INSTRUCTION MANUAL

for WR-250 Series

WIDE RANGE RECEIVERS

Micro-Tel Corporation

INSTRUCTION MANUAL

for WR-250 Series

WIDE RANGE RECEIVERS

MICRO-TEL CORPORATION

1406 Shoemaker Road

Baltimore, Maryland 21209

Jan. 1969

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS

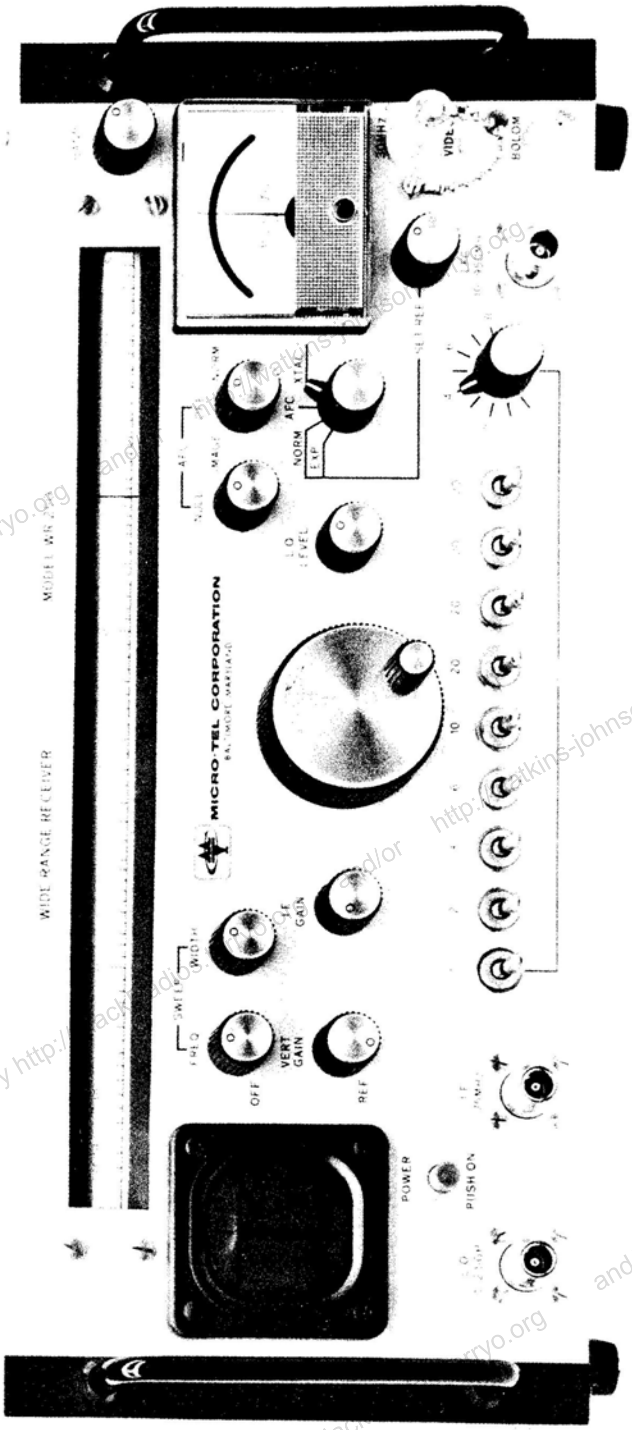

WIDE RANGE RECEIVER
MICRO-TEL CORPORATION
POWER
PUSH ON
OFF
VERT GAIN
REF
FREQ
SWEEP
WIDTH
IF GAIN
AFC
NORM
EXP
XTAL
VIDEO
BOLOM

Figure 1.1

1.0 GENERAL DESCRIPTION

The Model WR-250 Wide Range Receiver is a versatile laboratory instrument designed for antenna pattern ranges, attenuation measurements, spectrum surveillance, and general laboratory use. It is a highly linear receiver which features a square law bolometer output, an audio-video crystal detector, IF output, internal attenuator, and reference channel for slideback measurements. The receiver covers the frequency range of 7.5 MHz to above 100 GHz, with a slide-rule dial directly calibrated to 22.5 GHz.

All major components are contained in a single case as shown in Figure 1.1. It is a fully solid state receiver except for the cathode ray tuning indicator and the first local oscillator.

At frequencies above 950 MHz a signal combiner and remote mixer permit the use of a single coaxial cable between the receiver and antenna with reduced loss of sensitivity since the cable carries the first local oscillator signal up to the mixer and the first intermediate frequency returns through the cable to the receiver.

The received signal may be CW, pulse or square-wave modulated. An internal modulator provides the 1000 Hz output signal required for antenna pattern recorder use. The bolometer output is linear over a 40 decibel range, and the receiver may be operated over a 100 decibel range as a slideback device with continuous readout of attenuation. Mechanical and electronic automatic frequency control permits the reception of CW signals from simple signal sources. Frequency preselection is not required below 950 MHz because of the conversion method. Automatically tracked preselection is available from 1 to 12.4 GHz as an option.

1.1 PRINCIPLES OF OPERATION

Refer to the block diagram Figure 1.2. For convenience, assume the presence of a 75 MHz signal at the input to the Step Attenuator. Operation of the First Local Oscillator, mixer, and Low Frequency Converter will be covered later.

The Step Attenuator is a step unit which may be adjusted to attenuate the input signal to the 75 MHz Preamplifier over a range of 102 db in 1 db steps. In addition, the 0-1 db attenuator control provides finer adjustment, but it actually controls the gain of the IF Amplifier. The Preamplifier has a bandwidth of 5 MHz and is extremely flat over at least 2 MHz. The flatness is required so that AFC corrections will not cause a change in the amplitude response of the amplifier. The output of the 75 MHz Preamplifier is fed to the Second Mixer.

The Swept Oscillator provides a heterodyne signal to the second mixer. It may be operated CW or in a swept mode. The CW mode is selected when the receiver is used for the detection of pulse signals. For the reception of CW signals, the oscillator is swept about its center frequency at a 1000 Hz rate, adjustable

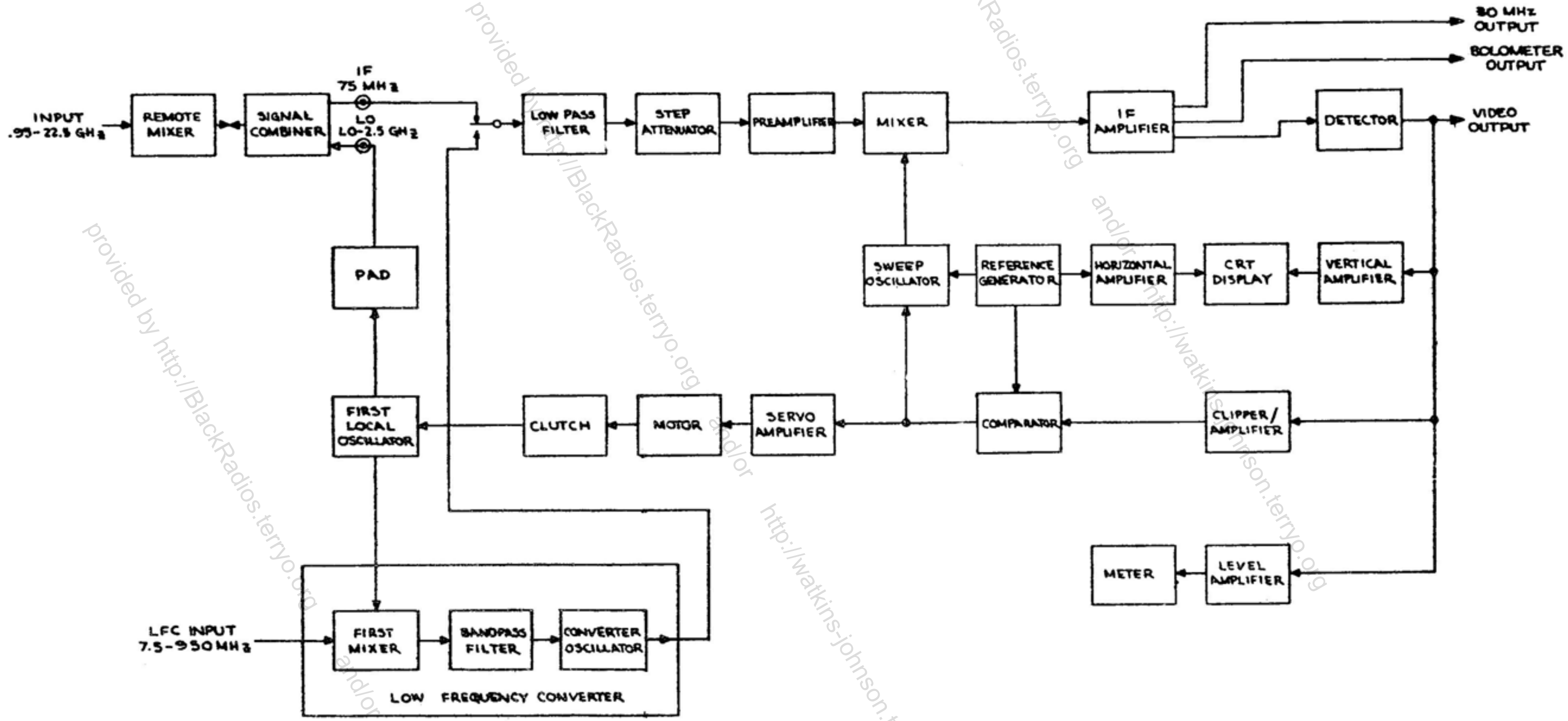


FIGURE 1.2
BLOCK DIAGRAM
RECEIVER AND LOW FREQUENCY CONVERTER

plus and minus 5 percent. The Swept Oscillator operates at a center frequency of 105 MHz and may be swept up to ±2 MHz. The oscillator mode is selected by a control on the front panel. Wide sweep is used for convenience in tuning to display the maximum frequency spectrum on the Scope Display. Narrowed sweep insures the maximum transfer of useable energy through the receiver to the VSWR Amplifier or Antenna Pattern Recorder.

The second mixer output, sweeping about a center frequency of 30 MHz, produces a 1000 cycle AM signal at the output of the linear 30 MHz IF amplifier. The amplitude of this signal is precisely proportional to the incoming signal level over a 40 db dynamic range.

Three output signals are derived from the IF Amplifier. One is connected to a square law detector (bolometer) and the bolometer output is available at the front panel for direct connection to a VSWR Amplifier, Antenna Pattern Recorder, or other device calibrated for use with square law detectors.

The second output is connected to a crystal diode, and the detected envelope is displayed on the front panel cathode ray tube and also used for the AFC and level signal. This output is marked VIDEO on the front panel. The Scope Display shows frequency versus amplitude with the horizontal axis representing up to 4 MHz depending on the position of the sweep control.

The third output is a sample of the 30 MHz IF and is also available on the front panel. It has a bandwidth of 5 MHz and may be used to drive a noise meter or crystal detector. With the latter, the WR-250 becomes a broadband receiver for observing pulses.

For AFC, a sample of the diode detector output is filtered, amplified, and applied to a phase comparator. The reference generator, which provides the sweep to the Swept Oscillator, also supplies a reference square wave to the phase comparator. A shift in phase balance between these two signals is interpreted as a shift in the incoming 75 MHz signal. The output of the phase comparator shifts the center frequency of the Swept Oscillator electronically to keep the incoming signal in the center of the receiver passband. The phase comparator output is further amplified and applied to a servo motor which mechanically repositions the first local oscillator to compensate for large frequency shifts in the received signal.

For operation at frequencies above 950 MHz, the output of the First Local Oscillator is normally passed to a signal combiner which isolates the local oscillator frequency and the intermediate frequency. Oscillator energy is passed along the coaxial cable to the remote mixer. Fundamental or harmonics of the oscillator heterodyne the incoming RF signal to generate a 75 MHz signal which is returned to the combiner on the same cable.

The combiner mounts directly to the LO and IF connectors on the receiver front panel. A three-port mixer may be used by connecting its IF and LO ports to these same connectors.

For operation between 7.5 and 950 MHz, a third local oscillator is introduced as shown on the block diagram. Mixing in this frequency range is performed internally within the receiver. The First Local Oscillator is tuned from 1007.5 to 1950 MHz to generate a 1000 MHz heterodyne with an incoming signal from 7.5 to 950 MHz. The 1000 MHz signal is passed through a steep-sided Bandpass Filter to another mixer for heterodyning with the fixed 925 MHz Converter Oscillator. The resulting 75 MHz heterodyne is fed to the Preamplifier.

1.2 EQUIPMENT

All of the WR-250 series receivers are supplied with a coaxial mixer and signal combiner. Both may be mounted at any distance up to 100 feet from the receiver. This mixer is used only above 950 MHz (refer to Section 3.2) and is rated for operation from 950 MHz to 15 GHz.

For short distances between the receiver and the signal source, RG-9B/U coaxial cable (not supplied) may be used between the receiver and the combiner or between the combiner and the mixer. Where increased sensitivity is required or where longer cable runs are necessary, the coaxial cable should be a low-loss type. At higher frequencies, waveguide mixers are recommended.

1.3 OPTIONS

The WR-250 Receiver is normally supplied with a Low Frequency Converter as shown in the block diagram Figure 1.2. Where coverage below 950 MHz is not required, the receiver may be supplied without the Low Frequency Converter. Other options are described below.

1.3.1 SOURCE LEVEL COMPENSATOR

When amplitude-unstable signal sources are to be employed, the use of the Model SLC-250 Source Level Compensator is recommended. This accessory samples the amplitude of the signal source and varies the gain of the receiver to compensate for changes in the source amplitude. The sample of the transmitter signal must be at a level greater than -35 dbm at the input to the Source Level Compensator.

1.3.2 PRESELECTION

A significant amount of preselection is inherent in the receiver below 950 MHz because of the method of heterodyning. Above 950 MHz preselection is not normally required, or may be added externally. However, a wide selection of internal, tracked preselectors is available. These use YIG filters which may be supplied in octave bandwidths up to 12.4 GHz, or a single unit is available covering 1 to 12.4 GHz.

1.4 SPECIFICATIONS

Frequency Range:	950 MHz to above 60 GHz
Input:	CW, Pulse, Squarewave -15 dbm maximum
Dial:	Direct Reading 950 MHz to 22.5 GHz Accuracy ±1%

Bandwidth:	300 KHz and 5 MHz
Output:	Bolometer, Xtal (Video) and IF
Dynamic Range:	Bolometer linear to ±0.25 db over 40 db range
IF Attenuation:	102 db in 1 db steps plus 0-1 db continuous
	Accuracy ±0.10 db per step
Reference Level Meter:	±10 db and ±0.5 db full scale, zero-center
AFC:	Electronic over 4 MHz range Mechanical - continuous Operable to 10 db above noise ±2 volt control signal for external use.
Size:	19" x 7" x 12" Rack Mount 17" x 7" x 12" Case
Weight:	24 pounds
Power:	117 Volts, 50-400 Hz, 35 watts

1.4.1 SENSITIVITY

The basic system, without the external mixer, consists of a low-noise 75 MHz receiver and a tuneable oscillator. The oscillator covers the frequency range of 1000 to 2575 MHz and provides a power output of at least 500 milliwatts at the LO connector on the front panel (with the internal oscillator attenuator removed). The receiver has an equivalent noise input of -120 dbm at 75 MHz.

Sensitivity:	.95 to 2.5 GHz	-110 dbm min.
	2.5 to 10 GHz	-85 to -105 dbm min.

These sensitivity figures are for the untuned coaxial mixer supplied with the receiver. Significant improvement will be realized by use of a double stub tuner, by tuned waveguide mixers, or by a 3-port mixer. Sensitivities of -105 dbm may be attained at X-band by optimum choice of mixer components. Sensitivities continue to decrease above 10 GHz because of the harmonic mixing technique employed; sensitivities of -60 dbm at 70 GHz may be expected. By employing backward wave oscillators up to 40 GHz (with AFC supplied by the receiver) sensitivities of -105 dbm are attainable.

1.4.2 LOW FREQUENCY CONVERTER

Frequency Range:	7.5 to 950 MHz
Dial:	Direct Reading
Sensitivity:	-90 dbm minimum from 10 to 950 MHz -105 dbm with optional amplifier Usable to 7.5 MHz.

1.4.3 SOURCE LEVEL COMPENSATOR

Input:	-35 dbm minimum
Control Range:	±2 db
Correction:	Within 0.5 db

1.5 FUSE

The power line is protected by a 1-ampere type 3AG fuse which is located on the rear panel of the receiver.

1.6 VACUUM TUBES

The receiver uses only two vacuum tubes. A type 2AP1-A cathode ray tube is the display, and a planar triode is used in the First Local Oscillator.

2.0 INSTALLATION

The receiver should be unpacked and visually inspected for any damage during shipment. Locate the signal combiner, the remote mixer, and printed circuit extender board. Next remove the top and bottom receiver covers and inspect for loose components. Push all printed circuit cards firmly down into their connectors. Check all coaxial connectors to ensure that they are firmly mated.

The receiver may be mounted in any convenient position or attitude, and no consideration need be given to cooling unless it is operating in a high ambient temperature or is placed next to equipment which radiates excessive heat.

Connect the receiver to a 3-wire grounded 117 volt, 50/400 Hz power source. Current drain is well below one ampere so any conventional power cable or connectors are suitable. If the receiver has not been exposed to a large change in ambient temperature, it will be ready for operation in a few minutes.

For operation below 950 MHz, connect the signal source to be measured directly to the Type N connector on the front panel marked LFC. For operation above 950 MHz, a remote mixer should be used. If the two-port mixer is to be used, connect the signal combiner to the receiver, either directly mounted to the LO and IF or connected through cables. Then connect the combiner to the mixer. The female type N connector on the mixer connects to the fitting marked MIXER on the combiner. If a three-port mixer is used, the combiner is not; instead its LO and IF mixer ports are connected to the corresponding receiver outputs. Use RG-9B/U coaxial cable for short distances; for distances in excess of 75-100 feet, use 50 ohm cable with lower loss, such as styrofoam.

3.0 OPERATION

WR-250 Series Receivers are available with numerous optional features and accessories. This section describes the Model WR-250-1 which contains the Low Frequency Converter and operates from 7.5 MHz to above 60 GHz. It performs the following basic measurement functions:

Antenna Pattern Recording

Attenuation Measurement

Pulse Detection and Measurement

The Model WR-250-1 operates in two different frequency domains; i.e., 7.5 MHz to 950 MHz, and 950 MHz to above 60 GHz. All of the above basic measurement functions can be performed in both frequency domains.

3.1 TURN-ON

Connect the receiver to a source of 115 volt 50/400 Hz power.

Set each control as follows:

SWEEP FREQ	Centered
SWEEP WIDTH	NARrow
SCOPE GAIN	Centered
I.F. GAIN	Clockwise
AFC NULL	Centered
AFC	Off
LEVEL SET	Centered
LO LEVEL	Counterclockwise
METER SWITCH	Xtal
BAND	Desired Frequency Range
STEP ATTENUATOR	0 db

Push the power switch to on and, after about 30 seconds, observe a horizontal trace on the cathode ray tube. A small amount of noise may be observed on the trace. Always connect the 50 ohm termination to the 30 MHz output if it is not loaded externally.

3.2 ADJUSTMENT FOR FREQUENCY DOMAIN

3.2.1 7.5 MHz to 950 MHz

Turn the BAND knob so that this frequency band appears in the dial window. Observe crystal current on the front panel meter. In low band operation, this meter reads crystal current as generated by the fixed local oscillator. Its level is determined by an internal factory adjustment and is not controlled by the front panel LO LEVEL control.

Connect a source of CW energy to the front panel connector marked LFC. Use RG-9A/U or other low-loss 50 ohm cable. Do not use an external mixer. In low band operation, the first mixer is internal to the receiver. Adjust the Main Tuning control until the pip representing the desired incoming signal is centered on the cathode ray tube.

3.2.2 950 MHz to above 100 GHz

Turn the BAND knob so that the appropriate band appears in the dial window. If operation above 22.5 GHz (the highest band displayed) is desired, select the lowest convenient submultiple of the operating frequency. For example, if operation at 40 GHz is desired, use a submultiplier of two and set the tuning dial to 20 GHz; for 70 GHz, use 4 and set the dial to 17 GHz.

For operation between 950 MHz and 15 GHz, use the frequency combiner and coaxial mixer supplied with the receivers. Consult the factory for waveguide mixers at frequencies to 90 GHz. Connect the combiner directly to the receiver or via a length of RG-9/U cable. Then connect the mixer to the combiner. The total cable length may be as long as 300 feet although, at extreme lengths, it may not be possible to read mixer crystal current. Inability to read crystal current at the receiver does not infer that mixing action will not take place. Since the mixer presents a severe mismatch to the coaxial cable, varying the length of the cable slightly may markedly change the indicated crystal current.

Set the tuning dial to the approximate frequency to be measured and adjust LO LEVEL for approximately 1 ma. of crystal current (or use maximum LO LEVEL if necessary). This is not a critical adjustment.

Now adjust the tuning dial so that the incoming CW signal is centered on the cathode ray tube. Adjust the SWEEP frequency control and LO LEVEL for maximum output on the VSWR meter or recorder.

3.3 AUTOMATIC FREQUENCY CONTROL

This section assumes that a CW signal has been tuned in and that it is properly centered on the cathode ray tube with the LO LEVEL adjusted for maximum output.

Turn the AFC switch from OFF to NORMAL and the meter switch to AFC. Remove or lower the signal to at least -120 dbm, adjust the NULL control for 0 reading on meter. (NOTE: Another setting of the SWEEP FREQ, LO LEVEL, or IF GAIN controls may require resetting of the NULL control as above.) Check the operation of the AFC by very slightly shifting the incoming signal. The main tuning knob should automatically retune to keep the pip and the meter centered. For frequencies above 950 MHz, the receiver does not discriminate between upper and lower image. However, the tuning dial is arbitrarily calibrated on the upper image for which the AFC switch should be set to NORMAL. If for some reason operation on the lower image is desired, this will be found 150 MHz lower in frequency (above 950 MHz only) and the AFC switch should be set to IMAGE.

IN LOW BAND operation (below 950 MHz), the receiver does discriminate against the image frequency and the AFC switch should always be set to NORMAL.

The mechanical AFC is designed to correct only for slow drift of the signal source and it will do this over extremely wide excursions.

3.4 ANTENNA PATTERN MEASUREMENTS

This section assumes that the desired signal is properly tuned, the AFC is now operative, and the maximum signal is being received; i.e., the test and source antenna are pointing directly at each other.

Set the gain control to REF. and adjust the IF GAIN so that the response curve on the cathode ray tube fills the space between the two scribed horizontal lines. If necessary to achieve this condition, switch in the Step Attenuator.

CAUTION: Consideration should be given to the signal level at the mixer input. The mixer can be expected to be highly linear from approximately -15 dbm to the noise level of the receiver which occurs between -85 and -105 dbm depending on frequency. Therefore, the incoming signal should always be less than -15 dbm at the mixer.

Connect the antenna pattern recorder input to the BOLOMETER output of the receiver.

CAUTION: Observe the usual precautions when connecting and disconnecting to the bolometer. The recorder bolometer bias supply should always be turned off when making or breaking the connection.

Adjust the bias supply in the recorder for 8.75 ma. Adjust the SWEEP FREQ. control for maximum deflection of the recorder pen. Receiver and recorder linearity may be checked by inserting attenuation in the receiver.

The receiver is now ready to record over a 40 db dynamic range. Greater dynamic ranges may be recorded by IF substitution but the saturation level of the mixer should be observed.

3.5 ATTENUATOR CALIBRATION

In this mode of operation, the receiver functions as an IF substitution device and is limited only by the saturation level of the mixer, receiver noise level, and accuracy of the Step Attenuator supplied in the receiver. Where greater accuracy is desired, other types of attenuators are available. Contact the factory for details.

Apply a CW signal whose level is not greater than -20 dbm to the mixer. Turn the meter selector switch to LEVEL. By a combination of IF GAIN, LEVEL SET and the attenuator, set the meter to zero. Note the amount of attenuation inserted includ- the 0-1 db control. Now insert the attenuator to be measured between the mixer and signal source. Note the usual precautions involved in attenuation measurement; i.e., mismatch and the necessity for padding.

Readjust the Step Attenuator and 0-1 db control to again establish zero on the meter. The difference between the first and second setting of attenuation represents the value of the unknown attenuator provided the precautions concerning mixer saturation and VSWR error have been taken.

3.6 MODULATED SIGNALS

The receiver will operate properly with most modulated signals. However, the SWEEP FREQ control should be adjusted to ensure that a zero beat does not occur between the external modulating frequency and the internal sweep. Turn off the internal sweep if the incoming signal is modulated at exactly 1000 Hz.

3.7 PULSE OPERATION

The VIDEO channel bandwidth is approximately 300 KHz. This will pass pulses of 5 microseconds width or greater with reasonable fidelity. The IF output bandwidth is approximately 5 MHz. For reception of pulses with widths down to about 0.2 microseconds connect an external crystal detector to the front panel 30 MHz output. The SWEEP WIDTH control should be turned to the OFF position and an appropriate oscilloscope connected to the VIDEO output on the front panel or the external 30 MHz detector. Care should be taken to tune the receiver exactly to the frequency of the RF pulse.

AFC is not available in this mode of operation. However, an option is available, and the factory should be contacted for details.

3.8 EXTERNAL FIRST LOCAL OSCILLATOR

The receiver may be used with an external first local oscillator and will operate with any oscillator-mixer combination having an output frequency of 75 MHz. No modifications to the receiver are necessary, and the mixer output is connected directly to the IF connector on the front panel. An AFC signal is available at the rear panel. It swings approximately plus and minus 2 volts, and may be used to control the external oscillator.

3.9 CONTROLS

SWEEP FREQUENCY: Adjusts the sweep frequency of the second local oscillator over a range of approximately plus and minus 5 percent about the nominal center frequency of 1000 Hz. When an antenna pattern recorder or VSWR meter is used, adjust for maximum deflection; this sets the receiver sweep frequency to the center frequency of the recorder or meter.

SWEEP WIDTH: Varies the dispersion of the second local oscillator sweep. Wide dispersion aids tuning when viewing the CRT display. Narrow sweep gives maximum deflection of the pattern recorder, VSWR meter, or the integral level meter. In the OFF position, the sweep is disabled, and the incoming signal is not internally modulated at 1000 Hz.

VERTICAL GAIN: Sets the gain of the vertical scope amplifier. When searching for a signal, this control should be set fully clockwise for maximum gain. As the signal level increases, it may be backed off to limit the CRT display height. When this control is fully counter-clockwise and switched to the REFerence position, the scope gain is set to a fixed value. At this setting, when the display on the CRT face just fills the height between the scribed lines, the output to the bolometer is at the maximum level below bolometer saturation. If the signal input level is greater, it must be reduced by the IF GAIN control or step attenuator.

IF GAIN: Controls the gain of the receiver IF strip. Normally this control is set fully clockwise but it may be used, along with the step attenuator, to reduce the receiver output level. In no case should the input to the mixer exceed -15 dbm.

AFC IMAGE - OFF - NORMAL: In the OFF position the receiver AFC is disabled. In NORMal, the mechanical and electronic AFC operates correctly for the low frequency band of 7.5 to 950 MHz and in all higher bands when the receiver is tuned to the correct frequency and not the image. Above 950 MHz the receiver may receive on the image frequency by tuning 150 MHz below the correct dial frequency. When tuned to an image, the AFC sense is incorrect and therefore the AFC is unstable unless this switch is set to IMAGE.

AFC NULL: Balances residual noise in the AFC circuit so that the tuning motor will not drive in either direction when there is no signal. With no signal input this control is adjusted for zero deflection of the meter (with the meter switch set to AFC), or to stop the motor

<u>LO LEVEL</u>: Varies the power output of the first local oscillator. Adjust for best mixer gain by observing the signal level on the CRT or output device. This control is out of the circuit on the low-band of 7.5 to 950 MHz.

<u>METER SWITCH</u>: Selects the meter function. XTAL indicates crystal current of the external mixer only and is not used in the low-band of 7.5 to 950 MHz. AFC indicates error signal in the automatic frequency control servo loop. In NORMal, the meter connects to the internal level amplifier and has a full scale range of about 20 db; in the EXPand position, the sensitivity is increased to approximately 5 db full scale.

<u>SET REFERENCE</u>: Multi-turn control to adjust the gain of the internal level amplifier. Use this control to zero the meter when the receiver is used as a slideback power meter.

<u>ATTENUATOR</u>: The step attenuator is placed between the mixer and the preamplifier, and reduces the signal level to the latter in 1 db steps. Finer resolution is available by the continuous 1 db control; this 1 db control varies IF gain. The attenuators permit the receiver to be used as an accurate, convenient slide back power meter, and also prevent overload of the preamplifier. The input to the mixer must never exceed -15 dbm.

4.0 THEORY OF OPERATION

This section explains in detail the circuits and components of the Wide Range Receiver. Reference should be made to the corresponding schematics contained in Section 7 when reading the following sections. It is recommended that the functional description and principles of operation contained in Section 1.1 be read beforehand.

4.1 SIGNAL COMBINER

The Signal Combiner permits the use of a two-port remote mixer which can be connected to the receiver by a single coaxial cable. The combiner is a three-port device which directs the First Local Oscillator energy up to the mixer, and directs the returned heterodyned signal to the preamplifier.

The local oscillator energy passes from the LO input to the mixer because a built-in capacity offers a low impedance at the relatively high frequency (1-2.5 GHz). A series inductor attenuates the oscillator energy entering the IF connector. The heterodyne output from the remote mixer is 75 MHz. At this comparatively low frequency, the inductor is a low impedance, so the 75 MHz entering the mixer connector is directed to the IF and isolated from the LO port.

4.2 FIRST LOCAL OSCILLATOR

The first Local Oscillator is tuneable over the range of 1025 to 2575 MHz, and consists of a planar triode tuned by two concentric coaxial type cavities. The oscillator output, and therefore crystal current, is varied by mechanical adjustment of the oscillator output probe. The LO LEVEL control thus varies the output by approximately 20 db.

4.3 OSCILLATOR ATTENUATOR

A 3 db fixed attenuator pads the oscillator output. If additional oscillator power is required for long cable lengths, this attenuator may be removed. The cable length then supplies the necessary padding.

4.4 CRYSTAL MONITOR

The Crystal Monitor provides the direct current path for the crystal in the remote mixer, and the means for metering crystal current for presentation on the front panel meter. The monitor is packaged with the Low Pass Filter, and is itself a low pass filter which passes only direct current.

4.5 LOW PASS FILTER

The Low Pass Filter is a lumped constant device with a cutoff frequency in the vicinity of 90 MHz. Its purpose is to eliminate any possible overloading of the IF amplifier by the local oscillator.

4.6 STEP ATTENUATOR

The Step Attenuator is a conventional ladder-type resistive network with toggle switch selection. It provides a total attenuation of 102 db in 1 db steps.

4.7 PREAMPLIFIER

The Preamplifier, Swept Oscillator and IF Amplifier are packaged as a single unit. The 75 MHz output of the first mixer is amplified and converted to the second intermediate frequency of 30 MHz for further amplification. The swept oscillator is the second local oscillator. When swept by the reference generator, this oscillator converts the incoming signal into a swept signal at the second intermediate frequency and, due to the IF Amplifier selectivity, amplitude modulates an incoming CW signal at the sweep frequency (1000 Hz).

The input stages Q901 and Q902 accept the 75 MHz signal output from the first mixer and frequency combiner. They are connected as a low-noise cascode amplifier. Q901 is low-noise transistor and its base is impedance-matched to a 50 ohm input. A potentiometer across the collector circuit of Q902 is the RF Gain Control. The next stage, Q903, is a common emitter transistor amplifier. Field effect transistor Q904, connected across the unbypassed emitter resistor, provides electronic gain control of this stage. The preamplifier output, across the collector of Q903, connects to the mixer Q905. This mixer is a dual gate field effect transistor with the signal introduced on one gate and the second local oscillator energy driving the second gate.

4.8 SWEPT OSCILLATOR

The Swept Oscillator Q905 (second local oscillator) is a Colpitts circuit with a grounded base. A varactor is connected across the oscillator resonant circuit. This varactor is AC coupled to the output of the Reference Generator and is therefore swept at 1000 Hz. Automatic frequency control is obtained by DC coupling of the varactor to the output of the AFC Comparator.

4.9 IF AMPLIFIER

The mixer output is divided into two paths. One drives the base of common emitter amplifier Q907, which is followed by a similar amplifier, Q908. These two common emitter amplifiers are broadband and provide the 50 ohm front panel output at 30 MHz.

The second output from the mixer is capacitively coupled to common emitter amplifier Q909. Its collector is coupled to the following stage (Q910) through a narrow band double-tuned transformer. This transformer sets the IF bandwidth for the bolometer output and video output at approximately 300 KHz. Transistors Q910, Q912, and Q913 amplify the signal to a suitable level for the bolometer element. Field effect transistor Q911 is connected across the collector of Q910 and may be connected to a source level compensator or other circuits to change the overall gain in the bolometer circuit. Q914 is tapped across the collector of Q913 through a resistive isolator and further amplifies the IF signal to drive Q915 and the internal crystal video detector.

4.10 AFC

The receiver has both electronic and mechanical automatic frequency control. The electronic AFC is applied to the second local oscillator (Swept Oscillator) and compensates for fast small changes in center frequency. The mechanical AFC drives the tuning shaft of the First Local Oscillator through the AFC clutch and will follow slow drifts of the signal source over the entire dial range.

4.10.1 REFERENCE GENERATOR

The Reference Generator located on printed circuit board 2 generates the 1000 Hz sawtooth and square wave signal which (1) drives the Swept Oscillator (2) supplies the reference signal to the AFC Comparator and (3) is amplified to form the horizontal trace on the cathode ray tube display.

The 1000 Hz sawtooth waveform is generated by the unijunction transistor Q201. The capacitor C203 and C204 charge through resistances R7, R202, R203, and R204 until the emitter voltage reaches its peak point voltage and discharges the capacitors.

The frequency is dependent on the time constant of the resistors and capacitors in the emitter circuit. R202 is a coarse frequency adjustment which compensates for circuit tolerances, and R7 is the front panel SWEEP FREQ control. The components C201 and R205 increase the sweep linearity. The sawtooth waveform is fed to the base of amplifier Q202. The output to the Swept Oscillator is taken from the unbypassed emitter resistors of this stage through the front panel SWEEP WIDTH switch and width adjustment potentiometer.

The emitter of Q202 also drives the horizontal amplifier of the Scope Display through the H. GAIN control R213 which is a screwdriver adjustment available on this board.

Output from the collector of Q202 drives the flip-flop Q203-Q204. The common charging capacitor C206 maintains a symmetrical square wave output as the frequency is varied. The output taken from the collector of Q204 is the reference input to the AFC Comparator.

4.10.2 CLIPPER/AMPLIFIER

The Clipper/Amplifier amplifies, filters, and clips the video detector output, and supplies the signal which is compared with the AFC reference signal to generate the tuning error signal. The Clipper/Amplifier is located on the same printed circuit board as the AFC Comparator (board 3).

The base of the first amplifier stage Q301 is capacitively coupled to the detector output. This common emitter stage has a resonant collector circuit (the inductor L2 is located on the chassis) which reduces the noise bandwidth and thereby increases the output signal-to-noise ratio of the AFC subsystem.

The following three amplifier stages Q302, Q303, Q304 are essentially identical. Each is a common emitter amplifier with diode clipping in the input circuit. The output at the collector of Q304 is a clipped 1000 Hz square wave which is synchronously detected by the Comparator Q307. The output at the emitter of Q304 drives the AFC relay rectifier to actuate the clutch when the signal level is sufficient to produce an AFC signal.

4.10.3 COMPARATOR

The Comparator on board 3 is a chopper switch Q307 which is driven by the square wave from the Reference Amplifier. Transistor Q306 is an emitter follower which provides a low impedance driving source for the chopper. The synchronous detection produces a dc voltage at the base of Q305 which is proportional in amplitude to the phase difference between the 1000 Hz output of Q304 and the 1000 Hz output of the reference generator. The polarity of the dc signal depends on the polarity of the phase difference. The reference of "zero-error" voltage of the AFC is varied by the AFC NULL control on the front panel. This control varies the dc level at the collector of the chopper transistor Q307.

Transistor Q305 is a direct current emitter follower which drives the AFC Servo Amplifier and supplies the DC bias for center frequency correction of the Swept Oscillator. The emitter resistor of Q305 is returned to the negative 15 volt supply.

4.10.4 SERVO AMPLIFIER

The Servo Amplifier is located on board 4. It increases the DC output of the Comparator to a power level sufficient to drive the direct current motor which tunes the First Local Oscillator. Direction of motor rotation is determined by the polarity of the DC input voltage, and may be reversed by changing the AFC switch from NORMal to IMAGE or vice versa. See Section 3.3. The rectifier and voltage regulator for the Servo Amplifier are described in Section 4.13.4.

The DC input drives the base of Q408 which is connected with Q409 to form a differential amplifier having a balanced output. The common emitter resistor is returned to the negative 15 volt supply. Potentiometer R428 is the balance control. The balanced output is DC coupled to emitter followers Q410 and Q412 which, in turn, are DC coupled to the power amplifier Q411 and Q413. The motor is connected between the emitters of the power amplifier, in series with the polarity reversing switch functions.

4.10.5 CLUTCH

The 1000 Hz output from the AFC Clipper/Amplifier is amplified by transistor Q403 and rectified by diode D402. The DC output is applied to Schmitt Trigger Q404 and Q405. The AFC threshold is set by control R412. When the input to Q404 rises above threshold, the output of Q405 goes positive, turning on transistor switch Q405-Q406 through zener diode D403 and energizes the clutch coil. Therefore, the cluth operates when the receiver input signal is sufficient to generate an adequate signal-to-noise ratio in the AFC channel. It completes the mechanical link between the motor and the First Local Oscillator tuning shaft. If the clutch did not disengage the motor when the signal level dropped, residual noise might detune the receiver, or drive the tuning shaft against the mechanical stops.

4.10.6 MOTOR

The motor is a DC current type, and direction of rotation is determined by the polarity of the voltage across its terminals. The overall sense of the AFC system is changed when the AFC switch is changed between NORMal and IMAGE. This is done by interchanging the input leads to the motor.

4.11 LEVEL AMPLIFIER

The LEVEL Amplifier amplifies the 1000 Hz output of the crystal detector to drive the reference level meter. It operates only when the meter switch is set to NORMal and EXPand. The amplified signal is rectified and compared against a predetermined DC level, using a differential amplifier to drive the zero center meter.

The front panel SET REFerence control R14 is connected across the output of the video detector. The arm of the gain control drives the base of Q601 which is a common emitter amplifier. The collector load is a resonant circuit, L2 (on main chassis), and C602, which is tuned to 1000 Hz and establishes a narrow noise bandwidth for the amplifier. Q601 is directly coupled to the next stage Q602 which is an emitter follower, and, therefore, presents a minimum load on the resonant circuit. The DC negative feedback from the emitter of Q602 to the base of Q601 provides bias stabilization. The overall gain of the level amplifier in the EXPand mode is adjusted by R611 in the emitter circuit of Q602. The gain is decreased in the NORMal mode by switching resistor R610 in parallel with R611. The output tap on R611 drives the voltage amplifier Q603 which is stabilized by feedback resistor R614. The output of Q603 drives a class B power amplifier consisting of Q604, Q605, Q606 and Q607. Under no-signal conditions, both Q606 and Q607 are cut off. The voltage gain from the base of Q604 to output (emitters of Q606 and Q607) is approximately unity, maintained by infinite feedback through capacitor C609. As the base of Q604 goes positive so does the output, charging capacitor C610 to the peak positive voltage. The capacitor is charged through Q606 but must be discharged through Q607 on the negative swing of the input voltage. During the negative swing, the charge placed in C610 during the positive cycle is transferred to the capacitor C611; through Q607 this charge current flows out through limiting network to the level meter. The class B amplifier functions as a power rectifier. Diode D603 limits the maximum meter current for overload protection. The zero center meter is initially deflected to the left by current through resistors R632 and R634 in EXPand. This current is reduced by grounding resistor R633 to bring the no-signal needle position on scale slightly for measuring small signal levels in NORMal.

In EXPand the amplifier gain is increased (ungrounding shunt signal path through R610), and the current through the meter increases. The current is shunted away from the meter in EXPand by constant current sink Q608, to balance the meter when switching between NORMal and EXPand, when the meter is "zeroed." Control R630 adjusts this balance through temperature compensating coupling transistor Q609.

4.12 SCOPE DISPLAY

The Scope Display circuits present a cathode ray tube presentation of the received signal. The horizontal trace is swept by the sweep voltage applied to the Swept Oscillator, and the vertical trace is the amplified video detector output. In the presence of a CW signal, the scope pattern is the receiver response function. The height is proportional to receive signal strength and may be changed by the IF Gain control, the scope gain control, or the Step Attenuator. The incoming signal is centered in the passband when the display is centered on the cathode ray tube. The width of the displayed response function decreases as the sweep width is increased.

4.12.1 HORIZONTAL AMPLIFIER

The horizontal amplifier of the scope display is located on board 2 with the AFC Reference Generator and the Sweep Generator. Its input is connected to the latter. The amplifier consists of two transistors, Q205 and Q206, connected as an emitter-coupled phase splitter which provides an amplified balanced output from the unbalanced input. The control R221 balances the push-pull output to the vertical plates of the cathode ray tube. The input is connected to the base of Q205 through R213, the H. GAIN control, a screwdriver adjustment located on board 2.

4.12.2 VERTICAL AMPLIFIER

The vertical amplifier is located on board 5.

The video detector output is connected to the base of the first vertical amplifier stage Q502 through the continuously variable control R10 (the screwdriver adjustment located on the rear of the front panel near the VERTical GAIN control) and the front panel VERTical GAIN control located just to the right of the bezel. The first two stages Q501, Q502 are common emitter amplifiers. Q501 and Q502 are directly coupled with dc feedback for bias stabilization. The output of Q502 is capacitively coupled to Q603, which combines with Q604 to form an emitter coupled phase splitter. The unbalanced input to Q603 is amplified and converted to a balanced output which drives the vertical plates of the cathode ray tube.

4.12.3 POWER SUPPLY

The low-level stages of the scope amplifiers are connected to the common +20 volt supply located on board 1. The positive scope power supply is also located on this board and provides the higher positive potentials needed by the cathode ray tube and the collectors of the transistors which drive the horizontal and vertical deflection plates. A separate high-voltage center-tapped winding on the power transformer connects to full-wave rectifiers D101 and D102. The capacitor C101 is the filter, and the output voltage is regulated at 250 volts nominal by the series-connected zener diodes D105-D108.

The power transformer T1 has a 6.3 volts winding for the cathode ray tube filament. This winding is at a high DC potential.

The high-voltage negative supply for the scope, along with the intensity and focus controls, is mounted directly behind the CRT socket. A separate high-voltage winding on the power transformer connects to half-wave rectifier D1 and input filter capacitors C2, C3 to give a negative voltage of 1000 volts nominal.

4.13 POWER SUPPLY

The Power Supply provides power to the entire receiver except for portions of the scope display circuits as noted in Section 4.12. The following outputs are available from the Power Supply:

6.3	VAC
-15	VDC
+20	VDC
+140	VDC
+250	VDC

The 6.3 VAC supply is a winding on the power transformer T1 and goes only to the filament of the tube in the First Local Oscillator.

In addition to this filament winding, the power transformer has two other secondary windings, one of which is center tapped and has two voltage ranges; this winding supplies all dc voltages except the +30 VDC for the Servo Amplifier.

4.13.1 NEGATIVE SUPPLY

The full wave rectifier, part of DA102, uses the low voltage taps of the center-tapped winding and is connected to the capacitor input filter C107 through the peak current limiting resistor R112. Zener diode D110 drops this voltage to drive the integrated circuit regulator QA102. The output from QA102 is set to -15 volts nominal by resistors R113, R114, and R115. Capacitor C108 provides additional filtering.

4.13.2 +20 VDC

The full wave rectifier, part of DA102, uses the low voltage taps of the center-tapped winding and is connected to the capacitor input filter C104 through the peak current limiting resistor R108.

The series transistor Q104 regulates the dc output voltage and further reduces the ripple. It is a conventional series regulator. Integrated circuit voltage regulator QA101 is connected across the supply output terminals. It compares the output to its internal reference, and amplifies the error signal and feeds it to the base of Q104 with the correct polarity to oppose the error. R109 sets the output current level at which overload protection occurs.

4.13.3 +140 VDC

The full wave rectifier DA101, DA102 uses the high voltage center-tapped winding of T1 and is connected to the capacitor input filter C1 located on the chassis. Series transistor Q101 regulates the dc output voltage. Zener diodes D103 and D104 reduce the ripple to the collector of Q103. Q103 is an error amplifier using the +20 volt supply as reference. Q103 amplifies the error signal and feeds it to the base of Q101 with the polarity to oppose the error. When the current through current limiting resistor R104 reaches the base-emitter potential of Q102, it conducts and reduces the base-emitter bias of Q101; this cuts off Q101 and prevents damage due to overload of this supply.

4.13.4 +30 VDC

The +30 volt supply is located on board 4 with the AFC Servo Amplifier. It powers the AFC drive motor and clutch. The full wave bridge rectifier DA1 is connected to a separate secondary winding on the power transformer. The rectifier output is connected to the capacitor input filter through the peak current limiting resistor R401. Transistor Q401 is a series regulator and further reduces the ripple. Zener diode D401 regulates the output voltage by maintaining the base of Q401 at a constant potential.

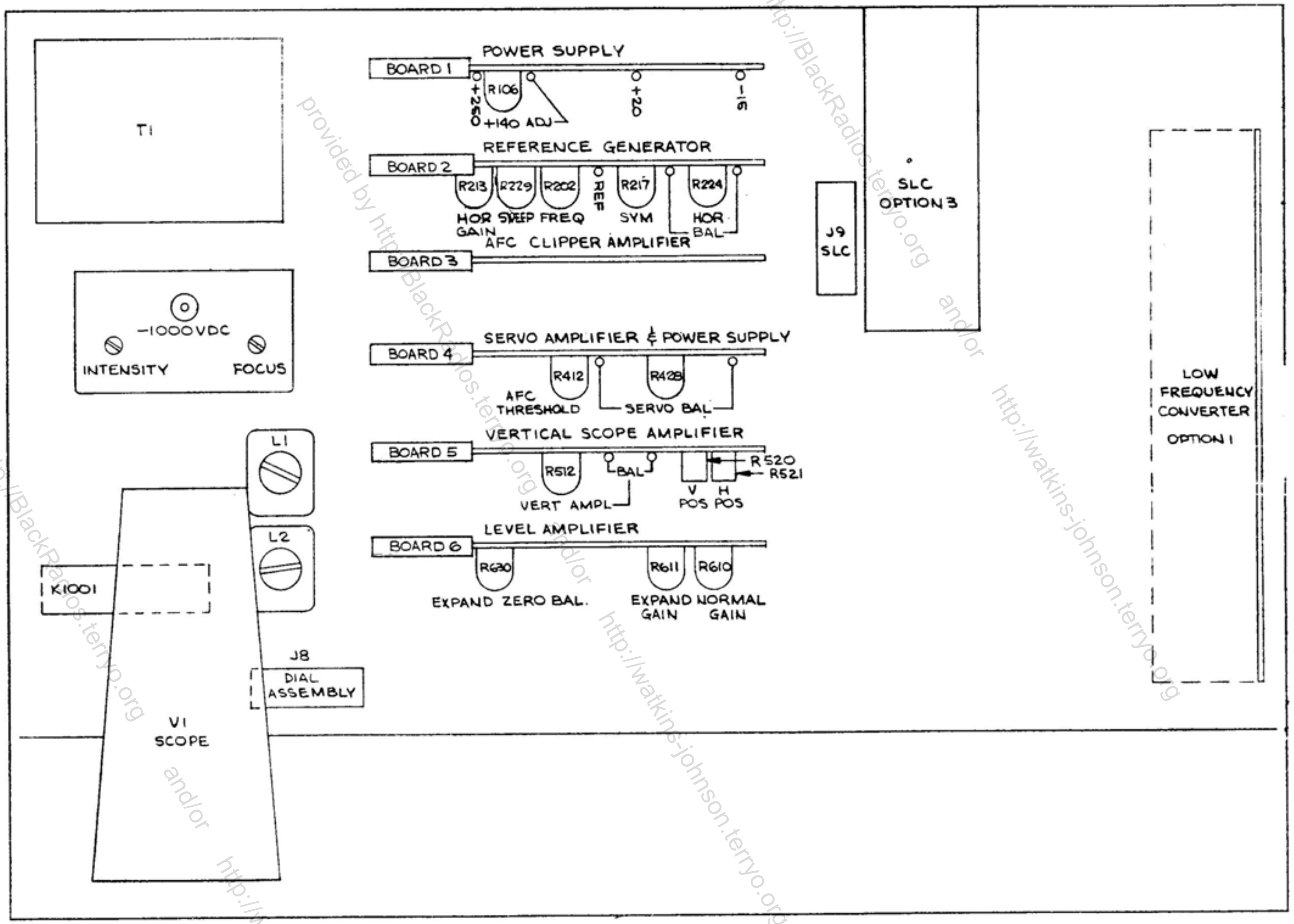
5.0 MAINTENANCE

This section describes the maintenance procedures for the Wide Range Receiver. Periodic adjustments are not normally required. Familiarization with the previous sections of this manual is recommended before attempting any of the steps described herein.

CAUTION: Most components and circuits operate at low potentials. However, the power supply and scope display circuits contain high voltages which are dangerous to personnel. Become familiar with the circuit operation and component locations before servicing. Disconnect the power cord before installing or removing components and assemblies.

Most diagnoses, adjustments and repairs can be made on a modular basis. Printed circuit cards may be operated on the extender board supplied, without deteriorating performance. Remove the polarizing key from the card connector before inserting the extender board, and replace the key after servicing.

The tables giving typical values of voltages at transistor and tube terminals are measured using a voltmeter having a sensitivity of 20,000 ohms per volt DC and 1,000 ohms per volt AC. Values marked by an asterisk (*) are high-impedance points which must be measured with a VTVM. Readings are referred to chassis ground unless otherwise indicated. Care must be taken to avoid shorting adjacent terminals when making measurements. When soldering small components, particularly semiconductors, clamp pliers on the leads between the component and solder joint in order to minimize heating of the component.



RECEIVER, TOP VIEW
FIGURE 5.1

PIN	BOARD					
	1.	2.	3.	4.	5.	6.
A	Gnd	Gnd	Gnd	Gnd	Gnd	Gnd
B	260 VAC	-	17	45 VAC	-	20
C	260 VAC	1.5	-	45 VAC	0	0
D	250	0.2	17	-	Gnd	-15
E	145 VAC	18	1.1	31	-	0
F	195	20	-	31	-	-15
H	145 VAC	-	-	-	20	0
J	140	-	-	0	250	18
K	20	-	19	-	-	18
L	-	-	13	15	Gnd	-
M	-	13	-	15	30	-
N	29 VAC	-	-	0	50	-
P	29 VAC	-	0	-15	50	0
R	-15	250	0.8	20	40	-
S	Gnd	-	-15	0	80	0

Board 1	Power Supply
Board 2	Reference Generator
Board 3	AFC Clipper/Amplifier
Board 4	Servo Amplifier
Board 5	Vertical Scope Amplifier
Board 6	Level Amplifier

Voltage Readings, P.C. Connectors

Figure 5.2

Figure 5.2 lists all of the voltage readings on the printed circuit connectors. These cards are numbered starting at the rear of the receiver; refer to Figure 5.1. The values in Figure 5.2 are taken with no signal input and the meter switch in NORMal. These values should be used only for isolation a failure to a specific board. Then refer to the measurements for that board.

When a measurement, test, or observation requires an input signal, it is most convenient to connect a 75 MHz signal generator directly to the IF input connector on the front panel. The low-frequency converter option, if installed, must be switched out by rotating the bandswitch to a band above 950 MHz.

5.1 FIRST LOCAL OSCILLATOR

The First Local Oscillator is a triode vacuum tube oscillator, tuned by two concentric cavities which are ganged together and connected to the tuning shaft by a non-translating lead screw mechanism. The tuning shaft rotates 58 turns between mechanical stops, and the oscillator has lower and upper frequency limits of at least 1000 and 2575 MHz respectively.

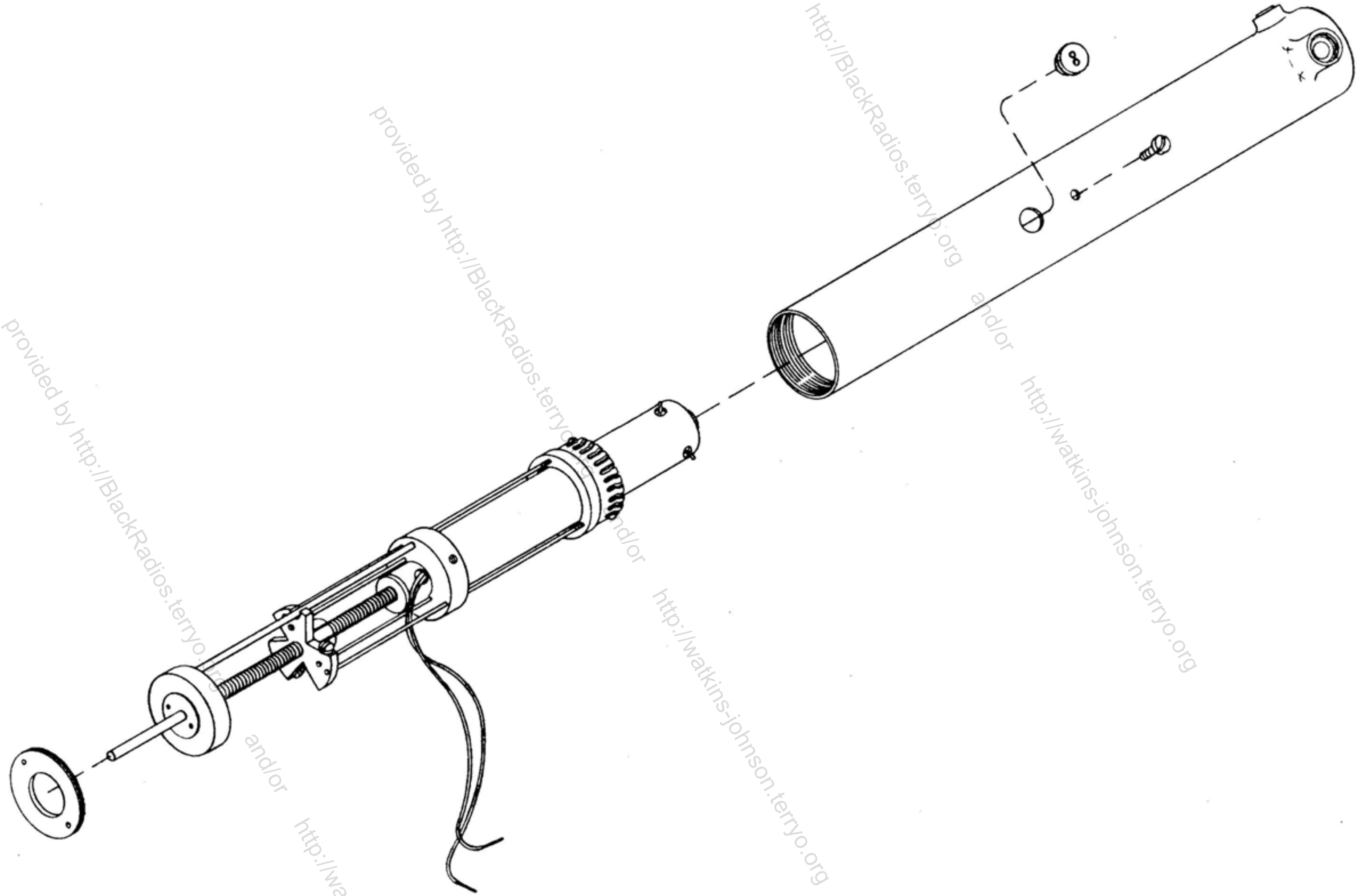
Use extreme care in servicing the cavity, and particularly avoid damage to the spring contacts which wipe against the cavity walls.

5.1.1 TUBE REPLACEMENT

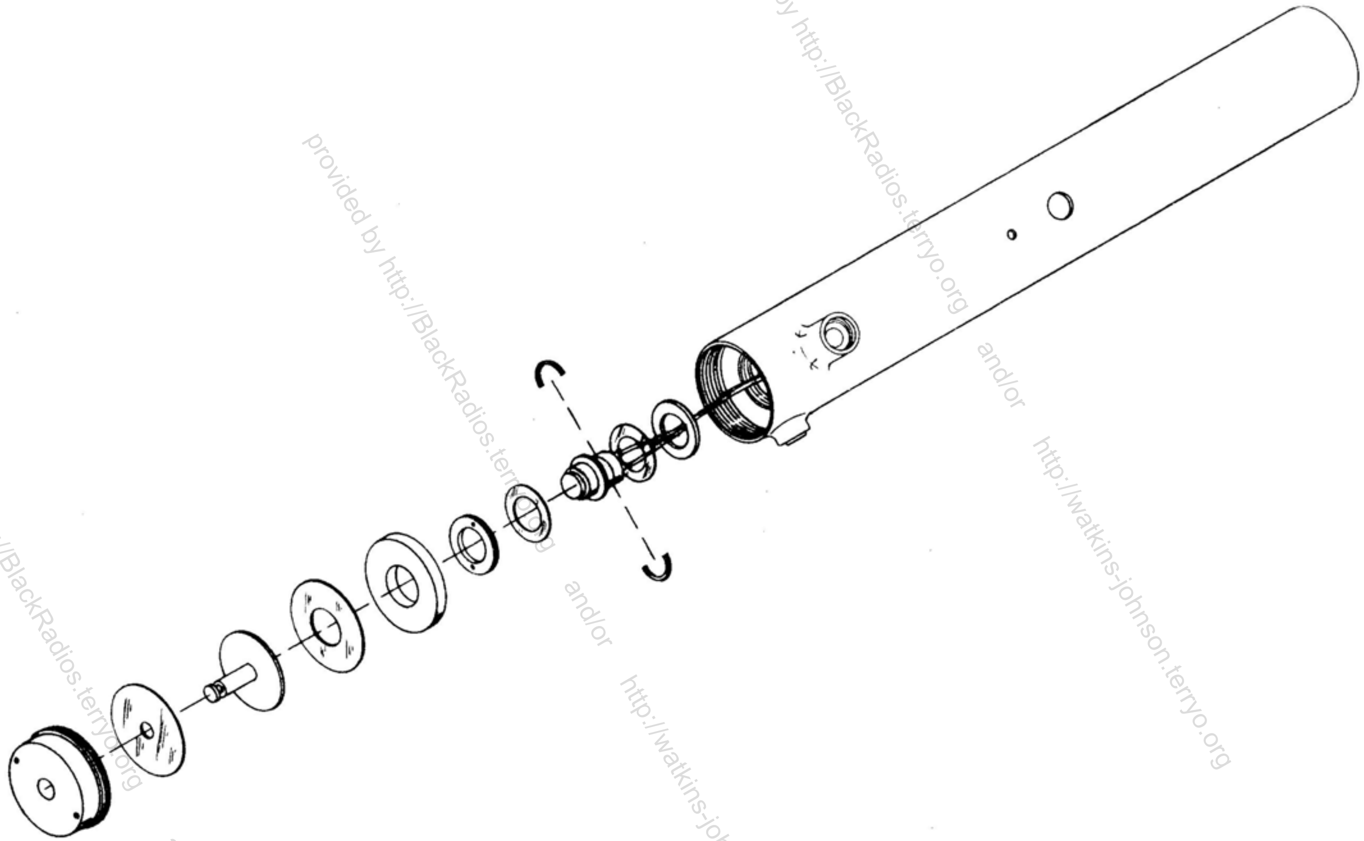
Refer to Figures 5.3 and 5.4 during the following steps. Remove the anode retaining nut, the anode line assembly, anode stop and the grid retainer nut. Then pull the tube straight out until it is loosened from the cathode stem. Remove the filament wire feed-thru and push the filament wires into the cavity as the tube is pulled on out. All parts are reusable except the mica washers.

Before installing a new tube, solder the filament wires to the tubes. Do not allow the soldering iron to remain on the filament pins longer than necessary, but the pins should be completely covered with solder to insure good bonding. Also, paint the grid-to-cathode resistance on the tube using a resistive type paint such as TV Tube Coat. The paint must extend over the edge of the cermaic so that the cathode rings make good contact. The resistance should measure between 200 to 500 ohms. Replace the tube by pushing it into the cathode stem so the cathode rings make good contact.

Reassemble the remaining parts. The oscillator should be checked for power output and frequency coverage. Minimum power should exceed 50 MW. If the oscillator does not perform satisfactorily, realign as indicated in Section 5.1.2.



FIRST LOCAL OSCILLATOR
MECHANICAL ASSEMBLY
FIGURE 5.3



FIRST LOCAL OSCILLATOR
MECHANICAL ASSEMBLY
FIGURE 5.4

5.1.2 ALIGNMENT

Note the oscillator frequency coverage and power output over the band; if unsatisfactory, the grid and cathode fingers must be repositioned. The outside rods control frequency coverage, and the inside rods maintain the power over the band. The main subassembly must be removed from the housing. Remove the anode retainer nut, the anode line assembly, the anode stop, and the rear plug. Tune the oscillator to the low end (full CCW) and feed the filament leads completely inside the housing. Push the main assembly out of the housing through the rear end. Use extreme caution to insure that the grid fingers and feedback probes are not damaged. Remove the tuning shaft subassembly. Unscrew the three screws in the tuning nut, holding the pushrods. Loosen the rods so they slide easily in the tuning nut. If excess power is available at the high end, pull the inside rod backwards a slight amount. This will aid the lower end of the tuning range.

After having properly positioned the rods at the high end, slide the tuning nut forward until it rests against the phenolic insert in the rear of the main assembly Tighten the retaining screws so the push rods can not move in the tuning nut.

Check the oscillator over the complete tuning range. If its operation is unsatisfactory at any point in the frequency range, the problem may be due to the improper position of the pushrods or feedback probes. To adjust feedback, reposition the probes until best operation over the complete range is obtained. If this does not correct the problem, re-align the pushrods as described above.

When operation over the complete frequency range is satisfactory, use some type of "Loctite" to insure that pushrods will not slip.

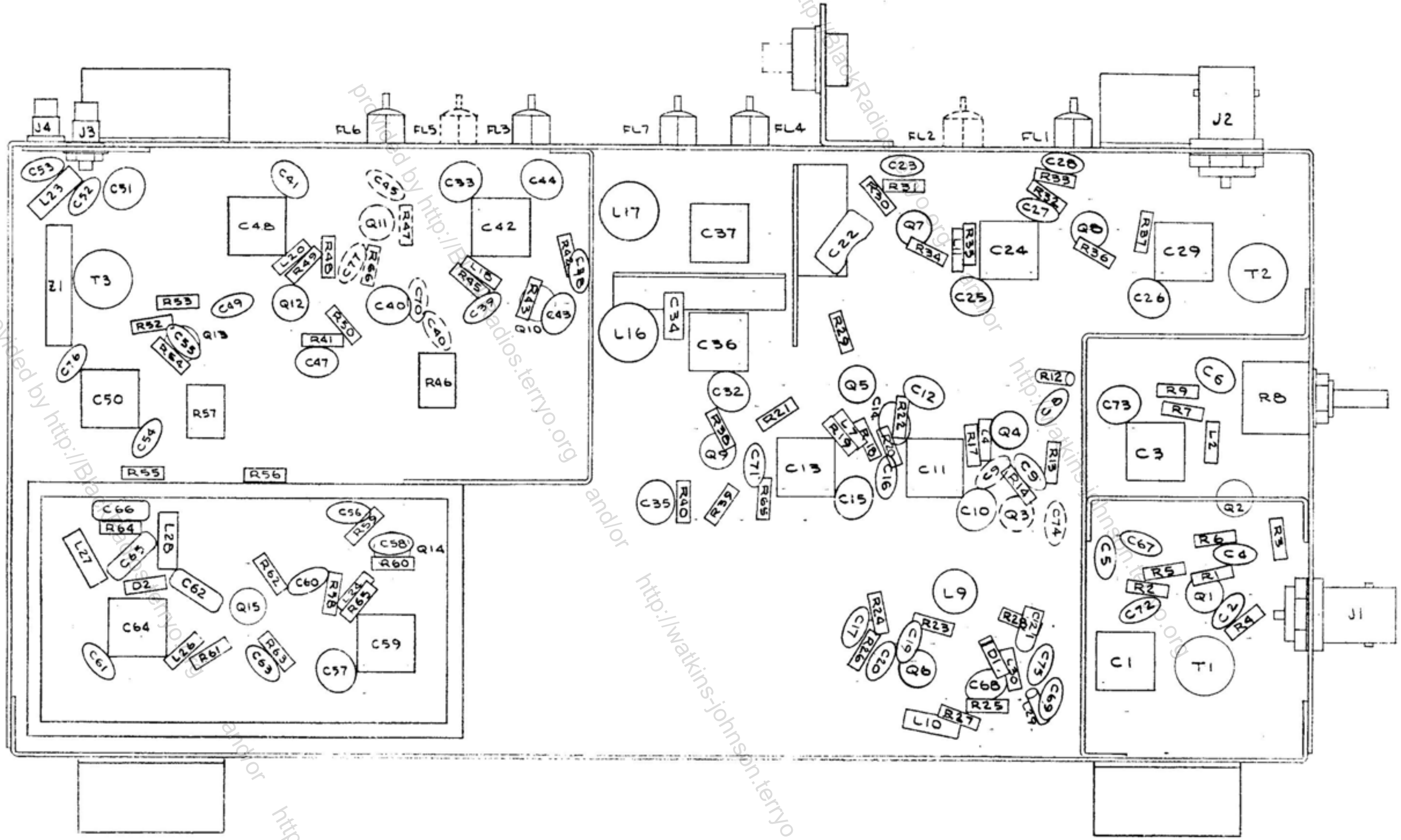
Insert main assembly into housing from the front, pushing it down until the retaining screw holds in the support block line up with the holes in the housing. Insert screws and tighten. Feed the filament leads back through housing and filament feedthru. Replace the front-end assembly, using new mica washers. Insert the tuning shaft into the oscillator; push forward until front-end of shaft rests in the phenolic insert. Replace and tighten the rear plug. Check oscillator for proper operation.

5.2 PREAMPLIFIER/SWEPT OSCILLATOR/IF AMPLIFIER

The Preamplifier/Swept Oscillator/IF Amplifier Assembly is located on the underside of the chassis. It may be aligned without removal from the chassis. All necessary tuning devices and level controls are accessible through openings in the cover plate.

5.2.1 MEASUREMENTS

Voltage measurements may be made with the unit in place



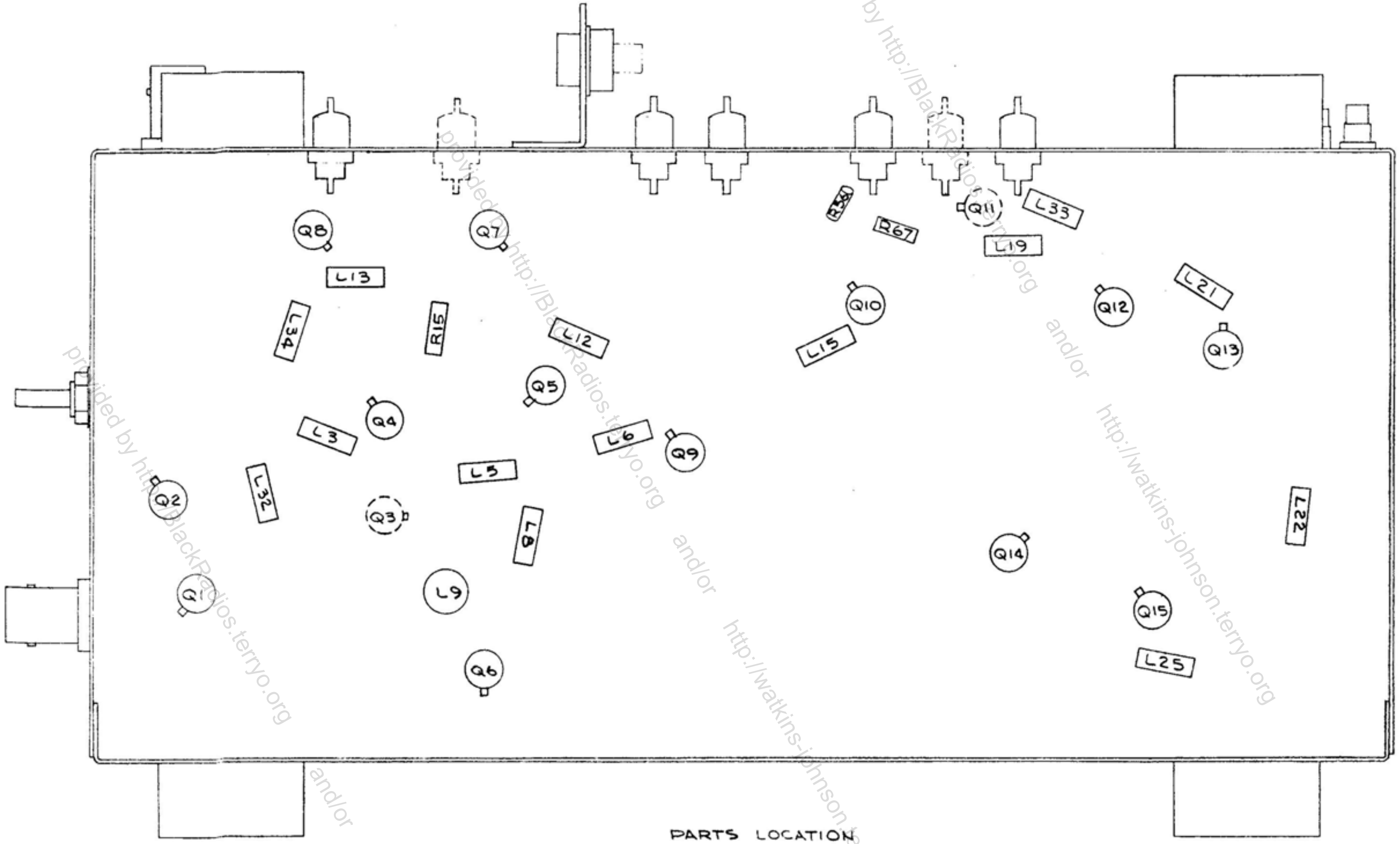
NOTE: ADD 900 TO REFERENCE NUMBERS OF COMPONENTS IN THIS ASSEMBLY ONLY.

PARTS LOCATION

IF AMPLIFIER

BOTTOM VIEW
FIGURE 5.5A

NOTE 1: DOTTED LINE COMPONENTS ON 60 db AND SLC OPTIONS ONLY.



NOTE: ADD 900 TO REFERENCE NUMBERS OF COMPONENTS IN THIS ASSEMBLY ONLY.

PARTS LOCATION

IF AMPLIFIER

TOP VIEW

FIGURE 5.5 B

NOTE 1: DOTTED LINE COMPONENTS ON 60db AND SLC OPTIONS ONLY.

by removing the cover plate. Set the SWEEP control to OFF, the IF GAIN fully counterclockwise, and the 0-1 db control fully counterclockwise.

The following voltages are present at the filter terminals shown in Figure 5.5:

FL901	-15 VDC.
FL902	Variable +5 VDC to -5 VDC ± 20% with 60 db option, 0 VDC otherwise.
FL903	Variable 0 VDC to approximately +5 VDC ± 20% with 0-1 db control.
FL904	0 VDC.
FL905	Variable 0 to -2 VDC ± 20% with SLC option, 0 VDC otherwise.
FL906	+20 VDC.
FL907	+6 VDC with AFC ON.

Transistor terminal voltages are measured by removing the amplifier cover plate. Care must be exercised in making transistor measurements to prevent accidental burnout. Readings may vary 20 percent from those tabulated below:

	EMITTER	BASE	COLLECTOR
Q901	+4.0	+4.7	+19.2
Q902	-0.75	0	+20
Q904	+4.0	+4.7	+20
Q906	+4.6	+3.8	+20
Q907	+4.0	+4.7	+20
Q908	+4.0	+4.7	+20
Q909	+4.0	+4.7	+20
Q910	+3.6	+4.2	+20
Q912	+4.0	+4.7	+20
Q913	+4.0	+4.7	+20
Q914	+4.0	+4.7	+20
Q915	+4.0	+4.7	+20

	SOURCE	DRAIN	GATE 1	GATE 2
*Q903	0	0	+0.75	+0.75
Q905	+5.0	+20	+5.7	+0.25
**Q911	0	0	0	0

*Q903 supplied only with 60 db option. Disconnect external wire to FL902 to make measurement.

**Q911 supplied only with SLC option. Disconnect external wire from FL905 to make measurement.

5.2.2 ALIGNMENT

Alignment is made with the unit fastened to the chassis and with its cover plate installed. Turn the IF GAIN fully clockwise and turn the SWEEP control to OFF. Turn the VERT GAIN control fully clockwise. Adjust R946 (30 MHz gain control) fully clockwise and R957 (video level control) fully counterclockwise. The 30 MHz section may be aligned as follows: Connect a signal generator to the 75 MHz input jack on the receiver front panel. Set the generator frequency to 30 MHz, modulated 50 percent with 1000 Hz. Increase the generator output until a signal appears on the scope display. The generator level required to produce this output will be typically -40 dbm.

The front panel FREQ control may be adjusted to sychronize the scope speed with the 1000 Hz modulation, although this is not essential for alignment. Align the following capacitors for maximum video amplitude: C950, C948, C942, C936, C935, C913 and C911. Adjust the generator level as required to maintain a suitable scope presentation. Capacitors C959 and C963 of the 30 MHz video section are located within the shielded subassembly and should not require tuning unless a component is replaced. The 75 MHz stages are aligned by changing the generator frequency to 75 MHz and adjusting L909, C911, C903 and C901 for maximum video amplitude. Switch the generator modulation to OFF and the receiver SWEEP control to WIDE. Adjust C936 and C935 for a symmetrical response of maximum amplitude.

Proper setting of the amplifier gain control is accomplished as follows: Connect an audio VTVM and VSWR meter in parallel at the BOLOMeter output jack J5. Set the VSWR meter for 8.75 ma bolometer bias. Set the signal generator level to -73 dbm and the receiver SWEEP control to NARrow. Adjust R8 on the main receiver chassis for maximum meter indication. Adjust R946 of the IF Amplifier for a 4 MV meter indication on the VTVM, then connect the VTVM to Video jack J6 and adjust R957 for a 225 MV indication.

The two 30 MHz broadband stages are aligned by connecting an RF voltmeter, or high-frequency oscilloscope to 30 MHz jack J4 on the front panel and adjusting C929 and C924 for maximum output.

5.2.3 BOLOMETER REPLACEMENT

One common fault is the destruction of the bolometer element by transients in conventional VSWR meters and pattern recorders, particularly when it is connected with the bias supply on. A good operating practice is to turn off the bias supply in the external recorder before connecting or disconnecting the cable to the bolometer output of the receiver. The bolometer may be checked by measuring the resistance between the shell (not ground) and center conductor of the BOLOM output jack. The resistance value should read 200 ohms or less. An open circuit indicates a burned out bolometer.

The bolometer is located in the IF amplifier, as shown in Figure 5.5, and is held in place by the snap-in clips only. Do not solder.

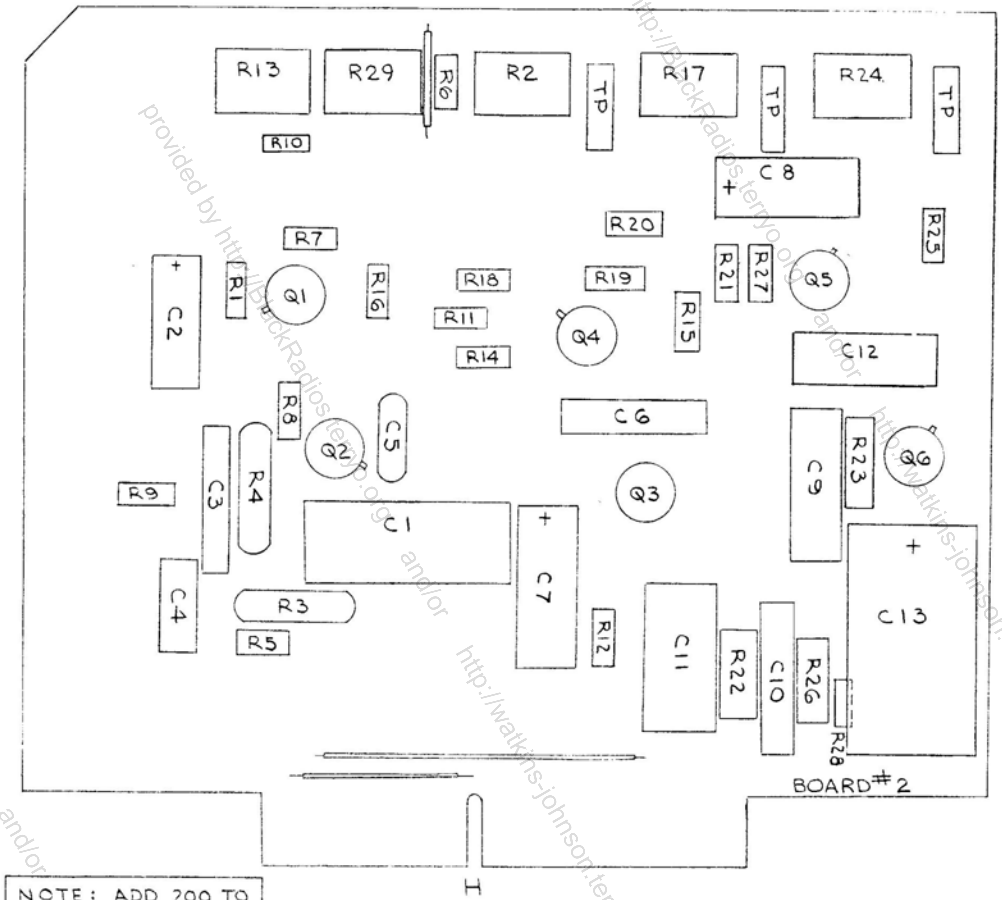
5.3 REFERENCE GENERATOR

The reference generator located on Board 2 generates the 1000 Hz signal which sweeps the second local oscillator, and, thereby, modulates the incoming RF signal. The 1000 Hz output of this reference generator is also the reference phase of the scope display.

5.3.1 ALIGNMENT

It is most convenient to align the reference generator if a signal is being received and the bolometer (or video) output is connected to a pattern recorder or VSWR meter. Set the front panel SWEEP FREQ control to its center position and the SWEEP control to NARrow. Connect the receiver to a CW signal source (75 MHz into the front panel IF connector) and increase the input level until there is a reading on the indicating device. Adjust the frequency control, R202 on Board 2, and the sweep width potentiometer for maximum indicated output. In some receivers the latter control is on the chassis in front of the printed card holder; in others, it is on Board 2.

Connect an oscilloscope to the test point near the middle of Board 2 and adjust R217 for the best symmetry of the waveform.



NOTE: ADD 200 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD.

BOARD 2 PARTS LOCATION
REFERENCE GENERATOR
FIGURE 5.4

Connect a voltmeter between the test points adjacent to R224 and adjust this balance control for zero on the meter: No incoming signal is required for this step.

5.3.2 MEASUREMENTS

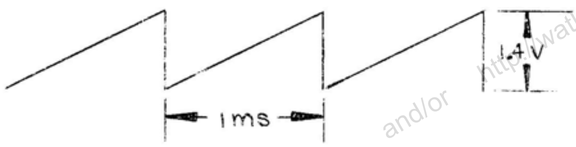
	EMITTER	BASE I	BASE 2
Q201	6.1	0	18

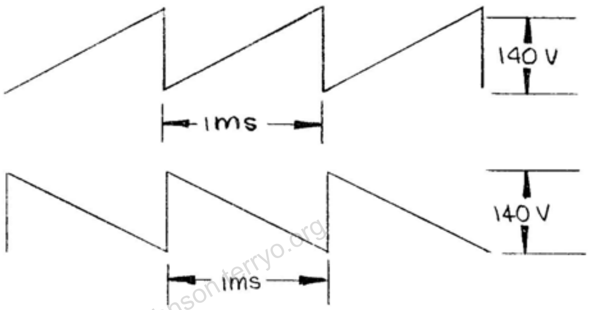
	EMITTER	BASE	COLLECTOR
Q202	5.4	6.1	16
Q203	6.3	5.8	7.4
Q204	8.0	7.5	13
Q205	15	16	135
Q206	15	16	135

5.3.3. WAVEFORMS

The following waveforms are observed with the SWEEP control in the NARrow position. No external receiver connections are necessary.

Pin E, Board 2





5.4 AFC CLIPPER/AMPLIFIER

All measurements and waveforms are taken with the front panel controls set as follows:

SWEEP NARrow

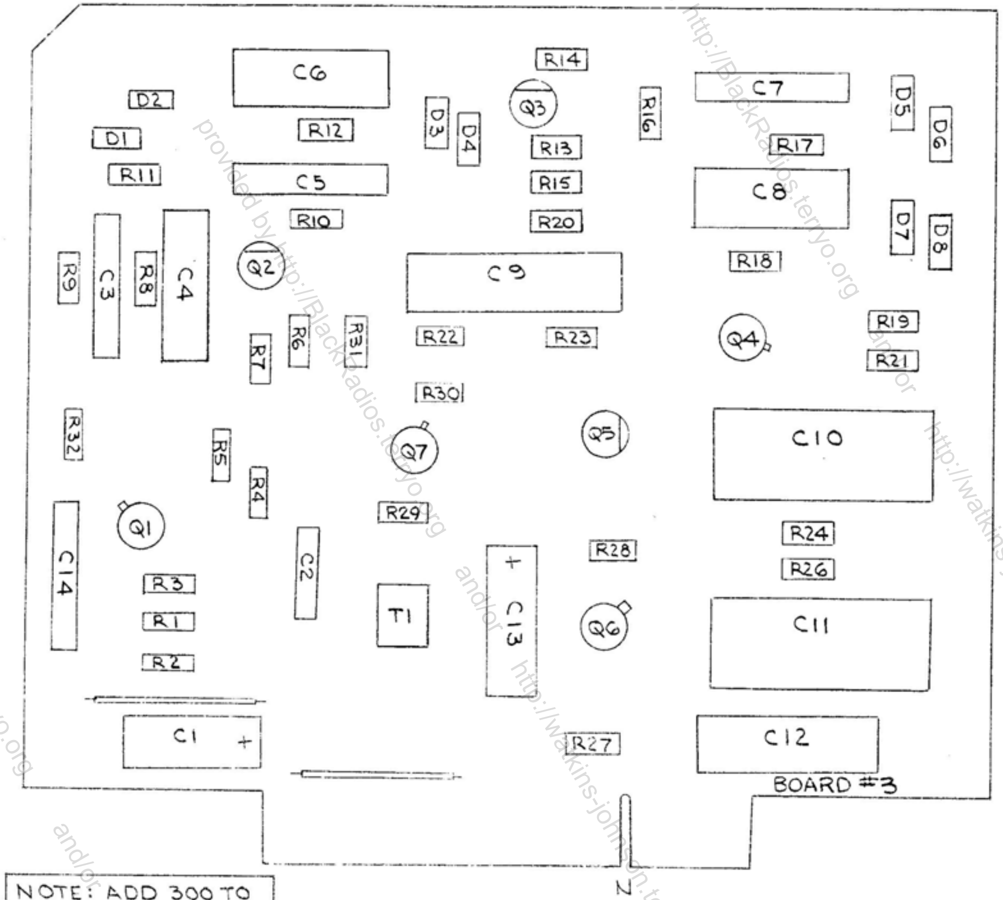
AFC NORMal

AFC NULL centered

Connect the receiver to a signal source (75 MHz into the IF front panel connector is satisfactory) and adjust the signal level to the reference level; refer to Section 3.4.

5.4.1 MEASUREMENTS

	EMITTER	BASE	COLLECTOR
Q301	1.2	0.6*	17
Q302	0.4	0.2*	10
Q303	0.4	0.2*	10
Q304	0.4	0.9	8.0
Q305	0	0	18
Q306	13	13	18
Q307	0.9	0.9	1.1



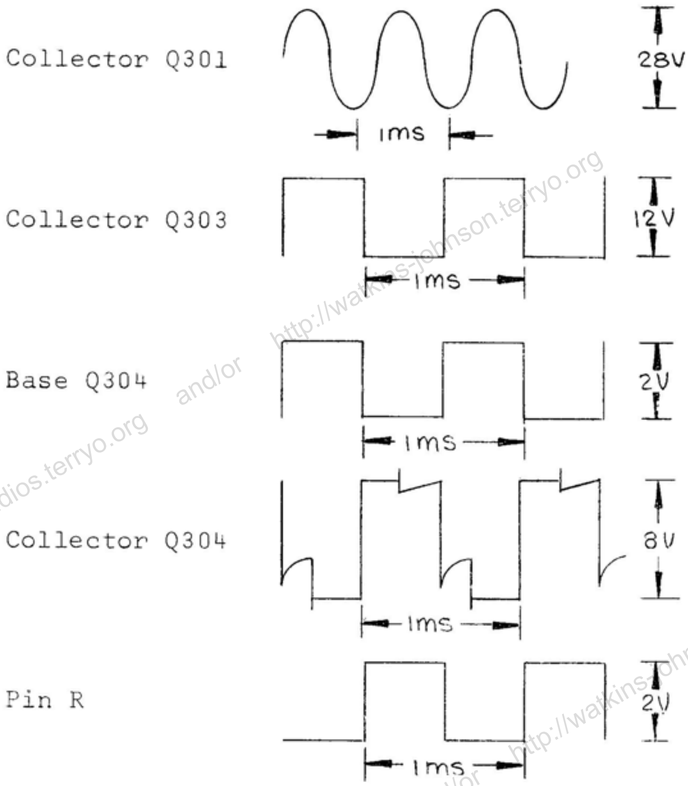
NOTE: ADD 300 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD.

BOARD 3 PARTS LOCATION

AFC CLIPPER/AMPLIFIER

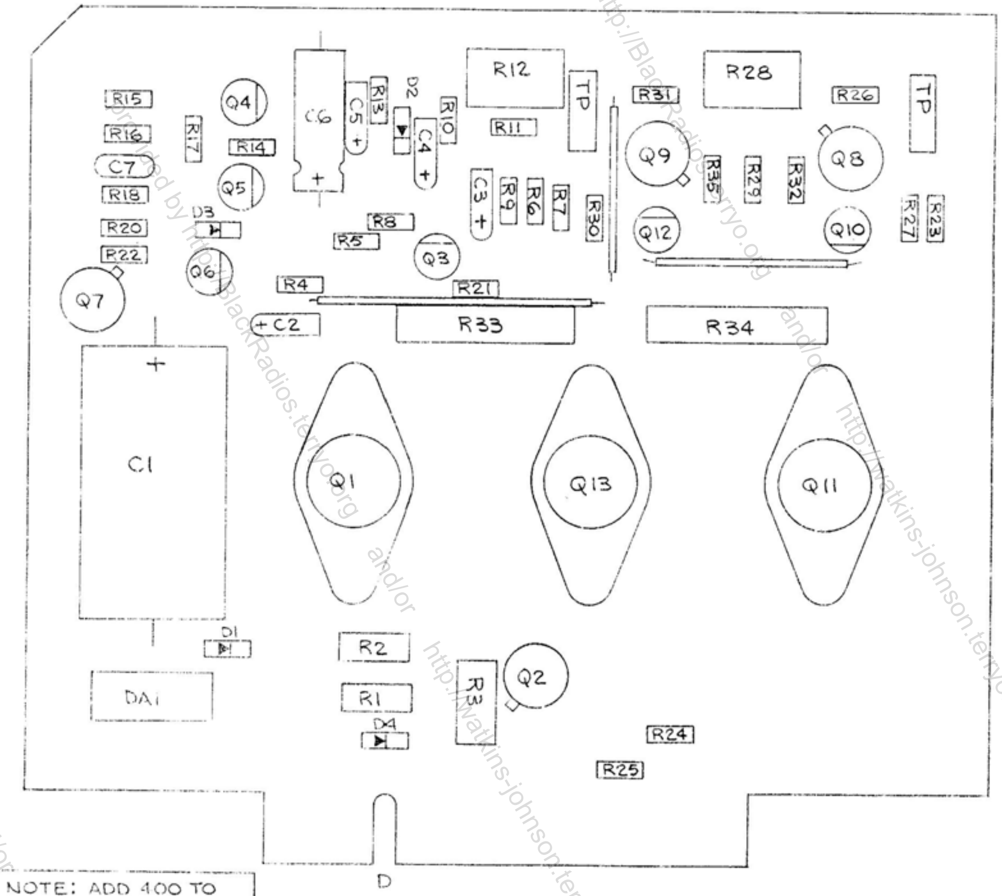
FIGURE 5.7

5.4.2 WAVEFORMS



5.5 SERVO AMPLIFIER

The Servo Amplifier is located on Board 4 along with the 30-volt power supply and clutch circuits. When aligning the servo amplifier, or making measurements, ground pin S of the circuit board to the chassis. <u>CAUTION: Grounding of other connector pins may damage other circuits.</u>



NOTE: ADD 400 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

BOARD 4 PARTS LOCATION

SERVO AMPLIFIER AND POWER SUPPLY

FIGURE 5.8

5.5.1 ALIGNMENT

With pin S grounded, adjust R428 for equal DC voltages at the two test points on each side of this control. This is the same as zero voltage between these two test points.

5.5.2 MEASUREMENTS

These measurements are taken with the AFC switch at NORMal, no signal input, and the AFC NULL control adjusted to stop the tuning motor.

	EMITTER	BASE	COLLECTOR
Q401	31	32	40
Q402	31	32	32
Q408	0	0	11
Q409	0	0	11
Q410	13	13	20
Q411	12	13	40
Q412	12	13	40
Q413	13	13	20

5.6 CLUTCH

The clutch circuts are located on Board 4. When this clutch is engaged, the tuning knob is connected to the drive motor and requires significant torque to manually tune. It only operates with the AFC on.

5.6.1 ALIGNMENT

The AFC threshold control R412 is set as follows: Turn the AFC on and the SWEEP to NARrow. Connect a VSWR meter to the BOLOMeter output and operate the receiver above 940 MHz in accordance with Section 3. Adjust R412 so that the clutch engages when the signal-to-noise ratio is about 10 db. It may be adjusted for a lower level but may not release if mixer noise rises significantly.

5.6.2 MEASUREMENTS

These measurements are taken with the AFC switch set to NORMal, and no input signal.

	EMITTER	BASE	COLLECTOR
Q403	2.0	2.5	11
Q406	0	0	20
Q407	0	0	31

	SOURCE	GATE	DRAIN
Q404	20	0	20
Q405	20	10*	20

When the input signal level increases enough to operate the clutch, the collector voltage of Q407 approaches zero.

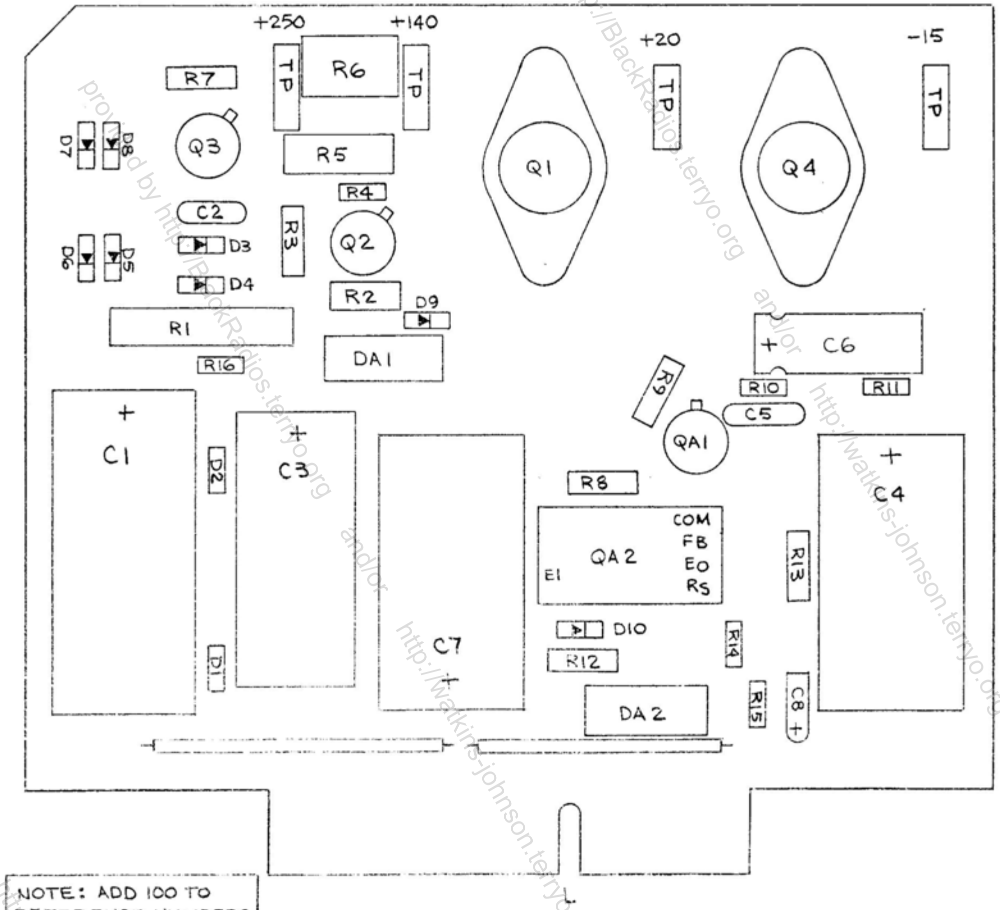
5.7 POWER SUPPLY

The power transformer is located on the chassis. The 30-volt supply for the servo is located on Board 4 and included in Section 5.5. The high-voltage scope supply is included in Section 5.7.1. All components for the -15, +20, +140, and +250 volt supplies are located on Board 1, with the exception of filter capacitor C1 which is located on the chassis.

Test points on Board 1 permit rapid measurement of all voltage supplies on this board without removal of the board. The +140 volt supply may be adjusted to exactly its nominal value by potentiometer R106. All other supplies are fixed and should remain within 10 percent of their nominal potentials.

The following readings are taken without options. Set the bands width for 1 GHz or above, and turn the SLC off if one is supplied with the receiver.

	EMITTER	BASE	COLLECTOR
Q101	147	148	190
Q102	140	147	148
Q103	20	21	148
Q104	34	33	21



NOTE: ADD 100 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

BOARD 1 PARTS LOCATION

POWER SUPPLY

FIGURE 5.9

	1	2	3	4	5	6	7	8
QA101	21	33	34	Gnd	-	1.6	21	20

	COM	E1	FB	EO	RS
QA102	Gnd	-25	-6.8	-15	-15

5.8 SCOPE DISPLAY

The alignment and maintenance of all circuits of the scope display are covered in this section. The cathode ray tube, high-voltage power supply, and several controls are located on the left portion of the chassis. The horizontal scope amplifier is on Board 2; the vertical amplifier is located on Board 5. Faults in the scope display can usually be identified by observing the cathode ray tube display itself; i.e., no horizontal sweep indicates a fault in the horizontal scope amplifier. EXERCISE EXTREME CAUTION - POTENTIALS IN THESE CIRCUITS ARE DANGEROUS.

5.8.1 ALIGNMENT

The INTENSITY and FOCUS controls are located above the cathode ray tube socket. Adjust these for the best focus and minimum brightness consistent with ambient lighting. The horizontal and vertical position controls, located on Board 5, are set, with no signal input, to give a straight horizontal line, centered with respect to the vertical axis and coincident with the lower horizontal scribed line on the bezel.

Connect the receiver to a CW signal source (75 MHz into the front panel IF connector is satisfactory) and connect the BOLOMeter output to a VSWR meter or recorder which can furnish 8.7 milliampere bias. Set the SWEEP to NAR and raise this signal level to produce a 4-millivolt signal at the BOLOMeter output. Rotate the front panel VERT GAIN control fully counterclockwise to the switched REF position. Adjust R12, located on the back of the front panel near the SWEEP switch, so that the cathode ray tube presentation just fills the height between the two horizontal scribed lines. R10, which is adjacent to R12, is a vertical gain control in series with the front panel VERT GAIN when the latter is positioned at other than its REF position. The setting of R12 is not critical, but may be conveniently adjusted to give an indication of receiver noise with no signal input and the VERT GAIN rotated fully clockwise.

5.8.2 POWER SUPPLY

The power supply is located on the bracket which mounts the cathode ray tube socket. The test point above the socket may be used to check this supply. Use CAUTION in servicing this supply because potentials are dangerous.

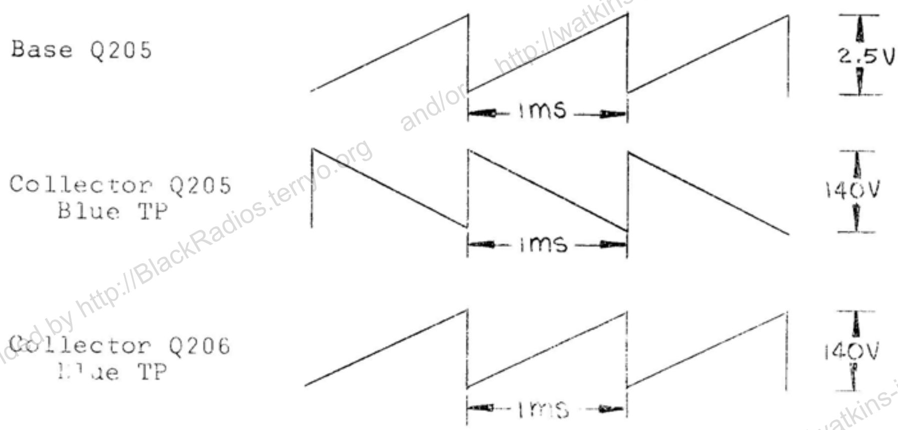
5.8.3 HORIZONTAL AMPLIFIER

The horizontal amplifier is located on Board 2. The balance control R224 is adjusted for equal DC voltages at the collectors of Q205 and Q206. This is indicated by zero voltage between the two test jacks on either side of R224.

5.8.3.1 MEASUREMENTS

	EMITTER	BASE	COLLECTOR
Q205	15	16	135
Q206	15	16	135

5.8.3.2 WAVEFORMS



5.8.4 VERTICAL AMPLIFIER

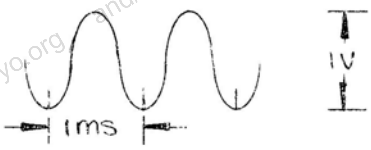
The vertical scope amplifier is located on Board 5. The balance control R512 is adjusted for equal voltages at the collectors of Q503 and Q504. This is indicated by zero voltage between the two test jacks adjacent to R512.

5.8.4.1 MEASUREMENTS

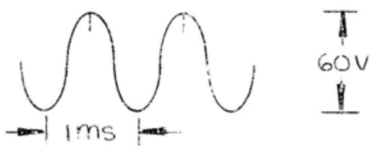
	EMITTER	BASE	COLLECTOR
Q501	0.6	1.0*	3.0
Q502	2.6	3.0	10
Q503	16	16	145
Q504	16	16	145

5.8.4.2 WAVEFORMS

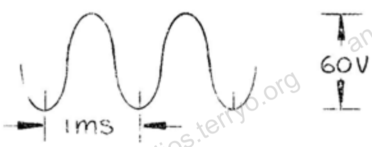
Collector Q502

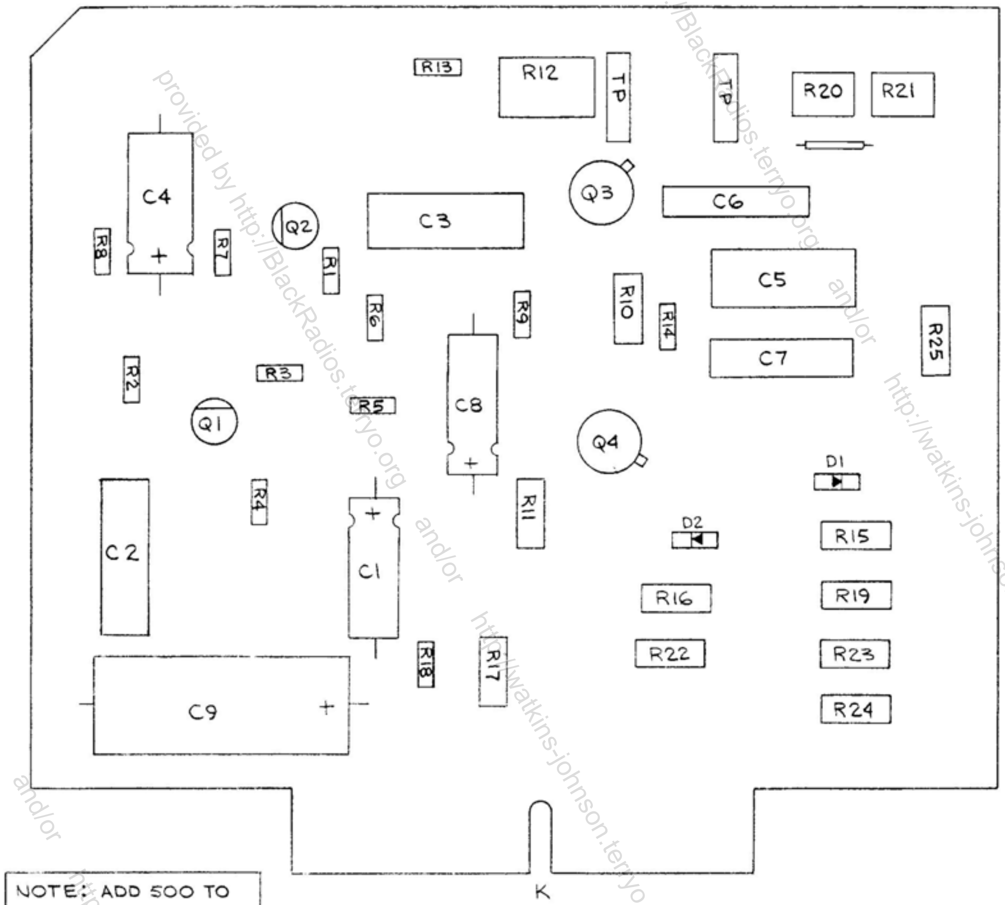


Collector Q503



Collector Q504





NOTE: ADD 500 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

BOARD 4 PARTS LOCATION

VERTICAL SCOPE AMPLIFIER

FIGURE 5.10

5.8.5 CATHODE RAY TUBE

The cathode ray tube is a type 2AP1-A. The INTENSITY and FOCUS controls are located above the CRT socket, and the horizontal and vertical position controls are located on Board 5.

5.8.5.1 REPLACEMENT

Remove the two screws holding the bezel to the front panel. The cathode ray tube is then removed through the front panel. It is not necessary to remove the tube shield. When installing a new tube, it may be necessary, because of variations in tube length, to loosen the screws holding the socket bracket to the chassis and adjust the position of this bracket until the new tube fits firmly against the bezel.

5.8.5.2 MEASUREMENTS

The following measurements are made at the cathode ray tube socket with respect to chassis ground.

SOCKET PIN	VOLTS
1	-845
2	-845
3	+50*
4	-590**
5	---
6	+25*
7	+97*
8	+67*
9	+67*
10	-890**
11	-850**

** Nominal value. Actual value may vary 20 percent depending on setting of scope controls.

Measure the AC voltage between pins 1 and 11. It should be 6.3 volts. CAUTION! BOTH OF THESE PINS ARE AT DANGEROUS POTENTIALS ABOVE GROUND.

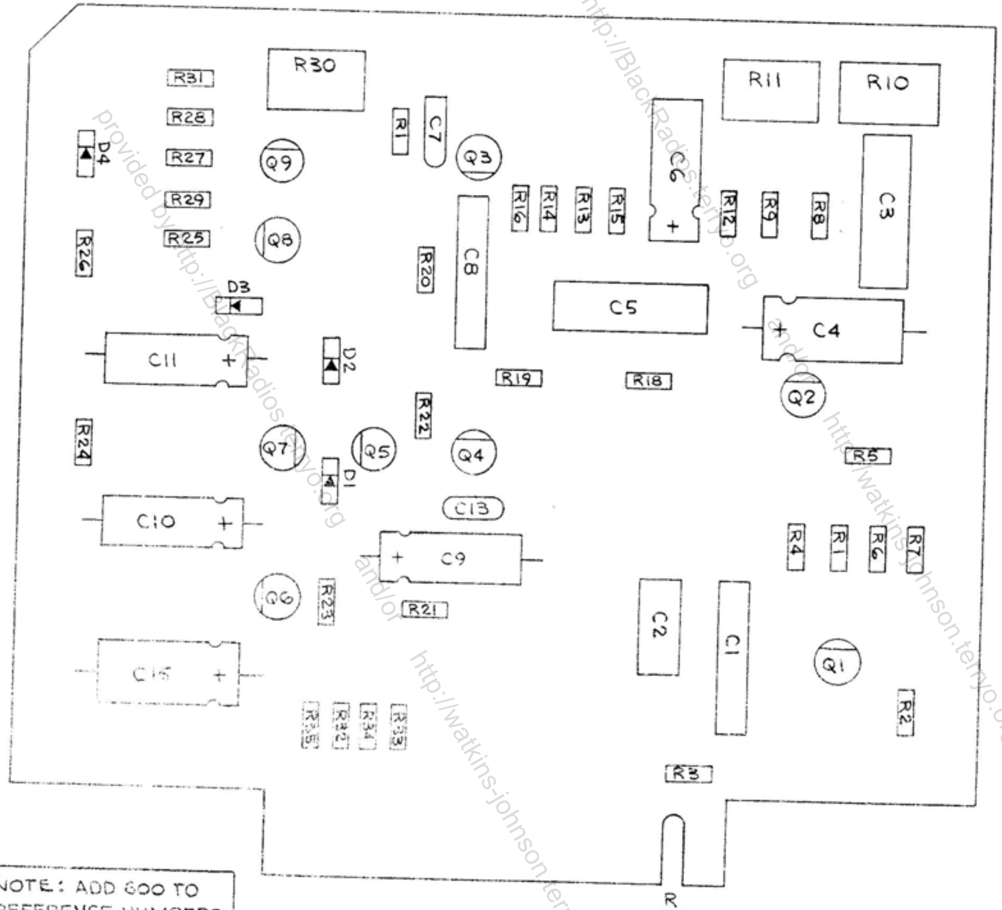
5.9 LEVEL AMPLIFIER

Connect a 75 MHz CW signal generator to the IF input connector and rotate the bandswitch to any band above 950 MHz.

5.9.1 ALIGNMENT

Set the IF GAIN fully counterclockwise, the SET REFerence control to approximate mid-range, and the meter switch to NORMal. Increase the input signal until the meter is centered. Adjust L2, located on the chassis, for maximum meter deflection; decrease the input signal, as necessary, to keep the meter near center.

Set the IF GAIN fully clockwise, the SET REFerence control one turn back from its maximum clockwise position, and the meter switch to EXPand. Using a VSWR meter connected to the BOLOMeter output, increase the input signal for a signal-to-noise ratio of 13 db. Set the expand gain control R611 to about 90 percent of its clockwise rotation and adjust the expand zero balance control R630 for zero centering of the meter. Vary the signal strength by one db (the front panel control may be used for this purpose) and note the meter deflection. Adjust R611 for approximate full-



NOTE: ADD 600 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

BOARD 6 PARTS LOCATION

LEVEL AMPLIFIER

FIGURE 5.11

scale meter deflection with the one db change, and for each change of R611, re-adjust R630 for zero centering at about 13 db signal-to-noise. Then switch to NORMal, without changing any test conditions, and adjust the normal gain control for zero meter reading.

5.9.2 MEASUREMENTS

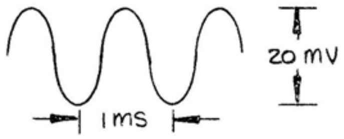
The following dc measurements are taken with no input signal, and the meter switch set to NORMal.

	EMITTER	BASE	COLLECTOR
Q601	0.3	0.4*	18
Q602	7.0	7.5*	18
Q603	1.0	1.2	12
Q604	10	10	1.0
Q605	0	1.0	11
Q606	11	12	18
Q607	11	11	0
Q608	-14	-14	0
Q609	-14	-14	-14

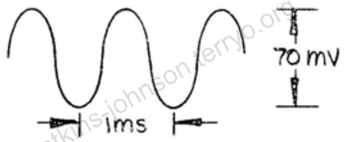
5.9.3 WAVEFORMS

These waveforms are observed with the meter switch at NORMal, an input signal level which gives an output signal-to-noise ratio of about 20 db, and the REFerence SET control adjusted for centering of the meter.

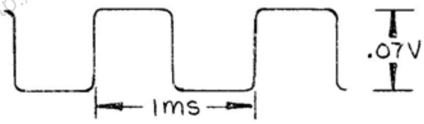
Emitter Q602



Collector Q603



Collector Q605



Emitter Q607

PARTS LIST

MISCELLANEOUS SUBASSEMBLIES

Ref.	Description	Mfg./Type
M-100	External Mixer	Sage 1026H
	Crystal	1N23E
	P.C. Board Extender	M/T 32-016
SC-250	Signal Combiner	M/T SC-250

PARTS LIST

MAIN CHASSIS

Ref.	Description	Mfg./Type
C1	Capacitor 100 uf 250 WVDC	Sprague TVL-1535
C2	Capacitor .05 uf 1,600 WVDC	Sprague 160P-MB-S5
C3	Capacitor .05 uf 1,600 WVDC	Sprague 160P-MB-S5
D1	Diode	EDI 1G5
DS1	Pilot Lamp	Marco-Oak A1G
F1	Fuse, 1 Amp., Slo-Blo	Littlefuse 313001
J1	Connector	UG-1095B/U
J2	Connector	UG-1095B/U
J3	Connector	UG-492A/U
J4	Not Used	
J5	Connector	UG-657/U
J6	Connector	UG-657/U
J7	Connector	UG-625/U
J8	Connector	Cinch-Jones DAM-15S
J9	Connector	Cinch-Jones DAM-15S
J10	Not Used	
J11	Connector	Winchester HB15-S-0-0
J12	Connector	Winchester HB15-S-0-0
J13	Connector	Winchester HB15-S-0-0
J14	Connector	Winchester HB15-S-0-0
J15	Connector	Winchester HB15-S-0-0
J16	Connector	Winchester HB15-S-0-0
J17	CRT Socket	Cinch-Jones 3M11
L1	Inductor, Variable 1-11	UTC HVC-8
L2	Inductor, Variable 1-11	UTC HVC-8
M1	Meter	M/T 32-047
P1	Connector	Gremar 6002
P2	Not Used	
P3	Connector	UG-88C/U
P4	Connector	UG-88C/U
P5	Connector	UG-88C/U
P6	Connector	UG-1465/U
P7	Connector	UG-1465/U
P8	Connector	Cinch-Jones DAM-15S
P9	Connector	UG-88C/U

PARTS LIST
Main Chassis (Continued)

Ref.	Description	Mfg./Type
R1	Resistor 47,000 ohms 5% 1/4 Watt	RC07GF473J
R2	Resistor, Variable 500,000 ohms 1 Watt	Mallory SU-50
R3	Resistor 470,000 ohms 5% 1/2 Watt	RC20GF474J
R4	Resistor, Variable 1 megohms 1 Watt	Mallory SU-54
R5	Resistor 2.7 megohms 5% 1 Watt	RC32GF275J
R6	Resistor 330,000 ohms 5% 1/2 Watt	RC20GF334J
R7	Resistor, Variable 5,000 ohms 1/2 Watt	IRC PQ11-114
R8	Not Used	
R9	Resistor, Variable 250,000 ohms 1/2 Watt	IRC PQ11-130
R10	Resistor, Variable 10,000 ohms 1/2 Watt	Bourns 3067S-1-103
R11	Resistor 680,000 ohms 5% 1/4 Watt	RC07GF684J
R12	Resistor, Variable 10,000 ohms 1/2 Watt	Bourns 3067S-1-103
R13	Resistor, Variable 500 ohms 1/2 Watt	IRC PQ11-103
R14	Resistor, Variable 50,000 ohms 2 Watts	IRC 8400
R15	Resistor, Variable 5,000 ohms 1/2 Watt	IRC PQ11-114
S1	Switch, Pushbutton	Marco-Oak 54-61681-28
S2	Switch, Slide	Switchcraft 46206LF
S3	Switch, SPDT	IRC 76-4
S4	Switch, Rotary	Mallory 3223J
S5	Switch, Rotary	Mallory 3243J
S6	Switch, Rotary	Oak 399225-A
T1	Transformer	M/T 32-004
TP1	Test Jack	E.F.Johnson 106-602
V1	Cathode Ray Tube	RCA 2AP1A
W1	Power Cable	Belden 17236
XF1	Fuseholder	Littlefuse 342001
Z1	Step Attenuator	Telonic TG-950
Z2	50 Ohm Load	MX-554/U-51

PARTS LIST

POWER SUPPLY

Ref.	Description					Mfg./Type
C101	Capacitor	16 uf			450 WVDC	CDE BR16-450
C102	Capacitor	.001 uf			1,000 WVDC	Sprague 5GA-D10
C103	Capacitor	8 uf			350 WVDC	CDE BR8-350
C104	Capacitor	250 uf			50 WVDC	CDE BR250-50
C105	Capacitor	50 pf			300 WVDC	CM05ED510J03
C106	Capacitor	20 uf			50 WVDC	Sprague TE1305
C107	Capacitor	250 uf			50 WVDC	CDE BR250-50
C108	Capacitor	1.0 uf			35 WVDC	Kemet K1C35K
D101	Diode					1N4007
D102	Diode					1N4007
D103	Diode, zener					1N4761A
D104	Diode, zener					1N4761A
D105	Diode, zener					1N4759A
D106	Diode, zener					1N4759A
D107	Diode, zener					1N4759A
D108	Diode, zener					1N4759A
D109	Diode					1N4002
D110	Diode, zener					1N4740A
DA101	Diode Assembly					Mallory CTP-500
DA102	Diode Assembly					Mallory FW-200
Q101	Transistor					2N3738
Q102	Transistor					2N2270
Q103	Transistor					2N3440
Q104	Transistor					2N4898
QA101	Microcircuit					NSC LM-300
QA102	Microcircuit					Beckman 852
R101	Resistor	8,000 ohms	5%		5 Watts	Sprague 243E8025
R102	Resistor	5,600 ohms	5%		3 Watts	Ohmite 995-3A
R103	Resistor	4,700 ohms	5%		1/2 Watt	RC20GF472J
R104	Resistor	12 ohms	5%		1/4 Watt	RC07GF120J
R105	Resistor	39,000 ohms	5%		1 Watt	RC32GF393J
R106	Resistor, Variable	10,000 ohms			1 Watt	IRC106-2
R107	Resistor	3,900 ohms	5%		1/2 Watt	RC20GF392J
R108	Resistor	10 ohms	5%		1/2 Watt	RC20GF100J
R109	Resistor	1.5 ohms	5%		1.5 Watts	Ohmite 995-1A
R110	Resistor	39,000 ohms	5%		1/4 Watt	RC07GF393J
R111	Resistor	3,600 ohms	5%		1/4 Watt	RC07GF362J
R112	Resistor	10 ohms	5%		1/2 Watt	RC20GF100J
R113	Resistor	10 ohms	5%		1/2 Watt	RC20GF100J
R114	Resistor	4,300 ohms	5%		1/4 Watt	RC07GF432J
R115	Resistor	3,600 ohms	5%		1/4 Watt	RC07GF362J
R116	Resistor	1 megohm	5%		1/4 Watt	RC07GF105J

PARTS LIST

REFERENCE GENERATOR

Ref.	Description	Mfg./Type
C201	Capacitor 1.0 uf 10% 50 WVDC	GE 75F7R5A105
C202	Capacitor 10 uf 25 WVDC	Sprague TE1204
C203	Capacitor 0.1 uf 10% 50 WVDC	GE 75F2R5A104
C204	Capacitor .056 uf 10% 100 WVDC	Sprague 225P56391
C205	Capacitor 470 pf 10% 200 WVDC	Sprague 192P47192
C206	Capacitor 0.1 uf 10% 50 WVDC	GE 75F2R5A104
C207	Capacitor 10 uf 25 WVDC	Sprague TE1204
C208	Capacitor 10 uf 25 WVDC	Sprague TE1204
C209	Capacitor .022 uf 10% 400 WVDC	GE 75F3R4A223
C210	Capacitor .022 uf 10% 400 WVDC	GE 75F3R4A223
C211	Capacitor 1.0 uf 35 WVDC	Kemet K1C35K
C212	Capacitor 1.0 uf 35 WVDC	Kemet K1C35K
C213	Capacitor 4 uf 350 WVDC	CDE BR4-350
Q201	Transistor	2N1671
Q202	Transistor	2N2270
Q203	Transistor	2N2270
Q204	Transistor	2N2270
Q205	Transistor	2N3440
Q206	Transistor	2N3440
R201	Resistor 330 ohms 5% 1/4 Watt	RC07GF331J
R202	Resistor, Variable 10,000 ohms 1 Watt	IRC 106-2
R203	Resistor 10,000 ohms 1% 1/2 Watt	IRC CEC T-0
R204	Resistor 22,600 ohms 1% 1/2 Watt	IRC CEC T-0
R205	Resistor 15,000 ohms 5% 1/4 Watt	RC07GF153J
R206	Not Used	
R207	Resistor 100 ohms 5% 1/4 Watt	RC07GF101J
R208	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R209	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R210	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R211	Resistor 15,000 ohms 5% 1/4 Watt	RC07GF153J
R212	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R213	Resistor, Variable 1,000 ohms 1 Watt	IRC 106-2
R214	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R215	Resistor 6,800 ohms 5% 1/4 Watt	RC07GF682J
R216	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R217	Resistor, Variable 5,000 ohms 1 Watt	IRC 106-2
R218	Resistor 4,700 ohms 5% 1/4 Watt	RC07GF472J
R219	Resistor 6,800 ohms 5% 1/4 Watt	RC07GF682J
R220	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J

PARTS LIST
Reference Generator (Continued)

Ref.	Description	Mfg./Type
R221	Resistor 47,000 ohms 5% 1/4 Watt	RC07GF473J
R222	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R223	Resistor 56,000 ohms 5% 1/2 Watt	RC20GF563J
R224	Resistor, Variable 100 ohms 1 Watt	IRC 106-2
R225	Resistor 3,900 ohms 5% 1/4 Watt	RC07GF392J
R226	Resistor 56,000 ohms 5% 1/2 Watt	RC20GF563J
R227	Resistor 47,000 ohms 5% 1/4 Watt	RC07GF473J
R228	Resistor 1 Megohm 5% 1/4 Watt	RC07GF105J
R229	Resistor, Variable 2,000 ohms 1 Watt	IRC 106-2

PARTS LIST

AFC CLIPPER/AMPLIFIER

Ref.	Description				Mfg./Type
C301	Capacitor	10 uf		25 WVDC	Sprague TE1204
C302	Capacitor	.0047 uf	10%	400 WVDC	GE 75F1R4A472
C303	Capacitor	0.1 uf	10%	50 WVDC	GE 75F2R5A104
C304	Capacitor	.22 uf	10%	50 WVDC	GE 75F3R5A224
C305	Capacitor	0.1 uf	10%	50 WVDC	GE 75F2R5A104
C306	Capacitor	.22 uf	10%	50 WVDC	GE 75F3R5A224
C307	Capacitor	0.1 uf	10%	50 WVDC	GE 75F2R5A104
C308	Capacitor	.22 uf	10%	50 WVDC	GE 75F3R5A224
C309	Capacitor	.47 uf	10%	50 WVDC	GE 75F6R5A474
C310	Capacitor	1.0 uf	10%	50 WVDC	GE 75F7R5A105
C311	Capacitor	1.0 uf	10%	50 WVDC	GE 75F7R5A105
C312	Capacitor	10 uf		25 WVDC	Sprague TE1204
C313	Capacitor	10 uf		25 WVDC	Sprague TE1204
C314	Capacitor	0.1 uf	10%	50 WVDC	GE 75F2R5A104
D301	Diode				1N456
D302	Diode				1N456
D303	Diode				1N456
D304	Diode				1N456
D305	Diode				1N456
D306	Diode				1N456
D307	Diode				1N456
D308	Diode				1N456
Q301	Transistor				2N2270
Q302	Transistor				2N3391
Q303	Transistor				2N3391
Q304	Transistor				2N2270
Q305	Transistor				2N3904
Q306	Transistor				2N2270
Q307	Transistor				2N2195
R301	Resistor	1 megohm	5%	1/4 Watt	RC07GF105J
R302	Resistor	150,000 ohms	5%	1/4 Watt	RC07GF154J
R303	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R304	Resistor	200,000 ohms	5%	1/4 Watt	RC07GF204J
R305	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R306	Resistor	100,000 ohms	5%	1/4 Watt	RC07GF104J
R307	Resistor	150,000 ohms	5%	1/4 Watt	RC07GF154J
R308	Resistor	1 megohm	5%	1/4 Watt	RC07GF105J
R309	Resistor	27,000 ohms	5%	1/4 Watt	RC07GF273J
R310	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R311	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R312	Resistor	68,000 ohms	5%	1/4 Watt	RC07GF683J
R313	Resistor	1 megohm	5%	1/4 Watt	RC07GF105J

PARTS LIST
AFC Clipper/Amplifier (Continued)

Ref.	Description					Mfg./Type
R314	Resistor	150,000 ohms	5%	1/4 Watt		RC07GF154J
R315	Resistor	15,000 ohms	5%	1/4 Watt		RC07GF153J
R316	Resistor	1,000 ohms	5%	1/4 Watt		RC07GF102J
R317	Resistor	68,000 ohms	5%	1/4 Watt		RC07GF683J
R318	Resistor	330,000 ohms	5%	1/4 Watt		RC07GF334J
R319	Resistor	150,000 ohms	5%	1/4 Watt		RC07GF154J
R320	Resistor	10,000 ohms	5%	1/4 Watt		RC07GF103J
R321	Resistor	1,000 ohms	5%	1/4 Watt		RC07GF102J
R322	Resistor	10,000 ohms	5%	1/4 Watt		RC07GF103J
R323	Resistor	10,000 ohms	5%	1/4 Watt		RC07GF103J
R324	Resistor	100,000 ohms	5%	1/4 Watt		RC07GF104J
R325	Not Used					
R326	Resistor	36,000 ohms	5%	1/4 Watt		RC07GF363J
R327	Resistor	220 ohms	5%	1/4 Watt		RC07GF221J
R328	Resistor	4,700 ohms	5%	1/4 Watt		RC07GF472J
R329	Resistor	10,000 ohms	5%	1/4 Watt		RC07GF103J
R330	Resistor	10,000 ohms	5%	1/4 Watt		RC07GF103J
R331	Resistor	5,600 ohms	5%	1/4 Watt		RC07GF562J
R332	Resistor	100,000 ohms	5%	1/4 Watt		RC07GF104J
T301	Transformer	10,000:10,000 ohms				Triad SP-66

PARTS LIST

SERVO AMPLIFIER

Ref.	Description			Mfg./Type
C401	Capacitor	250 uf	50 WVDC	CDE BR250-50
C402	Capacitor	1.0 uf	35 WVDC	Kemet K1C35K
C403	Capacitor	1.0 uf	35 WVDC	Kemet K1C35K
C404	Capacitor	1.0 uf	35 WVDC	Kemet K1C35K
C405	Capacitor	2.2 uf	20 WVDC	Kemet K2R2C20K
C406	Capacitor	10 uf	25 WVDC	Sprague TE1204
C407	Capacitor	100 pf	1000 WVDC	CM05FD101J03
C408	Capacitor	390 pf	500 WVDC	CM05FD391J03
D401	Diode, zener			1N4751A
D402	Diode			1N270
D403	Diode, zener			1N5245B
D404	Diode			1N4002
DA401	Diode Assembly			Mallory FW-200
Q401	Transistor			2N3054
Q402	Transistor			2N2270
Q403	Transistor			2N3391
Q404	Transistor			MPF105
Q405	Transistor			MPF105
Q406	Transistor			2N3391
Q407	Transistor			2N2270
Q408	Transistor			2N2270
Q409	Transistor			2N2270
Q410	Transistor			2N3391
Q411	Transistor			2N3054
Q412	Transistor			2N3391
Q413	Transistor			2N3054
R401	Resistor	2.7 ohms 5%	1.5 Watts	Ohmite 995-1A
R402	Resistor	680 ohms 5%	1.5 Watts	Ohmite 995-1A
R403	Resistor	3.3 ohms 5%	3 Watts	Sprague 242E3R35
R404	Resistor	1,000 ohms 5%	1/4 Watt	RC07GF102J
R405	Resistor	82,000 ohms 5%	1/4 Watt	RC07GF823J
R406	Resistor	27,000 ohms 5%	1/4 Watt	RC07GF273J
R407	Resistor	330 ohms 5%	1/4 Watt	RC07GF331J
R408	Resistor	3,900 ohms 5%	1/4 Watt	RC07GF392J
R409	Resistor	1,000 ohms 5%	1/4 Watt	RC07GF102J
R410	Resistor	10,000 ohms 5%	1/4 Watt	RC07GF103J
R411	Resistor	15,000 ohms 5%	1/4 Watt	RC07GF153J
R412	Resistor, Variable	10,000	1 Watt	IRC 106-2
R413	Resistor	220,000 ohms 5%	1/4 Watt	RC07GF224J
R414	Resistor	6,800 ohms 5%	1/4 Watt	RC07GF682J

PARTS LIST
Servo Amplifier (Continued)

Ref.	Description					Mfg./Type
R415	Resistor	6,800 ohms	5%	1/4	Watt	RC07GF682J
R416	Resistor	270,000 ohms	5%	1/4	Watt	RC07GF274J
R417	Resistor	470 ohms	5%	1/4	Watt	RC07GF471J
R418	Resistor	220,000 ohms	5%	1/4	Watt	RC07GF224J
R419	Resistor	5,600 ohms	5%	1/4	Watt	RC07GF562J
R420	Resistor	22,000 ohms	5%	1/4	Watt	RC07GF223J
R421	Resistor	1,800 ohms	5%	1/4	Watt	RC07GF182J
R422	Resistor	6,800 ohms	5%	1/4	Watt	RC07GF682J
R423	Resistor	62,000 ohms	5%	1/4	Watt	RC07GF623J
R424	Resistor	1,000 ohms	5%	1/4	Watt	RC07GF102J
R425	Resistor	47,000 ohms	5%	1/4	Watt	RC07GF473J
R426	Resistor	12,000 ohms	5%	1/4	Watt	RC07GF123J
R427	Resistor	22,000 ohms	5%	1/4	Watt	RC07GF223J
R428	Resistor, Variable	100 ohms		1	Watt	IRC 106-2
R429	Resistor	15,000 ohms	5%	1/4	Watt	RC07GF153J
R430	Resistor	22,000 ohms	5%	1/4	Watt	RC07GF223J
R431	Resistor	10,000 ohms	5%	1/4	Watt	RC07GF103J
R432	Resistor	2,200 ohms	5%	1/4	Watt	RC07GF222J
R433	Resistor	150 ohms	5%	5	Watts	Sprague 243E1515
R434	Resistor	150 ohms	5%	5	Watts	Sprague 243E1515
R435	Resistor	2,200 ohms	5%	1/4	Watt	RC07GF222J
R436	Resistor	10,000 ohms	5%	1/4	Watt	RC07GF103J

PARTS LIST

VERTICAL AMPLIFIER

Ref.	Description	Mfg./Type
C501	Capacitor 10 uf 25 WVDC	Sprague TE1204
C502	Capacitor .022 uf 10% 400 WVDC	GE 75F3R4A223
C503	Capacitor .22 uf 10% 50 WVDC	GE 75F3R5A224
C504	Capacitor 50 uf 6 WVDC	Sprague TE1100
C505	Capacitor .22 uf 10% 50 WVDC	GE 75F3R5A224
C506	Capacitor .022 uf 10% 400 WVDC	GE 75F3R4A224
C507	Capacitor .022 uf 10% 400 WVDC	GE 75F3R4A224
C508	Capacitor 10 uf 25 WVDC	Sprague TE1204
C509	Capacitor 4 uf 350 WVDC	CDE BR4-350
D501	Diode	1N4005
D502	Diode	1N4005
Q501	Transistor	2N3391
Q502	Transistor	2N3391
Q503	Transistor	2N3440
Q504	Transistor	2N3440
R501	Resistor 220,000 ohms 5% 1/4 Watt	RC07GF224J
R502	Resistor 1 megohm 5% 1/4 Watt	RC07GF105J
R503	Resistor 51,000 ohms 5% 1/4 Watt	RC07GF513J
R504	Resistor 2,200 ohms 5% 1/4 Watt	RC07GF222J
R505	Resistor 2,200 ohms 5% 1/4 Watt	RC07GF222J
R506	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R507	Resistor 330 ohms 5% 1/4 Watt	RC07GF331J
R508	Resistor 3,000 ohms 5% 1/4 Watt	RC07GF302J
R509	Resistor 47,000 ohms 5% 1/4 Watt	RC07GF473J
R510	Resistor 56,000 ohms 5% 1/2 Watt	RC07GF563J
R511	Resistor 56,000 ohms 5% 1/2 Watt	RC07GF563J
R512	Resistor, Variable 100 ohms 1 Watt	IRC 106-2
R513	Resistor 3,900 ohms 5% 1/4 Watt	RC07GF393J
R514	Resistor 47,000 ohms 5% 1/4 Watt	RC07GF473J
R515	Resistor 2.2 megohms 5% 1/2 Watt	RC20GF225J
R516	Resistor 2.2 megohms 5% 1/2 Watt	RC20GF225J
R517	Resistor 1,000 ohms 5% 1/2 Watt	RC20GF102J
R518	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R519	Resistor 2.2 megohms 5% 1/2 Watt	RC07GF225J
R520	Resistor, Variable 1 megohm 1 Watt	Helipot 62PARIM
R521	Resistor, Variable 1 megohm 1 Watt	Helipot 62PARIM
R522	Resistor 27,000 ohms 5% 1/2 Watt	RC20GF273J
R523	Resistor 22,000 ohms 5% 1/2 Watt	RC20GF223J
R524	Resistor 68,000 ohms 5% 1/2 Watt	RC20GF683J
R525	Resistor 2.2 megohms 5% 1/2 Watt	RC20GF225J

PARTS LIST

LEVEL AMPLIFIER

Ref.	Description				Mfg./Type
C601	Capacitor	.1 uf	10%	50 WVDC	GE 75F2R5A104
C602	Capacitor	.0047 uf	10%	400 WVDC	GE 75F1R4A472
C603	Capacitor	.22 uf	10%	50 WVDC	GE 75F3R5A224
C604	Capacitor	20 uf		25 WVDC	Sprague TE1206
C605	Capacitor	.22 uf	10%	50 WVDC	GE 75F3R5A224
C606	Capacitor	10 uf		25 WVDC	Sprague TE1204
C607	Capacitor	1.0 uf		35 WVDC	Kemet K1C35K
C608	Capacitor	.1 uf	10%	50 WVDC	GE 75F2R5A104
C609	Capacitor	10 uf		25 WVDC	Sprague TE1204
C610	Capacitor	10 uf		25 WVDC	Sprague TE1204
C611	Capacitor	10 uf		25 WVDC	Sprague TE1204
C612	Capacitor	20 uf		25 WVDC	Sprague TE1206
D601	Diode				1N456
D602	Diode				1N456
D603	Diode				1N456
D604	Diode				1N456
Q601	Transistor				2N3904
Q602	Transistor				2N3904
Q603	Transistor				2N3904
Q604	Transistor				2N3906
Q605	Transistor				2N3904
Q606	Transistor				2N3904
Q607	Transistor				2N3906
Q608	Transistor				2N3904
Q609	Transistor				2N3904
R601	Resistor	100,000 ohms	5%	1/4 Watt	RC07GF104J
R602	Resistor	1,800 ohms	5%	1/4 Watt	RC07GF182J
R603	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R604	Resistor	330,000 ohms	5%	1/4 Watt	RC07GF334J
R605	Resistor	330,000 ohms	5%	1/4 Watt	RC07GF334J
R606	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R607	Resistor	1,800 ohms	5%	1/4 Watt	RC07GF182J
R608	Resistor	1,800 ohms	5%	1/4 Watt	RC07GF182J
R609	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R610	Resistor, Variable	1,000 ohms		1 Watt	IRC 106-2
R611	Resistor, Variable	10,000 ohms		1 Watt	IRC 106-2

PARTS LIST
Level Amplifier (Continued)

Ref.	Description	Mfg./Type
R612	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R613	Resistor 330,000 ohms 5% 1/4 Watt	RC07GF334J
R614	Resistor 150,000 ohms 5% 1/4 Watt	RC07GF154J
R615	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R616	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R617	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R618	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R619	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R620	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R621	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R622	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R623	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R624	Resistor 100 ohms 5% 1/4 Watt	RC07GF101J
R625	Resistor 3,900 ohms 5% 1/4 Watt	RC07GF392J
R626	Resistor 2,200 ohms 5% 1/4 Watt	RC07GF222J
R627	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R628	Resistor 5,600 ohms 5% 1/4 Watt	RC07GF562J
R629	Resistor 10,000 ohms 5% 1/4 Watt	RC07GF103J
R630	Resistor, Variable 10,000 ohms 1 Watt	IRC 106-2
R631	Resistor 1,000 ohms 5% 1/4 Watt	RC07GF102J
R632	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R633	Resistor 75,000 ohms 5% 1/4 Watt	RC07GF753J
R634	Resistor 100,000 ohms 5% 1/4 Watt	RC07GF104J
R635	Resistor 330 ohms 5% 1/4 Watt	RC07GF331J

PARTS LIST

DIAL ASSEMBLY

Ref.	Description		Mfg./Type
B701	Clutch		Altair MC545AA28
B702	Motor		Haden K5331-P-1-10 RPM
J701	Connector	(Part of Probe Assembly)	
J702	Connector		Winchester ME5P-LRN
J703	Connector	(Part of Cavity)	
J704	Connector		Winchester ME5S-LRN
P701	Connector		Winchester M5P-LS
S701	Switch		Grayhill 24002-10
Z701	Pad	3 db	Emco A-303J
Z702	Oscillator	1-2.5 GHz	RFD LS-5119

PARTS LIST

LOW PASS FILTER AND CRYSTAL MONITOR

Ref.	Description	Mfg./Type
C801	Capacitor 33 pf 5% 300 WVDC	CM05ED330J03
C802	Capacitor 75 pf 5% 300 WVDC	CM05ED750J03
C803	Capacitor 75 pf 5% 300 WVDC	CM05ED750J03
C804	Capacitor 33 pf 5% 300 WVDC	CM05ED330J03
C805	Capacitor .005 uf 20% 50 WVDC	Sprague TG-D50
E801	Cable Termination	MX-1684/U
E802	Cable Termination	MX-1684/U
FL801	Filtercon	Erie 1201-052
L801	Inductor 0.15 uh	Delevan 1025-00
L802	Inductor 0.15 uh	Delevan 1025-00
L803	Inductor 0.15 uh	Delevan 1025-00
L804	Inductor 4.7 uh	Delevan 1537-28
P801	Connector	UG-88C/U
R801	Resistor 6.2 ohms 5% 1/4 Watt	RC07GF6R2J

PARTS LIST

IF AMPLIFIER

Ref.	Description				Mfg./Type
C901	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C902	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C903	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C904	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C905	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C906	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C907	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C908	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C909	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C910	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C911	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C912	Capacitor	2.2 pf	NPO	1000 WVDC	Sprague 10TCC-V22
C913	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C914	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C915	Capacitor	.005		50 WVDC	Sprague TG-D50
C916	Capacitor	2.2 pf	NPO	1000 WVDC	Sprague 10TCC-V22
C917	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C918	Capacitor	51 pf		500 WVDC	CM05ED510J03
C919	Capacitor	5 pf	N750	1000 WVDC	Sprague 10TCU-V50
C920	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C921	Capacitor	1.0 uf	20%	200 WVDC	Aerovox P8292ZN13
C922	Capacitor	100 pf		500 WVDC	CM05FD101J03
C923	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C924	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C925	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C926	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C927	Capacitor	4.7 pf	NPO	500 WVDC	Sprague 10TCC-V47
C928	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C929	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C930	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C931	Capacitor	15 uf		500 WVDC	CM06FD150J03
C932	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C933	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C934	Capacitor	.15 pf	10%		Stackpole 23-6364
C935	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C936	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C937	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4
C938	Capacitor	1.0 pf	NPO	1000 WVDC	Sprague 10TCC-V10
C939	Capacitor	4.7 pf	NPO	500 WVDC	Sprague 10TCC-V47
C940	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C941	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C942	Capacitor, Variable	1-11 pf			E.F.Johnson 189-504-4

PARTS LIST
IF Amplifier (Continued)

Ref.	Description				Mfg./Type
C943	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C944	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C945	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C946	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C947	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C948	Capacitor, Variable		1-11 pf		E.F.Johnson 189-504-4
C949	Capacitor	2.2 pf	NPO	1000 WVDC	Sprague 10TCC-V22
C950	Capacitor, Variable		1-11 pf		E.F.Johnson 189-504-4
C951	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C952	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C953	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C954	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C955	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C956	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C957	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C958	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C959	Capacitor, Variable		1-11 pf		E.F.Johnson 189-504-4
C960	Capacitor	4.7 pf	NPO	1000 WVDC	Sprague 10TCC-V47
C961	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C962	Capacitor	100 pf		50 WVDC	CM05FD101J03
C963	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C964	Capacitor, Variable		1-11 pf		E.F.Johnson 189-504-4
C965	Capacitor	680 pf			CM06FD681J03
C966	Capacitor	680 pf			CM06FD681J03
C967	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C968	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C969	Not Used				
C970	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C971	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C972	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C973	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C974	Capacitor	..01 uf		50 WVDC	Sprague TG-S10
C975	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
C976	Capacitor	.01 uf		50 WVDC	Sprague TG-S10
C977	Capacitor	.005 uf		50 WVDC	Sprague TG-D50
D901	Diode				1N5140
D902	Diode				1N270
D903	Diode				1N456

PARTS LIST
IF Amplifier (continued)

Ref.	Description		Mfg./Type
FL901	Filtercon		Erie 1201-052
FL902	Filtercon		Erie 1201-052
FL903	Filtercon		Erie 1201-052
FL904	Filtercon		Erie 1201-052
FL905	Filtercon		Erie 1201-052
FL906	Filtercon		Erie 1201-052
FL907	Filtercon		Erie 1201-052
J901	Connector		UG-625/U
J902	Connector		UG-625/U
J903	Connector		Micon 1004
J904	Connector		Micon 1004
J905	Connector		Cinch-Jones DAM-15P DAM-15P
L901	Inductor	.15 uh	Delevan 1025-00
L902	Inductor	.47 uh	Delevan 1025-12
L903	Inductor	2.2 uh	Delevan 1537-20
L904	Inductor	.56 uh	Delevan 1025-14
L905	Inductor	2.2 uh	Delevan 1537-20
L906	Inductor	2.2 uh	Delevan 1537-20
L907	Inductor	2.2 uh	Delevan 1025-28
L908	Inductor	2.2 uh	Delevan 1537-20
L909	Inductor, Variable		M/T 32-070-1
L910	Not Used		
L911	Inductor	1.5 uh	Delevan 1025-24
L912	Inductor	6.8 uh	Delevan 1537-32
L913	Inductor	6.8 uh	Delevan 1537-32
L914	Not Used		
L915	Inductor	6.8 uh	Delevan 1537-32
L916	Inductor		M/T 32-070-5
L917	Inductor		M/T 32-070-9
L918	Inductor	1.5 uh	Delevan 1025-24
L919	Inductor	6.8 uh	Delevan 1537-32
L920	Inductor	2.2 uh	Delevan 1025-28
L921	Inductor	6.8 uh	Delevan 1537-32
L922	Inductor	6.8 uh	Delevan 1537-32
L923	Inductor	6.8 uh	Delevan 1537-32
L924	Inductor	2.2 uh	Delevan 1025-28
L925	Inductor	6.8 uh	Delevan 1537-32
L926	Inductor	2.2 uh	Delevan 1025-28
L927	Inductor	10 uh	Delevan 1025-44
L928	Inductor	6.8 uh	Delevan 1537-32
L929	Not Used		
L930	Not Used		
L931	Inductor	6.8 uh	Delevan 1537-32

PARTS LIST
IF Amplifier (Continued)

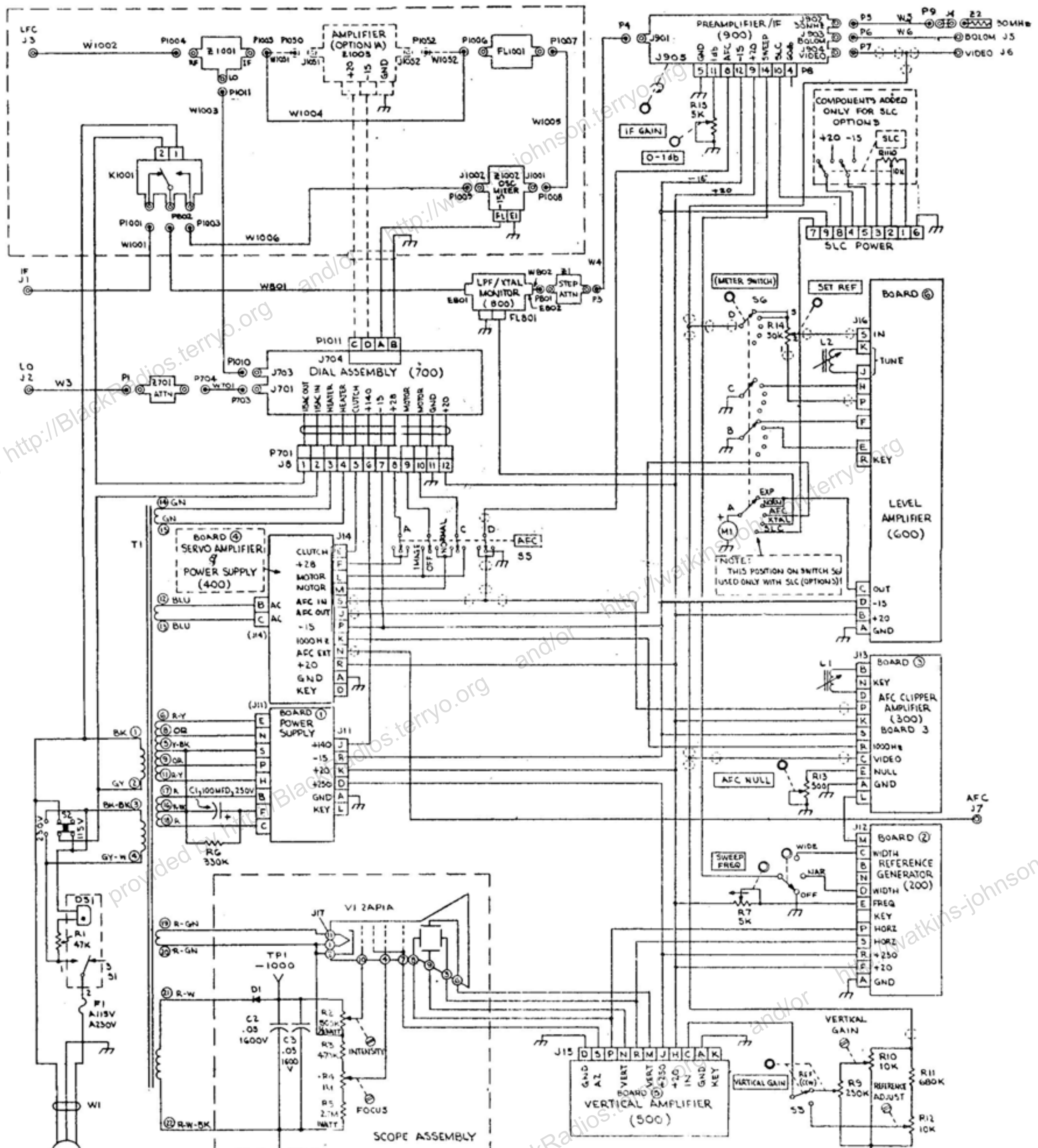
Ref.	Description				Mfg./Type
L932	Inductor	2.2 uh			Delevan 1537-20
L933	Inductor	6.8 uh			Delevan 1537-32
L934	Inductor	2.2 uh			Delevan 1537-20
Q901	Transistor				2N3478
Q902	Transistor				2N3478
Q903	Transistor				3N128
Q904	Transistor				Amperex A473
Q905	Transistor				3N126
Q906	Transistor				Mctorola MPS-6546
Q907	Transistor				Amperex A473
Q908	Transistor				Amperex A473
Q909	Transistor				Amperex A473
Q910	Transistor				Amperex A473
Q911	Transistor				3N128
Q912	Transistor				Amperex A473
Q913	Transistor				Amperex A473
Q914	Transistor				Amperex A473
Q915	Transistor				Amperex A473
R901	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R902	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R903	Resistor	56 ohms	5%	1/4 Watt	RC07GF560J
R904	Resistor	1,200 ohms	5%	1/4 Watt	RC07GF122J
R905	Resistor	180 ohms	5%	1/4 Watt	RC07GF181J
R906	Resistor	6,800 ohms	5%	1/4 Watt	RC07GF682J
R907	Resistor	3,300 ohms	5%	1/4 Watt	RC07GF332J
R908	Resistor, Variable	500 ohms			RV6NAYSD501A
R909	Resistor	100 ohms	5%	1/4 Watt	RC07GF101J
R910	Not Used				
R911	Resistor	6,800 ohms	5%	1/4 Watt	RC07GF682J
R912	Resistor	390 ohms	5%	1/4 Watt	RC07GF391J
R913	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R914	Resistor	1,500 ohms	5%	1/4 Watt	RC07GF152J
R915	Resistor	2,200 ohms	5%	1/4 Watt	RC07GF222J
R916	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R917	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R918	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R919	Resistor	2,200 ohms	5%	1/4 Watt	RC07GF222J
R920	Resistor	1,200 ohms	5%	1/4 Watt	RC07GF122J
R921	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R922	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R923	Resistor	22,000 ohms	5%	1/4 Watt	RC07GF223J

PARTS LIST
IF Amplifier (Continued)

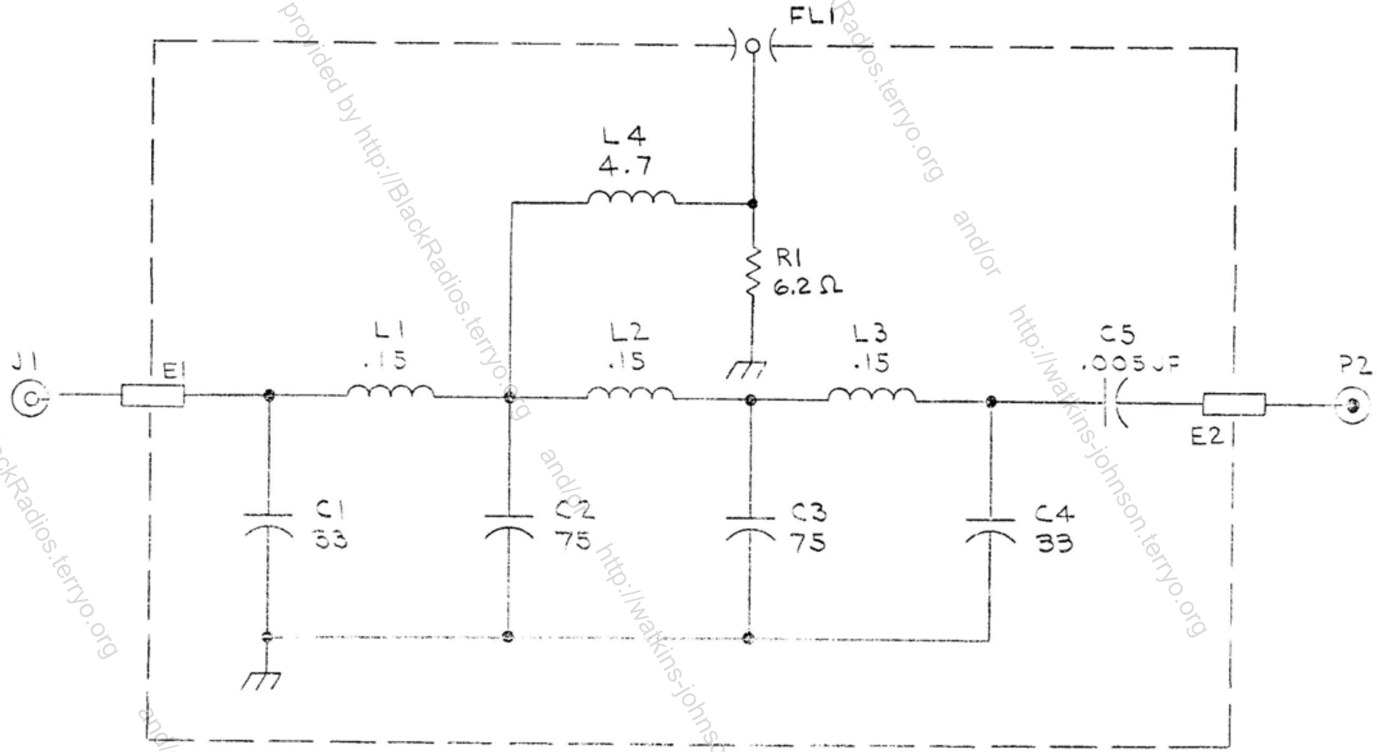
R924	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R925	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R926	Resistor	3,000 ohms	5%	1/4 Watt	RC07GF302J
R927	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R928	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R929	Resistor	6,800 ohms	5%	1/4 Watt	RC07GF682J
R930	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R931	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF103J
R932	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R933	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R934	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R935	Resistor	2,200 ohms	5%	1/4 Watt	RC07GF222J
R936	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R937	Resistor	2,700 ohms	5%	1/4 Watt	RC07GF272J
R938	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R939	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R940	Resistor	12,000 ohms	5%	1/4 Watt	RC07GF123J
R941	Resistor	2,200 ohms	5%	1/4 Watt	RC07GF222J
R942	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R943	Resistor	820 ohms	5%	1/4 Watt	RC07GF821J
R944	Not Used				
R945	Not Used				
R946	Resistor, Variable	10,000 ohms		1 Watt	Helipot 62PAR10K
R947	Resistor	2,700 ohms	5%	1/4 Watt	RC07GF272J
R948	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R949	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R950	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R951	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R952	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R953	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R954	Resistor	680 ohms	5%	1/4 Watt	RC07GF681J
R955	Resistor	2,700 ohms	5%	1/4 Watt	RC07GF272J
R956	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R957	Resistor, Variable	10,000 ohms		1 Watt	Helipot 62PAR10K
R958	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R959	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R960	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R961	Resistor	15,000 ohms	5%	1/4 Watt	RC07GF153J
R962	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R963	Resistor	1,000 ohms	5%	1/4 Watt	RC07GF102J
R964	Resistor	2,200 ohms	5%	1/4 Watt	RC07GF222J
R965	Resistor	4,700 ohms	5%	1/4 Watt	RC07GF472J
R966	Resistor	8,200 ohms	5%	1/4 Watt	RC07GF822J
R967	Resistor	13,000 ohms	5%	1/4 Watt	RC07GF133J
R968	Resistor	39,000 ohms	5%	1/4 Watt	RC07GF393J
R969	Resistor	10,000 ohms	5%	1/4 Watt	RC07GF103J
R970	Resistor, Variable	10,000 ohms		1 Watt	Helipot 62PAR10K

PARTS LIST
IF Amplifier (Continued)

Ref.	Description	Mfg./Type
T901	Transformer	M/T 32-070-2
T902	Transformer	M/T 32-070-3
T903	Transformer	M/T 32-070-4
Z901	Bolometer	Filmohm FSB 875-200



SCHEMATIC DIAGRAM - RECEIVER
FIGURE 7.1

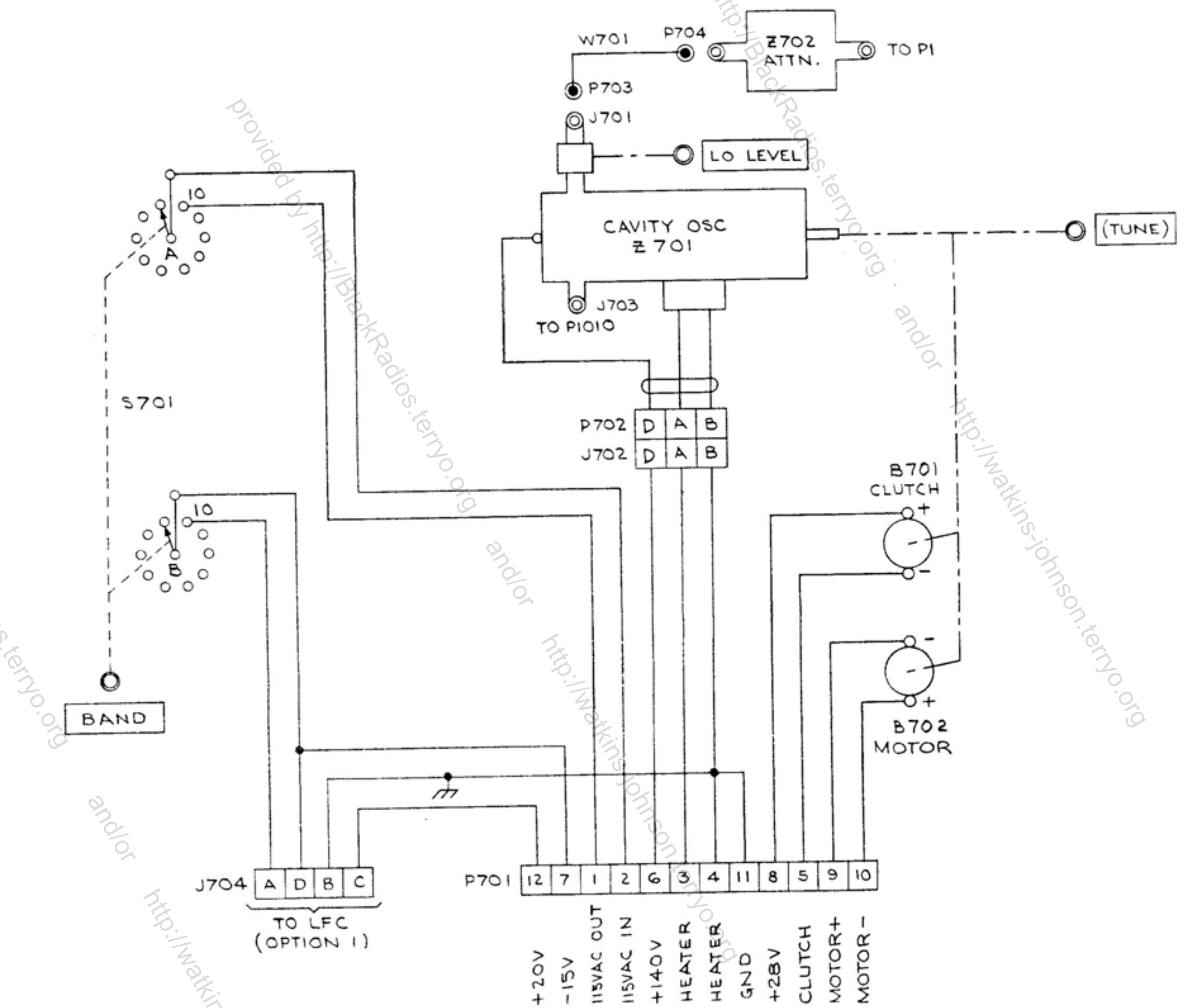


NOTE: ADD 800 TO REFERENCE NUMBERS OF COMPONENTS ON THIS ASSEMBLY.

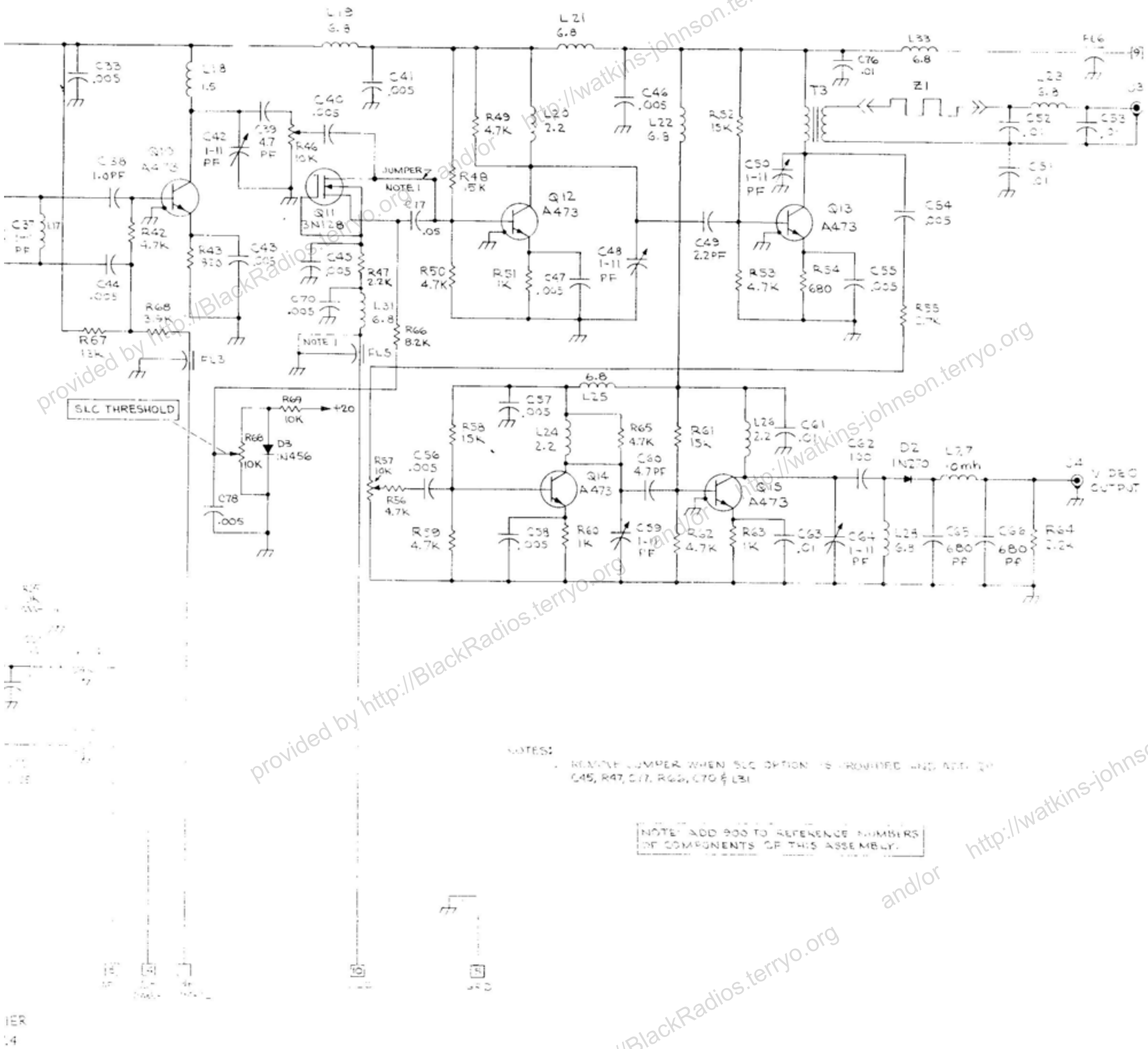
UNLESS OTHERWISE SPECIFIED:
1. ALL CAPACITANCE VALUES IN PF.
2. ALL INDUCTANCE VALUES IN UH.

LOW PASS FILTER AND CRYSTAL MONITOR

FIGURE 7.2

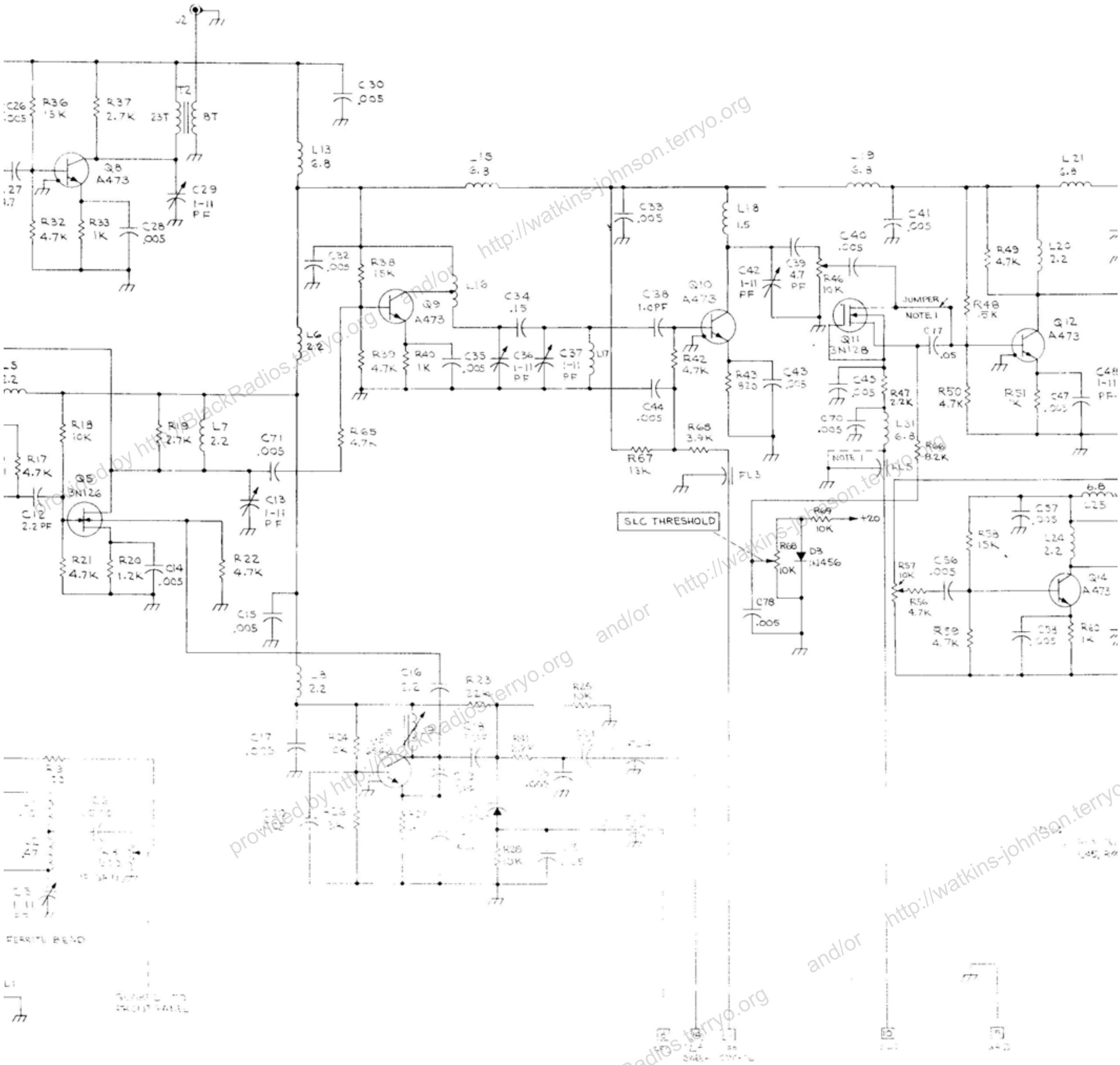


SCHEMATIC DIAGRAM
DIAL ASSEMBLY
FIGURE 7.3

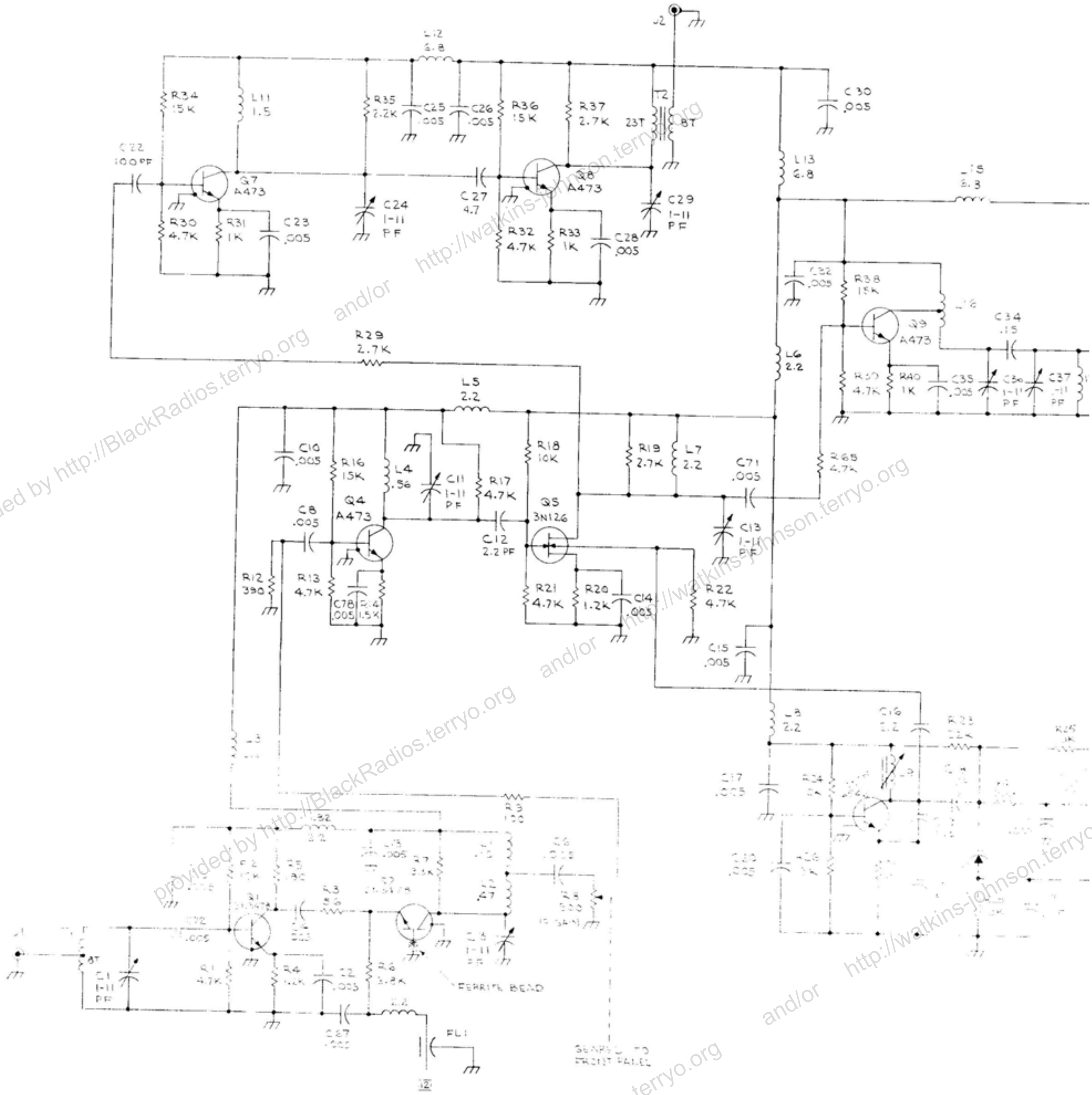


NOTES:
1. REMOVE JUMPER WHEN SLC OPTION IS PROVIDED AND ADD Q11, C45, R47, C17, R66, C70 & L31

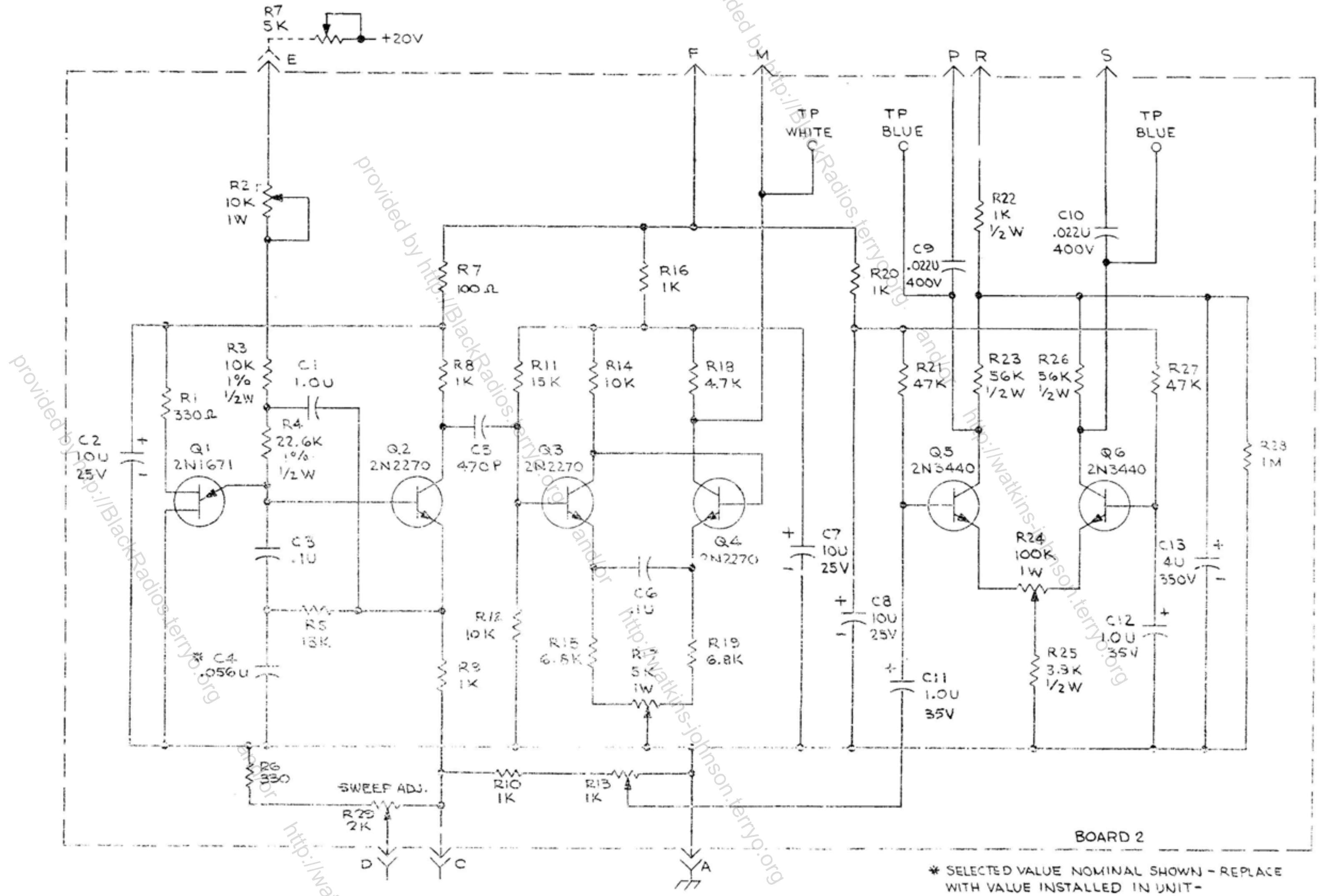
NOTE: ADD 900 TO REFERENCE NUMBERS OF COMPONENTS OF THIS ASSEMBLY.



IF AMPLIFIER
FIGURE 7-4



IF AMPLIFIER
FIGURE [illegible]

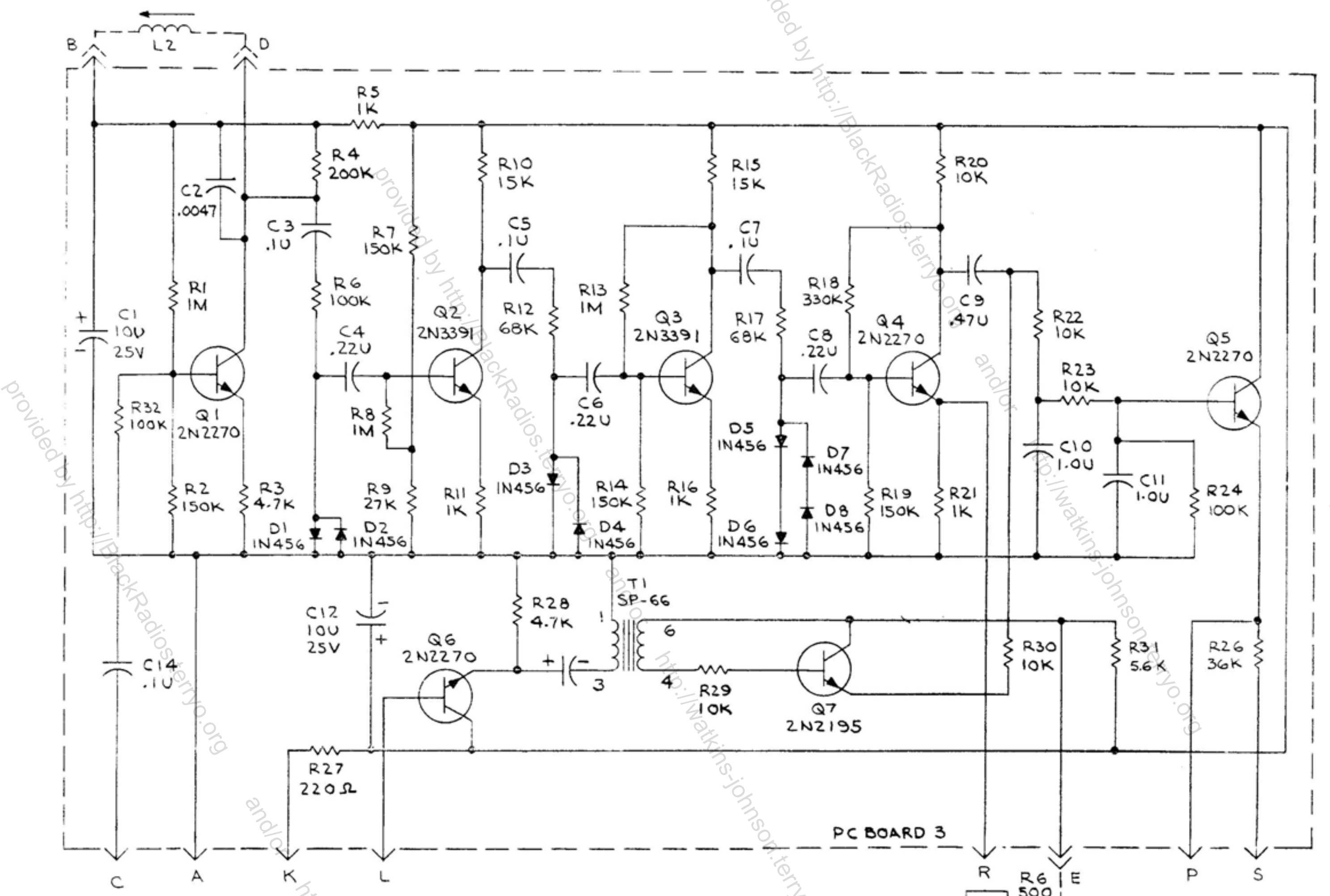


* SELECTED VALUE NOMINAL SHOWN - REPLACE WITH VALUE INSTALLED IN UNIT-

NOTE: ADD 200 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

REFERENCE GENERATOR

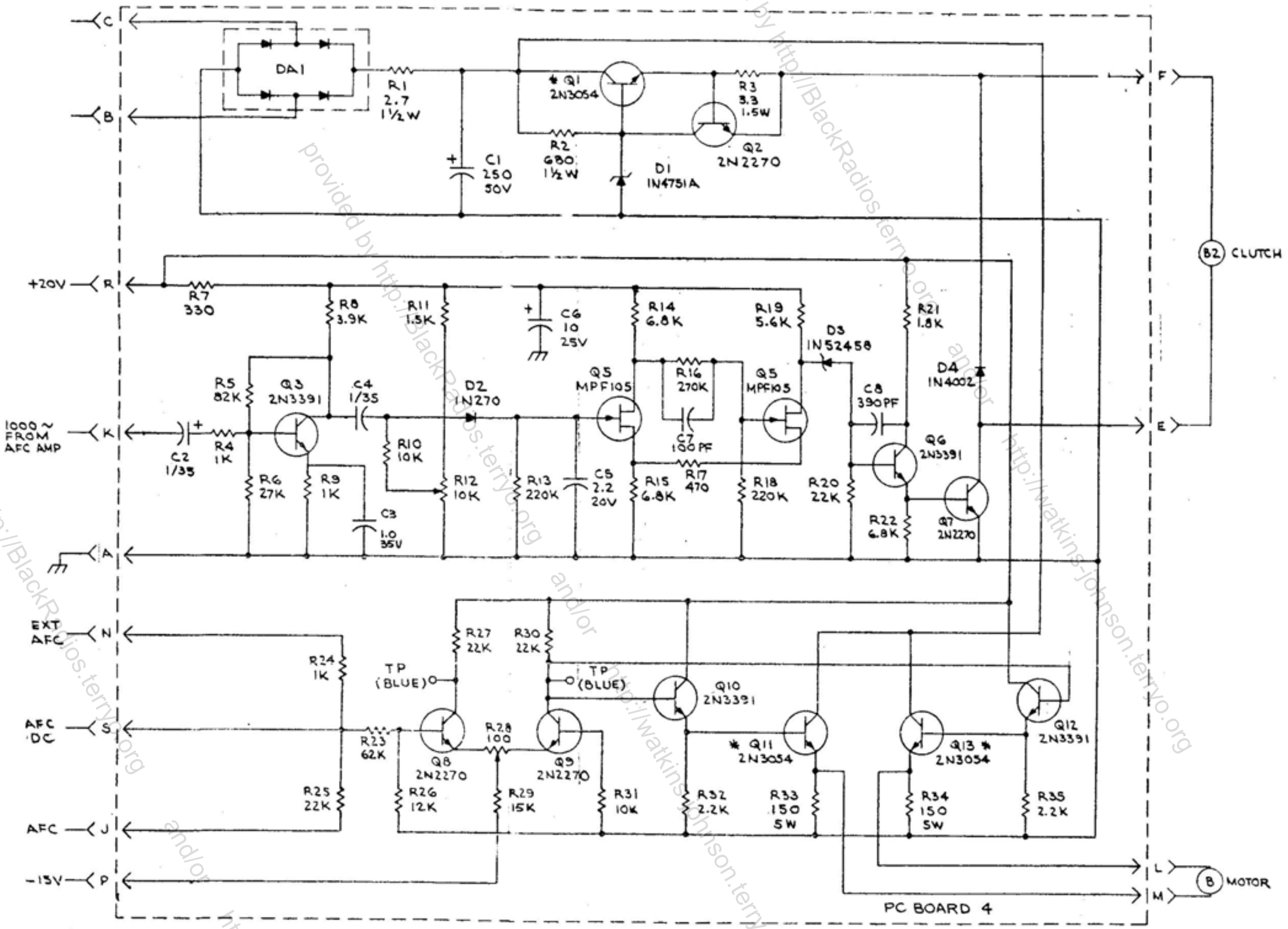
FIGURE 7.5



NOTE: ADD 300 TO REFERENCE NUMBERS OF COMPONENTS ON BOARD.

AFC CLIPPER AMPLIFIER
FIGURE 7.6

1

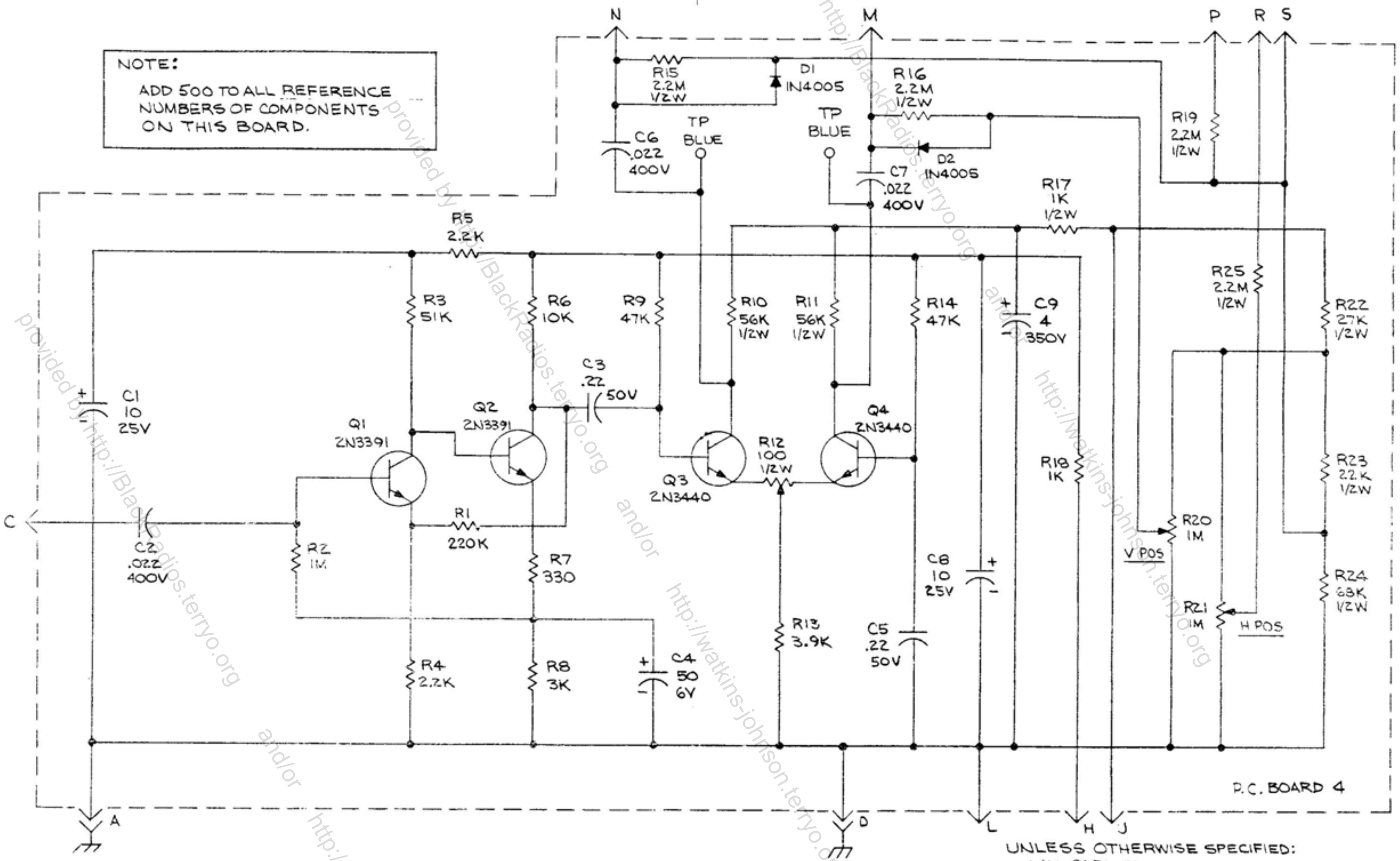


NOTES:
UNLESS OTHERWISE NOTED:
1. ALL RESISTANCE VALUES IN OHMS
2. ALL CAPACITANCE VALUES IN MICROFARADS
3. * TRANSISTOR MOUNTED ON HEAT SINK

ADD 400 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD

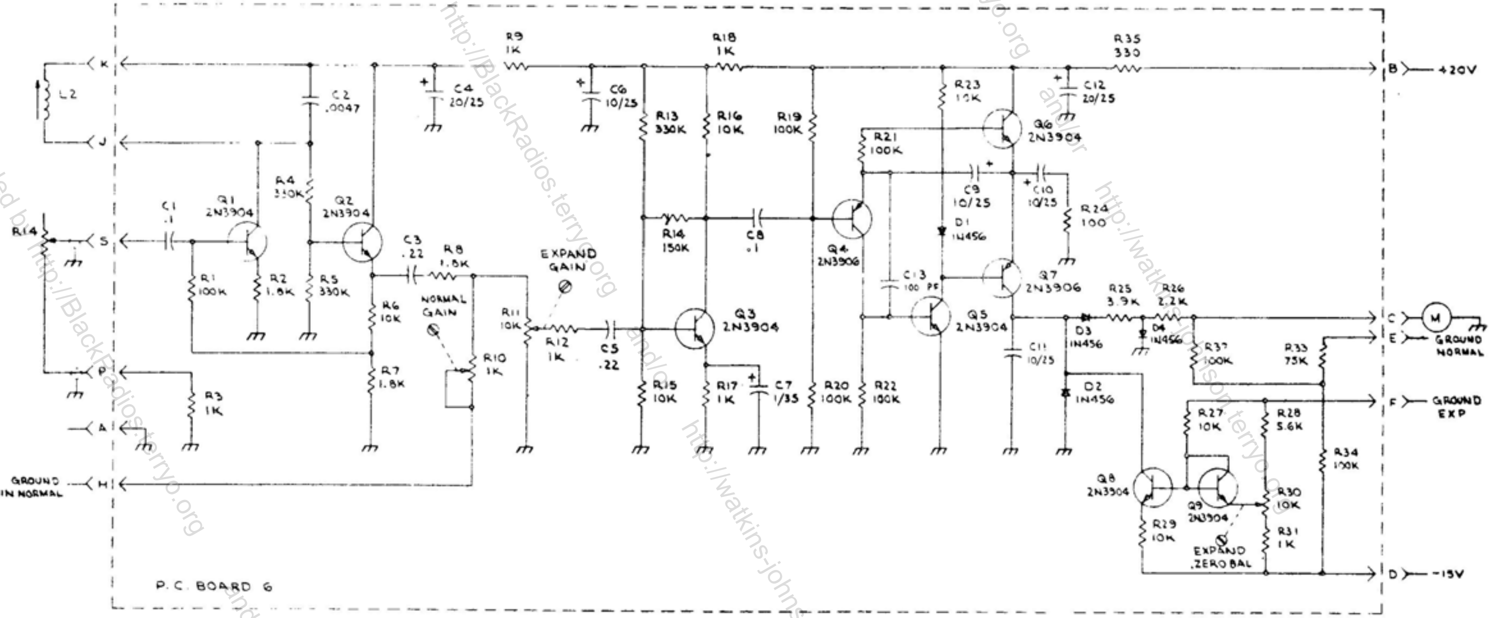
SERVO AMPLIFIER
FIGURE 7.7

NOTE:
ADD 500 TO ALL REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD.



UNLESS OTHERWISE SPECIFIED:
1. ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2. ALL RESISTANCE VALUES ARE IN OHM; ±5%.
3. ALL RESISTORS ARE 1/4 WATT.

VERTICAL SCOPE AMPLIFIER
SCHEMATIC DIAGRAM
FIGURE 7.8

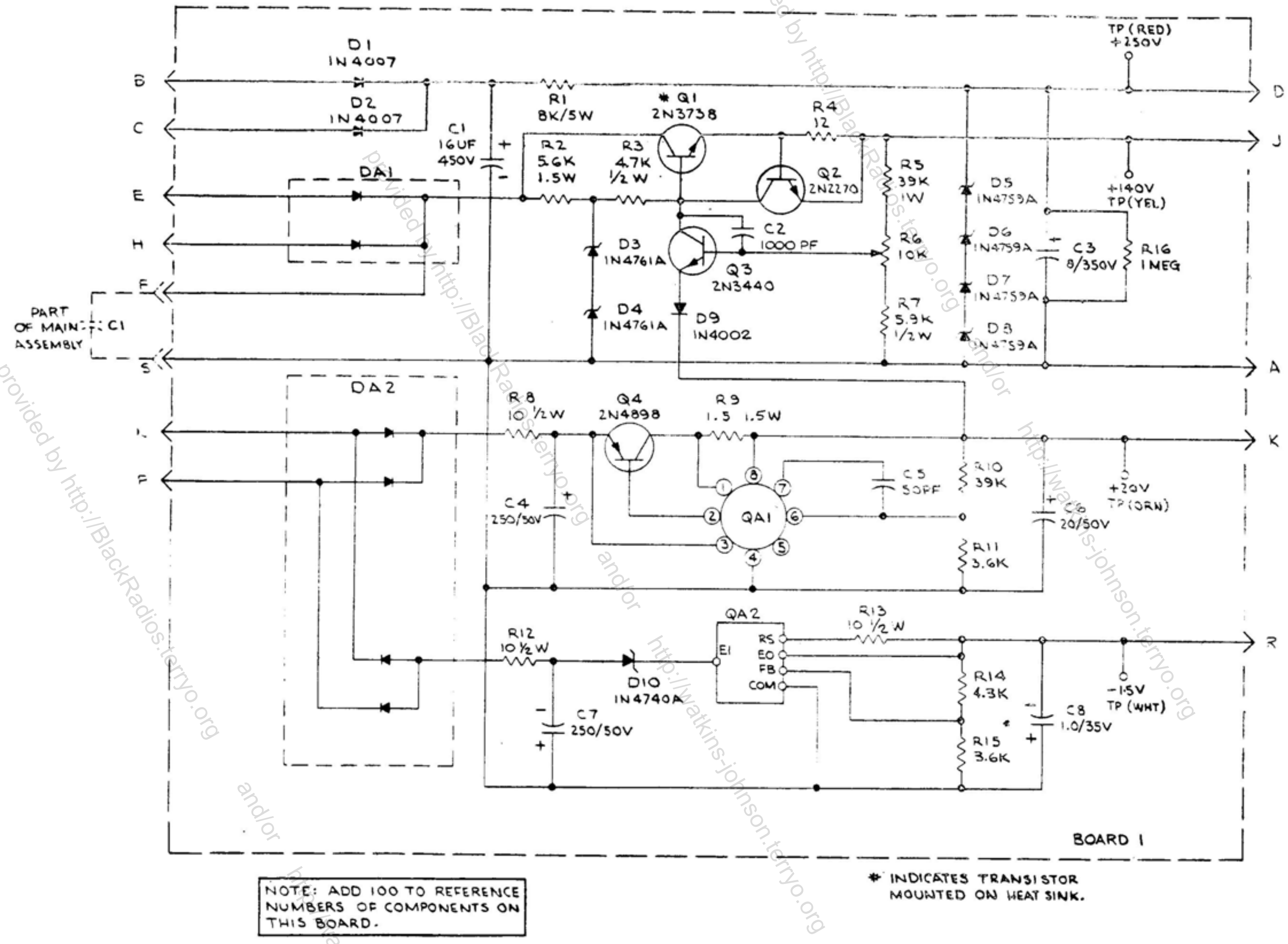


NOTES:
UNLESS OTHERWISE NOTED
1. ALL RESISTANCE VALUES IN OHMS
2. ALL CAPACITANCE VALUES IN MICROFARADS

LEVEL AMPLIFIER

FIGURE 7.9

ADD 600 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD



NOTE: ADD 100 TO REFERENCE NUMBERS OF COMPONENTS ON THIS BOARD.

* INDICATES TRANSISTOR MOUNTED ON HEAT SINK.

POWER SUPPLY
FIGURE 7.10