL, VARIABLE	3476-25	14632
L2	Same as L1		
Q1	TRANSISTOR	2N3478	07688
Q2	Same as Q1		
Q3	TRANSISTOR	2N706	07688
Q4	Same as Q3		
Q5	Same as Q3		
Q6	Same as Q3		
R1	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R2	RESISTOR, FIXED, COMPOSITION: 15K, 5%, 1/4W	CB1535	01121
R3	RESISTOR, FIXED, COMPOSITION: 47 $\Omega$ , 5%, 1/4W	CB4705	01121
R4	RESISTOR, FIXED, COMPOSITION: 4.7K, 5%, 1/4W	CB4725	01121
R5	RESISTOR, FIXED, COMPOSITION: 3.0 $\Omega$ , 5%, 1/4W	CB30G5	01121
R6	Same as R1		
R7	Same as R1		
R8	Same as R2		
R9	Same as R3		

Figure 5-12

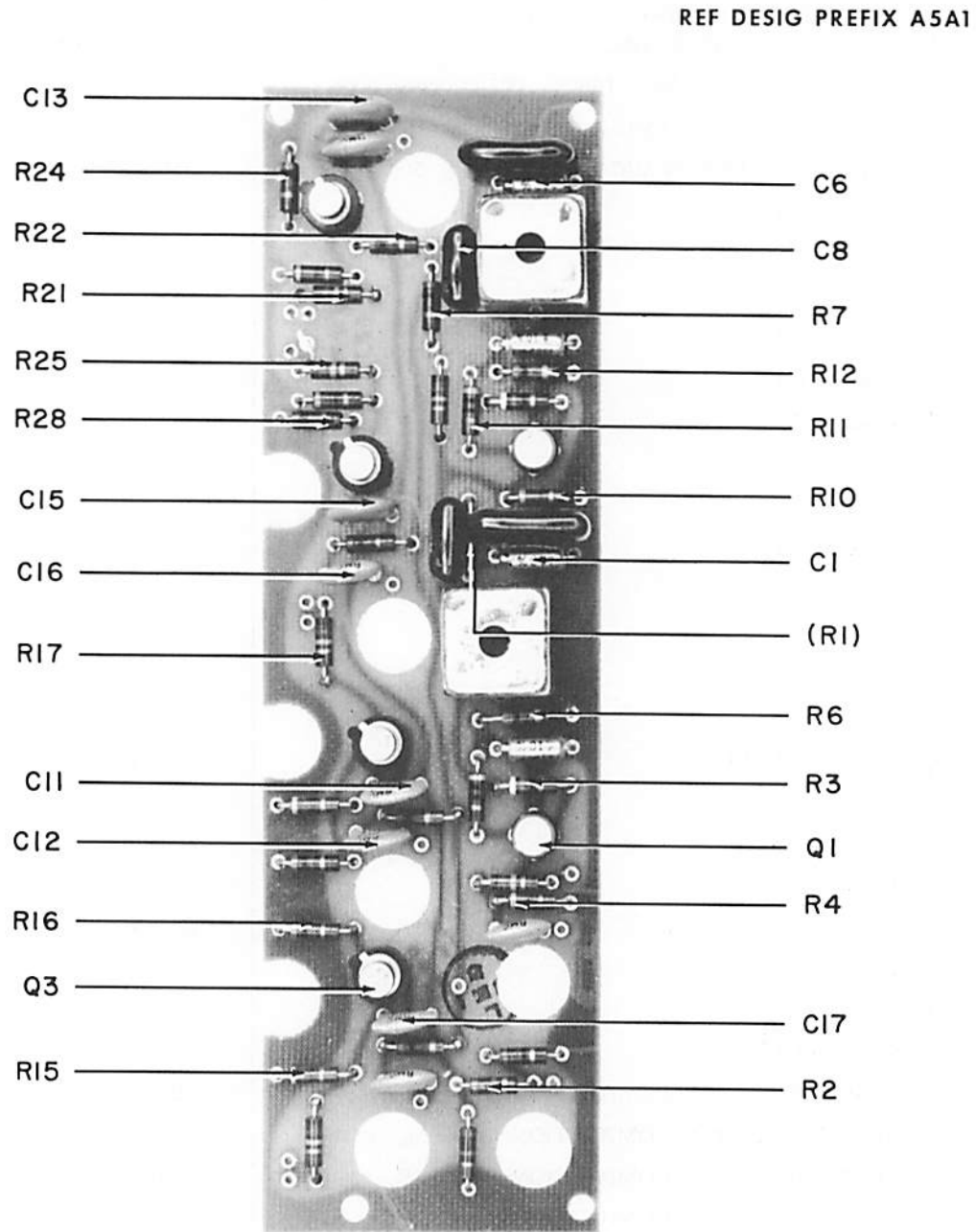


Figure 5-12. IF BW Switching Amplifier "A," Part 11962, Component Locations



REF DESIG PREFIX A5A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R10	Same as R4		
R11	Same as R5		
R12	Same as R1		
R13	RESISTOR, FIXED, COMPOSITION: 27K, 5%, 1/4W	CB2735	01121
R14	Same as R1		
R15	Same as R4		
R16	Same as R1		
R17	Same as R13		
R18	Same as R1		
R19	Same as R4		
R20	Same as R1		
R21	Same as R13		
R22	Same as R1		
R23	Same as R4		
R24	Same as R1		
R25	Same as R13		
R26	Same as R1		
R27	Same as R4		
R28	Same as R1		
R29	RESISTOR, FIXED, COMPOSITION: 120 $\Omega$ , 5%, 1/4W	CB1215	01121
R30	RESISTOR, FIXED, COMPOSITION: 75 $\Omega$ , 5%, 1/4W	CB7505	01121
R31	RESISTOR, FIXED, COMPOSITION: 750 $\Omega$ , 5%, 1/4W	CB7515	01121

Figure 5-13

REF DESIG PREFIX A5A1

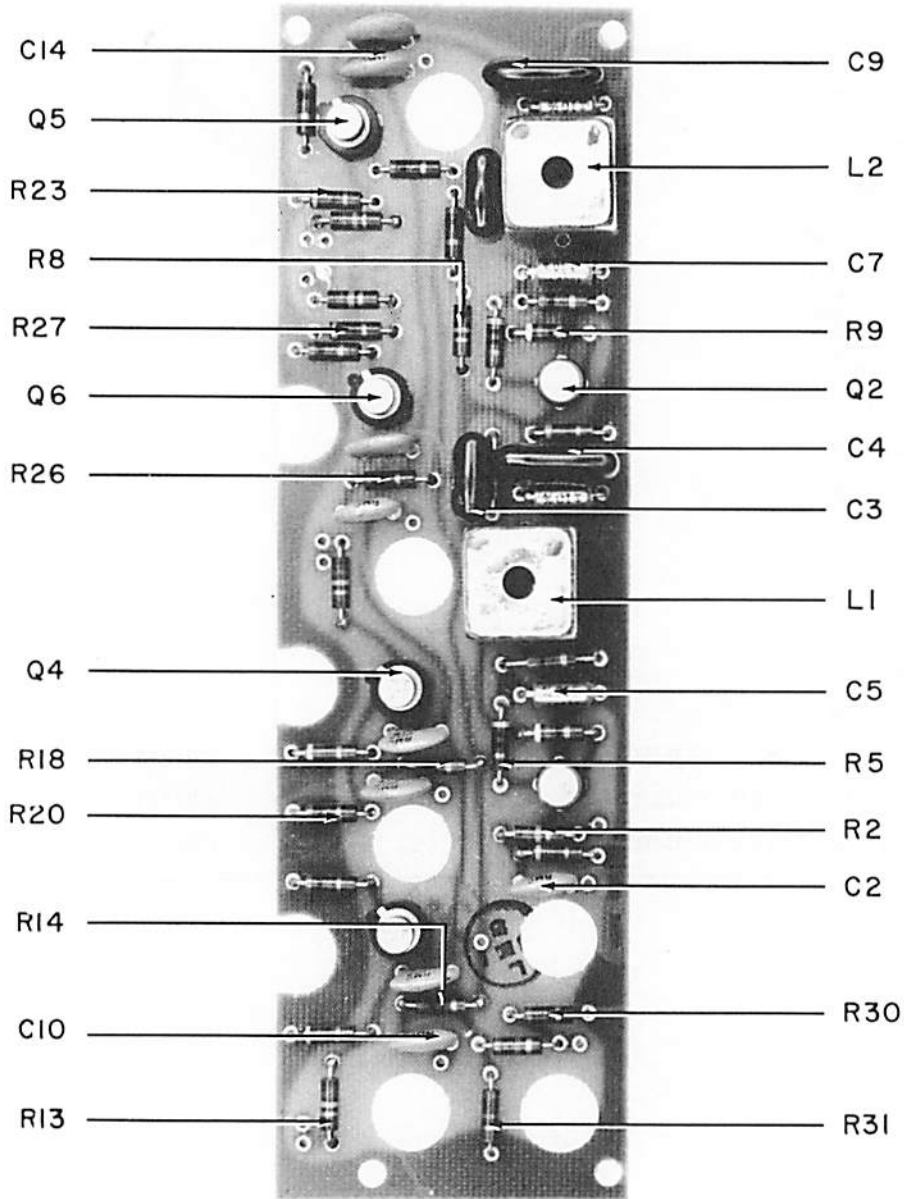


Figure 5-13. IF BW Switching Amplifier "A," Part 11962, Component Locations

5.4.6.2 IF BW Switching Amplifier "B", Part 11964

REF DESIG PREFIX A5A2

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: .47 $\mu$ f, 10%, 35V	150D474X9035A2	56289
C3	Same as C1		
C4	Same as C1		
C5	CAPACITOR, DIPPED MICA: 820 pf, 5%, 500V	DM15-821J	72136
C6	CAPACITOR, DIPPED MICA: 1800 pf, 5%, 500V	DM19-182J	72136
C7	Same as C1		
L1	COIL, VARIABLE	3476-25	14632
Q1	TRANSISTOR	2N3478	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
R1	RESISTOR, FIXED, COMPOSITION: 27K, 5%, 1/4W	CB2735	01121
R2	RESISTOR, FIXED, COMPOSITION: 47 $\Omega$ , 5%, 1/4W	CB4705	01121
R3	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	CB5115	01121
R4	RESISTOR, FIXED, COMPOSITION: 1.5K, 5%, 1/4W	CB1525	01121
R5	RESISTOR, FIXED, COMPOSITION: 4.7K, 5%, 1/4W	CB4725	01121
R6	Same as R3		
R7	Same as R1		
R8	Same as R2		
R9	RESISTOR, FIXED, COMPOSITION: 680 $\Omega$ , 5%, 1/4W	CB6815	01121
R10	RESISTOR, FIXED, COMPOSITION: 300 $\Omega$ , 5%, 1/4W	CB3015	01121
R11	Same as R5		
R12	Same as R3		
R13	Same as R1		
R14	Same as R2		
R15	RESISTOR, FIXED, COMPOSITION: 820 $\Omega$ , 5%, 1/4W	CB8215	01121
R16	RESISTOR, FIXED, COMPOSITION: 160 $\Omega$ , 5%, 1/4W	CB1615	01121
R17	Same as R5		
R18	Same as R3		
R19	Same as R1		
R20	Same as R2		
R21	RESISTOR, FIXED, COMPOSITION: 910 $\Omega$ , 5%, 1/4W	CB9115	01121
R22	RESISTOR, FIXED, COMPOSITION: 120 $\Omega$ , 5%, 1/4W	CB1215	01121

REPLACEMENT PARTS LIST

REF DESIG PREFIX A5A2

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R23	Same as R5		
R24	Same as R3		

REF DESIG PREFIX A5A2

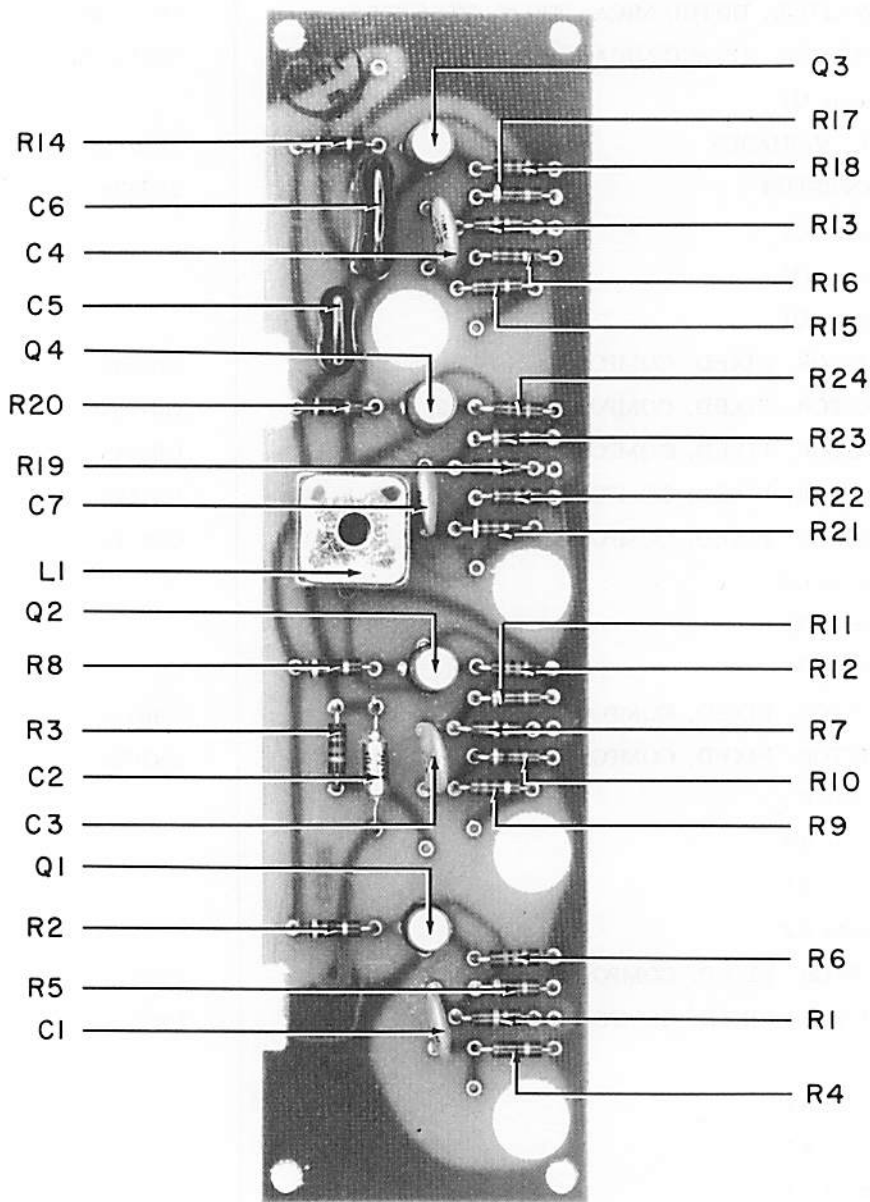


Figure 5-14. IF BW Switching Amplifier "B," Part 11964, Component Locations

5.4.6.3 IF Amplifier and AM Detector, Part 11937

REF DESIG PREFIX A5A3

Ref. Desig.	Description	Vendor Part. No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: .47 $\mu$ f, 10%, 35V	150D474X9035A2	56289
C2	CAPACITOR, CERAMIC, DISC: .05 $\mu$ f, 20%, 50V	55C23A1	56289
C3	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
C4	Same as C1		
C5	CAPACITOR, DIPPED MICA: 820 pf, 5%, 500V	DM15-821J	72136
C6	CAPACITOR, DIPPED MICA: 1800 pf, 5%, 500V	DM19-182J	72136
C7	Same as C1		
C8	Same as C5		
C9	Same as C6		
C10	Same as C1		
C11	Same as C1		
C12	Same as C5		
C13	Same as C6		
C14	Same as C1		
C15	Same as C5		
C16	Same as C6		
C17	Same as C1		
C18	CAPACITOR, CERAMIC, DISC: .01 $\mu$ f, 20%, 50V	19C214A6	56289
C19	CAPACITOR, DIPPED MICA: 470 pf, 5%, 500V	DM15-4715	72136
C20	Same as C19		
CR1	DIODE	1N462A	07688
CR2	Same as CR1		
CR3	DIODE	1N270	07688
L1	COIL, VARIABLE	3476-25	14632
L2	Same as L1		
L3	Same as L1		
L4	Same as L1		
Q1	TRANSISTOR	2N3478	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	TRANSISTOR	2N3251	07688
R1	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R2	RESISTOR, FIXED, COMPOSITION: 27K, 5%, 1/4W	CB2735	01121
R3	RESISTOR, FIXED, COMPOSITION: 4.7K, 5%, 1/4W	CB4725	01121

Figure 5-15

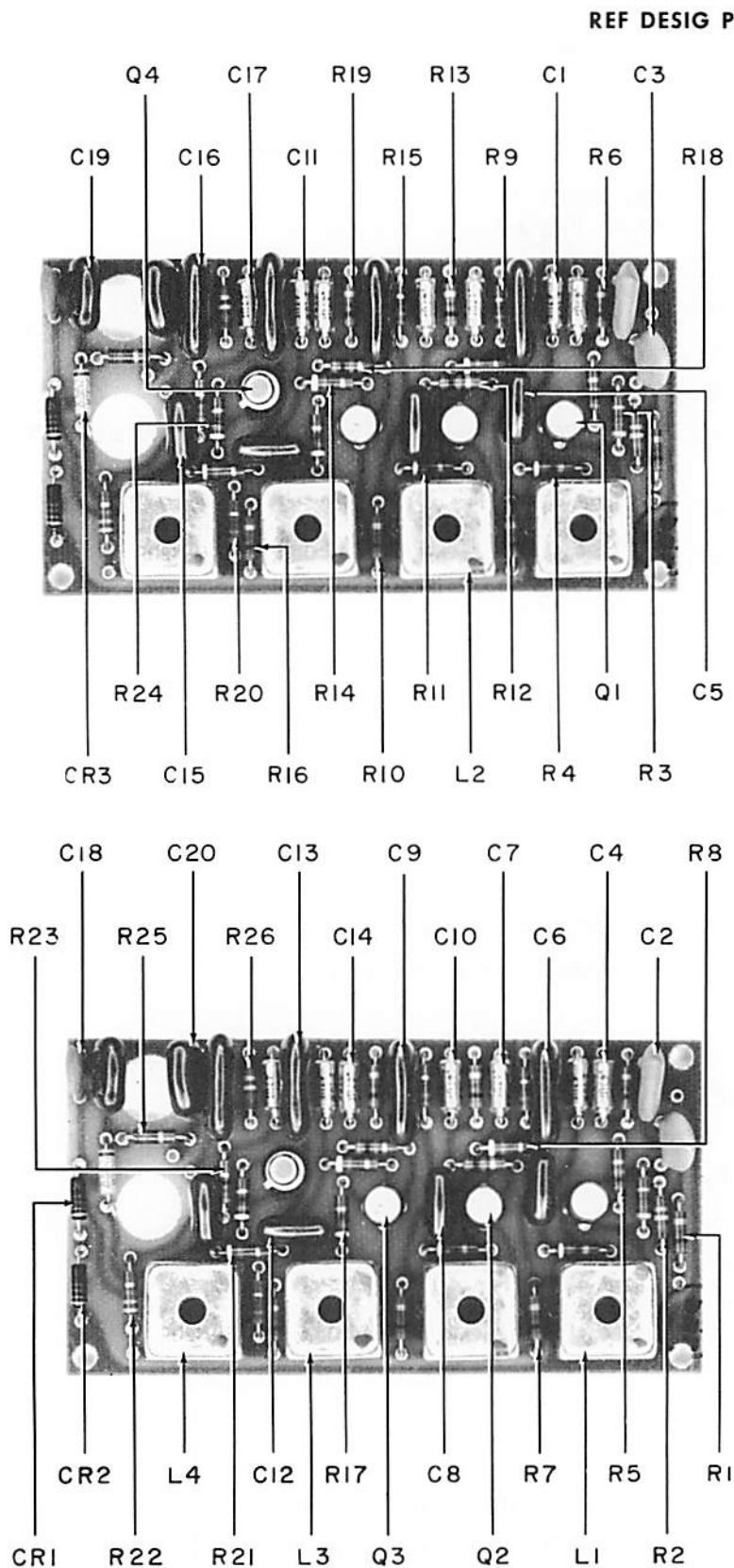


Figure 5-15. IF Amplifier and AM Detector, Part 11937, Component Locations



REF DESIG PREFIX A5A3

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R4	RESISTOR, FIXED, COMPOSITION: 47 $\Omega$ , 5%, 1/4W	CB4705	01121
R5	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R6	Same as R1		
R7	Same as R1		
R8	RESISTOR, FIXED, COMPOSITION: 9.1K, 5%, 1/4W	CB9125	01121
R9	RESISTOR, FIXED, COMPOSITION: 1.6K, 5%, 1/4W	CB1625	01121
R10	Same as R1		
R11	Same as R4		
R12	Same as R5		
R13	Same as R1		
R14	Same as R8		
R15	Same as R9		
R16	Same as R1		
R17	Same as R4		
R18	Same as R5		
R19	Same as R1		
R20	Same as R9		
R21	Same as R8		
R22	RESISTOR, FIXED, COMPOSITION: 330 $\Omega$ , 5%, 1/4W	CB3315	01121
R23	RESISTOR, FIXED, COMPOSITION: 82 $\Omega$ , 5%, 1/4W	CB8205	01121
R24	Same as R4		
R25	RESISTOR, FIXED, COMPOSITION: 2.7K, 5%, 1/4W	CB2725	01121
R26	Same as R2		

Figure 5-16

REF DESIG PREFIX A5A4

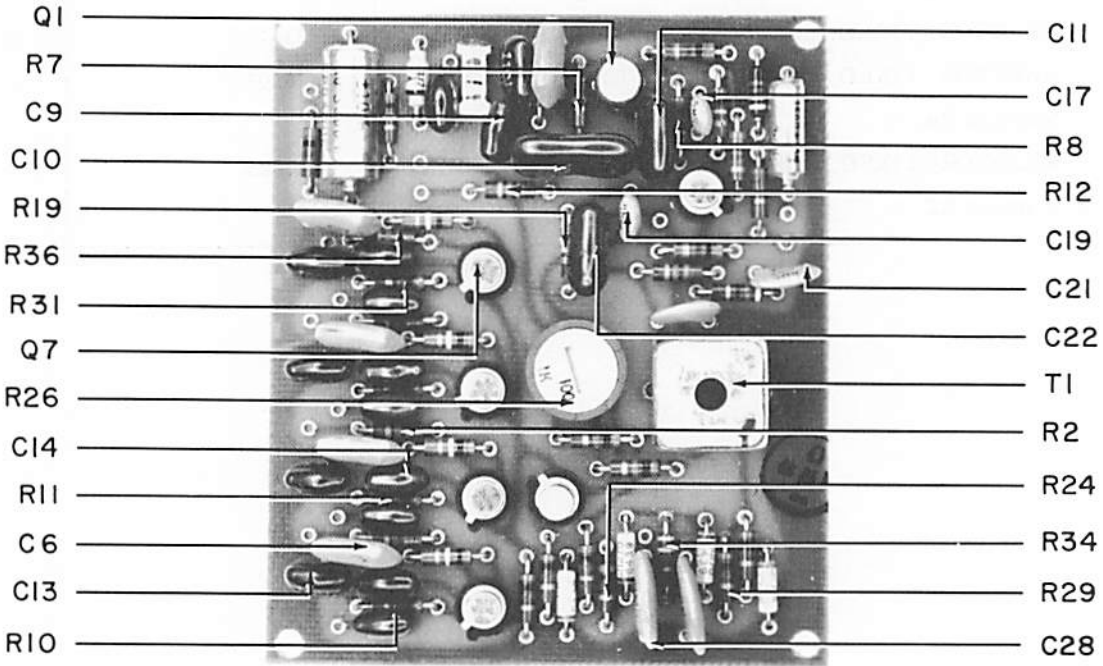
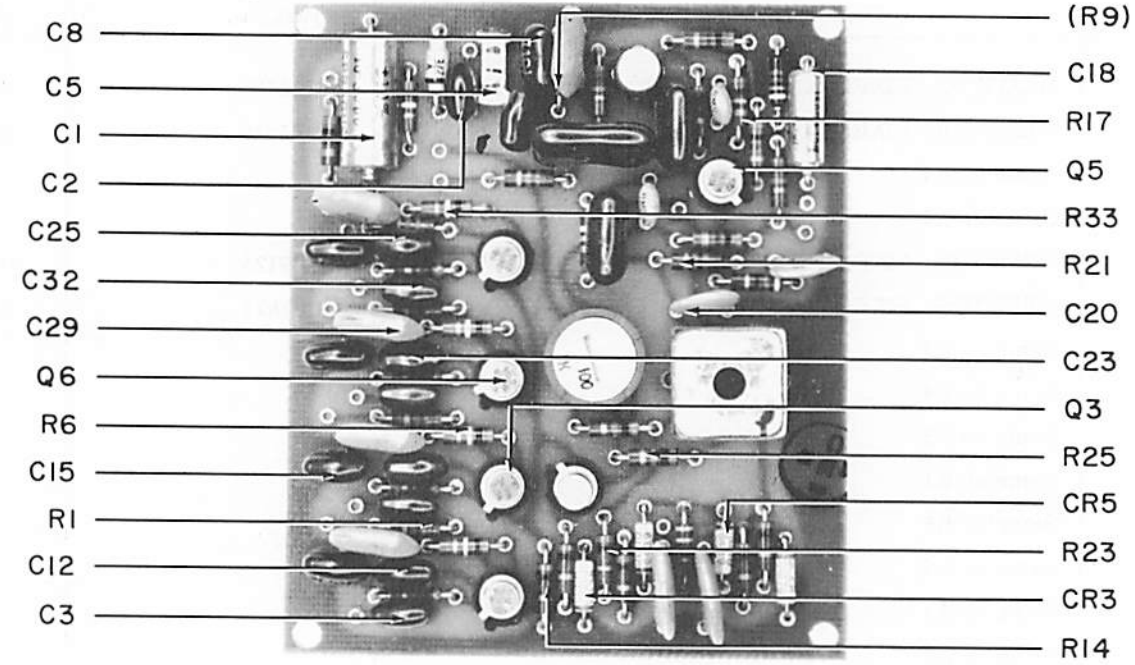


Figure 5-16. BFO and Product Detector, Part 11966, Component Locations

5.4.6.4 BFO and Product Detector, Part 11966

REF DESIG PREFIX A5A4

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 10 $\mu$ f, 10%, 35V	150D106X9035R2	56289
C2	CAPACITOR, DIPPED MICA: 39 pf, 5%, 500V	DM10-390J	72136
C3	CAPACITOR, DIPPED MICA: 33 pf, 5%, 500V	DM10-330J	72136
C4	Same as C3		
C5	CAPACITOR, CERAMIC, TUBULAR: 18 pf, 5%, 500V (TC-N750)	301-000-U2JO-180J	72982
C6	CAPACITOR, CERAMIC, DISC: .05 $\mu$ f, 20%, 50V	55C23A1	56289
C7	Same as C6		
C8	CAPACITOR, DIPPED MICA: 110 pf, 5%, 500V	DM10-111J	72136
C9	CAPACITOR, DIPPED MICA: 180 pf, 5%, 500V	DM10-181J	72136
C10	CAPACITOR, DIPPED MICA: 2000 pf, 5%, 500V	DM19-202J	72136
C11	CAPACITOR, DIPPED MICA: 1000 pf, 5%, 500V	DM15-102J	72136
C12	Same as C9		
C13	CAPACITOR, DIPPED MICA: 160 pf, 5%, 500V	DM10-161J	72136
C14	Same as C9		
C15	Same as C13		
C16	Same as C6		
C17	CAPACITOR, CERAMIC, DISC: .001 $\mu$ f, GMV, 500V	SM	91418
C18	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 $\mu$ f, 10%, 35V	150D475X9035B2	56289
C19	Same as C17		
C20	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	SM	91418
C21	Same as C20		
C22	CAPACITOR, DIPPED MICA: 430 pf, 5%, 500V	DM15-531J	72136
C23	Same as C9		
C24	Same as C13		
C25	Same as C9		
C26	Same as C13		
C27	CAPACITOR, CERAMIC, DISC: .0022 $\mu$ f, 20%, 1000V	JF	91418
C28	Same as C27		
C29	Same as C6		
C30	Same as C3		
C31	Same as C6		
C32	Same as C3		
CR1	DIODE, CAPACITOR	V27E	01281

REPLACEMENT PARTS LIST

REF DESIG PREFIX A5A4

Ref. Desig.	Description	Vendor Part No.	Vendor Code
CR2	DIODE, ZENER	1N961B	07688
CR3	DIODE	1N270	07688
CR4	Same as CR3		
CR5	Same as CR3		
CR6	Same as CR3		
Q1	TRANSISTOR	2N3478	07688
Q2	TRANSISTOR	2N706	07688
Q3	Same as Q2		
Q4	Same as Q2		
Q5	Same as Q2		
Q6	Same as Q2		
Q7	Same as Q2		
R1	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	CB5115	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R4	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R5	Same as R4		
R6	Same as R4		
R7	RESISTOR, FIXED, COMPOSITION: 82K, 5%, 1/4W	CB8235	01121
R8	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R9	RESISTOR, FIXED, COMPOSITION: 220K, 5%, 1/4W	CB2245	01121
R10	Same as R8		
R11	Same as R8		
R12	Same as R1		
R13	Same as R3		
R14	Same as R3		
R15	Same as R3		
R16	RESISTOR, FIXED, COMPOSITION: 470 $\Omega$ , 5%, 1/4W	CB4715	01121
R17	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R18	Same as R3		
R19	RESISTOR, FIXED, COMPOSITION: 24K, 5%, 1/4W	CB2435	01121
R20	RESISTOR, FIXED, COMPOSITION: 47 $\Omega$ , 5%, 1/4W	CB4705	01121
R21	Same as R1		
R22	Same as R3		
R23	Same as R3		

REF DESIG PREFIX A5A4

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R24	Same as R3	CT-100	75042
R25	Same as R8		
R26	RESISTOR, VARIABLE, WIREWOUND: 1K, 5%, 1W		
R27	Same as R3		
R28	Same as R8		
R29	Same as R3		
R30	Same as R8		
R31	Same as R8		
R32	Same as R4		
R33	Same as R4		
R34	RESISTOR, FIXED, COMPOSITION: 3.3K, 5%, 1/4W	CB3325	01121
R35	Same as R1	3476-26	14632
R36	Same as R1		
T1	TRANSFORMER		
TP1	TEST JACK, Part of PRINTED CIRCUIT BOARD	--	

REF DESIG PREFIX A5A4

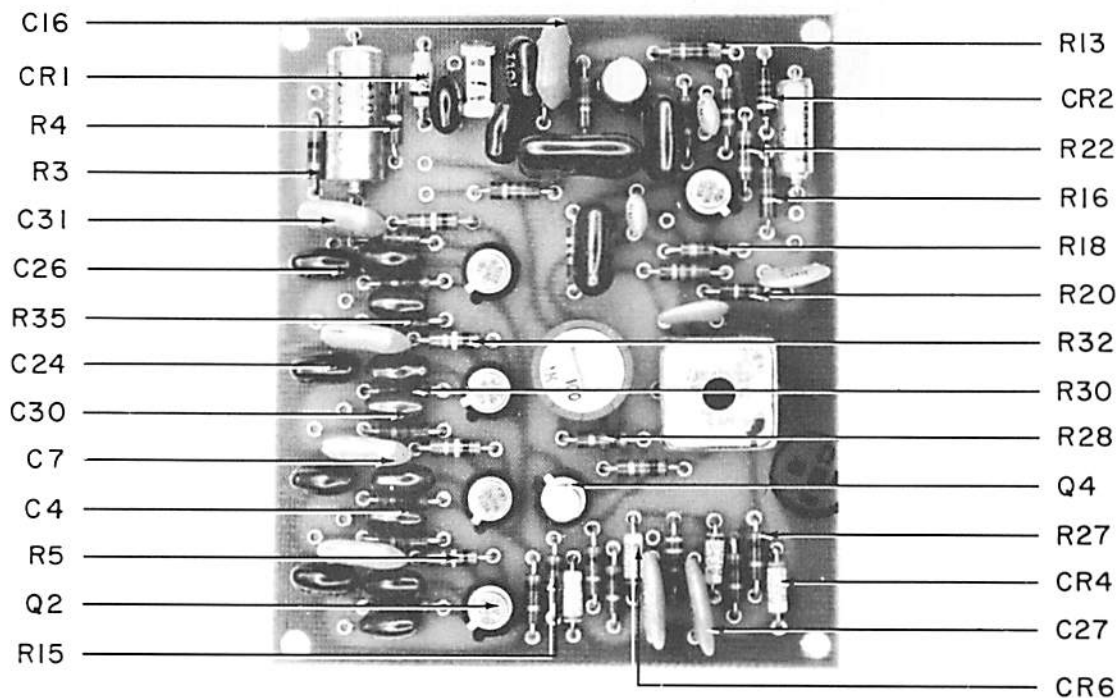


Figure 5-17. BFO and Product Detector, Part 11966, Component Locations

Figure 5-18

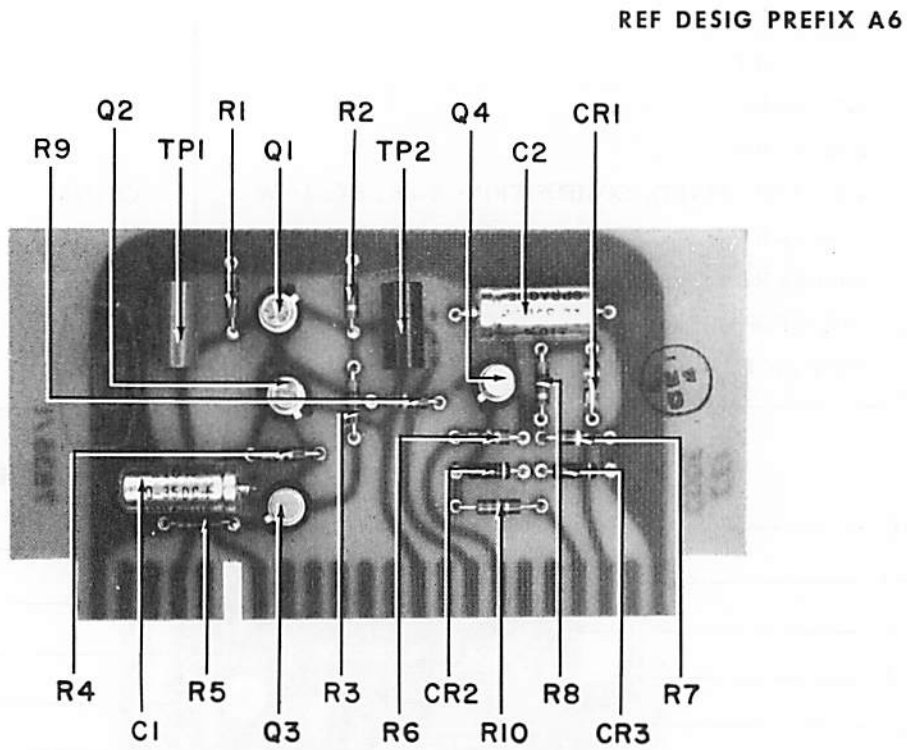


Figure 5-18. Type 7835 AGC Amplifier, Component Locations



5.4.7 Type 7835 AGC Amplifier

REF DESIG PREFIX A6

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 10 $\mu$ f, 10%, 35V	150D106X9035R2	56289
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 $\mu$ f, 10%, 35V	150D226X9035R2	56289
CR1	DIODE	1N198	07688
CR2	DIODE	1N462A	07688
CR3	Same as CR2		
Q1	TRANSISTOR	2N706	07688
Q2	Same as Q1		
Q3	TRANSISTOR	2N929	07688
Q4	Same as Q3		
R1	RESISTOR, FIXED, COMPOSITION: 82K, 5%, 1/4W	CB8235	01121
R2	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R3	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R4	RESISTOR, FIXED, COMPOSITION: 18K, 5%, 1/4W	CB1835	01121
R5	RESISTOR, FIXED, COMPOSITION: 1.8K, 5%, 1/4W	CB1825	01121
R6	Same as R3		
R7	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R8	Same as R2		
R9	Same as R4		
R10	RESISTOR, FIXED, COMPOSITION: 16K, 5%, 1/4W	CB1635	01121
TP1	TEST JACK	TJ-6	04013
TP2	Same as TP1		

Figure 5-19

REF DESIG PREFIX A7

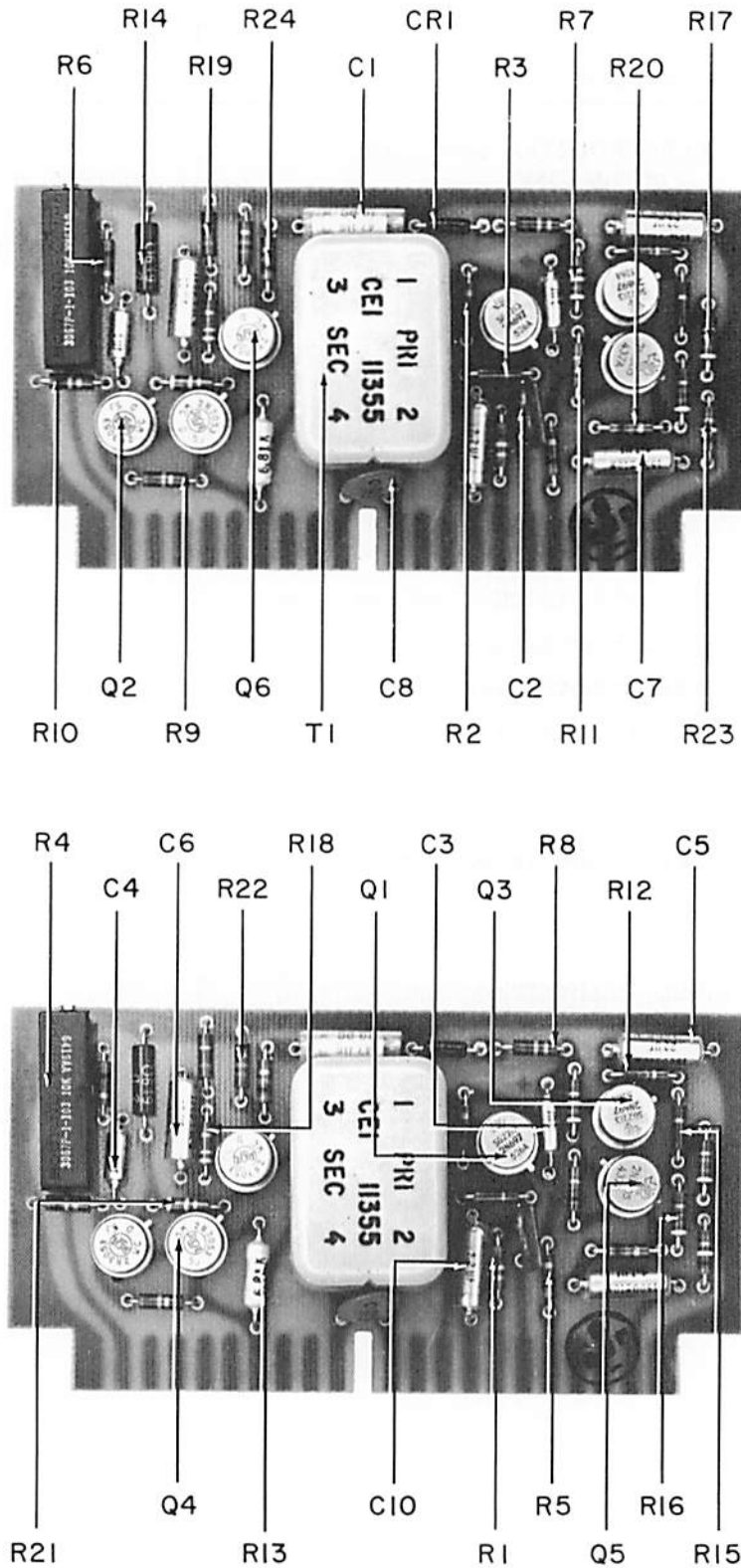


Figure 5-19. Type 7411 Audio Amplifier, Component Locations

5.4.8 Type 7411 Audio Amplifier

REF DESIG PREFIX A7

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 47 $\mu$ f, 20%, 10V	109D476X0010C2	56289
C2	CAPACITOR, CERAMIC, DISC: .01 $\mu$ f, 20%, 200V	SMCB-.01-131	86335
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 1 $\mu$ f, 10%, 35V	150D105X9035A2	56289
C4	Same as C3		
C5	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 $\mu$ f, 10%, 15V	150D226X9015B2	56289
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 10 $\mu$ f, 10%, 20V	150D106X9020B2	56289
C7	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 $\mu$ f, 10%, 35V	150D475X9035B2	56289
C8	CAPACITOR, CERAMIC, DISC: .1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
C9	NOT USED		
C10	CAPACITOR, ELECTROLYTIC, TANTALUM: 2.2 $\mu$ f, 10%, 35V	150D225X9035B2	56289
CR1	DIODE	1N462A	07688
Q1	TRANSISTOR	2N697	07688
Q2	TRANSISTOR	2N3053	07688
Q3	Same as Q1		
Q4	Same as Q2		
Q5	TRANSISTOR	2N1305	07688
Q6	Same as Q2		
R1	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R2	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R3	RESISTOR, FIXED, COMPOSITION: 6.2K, 5%, 1/4W	CB6225	01121
R4	RESISTOR, VARIABLE, WIRE-WOUND: 10K, 10%, .5W	3067-P-1-103	80294
R5	Same as R2		
R6	Same as R2		
R7	RESISTOR, FIXED, COMPOSITION: 47K, 5%, 1/4W	CB4735	01121
R8	RESISTOR, FIXED, COMPOSITION: 22K, 5%, 1/4W	CB2235	01121
R9	RESISTOR, FIXED, COMPOSITION: 82K, 5%, 1/4W	CB8235	01121
R10	Same as R1		
R11	RESISTOR, FIXED, COMPOSITION: 2K, 5%, 1/4W	CB2025	01121
R12	RESISTOR, FIXED, COMPOSITION: 220 $\Omega$ , 5%, 1/4W	CB2215	01121
R13	RESISTOR, FIXED, FILM: 6.81K, 1%, 1/4W	RN60D6811F	81349
R14	RESISTOR, FIXED, FILM: 619 $\Omega$ , 1%, 1/4W	RN60D6190F	81349

REPLACEMENT PARTS LIST

REF DESIG PREFIX A7

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R15	RESISTOR, FIXED, COMPOSITION: 2.2K, 5%, 1/4W	CB2225	01121
R16	RESISTOR, FIXED, COMPOSITION: 470 $\Omega$ , 5%, 1/4W	CB4715	01121
R17	Same as R16		
R18	RESISTOR, FIXED, COMPOSITION: 3.3K, 5%, 1/4W	CB3325	01121
R19	RESISTOR, FIXED, COMPOSITION: 2.7K, 5%, 1/4W	CB2725	01121
R20	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R21	Same as R7		
R22	RESISTOR, FIXED, COMPOSITION: 270 $\Omega$ , 5%, 1/4W	CB2715	01121
R23	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R24	Same as R20		
T1	TRANSFORMER	11355	14632

5.4.9 Type 79101 VLF Counter Assembly

REF DESIG PREFIX A8

Ref. Desig.	Description	Vendor Part No.	Vendor Code
A1	1-MC OSCILLATOR	7715	14632
A2	HIGH SPEED DECADE SCALER, RESET TO ZERO	7984	14632
A3	DECADE SCALER, RESET TO ZERO	7985	14632
A4	Same as A3		
A5	Same as A3		
A6	Same as A3		
A7	DECIMAL SHIFTER	79116	14632
A8	GATE GENERATOR	7991	14632
A9	AMPLIFIER AND GATE	7981/1	14632
A10	READOUT DECODER/DRIVER	7932/1	14632
A11	Same as A2		
A12	Same as A10		
A13	Same as A3		
A14	Same as A10		
A15	Same as A3		
A16	Same as A10		
A17	Same as A3		
C1	CAPACITOR, PAPER, THRU-PASS: .01 $\mu$ f, 600V	102P515	56289
C2	Same as C1		
C3	Same as C1		
C4	CAPACITOR, CERAMIC, FEEDTHRU: 1000 pf, GMV, 500V	FA5C-102W	56289
C5	Same as C4		
C6	Same as C4		
C7	Same as C4		
C8	Same as C4		
C9	Same as C4		
C10	Same as C4		
C11	Same as C4		
C12	Same as C4		
C13	Same as C4		
C14	Same as C4		
C15	Same as C4		
C16	Same as C4		
C17	Same as C4		
C18	Same as C4		

REPLACEMENT PARTS LIST

REF DESIG PREFIX A8

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C19	Same as C4		
C20	Same as C4		
C21	Same as C4		
C22	Same as C4		
C23	Same as C4		
C24	Same as C4		
C25	Same as C4		
C26	Same as C4		
C27	Same as C4		
C28	Same as C4		
C29	Same as C4		
C30	Same as C4		
C31	Same as C4		
C32	Same as C4		
C33	Same as C4		
C34	Same as C4		
C35	Same as C4		
C36	Same as C4		
C37	Same as C4		
C38	Same as C4		
C39	Same as C4		
C40	Same as C4		
C41	Same as C4		
C42	Same as C4		
C43	Same as C4		
C44	Same as C4		
C45	Same as C4		
C46	Same as C4		
C47	Same as C4		
C48	Same as C4		
C49	Same as C4		
C50	CAPACITOR, ELECTROLYTIC, TANTALUM: 47 $\mu$ f, 10%, 35V	150D476X9035S2	56289
C51	Same as C50		
FB1	FERRITE BEAD	56-590-65/4A	02114



REF DESIG PREFIX A8

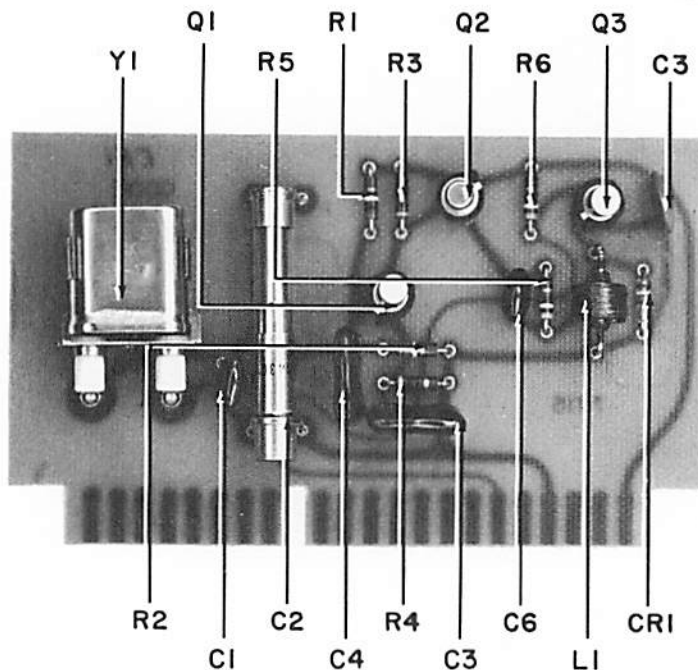
Ref. Desig.	Description	Vendor Part No.	Vendor Code
FB2	Same as FB1		
FB3	Same as FB1		
FB4	Same as FB1		
FB5	Same as FB1		
FB6	Same as FB1		
FB7	Same as FB1		
FB8	Same as FB1		
FB9	Same as FB1		
FB10	Same as FB1		
FB11	Same as FB1		
FB12	Same as FB1		
J1	CONNECTOR, RECEPTACLE, MB SERIES	46025	74868

REPLACEMENT PARTS LIST

5.4.9.1 Type 7715 1-mc Oscillator

REF DESIG PREFIX A8A1

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, DIPPED MICA: 15 pf, 5%, 500V	DM10-150J	72136
C2	CAPACITOR, VARIABLE, GLASS: .8 - 38 pf	NVC43GW	73899
C3	CAPACITOR, CERAMIC, DISC: .1 $\mu$ f, +80 - 20%, 10V	UK10-104	71590
C4	CAPACITOR, DIPPED MICA: 1100 pf, 5%, 500V	DM19-112J	72136
C5	Same as C4		
C6	CAPACITOR, DIPPED MICA: 30 pf, 5%, 500V	DM10-300J	72136
CR1	DIODE	1N198	07688
L1	COIL, FIXED: 430 $\mu$ h	3430-15	99848
Q1	TRANSISTOR	2N929	07688
Q2	TRANSISTOR	2N3251	07688
Q3	TRANSISTOR	2N706	07688
R1	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R2	RESISTOR, FIXED, COMPOSITION: 160K, 5%, 1/4W	CB1645	01121
R3	RESISTOR, FIXED, COMPOSITION: 300 $\Omega$ , 5%, 1/4W	CB3015	01121
R4	RESISTOR, FIXED, COMPOSITION: 3K, 5%, 1/4W	CB3405	01121
R5	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R6	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121
Y1	CRYSTAL, QUARTZ: 1 MC, 32 $\pm$ .5 pf Load, Frequency Tol. $\pm$ 0.001% from 0 to plus 50 $^{\circ}$ C, HC-6 Holder	As Detailed	74306



REF DESIG PREFIX A8A1

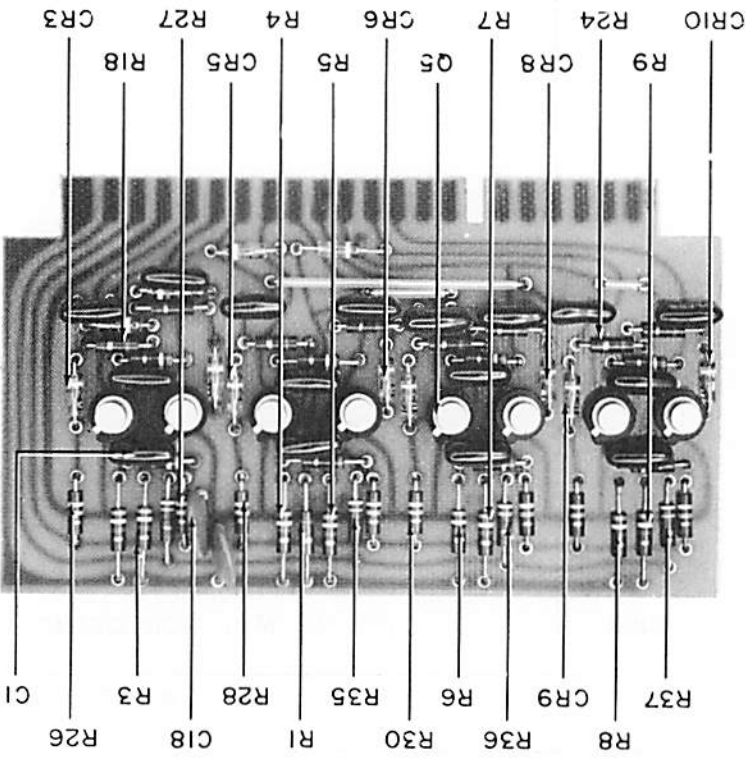
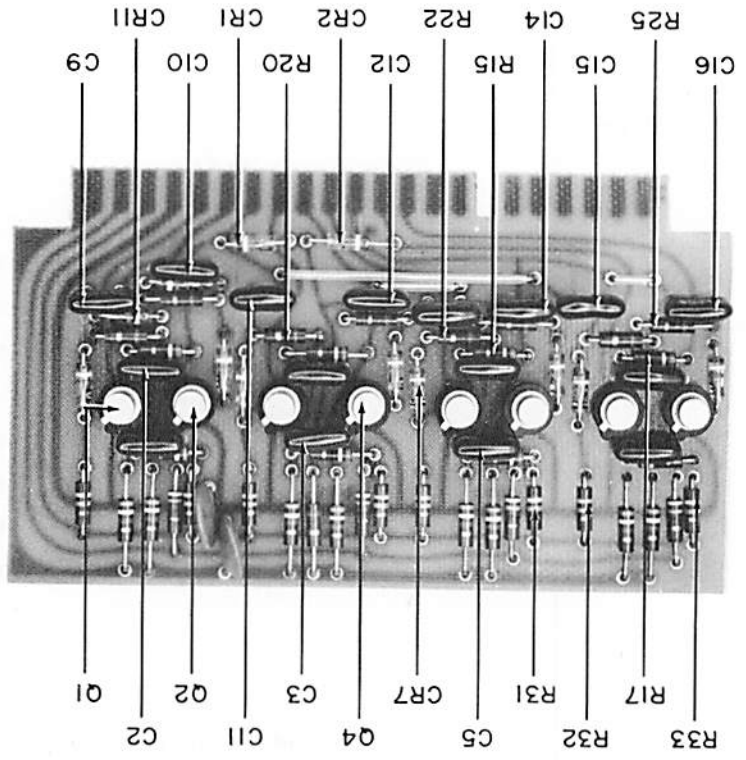
Figure 5-20. Type 7715 1-mc Oscillator, Component Locations

5.4.9.2 Type 7984 High Speed Decade Scaler -- Reset to Zero

REF DESIG PREFIX A8A2, A8A11

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, DIPPED MICA: 30 pf, 5%, 500V	DM10-300J	72136
C2	Same as C1		
C3	Same as C1		
C4	Same as C1		
C5	Same as C1		
C6	Same as C1		
C7	Same as C1		
C8	Same as C1		
C9	Same as C1		
C10	Same as C1		
C11	Same as C1		
C12	Same as C1		
C13	Same as C1		
C14	Same as C1		
C15	Same as C1		
C16	Same as C1		
C17	CAPACITOR, CERAMIC DISC: .1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
C18	Same as C17		
CR1	DIODE	1N198	07688
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
Q1	TRANSISTOR	2N706	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
Q5	Same as Q1		

Figure 5-21. Type 7984 High-Speed Decade Scaler, Component Locations



REF DESIGN PREFIX A8A2, A8A11

REF DESIG PREFIX A8A2, A8A11

Ref. Desig.	Description	Vendor Part No.	Vendor Code
Q6	Same as Q1		
Q7	Same as Q1		
Q8	Same as Q1		
R1	RESISTOR, FIXED, COMPOSITION: 2.7K, 5%, 1/4W	CB2725	01121
R2	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121
R3	Same as R2		
R4	Same as R2		
R5	Same as R2		
R6	Same as R2		
R7	Same as R2		
R8	Same as R2		
R9	Same as R2		
R10	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R11	Same as R10		
R12	Same as R10		
R13	Same as R10		
R14	Same as R10		
R15	Same as R10		
R16	Same as R10		
R17	Same as R10		
R18	RESISTOR, FIXED, COMPOSITION: 5.1K, 5%, 1/4W	CB5125	01121
R19	Same as R18		
R20	Same as R18		
R21	Same as R18		
R22	Same as R18		
R23	Same as R18		
R24	Same as R18		
R25	Same as R18		
R26	RESISTOR, FIXED, COMPOSITION: 24K, 5%, 1/4W	CB2435	01121
R27	Same as R26		
R28	Same as R26		
R29	Same as R26		
R30	Same as R26		
R31	Same as R26		
R32	Same as R26		

REPLACEMENT PARTS LIST

REF DESIG PREFIX A8A2, A8A11

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R33	Same as R26	CB4325	01121
R34	RESISTOR, FIXED, COMPOSITION: 4.3K, 5%, 1/4W		
R35	Same as R34		
R36	Same as R34		
R37	Same as R34		

REF DESIG PREFIX A8A2, A8A11

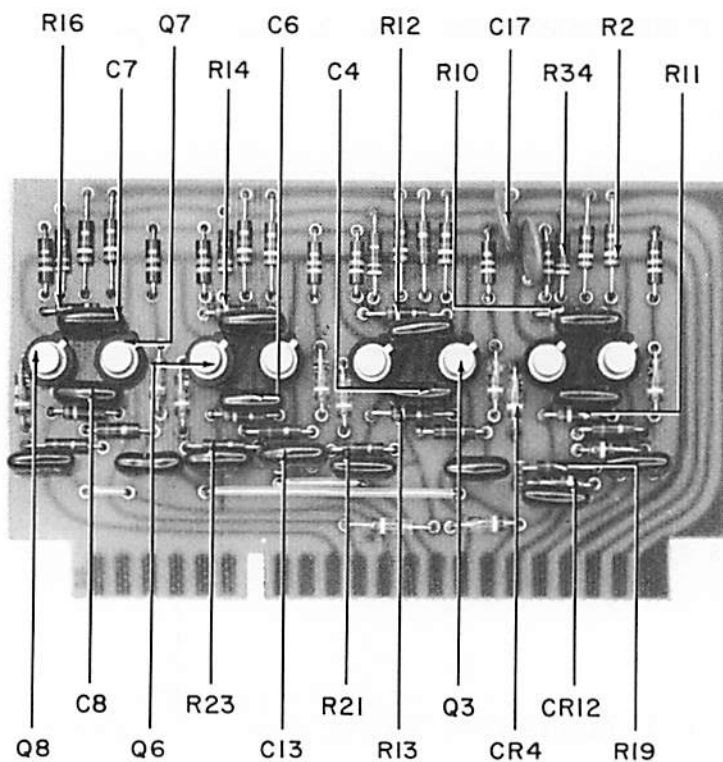


Figure 5-22. Type 7984 High-Speed Decade Scaler, Component Locations



5.4.9.3 Type 7985 Decade Scaler

REF DESIG PREFIX A8A3 thru A8A6  
A8A13, A8A15, A8A17

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, DIPPED MICA: 30 pf, 5%, 500V	DM10-300J	72136
C2	Same as C1		
C3	Same as C1		
C4	Same as C1		
C5	Same as C1		
C6	Same as C1		
C7	Same as C1		
C8	Same as C1		
C9	Same as C1		
C10	Same as C1		
C11	Same as C1		
C12	Same as C1		
C13	Same as C1		
C14	Same as C1		
C15	Same as C1		
C16	Same as C1		
C17	CAPACITOR, CERAMIC DISC: 0.1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
C18	Same as C17		
CR1	DIODE	1N198	07688
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
Q1	TRANSISTOR	2N706	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
Q5	Same as Q1		
Q6	Same as Q1		

Figure 5-23

REF DESIG PREFIX A8A3 THRU A8A6,  
A8A13, A8A15, A8A17

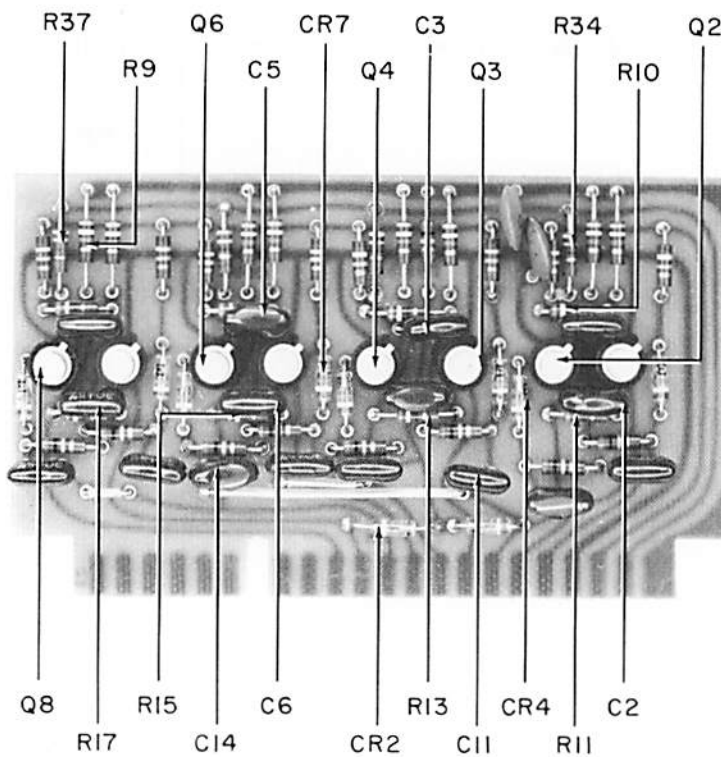
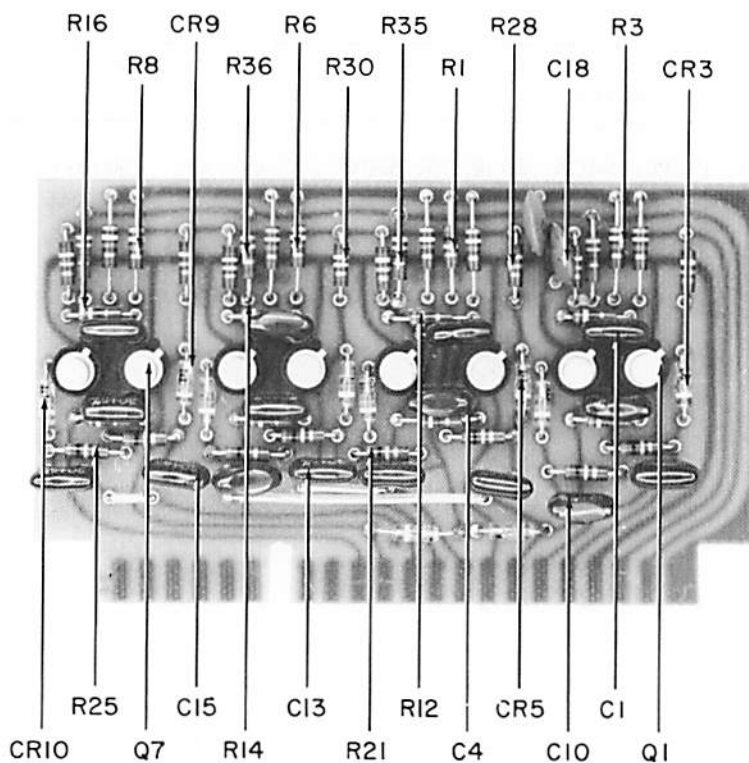


Figure 5-23. Type 7985 Decade Scaler, Component Locations

REF DESIG PREFIX A8A3 thru A8A6  
A8A13, A8A15, A8A17

Ref. Desig.	Description	Vendor Part No.	Vendor Code
Q7	Same as Q1		
Q8	Same as Q1		
R1	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R2	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121
R3	Same as R2		
R4	Same as R2		
R5	Same as R2		
R6	Same as R2		
R7	Same as R2		
R8	Same as R2		
R9	Same as R2		
R10	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R11	Same as R10		
R12	Same as R10		
R13	Same as R10		
R14	Same as R10		
R15	Same as R10		
R16	Same as R10		
R17	Same as R10		
R18	Same as R1		
R19	Same as R1		
R20	Same as R1		
R21	Same as R1		
R22	Same as R1		
R23	Same as R1		
R24	Same as R1		
R25	Same as R1		
R26	RESISTOR, FIXED, COMPOSITION: 24K, 5%, 1/4W	CB2435	01121
R27	Same as R26		
R28	Same as R26		
R29	Same as R26		
R30	Same as R26		
R31	Same as R26		
R32	Same as R26		

REPLACEMENT PARTS LIST

REF DESIG PREFIX A8A3 thru A8A6  
A8A13, A8A15, A8A17

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R33	Same as R26	CB4325	01121
R34	RESISTOR, FIXED, COMPOSITION: 4.3K, 5%, 1/4W		
R35	Same as R34		
R36	Same as R34		
R37	Same as R34		

REF DESIG PREFIX A8A3 THRU A8A6,  
A8A13, A8A15, A8A17

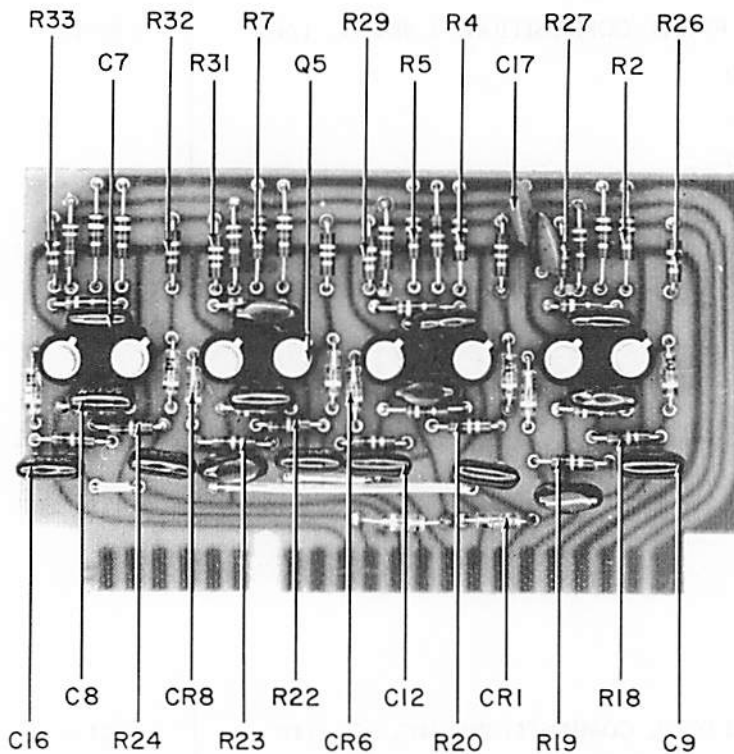


Figure 5-24. Type 7985 Decade Scaler, Component Locations

5.4.9.4 Type 79116 Decimal Shifter

REF DESIG PREFIX A8A7

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, CERAMIC DISC: .1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
C2	Same as C1		
C3	CAPACITOR, DIPPED MICA: 30 pf, 5%, 500V	DM10-300J	72136
C4	Same as C3		
CR1	DIODE	1N914	07688
CR2	Same as CR1		
CR3	DIODE	1N198	07688
CR4	Same as CR3		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR3		
CR8	Same as CR3		
CR9	Same as CR3		
CR10	Same as CR3		
CR11	Same as CR3		
CR12	Same as CR3		
Q1	TRANSISTOR	2N706	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
R1	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 24K, 5%, 1/4W	CB2435	01121
R4	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121
R5	Same as R1		
R6	Same as R3		
R7	Same as R1		
R8	Same as R3		
R9	Same as R4		
R10	Same as R3		
R11	Same as R1		
R12	Same as R1		

Figure 5-25

REF DESIG PREFIX A8A7

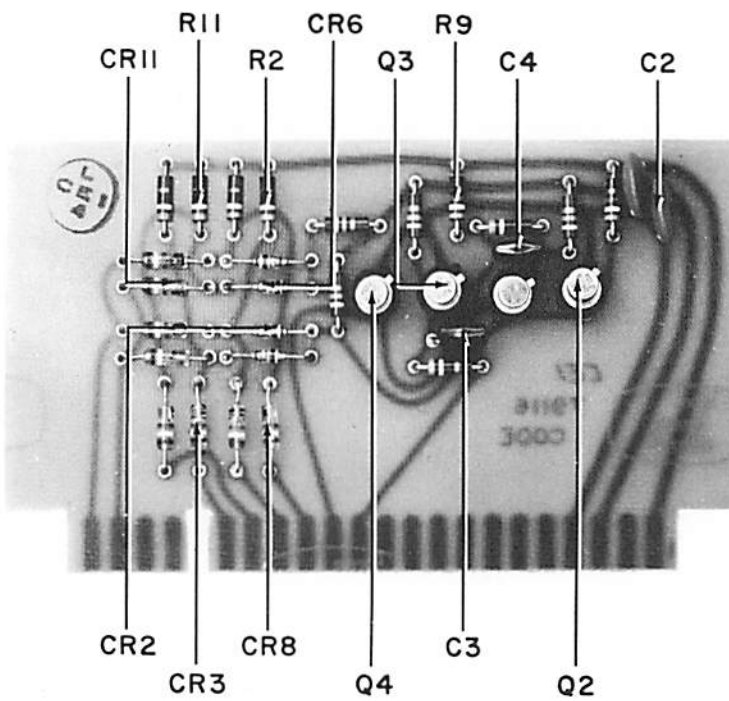
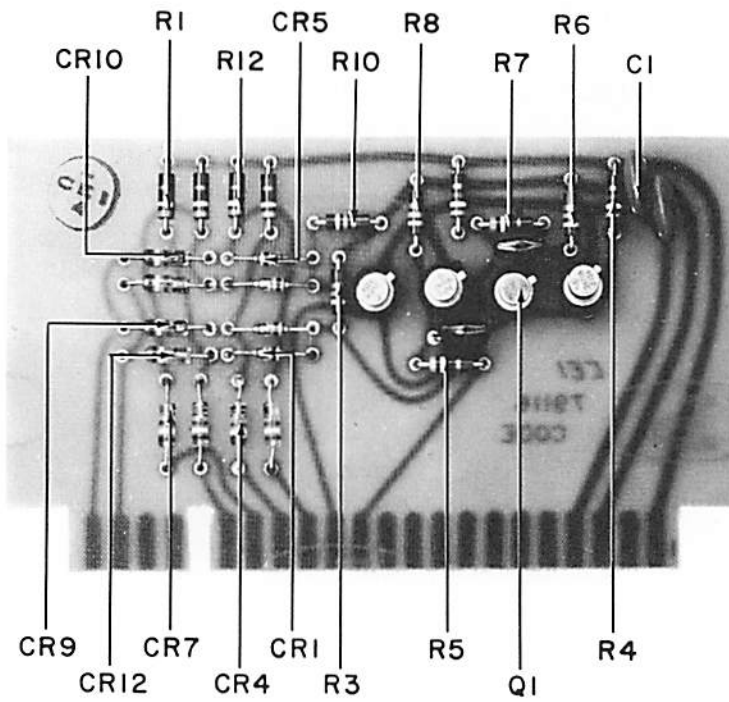


Figure 5-25. Type 79116 Decimal Shifter, Component Locations

5.4.9.5 Type 7991 Gate Generator

REF DESIG PREFIX A8A8

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, DIPPED MICA: 15 pf, 5%, 500V	DM10-150J	72136
C2	CAPACITOR, DIPPED MICA: 27 pf, 5%, 500V	DM10-270J	72136
C3	CAPACITOR, DIPPED MICA: 30 pf, 5%, 500V	DM10-300J	72136
C4	Same as C3		
C5	Same as C3		
C6	Same as C2		
C7	Same as C2		
C8	Same as C3		
C9	CAPACITOR, ELECTROLYTIC, TANTALUM: 0.1 $\mu$ f, 10%, 35V	150D104X9035A2	56289
CR1	DIODE	1N198	07688
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	DIODE	1N270	07688
Q1	TRANSISTOR	2N709	07688
Q2	Same as Q1		
Q3	TRANSISTOR	2N706	07688
Q4	Same as Q3		
Q5	Same as Q3		
Q6	Same as Q3		
Q7	TRANSISTOR	2N3440	07688
Q8	TRANSISTOR	2N3495	07688
R1	RESISTOR, FIXED, COMPOSITION: 120 $\Omega$ , 5%, 1/2W	EB1215	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121
R4	RESISTOR, FIXED, COMPOSITION: 200 $\Omega$ , 5%, 1/4W	CB2015	01121
R5	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R6	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R7	Same as R4		
R8	RESISTOR, FIXED, COMPOSITION: 1.2K, 5%, 1/4W	CB1225	01121
R9	Same as R8		
R10	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	CB3925	01121
R11	Same as R10		
R12	Same as R5		



Figure 5-26

REF DESIG PREFIX A8A8

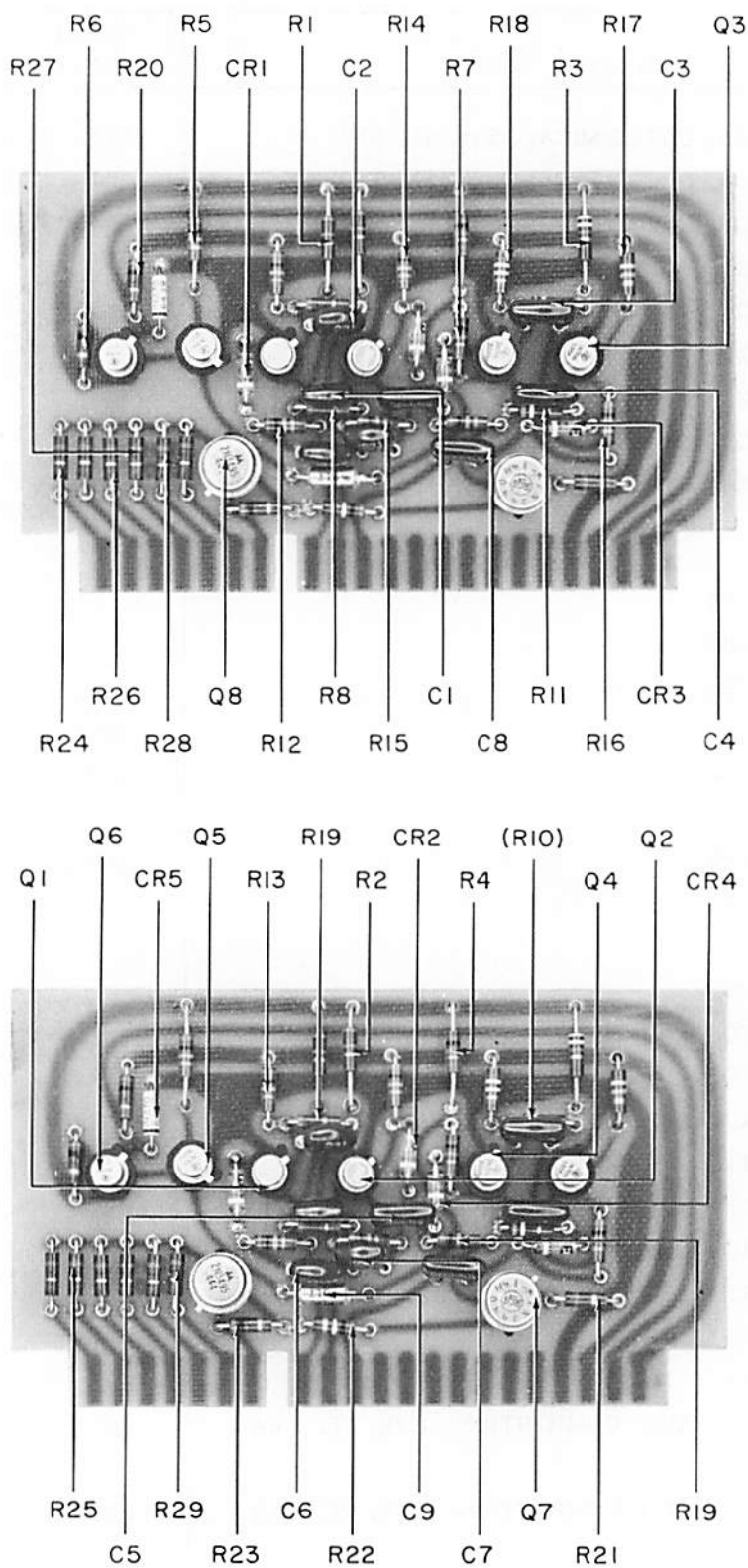
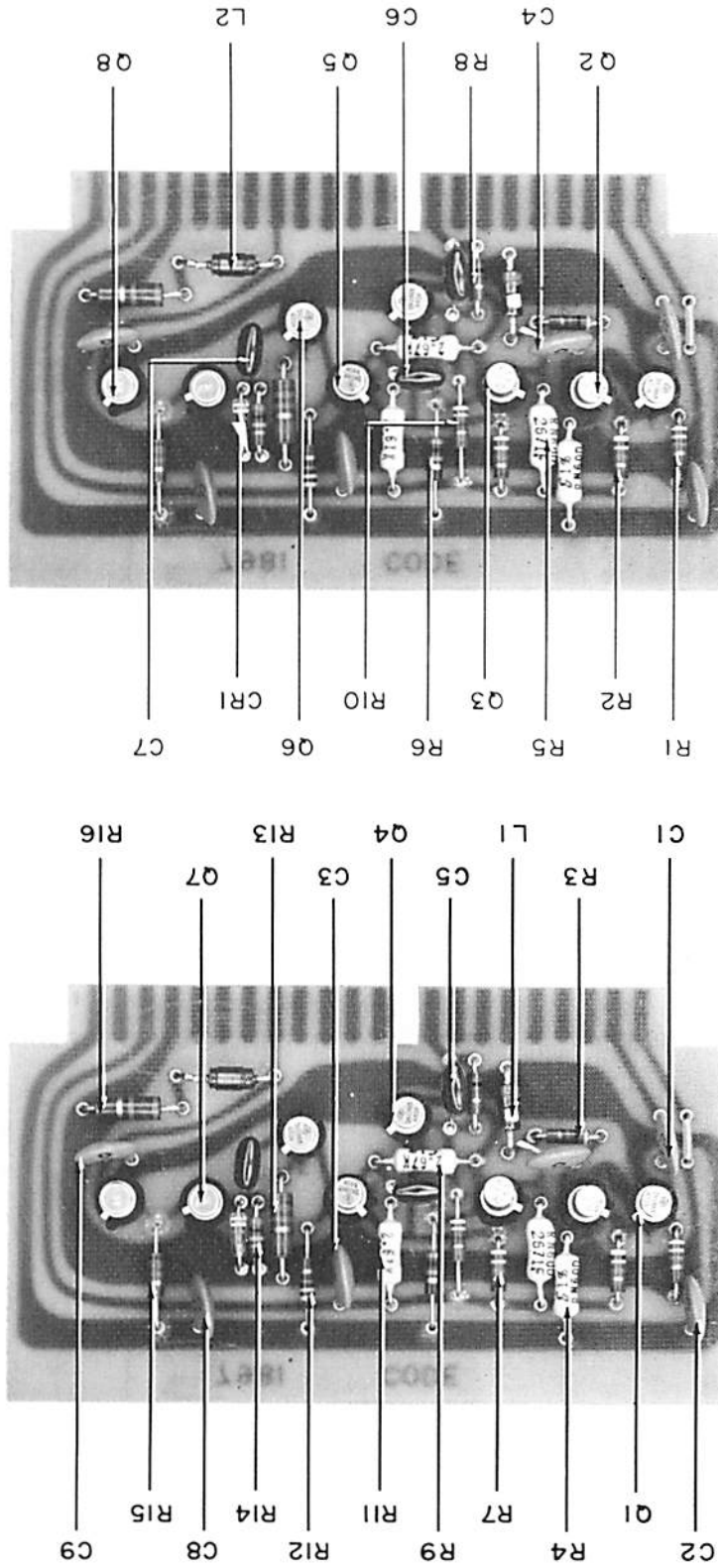


Figure 5-26. Type 7991 Gate Generator, Component Locations

Figure 5-27. Type 7981/1 Amplifier and Gate, Component Locations



REF DESIGN PREFIX A8A9

REF DESIG PREFIX A8A8

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R13	Same as R5		
R14	Same as R5		
R15	Same as R5		
R16	Same as R5		
R17	RESISTOR, FIXED, COMPOSITION: 24K, 5%, 1/4W	CB2435	01121
R18	Same as R17		
R19	Same as R5		
R20	Same as R6		
R21	RESISTOR, FIXED, COMPOSITION: 5.1K, 5%, 1/4W	CB5125	01121
R22	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	CB1045	01121
R23	Same as R6		
R24	RESISTOR, FIXED, COMPOSITION: 5.6K, 5%, 1/4W	CB5625	01121
R25	Same as R24		
R26	Same as R24		
R27	Same as R24		
R28	Same as R24		
R29	Same as R24		

5.4.9.6 Type 7981/1 Amplifier and Gate

REF DESIG PREFIX A8A9

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, CERAMIC DISC: .05 $\mu$ f, +80 -20%, 20V	UK20-503	71590
C2	CAPACITOR, CERAMIC DISC: .1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
C3	Same as C2		
C4	CAPACITOR, DIPPED MICA: 51 pf, 5%, 500V	DM10-510J	72136
C5	CAPACITOR, DIPPED MICA: 15 pf, 5%, 500V	DM10-150J	72136
C6	CAPACITOR, DIPPED MICA: 10 pf, 5%, 500V	DM10-100J	72136
C7	CAPACITOR, DIPPED MICA: 22 pf, 5%, 500V	DM10-220J	72136
C8	Same as C2		
C9	Same as C2		
CR1	DIODE	1N995	07688
L1	COIL, FIXED: .24 $\mu$ h	200-11	99848
L2	COIL, FIXED: .56 $\mu$ h	202-11	99848
Q1	TRANSISTOR	2N2865	07688
Q2	Same as Q1		
Q3	Same as Q1		
Q4	Same as Q1		
Q5	Same as Q1		
Q6	Same as Q1		
Q7	TRANSISTOR	2N709	07688
Q8	Same as Q7		
R1	RESISTOR, FIXED, COMPOSITION: 430 $\Omega$ , 5%, 1/4W	CB4315	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 300 $\Omega$ , 5%, 1/4W	CB3015	01121
R4	RESISTOR, FIXED, FILM: 2.67K, 1%, 1/4W	RN60D2671F	81349
R5	Same as R4		
R6	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R7	Same as R1		
R8	RESISTOR, FIXED, COMPOSITION: 2K, 5%, 1/4W	CB2025	01121
R9	Same as R4		
R10	RESISTOR, FIXED, COMPOSITION: 4.3K, 5%, 1/4W	CB4325	01121
R11	RESISTOR, FIXED, FILM: 2.61K, 1%, 1/4W	RN60D2611F	81349
R12	RESISTOR, FIXED, COMPOSITION: 330 $\Omega$ , 5%, 1/4W	CB3315	01121
R13	RESISTOR, FIXED, COMPOSITION: 270 $\Omega$ , 5%, 1/2W	EB2715	01121
R14	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R15	RESISTOR, FIXED, COMPOSITION: 270 $\Omega$ , 5%, 1/4W	CB2715	01121
R16	RESISTOR, FIXED, COMPOSITION: 120 $\Omega$ , 5%, 1/2W	EB1215	01121

Figure 5-28

REF DESIG PREFIX A8A10, A8A12,  
A8A14, A8A16

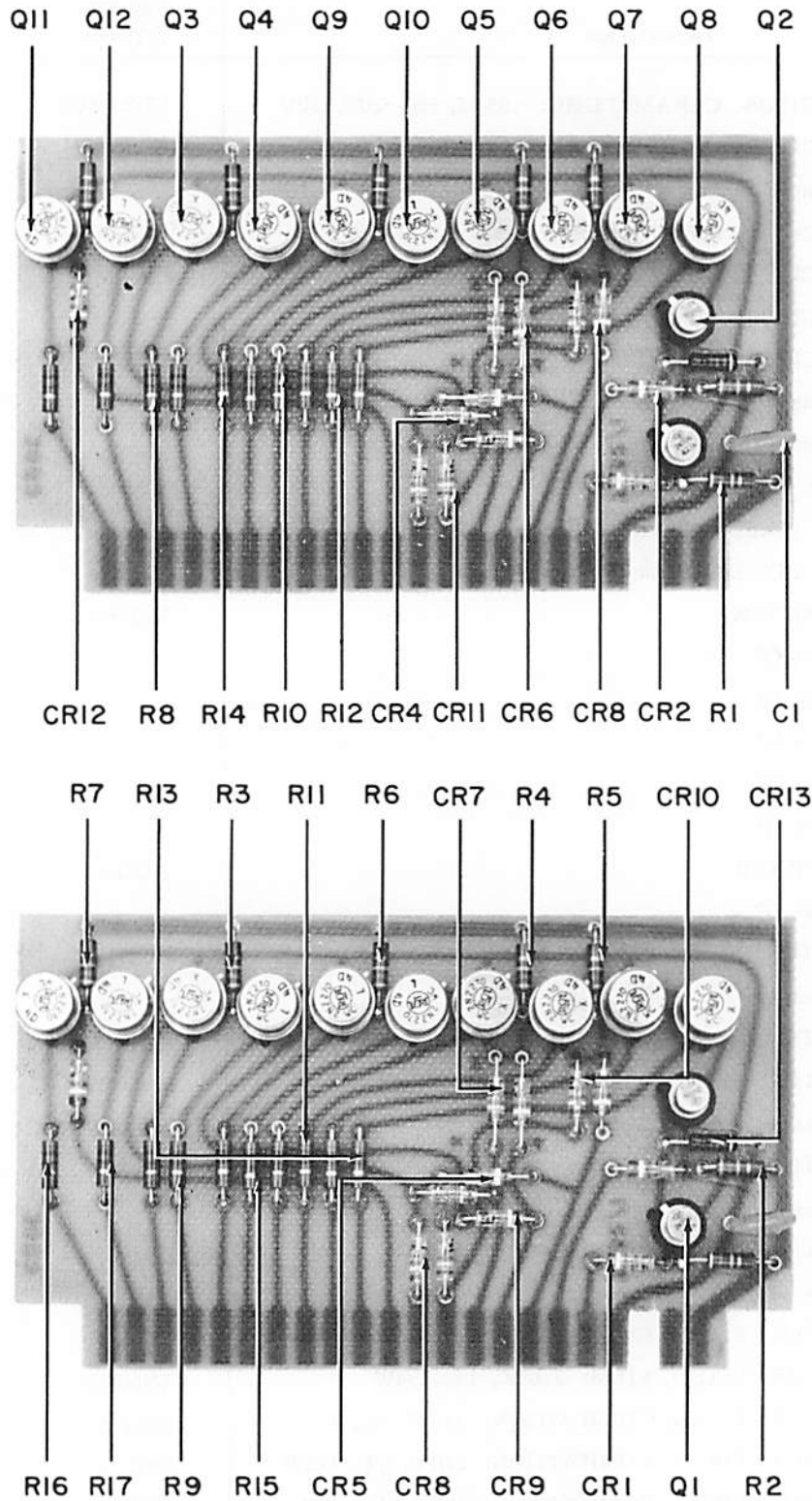


Figure 5-28. Type 7932/1 Readout Decoder-Driver, Component Locations

5.4.9.7 Type 7932/1 Readout Decoder -Driver

REF DESIG PREFIX A8A10, A8A12,  
A8A14, A8A16

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, CERAMIC DISC: 0.1 $\mu$ f, +80 -20%, 10V	UK10-104	71590
CR1	DIODE	1N198	07688
CR2	Same as CR1		
CR3	Same as CR1		
CR4	Same as CR1		
CR5	Same as CR1		
CR6	Same as CR1		
CR7	Same as CR1		
CR8	Same as CR1		
CR9	Same as CR1		
CR10	Same as CR1		
CR11	Same as CR1		
CR12	Same as CR1		
CR13	DIODE	1N462A	07688
Q1	TRANSISTOR	2N706	07688
Q2	Same as Q1		
Q3	TRANSISTOR	2N2270	07688
Q4	Same as Q3		
Q5	Same as Q3		
Q6	Same as Q3		
Q7	Same as Q3		
Q8	Same as Q3		
Q9	Same as Q3		
Q10	Same as Q3		
Q11	Same as Q3		
Q12	Same as Q3		
R1	RESISTOR, FIXED, COMPOSITION: 36K, 5%, 1/4W	CB3635	01121
R2	Same as R1		
R3	Same as R1		
R4	Same as R1		
R5	Same as R1		
R6	Same as R1		
R7	Same as R1		
R8	RESISTOR, FIXED, COMPOSITION: 6.2K, 5%, 1/4W	CB6225	01121
R9	Same as R8		

REPLACEMENT PARTS LIST

REF DESIG PREFIX A8A10, A8A12,  
A8A14, A8A16

Ref. Desig.	Description	Vendor Part No.	Vendor Code
R10	Same as R8		
R11	Same as R8		
R12	Same as R8		
R13	Same as R8		
R14	Same as R8		
R15	Same as R8		
R16	Same as R8		
R17	Same as R8		

REF DESIG PREFIX A9

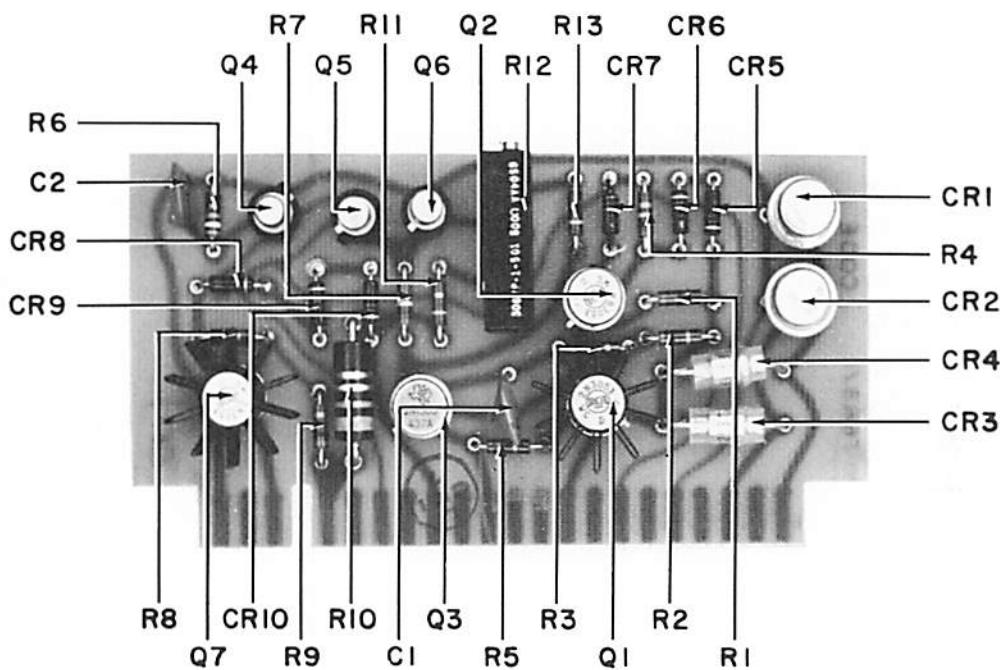


Figure 5-29. Type 7683/1 +6 and -6- vdc Power Supply, Component Locations



5.4.10 Type 7683 +6 vdc and -6 vdc Power Supply

REF DESIG PREFIX A9

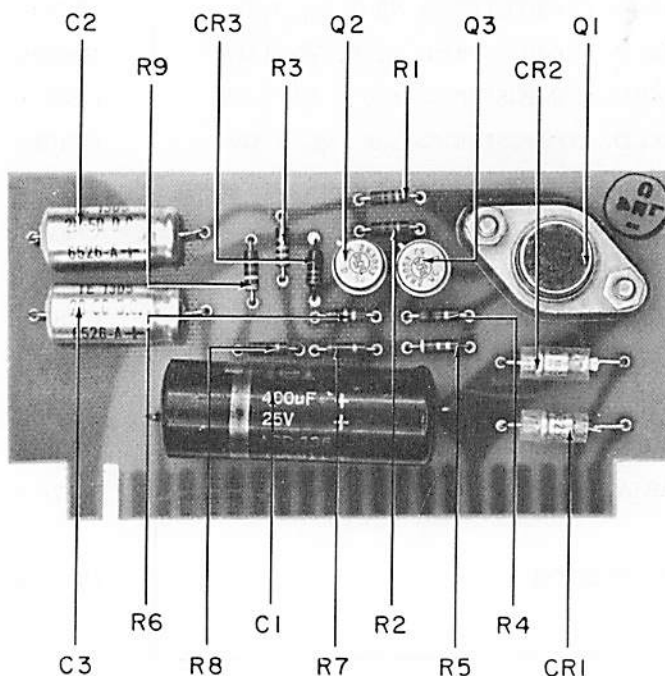
Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, CERAMIC DISC: .05 $\mu$ f, 20V	UK20-503	71590
C2	Same as C1		
CR1	DIODE	MR1031	04713
CR2	Same as CR1		
CR3	DIODE	1N3253	07688
CR4	Same as CR3		
CR5	DIODE	1N462A	07688
CR6	Same as CR5		
CR7	DIODE, ZENER	1N753A	07688
CR8	Same as CR5		
CR9	Same as CR5		
CR10	Same as CR5		
Q1	TRANSISTOR	2N3053	07688
Q2	Same as Q1		
Q3	TRANSISTOR	2N1305	07688
Q4	TRANSISTOR	2N3251	07688
Q5	TRANSISTOR	2N929	07688
Q6	Same as Q5		
Q7	Same as Q1		
R1	RESISTOR, FIXED, COMPOSITION: 75 $\Omega$ , 5%, 1/4W	CB7505	01121
R2	RESISTOR, FIXED, COMPOSITION: 6.2K, 5%, 1/4W	CB6225	01121
R3	RESISTOR, FIXED, COMPOSITION: 620 $\Omega$ , 5%, 1/4W	CB6215	01121
R4	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R5	RESISTOR, FIXED, COMPOSITION: 27 $\Omega$ , 5%, 1/4W	CB2705	01121
R6	RESISTOR, FIXED, COMPOSITION: 39K, 5%, 1/4W	CB3935	01121
R7	RESISTOR, FIXED, COMPOSITION: 120K, 5%, 1/4W	CB1245	01121
R8	RESISTOR, FIXED, COMPOSITION: 2K, 5%, 1/4W	CB1025	01121
R9	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	CB1025	01121
R10	RESISTOR, FIXED, WIREWOUND: 0.33 $\Omega$ , 5%, 2W	BWH	75042
R11	RESISTOR, FIXED, COMPOSITION: 2.4K, 5%, 1/4W	CB2425	01121
R12	RESISTOR, VARIABLE, WIREWOUND: 500 $\Omega$ , 10%, 1/2W	3067P-1-501	80294
R13	Same as R11		
RA1	RADIATOR, TRANSISTOR	NF-205	05820
RA2	Same as RA1		

REPLACEMENT PARTS LIST

5.4.11 Type 7681 +12V Regulated Power Supply Board

REF DESIG PREFIX A10

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC: 400 $\mu$ f, -10 +100%, 25V	APD136	02567
C2	CAPACITOR, ELECTROLYTIC: 20 $\mu$ f, -10 +75%, 50V	30D206G050DC4	56289
C3	Same as C2		
CR1	DIODE	1N3253	07688
CR2	Same as CR1		
CR3	DIODE, ZENER	1N753A	07688
Q1	TRANSISTOR	2N3054	07688
Q2	TRANSISTOR	2N3053	07688
Q3	Same as Q2		
R1	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	CB5115	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 33K, 5%, 1/4W	CB3335	01121
R4	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121
R5	RESISTOR, FIXED, COMPOSITION: 4.7 $\Omega$ , 5%, 1/4W	CB47G5	01121
R6	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R7	RESISTOR, FIXED, COMPOSITION: 1.5K, 5%, 1/4W	CB1525	01121
R8	Same as R7		
R9	RESISTOR, FIXED, COMPOSITION: 390 $\Omega$ , 5%, 1/4W	CB3915	01121



REF DESIG PREFIX A10

Figure 5-30. Type 7681 +12V Regulated Power Supply, Component Locations

5.4.12 Type 7680 -12V Regulated Power Supply

REF DESIG PREFIX A11

Ref. Desig.	Description	Vendor Part No.	Vendor Code
C1	CAPACITOR, ELECTROLYTIC: 400 $\mu$ f, -10 +100%, 25V	APD136	02567
C2	CAPACITOR, ELECTROLYTIC: 20 $\mu$ f, -10 +75%, 50V	30D206G050DC4	56289
C3	Same as C2		
CR1	DIODE	1N3243	07688
CR2	Same as CR1		
CR3	DIODE, ZENER	1N753A	07688
Q1	TRANSISTOR	2N2869	07688
Q2	TRANSISTOR	2N526	07688
R1	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	CB5115	01121
R2	Same as R1		
R3	RESISTOR, FIXED, COMPOSITION: 33K, 5%, 1/4W	CB3335	01121
R4	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	CB1035	01121
R5	RESISTOR, FIXED, COMPOSITION: 1.5K, 5%, 1/4W	CB1525	01121
R6	Same as R5		
R7	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	CB1015	01121

REF DESIG PREFIX A11

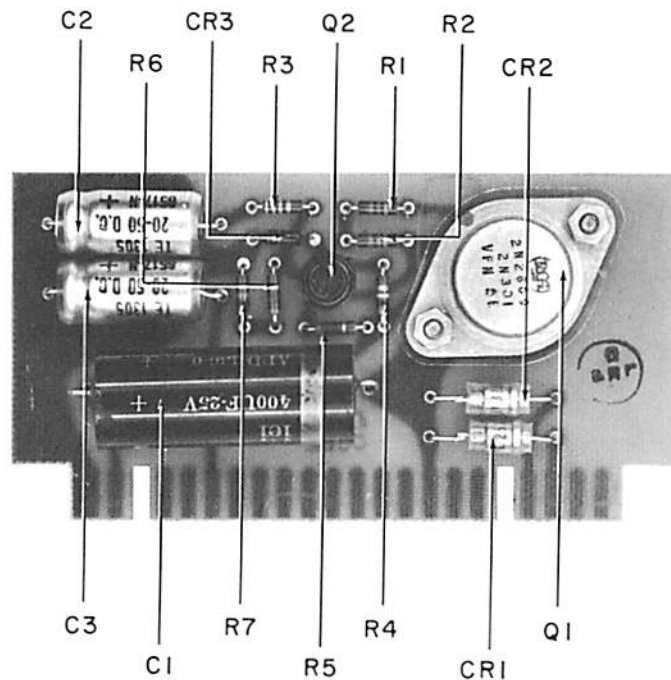
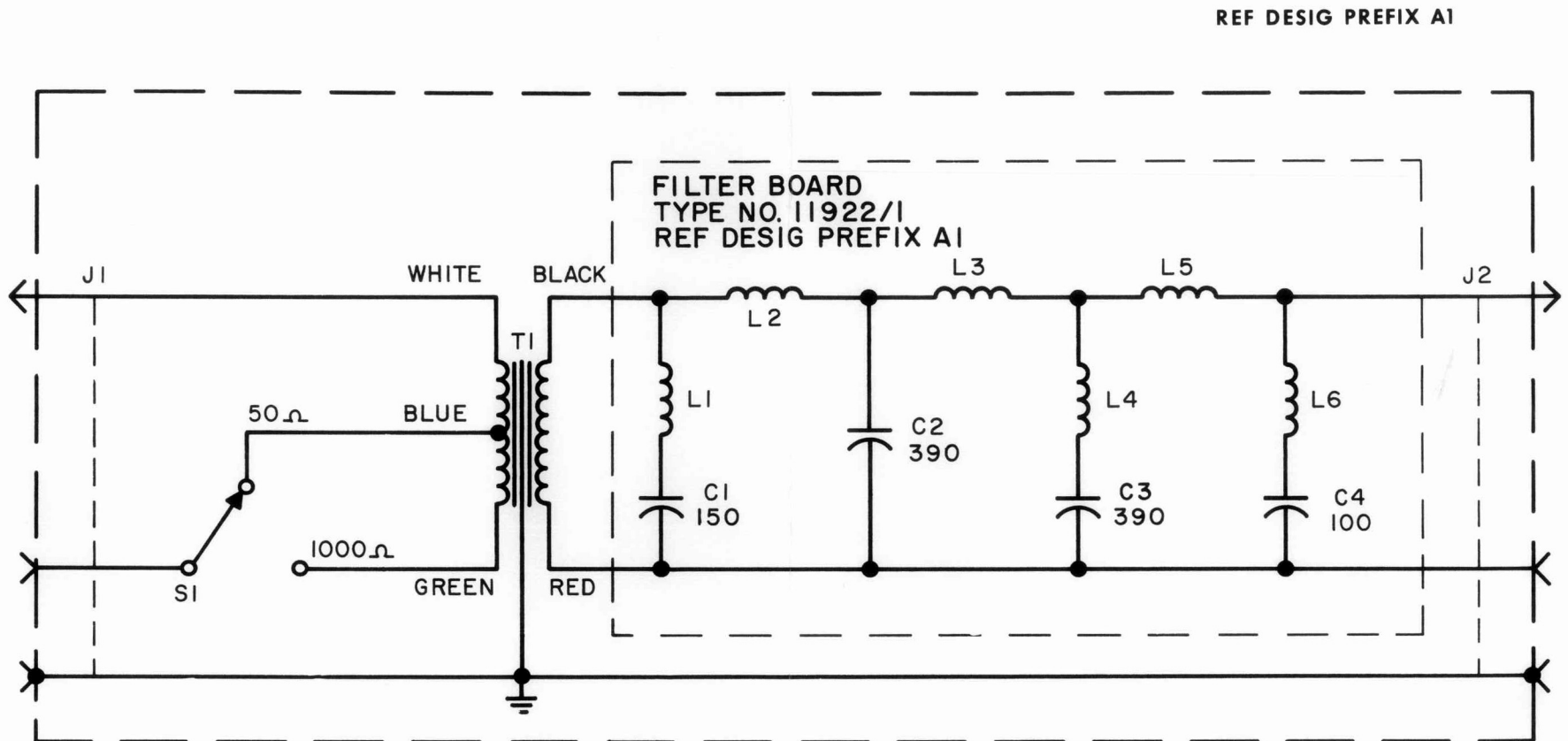


Figure 5-31. Type 7680 -12V Regulated Power Supply, Component Locations

SECTION VI

SCHEMATIC DIAGRAMS

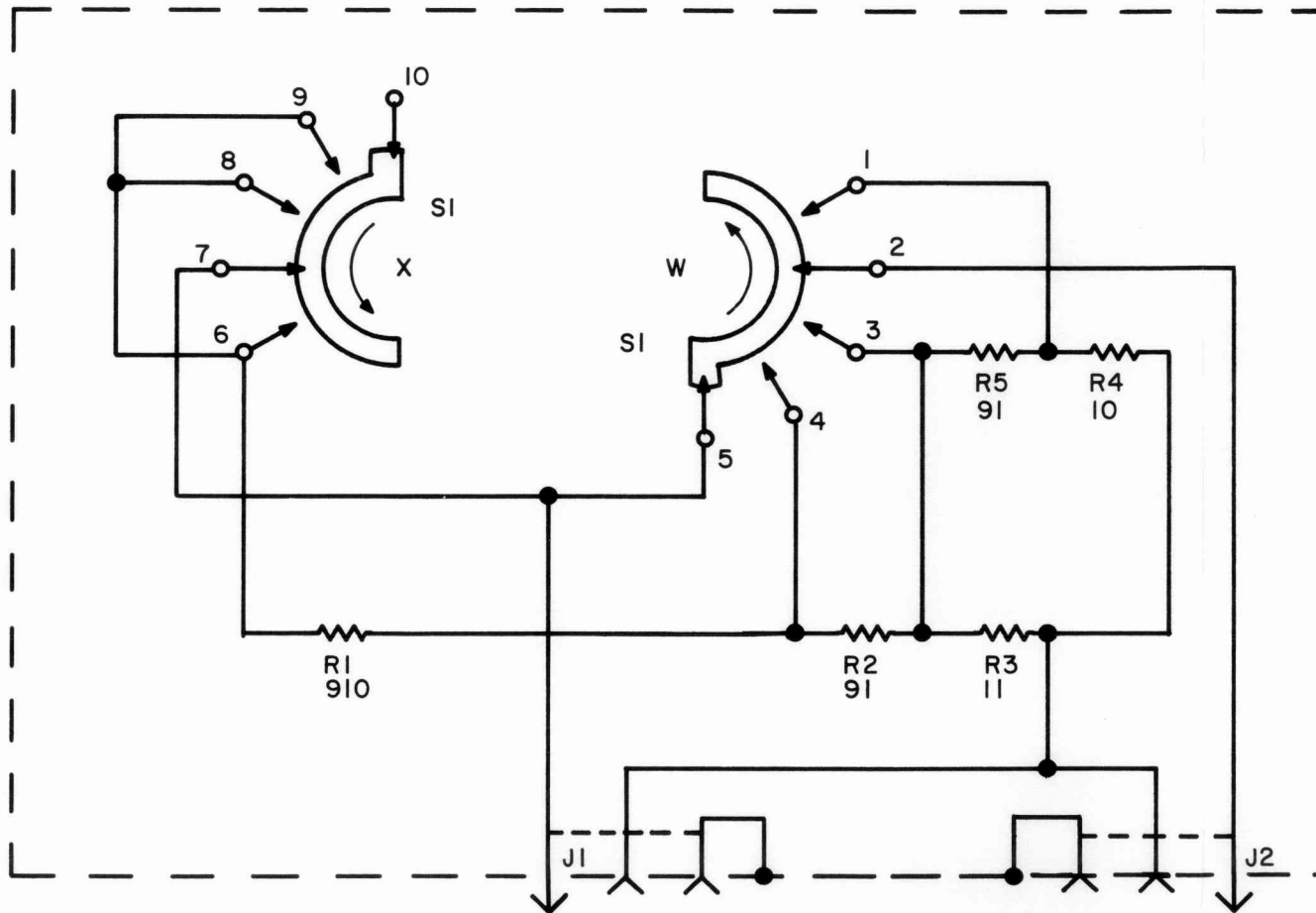


NOTES:

1. CAPACITANCE IS MEASURED IN pf

Figure 6-1. Type 79123 Input Transformer and Filter Assembly, Schematic Diagram

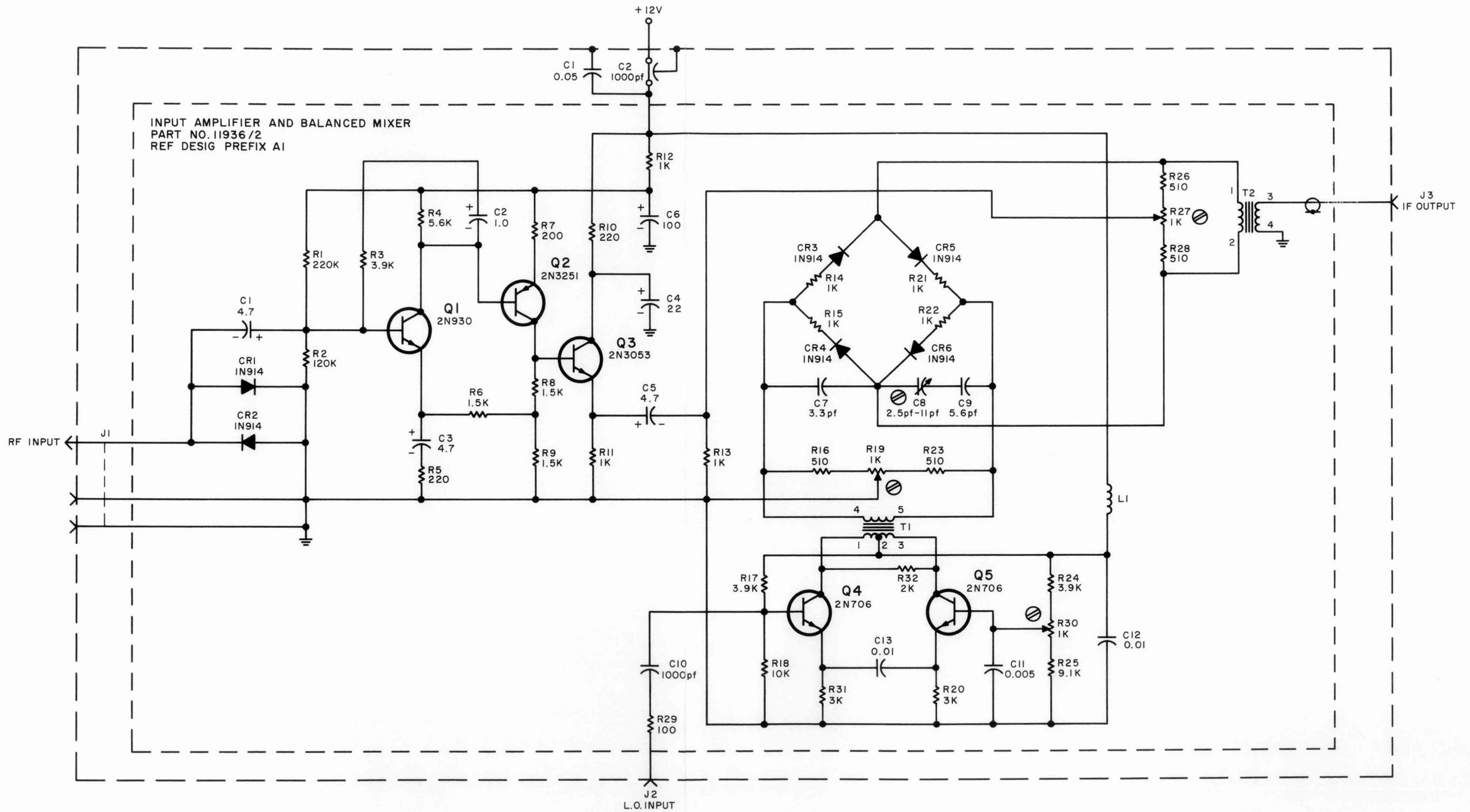
REF DESIG PREFIX A2



NOTES:

1. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%.
2. SWITCH SI IS SHOWN IN EXTREME COUNTERCLOCKWISE POSITION AND VIEWED FROM END OPPOSITE CONTROL KNOB. ARROW INDICATES CLOCKWISE ROTATION OF CONTROL KNOB. SEGMENTS OF WAFER ARE IDENTIFIED BY LETTERS W & X AND ARE SHOWN IN PROPER PHYSICAL POSITION.

Figure 6-2. Type 79108 Input Attenuator, Schematic Diagram




NOTES:  
 1. UNLESS OTHERWISE SPECIFIED:  
 a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W  
 b) CAPACITANCE IS MEASURED IN  $\mu f$   
 2.  INDICATES SCREWDRIVER ADJUSTMENT

Figure 6-3. Type 79124 Input Amplifier and Balanced Mixer, Schematic Diagram



REF DESIG PREFIX A4

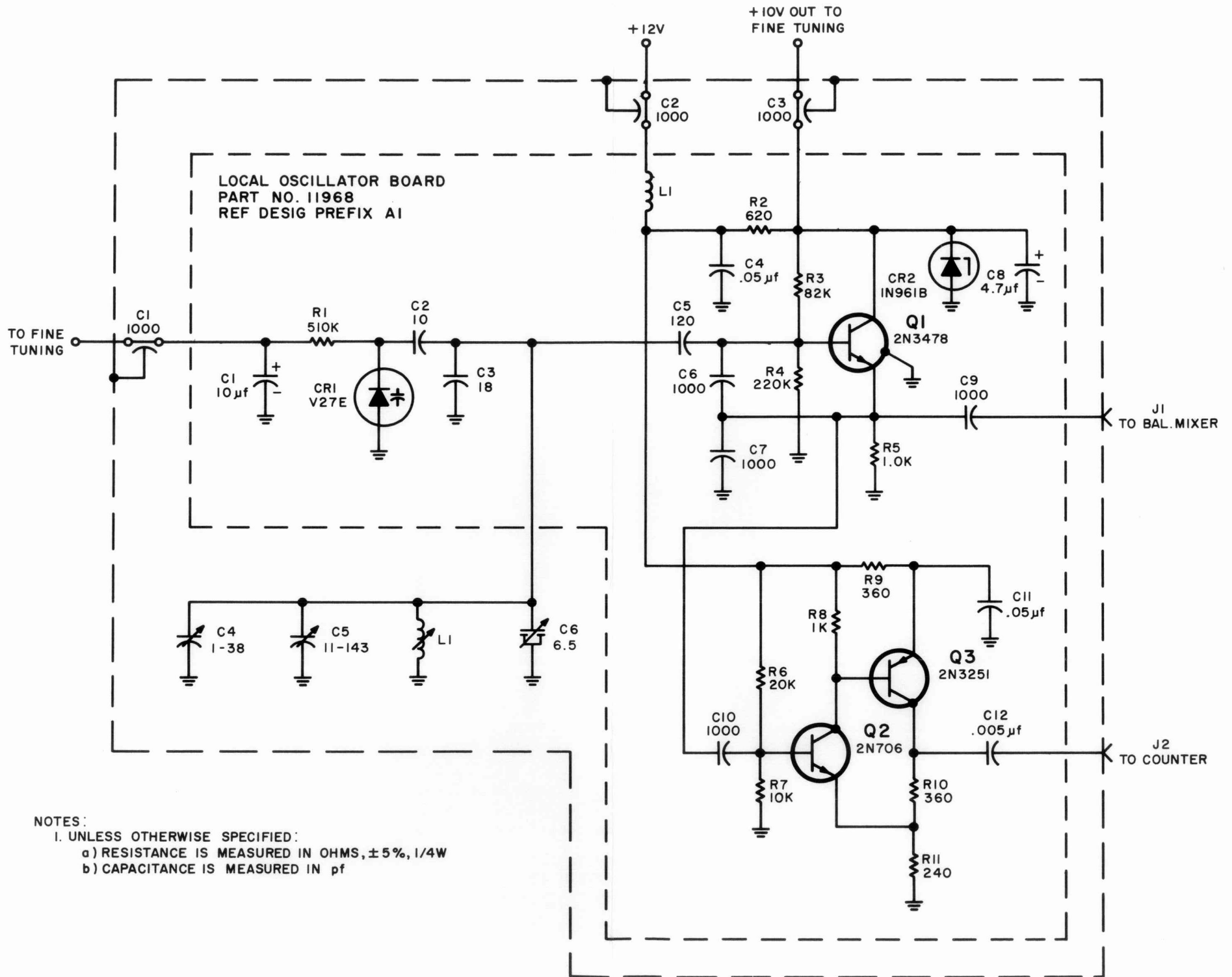
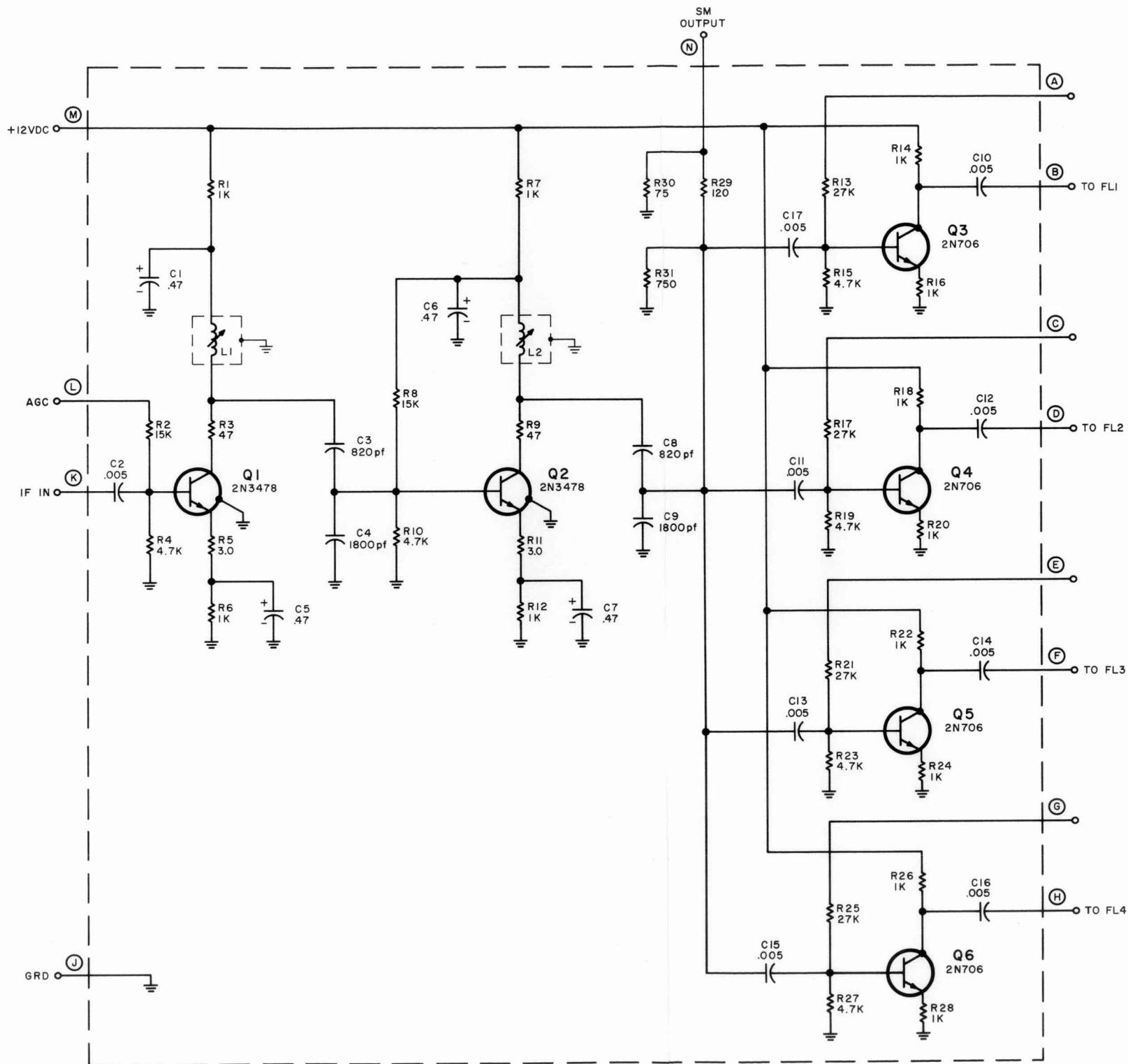


Figure 6-4. Type 7713 Local Oscillator Assembly, Schematic Diagram

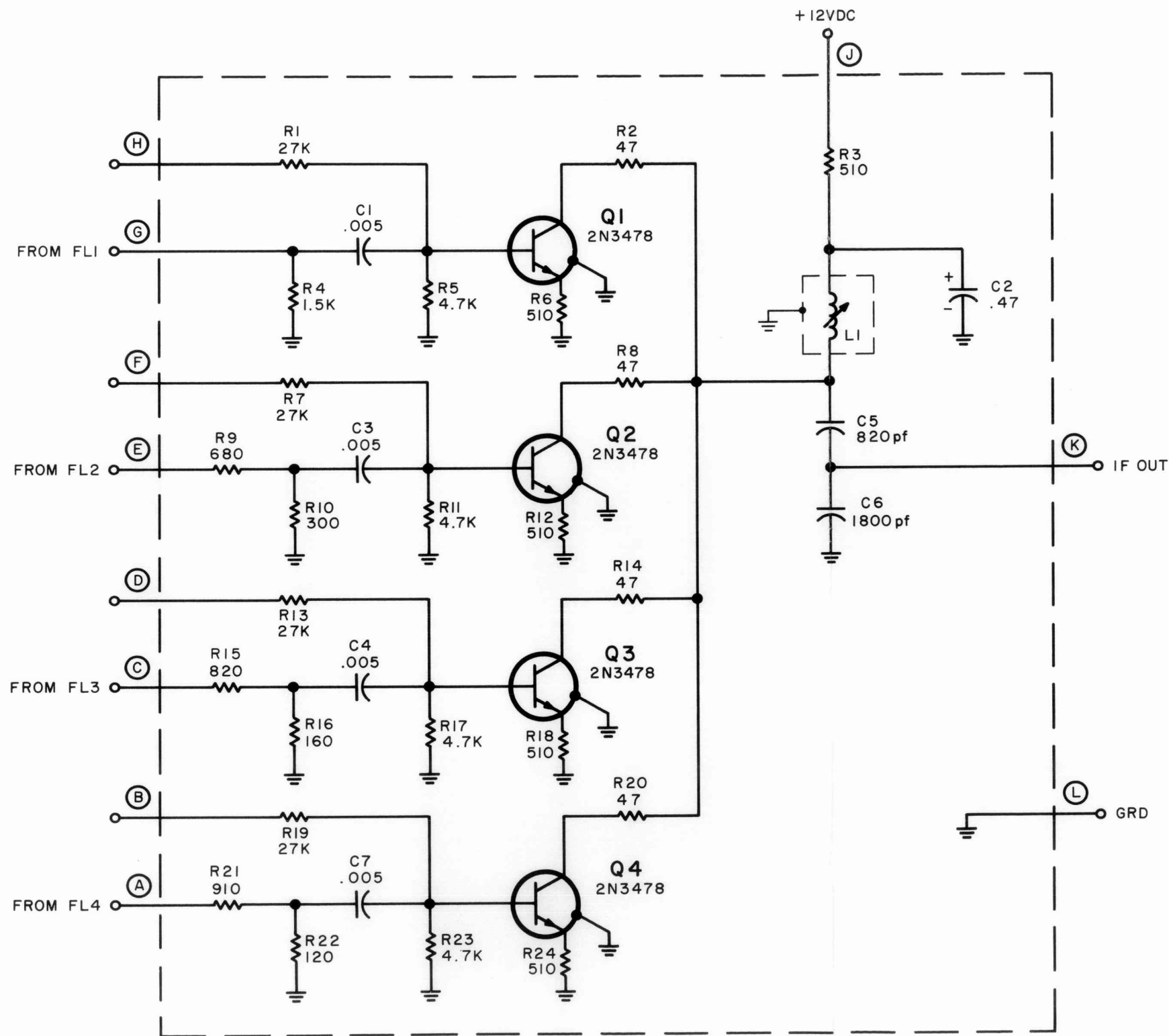
REF DESIG PREFIX A5A1



NOTES:  
 1. UNLESS OTHERWISE SPECIFIED:  
 a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W  
 b) CAPACITANCE IS MEASURED IN  $\mu f$   
 2. ENCIRCLED LETTERS ARE FOR REFERENCE ONLY

Figure 6-5. IF BW Switching Amplifier "A," Part 11962, Schematic Diagram

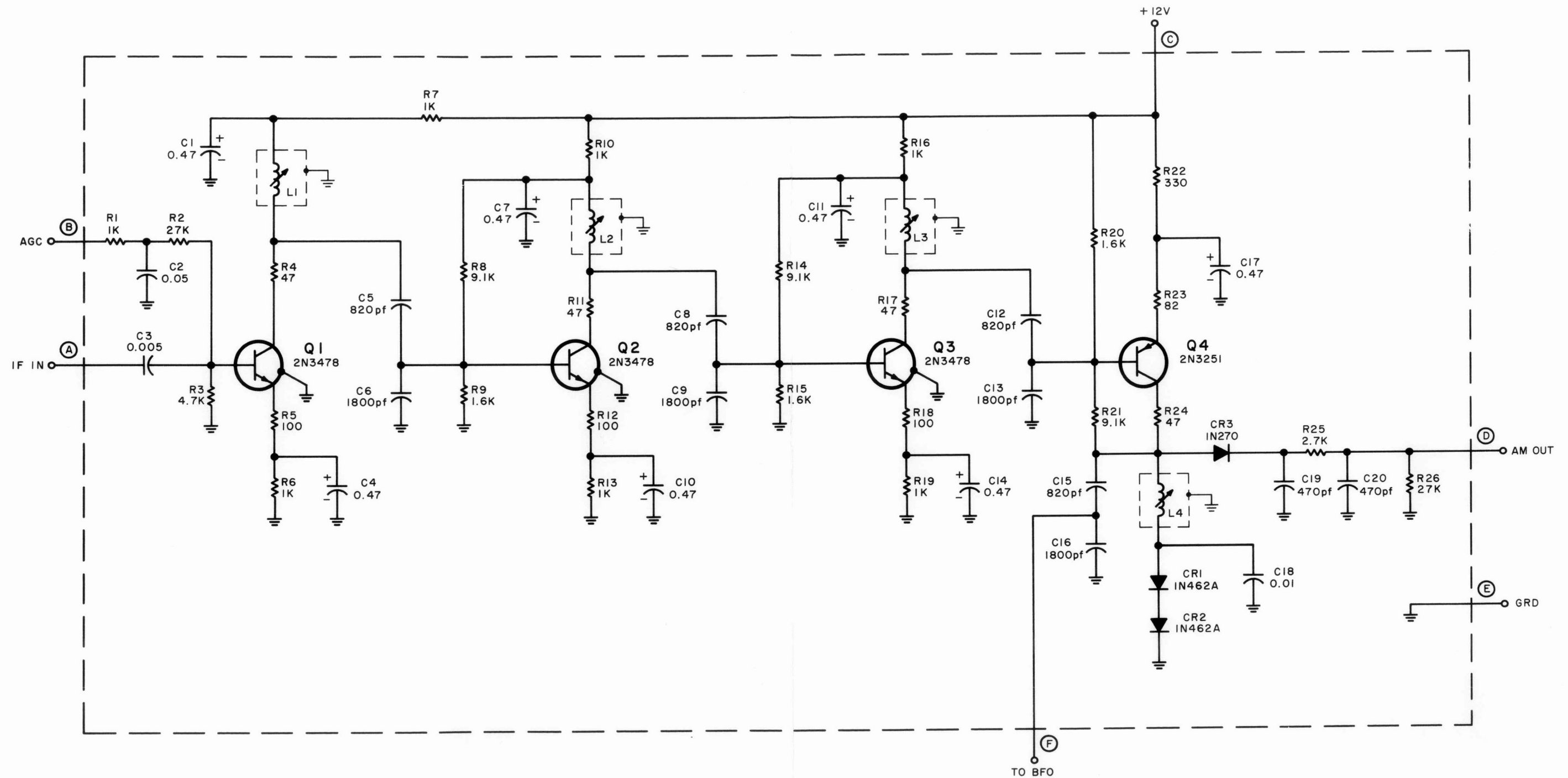
REF DESIG PREFIX A5A2



- NOTES:
1. UNLESS OTHERWISE SPECIFIED:
    - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
    - b) CAPACITANCE IS MEASURED IN  $\mu f$
  2. ENCIRCLED LETTERS ARE FOR REFERENCE ONLY

Figure 6-6. IF BW Switching Amplifier "B"  
Part 11964, Schematic Diagram

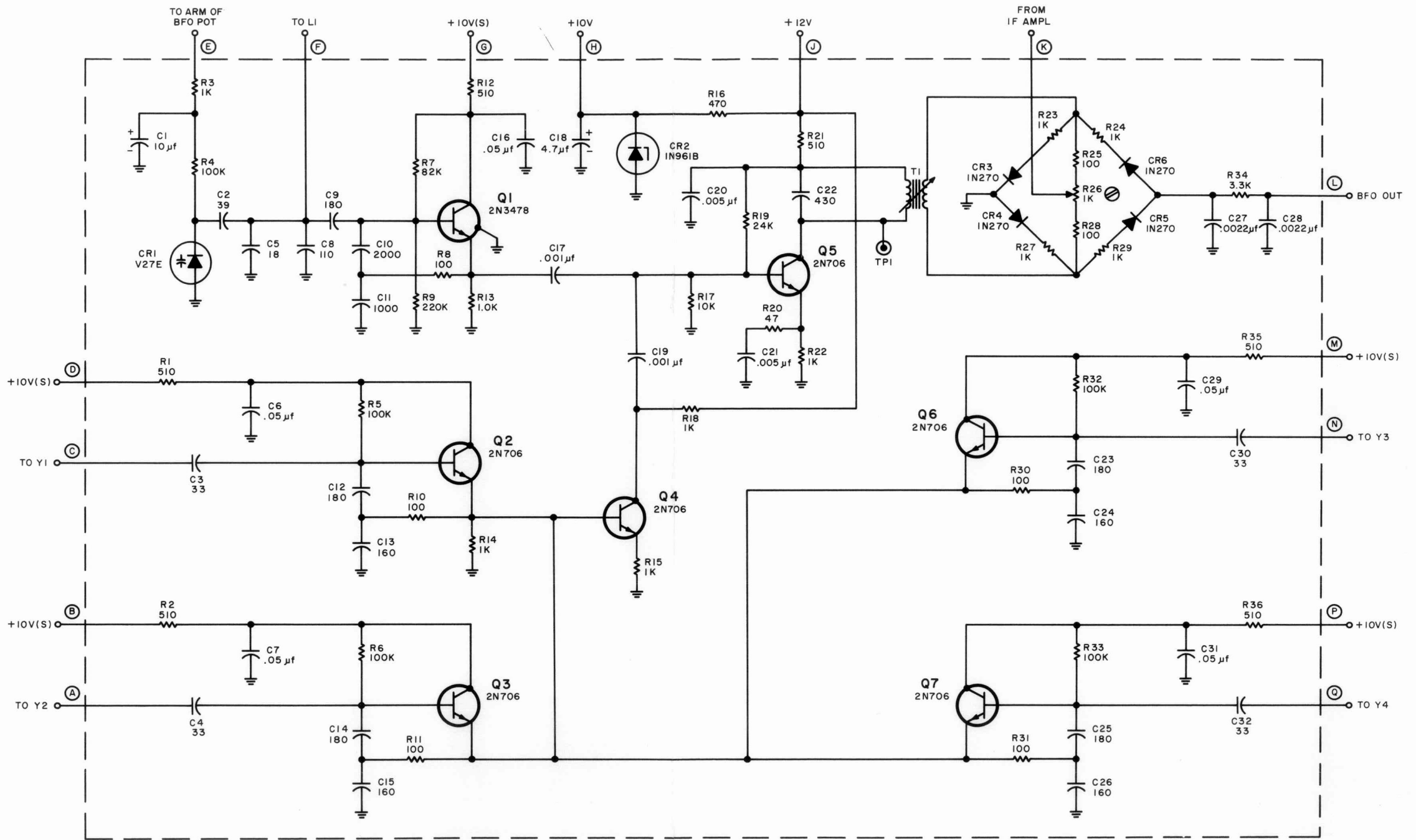
REF DESIG PREFIX A5A3



NOTES :

1. UNLESS OTHERWISE SPECIFIED:
  - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
  - b) CAPACITANCE IS MEASURED IN  $\mu f$
2. ENCIRCLED LETTERS ARE FOR REFERENCE ONLY

Figure 6-7. IF Amplifier and AM Detector, Part 11937, Schematic Diagram




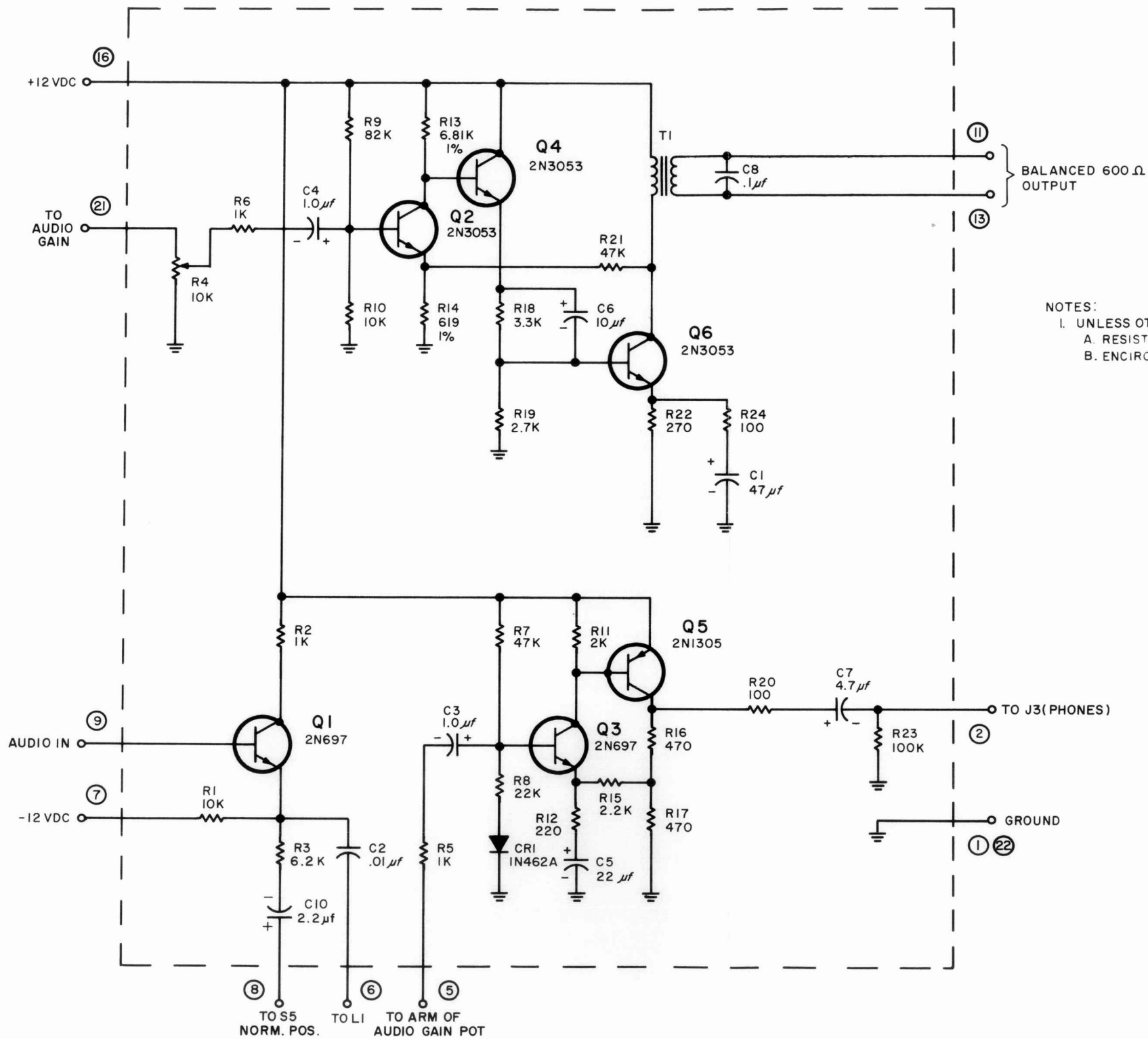
- NOTES:
1. UNLESS OTHERWISE SPECIFIED:
    - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
    - b) CAPACITANCE IS MEASURED IN pf
  2. ENCIRCLED LETTERS ARE FOR REFERENCE ONLY
  3.  INDICATES SCREWDRIVER ADJUSTMENT

Figure 6-8. BFO and Product Detector, Part 11966, Schematic Diagram



REF DESIG PREFIX A7



- NOTES:  
 I. UNLESS OTHERWISE SPECIFIED:  
 A. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%  
 B. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-10. Type 7411 Audio Amplifier Schematic Diagram



REF DESIG PREFIX A8

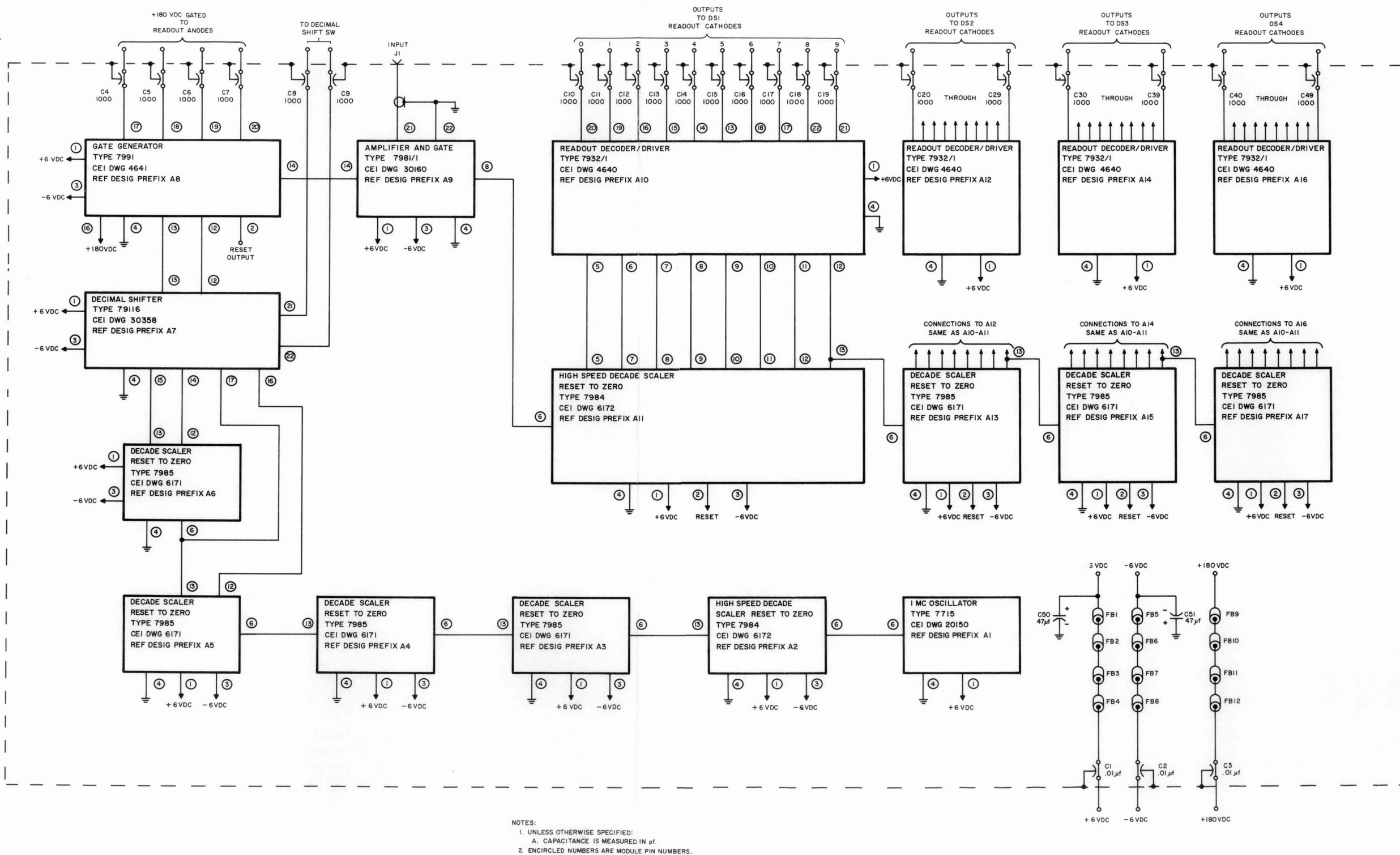
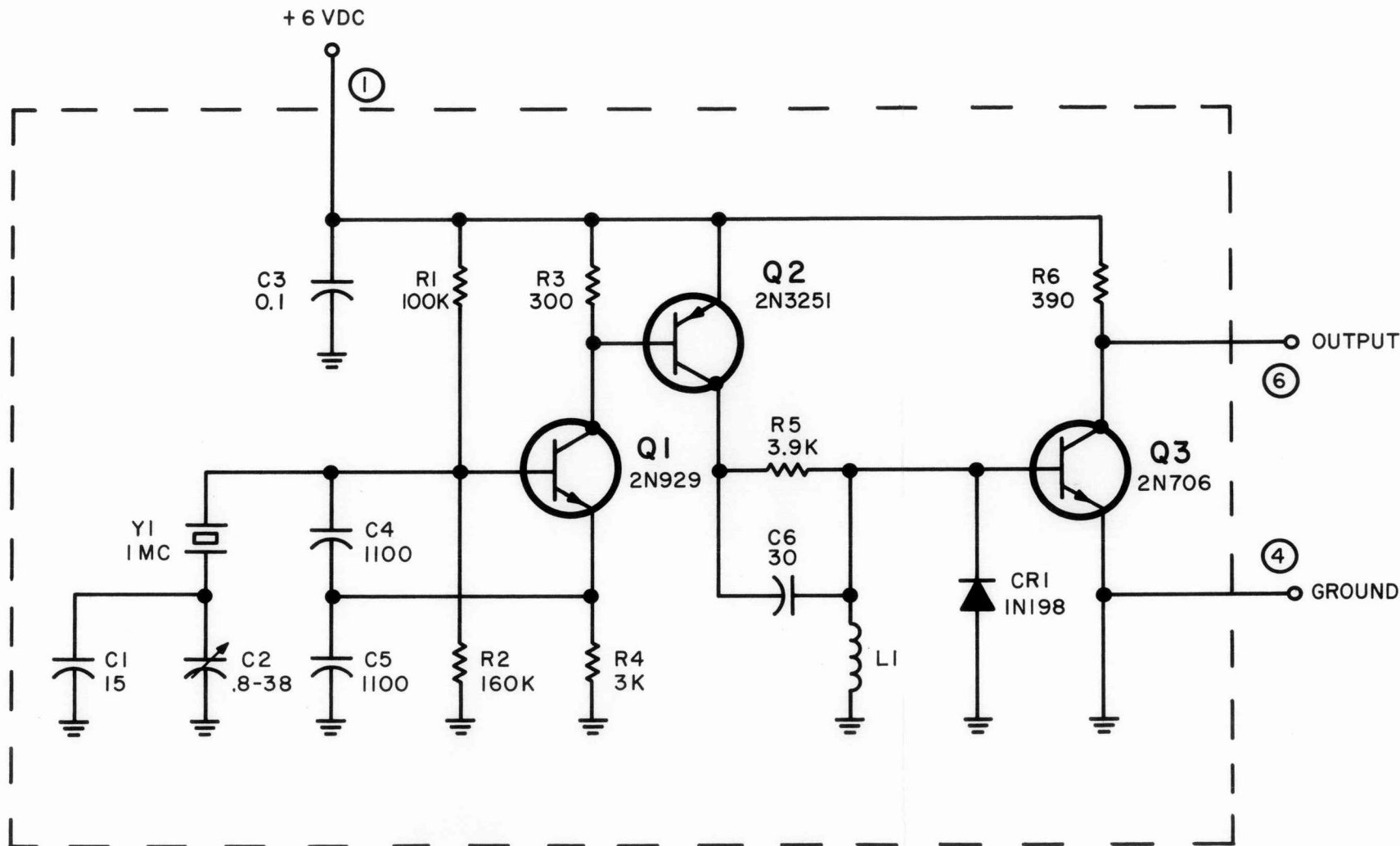


Figure 6-11. Type 79101 VLF Counter Assembly, Schematic Diagram

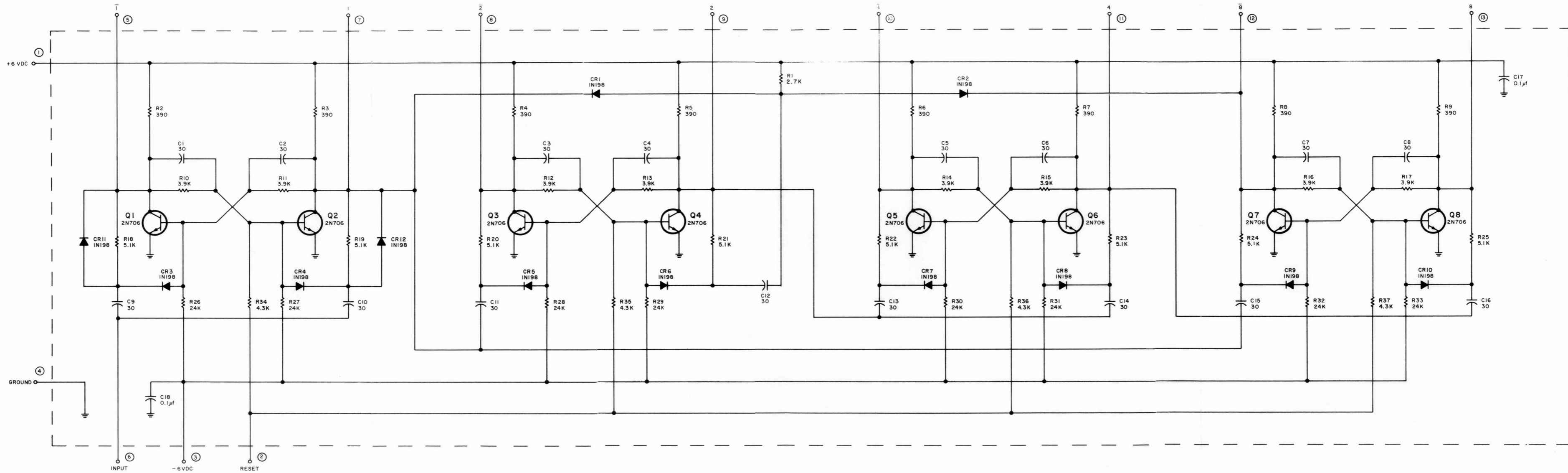
REF DESIG PREFIX A8A1



- NOTES:
1. UNLESS OTHERWISE SPECIFIED:
    - A. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%.
    - B. CAPACITANCE IS MEASURED IN pf.
  2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-12. Type 7715 1-mc Oscillator, Schematic Diagram

REF DESIG PREFIX A8A2,A8A11

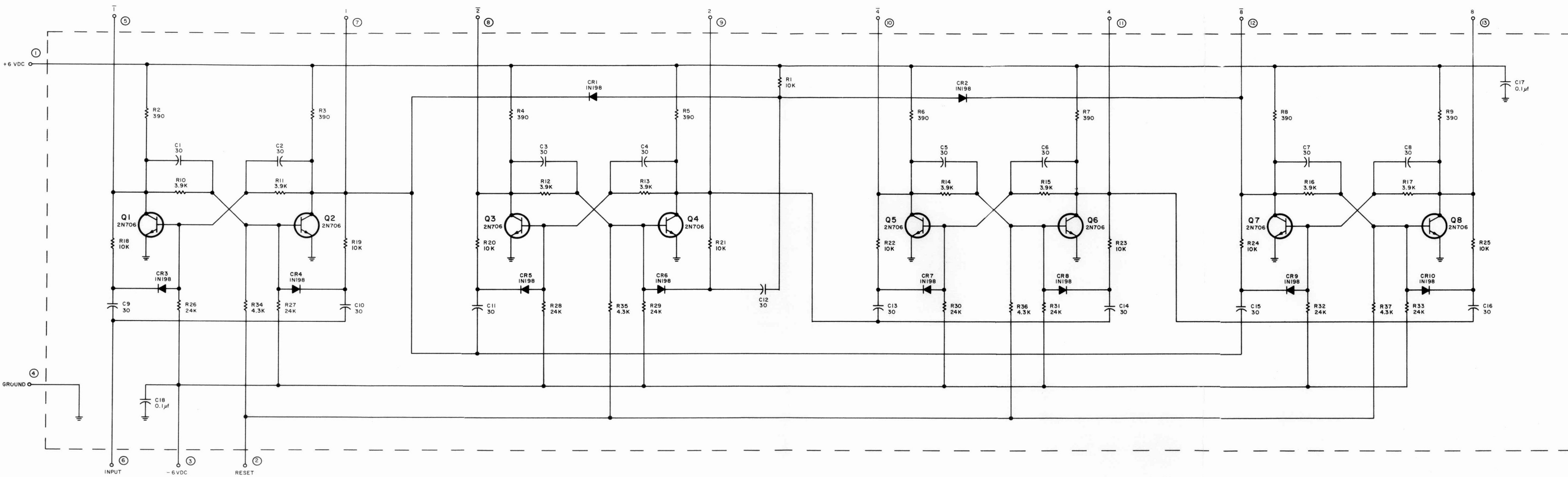


NOTES:  
1. UNLESS OTHERWISE SPECIFIED:  
A. CAPACITANCE IS MEASURED IN pF.  
B. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%  
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-13. Type 7984 High-Speed Decade Scaler, Schematic Diagram

# Courtesy of <http://BlackRadios.terryo.org>

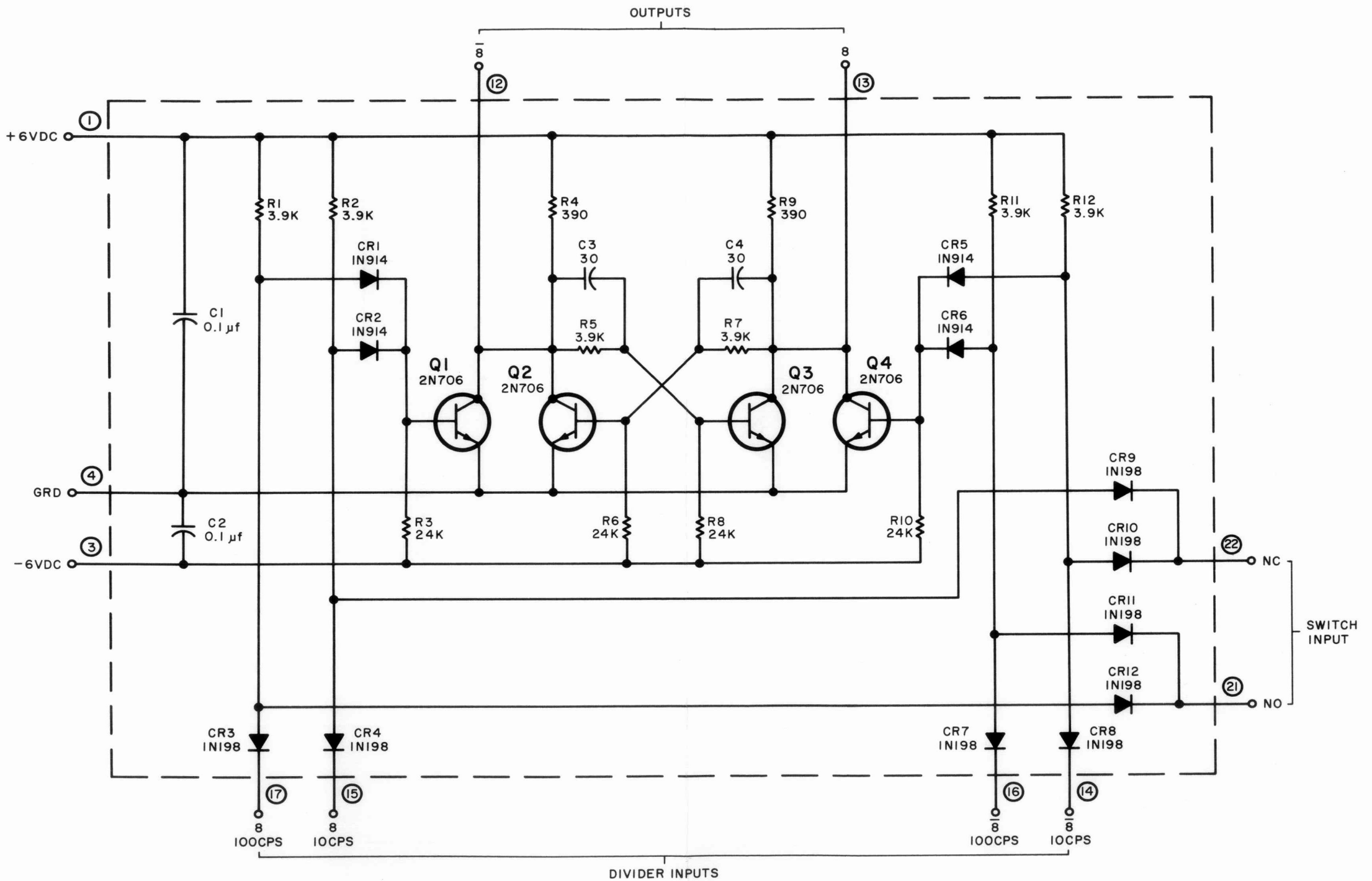
REF DESIG PREFIX A8A3 THRU A8A6  
A8A13, A8A15, A8A17



NOTES:  
1. UNLESS OTHERWISE SPECIFIED:  
A. CAPACITANCE IS MEASURED IN pF.  
B. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%  
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-14. Type 7985 Decade Scaler, Schematic Diagram

REF DESIG PREFIX A8A7

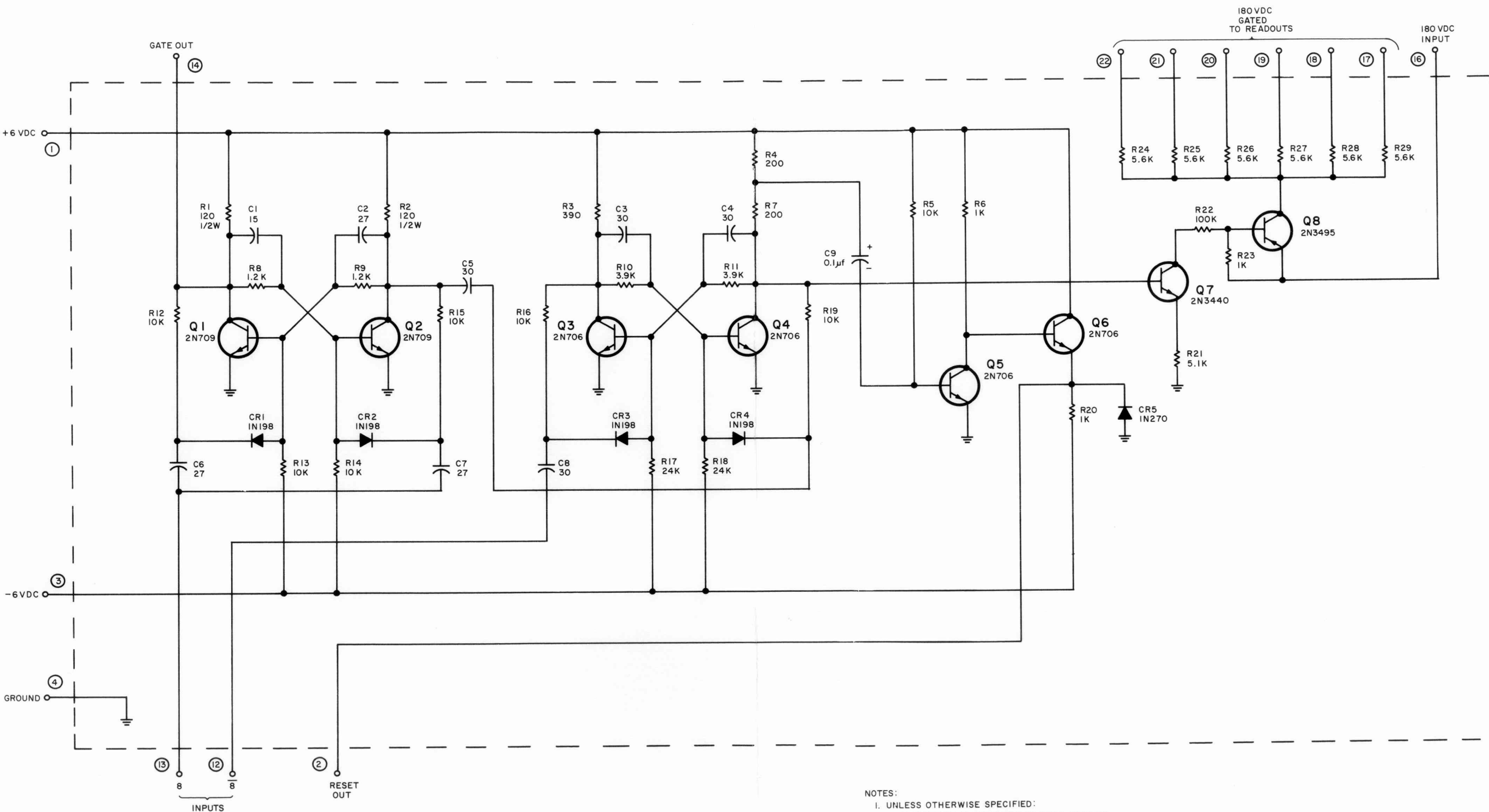


NOTES:

1. UNLESS OTHERWISE SPECIFIED:
  - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
  - b) CAPACITANCE IS MEASURED IN pf
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS

Figure 6-15. Type 79116 Decimal Shifter, Schematic Diagram

REF DESIG PREFIX A8A8



- NOTES:
1. UNLESS OTHERWISE SPECIFIED:
    - A. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%.
    - B. CAPACITANCE IS MEASURED IN pf.
  2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-16. Type 7991 Gate Generator, Schematic Diagram

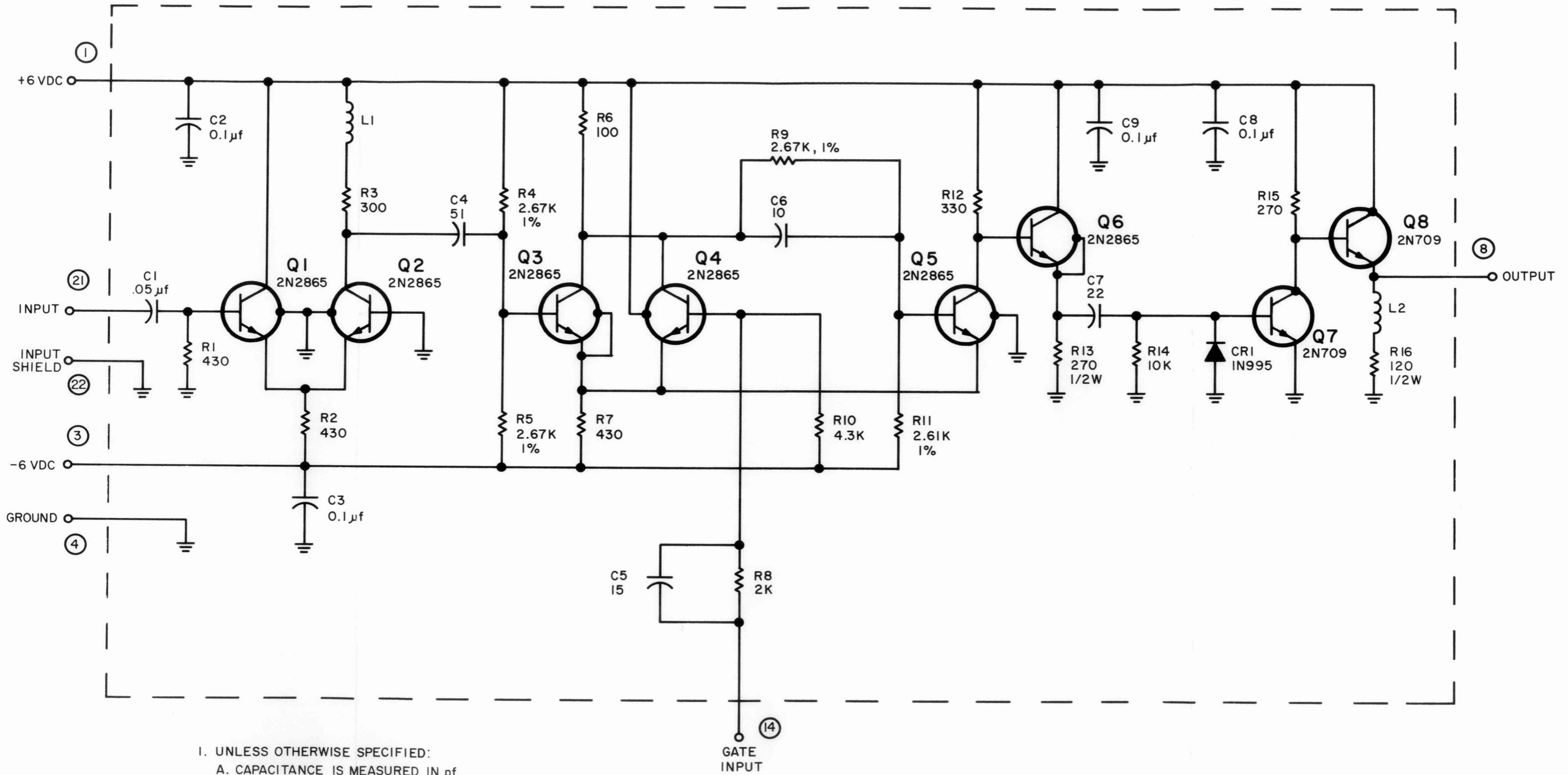
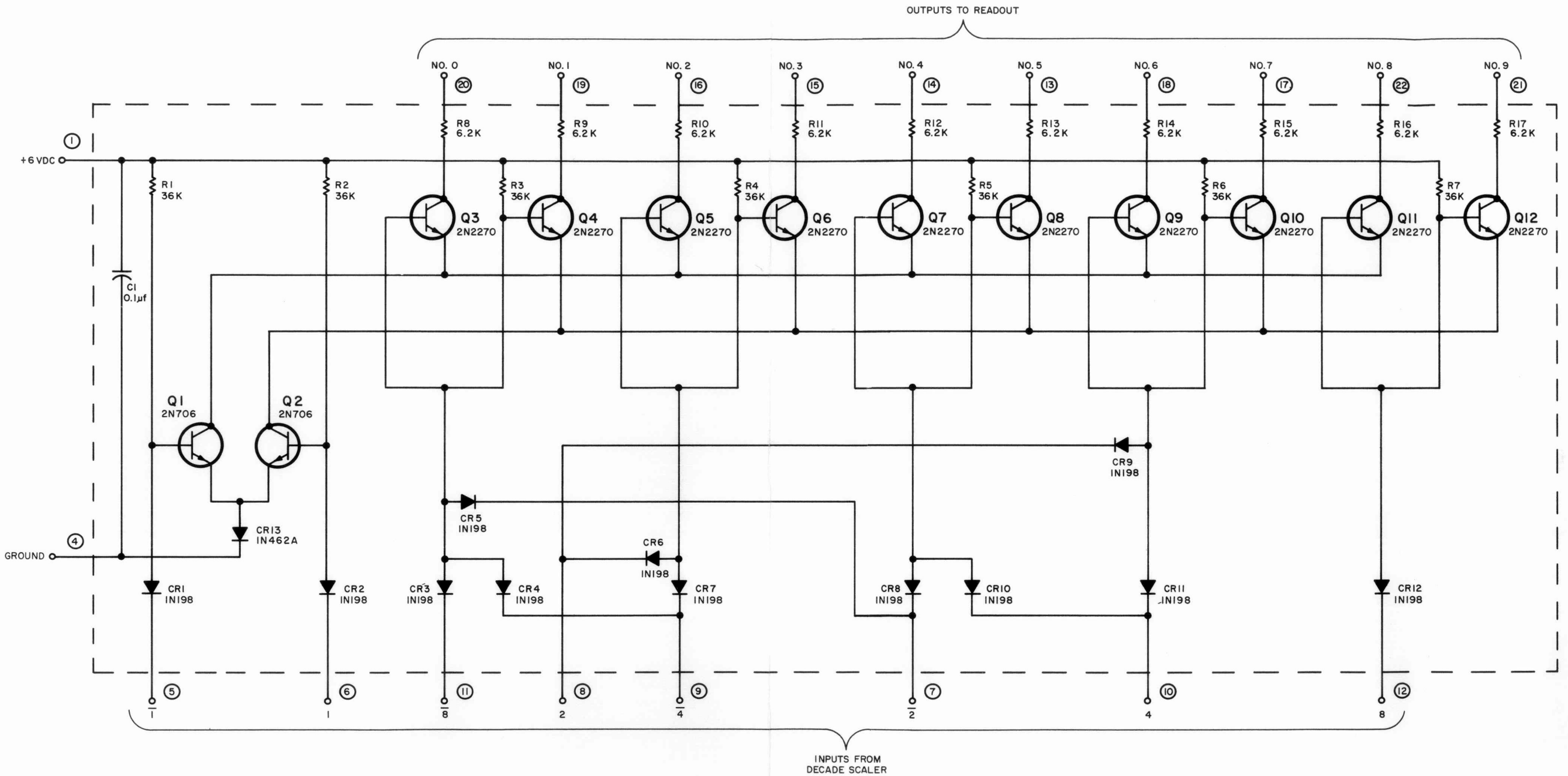


Figure 6-17. Type 7981/1 Amplifier and Gate, Schematic Diagram



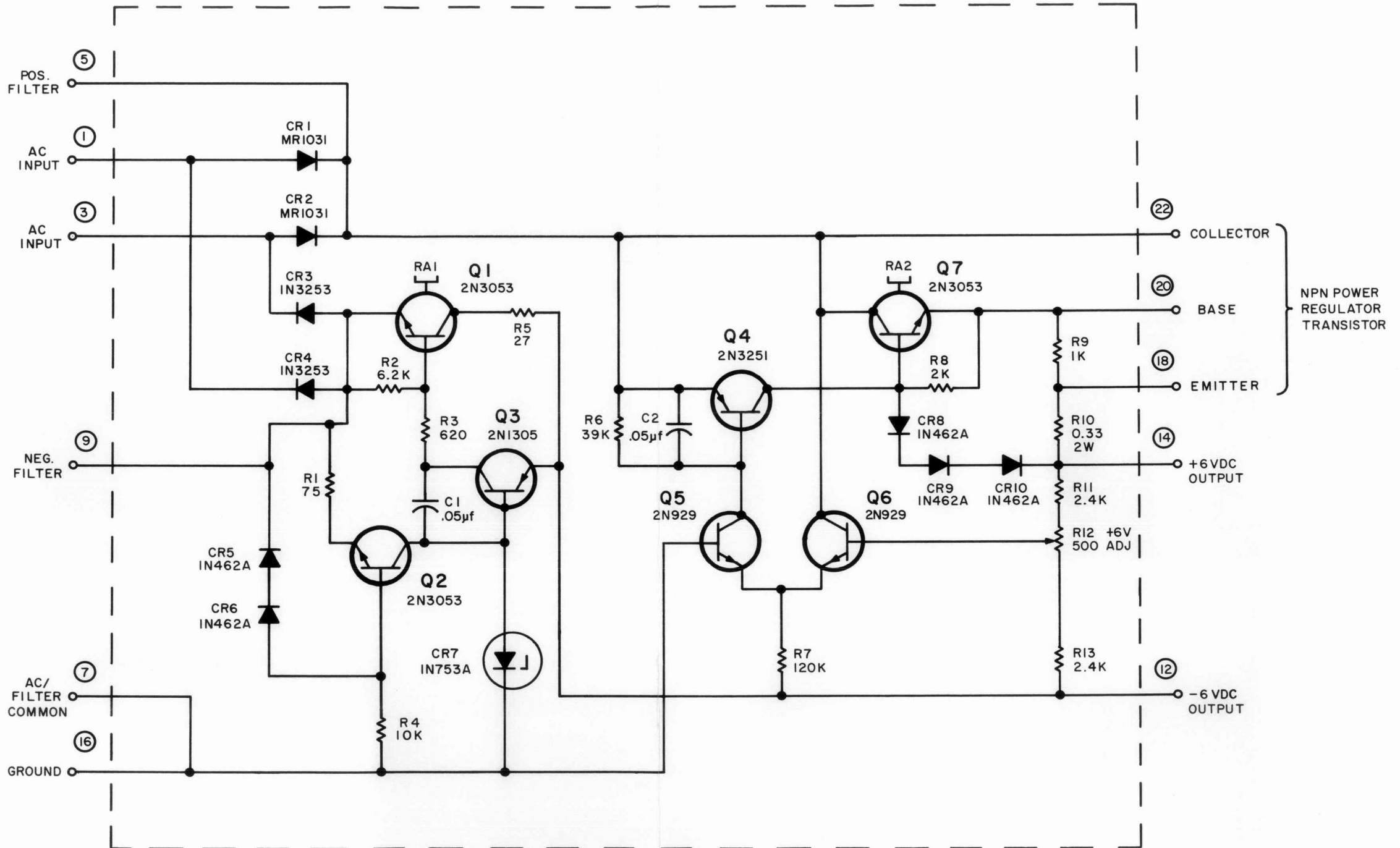
REF DESIG PREFIX A8A10,A8A12  
A8A14,A8A16



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
  - A. RESISTORS ARE MEASURED IN OHMS, 1/4W, 5%.
  - B. CAPACITANCE IS MEASURED IN µf.
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-18. Type 7932/1 Readout Decoder-Driver, Schematic Diagram

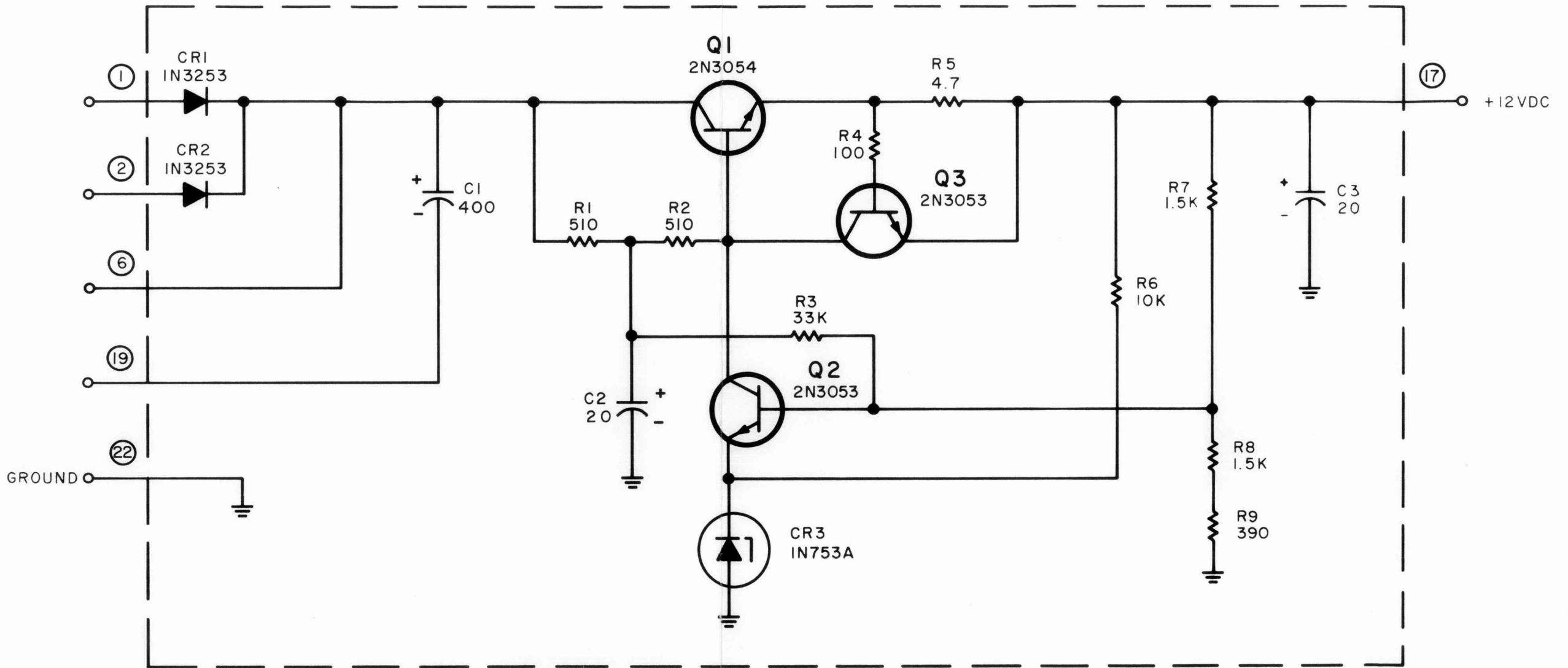


NOTES:

1. UNLESS OTHERWISE SPECIFIED:
  - A. RESISTANCE IS MEASURED IN OHMS, 1/4W, 5%.
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.

Figure 6-19. Type 7683/1 +6 and -6 vdc Power Supply, Schematic Diagram

REF DESIG PREFIX A10

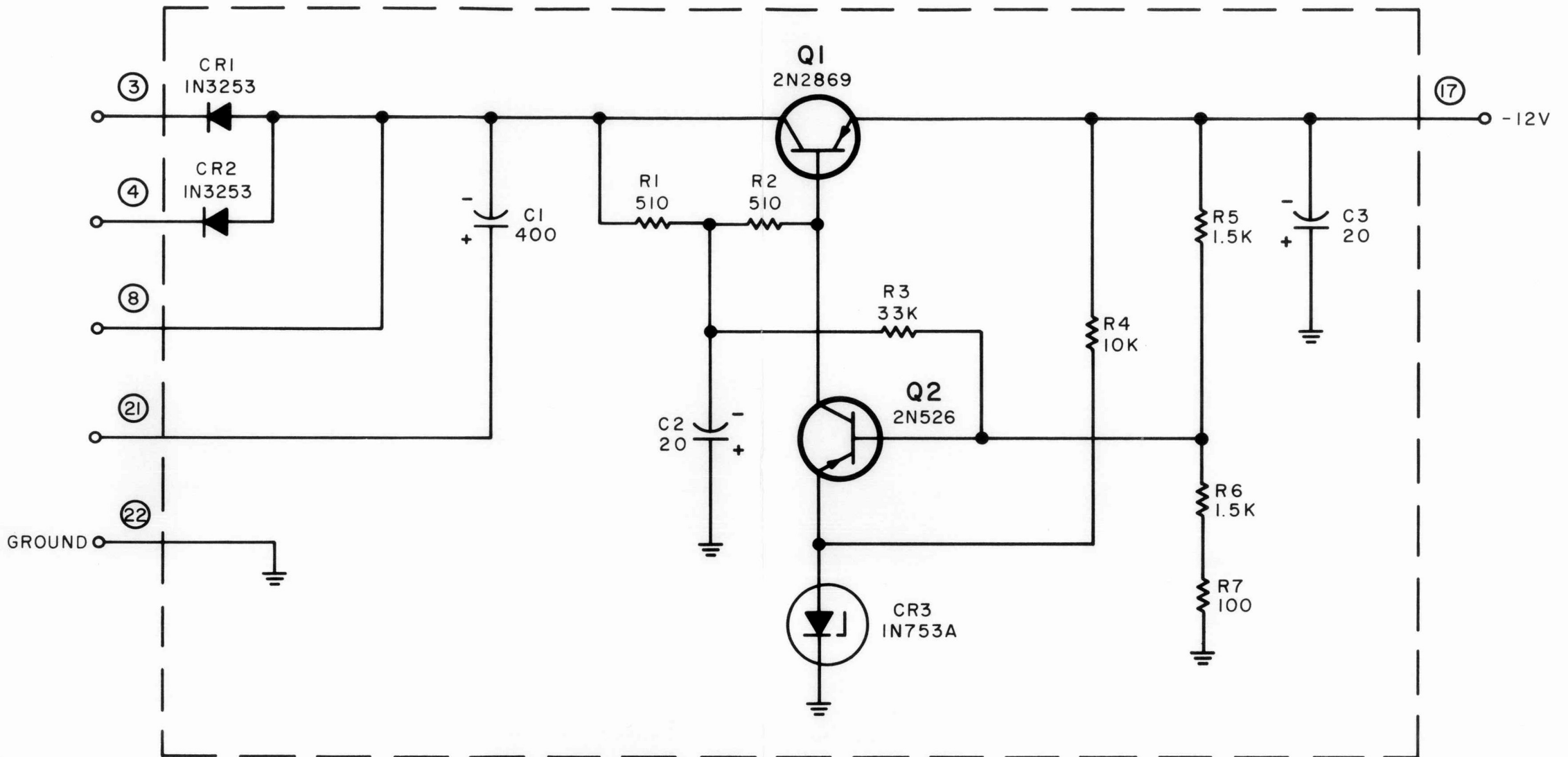


NOTES:

1. UNLESS OTHERWISE SPECIFIED:
  - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
  - b) CAPACITANCE IS MEASURED IN  $\mu f$
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS

Figure 6-20. Type 7681 +12V Regulated Power Supply, Schematic Diagram

REF DESIG PREFIX A11



NOTES :

1. UNLESS OTHERWISE SPECIFIED:
  - a) RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4 W
  - b) CAPACITANCE IS MEASURED IN  $\mu f$
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS

Figure 6-21. Type 7680 -12V Regulated Power Supply, Schematic Diagram

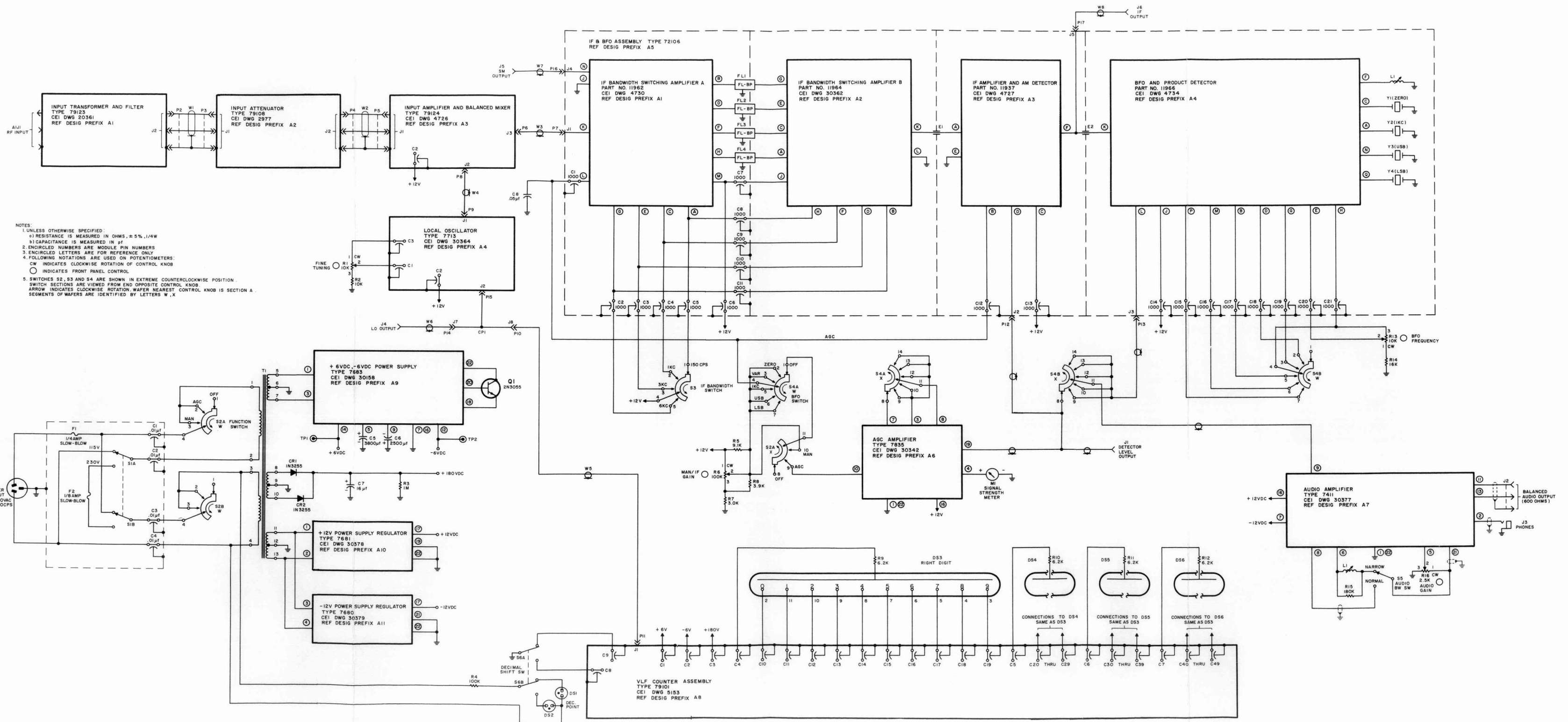


Figure 6-22. Type R-1401/G VLF Receiver, Main Chassis Schematic Diagram









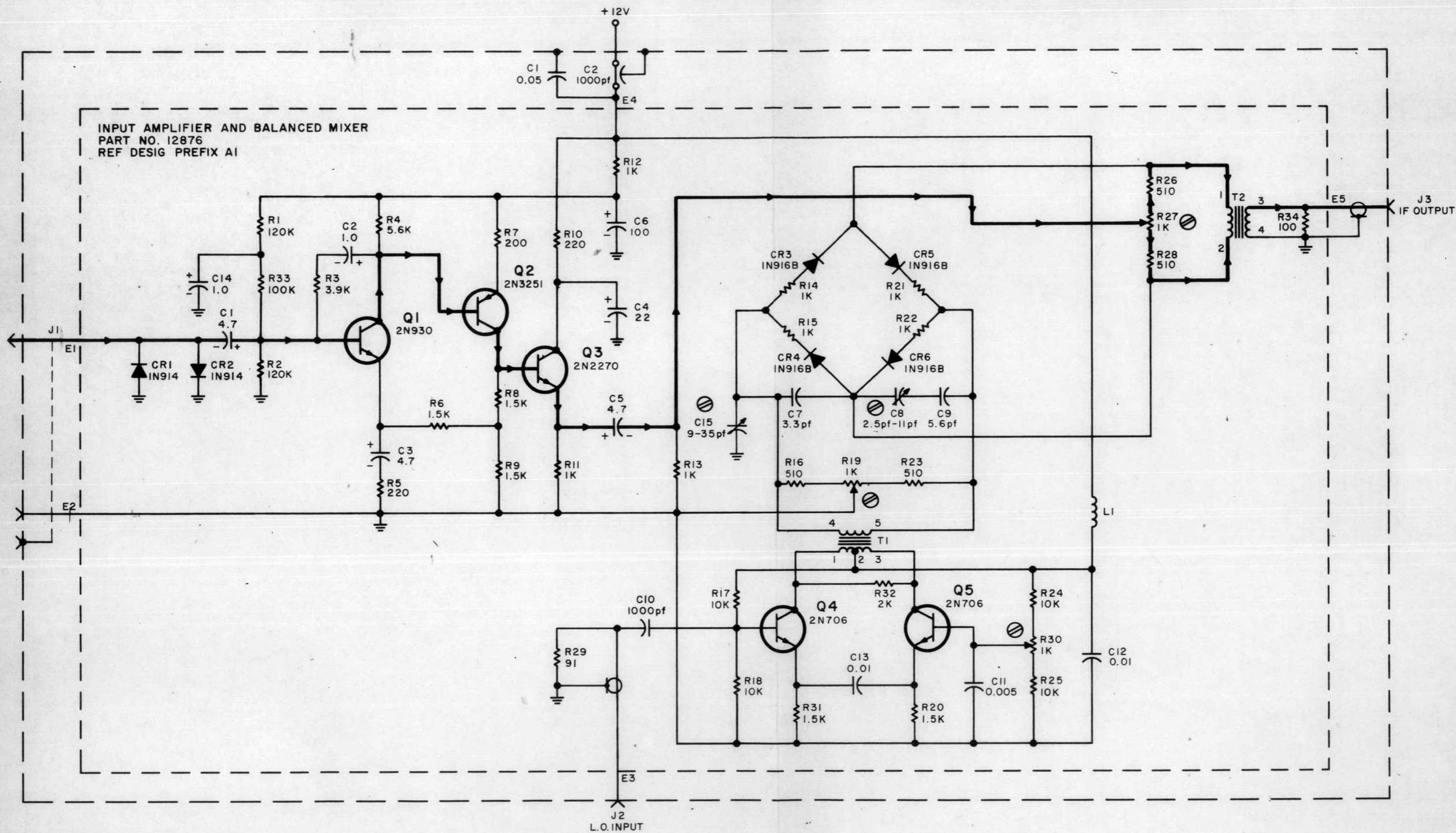


SYMBOL NO.	DESCRIPTION	UNITS PER ASS'Y	VENDOR PART NO.	VENDOR NAME
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 $\mu$ f, 10%, 35V	3	150D475X9035B2	56289
C2	CAPACITOR, ELECTROLYTIC, TANTALUM: 1 $\mu$ f, 10%, 35V	2	150D105X9035A2	56289
C3	Same as C1			
C4	CAPACITOR, ELECTROLYTIC, TANTALUM: 22 $\mu$ f, 10%, 35V	1	150D226X9035R2	56289
C5	Same as C1			
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 100 $\mu$ f, 20%, 20V	1	150D107X0020S2	56289
C7	CAPACITOR, CERAMIC, TUBULAR: 3.3 pf, $\pm$ .25 pf, 500V	1	301-000-COHO-339C	72982
C8	CAPACITOR, VARIABLE, CERAMIC, : 2.5 - 11 pf, 350V	1	538-002-90R	72982
C9	CAPACITOR, CERAMIC, TUBULAR: 5.6 pf, $\pm$ .5 pf, 500V	1	301-000-COHO-569D	72982
C10	CAPACITOR, CERAMIC, DISC: 1000 pf, GMV, 500V	1	SM	91418
C11	CAPACITOR, CERAMIC, DISC: .005 $\mu$ f, 20%, 500V	1	SM	91418
C12	CAPACITOR, CERAMIC, DISC: .01 $\mu$ f, 20%, 50V	2	19C214A6	56289
C13	Same as C12			
C14	Same as C2			
C15	CAPACITOR, VARIABLE, CERAMIC: 9-35 pf	1	538-002-E2P0-94R	72982
CR1	DIODE	2	1N914	07688
CR2	Same as CR1			
CR3	DIODE	4	1N916B	SYLVANIA PREFERRED
CR4	Same as CR3			
CR5	Same as CR3			
CR6	Same as CR3			

SYMBOL NO.	DESCRIPTION	UNITS PER ASS'Y	VENDOR PART NO.	VENDOR NAME
L1	COIL, FIXED: 120 $\mu$ h	1	1120-15	99848
Q1	TRANSISTOR	1	2N930	07688
Q2	TRANSISTOR	1	2N3251	07688
Q3	TRANSISTOR	1	2N2270	07688
Q4	TRANSISTOR	2	2N706	07688
Q5	Same as Q4			
R1	RESISTOR, FIXED, COMPOSITION: 120K, 5%, 1/4W	2	CB1245	01121
R2	Same as R1			
R3	RESISTOR, FIXED, COMPOSITION: 3.9K, 5%, 1/4W	1	CB3925	01121
R4	RESISTOR, FIXED, COMPOSITION: 5.6K, 5%, 1/4W	1	CB5625	01121
R5	RESISTOR, FIXED, COMPOSITION: 220 $\Omega$ , 5%, 1/4W	2	CB2215	01121
R6	RESISTOR, FIXED, COMPOSITION: 1.5K, 5%, 1/4W	5	CB1525	01121
R7	RESISTOR, FIXED, COMPOSITION: 200 $\Omega$ , 5%, 1/4W	1	CB2015	01121
R8	Same as R6			
R9	Same as R6			
R10	Same as R5			
R11	RESISTOR, FIXED, COMPOSITION: 1K, 5%, 1/4W	7	CB1025	01121
R12	Same as R11			
R13	Same as R11			
R14	Same as R11			

SYMBOL NO.	DESCRIPTION	UNITS PER ASS'Y	VENDOR PART NO.	VENDOR NAME
R15	Same as R11			
R16	RESISTOR, FIXED, COMPOSITION: 510 $\Omega$ , 5%, 1/4W	4	CB5115	01121
R17	RESISTOR, FIXED, COMPOSITION: 10K, 5%, 1/4W	4	CB1035	01121
R18	Same as R17			
R19	RESISTOR, VARIABLE, WIREWOUND: 1K, 5%, 1W	3	CT-100	75042
R20	Same as R6			
R21	Same as R11			
R22	Same as R11			
R23	Same as R16			
R24	Same as R17			
R25	Same as R17			
R26	Same as R16			
R27	Same as R19			
R28	Same as R16			
R29	RESISTOR, FIXED, COMPOSITION: 91 $\Omega$ , 5%, 1/4W	1	CB9105	01121
R30	Same as R19			
R31	Same as R6			
R32	RESISTOR, FIXED, COMPOSITION: 2K, 5%, 1/4W	1	CB2025	01121
R33	RESISTOR, FIXED, COMPOSITION: 100K, 5%, 1/4W	1	CB1045	01121
R34	RESISTOR, FIXED, COMPOSITION: 100 $\Omega$ , 5%, 1/4W	1	CB1015	01121
T1	TRANSFORMER	1	30312-37	14632
T2	TRANSFORMER	1	30312-38	14632





- NOTES:
- UNLESS OTHERWISE SPECIFIED:
    - RESISTANCE IS MEASURED IN OHMS,  $\pm 5\%$ , 1/4W
    - CAPACITANCE IS MEASURED IN  $\mu f$
  - ⊗ INDICATES SCREWDRIVER ADJUSTMENT
  - HEAVY LINE INDICATES MAIN SIGNAL PATH.

Figure 6-3. Type 79124 Input Amplifier and Balanced Mixer, Schematic Diagram