WATKINS-JOHNSON

INSTRUCTION MANUAL

FOR

TYPE TH-480B, C TUNING HEADS

INTRODUCTION

The Type TH-480B Tuning Head is nearly identical to the TH-480C Tuning Head. The differences between units are shown in the following table.

	TH-480B	TH-480C
Oscillator	17044	17335
Calibrated Tape	33306	33461
Gear Train Assembly	85103	85111
Gear #1	2984-1	2984-73
Gear #2	20180-12	20180-50

WATKINS-JOHNSON COMPANY
CEI DIVISION
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WARNING

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

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Table 1-1. Type TH-480B Tuning Head, Specifications

Electrical	
Tuning Range	4-8 GHz
Imput Impedance	50 ohms, nominal
Noise Figure	16 dB, typical; 20 dB maximum
Tuner Gain	14 dB, nominal
IF Rejection	80 dB, minimum
Image Rejection	60 dB, minimum
Input VSWR	3:1; maximum
Local Oscillator Output Frequency	$F_{LO} = F_{Tuned} \frac{}{2} + 80$ MHz
Antenna Conducted LO Radiation	-76 dBm, maximum
LO OUTPUT Level	-20 dBm, minimum into 50 ohms
ANALOG OUTPUT Level	-10V to +10V
Varactor Tuning Range	500 kHz, minimum
External AFC Tuning Range	500 kHz, minimum
RF AGC Range, MAN GAIN Control	10 dB, minimum
Dial Calibration	1%
Dial Resetability	0.5%
Power Supply Voltages Required for Operation	+12 to +28 Vdc, regulated; +15 Vdc, regulated; -15 Vdc, regulated; 24 to 20 Vac or dc (heaters)
Mechanical	
Size	3.15 inches high; 7.75 inches wide; 14.9 inches deep
Weight	7 lbs., approximately

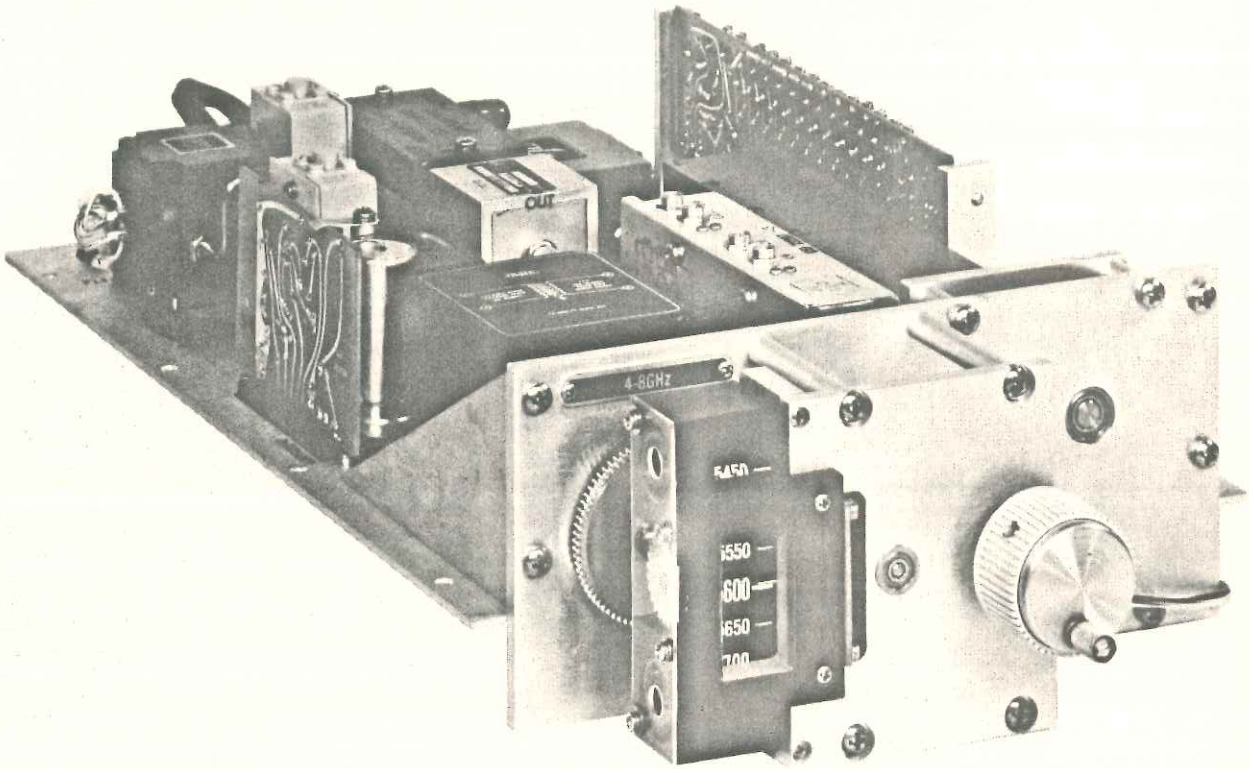


Figure 1-1. Type TH-480B Tuning Head, Front View

SECTION I

GENERAL DESCRIPTION

1.1 ELECTRICAL CHARACTERISTICS

1.1.1 The TH-480B Tuning Head tunes the 4 to 8 GHz range. It is designed to be used with any of several types of equipment. These parent units supply power and control (AGC/AFC) voltages to the tuning head. As examples, the TH-480B will operate in the Type 112-(X) Microwave Receiver or with the combination of Types MTF-100/MTF-101 Microwave Tuning Frame(s), and Type DM-112 Demodulator.

1.1.2 The RF stage consists of an amplifier electrically connected between two double-tuned YIG filters that are housed in a single mechanical assembly. An RF amplifier yields an improved noise figure; the filters serve as RF pre and post selectors and have a bandwidth of approximately 30 MHz. Both filters are electrically tuned by circuitry associated with a multiturn precision potentiometer that is mechanically linked to the oscillator tuning drive and tape dial. YIG filters provide high image frequency rejection and low local oscillator conduction. The filter assembly has an internal self-regulated heating element which improves frequency-versus-temperature stability and increases the ability of the filter to handle high input signal levels.

1.1.3 The YIG shaper and driver modifies the drive current to the YIG filter so that it follows the tuning characteristics of the local oscillator (LO). The LO is a nonlinear tuning device and the YIG filter is linear. Proper tuning relationship between them is a 160 MHz difference frequency which must be achieved over the entire tuning range.

1.1.4 The LO is a solid state variable frequency device which has a 2.0 to 4.16 GHz output. It uses an internal varactor to provide fine tuning. The output of the LO drives a balanced mixer. A power-tapping coupler supplies a sample of the LO signal to the main chassis of the parent equipment. Attenuators and decouplers are used between the various microwave components to reduce undesirable circuit loading and spurious emissions.

1.1.5 The balanced mixer converts incoming signals to a 160 MHz IF. These signals are applied to a 160 MHz preamplifier with a 20 MHz bandwidth. The output of the preamplifier is supplied to the parent equipment.

1.1.6 The parent equipment supplies the tuning head with five regulated dc power supply voltages. It routes the antenna input to the YIG preselector and furnishes two control voltages, AGC and AFC. The AGC voltage controls the gain of the first stage of the IF preamplifier. The AFC voltage is supplied to a varactor in the local oscillator assembly, and induces small incremental frequency adjustments in response to the fine tuning control or the discriminator output (as applicable) of the parent equipment when used in the internal AFC mode.

1.2 MECHANICAL CHARACTERISTICS

1.2.1 The TH-480B Tuning Head is constructed on an aluminum plate, which serves as a chassis and measures approximately 8 x 12 inches. At the front of the chassis is a vertical plate 3 inches high, which mounts the tuning drive. The tuning control shaft and frequency indicator mechanism are fixed to the vertical plate and extend through the front panel of the receiver or tuning frame when the tuning head is installed. Various subassemblies which comprise the tuning head are mounted to the chassis and interconnected in a manner which facilitates repair and/or replacement. The tuning drive assembly positions the tape dial, the oscillator tuning shaft, and the YIG driver potentiometer.

1.2.2 The tuning head is mounted in the parent equipment by eight screws. A short cable with a multipin plug and three rigidly mounted coaxial connectors provide the electrical interconnections to the various subassemblies located on the main chassis. The wiring of an adaptor plug modifies the source of the YIG heater voltage to make the tuning head compatible with several types of parent equipment.

1.3 EQUIPMENT SUPPLIED

This equipment consists of the TH-480B Tuning Head only. The dimensions and weight are given in Table 1-1.

1.4 EQUIPMENT REQUIRED BUT NOT SUPPLIED

The TH-480B Tuning Head is designed to operate when installed in associated equipment. It is not capable of independent operation. As an aid to maintenance of the TH-480B, an extender cable is required to supply operating voltages when the tuning head is removed from the parent equipment. A schematic diagram of the cable is shown in Figure 1-2.

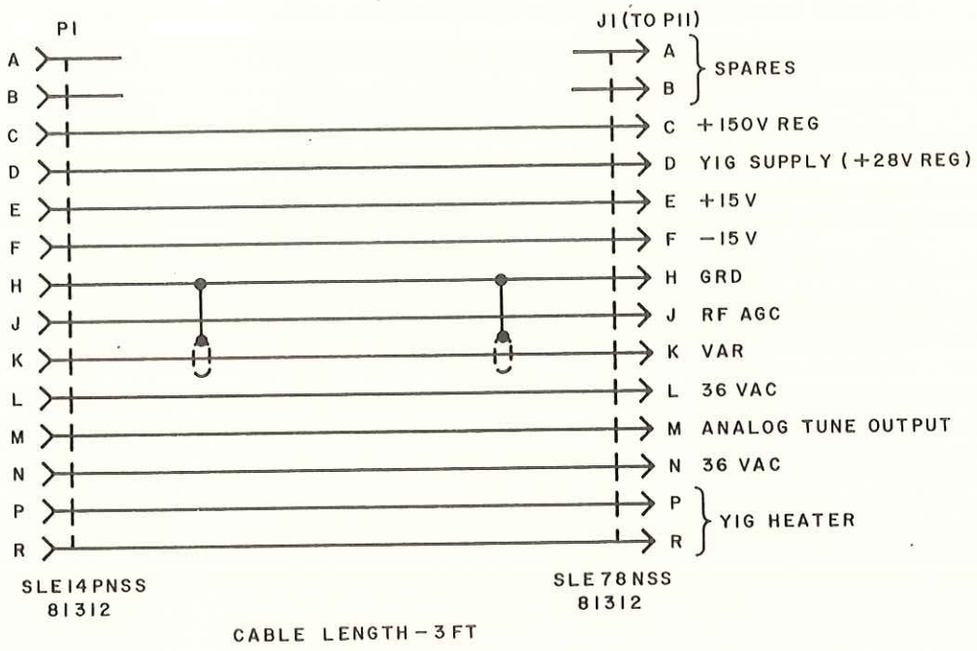


Figure 1-2. Extender Cable for TH-480B Maintenance, Schematic Diagram

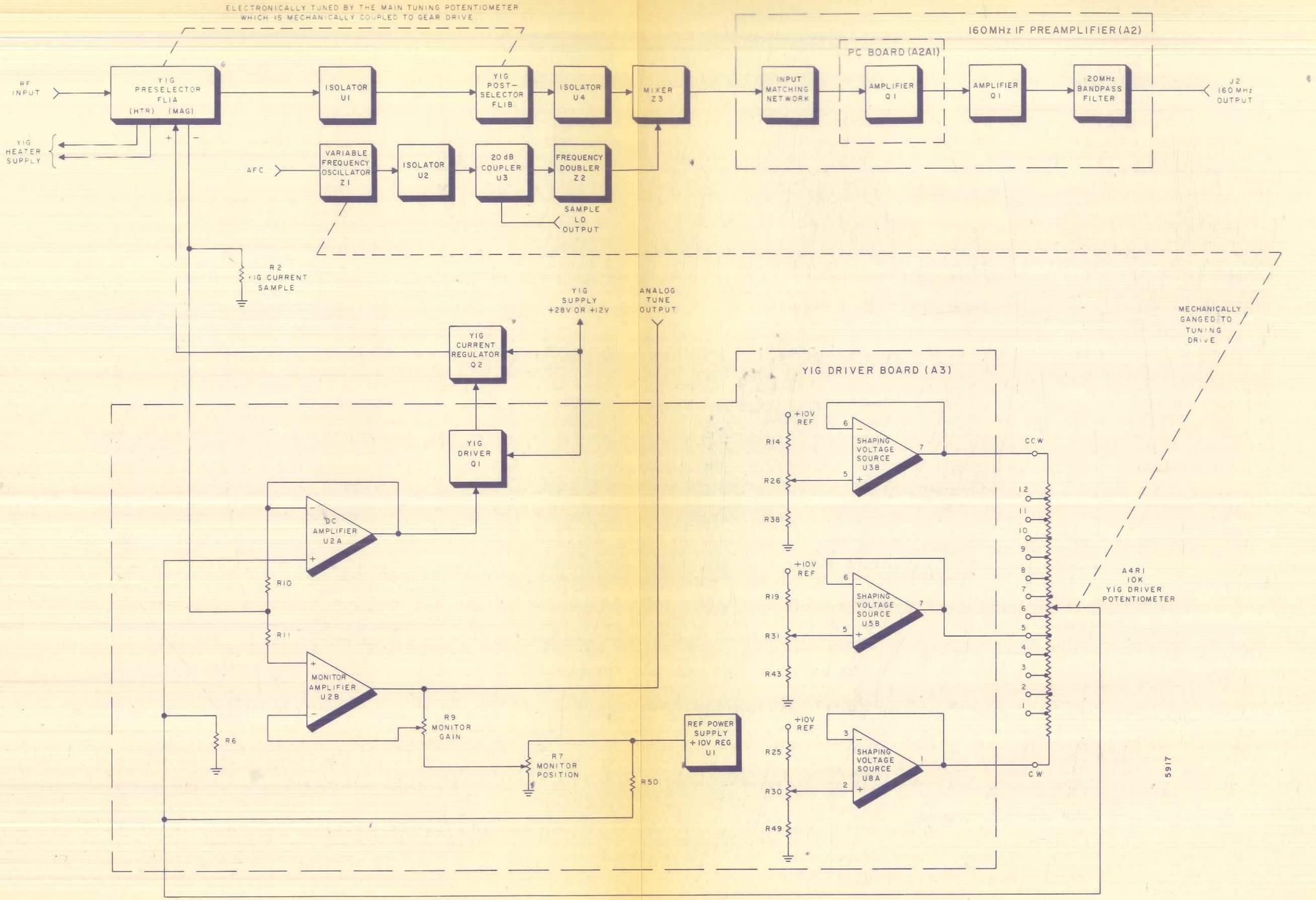


Figure 2-1. Type TH480B Tuner, Functional Block Diagram

SECTION II

CIRCUIT DESCRIPTION

2.1 GENERAL

The operation of the various stages in the TH-480B are explained using the functional block diagram, Figure 2-1, and the schematic diagrams included in Section VI of this manual. To identify the subassemblies used in the tuning head, consult the main chassis schematic diagram, Figure 6-4. Note also that the unit numbering system is used for the electrical components. This means that parts on subassemblies carry a prefix before the usual class letter and number of the item (such as A1R1 and A2C10). These subassembly prefixes are omitted on illustrations and in the text except in those cases where confusion might result from their omission.

2.2 FUNCTIONAL DESCRIPTION

2.2.1 The Type TH-480B Tuning Head covers the frequency range of 4 to 8 GHz in one band. Incoming signals are routed to the input of the 4 to 8 GHz filter, FL1A. This preselector, as well as a ganged post-selector, FL1B, are YIG (yttrium-iron-garnet) type, high Q microwave resonators that are magnetically tuned by a variable control current. The resonant frequency of each filter varies linearly with the magnetic field intensity incident on the YIG spheres. Since the field intensity is determined by the magnitude of the tuning current passing through the field-generating electromagnet (MAG), this parameter is accurately controlled by a precision potentiometer. This potentiometer is driven from the main tuning mechanism. Also, since a superheterodyne circuit is employed, the YIG filters must track with the local oscillator. Since the LO frequency rate of change is nonlinear, the YIG tuning current must be shaped, i.e., made to vary, in a similar nonlinear fashion.

2.2.2 The YIG shaper and driver circuitry accomplishes this by setting different voltage levels at different points on the YIG driver potentiometer. These levels are set such that they approximate the tuning response of the LO. Twelve identical circuits consisting of voltage divider networks, varied by potentiometers R26 through R37, and unity gain operational amplifiers U3 through U8 produce the constant voltages needed. Thus, a controlled voltage level is felt at each tap on the YIG driver potentiometer. Figure 2-2 shows a simulated YIG tuning curve which has four break points instead of the 12 points used in this unit. This curve is created by the YIG driver pot as the LO is swept through its range.

2.2.3 The tuning voltage produced at the YIG driver pot is applied to pin 1 of the YIG driver board, A3, and is summed with a +10V reference from power supply U1. The attenuated result is applied to the non-inverting input of the tuning voltage operational amplifier, U2A, which constantly maintains

this voltage at the base of A3Q1 making it conduct. A sample voltage from the YIG filter is applied to the inverting input of U2A. This offsets the output voltage by small amounts in order to compensate for temperature changes in the YIG filter. The conduction of the YIG driver, A3Q1, applies a voltage to Q2, the YIG current regulator.

2.2.4 The YIG sampling voltage and the amplified tuning voltage also are applied to the non-inverting input of the monitor amplifier, U2B. This is a variable-gain operational amplifier, the output of which can be used to indicate the approximate tuned frequency of the TH-480B. When the YIG filter is at mid-range, the monitor position control, R7, is adjusted such that the voltage applied to the inverting input of U1B offsets the output to 0 volts. When the YIG filter is tuned somewhere off of the mid-range, the monitor gain control sets the gain of U2B proportionally to the tuned frequency. This voltage is applied to a rear-apron connector, ANALOG TUNE OUTPUT. The voltage varies from -10V at 4.0 GHz to 0V at 6.0 GHz to +10V at 8.0 GHz linearly.

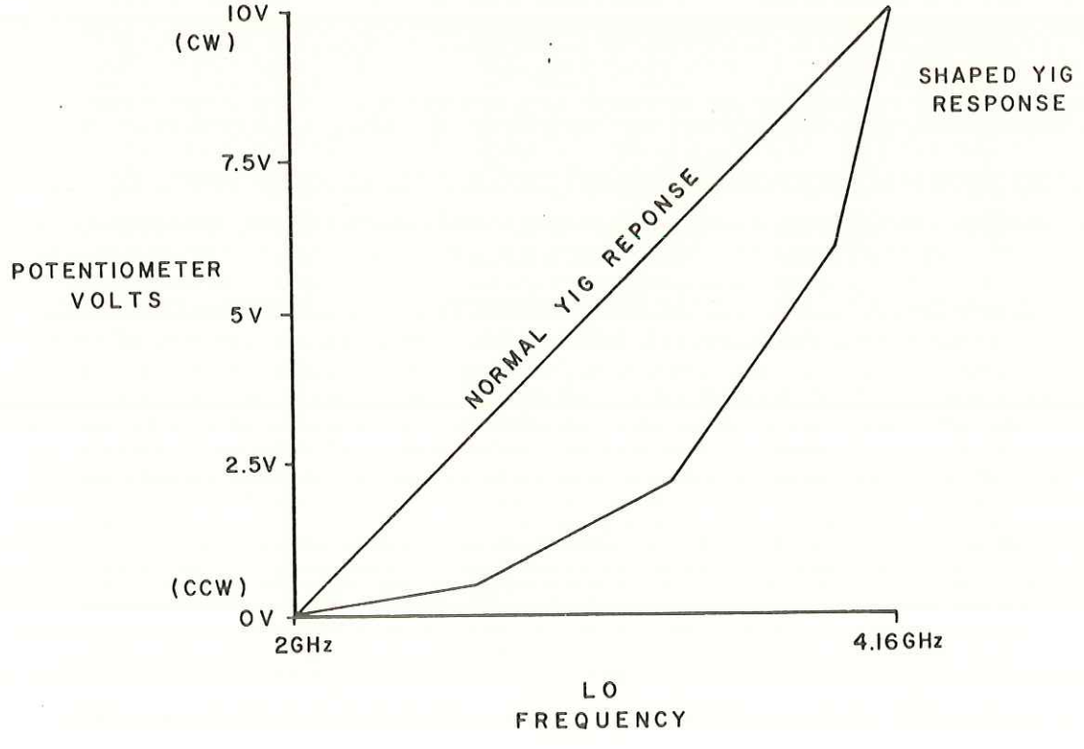


Figure 2-2. Simulated YIG-to-LO Tuning Curve

2.2.5 The YIG current regulator, Q2, acts as a series-pass transistor for the +28 volt YIG supply. Since the conduction of Q2 is controlled by A3Q1, the amount of current applied to the YIG filter is directly proportional to the tuned frequency of the LO. Thus, the YIG preselector is constantly maintained 160 MHz below the LO tuned frequency.

2.2.6 The resonant frequency, bandwidth, and other characteristics of YIG filter FL1 are temperature dependent. For this reason, a constant temperature oven is built into the filter housing. Tuning current requirements for the YIG filter are on the order of 240-480 mA to tune the range of 4 to 8 GHz. The YIG tuning sensitivity is such that a current change of 1 mA will shift the YIG tuned frequency by 17 MHz.

2.2.7 The output of preselector FL1A is applied to an isolator U1. This serves as an impedance matching device between FL1A and FL1B, the YIG postselector. The postselector output is supplied to mixer, Z3, which also receives the tuned frequency output from Z2, the VFO frequency doubler.

2.2.8 The VFO is a solid state variable frequency oscillator which covers from 2 to 4.16 GHz. It is mechanically tuned by the front apron tuning knob through a gear train and tape frequency drive. The VFO output is applied to a passive 20 dB directional coupler which provides the LO sample output. The remaining VFO power is applied to Z2 the frequency doubler. The doubled LO signal is applied to the mixer.

2.2.9 The mixer, Z3, is a double balanced diode mixer which provides good isolation of the RF input from the LO input. The primary output signals from the mixer are the sum difference of its two inputs. Tuned circuits in the IF preamplifier (A2) select the 160 MHz difference frequency.

2.2.10 The IF preamplifier, A2, employs a modified cascode amplifier consisting of common emitter amplifier A2A1Q1 and grounded base amplifier A2Q1. RF AGC is applied to the base of A2A1Q1. A 160 MHz, double-tuned circuit filters the output of the cascode amplifier. The amplified 160 MHz signal, with a bandwidth of 20 MHz, is matched to 50 ohms and supplied to the parent equipment via connector A1J2.

2.3 CIRCUIT DESCRIPTION

2.3.1 Type TH-480B Tuning Head. - The main chassis schematic diagram is Figure 6-4. As the frequency is selected by the tuning drive, two major events take place: (1) the LO begins to track with the tuning drive, 160 MHz above the incoming RF; and (2) A4R1, the wiper of the YIG driver potentiometer begins to move and transfer voltage to the YIG driver (A3).

In turn, A3 supplies a positive voltage to the base of Q2 causing it to conduct more heavily. Depending on the value of the drive on the base of Q2, it conducts more or less current from the YIG supply voltage at the collector. Thus, the YIG filters begin to track with the LO as previously described. The RF input is preselected, amplified, and postselected such that when it is applied to the mixer, it is a 30 MHz wide RF spectrum. When both the filtered RF and the LO inputs are applied to the mixer, a 160 MHz IF frequency is produced. This is applied to the preamplifier (A2) which amplifies the 160 MHz IF, establishes the bandwidths, and makes it available to the receiver.

2.3.2 Type 76224 -20V Power Supply. -

2.3.2.1 The reference designation for this module is A1; its schematic diagram is Figure 6-1. A 36 Vac source is provided by the parent equipment, and rectified by A1U1, a full wave device. The rectified voltage is regulated by operational amplifier A1U1 and by series pass transistor, Q1 (main chassis). Module A3 provides a +10V reference source which is summed with the -20V output through potentiometer A1R1 and resistors A1R2 and A1R3. This summation (near ground level) is felt at the non-inverting input of A1U1, an open loop operational amplifier providing very high gain. Any change in the -20V output, thus, is multiplied by A1U2. In turn, transistor Q1 conducts more or less heavily depending on the direction of the output change. If the -20V output drops (moves in the positive direction), the conduction of Q1 is increased until the output again stabilizes at the nominal -20V level. Should the -20V output swing in a negative direction, the opposite action of the regulator is effected.

2.3.3.2 Transistor A1Q1 protects the main chassis pass transistor (Q1) from overload. When the current flow through A1R7 produces enough voltage at the base of A1Q1 to make it conduct (0.6V), part of the current from A1U2 flows through A1Q1 to ground. This reduces the conduction of Q1 and protects the supply.

2.3.3 Type 72297-3 160 MHz IF Preamplifier (20 MHz BW). - The reference designation for this module is A2; its schematic diagram is Figure 6-2. The IF input of 160 MHz is applied to J1. Inductor L1 and capacitor C2 provide impedance matching for the input. Transistor A2Q1 is a common emitter amplifier controlled at the base by the 160 MHz input and RF AGC from the associated receiver. Capacitor C5 couples the signal to Q1, a grounded base amplifier. This amplifier provides good voltage gain and a high output impedance to the double-tuned bandpass filter network consisting of L9 and L2, and coupled by C10 to L3 and C11. This filter has a bandwidth of 20 MHz. Output from the double-tuned circuit is coupled through C12 to a grounded base output stage, Q2. The shunt-fed output circuit consists of C16, L4, and R8. Capacitor C17 couples the 160 MHz IF signal to J2. Resistor R9 sets the output impedance.

2.3.4 Types 791099-1, -2, -3 YIG Shaper and Driver. - Figure 6-4 is the schematic diagram; the reference designation is A3. The three plug-in boards are identical, except for the values of resistance used in various portions of the circuitry. These differences are tabulated in notes on the schematic diagram.

2.3.4.1 Voltage Shaper. - The board consists of circuitry which when combined with the main chassis YIG drive potentiometer A4R1, forms a twelve breakpoint voltage shaper. Shaper circuitry consists of twelve identically arranged resistive voltage divider networks connected between a highly regulated +10 volt source and ground. A potentiometer in each voltage divider allows a portion of the +10 volts to be taken from the divider and applied to twelve identical buffers. The buffers are unity gain connected operational amplifiers U3A-B through U8A-B. Output voltages from the buffers are connected to the YIG driver potentiometer. By means of these output voltages, the output voltage from the YIG driver potentiometer can be made to vary in a non-linear fashion as the potentiometer is turned. Since the YIG driver potentiometer and LO are geared and thus tuned together, the output voltage from the YIG driver potentiometer can be adjusted to vary in such a manner that it turns-versus-voltage characteristic matches the turns-versus-frequency characteristics of the LO. Thus, the two can be made to track. The YIG driver potentiometer output voltage is applied to additional circuitry of the board to develop the current drive necessary to tune the YIG filter.

2.3.4.2 Reference Voltage Regulator. - Integrated circuit U1 utilizes the +15 volt supply input and provides a regulated +10 volt reference voltage source for the shaping circuit dividers and operational amplifiers U2A and U2B. Voltages for the various elements of the dc regulator are provided by divider resistors R1, R2, and R3. Capacitor C3 removes high frequency noise from the supply output.

2.3.4.3 YIG Driver. - The YIG driver circuitry consists of U2A, and main chassis transistor Q1. Three inputs are supplied to U2A which sums the tuning voltage from the YIG tuning potentiometer and an offset voltage from the regulated +10 volt supply IC. This combination is amplified differentially with the YIG sampling input. The YIG sampling input is obtained by passing the YIG tuning current through a series resistance. Thus, the sampling voltage is directly proportional to the tuning current. This voltage is utilized as negative feedback in the YIG tuning loop. The output voltage from U2A is applied to Q1, which in conjunction with main chassis transistor Q1, forms a Darlington amplifier. A Darlington amplifier is used to obtain the current gain necessary to supply the large YIG tuning current.

2.3.4.4 Analog Tune Output. - Operational amplifier U2B provides the analog tune output voltage. This voltage is adjusted to -10 volts when the TH-480B is tuned to 4.0 GHz, 0 volts at mid-band, and +10 volts at 8.0 GHz. A sample of the +10 volt reference voltage is taken from potentiometer R7 and supplied to the inverting input of U2B through R8, and gain potentiometer R9. This voltage, when amplified differentially with the YIG sampling input, sets the low band voltage output. Potentiometer R9 sets the voltage slope by setting the overall operational amplifier gain.

SECTION III

INSTALLATION AND OPERATION

3.1 UNPACKING AND INSPECTION

3.1.1 Examine the shipping carton for damage before the equipment is unpacked. If the carton has been damaged, try to have the carrier's agent present when the equipment is unpacked. If not, retain the shipping cartons and padding material for the carrier's inspection if damage to the equipment is evident after it has been unpacked.

3.1.2 See that the equipment is complete as listed on the packing slip. Contact Watkins-Johnson Company, CEI Division, or your Watkins-Johnson representative with details for any shortage.

3.1.3 The unit was thoroughly inspected and factory adjusted for optimum performance prior to shipment. It is, therefore, ready for use upon receipt. After uncrating and checking contents against the packing slip, visually inspect all exterior surfaces for dents and scratches. Inspect the electronic components for apparent damage. Check all cables for loose connections.

3.2 INSTALLATION

The TH-480B Tuning Head is designed to be installed in and operate with several different types of parent equipment. Installation of the tuning head is specified in the instruction manual for the parent equipment.

3.2.1 Tuning Head Removal. - As an example, to remove a TH-480B Tuning Head from the Type 112-(X) Receiver, proceed as follows:

(1) Remove the receiver from the equipment rack and place it on its side on the work surface.

(2) Loosen the two screw fasteners at the rear of the top dust cover and slide the cover off.

(3) Loosen the two screw fasteners at the rear of the bottom dust cover and slide the cover off.

(4) Remove the largest of the three Allen wrenches mounted on the underside of the chassis. Remove the tuning knob from the tuning shaft by loosening the two setscrews with the Allen wrench. Return the Allen wrench to its mounting clip.

(5) Disconnect the interconnecting cables between the tuning head and the receiver chassis as follows:

(a) Disconnect the multipin power connector from the multipin jack J9 on the main chassis.

(b) Disconnect the LO coaxial cable connector from LO coupler U3 of the tuning head.

(c) Disconnect the subminiature plug from jack J2 of 160 MHz IF preamplifier A2 located on the tuning head.

(d) Disconnect the semi-rigid tubing with its RF connector from YIG filter FL1 which is located on the left corner of the tuning head. Carefully move the semi-rigid tubing and connector away from the jack on the YIG filter.

(6) Remove the eight screws which hold the tuning head to the main chassis. The screws are removed from the top side of the chassis.

(7) Working from the bottom side of the receiver, move the rear of the tuning head down and away from the main chassis.

(8) Remove the tuning head by moving it down and away from the main chassis so that the tuning shaft clears the front panel.

3.2.2 Tuning Head Installation. - To install a tuning head, reverse the above procedure. It is not necessary to remove any of the subassemblies, modules, or cables that are permanently affixed to the tuning head. Make certain that there are no cables pinched between the tuning head and main chassis before tightening the eight screws that secure the tuning head to the main chassis.

3.3 OPERATION

Operation of the TH-480B Tuning Head is controlled entirely by the parent equipment into which it is installed, with the exception of the front-panel manual tuning knob.

3.4 PREPARATION FOR RESHIPMENT AND STORAGE

3.4.1 If the unit must be prepared for reshipment, the packaging methods should follow the pattern established in the original shipment. If retained, much of the original packing material can be reused, or will at least provide guidance for the repackaging effort.

3.4.2 Conditions during storage and shipment should normally be limited as follows:

(1) Maximum humidity: 95% (no condensation).

(2) Temperature range: -30°C to +85°C.

SECTION IV

MAINTENANCE

4.1 GENERAL

The TH-480B Tuning Head has been conservatively designed to operate for extended periods of time with little or no routine maintenance. An occasional cleaning and inspection are the only preventive maintenance operations recommended. The intervals for these operations should be based on the operating environment. Should trouble occur, repair time will be minimized if the maintenance technician is familiar with the circuit descriptions found in Section II. Reference should also be made to the block diagram, Figure 2-1, and to the schematic diagrams found in Section VI. A complete parts list and part location illustrations can be found in Section V.

4.2 CLEANING

The unit should be kept free of dust, moisture, grease, and foreign matter to ensure trouble-free operation. If available, use clean, low velocity compressed air to blow accumulated dust from the unit. A clean dry cloth, soft bristled brush, or a cloth saturated with cleaning compound may also be used.

4.3 INSPECTION FOR DAMAGE OR WEAR

Many potential or existing troubles can be detected by a visual inspection of the unit. For this reason, a complete visual inspection should be made for indications of mechanical and electrical defects on a periodic basis, or whenever the unit is inoperative. Electronic components that show signs of deterioration should be checked and a thorough investigation of the associated circuitry should be made to verify proper operation. Damage to parts due to heat is often the result of other, less apparent troubles in the circuit. It is essential to determine and correct the cause of overheating before replacing the damaged parts. Mechanical parts should be inspected for excessive wear, looseness, misalignment, corrosion, and other signs of deterioration.

4.4 MAINTENANCE OF TUNING DRIVE ASSEMBLY

Figure 5-7 is an exploded view of the tuning drive assembly. The tuning drive assembly requires little maintenance except for the occasional removal of any dust or dirt that may accumulate.

4.4.1 The tuning drive assembly bearings should be lubricated annually with a small amount of light machine oil. Care should be taken to avoid accidental lubrication of the clutch plates.

4.4.2 Dial Lamp Replacement. - To replace a burned-out dial lamp, proceed as follows:

(1) Remove the two screws that hold the light bar to the tuning drive (refer to Figure 5-7).

(2) Gently pull the light bar and printed circuit light board away from the tuning drive.

(3) Remove the two screws that hold the light board to the light bar.

(4) Unsolder the burned out lamp and replace it with a new lamp. It is advisable to replace all lamps if parts are available. If one lamp burns out, it is likely that the other lamps are nearing the ends of their lives.

4.5 TROUBLESHOOTING AND PERFORMANCE CHECKS

The following tests determine that the function of the unit is adequate to meet factory performance standards. If the limits and tolerances specified cannot be met, refer to the alignment procedures in paragraph 4-7. These tests can be an aid to troubleshooting, and can also verify satisfactory performance of a repaired unit.

4.5.1 Equipment Required. - The following instruments or their equivalent are required to execute the performance tests on the TH-480B Tuner:

(1) Oscilloscope, Tektronix Type 503

(2) Sweep Generator, Hewlett Packard, Type 8690A

(3) Sweep Head, Hewlett Packard, Type 8693A

(4) Signal Generator, Hewlett Packard, Type 608E

(5) Microwave Marker Generator, Telonic TMS-1

(6) Signal Sampler, Telonic TSS-1

(7) Power Meter, Hewlett Packard, Type 431C

(8) 50 Ohm Detector, Hewlett Packard, Type 432A

(9) 50 Ohm Isotee, Micro Labs HM-10N

(10) Directional Coupler, ESCA-71023

(11) 1 dB Step Attenuator, Texscan, Model RA-50

(12) Step Attenuator, Hewlett Packard, Type 354A

(13) Digital Voltmeter, Dana Model 5500/112

(14) Assorted Pads, Connector Adaptors, Cables, etc.

4.5.2 -20V Power Supply (A1). - Check the performance of this subassembly as follows:

(1) Energize the equipment and place the associated receiver/tuning frame controls in any normal operating postions. Remove covers as necessary to gain access to receptacle XA1 on the TH-480B.

(2) Use a digital voltmeter and check the voltages at XA1 as shown.

PIN	VOLTAGE	LIMITS
4	0.39	
5	0.96	
9	-20.00	10%
12	15.2	
8	10.0	1%

4.5.3 VFO Power Output. - Satisfactory output power from the tuning head oscillator can be determined as follows:

(1) Connect the equipment as shown in Figure 4-1a, page 4-11.

(2) Observe the power meter indication and tune the TH-480B from 4000 MHz to 8000 MHz. The output should remain between -5 and -13 dBm.

4.5.4 Mixer, LO, IF Preamplifier. - Check the performance of this circuit group as follows:

(1) Connect the equipment as shown in Figure 4-1b, page 4-11.

(2) Tune the TH-480B to 6000 MHz.

(3) Adjust the test equipment controls to obtain a response as shown in Figure 4-1c.

(4) Record the attenuator settings required to obtain this response.

(5) Connect the detector input to the 1 dB step attenuator output and decrease the attenuator settings until the response is the same amplitude as shown in Figure 4-1c.

(6) The difference between the attenuator settings in steps (4) and (5) is the gain of the preamplifier less the loss of the mixer and should be between 5 and 16 dB.

4.5.5 YIG Shaper and Driver (A3). - Check the relative performance of this module as follows:

(1) Refer to Table 4-1 and using the digital voltmeter, verify the voltages as shown. The voltages obtained should be approximately as shown below.

Table 4-1. YIG Shaper Voltages

XA3 PIN	VOLTAGE*
6	0.44
7	0.74
8	1.06
9	1.40
10	1.80
11	3.10
12	4.35
13	5.00
14	5.70
15	6.40
16	7.30
17	8.30

* Nominal Values

(2) Tune the TH-480B to the frequencies shown in Table 4-2 and verify that the voltages are approximately as shown below.

Table 4-2. YIG Driver and Shaper and Main Chassis Q2 Voltages

TEST POINT	VOLTAGE* Frequency GHz		
	4.0	6.0	8.0
XA3, Pin 1	0.64	4.19	7.75
XA3, Pin 2	0.55	0.83	1.11
XA3, Pin 3	-10.00	0.04	10.06
XA3, Pin 4	3.38	4.81	6.27
A3Q1 Base	3.93	5.37	6.86
Main Chassis Q2 Emitter	2.73	4.13	5.55

* Nominal Values

4.5.6 YIG Filter (FL1) and Variable Frequency Oscillator (Z1). - Check the overall performance of these modules as follows:

(1) Determine that adequate output power is available from the VFO by performing the procedure as stated in paragraph 4.5.3.

(2) Interconnect the test equipment as shown in Figure 4-1d, page 4-11.

(3) Tune the TH-480B to 4000 MHz. Adjust the HP-8690A controls to sweep the 4-8 GHz range.

(4) Activate the TMS-1 100 MHz markers.

(5) Identify the 4000 MHz marker. Reduce the sweep width to expand and display the TH-480B IF response which should be approximately centered on the 4000 MHz marker. A typical overall response is shown in Figure 4-1e.

(6) Tune the TH-480B and sweep generator through the 4000-8000 MHz band stopping every 400 MHz and checking the overall response.

(7) The tape dial on the TH-480B should read correctly within 1% at each point and the response should be approximately centered on the marker, or close enough to center to ensure a 22 MHz minimum and 25 MHz maximum response to the 3 dB points.

4.6 ALIGNMENT

The alignment procedures in this book are suitable for performance in the field after replacing components. The alignment of this unit should be performed only with suitable test equipment and by technicians thoroughly familiar with its use. Allow at least 15 minutes for warm-up of the YIG filter. The parent equipment should be in a MAN gain control mode with the gain set to maximum. Fine tuning must be centered.

4.6.1 Test Equipment Required. - The following test instruments, or their equivalent are required to align the TH-480B Tuning Head:

(1) Sweep Generator, Hewlett Packard, Type 8690A

(2) Sweep Head, Hewlett Packard, Type 8693A

(3) Signal Sampler, Telonic TSS-1

(4) Directional Coupler, ESCA-71023 or equivalent.

(5) Step Attenuator, Hewlett Packard, Type 354A

(6) 1 dB Step Attenuator, Texscan Model RA-50

(7) 50 Ohm Isotee, Micro Labs, HM-10N

(8) 50 Ohm Detector, Hewlett Packard, Type 423A

(9) Microwave Marker Generator, Telonic TMS-1

(10) Signal Generator, Hewlett Packard, Type 608E

(11) Oscilloscope, Tektronix, Type 503

(12) Assorted Adaptors, Connectors, Cables, etc.

4.6.2 160 MHz IF Preamplifiers. - To align the IF preamplifier, proceed as follows:

(1) Connect the equipment as shown in Figure 4-1b, page 4-11.

NOTE

This procedure assumes that the mixer and VFO are operating normally. The IF Preamplifier is aligned using its normal mixer load for best results.

(2) Set the sweep generator controls for a 4100 MHz ±100 MHz sweep. Tune the TH-480B to 4100 MHz and adjust the oscilloscope and microwave attenuator controls to obtain a suitable display.

(3) Set the HP-608 for 160 MHz markers and the TMS-1 for 10 MHz markers.

(4) Adjust A2C11 and A2C9 for a maximum amplitude symmetrical response centered about the 160 MHz marker. A typical response is shown in Figure 4-1c, page 4-11.

(5) The bandwidth should be a minimum of 22 MHz and a maximum of 25 MHz at the 3 dB points.

(6) Tune the sweep generator and TH-480B simultaneously throughout the band and note the response variation. If excessive tilt occurs anywhere in the 4-8 GHz band, a slight compromise in the settings of A2C11 and A2C9 should be used to obtain the flattest overall response.

4.6.3 VFO To Tape Dial Tracking. - This procedure provides a means of tracking the VFO to the TH-480B tape dial frequency readout. It should be accomplished whenever the VFO, tape dial or components of the gear train have been replaced. Proceed as follows:

(1) Connect the equipment as shown in Figure 4-1b, page 4-11.

(2) Tune the TH-480B to 4000 MHz and carefully loosen the set-screws in the flexible coupling which connects the VFO to the gear train.

(3) Adjust the sweep generator controls to sweep from 4 to 8 GHz and the oscilloscope and attenuators to display a response similar to Figure 4-1f. Set the TMS-1 for 100 MHz markers.

(4) Identify the response that is lowest in frequency. Without moving the tape dial from 4000 MHz, carefully rotate the VFO tuning shaft and move the response to the 100 MHz marker representing 4000 MHz.

(5) Set the sweep generator for a narrow sweep mode of 4000 MHz $\pm$ 100 MHz.

(6) As in step (4), carefully center the response about the 4000 MHz marker. Figure 4-1c shows a typical response. Tighten the flexible coupling setscrews.

(7) Adjust the sweep generator controls for a 8000 MHz $\pm$100 MHz sweep. Note the relationships between the displayed response and the 8000 MHz marker. If the response is not centered, loosen the setscrews in the flexible coupling and carefully rotate the VFO shaft to remove one half of the error. Tighten the setscrews. The tape dial to frequency error should be no more than 1%, i.e., $\pm$80 MHz at 8000 MHz and $\pm$40 MHz at 4000 MHz. Errors in excess of this indicate a faulty VFO. With the end frequencies set correctly, the VFO to tape dial tracking should be satisfactory.

(8) Verify the correct VFO to tape dial tracking at 500 MHz intervals throughout the band by identifying the correct marker, adjusting the sweep generator and TH-480B tuning to the correct frequencies, and noting the response to frequency marker relationships.

4.6.4 VFO Replacement. - Should it ever be necessary to replace VFO Z1, this procedure should be followed:

(1) Tag and unsolder the -20V, GND, and AFC input wires to the VFO.

(2) Remove the LO output cable.

(3) Loosen the setscrews from the flexible coupling which attaches the VFO tuning shaft to the gear train.

(4) Remove the four screws which attach the VFO to the tuning head deck. Slide the VFO to the rear and remove it.

(5) Remove the attenuator (AT1) from the VFO output connector.

(6) To install a new VFO reverse steps (1) through (5).

(7) After installation of the new VFO, perform the VFO output power test as stated in paragraph 4.5.3. It may be necessary to select a new value for AT1 to provide the correct output level.

(8) After determining that the proper output power level is available from the VFO, perform the VFO to tape dial tracking adjustment as provided in paragraph 4.7.4.

4.6.5 YIG Filter to LO Tracking Alignment. - The following procedure requires that the VFO to tape dial tracking be accomplished. Proceed as follows:

(1) Tune the TH-480B to 4000 MHz.

(2) Measure and note the voltages at pins 6 through 17 of XA3. Table 4-3 illustrates typical readings for a correctly aligned shaper. These voltages will not be identical for every YIG filter. However, the voltages should vary as shown, i.e., the voltage at pin 7 is greater than that at pin 6, and the voltage at pin 8 is greater than that at pin 7, etc.

(3) If the measured voltage differs by a significant amount, or a new YIG filter has been installed, set the voltages to the readings shown in Table 4-3 using the appropriate potentiometers. Figure 4-1g, shows the potentiometer locations.

Table 4-3. YIG Tracking, Initial Settings

A3	R26	R27	R28	R29	R30	R31	R32	R33	R34	R35	R36	R37
Pin # (A3)	CCW 6	7	8	9	10	11	12	13	14	15	16	CW 17
Voltage	0.54	0.85	1.20	1.60	2.10	3.10	4.34	5.10	5.90	6.75	7.40	8.67

(4) Connect the equipment as shown in Figure 4-1d, page 4-11.

(5) Adjust the sweep generator for a 4000 MHz ±100 MHz sweep. Adjust the attenuators, and oscilloscope controls to display a response. Figure 4-1h illustrates a typical response.

(6) Use the TMS-1 100 MHz markers and identify the marker corresponding to 4000 MHz. Set the HP-608 Signal Generator for minimum output level.

(7) Adjust A3R26 CCW until the YIG response is centered about the 4000 MHz marker.

(8) Turn off the TMS-1 markers and adjust the HP-608 Signal Generator for an accurate 160 MHz CW output signal which produces a visible marker on the YIG response.

NOTE

The 160 MHz input signal beats with the LO signal and produces a marker at the RF frequency in addition to the sum marker at 4160 MHz. The marker on the response will be referred to as the RF marker.

(9) Using A3R26, center the YIG response on the RF marker.

(10) Slowly tune the TH-480B and the sweep generator upward in frequency until, unless the unit is perfectly aligned, the YIG response begins to move away from the RF marker. Continue until the marker reaches the 3 dB point on the response indicating a significant tracking error.

(11) Measure the voltage at pin 1 of A3 (the wiper voltage of the YIG drive potentiometer) and the voltage at pins 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, or 17 of XA3 in that order until a voltage greater than that at pin 1 is first located. This point determines which tap and adjusting potentiometer is active at the frequency which is tuned.

(12) When the active potentiometer has been located, adjust it to center theYIG response on the RF marker.

NOTE

Normally if the TH-480B shaper is completely misaligned, each potentiometer in ascending frequency order will require adjustment. After each potentiometer adjustment, tune the TH-480B lower in frequency to ensure that the response remains centered. This check should be carefully made whenever a tap is passed without any required adjustment. In some cases the adjustment of a higher frequency point will require that the adjacent lower tap be re-adjusted slightly. Return to the higher frequency adjustment point.

(13) Continue tuning the TH-480B higher in frequency making adjustments as necessary until the entire 4000 to 8000 MHz band is properly tracked.

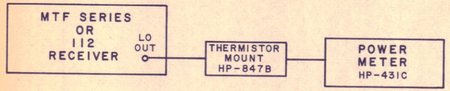


Figure 4-1a. Equipment Connections, VFO Power Output Test

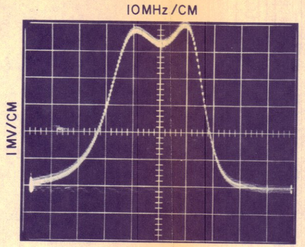


Figure 4-1c. Typical Response, IF Preamplifier

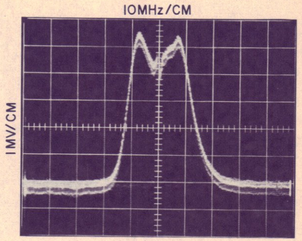


Figure 4-1e. Typical Tuning Head Overall Response

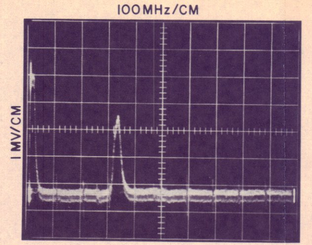


Figure 4-1f. Typical Band Response, VFO to Tape Dial Tracking

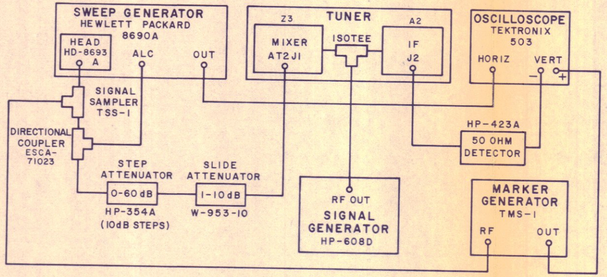


Figure 4-1b. Equipment Connections, Mixer, LO, IF Preamplifier (YIG Filter Bypassed)

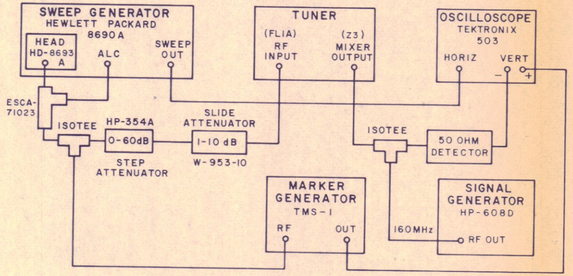


Figure 4-1d. Equipment Connections, YIG Filter and LO Tests

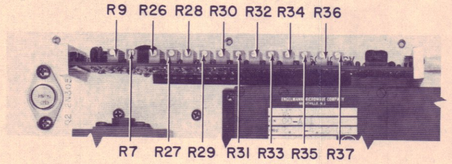


Figure 4-1g. YIG Tracking Potentiometer Locations

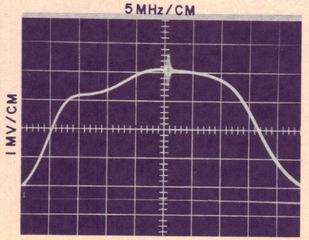


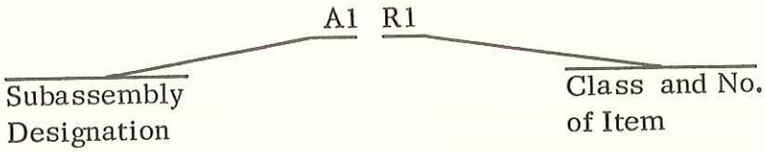
Figure 4-1h. Typical YIG Response

Figure 4-1. Maintenance Waveforms and Test Equipment Diagrams

SECTION V
REPLACEMENT PARTS LIST

5.1 UNIT NUMBERING METHOD

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



Identify from right to left as: First (1) resistor (R) of first (1) subassembly (A)

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

5.2 REFERENCE DESIGNATION PREFIX

Partial reference designations have been used on the equipment and on the illustrations in this manual. The partial reference designations consist of the class letter(s) and identifying item number. The complete reference designations may be obtained by placing the proper prefix before the partial reference designation. Reference Designation Prefixes are provided on drawings and illustrations in parenthesis within the figure titles.

5.3 LIST OF MANUFACTURERS

Mfr. Code	Name and Address
01121	Allen-Bradley Company 1201 South 2nd Street Milwaukee, Wisconsin 53212
01351	Dynamic Gear Company, Inc. 175 Dixon Avenue Amityville, New York 11701
02114	Ferroxcube Corporation P. O. Box 359 Mt. Marion Road Saugerties, New York 12477
02735	RCA Corporation Solid State Division Route 202 Somerville, New Jersey 08876
04013	Taurus Corporation 1 Academy Hill Lambertville, New Jersey 08530
04713	Motorola Semiconductor Products, Inc. 5005 East McDowell Road Phoenix, Arizona 85008

Mfr. Code	Name and Address
05375	Varil Co., Inc. 3883 Monaco Parkway Denver, Colorado 80207
07180	Sage Laboratories, Inc. 3 Huron Drive East Natick Industrial Park Natick, Massachusetts 01760
07263	Fairchild Camera and Instrument Corp., Semiconductor Division 464 Ellis Street Mountain View, California 94040
14482	Watkins-Johnson Company 3333 Hillview Avenue Palo Alto, California 94304
14632	Watkins-Johnson Company CEI Division 6006 Executive Boulevard Rockville, Maryland 20852
15915	Tepro of Florida, Incorporated 375 Patricia Avenue Dunedin, Florida 33528
16179	Omni-Spectra, Incorporated 24600 Hallwood Court Farmington, Michigan 48024
23615	Mark I Engineering Company P. O. Box 32 Glendale, California 91209
24539	Avantek, Incorporated 2981 Copper Road Santa Clara, California 95051
24602	E.M.C. Technology, Inc. 1300 Arch Street Philadelphia, Pennsylvania 19107
27014	National Semi-Conductor Corp. 2950 San Ysidro Way Santa Clara, California 95051
27338	Addington Laboratories, Inc. 1043 Digiulio Avenue Santa Clara, California 95050
31597	Anaren Microwave, Inc. 185 Ainsley Drive Syracuse, New York 13205
56289	Sprague Electric Company Marshall Street North Adams, Massachusetts 01247
70417	Chrystler Corporation Amplex Division 6501 Harper Avenue Detroit, Michigan 48211
71400	Bussman Manufacturing Division of McGraw-Edison Company 2536 W. University Street St. Louis, Missouri 63107
71744	Chicago Miniature Lamp Works 4433 Ravenswood Avenue Chicago, Illinois 60604
71785	Cinch Manufacturing Company Howard B. Jones Division 1026 South Homan Avenue Chicago, Illinois 60624
72136	Electro Motive Manufacturing Co., Inc. South Park and John Streets Willimantic, Connecticut 06226
72982	Erie Technological Products, Inc. 644 West 12th Street Erie, Pennsylvania 16512

Mfr. Code	Name and Address
73138	Beckman Instruments, Inc. Helipot Division 2500 Harbor Boulevard Fullerton, California 92634
73734	Federal Screw Products, Inc. 3917 North Kenzie Avenue Chicago, Illinois 60618
74868	Bunker Ramo Corporation The Amphenol RF Division 33 East Franklin Street Danbury, Connecticut 06810
75042	IRC Division of TRW Inc. 401 North Broad Street Philadelphia, Pennsylvania 19108
75915	Littelfuse, Incorporated 800 East Northwest Highway Des Plaines, Illinois 60016
78189	Illinois Tool Works, Inc. Shakeproof Division St. Charles Road Elgin, Illinois 60126
79136	Waldes Kohinoor Inc. 47-16 Austel Place Long Island City, New York 11101
80058	Joint Electronic Type Designation System
80131	Electronic Industries Associates 2001 Eye Street, N. W. Washington, D. C. 20006
80205	National Aerospace Standards
81312	Winchester Electronics Division Litton Industries, Inc. Main Street & Hillside Avenue Oakville, Connecticut 06779
81349	Military Specifications
83086	New Hampshire Ball Bearings, Inc. Petersborough, New Hampshire 03458
91293	Johanson Manufacturing Company P. O. Box 329 Boonton, New Jersey 07005
91418	Radio Materials Company 4242 West Bryn Mawr Avenue Chicago, Illinois 60646
91637	Dale Electronics, Inc. P. O. Box 609 Columbus, Nebraska 68601
93332	Sylvania Electric Products, Inc. Semiconductor Products Division 100 Sylvan Road Woburn, Massachusetts 01801
95121	Quality Components, Inc. P. O. Box 113 St. Mary's, Pennsylvania 15857
96906	Military Standards

5.4 PARTS LIST

The parts list which follows contains all electrical parts used in the equipment and certain mechanical parts which are subject to unusual wear or damage. When ordering replacement parts from the Watkins-Johnson Co., specify the type and serial number of the equipment and the reference designation and description of each part ordered. The list of manufacturers provided in paragraph 5.3 and the manufacturer's part numbers for components are included as a guide to the user of the equipment in the field. These parts may not necessarily agree with the parts installed in the equipment, however, the parts specified in this list will provide satisfactory operation of the equipment. Replacement parts may be obtained from any manufacturer as long as the physical and electrical parameters of the part selected agree with the original part. In the case of components defined by a military or industrial specification, a vendor which can provide the necessary component is suggested as a convenience to the user.

NOTE

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

5.4.1 Type TH-480B Tuning Head, Main Chassis

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	-20V POWER SUPPLY	1	76224	14632	
A2	160 MHz IF PREAMPLIFIER	1	72297-3	14632	
A3	YIG SHAPER AND DRIVER	1	791099-1	14632	
A4	TUNING DRIVE	1	85103	14032	
AT1*	ATTENUATOR	1	4401	24602	
AT1*	ATTENUATOR	1	4403	24602	
FL1	FILTER, YIG	1	WJ621-37	14482	
F1	FUSE, CARTRIDGE: 3AG, 1A	1	MDL1	71400	
J1	CONNECTOR, RECEPTACLE	1	SRE7SNSS	81312	
J2	ADAPTER, CONNECTOR	3	218	16179	
J3	Same as J2				
J4	Same as J2				
P1	CONNECTOR, PLUG, SMA SERIES	10	201-2A	16179	
P2	Same as P1				
P3	Same as P1				
P4	Same as P1				
P5	NOT USED				
P6	NOT USED				
P7	NOT USED				
P8	NOT USED				
P9	CONNECTOR, PLUG, SMA SERIES	2	501-3	16179	

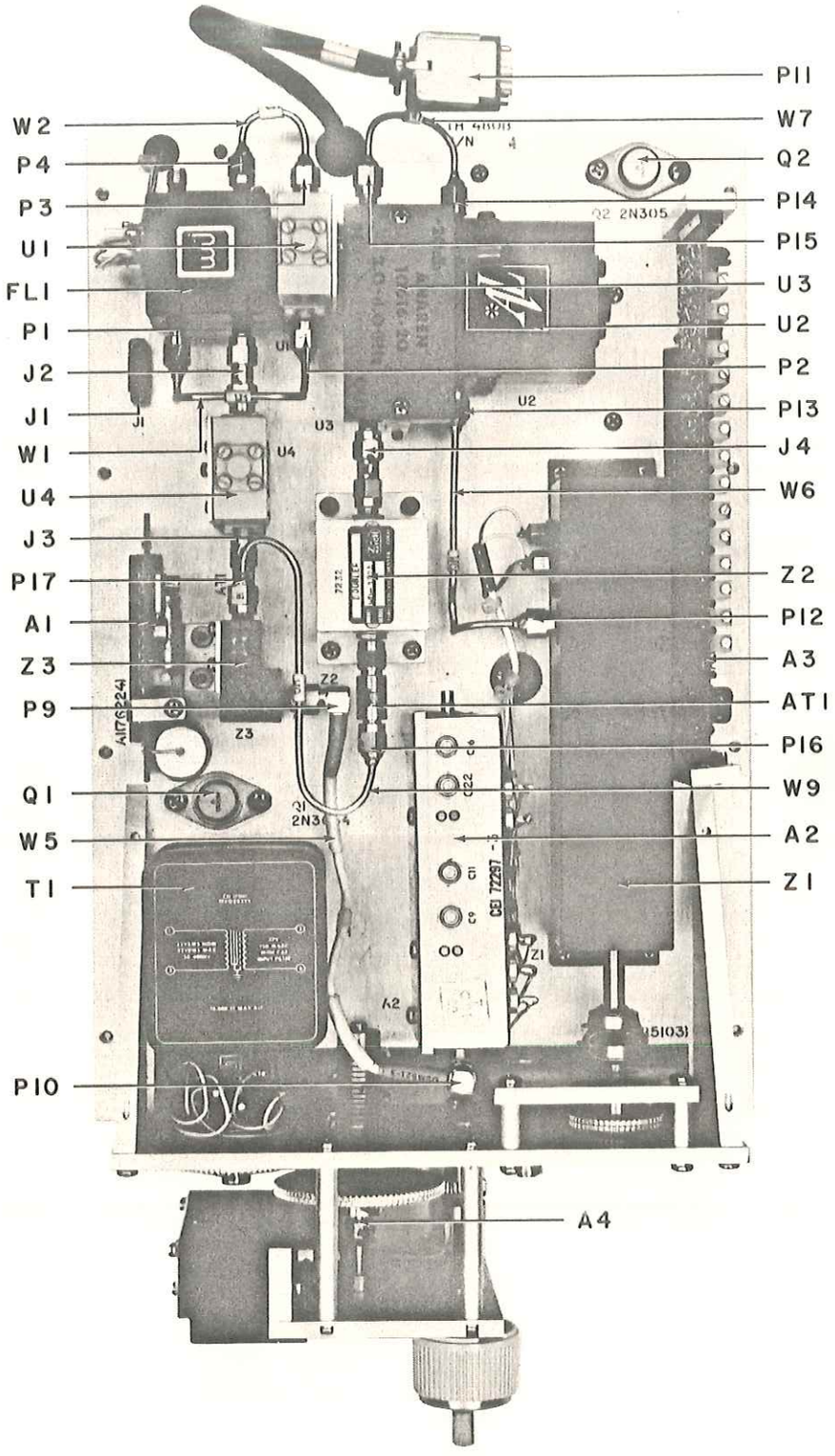


Figure 5-1. Type TH-480B Tuning Head, Top View, Location of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
P10	Same as P9				
P11	CONNECTOR, PLUG	1	SLE14PNSSH13	81312	
P12	Same as P1				
P13	Same as P1				
P14	Same as P1				
P15	Same as P1				
P16	Same as P1				
P17	Same as P1				
Q1	TRANSISTOR	2	2N3054	80131	02735
Q2	Same as Q1				
R1	RESISTOR, FIXED, WIRE-WOUND: 2.5 Ω, 1%, 5W	1	RH5-2.5PORM1PCT	91637	
R2	RESISTOR, FIXED, WIRE-WOUND: 30 kΩ, 1%, 5W	1	TS5W30KPORM1PCT	15915	
T1	TRANSFORMER, POWER	1	17041	14632	
U1	ISOLATOR	2	217-0600	27338	
U2	ISOLATOR	1	217-0300	27338	
U3	COUPLER, DIRECTIONAL	1	10616-20	31597	
U4	Same as U1				
W1	CABLE ASSEMBLY	1	22995-30	14632	
W2	CABLE ASSEMBLY	1	22995-28	14632	
W3	NOT USED				
W4	NOT USED				

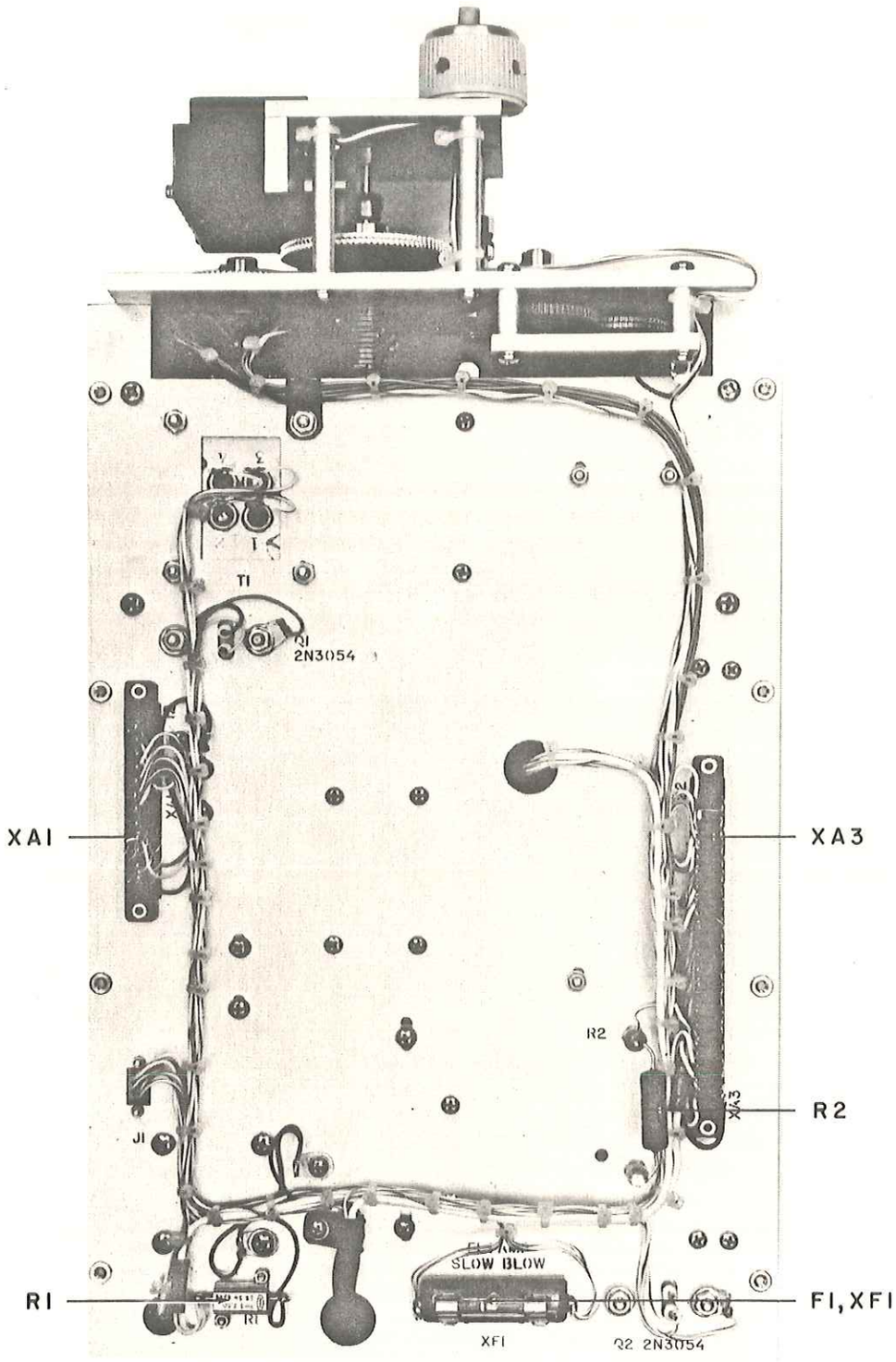


Figure 5-2. Type TH-480B Tuning Head, Bottom View, Location of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
W5	CABLE ASSEMBLY	1	30020-1866	14632	
W6	CABLE ASSEMBLY	1	22995-33	14632	
W7	CABLE ASSEMBLY	1	22995-29	14632	
W8	NOT USED				
W9**	CABLE ASSEMBLY	1	22995-31	14632	
W9**	CABLE ASSEMBLY	1	22995-32	14632	
XA1	CONNECTOR, PRINTED CIRCUIT CARD	1	250-12-30-170	71785	
XA3	CONNECTOR, PRINTED CIRCUIT CARD	1	251-22-30-160	71785	
XF1	FUSEHOLDER	1	357001	75915	
Z1	OSCILLATOR	1	17044	14632	
Z2	MULTIPLIER	1	WD-102A	05375	
Z3	MIXER, BALANCED	1	22543	07180	

* Factory selected item for power level. May not be required.

** When AT1 is required, use 22995-31. If AT1 is not required, use 22995-32.

5.4.2 Type 76224 -20V Power Supply

REF DESIG PREFIX A1

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	2	1N4446	80131	93332
CR2	Same as CR1				
C1	CAPACITOR, ELECTROLYTIC, ALUMINUM: 50 μF, -10+75%, 50V	1	30D506G050DD2	56289	
C2	CAPACITOR, ELECTROLYTIC, ALUMINUM: 200 μF, -10+75%, 50V	1	39D207G050FJ4	56289	
C3	CAPACITOR, ELECTROLYTIC, TANTALUM: 4.7 μF, 10%, 35V	3	CS13BF475K	81349	56289
C4	Same as C3				
C5	Same as C3				
C6	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 200V	1	8131A200Z5U0-103M	72982	
Q1	TRANSISTOR	1	2N2222A	80131	04713
R1	RESISTOR, VARIABLE, FILM: 2 kΩ, 10%, 3/4W	1	89PR2K	73138	
R2	RESISTOR, FIXED, FILM: 9.09 kΩ, 1%, 1/4W	1	RN60D9091F	81349	75042
R3	RESISTOR, FIXED, FILM: 20.0 kΩ, 1%, 1/4W	1	RN60D2002F	81349	75042
R4	RESISTOR, FIXED, FILM: 7.50 kΩ, 1%, 1/4W	1	RN60D7501F	81349	75042
R5	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/2W	1	RCR20G471JS	81349	01121
R6	RESISTOR, FIXED, COMPOSITION: 1.0 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R7	RESISTOR, FIXED, COMPOSITION: 3.3 Ω, 5%, 1/4W	1	RCR07G3R3JS	81349	01121
U1	DIODE ASSEMBLY	1	MDA920A3	04713	
U2	INTEGRATED CIRCUIT	1	U5B7741393	07263	

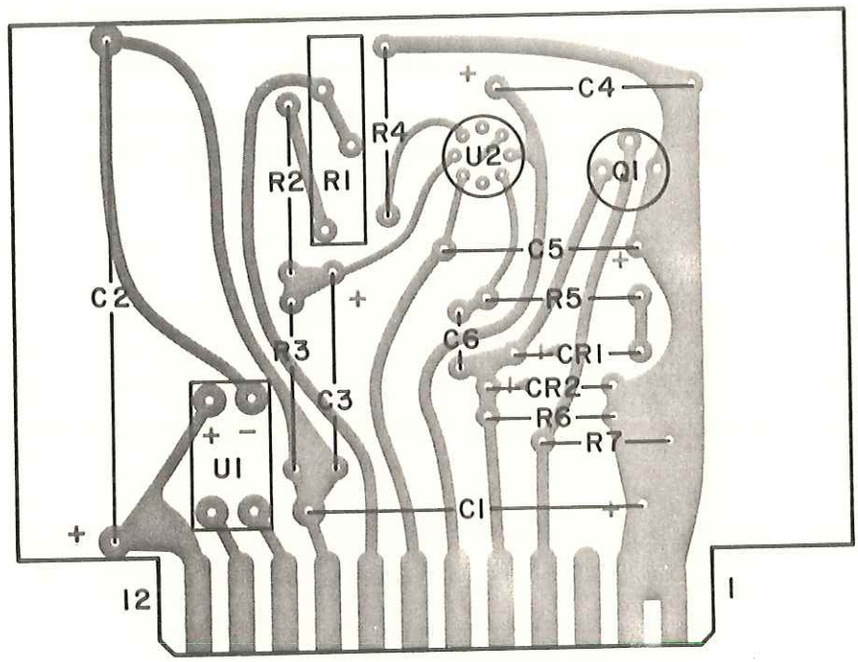


Figure 5-3. Type 76224 -20V Power Supply (A1), Location of Components

5.4.3 Type 72297-3 160 MHz IF Preamplifier

REF DESIG PREFIX A2

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
A1	INPUT AMPLIFIER	1	15578-2	14632	
C1	CAPACITOR, CERAMIC, DISC: 1000 pF, GMV, 500V	1	SM (1000 pF, P)	91418	
C2	NOT USED				
C3	CAPACITOR, CERAMIC, FEEDTHRU: 470 pF, 20%, 500V	5	FA5C-4712	01121	
C4	Same as C3				
C5	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 1000V	1	B (470 pF, M)	91418	
C6	Same as C3				
C7	CAPACITOR, CERAMIC, DISC: 0.01 μF, 20%, 100V	5	C023B101F103M	56289	
C8	CAPACITOR, CERAMIC, TUBULAR: 22 pF, 5%, 500V	2	301-000-C0G0-220J	72982	
C9	CAPACITOR, VARIABLE, AIR: 0.8-10 pF, 250V	4	2954	91293	
C10	CAPACITOR, CERAMIC, TUBULAR: 1.1 pF, 10%, 500V	1	QC (1.1 pF, K)	95121	
C11	Same as C9				
C12	CAPACITOR, CERAMIC, TUBULAR: 3.3 pF, ±0.1 pF, 500V	1	301-000-C0J0-339B	72982	
C13	Same as C3				
C14	Same as C8				
C15	Same as C3				
C16	Same as C9				
C17	CAPACITOR, CERAMIC, TUBULAR: 3 pF, ±0.1 pF, 500V	1	301-000-C0J0-309B	72982	
C18	Same as C7				
C19	Same as C7				
C20	Same as C7				

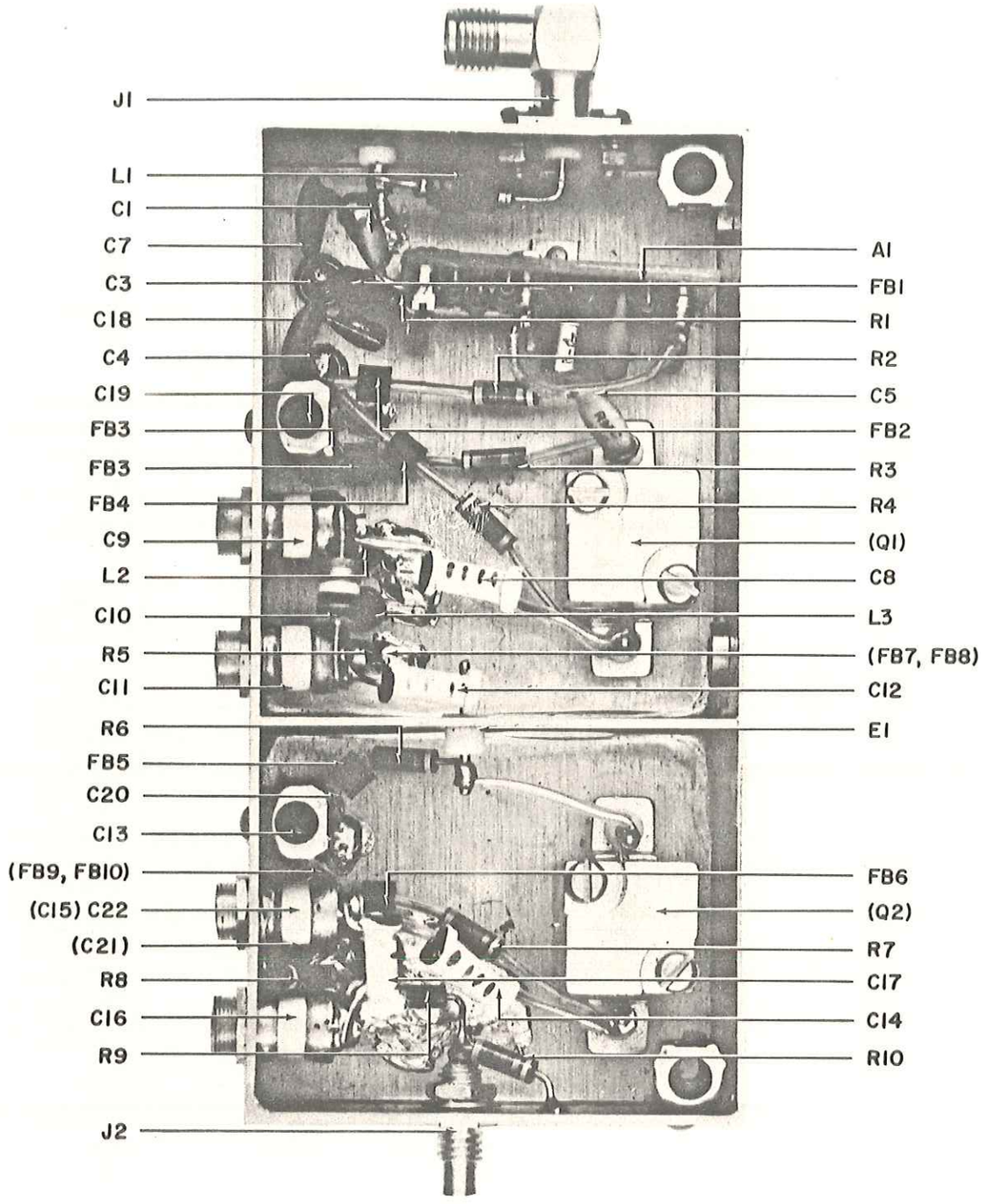


Figure 5-4. Type 72297-3 160 MHz IF Preamplifier (A2), Location of Components

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C21	Same as C7				
C22	Same as C9				
E1	TERMINAL, FEEDTHRU	1	SFU-16	04013	
FB1	FERRITE BEAD	10	56-590-65-4A	02114	
FB2	Same as FB1				
FB3	Same as FB1				
FB4	Same as FB1				
FB5	Same as FB1				
FB6	Same as FB1				
FB7	Same as FB1				
FB8	Same as FB1				
FB9	Same as FB1				
FB10	Same as FB1				
J1	CONNECTOR, RECEPTACLE, SMA SERIES	1	224	16179	
J2	CONNECTOR, RECEPTACLE, MINIATURE SERIES	1	UG-1464/U	80058	74868
L1	COIL, FIXED	1	21210-33	14632	
L2	COIL, FIXED	3	21210-25	14632	
L3	Same as L2				
L4	Same as L2				
MP1	COVER	1	15936	14632	
Q1	TRANSISTOR	2	2N918	80131	04713

REF DESIG PREFIX A2

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
Q2	Same as Q1				
R1	RESISTOR, FIXED, COMPOSITION: 1 kΩ, 5%, 1/4W	1	RCR07G102JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/4W	1	RCR07G471JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 5.6 kΩ, 5%, 1/4W	2	RCR07G562JS	81349	01121
R4	RESISTOR, FIXED, COMPOSITION: 3 kΩ, 5%, 1/4W	2	RCR07G302JS	81349	01121
R5	RESISTOR, FIXED, COMPOSITION: 6.2 kΩ, 5%, 1/4W	1	RCR07G622JS	81349	01121
R6	Same as R3				
R7	Same as R4				
R8	RESISTOR, FIXED, COMPOSITION: 300 Ω, 5%, 1/4W	2	RCR07G301JS	81349	01121
R9	RESISTOR, FIXED, COMPOSITION: 18 Ω, 5%, 1/4W	1	RCR07G180JS	81349	01121
R10	Same as R8				

5.4.3.1 Part 15578-2 Input Amplifier

REF DESIG PREFIX A2A1

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
C1	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 200V	1	CK05BX471M	81349	56289
C2	CAPACITOR, CERAMIC, DISC: 470 pF, 20%, 1000V	1	B (470 pF, 1000V, M)	91418	
C3	CAPACITOR, CERAMIC, DISC: 1000 pF, GMV, 500V	1	SM (1000 pF, GMV)	91418	
Q1	TRANSISTOR	1	AT17	24539	
R1	RESISTOR, FIXED, COMPOSITION: 10 kΩ, 5%, 1/4W	1	RCR07G103JS	81349	01121
R2	RESISTOR, FIXED, COMPOSITION: 5.1 kΩ, 5%, 1/4W	1	RCR07G512JS	81349	01121
R3	RESISTOR, FIXED, COMPOSITION: 470 Ω, 5%, 1/4W	2	RCR07G471JS	81349	01121
R4	Same as R3				

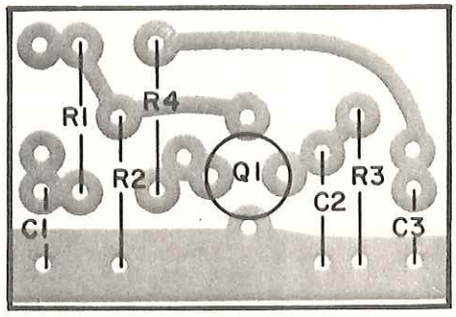


Figure 5-5. Part 15578-2 Input Amplifier (A2A1), Location of Components

5.4.4 Type 791099-1 YIG Shaper And Driver

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
CR1	DIODE	1	1N4449	80131	93332
C1	CAPACITOR, ELECTROLYTIC, TANTALUM: 10 μF, 10%, 20V	3	CS13BE106K	81349	56289
C2	Same as C1				
C3	CAPACITOR, MICA, DIPPED: 100 pF, 5%, 500V	4	CM05FD101J03	81349	72136
C4	Same as C1				
C5	Same as C3				
C6	CAPACITOR, ELECTROLYTIC, TANTALUM: 0.22 μF, 10%, 35V	1	150D224X9035A2	56289	
C7	Same as C3				
C8	Same as C3				
C9	CAPACITOR, CERAMIC, DISC: 0.1 μF, 20%, 100V	1	8131M100-651-104M	72982	
Q1	TRANSISTOR	1	2N2270	80131	02735
R1	RESISTOR, FIXED, COMPOSITION: 7.5 Ω, 5%, 1/4W	1	RCR07G7R5JS	81349	01121
R2	RESISTOR, FIXED, FILM: 3.24 kΩ, 1%, 1/4W	1	RN60D3241F	81349	75042
R3	RESISTOR, FIXED, FILM: 8.06 kΩ, 1%, 1/4W	1	RN60D8061F	81349	75042
R4	RESISTOR, FIXED, FILM: 31.6 kΩ, 1%, 1/4W	1	RN60D3162F	81349	75042
R5	RESISTOR, FIXED, COMPOSITION: 8.2 kΩ, 5%, 1/4W	1	RCR07G822JS	81349	01121
R6	RESISTOR, FIXED, FILM: 2.87 kΩ, 1%, 1/4W	1	RN60D2871F	81349	75042
R7	RESISTOR, VARIABLE, FILM: 5 kΩ, 10%, 3/4W	1	89PR5K	73138	
R8	RESISTOR, FIXED, COMPOSITION: 7.5 kΩ, 5%, 1/4W	1	RCR07G752JS	81349	01121
R9	RESISTOR, VARIABLE, FILM: 20 kΩ, 10%, 3/4W	1	89PR20K	73138	
R10	RESISTOR, FIXED, COMPOSITION: 5.1 kΩ, 5%, 1/4W	1	RCR07G512JS	81349	01121

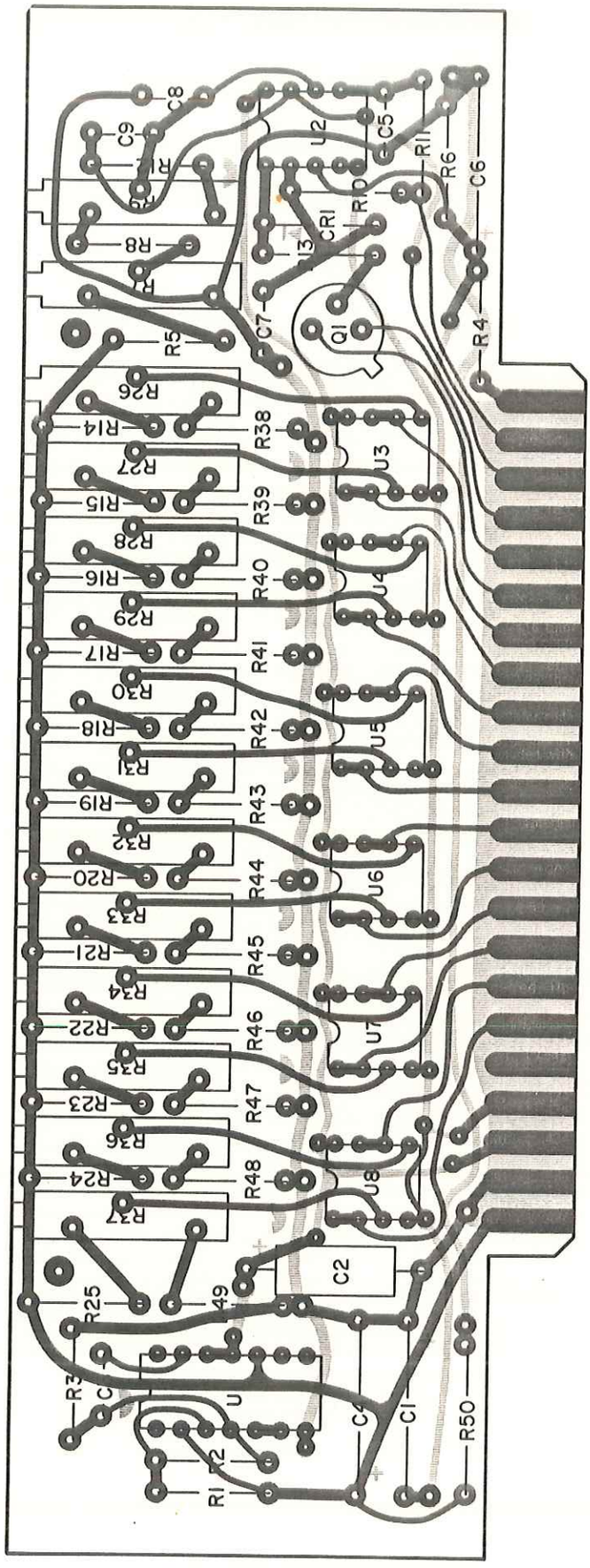


Figure 5-6. Type 791099-1 YIG Shaper and Driver (A3), Location of Components

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R11	RESISTOR, FIXED, COMPOSITION: 15 kΩ, 5%, 1/4W	1	RCR07G153JS	81349	01121
R12	RESISTOR, FIXED, COMPOSITION: 470 kΩ, 5%, 1/4W	1	RCR07G474JS	81349	01121
R13	RESISTOR, FIXED, COMPOSITION: 2.2 kΩ, 5%, 1/4W	1	RCR07G222JS	81349	01121
R14	RESISTOR, FIXED, FILM: 3.01 kΩ, 1%, 1/8W	3	RN55D3011F	81349	75042
R15	Same as R14				
R16	RESISTOR, FIXED, FILM: 2.80 kΩ, 1%, 1/8W	2	RN55D2801F	81349	75042
R17	Same as R16				
R18	RESISTOR, FIXED, FILM: 2.61 kΩ, 1%, 1/8W	2	RN55D2611F	81349	75042
R19	RESISTOR, FIXED, FILM: 1.82 kΩ, 1%, 1/8W	2	RN55D1821F	81349	75042
R20	RESISTOR, FIXED, FILM: 2.00 kΩ, 1%, 1/8W	1	RN55D2001F	81349	75042
R21	RESISTOR, FIXED, FILM: 1.62 kΩ, 1%, 1/8W	1	RN55D1621F	81349	75042
R22	RESISTOR, FIXED, FILM: 1.21 kΩ, 1%, 1/8W	1	RN55D1211F	81349	75042
R23	RESISTOR, FIXED, FILM: 806 Ω, 1%, 1/8W	1	RN55D8060F	81349	75042
R24	RESISTOR, FIXED, COMPOSITION: 2.7 Ω, 5%, 1/4W	4	RCR07G2R7JS	81349	01121
R25	Same as R24				
R26	RESISTOR, VARIABLE, FILM: 1 kΩ, 10%, 3/4W	12	89PR1K	73138	
R27	Same as R26				
R28	Same as R26				
R29	Same as R26				
R30	Same as R26				
R31	Same as R26				

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
R32	Same as R26				
R33	Same as R26				
R34	Same as R26				
R35	Same as R26				
R36	Same as R26				
R37	Same as R26				
R38	Same as R24				
R39	Same as R24				
R40	RESISTOR, FIXED, FILM: 200 Ω, 1%, 1/8W	2	RN55D2000F	81349	75042
R41	Same as R40				
R42	RESISTOR, FIXED, FILM: 402 Ω, 1%, 1/8W	1	RN55D4020F	81349	75042
R43	RESISTOR, FIXED, FILM: 324 Ω, 1%, 1/8W	1	RN55D3240F	81349	75042
R44	RESISTOR, FIXED, FILM: 1.0 kΩ, 1%, 1/8W	1	RN55D1001F	81349	75042
R45	RESISTOR, FIXED, FILM: 1.40 kΩ, 1%, 1/8W	1	RN55D1401F	81349	75042
R46	Same as R19				
R47	RESISTOR, FIXED, FILM: 2.21 kΩ, 1%, 1/8W	1	RN55D2211F	81349	75042
R48	Same as R18				
R49	Same as R14				
R50	RESISTOR, FIXED, FILM: 51.1 kΩ, 1%, 1/4W	1	RN60D5112F	81349	75042
U1	INTEGRATED CIRCUIT	1	U6A7723393	07263	
U2	INTEGRATED CIRCUIT	1	S5558V	27014	

REF DESIG PREFIX A3

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
U3	INTEGRATED CIRCUIT	6	N5558V	27014	
U4	Same as U3				
U5	Same as U3				
U6	Same as U3				
U7	Same as U3				
U8	Same as U3				

5.4.5. Type 85103 Tuning Drive

REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
1	FRONT GEAR PLATE	1	21612-1	14632	
2	LIGHT BAR	1	21363-1	14632	
3	LIGHT BAR WINDOW	1	14144-1	14632	
4	TAPE PRESSURE PLATE	1	14106-1	14632	
5	LIGHT BOARD (A1)	1	15531	14632	
6	INCANDESCENT LAMP (DS1, DS2, DS3)	3	CM8-683	71744	
7	PINION BEVEL GEAR	2	12124	14632	
8	COLLAR	1	11581-5	14632	
9	TENSION SPRING	1	13944	14632	
10	TAPE CHAMBER PLATE	1	14145-1	14632	
11	BEARING	1	14589-1	14632	
12	TAPE CHAMBER	1	31373-1	14632	
13	GEAR, TAPE DRIVE	1	14065	14632	
14	TAPE, CALIBRATED	1	33306	14632	
15	SHAFT	1	13908-6	14632	
16	COVER, TAPE CHAMBER	1	14083-1	14632	
17	BALL BEARING	1	SFR-63MM	83086	
18	BALL BEARING	1	SFR-33PP	83086	
19	BALL BEARING	6	SFR-1888PP	83086	
20	SHAFT	1	1002-79	14632	
21	RETAINING RING	2	5100-25	79136	

REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
22	COLLAR	1	11581-11	14632	
23	SPRING FRICTION WASHER	2	3502-14-47	78189	
24	TRUST BEARING	1	TT-504	70417	
25	CLUSTER GEAR	1	15042-1	14632	
26	SHIM SPACER	AR	SSS-33	01351	
27	SHIM SPACER	AR	SSS-23	01351	
28	COLLAR	1	1054-3	14632	
29	ANTI-BACKLASH GEAR	1	20180-35	14632	
30	GEAR, SPUR	1	2984-48	14632	
31	SPACER	4	20757-24	14632	
32	ANTI-BACKLASH GEAR	1	20180-23	14632	
33	ANTI-BACKLASH GEAR	1	20180-12	14632	
34	SHAFT	1	1002-91	14632	
35	SHAFT	1	1002-19	14632	
36	REAR GEAR PLATE	1	23144-1	14632	
37	SPRING PIN, 0.062 DIA. X 1/4 Lg.	1	MS16562-190	96906	73734
38	#10 FLAT WASHER	2	MS15795-807	96906	73734
39	STOP SHAFT	1	13884-1	14632	
40	STOP WASHER	13	13863-1	14632	
41	STOP RETAINER ASSEMBLY	1	13868-1	14632	
42	GEAR SPUR	1	2984-1	14632	

REF DESIG PREFIX A4

REF DESIG	DESCRIPTION	QTY. PER ASSY	MANFACTURER'S PART NO.	MFR. CODE	RECM. VENDOR
43	ANTI-BACKLASH GEAR	1	20180-47	14632	
44	SPACER	4	20757-4	14632	
45	OSCILLATOR PLATE	1	23143-1	14632	
46	SHAFT COUPLER	1	DSSD250	23615	
47	POTENTIOMETER (R1)	1	8106-62-0	73138	
48	#4-40 X 1/8 Lg. SET SCREW	AR	MS51021-9	96906	73734
49	#6-32 X 1/8 Lg. SET SCREW	AR	MS51021-21	96906	73734
50	#2-56 X 3/16 Lg. PAN HEAD MACHINE SCREW	AR	MS51957-2	96906	73734
51	#2-56 X 1/4 Lg. FLAT HEAD MACHINE SCREW	AR	MS35249-10	96906	73734
52	#2-56 X 5/16 Lg. PAN HEAD MACHINE SCREW	AR	MS51957-4	96906	73734
53	SHOULDER SPACER	2	15545-1	14632	
54	#6-32 X 3/8 PAN HEAD MACHINE SCREW	AR	MS51957-28	96906	73734
55	#2 LOCK WASHER (SPLIT)	AR	MS35338-134	96906	73734
56	#6 LOCK WASHER (SPLIT)	AR	MS35338-136	96906	73734
57	#2 FLAT WASHER	AR	NAS620C2	80205	73734

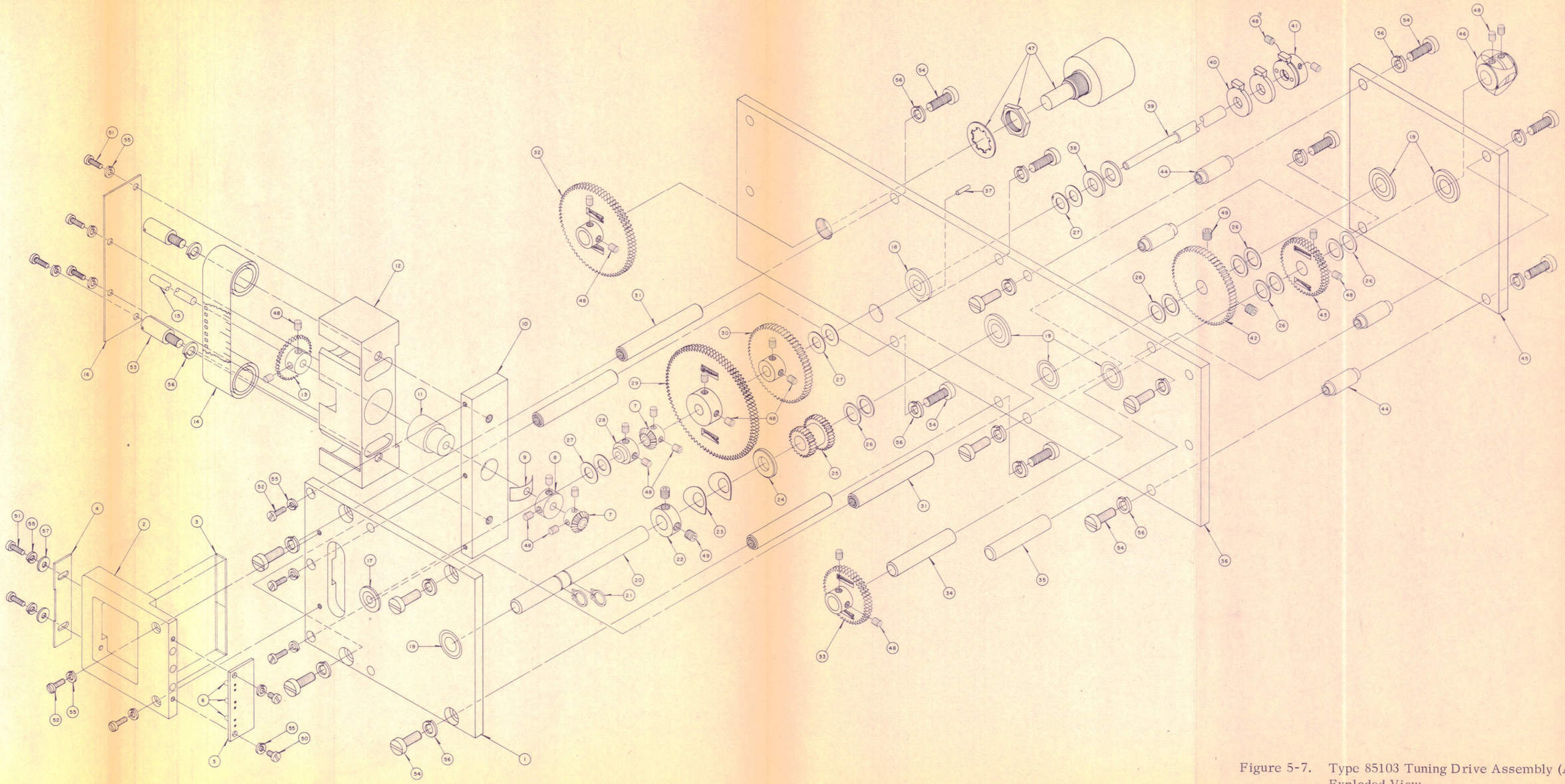
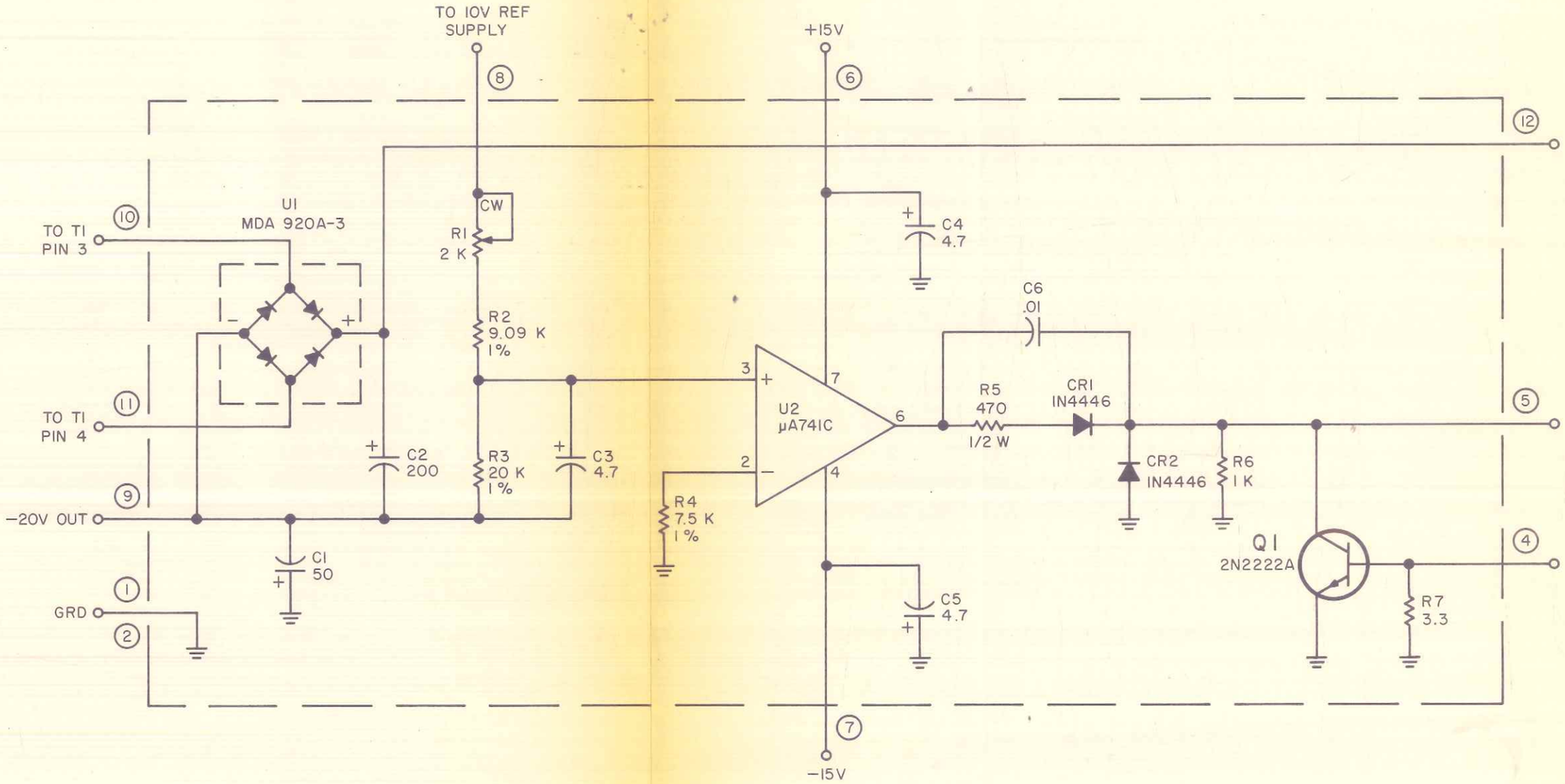


Figure 5-7. Type 85103 Tuning Drive Assembly (A4), Exploded View



NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ± 5%, 1/4 W.
   b) CAPACITANCE IS IN µF.
2. ENCIRCLED NUMBERS ARE MODULE PIN NUMBERS.
3. CW ON R1 INDICATES CLOCKWISE ROTATION OF ACTUATOR.
4. FOR PIN ARRANGEMENT OF U2, SEE DETAIL A.

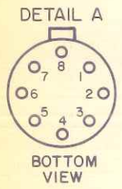
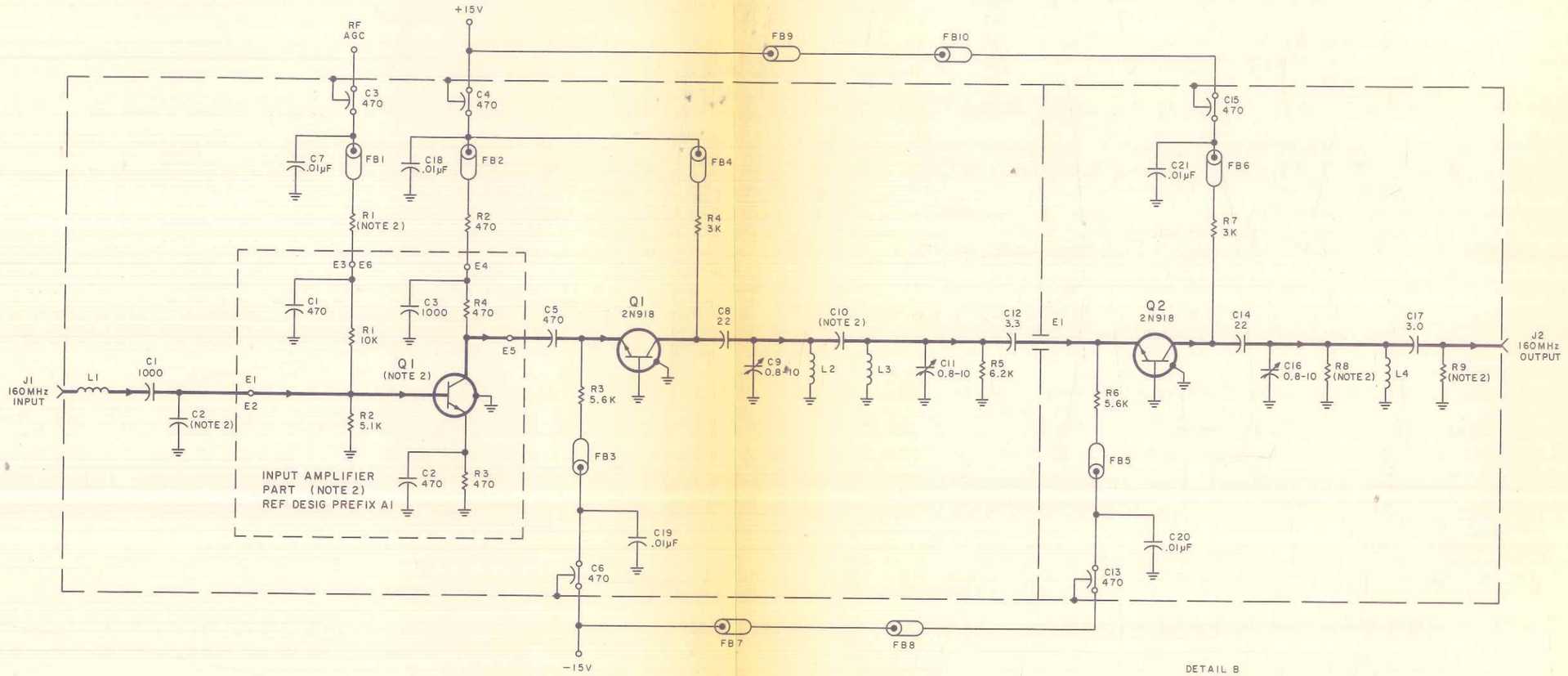


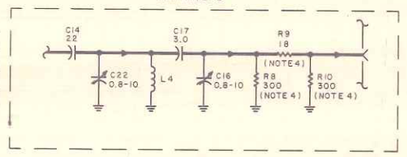
Figure 6-1. Type 76224 -20V Power Supply (A1), Schematic Diagram



DETAIL A

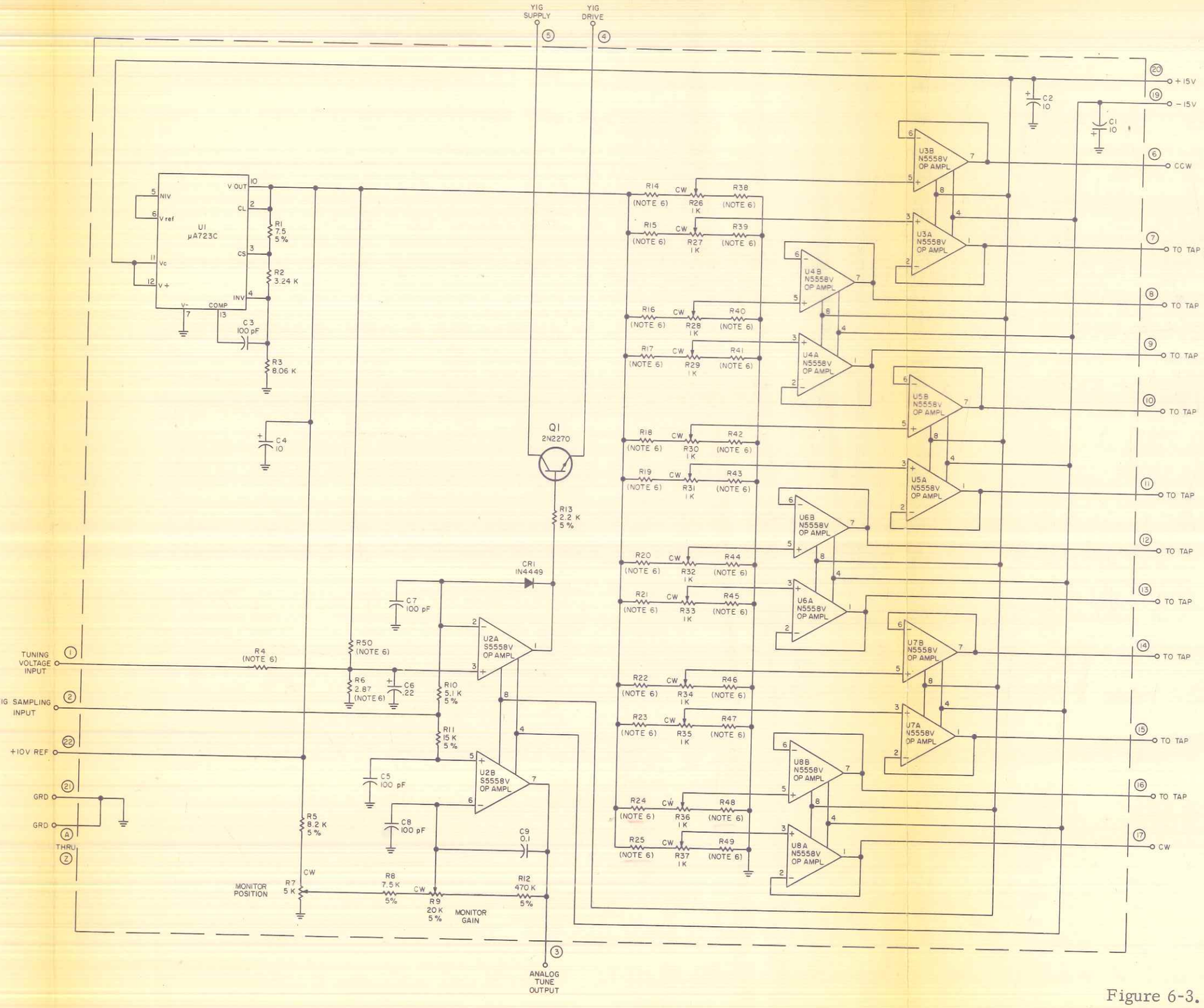
TYPE	R10	C22	C2	R1	R8	R9	A1Q1	C10	A1 PART
72297-1	N/U	N/U	12	1K	N/U	N/U	2N2857	1.0	15578-1
72297-2	N/U	N/U	N/U	20K	8.2K	100	2N2857	1.0	15578-1
72297-3 NOTE 3	300	0.8-10	N/U	1K	300	18	AT17	1.1	15578-2

DETAIL B



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ±5%, 1/4W.
   b) CAPACITANCE IS IN pF.
2. DIFFERENCE BETWEEN TYPES IS SHOWN IN DETAIL A.
3. OUTPUT NETWORK FOR 72297-3 IS SHOWN IN DETAIL B.
4. NOMINAL VALUE. FINAL VALUE FACTORY SELECTED.
5. HEAVY LINE INDICATES MAIN SIGNAL PATH.

Figure 6-2. Types 72297-1, -2, -3 160 MHz IF Preamplifier (A2) 20 MHz BW, Schematic Diagram



RESISTOR TABULATION

791099-1	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R6	
	31.6K *	3.01K	3.01K	2.8K	2.8K	2.61K	1.82K	2.0K	1.62K	1.21K	806	27 * *	27 * *	2.87K
	R50	R38	R39	R40	R41	R42	R43	R44	R45	R46	R47	R48	R49	
	51.1K *	27 * *	27 * *	200	200	402	324	1.0K	1.4K	1.82K	2.21K	2.61K	3.01K	
791099-2	R4	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R6
	28.7K *	3.01K	3.01K	2.8K	2.8K	2.61K	1.82K	2.49K	1.62K	1.21K	806	27 * *	27 * *	2.87K
	R50	R38	R39	R40	R41	R42	R43	R44	R45	R46	R47	R48	R49	
	56.2 *	27 * *	27 * *	200	200	402	324	750Ω	1.4K	1.82K	2.21K	2.61K	3.01K	
791099-3	R4	R14	R15	R16	R17	R18	R19	R20	R21	R22	R23	R24	R25	R6
	61.9K *	3.01K	3.01K	2.8K	2.61K	2.43K	2.0K	1.4K	1.0K	750Ω	511Ω	27 * *	27 * *	3.16K
	R50	R38	R39	R40	R41	R42	R43	R44	R45	R46	R47	R48	R49	
	42.2 *	27 * *	27 * *	200	402	604	1.0K	1.62K	2.15K	2.49K	3.01K	2.61K	3.01K	

NOTES:

1. UNLESS OTHERWISE SPECIFIED:
   a) RESISTANCE IS IN OHMS, ± 1%, 1/4 W.
   b) CAPACITANCE IS IN μF.
2. ENCIRCLED NUMBERS AND LETTERS ARE MODULE PIN NUMBERS AND LETTERS.
3. CW ON POTENTIOMETERS INDICATES CLOCKWISE ROTATION OF ACTUATOR.
4. FOR PIN ARRANGEMENT OF U1 SEE DETAIL A.
5. FOR PIN ARRANGEMENT OF U2 THRU U8 SEE DETAIL B.
6. THE DIFFERENCE BETWEEN TYPES IS SHOWN IN RESISTOR TABULATION. RESISTANCE IS IN OHMS, ± 1%, 1/8 W. (* ± 1%, 1/4 W. * * ± 5%, 1/4 W.)

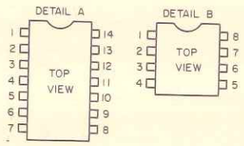
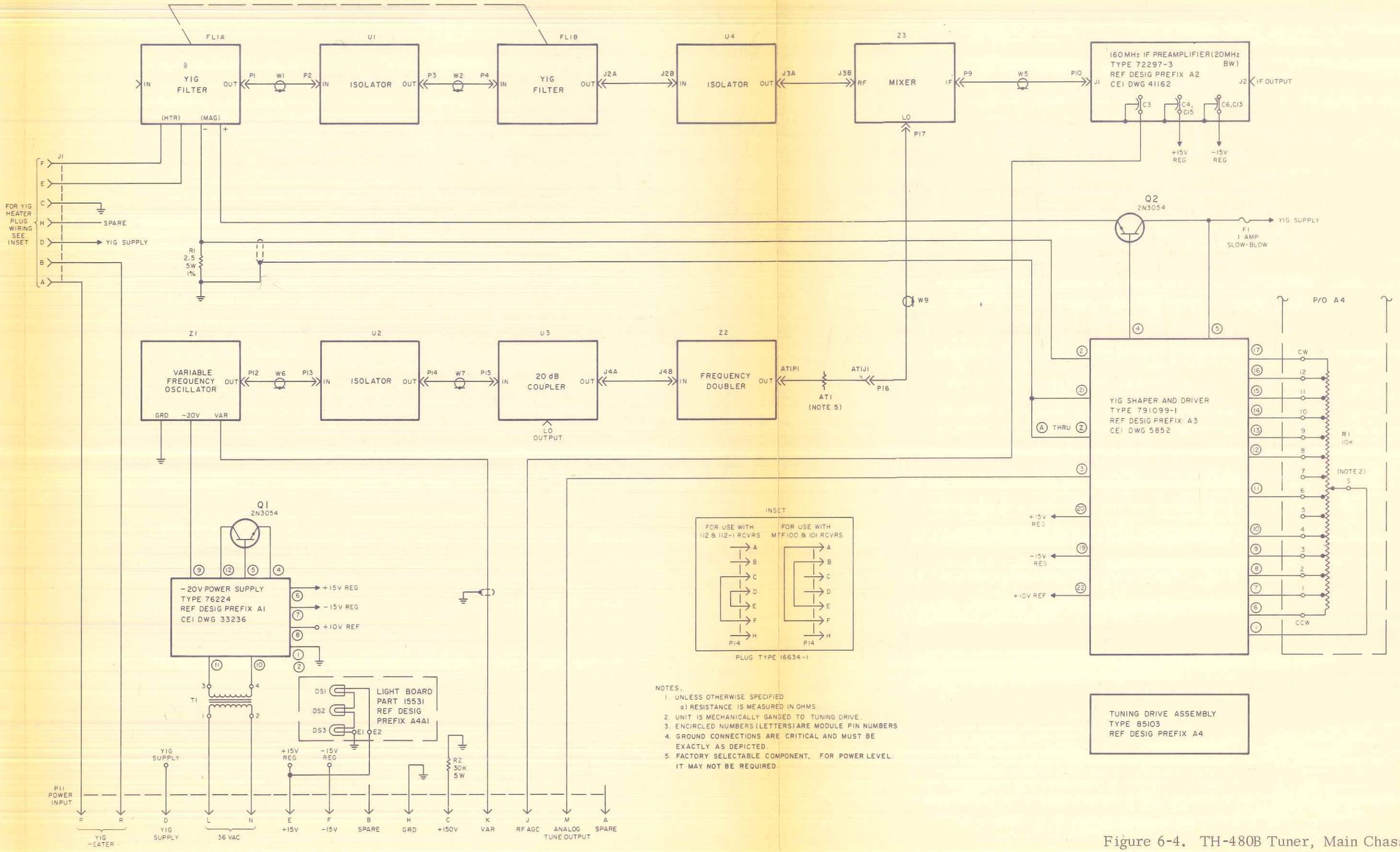


Figure 6-3. Types 791099-1, -2, -3 YIG Shaper and Driver (A3), Schematic Diagram



NOTES,

1. UNLESS OTHERWISE SPECIFIED
   a) RESISTANCE IS MEASURED IN OHMS.
2. UNIT IS MECHANICALLY GANGED TO TUNING DRIVE.
3. ENCIRCLED NUMBERS (LETTERS) ARE MODULE PIN NUMBERS.
4. GROUND CONNECTIONS ARE CRITICAL AND MUST BE EXACTLY AS DEPICTED.
5. FACTORY SELECTABLE COMPONENT. FOR POWER LEVEL. IT MAY NOT BE REQUIRED.

Figure 6-4. TH-480B Tuner, Main Chassis, Schematic Diagram