TM 11-5820-672-35-4

TECHNICAL MANUAL

DS, GS, AND DEPOT MAINTENANCE MANUAL

BANDPASS FILTER F-1138/GRC

HEADQUARTERS, DEPARTMENT OF THE ARMY

OCTOBER 1970

WARNING

DANGEROUS VOLTAGE EXIST IN THIS EQUIPMENT

Be careful when working on the input rectifier or on the input ac and dc line connections. Serious injury or death may result from contact with these points.

DON'T TAKE CHANCES!

CAUTION

Do not make resistance measurements on the transistorized circuits of this equipment without first checking the instructions given in paragraph 2–4*e*.

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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *7 October 1970*

DS, GS, and Depot Maintenance Manual
BANDPASS FILTER F-1138/GRC

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CHAPTER 1
FUNCTIONING

Section I. SYSTEM FUNCTIONING

1-1. Scope

a. General. This manual contains direct support (DS), general support (GS), and depot maintenance instructions for Bandpass Filter F-1138/GRC. Included are instructions for troubleshooting, testing, aligning, and repairing of the preselector, and the replacement of maintenance parts. Listings of tools, materials, and test equipment required for maintenance are also provided. The detailed functions of the equipment are covered in this chapter.

b. Related Manuals. The F-1138/GRC is part of Radio Set AN/GRC-158, and the operation and installation are covered in TM 11-5820-672-12. The remainder of the technical manuals associated with this equipment are listed in the appendix.

c. Reporting of Equipment Manual Improvements. Reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commanding General, U.S. Army Electronics Command, ATTN: AMSEL-ME-NMP-EM, Fort Monmouth, N.J. 07703.

NOTE

For other applicable forms and records, refer to TM 11-5820-672-12.

1-2. Indexes of Publications

a. DA Pam 310-4. Refer to DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment.

b. DA Pam 310-7. Refer to DA Pam 310-7 to determine whether there are modification work orders (MWO's) pertaining to the equipment.

1-3. System Application

Radio Set AN/GRC-158 has two Receiver-Transmitters, Radio RT-698/ARC-102. One is locked in receive only, and the other can transmit and receive. The F-1138/GRC (fig. 1-1) allows the RT-698/ARC-102, locked in receive only, to receive usable signals to within approximately ±10 percent of the frequency of the RT-698/ARC-102 used to transmit. Operation is maintained with a minimum of cross modulation.

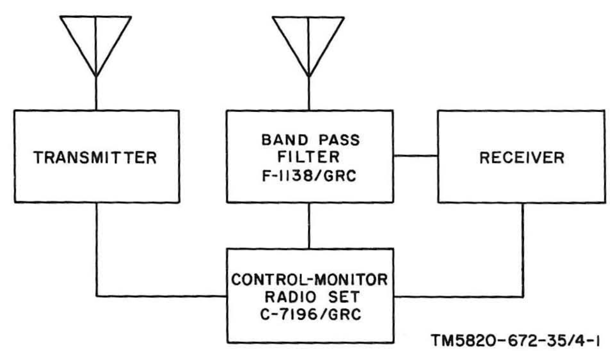


Figure 1-1. Application of Bandpass Filter F-1138/GRC.

Section II. FUNCTIONING OF F-1138/GRC

1-4. Block Diagram

The F-1138/GRC (fig. 5-2) is an automatically tuned, active bandpass filter with a frequency range of 2.000 to 29.999 MegaHertz (MHz). Signals in the passband are amplified by two low distortion amplifiers and fed to the receiver. Signals which are off-frequency, such as those from the adjacent RT-698/ARC-102, are sharply attenuated by the F-1138/GRC so that they do not distort weak desired signals. The attenuation of these undesired signals reduces cross modulation and intermodulation in the receiver. If the amplitude of radiofrequency (RF) input signals inside or outside the passband exceeds safe limits, the for base current to flow. The cutoff of A2Q3 disables the power supply.

(2) The 400-Hz oscillator consists of transistors A2Q1 and A2Q2, transformers A2T1 and A2T2, and associated circuit components. The oscillator starts upon application of +28 volts dc to the emitters of the transistors. Transistor A2Q2 conducts first because resistor A2R3 allows base current to flow, allowing current to flow through the emitter-collector junction of A2Q2 and through the primary winding of A2T2 to ground. The latter flow induces a secondary voltage in the feedback winding of A2T2. The voltage induced in the feedback winding of A2T2 is applied to the primary winding of saturable core transformer A2T1. Transformer A2T1 sustains the conduction of A2Q2 until the core of the transformer saturates. When A2T1 saturates, the secondary voltage decreases. This decreases the base current flow in A2Q2 and the primary current of A2T2. As the current decreases in A2T2, the induced secondary voltage driving A2T1 reverses, and the circuit quickly switches to the condition in which A2Q2 is cut off and base current in A2Q1 is increasing. This state is continued until transformer A2T1 again saturates, causing the oscillator circuit to switch states again. The frequency of oscillation depends on the time A2T1 takes to saturate. The saturation time of A2T1 depends on the amplitude of the primary driving voltage. This voltage is regulated by Zener diodes A2CR1 and A2CR2 which are chosen to regulate the frequency at 400 Hz. The output windings of A2T2 produce 115 (not used) and 28 volts alternating current (ac) for the follow-potentiometer drive motor, and chopper circuits. The rectifier circuits supply a floating 47 volts dc to follow-potentiometer R19 and +270 volts dc to the plate circuits of V1 and V2. Removal of either the equipment enable signal or the 28-volt dc power source disables the power supply.

1-7. Operation Control Circuits

The control circuits of the F-1138/GRC tune the filter circuits to the frequency selected by the frequency selector switches of Radio Set Control C-7207/GRC (referred to as the C-7207/GRC) mounted in the C-7196/GRC. The F-1138/GRC control circuits must convert the 2-out-of-5 digital code frequency input information to the corresponding mechanical position of the variable tuning capacitor shaft. The digital frequency information is first converted to a dc analog voltage (fig. 5-5). The analog voltage controls a servomechanism which drives the tuning capacitor. The sequence of events in the tuning cycle is explained below.

a. Frequency information reaches the F-1138/GRC in digital form as described above. When +28 volts dc is applied to the digital tune enable line (PIB 39, fig. 5-6①), digital to analog converter module A3 sets up to the new frequency information and applies a ground to the DTIP line, signaling the C-7196/GRC that correct frequency information is required. The motor driven switches in the digital to analog converter require a maximum of 1 second to set up to the new frequency. Inside the digital to analog converter, megahertz information goes to controlling switch wafers A3S1J and A3S1K (fig. 5-6②), 100-kiloHertz (kHz) information goes to wafers A3S2C and A3S2D, 10-kHz information goes to wafers A3S3C and A3S3D, and 1-Hz information goes to wafers A3S4B and A3S4C. For those digits which change with new frequency selection, the controlling switch wafer grounds terminal 5 of the associated motor control relay. Switch wafers A3S1Jand A3S1K control relay A3K1 and switch driving motor A3B1, and so on. When the C-7196/GRC applies ±28 volts dc to the digital tune enable (DTE) line (pin 18 of A3P1), relay A3K5 operates to apply +28 volts dc to terminal 1 of motor control relays A3K1, A3K2, A3K3, and A3K4. The motor control relays operate as dictated by the desired change in frequency, applying +28 volts dc to respective drive motors A3B1, A3B2, A3B3, and A3B4 through terminals 3 and 8 on each relay. As each drive motor rotates the controlling switch wafer to the proper position, the switch removes the ground from terminal 5 of the associated motor control relay. The removal of this ground deenergizes the relay and removes power from the motor. The moving motor is dynamically braked by short circuiting motor currents through terminals 2 and 8 of the motor control relay. As long as any of the motor driven switches are moving, associated motor control relay A3K1, A3K2, A3K3, or A3K4 keeps the digital tune in progress (DTIP) line (pin 14 of A3P1) grounded by closing terminal 7 to terminal 4. This, in turn, operates relay A3K6 to ground the DTIP line, signaling the C-7196/GRC that tuning is not complete and that frequency information is still required. When all motor control relays deenergize, the ground signal is removed from the DTIP line, and +28 volts dc is no longer required on the DTE line.

b. Operation of relay A3K6 also grounds capac-

(3) When the protection circuits operate, relay K2 places a ground on the fault line to light the C-7196/GRC FAULT/RESET indicator. A momentary ground on the F-1138/GRC fault reset line resets the protection circuits for normal operation. Depressing the C-7196/GRC FAULT/RESET pushbutton switch places the ground on the F-1138/GRC fault reset line.

1-5. Stage Analysis

The RF circuits allow desired signals to pass through to the receiver with enough gain to maintain receiver sensitivity while rejecting off-frequency signals. Off-frequency signals are attenuated as shown in figure 1-2.

a. An RF signal (fig. 5-3) reaches the F-1138/GRC through a coaxial terminal in connector P1 at the rear of the F-1138/GRC. Antenna relay K1 is normally energized, closing the normally-open contacts which carry the RF input signal. An RF overload will deenergize K1, opening these contacts to disconnect the F-1138/GRC input from the antenna. Normally-closed (NC) contacts on K1 ground the input tuned circuit when overload conditions occur. Paragraph 1-6 describes the conditions which deenergize K1.

b. During normal receiving conditions, the normally-open (NO) contacts on K1 apply the RF input signal to coupling capacitors C1E, C1F, and C1G and to series capacitors C66 and C67. Switches S1J and S1K select coupling capacitors singly or in combination, as appropriate, for each of the tuning bands. Switches S1J and S1K select capacitors C1F and C1G in parallel for the 2.000- to 3.999-MHz band, capacitor C1G for the 4.000- to 7.999-MHz band, C1F for the 8.000- to 15.999-MHz band, and capacitor C1E for the 16.000- to 29.999-MHz band. Band switch motor B1 drives switches S1J and S1K to the proper position. The purpose of the coupling capacitors, in series with the antenna input, is to couple the antenna to the first double tuned circuit. The input RF signal is then applied to tuning capacitor C1D and to band switches S1G and S1H. These switches select the double tuned circuit appropriate for the selected frequency and ground the unused tuned circuits to prevent interference with the selected circuit. For the 2.000- to 3.999-MHz band, the input double tuned circuit components are inductances L1, L25, and L2 and trimmer capacitors C8 and C9. Capacitors C1C and C1D tune the circuit. The tuned circuits are inductively coupled to maintain constant coupling when tuning across an entire band. The follow-potentiometer servosystem (para 1-8) positions tuning capacitors C1C and C1D and input coupling capacitors C1E, C1F, and C1G to produce resonance in the double tuned circuits at the desired frequency. The output of the first double tuned circuit is fed to band switches S1FB and S1FF and through a capacitance voltage divider to S1E, where band selection and grounding of unused circuits again takes place. Tuning capacitor C1C for the second tuned circuit is connected to the wiper of switch S1FB for use with all band circuits.

c. A capacitance voltage divider, consisting of capacitors C31 through C35 and resistors R30 and R31 in parallel with tuning capacitor C1C, provides impedance matching to input RF amplifier V1. Band switch motor B1 drives switch S1E to select the proper band voltage divider. Input RF amplifier V1 is a low-noise degenerative cascade amplifier which compensates for RF signal losses in the first double tuned circuit. The cascade circuit consists of a degenerative triode amplifier connected to a grounded grid amplifier. This circuit provides linear, low-noise amplification.

d. The output of cascade amplifier VI is coupled through C30 to band switch S1CB and tuning capacitor C1B. Switch S1CB selects the proper band components of the second double tuned circuits, and switch S1CF grounds the remaining band circuits to prevent interference with the selected band. The second double tuned band circuits are electrically identical with the first double tuned circuits described above except that the overall circuit Q is lower.

e. The output of the second double tuned band circuit is fed to capacitance voltage divider C39 through C45 and C83. This combination of capacitors reduces the overall input to the grid of V2B, a section of the output RF amplifier. Output RF amplifier V2 is a low-noise cascade stage which provides additional gain. Capacitor C29 couples the output of V2 to impedance matching transformer T1, which transform the 50-ohm load to the proper plate impedance for V2.

f. Inductor L24 and resistors R26 and R7 form a cathode degenerative feedback loop for cascade amplifier V2 with contacts 2 and 8 of low-gain relay K4 open. Resistors R10, R21, and R24 further reduce the output signal voltage when K4 is energized by a ground on the low-gain line.

1-6. Power Control and Protective Circuits

a. Protection Circuits. The protection circuits (fig. 5-4) prevent damage to the F-1138/GRC

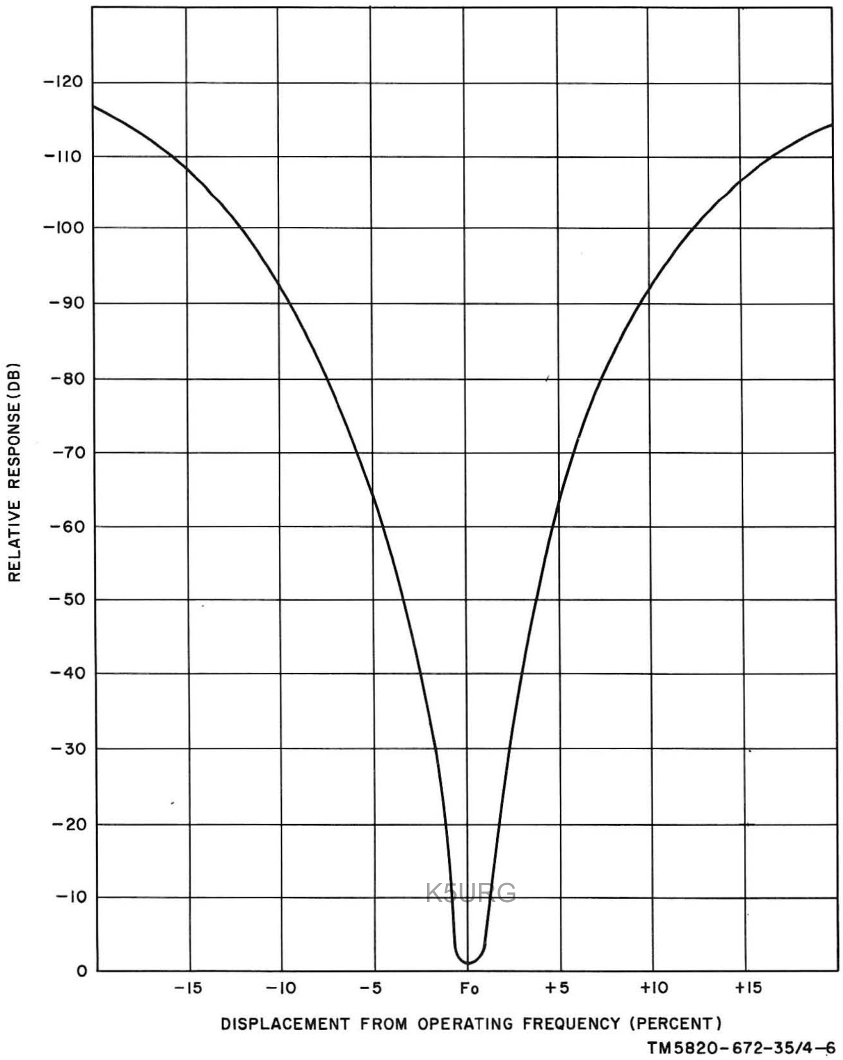


Figure 1-2. Typical RF passband, graph display.

and the receiver due to strong RF input signals either directly on- or off-frequency. Protection is accomplished by deenergizing relay K1 when damaging RF levels are present at the antenna input. When K1 deenergizes, it disconnects all RF circuits from the antenna input and grounds the input to the first double tuned circuit. Relay K1 is interlocked through band switch control relay K3 so that it is deenergized during band switching to prevent arcing of the band switches.

(1) The off-frequency protection circuit prevents strong RF signals at frequencies above or below the F-1138/GRC passband from being applied to the F-1138/GRC RF input.

(2) The RF signals are applied to the F-1138/GRC input circuits through antenna relay K1. Ground is supplied to the antenna relay through contacts 4 and 6 of protection relay K2, and contacts 2 and 8 of band switching relay K3. Thus, antenna relay K1 is normally energized, and the RF input signal is applied to coupling capacitors C1D, C1E, C1F, and C1G, through band switches S1J, S1K, and S1G, to off-frequency voltage divider capacitors C3, C4, C5, C6, C7, and C50 to the off-frequency protection device. Diodes CR1 and CR16 and capacitor C50 form a voltage doubler connected to the output of the voltage divider to rectify and double the input RF for operation of protection unijunction transistor CR15. The dc output of CR1 is filtered by capacitors C49 and C60 and is fed through dropping resistor R23 to off-frequency adjustment resistor R15. Resistor R15 is adjusted to trigger unijunction transistor CR15 when the off-frequency input, removed from the center frequency by ±10 percent, is 1,400 volts peak or greater.

The output of R15 is fed through blocking diode CR10 to R20, thermistor RT1, and R25. Thermistor RT1 compensates for changes in the firing voltage of R15 over the design temperature range. Filter C62 prevents RF energy, present after rectification, from being applied to unijunction transistor CR15, which conducts when 0.5 volt is applied to the control gate. When CR15 conducts, the resistance across the anode and cathode is reduced to 0, causing protection relay K2 to energize. As K2 energizes, contacts 4 and 6 open, causing antenna relay K1 to deenergize. This opens the F–1138/GRC RF input, and grounds the filter input circuits. The operator is warned of an overload by a ground placed on the fault line through K2 contacts 4 and 7 and contacts 8 and 2 of band switching relay K3. The fault line is connected to the C–7196/GRC FAULT/RESET indicator. This indicator lights when the ground is present, warning the operator of the overload condition. To restore normal F–1138/GRC operation, the cause of input overloading must be removed and a ground must be placed momentarily on the reset line by pressing the C–7196/GRC FAULT/RESET pushbutton switch. This places a momentary ground on the anode of CR15 through CR13 and CR14, removing the voltage potential across the unijunction transistor and resetting CR15. Zener diode CR14 insures that 0 volt is present on the anode of CR15 when the reset line is grounded.

(3) The on-frequency protection device utilizes the same switching circuits as the off-frequency protection circuits and uses the same type of detection circuit. A portion of the RF energy from the input of final cascade amplifier V2 is fed through C2 to a voltage doubler consisting of CR2, CR12, and C36. Thus, the filtered dc output across potentiometer R16, has a value that is approximately twice the RF root-mean-square (rms) input value. The output of R16 is fed through blocking diode CR11 to the unijunction transistor protection circuit as described in the off-frequency protection circuit description. When the on-frequency RF input reaches approximately 1.5 volt, unijunction transistor CR15 breaks down, causing relay K2 to energize. This opens K2 contacts 4 and 6, causing antenna relay K1 to deenergize, and the RF input is removed from the F–1138/GRC. Normal on-frequency operation is established by first removing the RF overload and grounding the reset line as described in the off-frequency protection circuit description.

(4) The band switching circuits cause antenna relay K1 to deenergize during band switching. This eliminates high switching currents through band switches S1J and S1K. Band switch relay K3 is energized by a ground received through S1D from the control module switching circuits. When relay K3 energizes during band switching, the ground on antenna relay K1 through contacts 2 and 8 of K3 is opened, and K1 deenergizes. This removes the F–1138/GRC circuits from the antenna. During band switching, relay K3 remains energized, causing the antenna to be disconnected during switching. Normal operation of the F–1138/GRC is restored when band switching is completed, in a maximum time of 1 second.

b. Power Control Circuits. The 28-volt dc power supply is essentially a 400-Hertz (Hz) oscillator connected to a power transformer to produce the required output voltages (fig. 5–6②). In addition to the oscillator, the power supply contains a transient blanker, voltage rectifiers, and a power control relay. When +28 volts dc from Power Supply PP–4721/GRC (referred to as the PP–4721/GRC) is present at P1B–6 and the equipment enable line is grounded at the C–7196/GRC, the power control relay is energized. With the relay energized, +28 volts dc is applied to the filaments of V1 and V2, the various circuits in the F–1138/GRC, and the transient blanker in the power supply.

(1) The transient blanker circuit includes transistors A2Q3 and A2Q4 which prevent transient and constant overvoltages with amplitudes in excess of approximately +36 volts dc from being applied to the oscillator. During normal operation, zener diode A2CR3 does not conduct, and the emitter-to-base voltage of A2Q4 is about 0.55 volt. This voltage is insufficient to cause base current to flow in A2Q4. With A2Q4 cut off, the input voltage is applied to the emitter of A2Q3 through blocking diode A2CR14. This causes base current to flow in A2Q3 and conduct through A2R7 to ground; A2Q3 saturates, and +28 volts dc is supplied to the emitter circuits of 400-Hz oscillator A2Q1 and A2Q2. If a transient of overvoltage condition causes the input voltage to rise, A2CR3 begins to conduct at about 34.5 volts. For further increases of input voltage, the current through A2R10, A2R9, and A3CR3 increases rapidly because of the conduction of A2CR3. This voltage across A2R10 exceeds that necessary to start base current flowing in A2Q4 (at about 0.7 volt). When A2Q4 begins to conduct, it causes the voltage across A2R7 to increase. As conduction of A2Q4 increases to saturation, the emitter-to-base voltage of A2Q3 decreases below that necessary

F-1138/GRC protection circuits disconnect the F-1138/GRC and receiver from the antenna.

a. RF Circuits.

(1) The RF circuits consist of an input double tuned circuit, an input RF amplifier, a second double tuned circuit, and an output RF amplifier.

(2) The RF circuits provide a narrow passband which is tunable from 2.000 to 29.999 MHz. The width of the passband between —2-decibel (db) points is approximately 0.4 percent of the operating frequency. The bandpass filter covers the 2- to 29.99-MHz range in four bands: 2.000 to 3.999 MHz, 4.000 to 7.999 MHz, 8.000 to 15.999 MHz, and 16.000 to 29.999 MHz.

(3) The first double tuned circuit is coupled to the antenna through a variable capacitor to match the low antenna impedance to the high circuit impedance. This coupling provides a high input impedance to the F-1138/GRC for frequencies other than the selected operating frequency. An impedance matching capacitive divider network couples the signal from the first double tuned circuit to the input RF amplifier. The input RF amplifier is a linear degenerative cascade amplifier which provides gain for good sensitivity to weak signals. The linearity of the input RF amplifier and the selectivity of the high Q first double tuned circuit produce a low distortion output.

(4) The second double tuned circuit filters the signal from the input RF amplifier, and another capacitive divider couples the signal to the output RF amplifier. When Control-Monitor C-7196/GRC (reffered to as the C-7196/GRC) places a ground on the low-gain line, relay K4 switches these circuits into the signal path to reduce the overall gain of the F-1138/GRC by 35 db. This prevents strong signals of the desired frequency from overloading the receiver.

b. Control Circuits.

(1) These circuits consist of circuits used to tune the F-1138/GRC on command to the desired frequency. The information inputs to the control circuits are digital frequency information and digital tune enable information. Digital frequency information is coded so that two of the five wires associated with each frequency decimal digit are grounded and the other three are open. Groups of five wires each represent the 1-, 10-, and 100-kHz digits, and the 1-MHz digit. A four-wire group represents the 10-MHz digit. Digital tune enable (DTE) information reaches the F-1138/GRC in the form of +28 volts direct current (dc) applied to the DTE line. The presence of this signal enables the F-1138/GRC to tune to a newly selected frequency.

(2) The digital tune in progress (DTIP) line carries an information output from the F-1138/GRC to the C-7196/GRC. The F-1138/GRC grounds the DTIP line as long as the digital to analog converter circuits are setting up to a new frequency. This takes a maximum of 1 second. Digital frequency information inputs must represent the desired frequency as long as the DTIP line remains grounded.

c. Protection Circuits.

(1) The protection circuits prevent damage to the F-1138/GRC and receiver which might result from strong RF input signals applied too close to the operating frequency. The F-1138/GRC operates normally in the presence of very strong off-frequency input signals. Protection is necessary if a strong signal 10 percent away from the operating frequency exceeds 1,400 volts peak. Strong signals closer to the operating frequency than 10 percent trigger the protection circuits at less than 1,400 volts peak. Signals directly inband operate the protection circuits if they exceed approximately 1.5 volt. Operation of the protection circuits opens relay K1 and grounds the antenna input. When an overload occurs, the RF detector circuits trigger silicon-controlled rectifier CR15. When CR15 conducts, it energizes relay K2, which is interlocked through the band switching circuit so that relay K1 is opened to prevent arcing of the switch contacts under high RF currents while band switching.

(2) RF detectors sample the RF level at two points in the circuit to provide protection. The first detector measures RF voltage across the input coils (fig. 5-3) triggering the protection circuits if the voltage across L1, L5, L9, or L13 reaches damaging levels. The input voltage is measured across the input inductors rather than directly at the input terminals. The first detector is set to trigger the protection circuits if 1,400 volts peak appears at the input terminals at ±10 percent from the tuned frequency. Because the voltage is sampled in a resonant circuit, higher input voltages will be required to trigger the protection circuits at greater than 10 percent separation from the tuned frequency and lower voltages at less separation. Strong on-frequency signals trigger a second detector at the output amplifier. The RF output of the filter to a 50-ohm load is limited to approximately 5 volts both by the protection circuits and by the limiting action of the output amplifier.

itors A3C1 and A3C2 through relay terminals 5 and 11. These capacitors, along with A3R61, A3R62, and A3CR31, form a timing circuit which activates A3K7 to energize the tuning servosystem. Proper positioning of motor driven switches A3S1, A3S2, A3S3, and A3S4 deenergizes relay A3K6, applying +28 volts dc to terminal 1 of A3K7 and A3R62 of the timing circuit. The consequent application of +28 volts dc to pin 17 of A3P1 through terminals 6 and 4 on A3K7 and of 28 volts ac to pin 24 of A3P1 through relay terminals 8 and 13 activate the servosystem for approximately 20 seconds. The servosystem repositions the variable tuning capacitor according to the new tuning information in a maximum time of 10 seconds.

c. Resistors A3R1 through A3R8 and A3R11 through A3R56 (fig. 5-5) form R_{top} and R_{bot} as described in paragraph 1-8. Motor driven switches A3S1 through A3S4 short out the appropriate resistors to give R_{top} and R_{bot} resistance values corresponding to the selected frequency. The voltage at the midpoint between R_{top} and R_{bot} is compared to that at the wiper of R19 (fig. 1-3) as described in paragraph 1-8. The 400-Hz signal voltage, which results if the two voltages differ, is fed to servoamplifier A1 (fig. 1-5) which amplifies the signal 1,000 times and applies the signal to servomotor B2 (fig. 1-3). The servomotor drives tuning capacitor C1 and follow-potentiometer R19 in the direction which reduces the dc voltage difference. When the servomotor has rotated R19 enough to reduce this voltage difference to approximately 10 millivolts, it no longer develops sufficient torque to move the runing capacitor and the associated gear train. The servomechanism has now completed its function. The servosystem remains energized for the remainder of its 20-second cycle. Capacitors A3C1 and A3C2, in the timing circuit, gradually accumulate charge through resistors A3R61 and A3R62 until finally the voltage across A3C1 reaches about 0.5 volt. The gate of unijunction transistor A3CR31 then conducts, causing the anode path to fire. This operates relay A3K7, opening contacts 8-13 and 6-4 to turn off the servosystem. Transistor A3CR31 continues to conduct and hold relay A3K7 until +28 volts dc is removed from terminal 1 of A3K7, and capacitors A3C1 and A3C2 discharge. This occurs at the start of the next tuning cycle through the action of A3K6.

1-8. Basic Servosystem

The basic servosystem is shown in figure 1-3. Tuning capacitor C1 is mechanically coupled to follow-potentiometer R19 and servomotor B2. Input digital frequency information controls the values of R_{top} and R_{bot} which form two adjacent legs of a resistive bridge. Follow-potentiometer R19 makes up the remaining two legs of the bridge. Capacitor C1 has a linear frequency characteristic and rotates through the entire range in each of the four F-1138/GRC tuning bands. Linear potentiometer R19 also runs through the entire range in each band.

a. **The action of R_{top} and R_{bot}, taken together** is the same as that of a conventional potentiometer except that changes in resistance are made in steps. The smallest step corresponds to the smallest frequency change. A 1-kHz change, for example, increases R_{top} by 2 ohms and decreases R_{bot} by 2 ohms. A 10-kHz change results in a step change of 20 ohms in each leg. Motor driven switches (fig. 5-6) controlled by the 2-out-of-5 digital frequency information make the resistance changes. The bridge formed by R_{top} and R_{bot}, with follow-potentiometer R19, is unbalanced by a change in digital frequency information inputs, causing an error voltage to appear across the input terminals of chopper G1 (fig. 5-6①). The armature of the chopper moves between the two contacts at a rate of 400 Hz, alternately charging and discharging capacitor C59. As a result, a 400-Hz ac signal with a peak-to-peak amplitude equal to the error voltage is applied to the servoamplifier (fig. 1-5) which amplifies the signal 1,000 times. The amplified signal drives servomotor B2, which is a two-phase motor whose direction of rotation depends on the phase relation between the servoamplifier output signal and the 28-volt ac line voltage applied to the fixed phase of the motor. Phase shifting network L22 and R17 (fig. 5-5), between the chopper driving coil and the 28-volt ac line, drives the armature of the chopper 90° out of phase with the 28-volt ac line voltage. The polarity of the error voltage determines whether the chopper input leads or lags the 28-volt ac line voltage and the consequent direction of rotation of the servomotor. As follow-potentiometer R19 is driven toward bridge balance, error voltage decreases in amplitude, and torque developed by servomotor B2 decreases. When error voltage is reduced to zero, tuning capacitor C1 has reached the proper position, and the F-1138/GRC is tuned to the selected frequency.

b. A step change in selected frequency always results in the same step resistance change regardless of the band being used. A 1-kHz frequency change always causes a 2-ohm resistance change. The sum of R_{top} and R_{bot} is constant within any one of the four frequency bands, but the sum is different for each band. The 2.000- to 3.999-MHz band requires 2,000 1-kHz steps. Therefore, the sum of R_{top} and R_{bot} must be 4,000 ohms. Similarly, the 4.000- to 7.999-MHz band requires 4,000 1-kHz steps and 8,000 ohms; the 8.000- to 15.999-MHz band requires 8,000 1-kHz steps and 16,000 ohms; and the 16.000- to 29.999-MHz band requires 16,000 1-kHz steps and 32,000 ohms.

1-9. Analog Bridge and Servosystem Operation

A simplified schematic diagram of the servosystem is shown in figure 5-5. Ten-turn precision follow-potentiometer R19 and resistors A3R1 through A3R8 and A3R11 through A3R56 form the resistance bridge which controls the position of tuning capacitor C1 (para 1-8). The power supply produces 47 volts dc which is applied to the circuit at terminals TB2-15 and TB2-17. Diodes CR5 and CR6 hold bridge reference voltage constant at 45 volts dc because voltage variations affect the positioning accuracy of the servomechanism. To unbalance the bridge and get an output voltage, resistors are shorted and unshorted by wafer switches located on MHz switch A3S1. Switches A3S2, A3S3, and A3S4 switch other resistors in and out of the bridge for each of the 100-, 10-, and 1-kHz frequency digits. Switch A3S1 controls the MHz bridge resistors and shorts or removes the short from across the resistors as dictated by the position of the MHz control motor. The MHz control motor is, in turn, controlled by wafers on A3S1 (fig. 5-6②). Table 1-1 shows which MHz bridge resistors are open and shorted for each of the 28-MHz switch positions. The total effect of switches A3S2, A3S3, and A3S4 is to place more resistance in the lower half of the bridge and simultaneously remove resistance from the upper half of the bridge. This occurs in similar fashion for each of the four bands. Switch wafers A3S2A and A3S2B (fig. 5-5) are mechanically coupled and moved up one step for each of the 100-kHz digits. Switch wafers A3S3A and A3S3B are also mechanically coupled, moving one step for each of the 10-kHz digits. Switch A3S4A moves one step for each 1-kHz digit. The tap on switch A3S4A is grounded at the

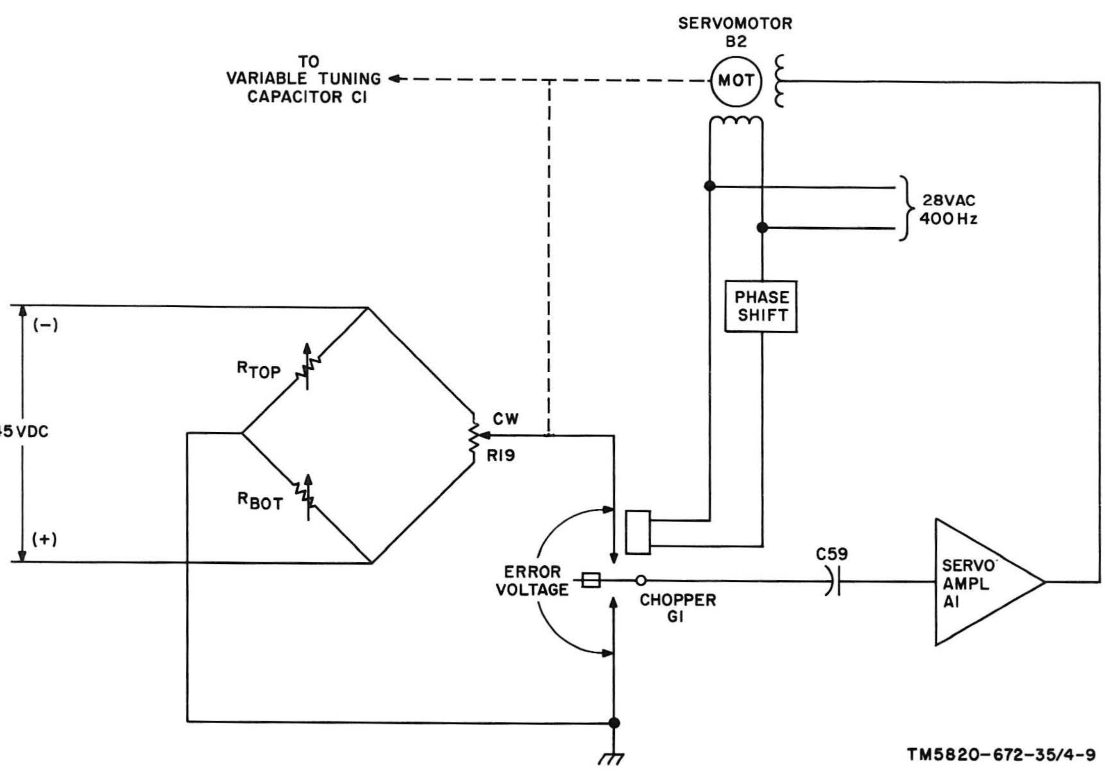


Figure 1-3. Basic servosystem, simplified schematic diagram.

chopper to eliminate undesirable induced voltages due to chassis ground currents. This ground also provides the reference point for the bridge.

a. The bridge is shown set to 2.000 MHz in figure 5-5. If the bridge were set up for 12.685 MHz, table 1-1 shows that switch A3S1 would short out A3R1, A3R3, A3R5, A3R6, and A3R8. This would place 8,000 ohms in the bottom half of the bridge and 6,000 ohms in the top half as a result of MHz information. Switch A3S2 would be set at tap 8, switch A3S3 would be set at tap 7, and switch A3S4 at tap 10. This would place a total of 6,684 ohms in the top half of the bridge and 9,316 ohms in the bottom half. Note that the sum of the two resistances is 16,000 ohms as required for the 8.000- to 15.999-MHz band.

b. Output from the bridge at follow-potentiometer R19 wiper reaches the chopper through resistor R22. A lag network, consisting of resistors R18 and R22 and capacitors C55 and C78 at the input to the chopper, eliminates hunting in the servosystem. The network applies a canceling voltage to the chopper input when follow-potentiometer R19 arm overshoots past the zeroing point of the bridge. Diodes CR7 and CR8 limit the voltage buildup across C55 to approximately 0.5 volt. The chopper changes the dc output of the resistance bridge to a 400-Hz signal which is fed to the servoamplifier through dc blocking capacitor C59. The output signal from the servoamplifier is 90° out of phase with the 28-volt, 400-Hz reference voltage on the fixed phase of servomotor B2. These voltages cause the motor to rotate, driving follow-potentiometer R19 until the bridge is again balanced, and no output voltage reaches the, servoamplifier.

1-10. Motor Driven Switch Operation

MHz control motor A3B1 (fig. 5-6②) responds to nine-wire MHz control information which originates in the C-7207/GRC. The frequency control information is supplied by the remote grounding (in the C-7270/GRC) of a combination of contacts on seeking switches A3S1H, A3S1J, and A3S1K. A ground, applied to the seeking switch rotors, energizes relay A3K1 which closes contacts 3 and 8 to apply 28 volts dc to MHz control motor A3B1. The MHz control motor rotates, driving the seeking switches of A3S1 until an open is reached. The open removes the ground on relay A3K1, deenergizing the relay, and removing the voltage from the motor. An open is present for only one position on the seeking switches of A3S1 for each of the 28 MHz frequency selections. Contacts 2 and 8, on relay A3K1, close when the relay is deenergized to short out the armature

Table 1-1. MHz Switch, Bridge Resistance Connection

Digit switch setting			Band 1		Band 2				Band 3								Band 4													
			2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Bridge resistor																														
V	2KΩ	R1	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*
		R4	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	---	*	
A	4KΩ	R3	---	---	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*		
L		R2	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*	---	---	*	*
	8KΩ	R7	---	---	---	---	---	---	---	---	---	---	*	*	*	*	---	---	---	---	*	*	*	*	---	---	---	---	*	*
U		R6	---	---	---	---	---	---	*	*	*	*	---	---	---	---	*	*	*	*	---	---	---	---	*	*	*	*		
	16KΩ	R5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	*	*	*	*	*	*
E		R8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	*	*	*	*	*	*	*	*						
Bridge bottom resistance (KΩ)			0	2	0	2	4	6	0	2	4	6	8	10	12	14	0	2	4	6	8	10	12	14	16	18	20	22	24	26
Bridge top resistance (KΩ)			2	0	6	4	2	0	14	12	10	8	6	4	2	0	30	28	26	24	22	20	18	16	14	12	10	8	6	4

*Indicates resistance in bridge.

winding in MHz control motor A3B1. This provides dynamic braking for the control motor. Diode A3CR26, across the armature of A3K1, provides transient protection when the relay deenergizes.

a. The C-7207/GRC supplies MHz control information by grounding combinations of nine lines. The tens digit of MHz control information (0, 1, or 2) is supplied by grounding two of the four 10-MHz control lines. The units digit of MHz control information (0 through 9) is supplied by grounding two of five control lines. Table 1-2 shows various combinations of frequency control lines which are grounded to select each digit of the MHz frequency positions. Diodes A3CR1 through A3CR9 are placed in the frequency control lines to isolate the F-1138/GRC from the receiver sharing the frequency control lines.

b. The 100-, 10-, and 1-kHz control motors respond to five-wire information from the C-7207/GRC. The three control motor and switch combinations are identical in their operation. This discussion describes only the operation of the 1-kHz control motor and switch, but the information pertains equally to the other two.

c. Grounds on two of the five wires in the 1-kHz control group supply frequency information to the 1-kHz control switch. The grounds are fed to open seeking switches A3S4B and A3S4C (fig. 5-6①) which are mechanically coupled to 1-kHz control motor A3B4. A ground on switch A3S4 energizes relay A3K4. The relay closes contacts 3 and 8 to place 28 volts dc across control motor A3B4. The control motor rotates open seeking switch A3S4 until the motor reaches the position which corresponds to the frequency selected at the C-7207/GRC. Open seeking switch A3S4 removes the ground from A3K4, deenergizing the relay and removing power from the control motor. Normally closed contacts 2 and 8 on A3K4 close when the relay is deenergized to brake the motor dynamically by shorting its armature.

d. The combinations of frequency control lines grounded by the C-7207/GRC to select each 1-, 10-, and 100-kHz digit is shown in table 1-3. The same two-out-of-five-wire code is used for each. Diodes A3CR20 through A3CR24 provide isolation from the receiver sharing the frequency control lines. For 10 and 100 Hz, isolation is accomplished by A3CR15 through A3CR19, and A3CR10 through A3CR14.

1-11. Band Switching Circuits

A simplified schematic diagram of the band control circuits is shown in figure 1-4. These circuits include band switch A3S1A in the digital to analog converter module, open seeking switch S1D coupled to control motor B1. Switch S1D and motor B1 are on the F-1138/GRC chassis. As the MHz control motor drives MHz control switches to the correct position, switch wafer A3S1A rotates with the rest of the wafers on A3S1. When

Table 1-2. MHz Tuning, Control Line Connection

Digit switch setting		Band 1		Band 2				Band 3					Band 4																
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
10-MHz CONTROL LINES	A									X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	B	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X										
	C																			X	X	X	X	X	X	X	X	X	X
	E	X	X	X	X	X	X	X	X																				
1-MHz CONTROL LINES	A	X						X	X		X	X						X	X		X	X						X	X
	B		X	X						X	X		X	X						X	X		X	X					
	C	X	X		X	X						X	X		X	X						X	X		X	X			
	D			X	X		X	X						X	X		X	X						X	X		X	X	
	E					X	X		X	X						X	X		X	X							X	X	X

NOTE

X indicates ground on line.

Table 1-3. 100-, 10-, and 1-kHz Switch, Control Line Connection (2-out-of-5 Digit Wire Code)

Digit switch setting	Control line (2-out-of-5 wire code)				
	A	B	C	D	E
1	X	X			
2	X		X		
3		X	X		
4		X		X	
5			X	X	
6			X		X
7				X	X
8	X			X	
9	X				X
0		X			X

NOTE

X indicates ground.

the MHz control motor stops, relay A3K1 is deenergized, placing a ground on one of the four band wires through contacts 4 and 6. This ground appears on one contact of chassis band control switch S1D and energizes relay K3. Control motor B1 drives the band switch shaft until S1D opens the ground, deenergizing relay K3. When K3 is deenergized, it closes contacts 4 and 6 to provide dynamic braking by shorting the motor armature winding. The F-1138/GRC is now switched to the correct band.

1-12. Servoamplifier Operation

a. Servoamplifier A1 (Collins part No. 768-3916-001 (used on F-1138/GRC manufacturers control No. 1270 and up, see figure 5-6①)) amplifies the ac output of chopper G1 and applies the resulting ac signal to servomotor B2. The square wave output of the chopper is applied through blocking capacitor C59 to the servoamplifier input through J4P1 pin 12 of the servoamplifier connector. The input signal is limited by resistor R1 and diodes A1CR1 and A1CR2, then fed through C2 to input amplifier A1Q1. Input amplifier A1Q1 amplifies the square wave input signal and applies the signal to the base of A1Q2 through coupling Zener diode A1CR3. The breakdown voltage of A1CR3 acts as a bias voltage between the high collector voltage of A1Q1 and the low base voltage of A1Q2. Direct current flows through A1CR3 under static conditions. Output from A1Q1 appears across A1Q1 collector resistor A1R4 and causes the diode A1CR3 current to vary, providing coupling from the collector of A1Q1 to the base of A1Q2. The Zener diode method of coupling eliminates the requirement for large coupling capacitors and provides dc feedback for stabilization. The signal is then amplified by A1Q3 and A1Q4. The output of amplifier A1Q4 is coupled through transformer A1T1 to push-pull power amplifier A1Q5, A1Q6, A1Q7, and A1Q8. Output amplifiers A1Q5, A1Q7, A1Q8, and A1Q6 receive +28-volt dc supply through the center-tapped winding of servomotor B2. The approximate overall voltage gain of the servoamplifier is

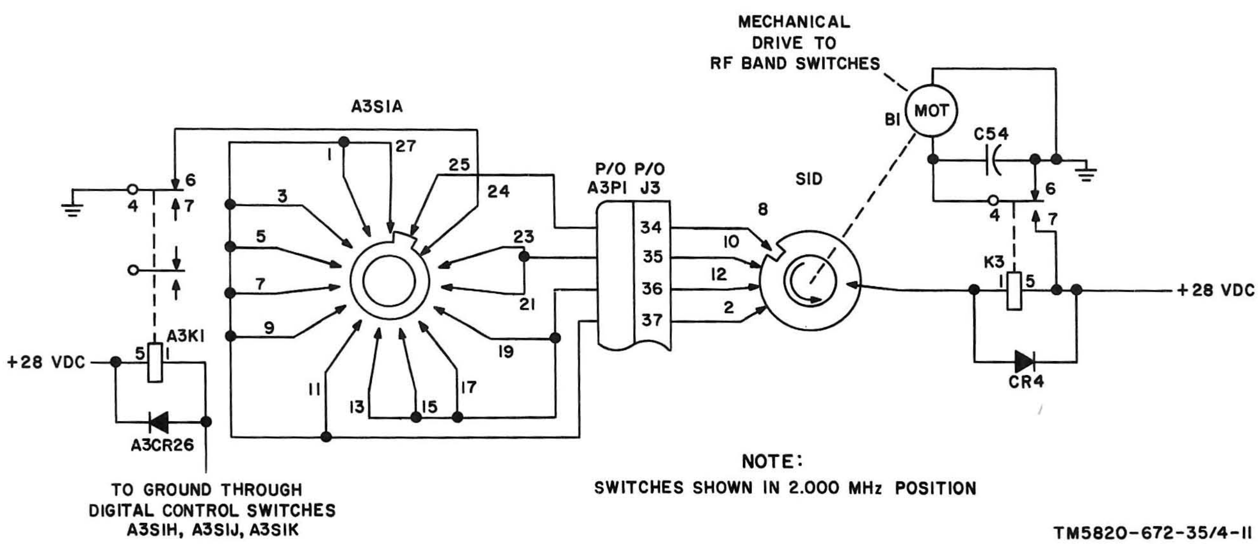
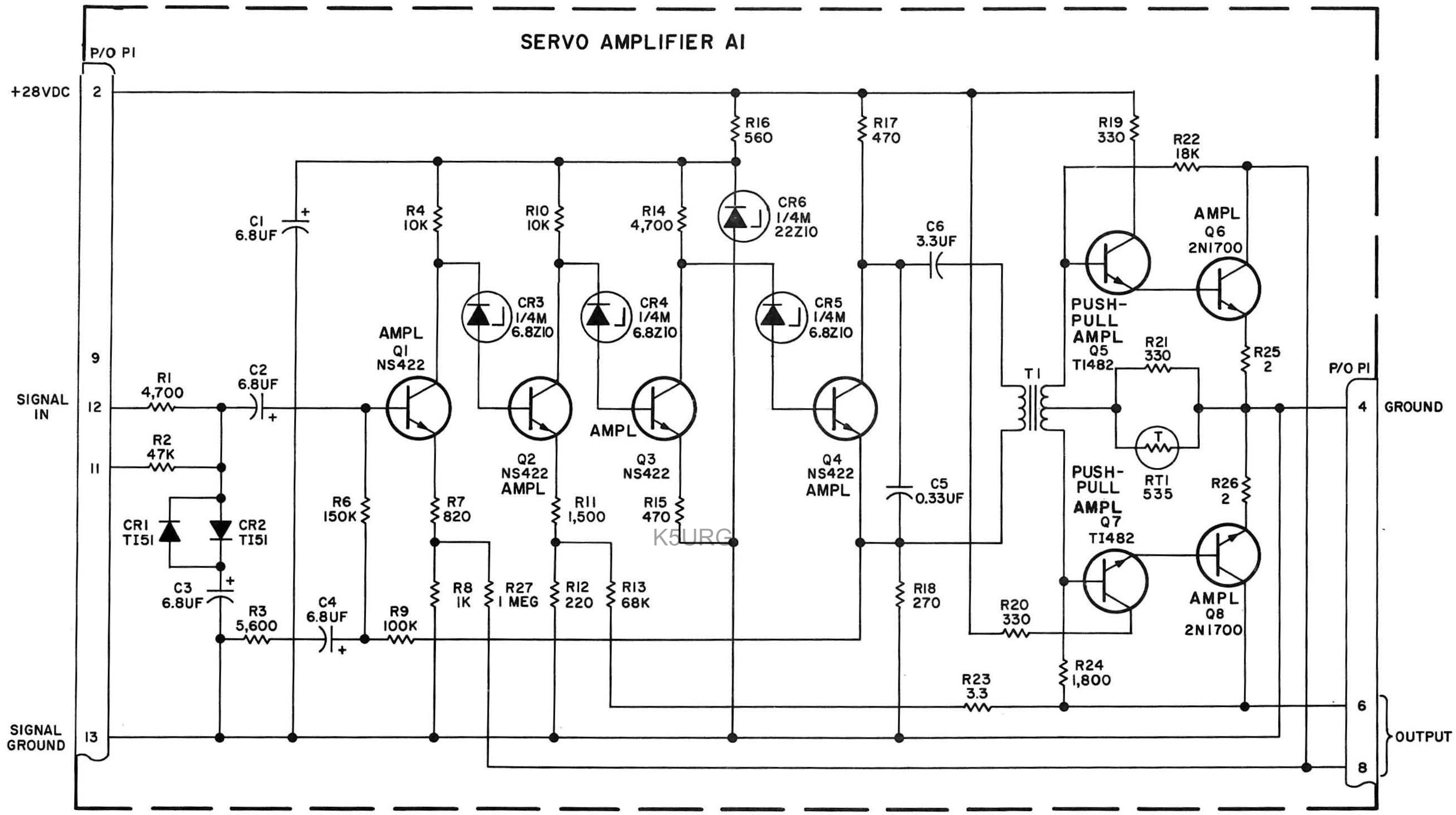
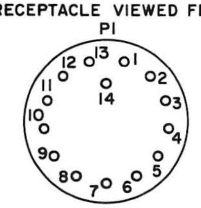


Figure 1-4. Band control circuits, simplified schematic diagram.



NOTES:

1. UNLESS OTHERWISE SPECIFIED,
   ALL RESISTANCE VALUES ARE IN OHMS,
   ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND
   ALL INDUCTANCE VALUES ARE IN MICROHENRYS.
2. THIS SERVO AMPLIFIER IS USED ON F-1138/GRC
   WITH MCN 1269 AND BELOW.
3. RECEPTACLE VIEWED FROM PIN OR RECEPTACLE SIDE.



TM5820-672-35/4-28

Figure 1–5. Servoamplifier, schematic diagram.

1,000. A portion of the amplifier output is fed back to the emitter of A1Q1 through A1R27, and to the emitter of A1Q2 through A1R13 to stabilize the amplifier gain. Zener diode A1CR6 regulates the supply voltage to low level amplifiers A1Q1, A1Q2, and A1Q3. Resistor A1R9 feeds a small portion of the dc voltage at the emitter of A1Q4 back through R9 and R6 to the base of A1Q1. This provides negative dc feedback through A1Q1, A1Q2, and A1Q3, stabilizing the current through A1Q4.

b. Servoamplifier A1 (Collins part No. 270-2039-010 (used on F-1138/GRC manufacturers control Nos. 1 through 1269, see figure 1-5)) amplifies the ac output of chopper G1 and applies the resulting ac signal to servomotor B2. The square wave output of the chopper is applied through blocking capacitor C59 (fig. 5-6) to the servoamplifier input through pin 12 (fig. 1-5) of the servoamplifier connector. Diode limiter A1CR1 and A1CR2 limits the input signal before it is applied to the base of first amplifier A1Q1 through blocking capacitor A1C2. The first amplifier initially amplifies the square wave chopper output and feeds the amplified signal to the base of A1Q2 through coupling Zener diode A1CR3. The breakdown voltage of A1CR3 acts as a bias voltage between the high collector voltage of A1Q1 and the low base voltage of A1Q2. Direct current flows through the diode under static conditions. A signal voltage appearing across A1Q1 collector resistor A1R4 causes the diode current to vary, providing coupling from the collector of A1Q1 to the base of A1Q2. The Zener diode method of coupling eliminates the requirement for large coupling capacitors and provides for dc feedback for stabilization. Amplifier stages A1Q2, A1Q3, and A1Q4 are similar to the first amplifier stage. The output of A1Q4 is fed through transformer A1T1 to push-pull power amplifier A1Q5, A1Q6, A1Q7, and A1Q8. These push-pull power amplifier stages receive their +28-volt dc supply from the center-tapped winding of servomotor B2. The approximate overall voltage gain of the servoamplifier is 1,000. A portion of the amplifier output is fed back to the amplifier input through resistors A1R13 and A1R27 to stabilize the amplifier gain. Zener diode A1CR6 regulates the supply voltage to low level amplifiers A1Q1, A1Q2, and A1Q3. Resistor A1R9 is also a stabilizing resistor which feeds a portion of the dc voltage at the emitter of transistor A1Q4 back through A1R6 to the base of transistor A1Q1. If the steady state direct current through the collector and emitter of A1Q4 should increase, a corresponding increase appears through A1Q4 emitter resistor A1R18. This voltage is fed through A1R9 to the base of A1Q1. The subsequent action of A1CR3, A1Q2, A1CR4, A1Q3, and A1CR5 applies a negative dc feedback to A1Q4, stabilizing its dc.

CHAPTER 2
MAINTENANCE PROCEDURES

Section I. DIRECT SUPPORT MAINTENANCE

2-1. Scope of Maintenance

The DS category of maintenance consists of checking the cables for Radio Set AN/GRC-158 for defects. The cables used for operation are illustrated in TM 11-5820-672-12. Use the ohmmeter section of Multimeter ME-26(*)/U for making the continuity checks.

2-2. Maintenance Process

a. To determine whether a cable is serviceable or defective, check each lead within the cable for continuity. Make a continuity reading of each lead within the suspect cable between the two end connectors. If a cable is verified as being defective, replace it with one known to be serviceable.

b. The extender cables supplied to allow power hookup to the components when removed from their fixed mounts for test and repair, are also checked for continuity. These cables (Collins No. 775-0361-001) connect between the fixed mount connector and the power connector on each unit.

Section II. GENERAL SUPPORT TROUBLESHOOTING

CAUTION

Never apply source power to the F-1138/GRC, without first connecting a cooling air source.

2-3. General Maintenance Instructions

The GS maintenance procedures *supplement* the procedures described in the organizational maintenance manual (TM 11-5820-672-12). The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational category, is carried to a higher level in this manual. Sectionalizing, localizing, and isolating techniques used in the troubleshooting procedures are more advanced.

CAUTION

Capacitor damage and improper operation results if capacitor plates are bent by mishandling. Do not allow tools or other instruments to come in contact with capacitor plates.

2-4. Organization of Troubleshooting Procedures

a. General. The first step in servicing a defective F-1138/GRC is to sectionalize the fault, which means tracing the fault to a major unit of the F-1138/GRC. The second step is to localize the fault, which means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, arcing, and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be isolated by checking voltages and resistances.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work, and to aid in tracing trouble in a defective F-1138/GRC. The first step is to locate the unit or units at fault by the following methods:

(1) *Visual inspection.* Purpose of visual inspection is to locate faults *without testing or measuring circuits.* Visual signs should be observed and attempts made to sectionalize the fault to a particular section of the F-1138/GRC.

(2) *Operational tests.* Operational tests frequently indicate general location of trouble. In many instances, the tests help in determining the exact nature of the fault.

c. Localization. After the trouble has been sectionalized (*b* above), the methods listed below will aid in localizing the trouble to a stage or module in the suspected unit.

d. Troubleshooting Chart. Meter indications, or lack of meter indications, and operational checks provide a systematic method of localizing trouble to a stage or module. The trouble symptoms listed in the troubleshooting chart (para 2–7) provide additional information for localizing troubles.

e. Isolation. After the trouble has been localized (*c* above), the methods outlined below aid in isolating the trouble to a defective circuit element.

(1) *Voltage measurements.* This equipment is transistorized. When measuring voltages, use tape or sleeving (spaghetti) to insulate the entire test probes, except for the extreme tip. Momentary short circuit can ruin the transistor.

(2) *Resistance measurements.* Make resistance measurements in equipment only as directed on voltage and resistance diagrams or charts (para 2–13). Use ohmmeter range specified on these diagrams or charts; otherwise, indications obtained will be inaccurate.

CAUTION

Before using ohmmeter to test transistors or transistor circuits, check the open circuit voltage across the ohmmeter test leads. Do not use ohmmeter if open circuit voltage exceeds 1.5 volt. Also, since the Rxl range normally connects ohmmeter internal battery directly across test leads, comparatively high current (50 milliamperes (ma) or more) may damage transistor under test. It is not recommended that the Rxl range of any ohmmeter be used when testing low-power transistors.

(3) *Test points.* The F–1138/GRC is equipped with test jacks to facilitate connection of test equipment (para 2–6) to various units. The test points should be used whenever possible to avoid needless disassembly of equipment. These test points are shown on the main schematic diagram (fig. 56–6) and on the test point location diagrams (figs. 2–1 and 2–2).

(4) *Intermittent troubles.* In all tests, possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring equipment. Make visual inspection of wiring and connections to units of the F–1138/GRC.

(5) *Resistor inductor, and capacitor color code diagram.* Resistor inductor, and capacitor color code diagram (fig. 5–1) is provided to aid maintenance personnel in determining value, voltage rating, and tolerance of capacitors, inductors, and resistors.

2–5. Test Equipment Required

Table 2–1 lists test equipment required for troubleshooting the F–1138/GRC and also lists the associated technical manuals.

CAUTION

This equipment contains transistor circuits. If any equipment item does not have an isolation transformer in its power supply circuit, connect one in the

Table 2–1. Test Equipment Required

Test equipment	Technical Manual	Common name
Signal Generator AN/GRM–50	TM 11–6625–573–15	
Multimeter ME–26(*)/U (two)	TM 11–6625–200–15	
Digital Readout, Electronic Counter, AN/USM–207	TM 11–6625–700–10	
Differential Voltmeter ME–202/U	TM 11–6625–537–15	
Voltmeter, Electronic ME–227/U	TM 11–6625–610–15	
Power Supply PP–3514/U (two)	TM 11–6625–617–12	
Radio Set Control C–7207/GRC	TM 11–5820–672–35–2	
56-ohm, 0.5-watt resistor		Load resistor.
Tool Kit, Electronic Equipment TK–100/G	SC–5180–91–CL–S21	
Cooling air supply (sufficient to maintain flow rate of 60 pounds per hour across F–1138/GRC at temperature of 40° C).		Cooling supply.
Connector Plug, Electrical PTSF06SE22–55PX (FSN 5935–637–2923).		
Connector DPX2EB–C1BS40W/S–33B–0201 (Code 71468) with 249–1329–000 insert (FSN 5935–909–6295).		
Wire—22 AWG, length as required.		

*Includes Multimeters ME–26A/U, ME–26B/U, ME–26C/U, and ME–26D/U.
[1] Power supplies PP–3514/U can be connected in parallel.

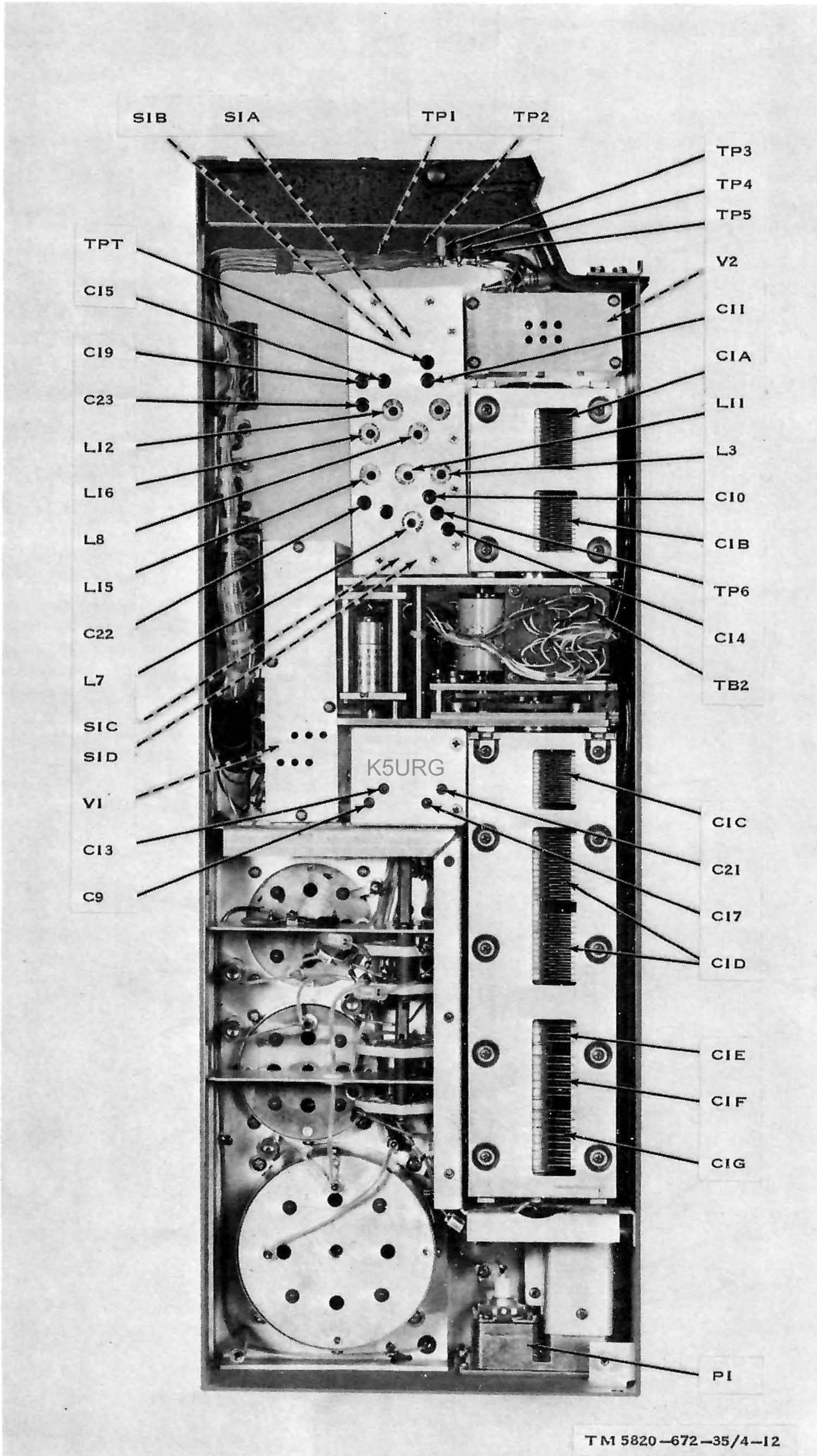


Figure 2-1. Bandpass Filter F-1138/GRC, test point location (left side).

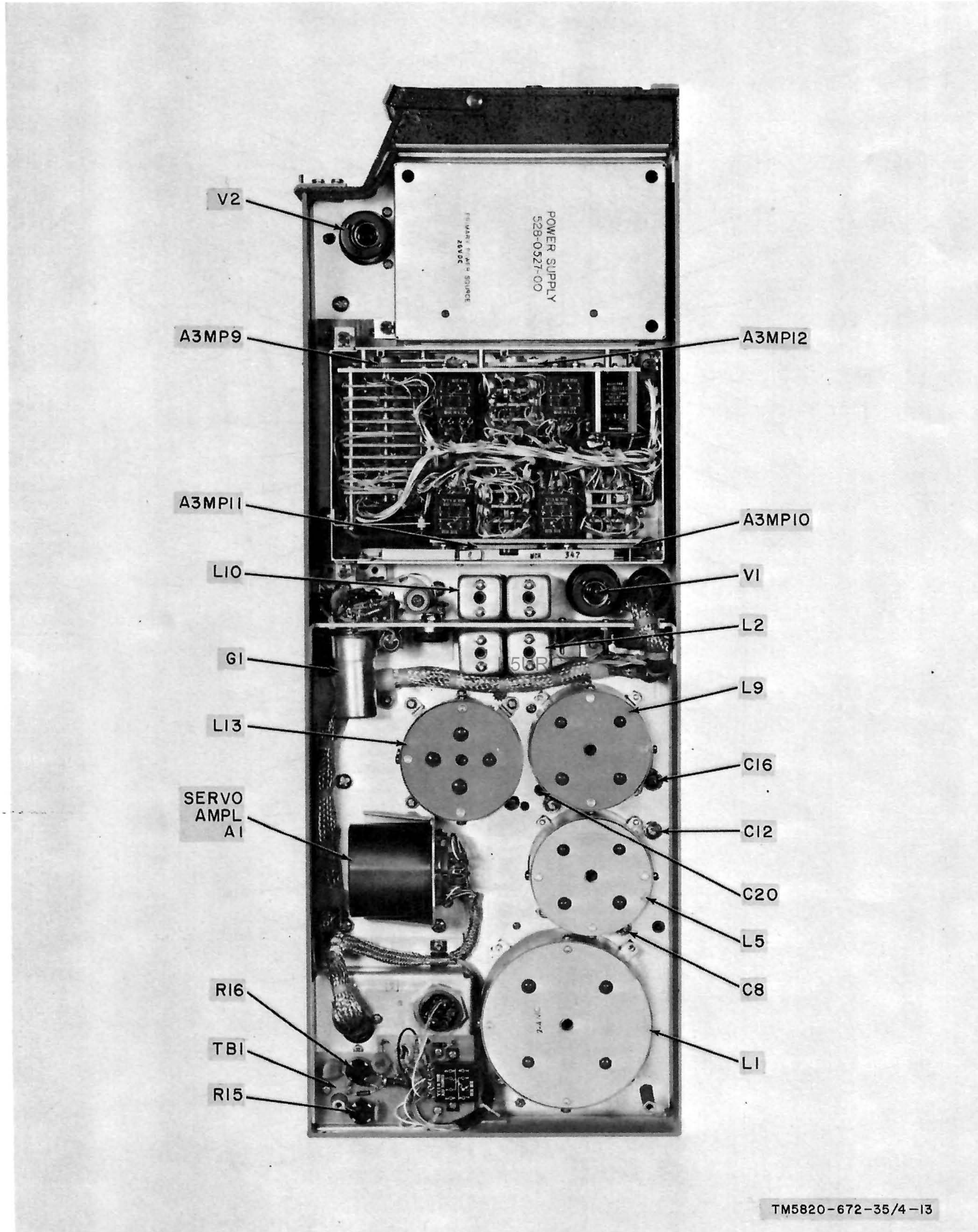


Figure 2-2. Bandpass Filter F-1138/GRC, test point location (right side).

power input circuit. A suitable transformer is identified by Federal stock number 5950-356-1779.

a. Never connect test equipment (other than multimeters) direct to a transistor circuit; use a coupling capacitor.

b. Make test equipment connections with care so that shorts are not caused by exposed test equipment connectors. Tape or sleeve (spaghetti) test probes or clips as necessary to leave as little exposed metal as needed to make contact to circuit under test.

Section III. UNIT TROUBLESHOOTING

CAUTION

Do not attempt removal or replacement of parts before reading instructions in chapter 3.

2-6. Test Setup

Troubleshooting procedures for the F-1138/GRC require connection to a power source and to various test equipments. Make the test setup described below (fig. 2-3).

CAUTION

Before making connections described below, follow caution notice given in paragraph 2-4 so that transistor damage may be avoided.

a. Power Supply PP-3514/U Connections.

(1) Connect PP-3514/U to F-1138/GRC as shown in figure 2-3.

(2) Adjust PP-3514/U controls for +28-volt dc output voltage.

b. Test Equipment Connections.

(1) Connect C-7207/GRC to F-1138/GRC as shown in figure 2-3.

(2) Test equipment is connected as outlined in troubleshooting procedures.

c. Cooling Air Supply. Connect supply of cooling air to F-1138/GRC. An external blower shall be used to draw air through the F-1138/GRC.

2-7. F-1138/GRC Overall Troubleshooting Procedure

a. General. Procedures are outlined in the following chart for localizing troubles to the RF, control, protection, servo, and power supply A2 sections of the F-1138/GRC. Depending on the nature of the operational symptoms, one or more of the localizing procedures may be necessary.

b. Conditions for Tests. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to PP-3514/U and C-7207/GRC as outlined in paragraph 2-6. Test points are illustrated on figures 2-1 and 2-2.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	TP1, TP2, TP3, TP4, TP5.	ME-26(*)/U	Turn C-7207/GRC mode switch to USB.	Lamps on C-7207/GCR for F-1138/GRC light. TP3 +28 vdc TP4 +12 vdc TP5 +275 vdc	Perform procedures outlined in paragraph 2-12.
2		None	Turn C-7207/GRC MHz switch through its 28 positions. Start at 2 MHz.	Band switch S1 rotates to 4, 8, and 16 MHz. The capacitor drive unit also rotates.	Perform procedures outlined in paragraph 2-9.
3		None	Set C-7207/GRC MHz switch at 3 MHz. Turn C-7207/GRC 100-kHz, 10-kHz, and 1-kHz switches through 10 positions each.	The capacitor drive unit positions for each switch position.	Perform procedures outlined in paragraph 2-9.
4	P1A-A2	AN/GRM-50 and ME-26(*)/U.	Apply RF input signal to connector P1A-A2. Connect ME-26(*)/U to connector P1B-A1. Connect load resistor across connector P1B-A1. Set AN/GRM-50 and C-7207/GRC frequencies to corresponding band center frequencies, 3.000, 6.000, 12.000, and 28.000 MHz.	ME-26(*)/U indication varies as RF input signal level is varied.	Perform procedures outlined in paragraph 2-8.
5	Tube V2-pin 2, PA1-A2, P1B-A1.	AN/GRM-50 and ME-26(*)/U.	Connect second ME-26(*)/U to tube V2, pin 2. Increase AN/URM-50 output until 3.0 volts is indicated at tube V2, pin 2. AN/GRM-50 frequency is set at F-1138/GRC frequency.	FAULT indicator shall light, ME-26(*)/U shall indicate no RF.	Perform procedures outlined in paragraph 2-10.
6	TP7	AN/GRM-50 and ME-26(*)/U.	With test equipment set up as in step 5, decrease AN/GRM-50 output frequency to lower value. Press C-7207/GRC FAULT/RESET button.	C-7207/GRC FAULT indicator goes out, normal operation is resumed as indicated on ME-26(*)/U.	Perform procedures outlined in paragraph 2-10.
7		PP-3514/U and ME-26(*)/U.	Connect negative lead of PP-3514/U to ground and positive lead to anode of CR1. Increase output of PP-3514/U to attain normal indication. **Caution:** Do not exceed power supply output of 40 volts.	C-7207/GRC FAULT indicator lights.	Perform procedures outlined in paragraph 2-10.

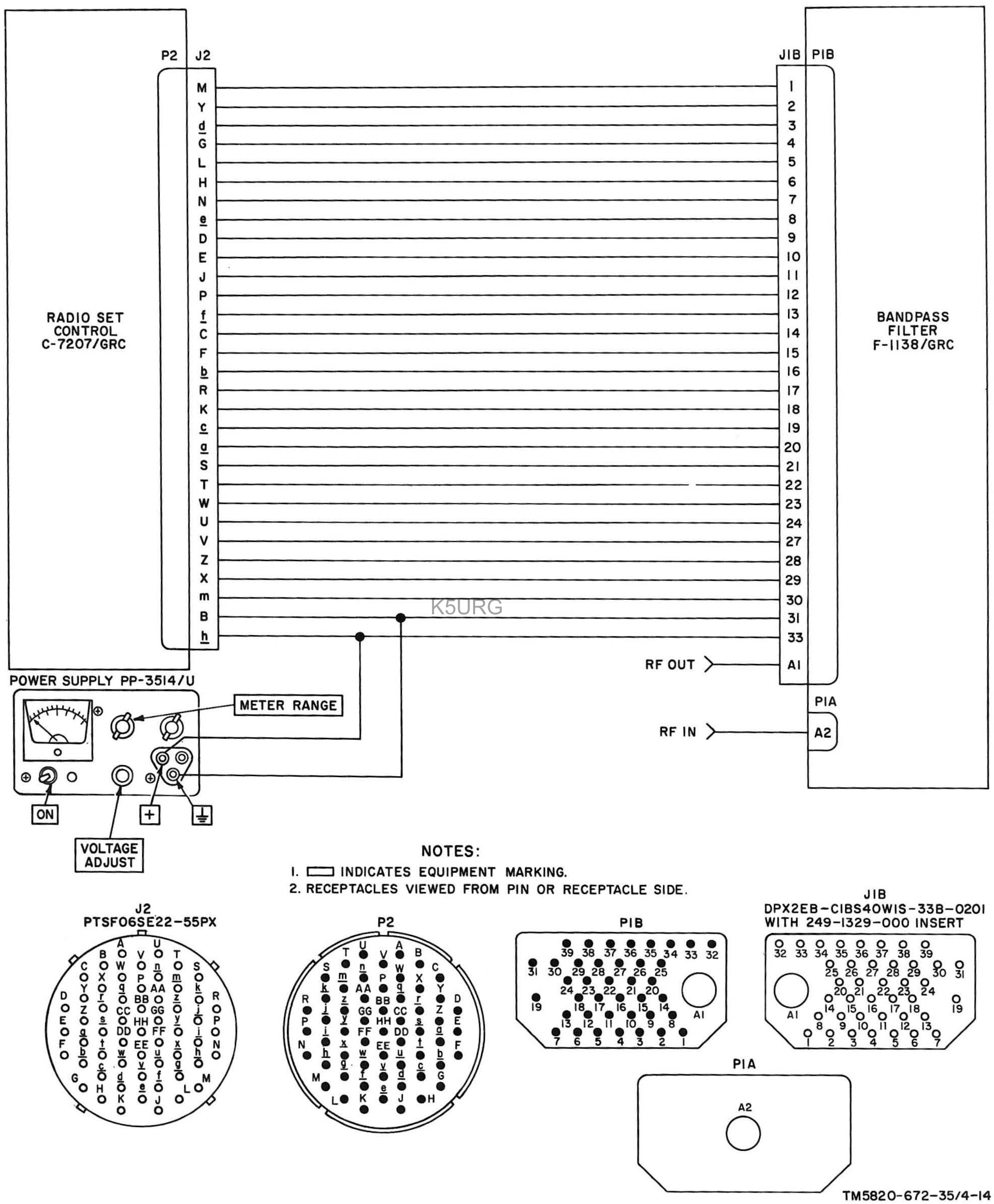


Figure 2–3. Test setup and connections for troubleshooting.

2-8. RF Crcuit Trouble Localization Procedure

a. General. The procedures outlined in the following chart check the RF circuits by injecting an RF input signal at approximately the center frequency of each band and tracing the signal through the F-1138/GRC. The band center frequencies are 3.000-, 6.000-, 12.000-, and 23.000-MHz.

NOTE

When attaching the ME-26(*)/U to test points, the F-1138/GRC may be detuned slightly by the added ME-26(*)/U capacitance. Adjust the AN/GRM-50 frequency for maximum output if detuning occurs.

b. Conditions for Tests. The checks outlined in the chart are to be performed only after localizing the trouble to the RF circuits by performing the tests outlined in paragraph 2-7*c*, step 4 of troubleshooting chart. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to the PP-3514/U and C-7207/GRC, as outlined in paragraph 2-6.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	Switch 11 SIG B contact 11.	AN/GRM-50 and ME-26(*)/U.	Connect AN/GRM-50 to connector P1A-A2 and ME-26(*)/U across capacitor C1D. Adjust AN/GRM-50 for 0.25 volt at center of frequency band.	ME-26(*)/U shall indicate 7.5 volts at 3.000 MHz, 5.5 volts at 6.000 MHz, 5.5 volts at 12.000 MHz, 2.1 volts at 23.000 MHz.	Check antenna relay K1 and/or protection circuits. Check switch contacts of S1G, S1H, and S1K. Check correct band series capacitors.
2	Tube VI and pin 2	Same as step 1 above.	Same AN/GRM-50 input as above	ME-26(*)/U shall indicate approximately 1.3 volt at 3.000 MHz, 1.2 volt at 6.000 MHz, 1.2 volt at 12.000 MHz, 1.0 volt at 23.000 MHz.	Check contacts of band switches S1E, S1FR, and S1FF. Check applicable band filter. Check filter tuning.
3	TP6	Same as step 1 above.	Same AN/GRM-50 input as above	ME-26(*)/U shall indicate approximately 12 volts at 3.000 MHz, 5.2 volts at 6.000 MHz, 4.5 volts at 12.000 MHz, and 1.7 volt at 23.000 MHz.	Check cascade amplifier input circuits, cascade amplifier tube V1, and supporting circuits. Check contacts of S1C. Check coupling capacitor C30 and capacitor C1B.
4	TP7	Same as step 1 above.	Same AN/GRM-50 input as above. ME-26(*)/U on TP7.	ME-26(*)/U shall indicate approximately 11 volts at 3.000 MHz, 4.5 volts at 6.000 MHz, 2.0 volts at 12.000 MHz, and 1.3 volt at 23.000 MHz.	Check contacts of band switches S1BR and S1BF. Check applicable band filter. Check filter tuning.
5	RF output P1B-A1	Same as step 1 above.	Same signal generator input as above. Connect ME-26(*)/U to connector P1B-A1. Connect load resistor (56Ω 0.5 watt) across connector P1B-A1.	ME-26(*)/U shall indicate approximately 2.2 volts at 3.000 MHz, 2.5 volts at 6.000 MHz, 1.8 volt at 12.000 MHz, and 1.0 volt at 23.000 MHz.	Check contacts of switch S1A and cascade amplifier input circuit. Check tube V2 and supporting circuits.

2-9. Control Circuit Trouble Localization Procedure

a. General. The procedures outlined in the following chart check the F-1138/GRC control circuits.

b. Conditions for tests. The checks outlined in the chart are to be performed only after localizing the trouble to control circuits, as outlined in paragraph 2-7*c*, steps 2 and 3 of troubleshooting chart. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to the PP-3514/U and C-7207/GRC as outlined in paragraph 2-6.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	None	ME–26(*)/U	Rotate C–7207/GRC MHz selector switch through 28 positions.	Bandswitch S1 rotates to 4.000, 8.000, and 16.000 MHz.	Check power supply A2 circuits. Check contacts of switch S1DR and K3. Check contacts of digital to analog control converter module switch A3S1A. Check enable relay A3K5.
2	None	None	Rotate C–7207/GRC MHz selector switch through 28 positions.	A3S1 rotates through corresponding positions. Capacitor C1 also rotates.	Check for proper grounds on frequency control lines from C–7207/GRC. Check contacts of switches A3S1H, A3S1J, and A3S1K. Check diodes A3CR1 through A3CR9. Check for operation of relay A3K1 and motor A3B1.
3	None	None	Set MHz selector switch to 2 MHz. Rotate control unit 100-kHz selector switch through 10 positions.	Converter motor A3B2 and switch A3S2 rotate to proper position. Capacitor C1 also rotates.	Check relay A3K2 and diodes A3CR10 through A3CR14. Check frequency control lines from C–7207/GRC.
4	None	None	Rotate control unit 10-kHz selector switch through 10 positions. MHz selector switch at 2 MHz.	Converter motor A3B3 and switch A3S3 rotate to proper position. Capacitor C1 rotates a slight amount.	Check relay A3K3 and diodes A3CR15 through A3CR19. Check frequency control lines from C–7207/GRC.
5	None	None	Rotate C–7207/GRC 1-kHz selector switch through 10 positions. MHz selector switch at 2 MHz.	Converter motor A3B4 and switch A3S4 rotate to proper position. Capacitor C1 rotates slight amount.	Check relay A3K4 and diodes A3CR20 through A3CR24. Check frequency control lines from C–7207/GRC. Check digital to analog measurements.
6	TB2–9, TB2–10	ME–26(*)/U	Connect ME–26(*)/U across TB2–9 and TB2–10. Rotate MHz selector switch.	ME–26(*)/U indicates 28 volts ac in 15 to 20 seconds.	Check operation of converter module relay A3K7 and associated time delay circuit. If capacitor C1 does not rotate, refer to paragraph 2–11.

2-10. Protection Circuit Trouble Localization Procedure

a. General. The procedures outlined in the following chart check the F-1138/GRC protection circuits by simulating an RF overload condition and checking the protection circuits.

b. Conditions for Tests. The checks outlined in the chart are to be performed only after localizing the trouble to the protection circuits by performing the tests outlined in paragraph 2-7*c*, steps 5, 6, and 7. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to the PP-3514/U and C-7207/GRC as outlined in paragraph 2-6.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	C-7207/GRC FAULT indicator. P1A-A2.	AN/GRM-50 and ME-26(*)/U.	Set AN/GRM-50 and F-1138/GRC to 16.000 MHz. With ME-26(*)/U at pin 2 of V2, and AN/GRM-50 at connector P1A-A2, adjust AN/GRM-50 output until ME-26(*)/U reads 5.5 vac.	FAULT indicator lights. Antenna relay K1 opens.	Check diodes CR2, CR11, CR12, and associated circuits. Check K1, K2, and K3. If no RF voltage, refer to paragraph 2-8.
2	C-7207/GRC FAULT indicator.	AN/GRM-50 and ME-26(*)/U.	Decrease output of AN/GRM-50 to 0 volt. Press C-7207/GRC FAULT/RESET pushbutton switch.	C-7207/GRC FAULT indicator extinguishes. Relay K1 closes.	Check FAULT indicator. Check CR15, C64, and K2.
3	C-7207/GRC FAULT indicator. (anode of CR1).	ME-26(*)/U and PP-3514/U.	Connect negative lead of PP-3514/U to chassis and positive lead to anode of CR1. Increase PP-3514/U output to approximately 23 volts. **Caution:** Do not allow PP-3514/U output to exceed 40 volts.	FAULT indicator lights. Antenna relay K1 opens.	Check diodes CR1, CR16, and associated circuits. Check R15, CR10, CR15, and CR13. Check for 28 volts on pin 1 of K2.
4	Same as step 3	Same as step 3	Reduce output of PP-3514/U	Same as step 2	Check for 28 vdc on pin 5 of K2.

2-11. Servosystem Trouble Localization Procedure

a. General. The procedures outlined in the following chart check the F-1138/GRC servosystem.

b. Conditions for Tests. The checks outlined in the chart are to be performed if the troubleshooting steps in paragraphs 2-7 through 2-10 have not isolated the defect. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to the PP-3514/GRC and C-7207/GRC as outlined in paragraph 2-6.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	J1-1	ME-26(*)/U	Remove chopper G1, slowly increase setting of MHz frequency selector from 16 MHz to 29 MHz.	Dc error voltage increases as difference between digital to analog converter output and R19 output increases.	Check for 45 vdc between TB2-2 and TB2-4. Check power supply A2 outputs. Refer to control circuit troubleshooting (para 2-7).
2	J4-13	ME-26(*)/U and AN/USM-207.	Replace chopper G1 and rotate A3S1	Chopper runs for approximately 20 seconds after A3S1 is repositioned and ac voltage reading decreases to 0 as C1 rotates.	If chopper does not run, check R17, L22. Check frequency of 115 vac at TP1, TP2 with AN/USM-207. Frequency shall be 380 to 420 Hz. Replace chopper.
3	J4-6, J4-8	ME-26(*)/U	Repeat step 2 **Caution:** Do not ground either test point. Grounding will damage servoamplifier A1.	Same as step 2	Check for +28 vdc at pins 2, 6, and 8 of J4. If +28 vdc is not present, check A3K7. Check servoamplifier A1.
4	TB2-1, TB2-9, TB2-10, TB2-13, TB2-14.	ME-26(*)/U	Repeat step 2	28 volts ac between TB2-9 and TB2-10. Servomotor B2 rotates, driving C1. Ac voltage between TB2-9 and TB2-10 decreases to zero as C1 is tuned. 28 vdc is present at TB2-1 only for duration of time delay.	Check wiring for opens. Check for short circuit at C57, C58 or open windings in B2. Check gear train to see that gears are clean and free from binding.

2-12. 28-Volt Dc Power Supply Module A2 Trouble Localization

a. General. The procedures outlined in the following chart check the F-1138/GRC 28-volt dc power supply module.

b. Conditions for Tests. The checks outlined in the chart are to be performed if the procedure given in paragraphs 2-7*c*, step 1 does not isolate a defect. All checks outlined in the chart are to be conducted with the F-1138/GRC connected to the PP-3514/U and C-7207/GRC, as outlined in paragraph 2-6.

c. Troubleshooting Chart.

Step	Test point	Test equipment	Control settings and instructions	Normal indication	If indication is abnormal—
1	As indicated on J2	AN/USM-207 and ME-26(*)/U.	Turn C-7207/GRC mode switch to USB. Set ME-26(*)/U range as indicated and measure voltages.	28 volts ac between pins 3 and 11. +28 volts dc at pin 5. +275 volts dc at pin 13. 47 volts dc between pins 8 and 15. 115 volts ac between pins 7 and 10. Frequency is 380 to 420 Hz.	Proceed to step 2. If voltage at J2-8 and 15 is incorrect, check Zener diodes CR5 and CR6. If frequency is too high, check Zener diodes CR1, CR2.
2	J2-2	ME-26(*)/U	Connect jumper wire between connector J2-2 and chassis.	Relay A2K1 energizes with ground at J2-2. +28 vdc at pin 5.	Check diode CR13 for open. Check relay A2K1 for open.
3	Emitter A2Q1	ME-26(*)/U	Increase input voltage to 40 volts **Caution:** Do not hold input voltage at 40 volts for more than 10 seconds.	As input voltage is increased to 40 volts, voltage at emitter of Q1 shall not increase to 40 volts.	Check Q3, Q4, CR3, and CR14.
4	As indicated on J2	ME-26(*)/U	Same as step 1	Same as step 1	Check output rectifier circuits. Check Q1, Q2, CR12, R1, R3, and T1 of oscillator circuits.

2-13. RF Circuit Voltage and Resistance Measurement Trouble Isolation Procedure

a. General. The following chart lists typical voltages and resistances measured at the terminals of XV1 and XV2.

b. Conditions for Tests. Voltage measurements are to be taken using the ME-26(*)/U. The F-1138/GRC frequency is set to 20.000 MHz, power on, and no RF signal is applied. Resistance measurements are to be taken with power off, all tubes removed, modules installed, and frequency control set to indicated band.

c. Voltage and Resistance Measurements Chart.

Terminal	Dc voltage (volts)	Resistance Band 1	Band 2	Band 3	Band 4
	Tube socket XV1				
1	135				Open circuit.
2	0	19K	17K	220K	22
3	3.0				105
4	24.5				4.8
5	12.0				4.6
6	138				Open circuit.
7	135				Open circuit.
8	Not used				
9	270				125K
	Tube socket XV2				
1	126				Open circuit.
2	0				220K
3	3.0				120
4	12.0				4.0
5	0.12				0.3
6	130				Open circuit.
7	126				Open circuit.
8	Not used				
9	270				125K

2-14. Digital-to-Analog Control Converter Trouble Isolation Procedure

a. General. The following procedures check digital-to-analog control converter module A3. Broken wires and faulty switch contacts are indicated by a change in one or more of the voltages measured in the procedure.

b. Test Conditions.

(1) Turn control unit mode switch to USB.

(2) Set frequency to 2.000 MHz and allow F-1138/GRC to warm up for at least 3 minutes.

(3) Use ME-202/U or ME-227/U (the one used depends on the voltage level) to measure voltage between TB2-2 and TB2-4. This voltage shall be between 41.8 volts and 46.2 volts.

(4) Divide 44.1 by voltage reading given in (3) above.

(5) Measure voltage between TB2-4 and ground at each of frequencies listed in output measurements chart.

NOTE

Allow 3-minute warmup period after each tuning band change.

(6) Multiply voltage reading given in (5) above by result of that in (4) above and compare adjusted value with that shown in column B of output measurements chart (*c* below).

(7) The difference between adjusted voltage found in (6) above at each frequency and that found for preceding frequency is listed in *column C* of output measurements chart.

c. Output Measurements Chart.

A Frequency (MHz)	B Voltage from TB2-4 to ground (adjusted)	C Difference from voltage at preceding frequency
2.000	−0.005	
2.001	−0.027	0.022
2.002	−0.049	0.022
2.003	−0.071	0.022
2.004	−0.093	0.022
2.005	−0.115	0.022
2.006	−0.137	0.022
2.007	−0.159	0.022
2.008	−0.181	0.022
2.009	−0.203	0.022
2.010	−0.226	0.023
2.020	−0.446	0.220
2.030	−0.666	0.220
2.040	−0.886	0.220
2.050	−1.106	0.220
2.060	−1.327	0.221
2.070	−1.547	0.220
2.080	−1.768	0.221
2.090	−1.998	0.220
2.100	−2.208	
2.200	−4.412	2.204
2.300	−6.616	2.204
2.400	−8.820	2.204
2.500	−11.03	2.20
2.600	−13.23	2.21
2.700	−15.44	2.21
2.800	−17.64	2.20
2.900	−19.85	2.21
3.000	−22.06	2.21
4.000	−0.002	
5.000	−11.14	11.14
6.000	−22.29	11.15
7.000	−33.44	11.15

A	B	C
Frequency (MHz)	Voltage from TB2-4 to ground (adjusted)	Difference from voltage at preceding frequency
8.000	-0.001	
9.000	-5.60	5.60
10.000	-11.20	5.60
11.000	-16.80	5.60
12.000	-22.40	5.60
13.000	-28.01	5.61
14.000	-33.62	5.61
15.000	-39.23	5.61
16.000	0.000	
17.000	-2.80	2.80
18.000	-5.60	2.80
19.000	-8.40	2.80
20.000	-11.20	2.80
21.000	-14.00	2.80
22.000	-16.80	2.80
23.000	-19.61	2.81
24.000	-22.42	2.81
25.000	-25.23	2.81
26.000	-28.04	2.81
27.000	-30.86	2.82
28.000	-33.67	2.81
29.000	-36.49	2.82

2-15. Servoamplifier Module Trouble Isolation Procedure

a. General. The following procedures check the servoamplifier module.

b. Conditions for Tests. The checks outlined below are to be conducted with the F-1138/GRC connected to dc power source and C-7207/GRC, as outlined in paragraph 2-6.

c. Troubleshooting Procedure.

(1) Turn C-7207/GRC mode switch to USB and measure servoamplifier input ripple with ME-26(*)/U connected across pins 12 and 13 of servoamplifier connector (ground on pin 13). The ME-26(*)/U shall indicate between 20 and 50 millivolts ac.

(2) Connect ungrounded ME-26(*)/U across pins 6 and 8 of connector J4 (ME-26(*)/U set to ac volts). If chopper is operating, indication on ME-26(*)/U shall be approximately 1,000 times greater than measured in (1) above.

(3) If results obtained in (2) above are satisfactory, servoamplifier module is operating correctly. If no output from servoamplifier is obtained in (2) above, check if +28 volts is present on pins 2, 6, and 8 of J4 and ground pin 13 and 4 of J4. If these conditions are present and no output is obtained, servoamplifier module is faulty and shall be repaired.

(4) Remove servoamplifier module from F-1138/GRC and disassemble as outlined in paragraph 3-4 or 3-5. Connect disassembled module to test setup shown in figure 2-4. The junction of two loads shall be connected to 28 volts dc. The input voltage shall not exceed 50 millivolts. Trace signal through module using figure 5-6 or 1-5.

NOTE

Servoamplifier output stage shall be tested using ME-26(*)/U ungrounded as servoamplifier has balanced output circuit.

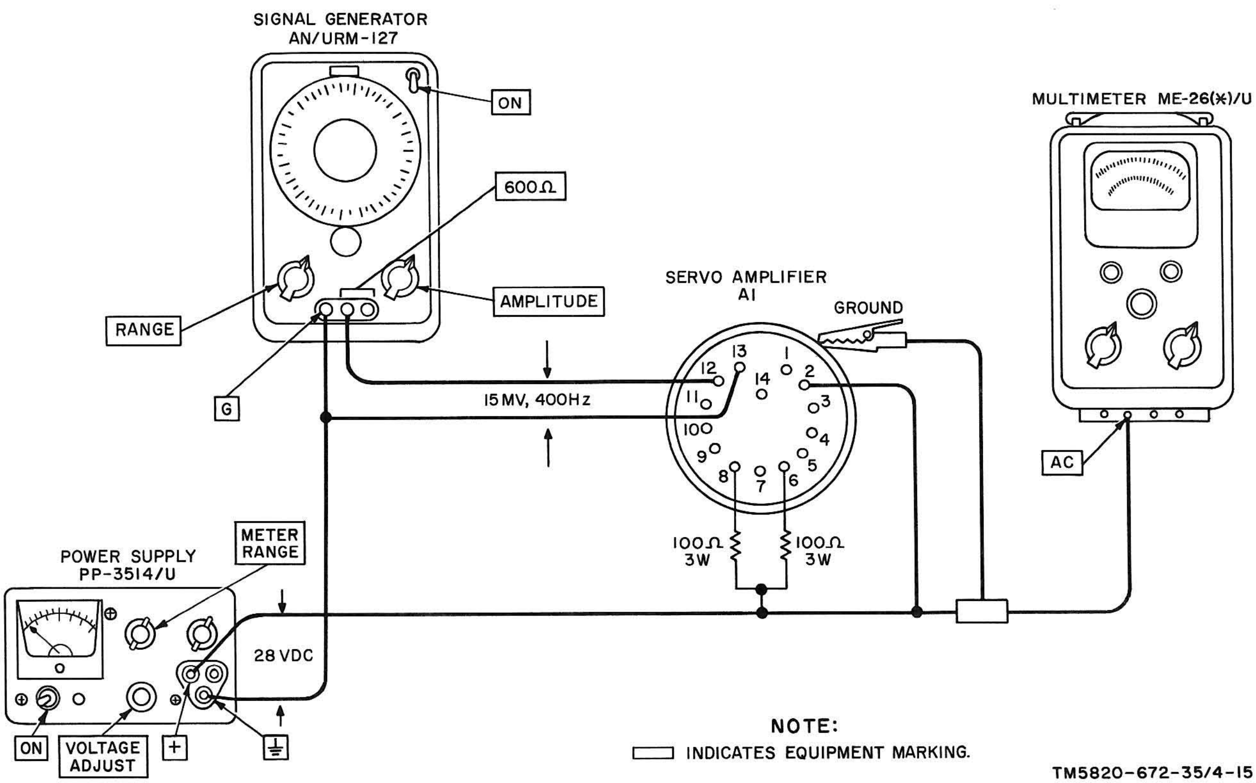


Figure 2-4. Servoamplifier trouble isolation test setup.

CHAPTER 3
REPAIRS AND ALIGNMENT PROCEDURES

Section I. REMOVAL AND REPLACEMENT OF SUBASSEMBLIES

3-1. General Repair Techniques

a. Removal of Electrical Wiring. Tag or otherwise identify all disconnected electrical wiring. Note color coding, placement of wires, and method of insulation (if any) before unsoldering or removing.

b. Removal of Transistors and Diodes. When removing transistors or diodes, use long-nose pliers to grasp lead to which heat is applied between solder joint and component.

c. Removal of Printed Circuit Boards. Printed circuit boards are removed by removing screws that fasten boards to spacers on chassis. When removing circuit boards, be careful not to damage any connecting wires, components mounted on board, or board circuits.

d. Replacement of Electrical Wiring. Replace electrical wiring with wires of same size and color code as those previously installed. Tie electrical cabling on both sides of breakouts at approximately ½-inch intervals with tape. Secure all ties with blue varnish, Collins part No. 005-0133-000 or equivalent.

e. Replacement of Transistors and Diodes. When installing a transistor or diode, use long-nose pliers to grasp lead to which heat is being applied between solder joint and component. Insure that wires being soldered are pretinned properly so connection can be made quickly. Excessive heat will permanently damage transistors or diode. Observe the following precautions when soldering transistors:

(1) Use soldering irons of not more than 25-watt rating for transistor work. If necessary to use iron with higher rating, wrap piece of No. 10 copper wire around tip of iron, and extend beyond tip of iron. Tin end of wire, and use as soldering tip.

(2) Before using electric soldering iron for transistor work, check for leakage current by connecting ME-26(*)/U between tip of iron and good ground connection. Allow iron to heat, and check for ac voltage with meter. Reverse plug in ac receptacle, and again check for voltage. If there is any indication on meter, isolate iron from ac line with transformer (FSN 5950-356-1779). Iron may be used without isolation transformer if iron is brought to correct temperature, then unplugged for soldering operation.

(3) When installing or removing a transistor, grasp lead to which heat is being applied, between solder joint and transistor, with long-nose pliers. Insure that wires being soldered to transistor terminals are pretinned properly so connections can be made quickly. Excessive heat will permanently damage transistors.

f. Soldering. Mechanically secure all wires to terminals before soldering. All soldering is to be per MIL-S-6872, using rosin-core solder QQ-S-571, composition SN60.

g. Mechanical Assembly. Secure all screws and fasteners, not secured with a locking device, with blue varnish, Collins part No. 005-0133-000 or equivalent.

3-2. Removal and Replacement of Subassemblies

a. Refer to figure 3-1. Remove the 1-kHz and 10-kHz tuning circuits assembly from the chassis as follows:

(1) Remove five screws that retain assembly to chassis.

(2) Disconnect connector from main chassis connector and lift assembly away from chassis.

(3) For access to components on terminal board, merely lift up on both sides of terminal board. Spring clips serve as retaining devices and clip onto two round posts which are secured to the main mounting plate.

(4) The gear train is made accessible, once the assembly is lifted clear of the chassis. If, for any reason, gears are removed, extreme care must

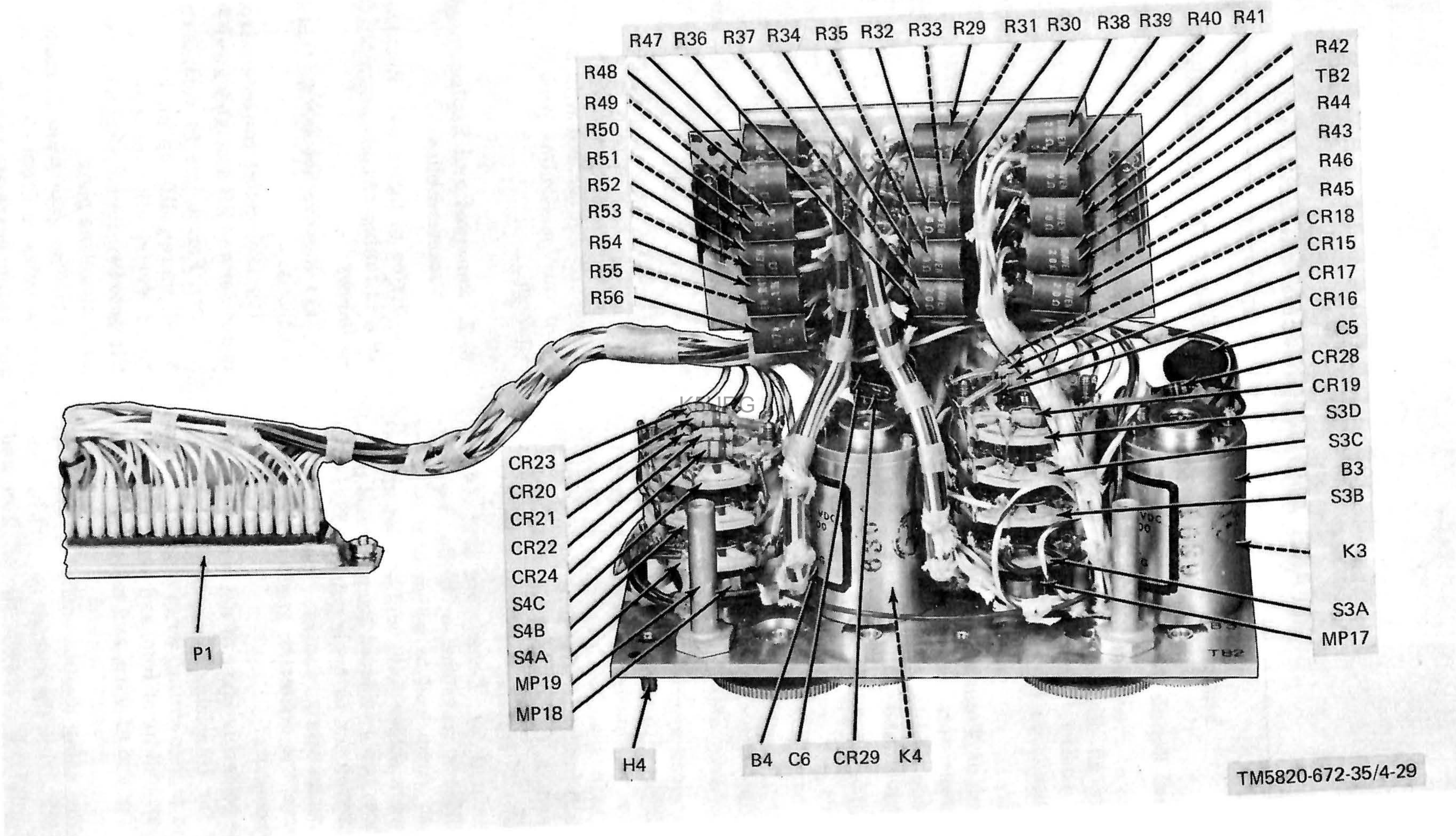


Figure 3–1. One-kHz and 10-kHz tuning circuits.

be taken to insure correct alignment during reassembly. Figure 3-3 shows correct alignment of gears to one another.

(5) For correct reassembly, follow above procedures in reverse order.

b. Refer to figure 3-2. Remove the 100-kHz and 1-MHz tuning circuits assembly from the chassis as follows:

(1) Remove five screws that retain assembly to chassis.

(2) Lift assembly away from chassis to limits of attached cable assembly.

(3) For access to components mounted on terminal board attached to top of largest rotary switch, remove one screw and one washer, and raise terminal board to limits of attached wires.

(4) For access to components mounted on terminal board mounted above smallest rotary switch, merely lift up on both sides of terminal board. Spring clips serve as retaining devices and clip onto two round posts which are secured to the main mounting plate.

(5) For access to components mounted on terminal board mounted over relays, remove three screws. These screws must be *glyped* prior to reassembly.

(6) The gear train is made accessible, once the assembly is lifted clear of the chassis. If, for any reason, gears are removed, extreme care must be taken to insure correct alignment during reassembly. Figure 3-3 shows correct alignment of gears to one another.

(7) For correct reassembly, follow above procedures in reverse order.

c. Refer to figure 3-4. Remove the input RF amplifier assembly from the chassis as follows:

(1) Remove four screws that retain cover.

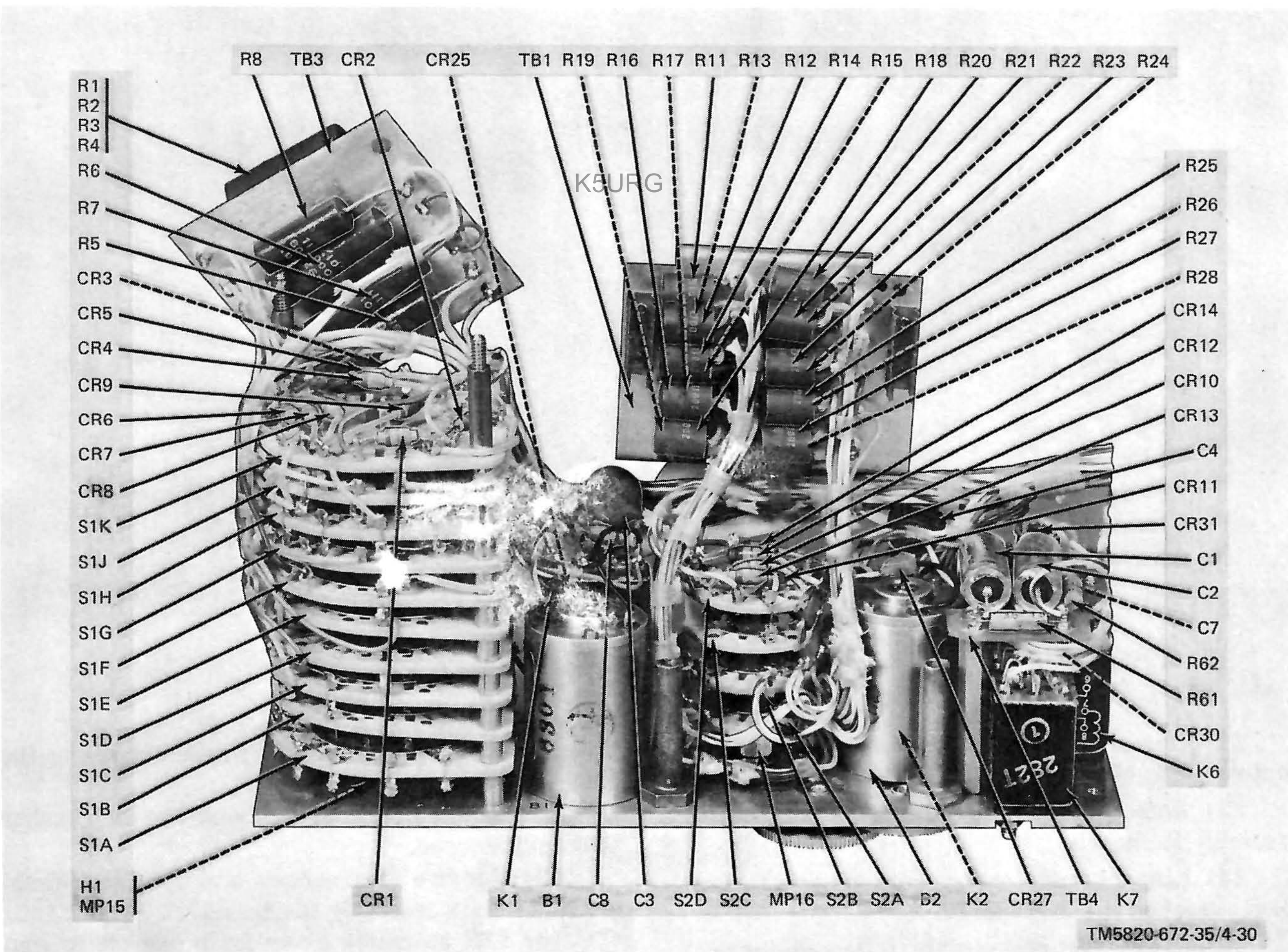


Figure 3-2. One-hundred-kHz and 1-MHz tuning circuits.

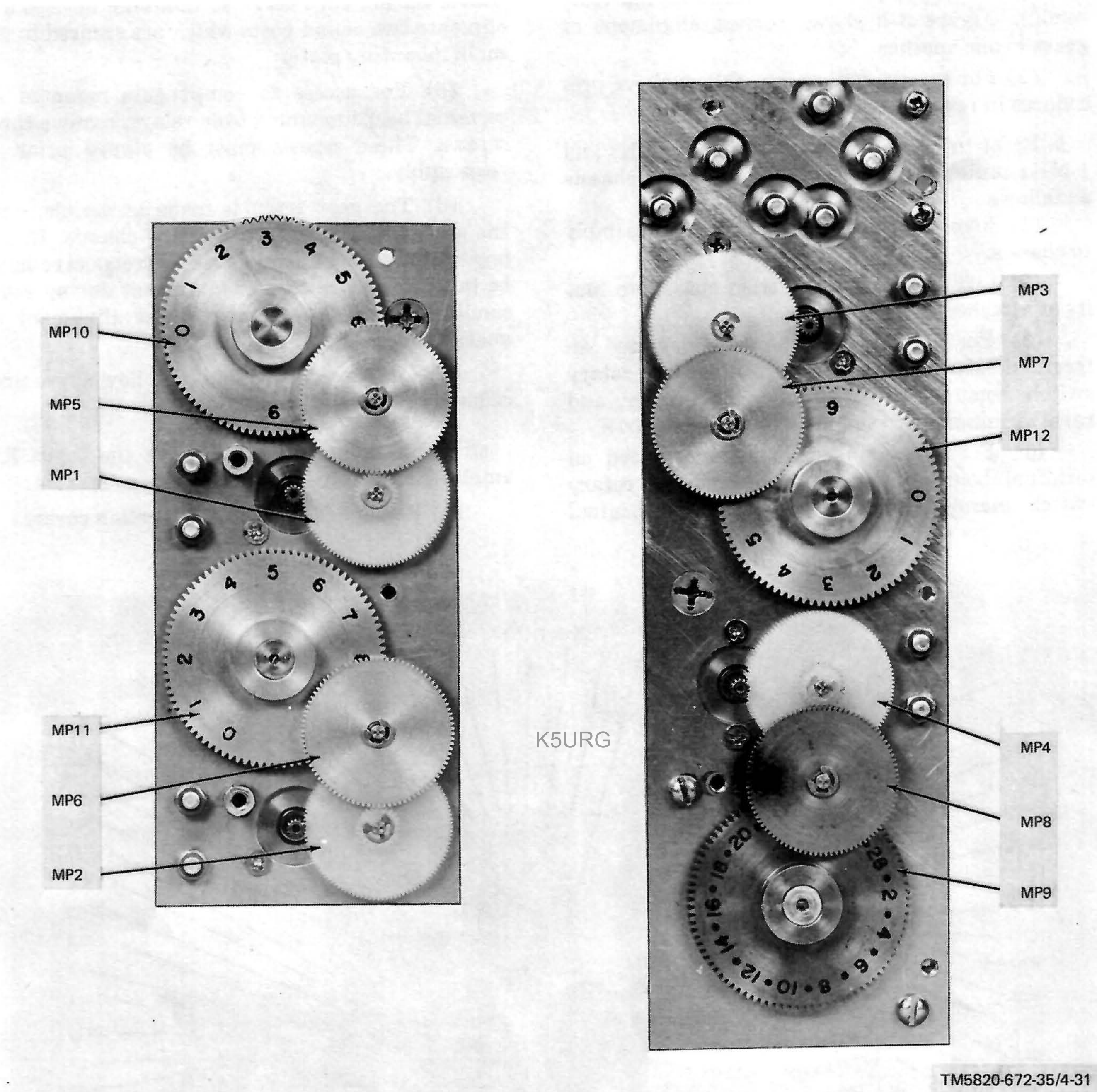


Figure 3-3. Digital to analog converter module gear train.

(2) Remove one screw and one flat washer that retain cable clamp to chassis.

(3) Remove three *glyped* screws that retain assembly to chassis.

(4) Lift assembly away from chassis to limits of attached cable assembly.

(5) For correct reassembly, follow above procedures in reverse order.

d. Refer to figure 3-5. Remove the first double tuned filter trimmer capacitors assembly from the chassis as follows:

(1) Remove three screws and one lockwasher that retain cover.

(2) Remove four screws and four lockwashers that retain assembly to chassis.

(3) Lift assembly away from chassis to limits of attached wires.

(4) For correct reassembly, follow above procedures in reverse order.

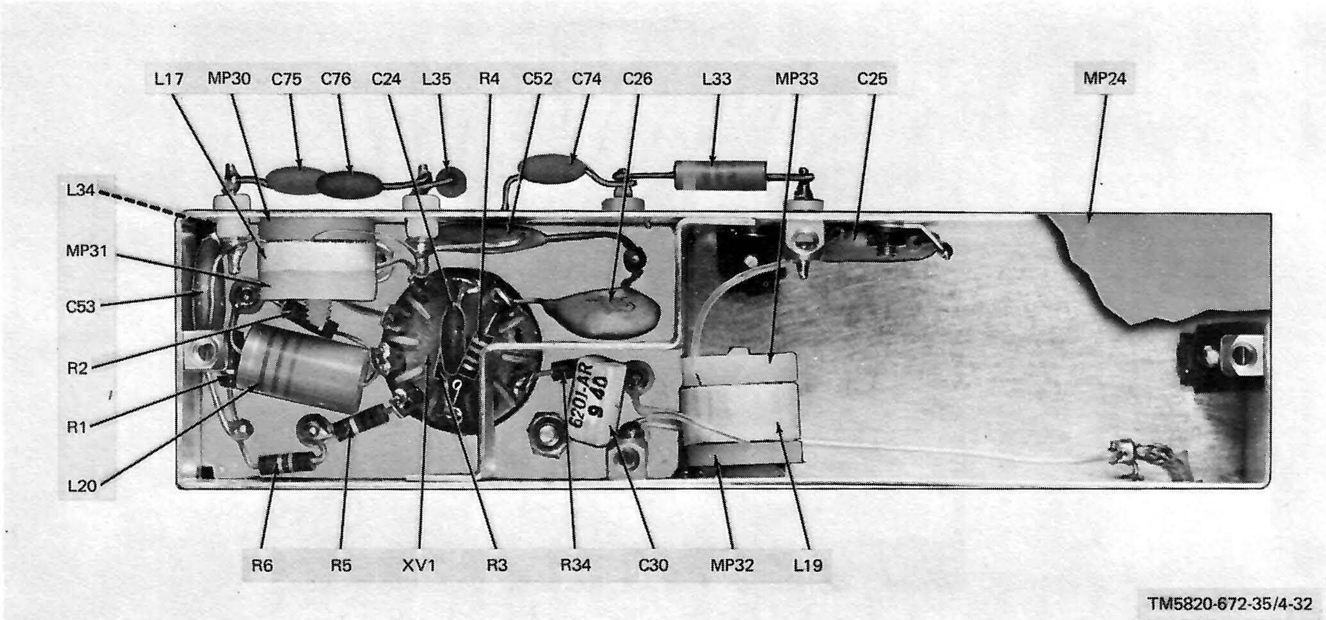


Figure 3-4. Input RF amplifier.

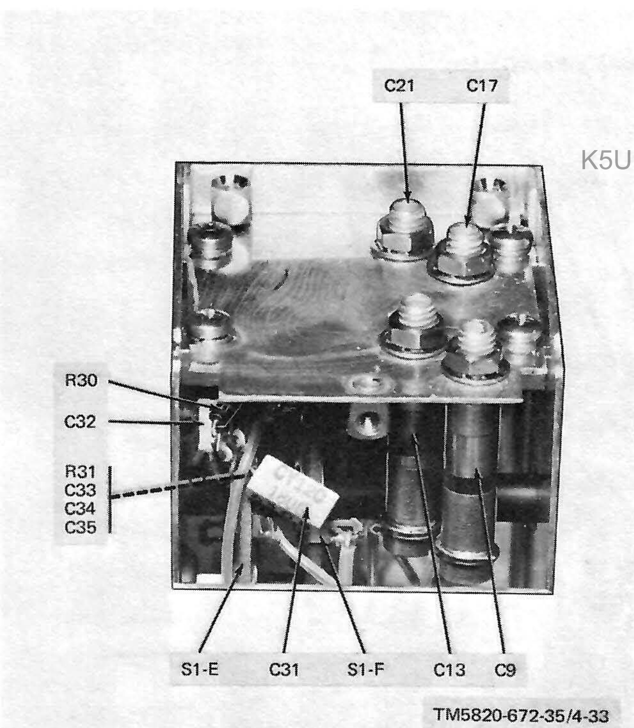


Figure 3-5. First double-tuned filter trimmer capacitors.

e. Refer to figure 3-6. Remove the double-tuned filter assembly from the chassis as follows:

(1) Remove nine screws that retain cover.

(2) Remove four screws and four lockwashers that retain assembly to chassis.

(3) Lift assembly away from chassis to limits of attached wires.

(4) For correct reassembly, follow above procedures in reverse order.

f. Refer to figure 3-7. Remove the RF amplifier assembly from the chassis as follows:

(1) Remove four screws that retain cover.

(2) Remove three screws and three lockwashers and one *glyped* screw that retain assembly to chassis.

(3) Lift assembly away from chassis to limits of attached wires.

(4) For correct reassembly, follow above procedures in reverse order.

g. Refer to figure 3-8. The chopper input circuit components mount directly to the main chassis and can be removed individually.

h. Refer to figure 3-9. Remove the capacitor drive and band switching circuits assembly from the chassis. The assembly is retained by screws coming in from the opposite side of the chassis. To remove the assembly retaining screws, remove the converter module which mounts over them.

i. Refer to figure 3-10. Remove the bridge equalizing circuits terminal board from the chassis as follows:

(1) Remove four screws and four flat washers that retain assembly to chassis.

(2) Lift assembly away from chassis to limits of attached wires.

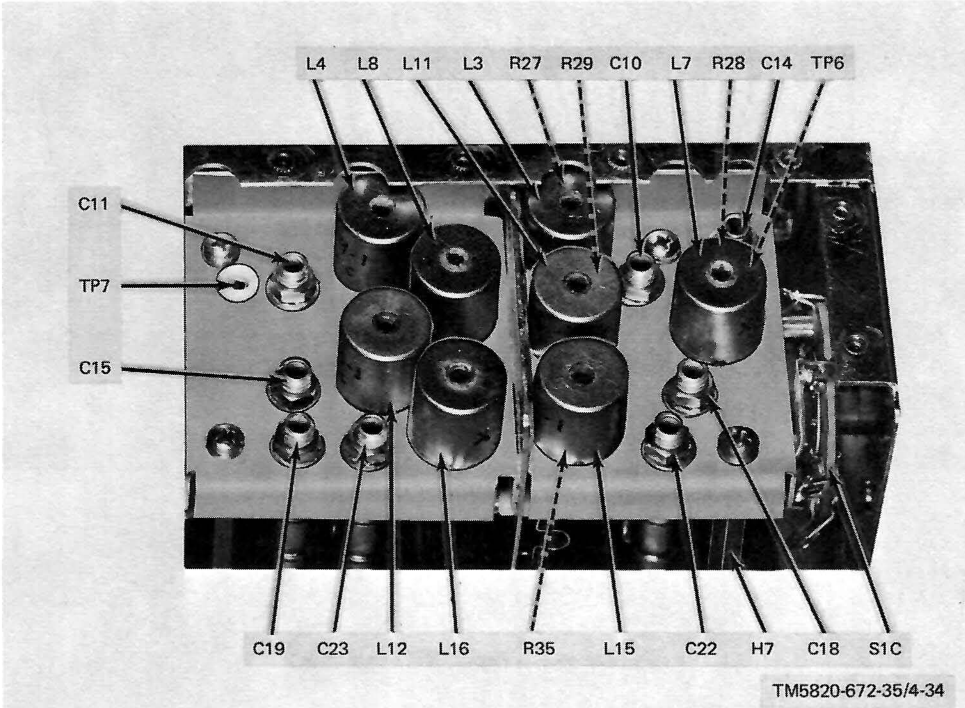


Figure 3-6. Second double-tuned filter.

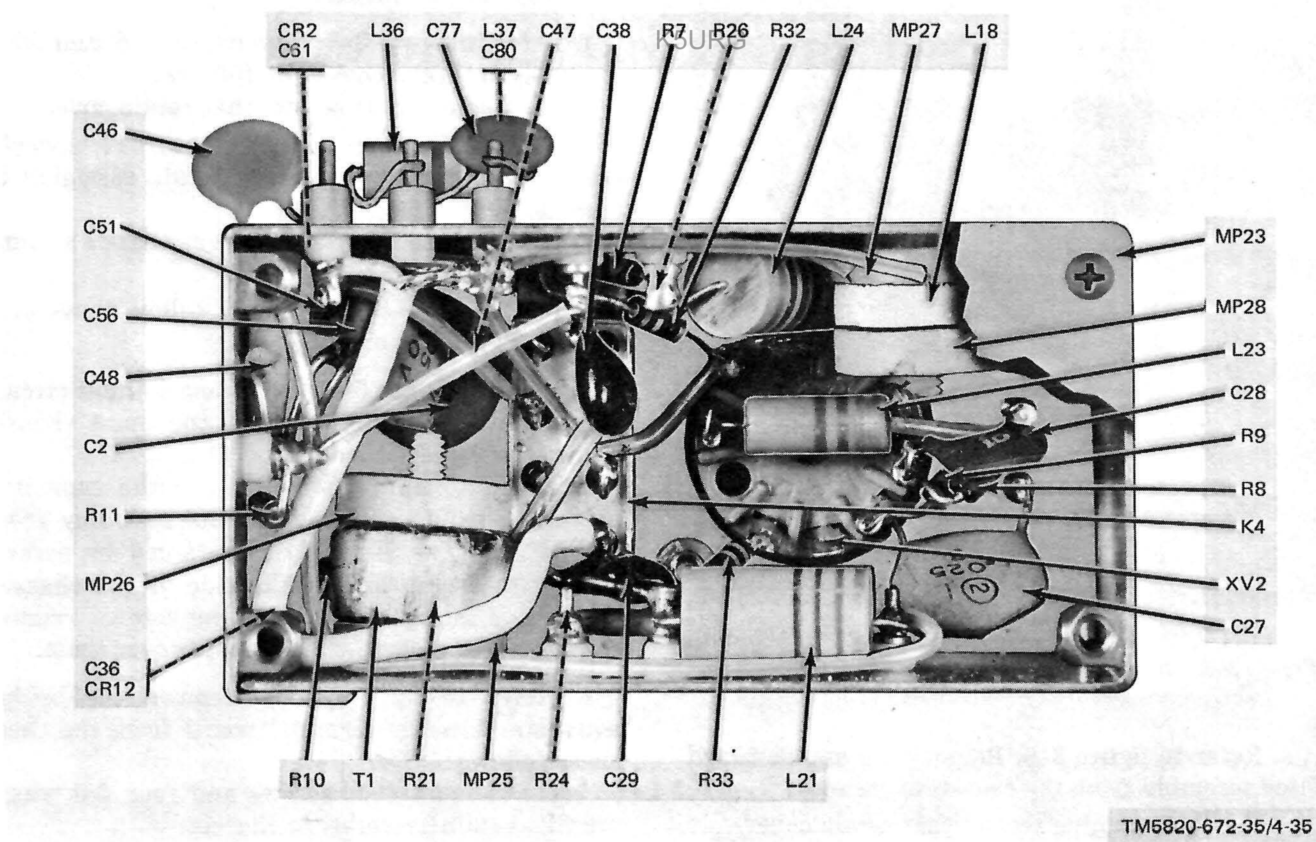


Figure 3-7. Output RF amplifier.

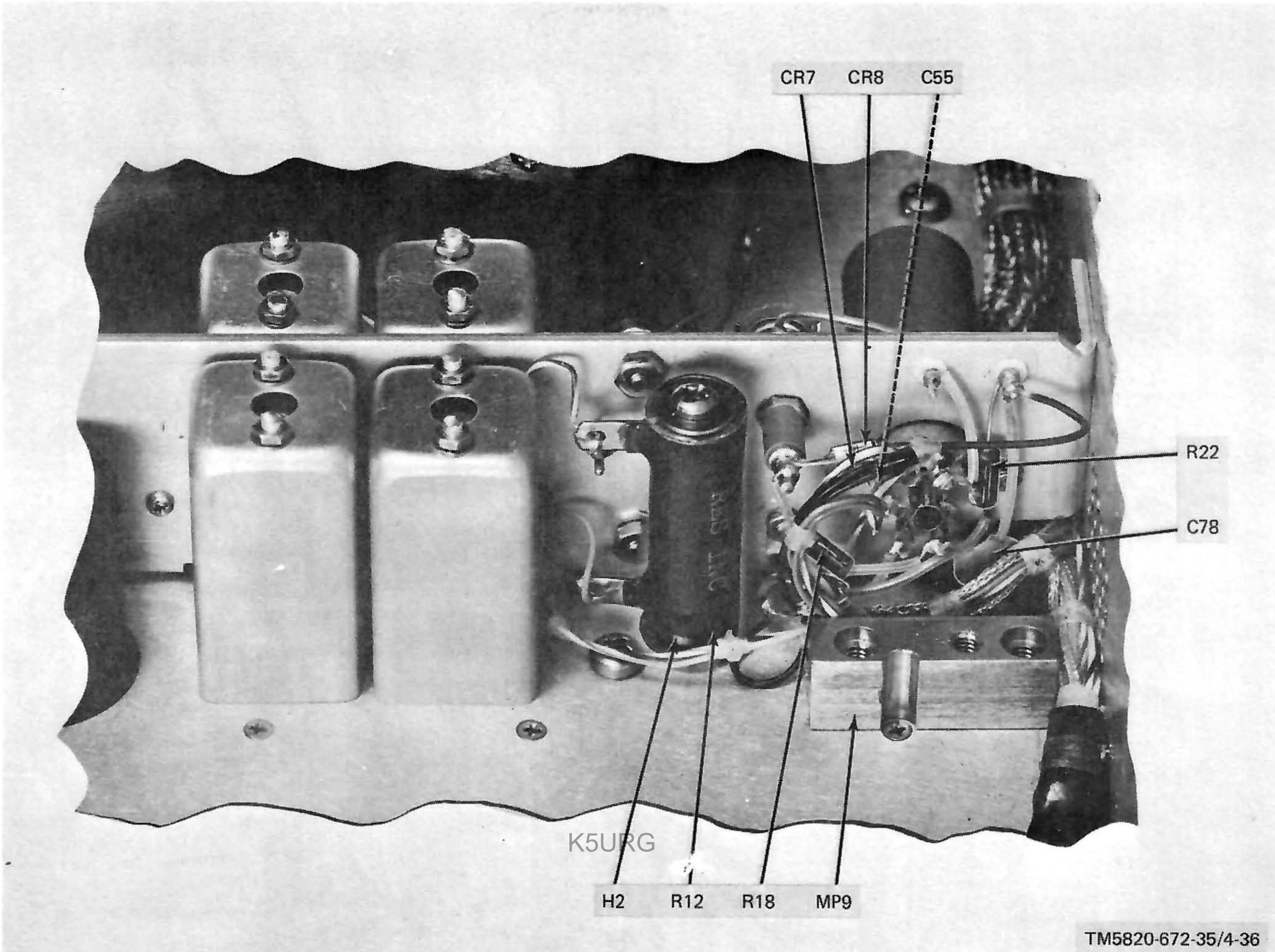


Figure 3-8. Chopper input circuit.

(3) For correct reassembly, follow above procedures in reverse order.

j. Refer to figure 3-11. Remove the overload protection terminal board from the chassis as follows:

(1) Remove three screws and three flat washers that retain assembly to chassis.

(2) Lift assembly away from chassis to limits of attached wires.

(3) For correct reassembly, follow above procedures in reverse order.

3-3. Disassembly and Reassembly of Servoamplifier Module A1, Collins Part No. 768-3916-001

The servoamplifier module is fabricated on three metal disks stacked one above the other and covered by a metal can. The top and middle disks have components on both sides; the bottom disk has components on the topside only. The bottom side contains the pins that plug into J4 on the F-1138/GRC chassis. Disassemble servoamplifier module as follows:

a. Remove covering metal can by removing three screws securing metal can to module. Slide off metal can.

b. Remove spacers holding servoamplifier terminal boards together.

c. Carefully note connection points for wires between three terminal boards.

d. Unsolder wires between terminal boards. If necessary, longer wires may be substituted for troubleshooting.

e. Reassemble servoamplifier module by carefully resoldering wires between terminal boards, replacing spacers between terminal boards, and replacing metal can on module.

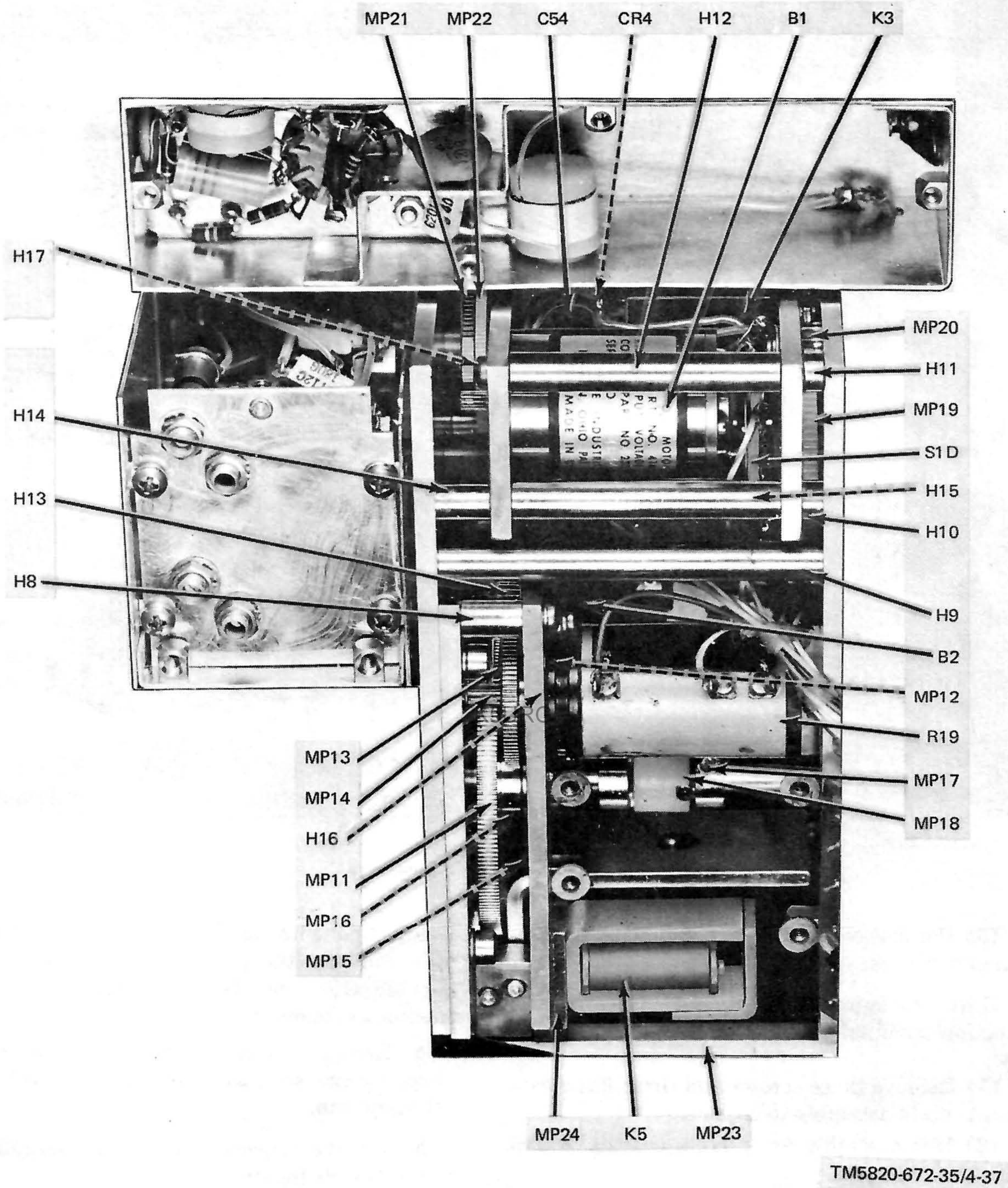


Figure 3-9. Capacitor drive and band switching circuits.

3-4. Disassembly and Reassembly of Servoamplifier Module A1, Collins Part No. 270-2039-010

The servoamplifier module is fabricated of 2-inch outside diameter tubing with a threaded cap on each end. The interior of the assembly is filled with sand to conduct heat away from the servoamplifier components. Disassemble servoamplifier module as follows:

a. Remove top threaded cap, using spanner wrench like one shown in figure 3-14. Engage two

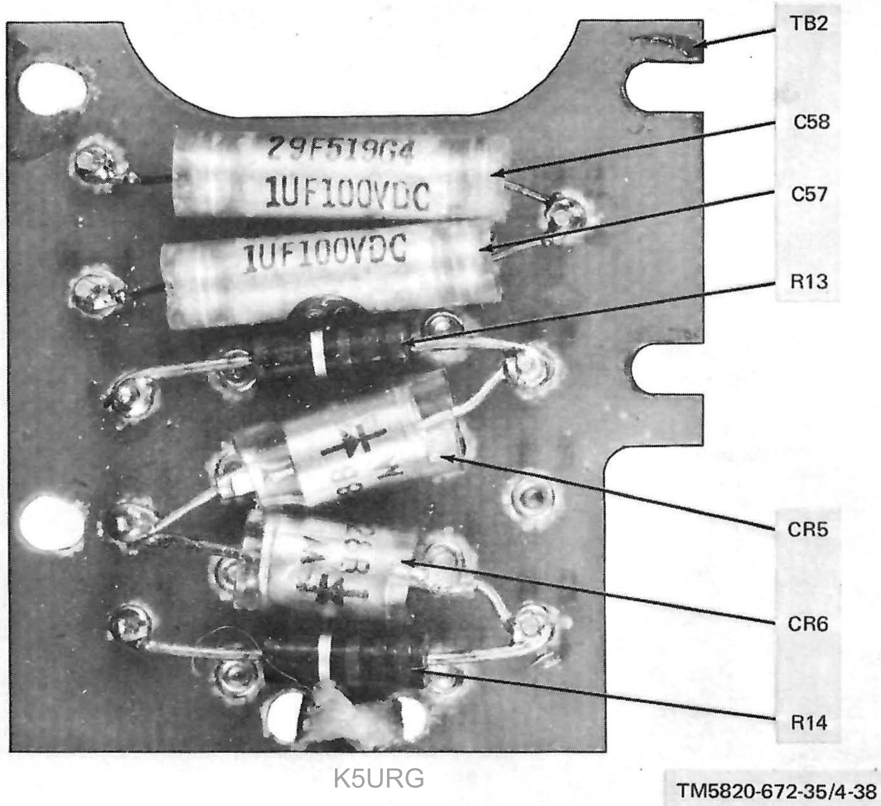


Figure 3-10. Bridge equalizing circuits.

small holes in cap and unscrew cap. Be careful not to spill sand.

b. Pour sand into container and save. Tap module case lightly to remove all sand.

c. Remove round module housing from base of module. Hold base with spanner wrench engaging two small holes.

d. Unscrew three screws securing two component mounting boards (fig. 3-15). These screws are threaded through module base and locked in place with round nuts.

e. Unsolder six wires between two component mounting boards. Longer wires may be substituted to facilitate troubleshooting.

f. Reassemble module by performing disassembly steps in reverse order. Be sure to replace entire quantity of sand and tighten caps securely. Use Silastic 731 RTV (Collins part No. 005-0737-001 or equivalent) around edges of caps after reassembly to prevent sand leakage.

3-5. On-Frequency Protection Adjustment

a. Perform procedures outlined in paragraph 2-6.

b. Connect AN/GRM-50 to connector P1A-A2 and connect ME-26(*)/U to V2-2.

c. Adjust AN/GRM-50 controls to provide a 5.5-volt test signal at 16.000 MHz, as indicated on ME-26(*)/U.

d. Adjust potentiometer R16 until on-frequency overload circuit operates as indicated by illumination of C-7207/GRC FAULT indicator. Ground is present on P1B-27, and ME-26(*)/U indicates 0 volt.

e. Reduce amplitude of AN/GRM-50 output signal to 0 volt.

f. Reset overload circuit by either grounding P1B-28 or pressing the C-7207/GRC FAULT/RESET pushbutton switch.

g. Increase AN/GRM-50 output until 5.5 volts

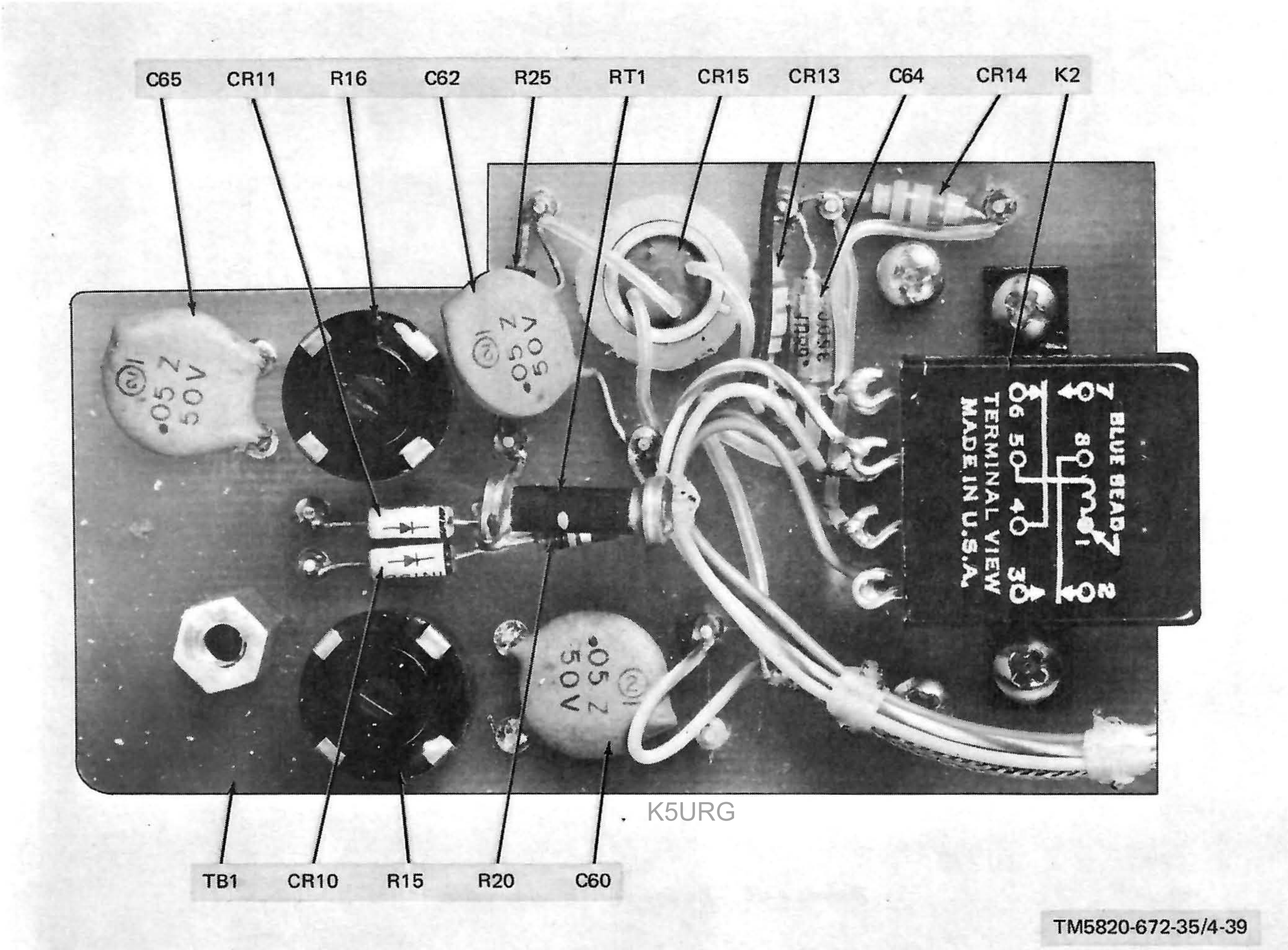


Figure 3-11. Overload protection terminal board.

is indicated on the ME-26(*)/U. The on-frequency overload circuit operates as described in *d* above. If not, readjust potentiometer R16 as necessary.

3-6. Off-Frequency Protection Adjustment

a. Perform procedures outlined in paragraph 2-6.

b. Connect second power source as follows: connect positive lead of PP-3514/U to ungrounded side of C50 and CR16, and connect its negative lead to P1B-31.

c. Connect ME-26(*)/U across PP-3514/U output terminals and set PP-3514/U output to 0 volt.

d. Increase PP-3514/U output to 23.0 volts.

e. Adjust potentiometer R15 until protection circuit operates as indicated by illumination of C-7207/GRC FAULT indicator.

3-7. Mechanical Adjustment of Capacitor Drive Gear

a. General. Mechanical adjustment of the capacitor drive gear involves the adjustment of the eccentric collar which positions the rear gear plate. The correct positioning of the rear gear plate removes backlash between the follow-potentiometer drive gear and the capacitor drive gear. Under normal operating conditions, no adjustment is required. If it is necessary to remove gear backlash, perform procedures given in *b*(1) through (5) below. If the gear train has been disassembled to replace a part, perform the procedure given in *b*(6) through (16) below.

b. Adjustment Procedure. Adjust capacitor drive gear as follows:

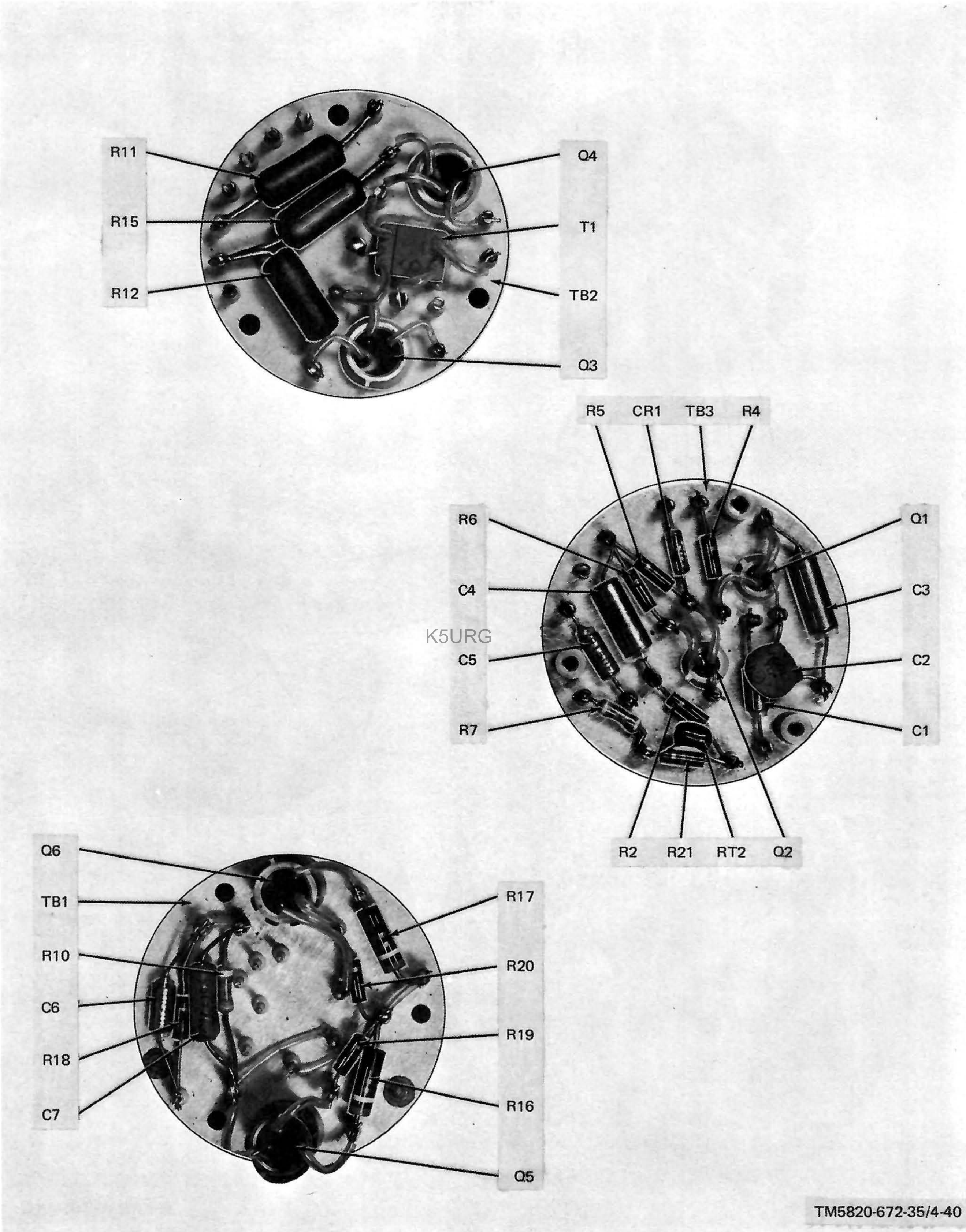


Figure 3-12. Servoamplifier module metal disks, top views.

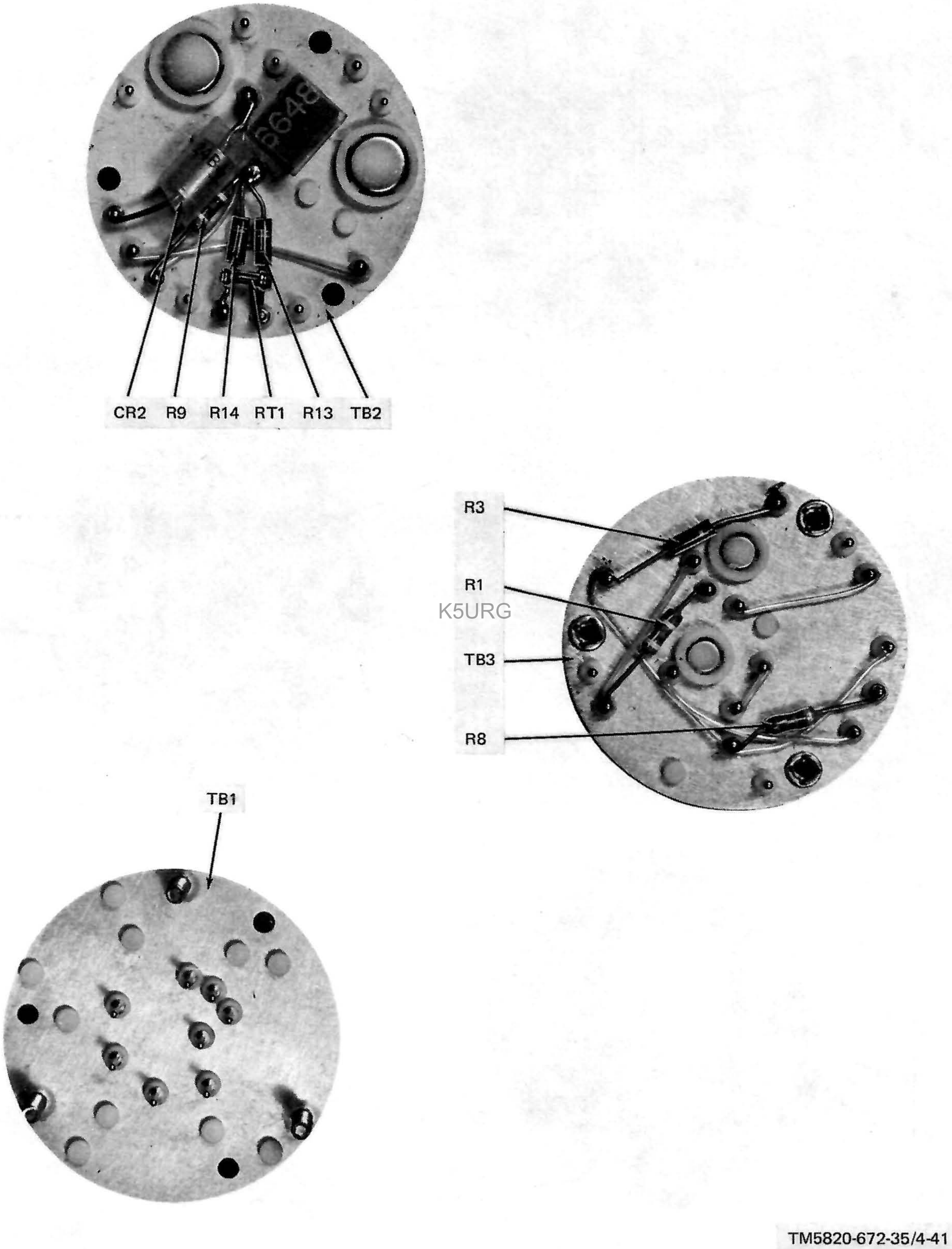


Figure 3-13. Servoamplifier module metal disks, bottom views.

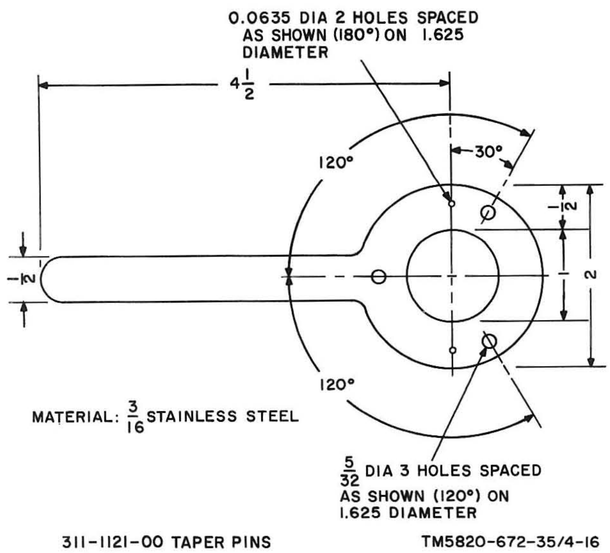


Figure 3-14. Spanner wrench for servoamplifier module disassembly.

(1) Remove variable tuning capacitor C1 and gear train assembly from F-1138/GRC chassis.

(2) Loosen four screws in rear gear plate marked A in figure 3-16.

(3) Use tool shown in figure 3-17 to rotate eccentric collar to provide minimum backlash.

CAUTION

Do not rotate eccentric collar unnecessarily or a great amount of gear mesh pressure develops. Such pressure causes extensive gear and bearing wear.

(4) Tighten four screws in rear gear plate and reassemble.

(5) Perform frequency band alignment procedures as outlined in paragraphs 3-11 through 3-14.

(6) Mount rear gear plate with screws marked A in figure 3-16. Leave screws loose.

(7) Rotate eccentric collar, using tool shown in figure 3-17 so thickest part of collar is nearest potentiometer gear bearing.

(8) Rotate capacitor C1 rotor until fully meshed with stator.

(9) Mount capacitor drive gear with punch-mark nearest potentiometer drive gear bearing as shown in figure 3-16, with 1/32-inch clearance between gear and gear plate.

(10) Mount follow-potentiometer R19 to front gear plate and rotate potentiometer drive gear fully counterclockwise (facing shaft).

(11) Rotate tuning capacitor C1 so upper edges of rotor blades are flush with upper edges of stator blades.

(12) Assemble front gear plate on rear gear plate, being careful not to disturb setting of C1 or R19.

NOTE

If meshing gear teeth to perform (12) above disturbs setting of R19 or C1, loosen two mounting screws and rotate R19 so it is in full counterclockwise position (facing shaft) while C1 is fully meshed. Tighten mounting screws.

(13) Adjust eccentric collar for minimum backlash.

(14) Tighten screws in rear gear plate and reassemble.

(15) Liquid-stake all screws not provided with lockwashers.

(16) Perform frequency band alignment as outlined in paragraphs 3-11 through 3-14 and check for correct brake alignment.

3-8. Mechanical Adjustment of Capacitor Gear Drive Brake Assembly

a. General. Mechanical adjustment of the capacitor gear drive brake assembly is required only if capacitor gear drive assembly is disassembled for repair or if the brake allows the capacitor to slip when the servomotor is not energized. The slip brake helps to prevent capacitor rotation during shock or vibration when the servomotor is not energized. The brake is released when the servomotor is energized.

b. Adjustment Procedure. Adjust capacitor drive gear brake assembly as follows (fig. 3-18):

(1) Adjust setscrew A, using Bristol wrench until plate actuator is approximately parallel with positioning plate.

NOTE

Access to setscrew A is provided through hole in bottom cover of F-1138/GRC (close to front panel).

(2) Energize actuator relay K5 by connecting +28 volts dc to P1B-39 and (—) to P1B-31.

(3) Adjust setscrew B so plate actuator travels 0.010 to 0.018 inch when energized.

NOTE

Access to setscrew B is provided through hole in bottom cover (close to rear of F-1138/GRC).

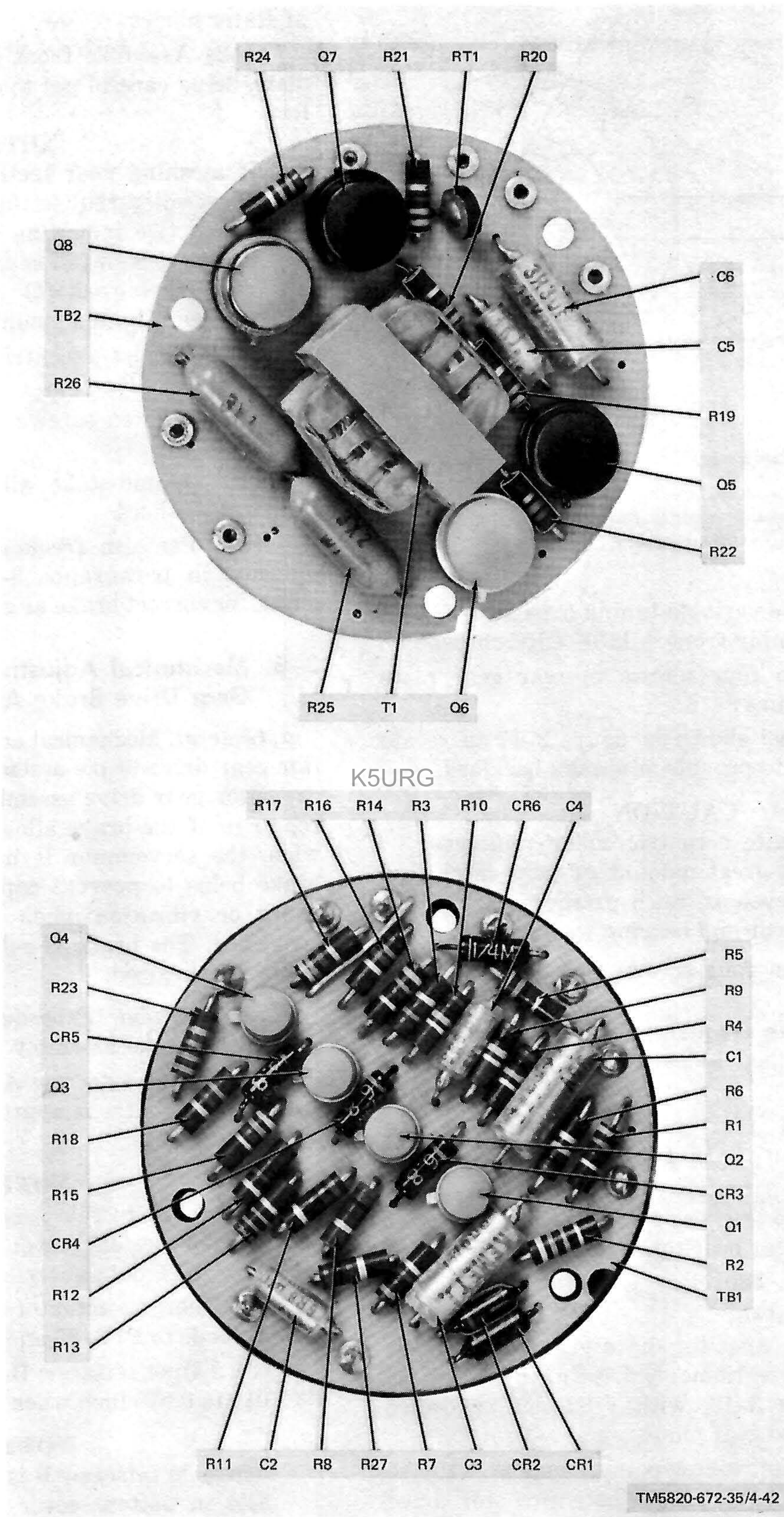


Figure 3-15. Servoamplifier (270-2039-010) terminal board.

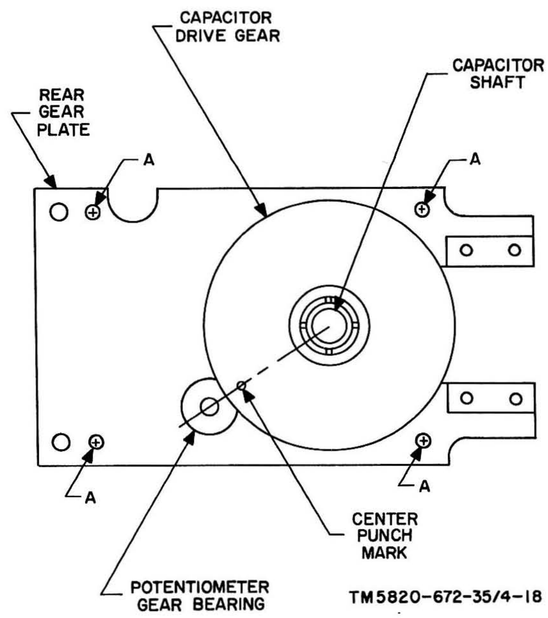


Figure 3-16. Capacitor drive gear alignment diagram.

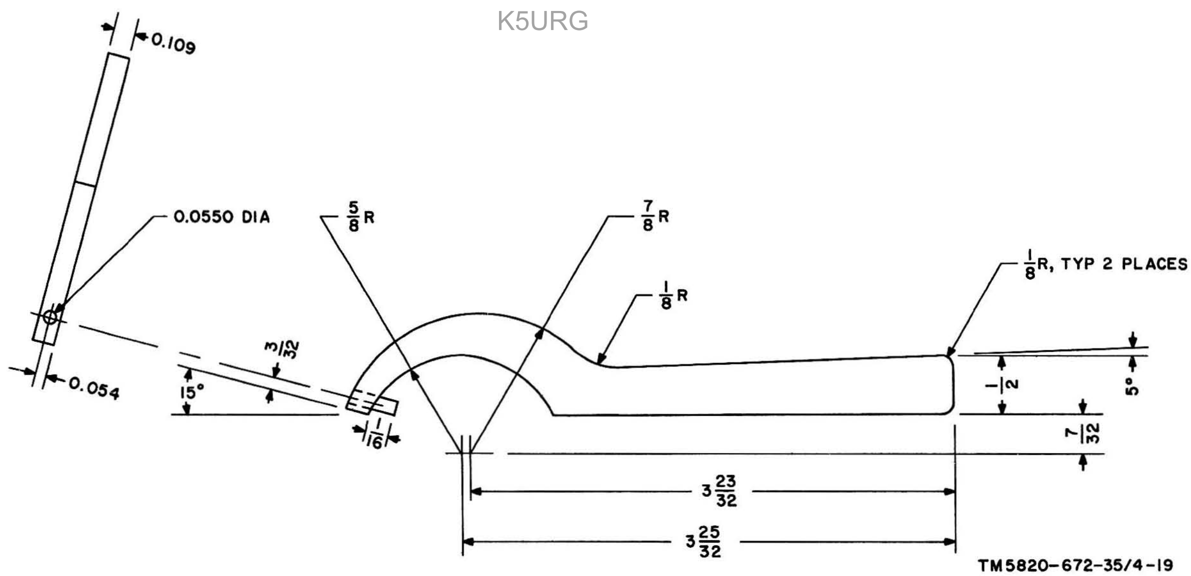


Figure 3-17. Capacitor drive gear adjusting wrench.

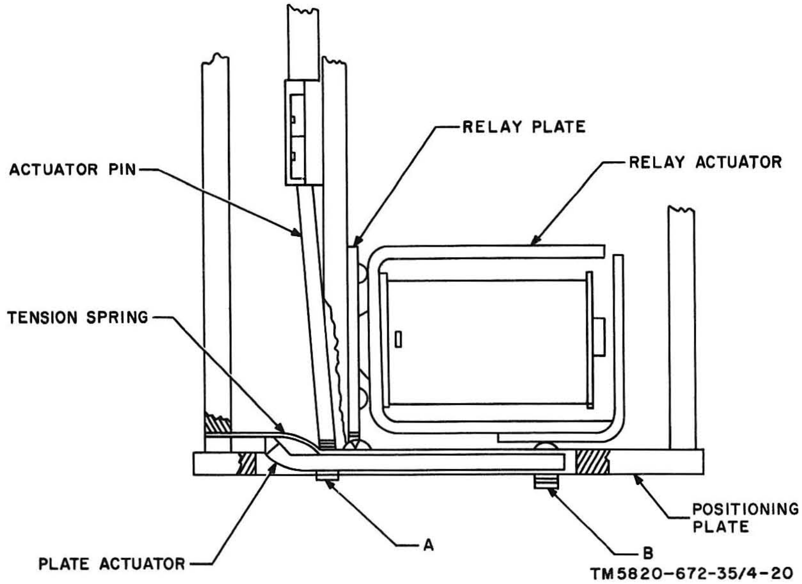


Figure 3-18. Brake adjustment points.

Section II. ALIGNMENT

3-9. Test Equipment and Special Tools

The test equipment and special tools required for alignment of the F-1138/GRC are listed in table 3-1.

Table 3-1. Test Equipment and Special Tools

Item	Technical manual
Signal Generator AN/GRM-50	TM 11-6625-573-15
Signal Generator AN/URM-127	TM 11-6625-683-15
Multimeter ME-26(*)/U	TM 11-6625-200-15
Resistor 56 ohms, 0.5 watt.	
Resistor 10K.	
Tool Kit, Electronic Equipment TK-105/G.	SC-5180-91-CL-R07
Power Supply PP-3514/U	TM 11-6625-617-12
Radio Set Control C-7207/GRC	TM 11-5820-672-35-2
Cooling air supply (sufficient to maintain flow rate of 60 pounds per hour at temperature of +40° C).	
Connector Plug, Electrical PTSF06SE22-55PX.	
Connector DPX2EB-C1BS40W1S-33B-0201 with 249-1329-000 insert.	
Radio Receiver R-1433/UR (FSN 5820-999-3915).	
Wire, 22 AWG; length as required.	

3-10. Characteristics of Test Equipment Required for Alignment

The type of test equipment required for alignment of the F-1138/GRC are those given in table 3-1. Their requirements are given in *a* through *d* below.

a. Signal Generator. A signal generator capable of supplying a 2.000-MHz to 29.000-MHz test signal at an amplitude of up to 3 volts in 50-ohm load (AN/GRM-50).

b. Vtvm. A vacuum tube voltmeter (vtvm) capable of up to 3.0-volt ac indication at frequencies in the 2.000-MHz to 29.000-MHz range (ME-26(*)/U).

c. Power Supply. A dc power supply capable of supplying 0- to 30.0-volt dc indication at 0.3 ampere (two PP-3514/U's in parallel).

d. Control Unit. A control unit capable of providing the following remote control functions for the F-1138/GRC (C-7207/GRC):

(1) Power on-off.
(2) Frequency selection.
(3) Overload (fault) reset control.
(4) Gain control.

3-11. Frequency Band Number One Alignment

a. Connect AN/GRM-50 to connector P1A-A2.

b. Connect ME-26(*)/U to connector P1B-A1 and connect 56-ohm resistor across connector P1B-A1.

c. Adjust AN/GRM-50 controls to provide 2.000-MHz test signal at 0 volt.

d. Set C-7207/GRC FREQUENCY-MC switches to 2.000 MHz.

e. Set ME-26(*)/U RANGE switch to 3V and increase amplitude of AN/GRM-50 test signal until indication is observed on ME-26(*)/U.

f. Connect 10K swamping resistor between TP6 and ground.

g. Adjust L1 and L4 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

h. Remove 10K swamping resistor and adjust L3 for peak indication on ME-26(*)/U.

i. Connect 10K swamping resistor across L1 and adjust L2 for peak indication on ME-26(*)/U.

j. Set AN/GRM-50 and C-7207/GRC frequency to 3.999 MHz. Connect 10K swamping resistor between TP6 and ground.

k. Adjust capacitors C8 and C11 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

l. Remove 10K swamping resistor and adjust C10 for peak indication on ME-26(*)/U.

m. Connect 10K swamping resistor across L1 and adjust C9 for peak indication on ME-26(*)/U.

n. Repeat steps *a* through *m* above as necessary until adjustments produce no further peak indication on ME-26(*)/U.

NOTE

Insure last adjustment is performed at 3.999 MHz.

3-12. Frequency Band Number Two Alignment

a. Connect AN/GRM-50 to connector P1A-A2.

b. Connect ME-26(*)/U to connector P1B-A1 and connect 56-ohm resistor across connector P1B-A1.

c. Adjust AN/GRM-50 controls to provide a 4.000-MHz test signal to 0 volt.

d. Set C-7207/GRC FREQUENCY-MC switches to 4.000 MHz.

e. Set ME-26(*)/U RANGE switch to 3V and increase amplitude of AN/GRM-50 test signal until indication is observed on ME-26(*)/U.

f. Connect 10K swamping resistor between TP6 and ground.

g. Adjust L5 and L8 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

h. Remove 10K swamping resistor and adjust L7 for peak indication on ME-26(*)/U.

i. Connect 10K swamping resistor across L5 and adjust L6 for peak indication on ME-26(*)/U.

j. Set AN/GRM-50 and C-7207/GRC frequency to 7.999 MHz. Connect 10K swamping resistor between TP6 and ground.

k. Adjust capacitors C12 and C15 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

l. Remove 10K swamping resistor and adjust C14 for peak indication on ME-26(*)/U.

m. Connect 10K swamping resistor across L5 and adjust C13 for peak indication on ME-26(*)/U.

n. Repeat *a* through *m* above as necessary until adjustments produce no further increase in peak indication on ME-26(*)/U.

NOTE

Insure last adjustment is performed at 7.999 MHz.

3-13. Frequency Band Number Three Alignment

a. Connect AN/GRM-50 to connector P1A-A2.

b. Connect ME-26(*)/U to connector P1B-A1 and connect 56-ohm resistor across connector P1B-A1.

c. Adjust AN/GRM-50 controls to provide 8.000-MHz test signal at 0 volt.

d. Set C-7207/GRC FREQUENCY-MC switches to 8.000 MHz.

e. Set ME-26(*)/U RANGE switch to 3V and increase amplitude of AN/GRM-50 test signal until indication is observed on ME-26(*)/U.

f. Connect 10K swamping resistor between TP6 and ground.

g. Adjust L9, L10, and L12 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

h. Remove 10K swamping resistor and adjust L11 for peak indication on ME-26(*)/U.

i. Set AN/GRM-50 and C-7207/GRC frequency to 15.999 MHz. Connect 10K swamping resistor between TP6 and ground.

j. Adjust capacitors C16, C17, and C19 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

k. Remove 10K swamping resistor and adjust C18 for peak indication on ME-26(*)/U.

l. Repeat *a* through *k* above as necessary until adjustments produce no further increase in peak indication on ME-26(*)/U.

NOTE

Insure last adjustment is performed at 15.999 MHz.

3-14. Frequency Band Number Four Alignment

a. Connect AN/GRM-50 to connector P1A-A2.

b. Connect ME-26(*)/U to connector P1B-A1 and connect 56-ohm resistor across connector P1B-A1.

c. Adjust AN/GRM-50 controls to provide 16.000-MHz test signal at 0 volt.

d. Set C-7207/GRC FREQUENCY-MC switches to 16.000 MHz.

e. Set ME-26(*)/U RANGE switch to 3V and increase amplitude of AN/GRM-50 test signal until indication is observed on AN/GRM-50.

f. Connect 10K swamping resistor between TP6 and ground.

g. Adjust L13, L14, and L16 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

h. Remove 10K swamping resistor and adjust L15 for peak indication on ME-26(*)/U.

i. Set AN/GRM-50 and C-7207/GRC frequency to 29.000 MHz. Connect 10K swamping resistor between TP6 and ground.

j. Adjust capacitors C20, C21, and C23 for peak indication on ME-26(*)/U.

NOTE

Do not allow ME-26(*)/U indication to exceed 1 volt.

k. Remove 10K swamping resistor and adjust C22 for peak indication on ME-26(*)/U.

l. Repeat steps *a* through *k* above as necessary until adjustments produce no further increase in peak indication on ME-26(*)/U.

NOTE

Be sure last adjustment is performed at 29.000 MHz.

CHAPTER 4
GENERAL SUPPORT TESTING PROCEDURES

4-1. General

a. General support testing procedures are prepared to determine the acceptability of repaired signal equipment. These procedures set forth specific requirements that *must* be met before repaired signal equipment is returned to the using organization.

b. Comply with the instructions preceding the body of each chart before proceeding to the chart. Perform each test in sequence. *Do not vary the sequence.* For each step, perform all the actions required in the *Test equipment control settings* and *Test procedure* columns; then perform each specific test procedure and verify it against its performance standard.

4-2. Test Equipment, Tools, Materials, and Other Equipment Required

All test equipment, tools, materials, and other equipment required to perform the testing procedures given in this section are listed in the following charts:

a. Test Equipment.

Nomenclature	Federal stock No.	Technical manual
Signal Generator AN/GRM-50	6625-868-8353	TM 11-6625-573-15
Multimeter ME-26(*)/U	6625-913-9781	TM 11-6625-200-15
Radio Receiver R-1433/UR	5820-999-3915	
Signal Generator SG-419/U	6625-643-7684	TM 11-6625-413-10

b. Other Equipment.

Nomenclature	Federal stock No.	Technical manual
Power Supply PP-3514/U	6625-445-6933	TM 11-6625-617-12
Radio Set Control C-7207/GRC	5820-933-5684	TM 11-5820-672-12
Attenuator CN-970/U	5985-993-1377	
Cooling air supply (sufficient to maintain flow rate of 60 pounds per hour at temperature of +40° C).		
Resistor, 56-ohm, 0.5 watt.		
Connector PTSF06SE22-55PXo		
Connector DPX2EB-C1BS40W1S-33B-0201 with 249-1349-000 insert.		
Adapter UG-349A/4.		
Tee Connector UG-274/U.		
Connector DPX2-43441.		
Connector UG-88/U (three).		
Connector 3501-M.		
Coaxial cable RG-58C/U, length as required.		
Connector UG-536B/U.		
Coaxial cable RG-8/U, length as required.		
Wire-22 AWG, length as required.		

4-3. Modification Work Orders

The performance standards listed in the tests (paras. 4-5 through 4-8) assume that any modification work orders that are listed in DA Pam 310-7 have been performed. A listing of current modification work orders is found in DA Pam 310-7.

4-4. Servotest

a. Test Equipment and Materials.

(1) PP-3514/U.

(2) C-7207/GRC.

(3) Air supply for cooling.

b. Test Connections and Conditions. Connect equipment as follows:

(1) Connect PP-3514/U to F-1138/GRC as shown in figure 2-3, for the servotest connections. Do not turn PP-3514/U on.

(2) Connect C-7207/GRC to F-1138/GRC as shown in figure 2-3.

(3) Connect cooling air supply to F-1138/GRC.

c. Procedure.

NOTE

Two PP-3514/U's can be connected in parallel.

Step No.	Test equipment control settings	Test procedure	Performance standard
1	*a.* Set C-7207/GRC to 3.000 MHz	Observe rotor position of tuning capacitor sections C1A and C1B.	
	b. Turn on PP-3514/U and adjust for 28-volt dc output.		Capacitor rotor plates shall position to approximately one-half mesh with respect to stator plates.
		Apply slight finger pressure on follow-potentiometer pinion.	Gear shall resist all efforts to move while power is applied.
2	Set C-7207/GRC to 2.000 MHz		Capacitor rotor plates shall position to within approximately 9° from fully meshed with capacitor stator.
3	Set C-7207/GRC to 3.999 MHz		Capacitor rotor plates shall position to within approximately 9° from fully open position.
4	Set C-7207/GRC to 2.000 MHz	Measure tuning time from open position to 9° closed position.	Time shall be not more than 10 seconds at room temperature and not more than 15 seconds cold.

4-5. Digital-to-Analog Converter Test

a. Test Equipment and Materials. PP-3514/U, C-7207/GRC, and cooling air supply.

b. Test Connections and Conditions. Connect test equipment as follows:

(1) Connect PP-3514/U to F-1138/GRC as shown in figure 2-3. Do not turn PP-3514/U on.

(2) Connect C-7207/GRC to F-1138/GRC as shown in figure 2-3.

(3) Connect cooling air supply to F-1138/GRC.

c. Procedure.

Step No.	Test equipment control settings	Test procedure	Performance standard
1	*a.* Turn on PP-3514/U and adjust for 28-volt dc output. *b.* Set C-7207/GRC to 3.000 MHz.	Remove cover from analog-to-digital converter module A3.	
2	Rotate 1-kHz thumbwheel switch on C-7207/GRC.		Switch A3S4 rotates to corresponding number on drive gear. Also note slight rotation of capacitor C1.
3	Rotate 10-kHz thumbwheel switch on C-7207/GRC.		Switch A3S3 rotates to corresponding number on drive gear. Also note slight rotation of capacitor C1.
4	Rotate 100-kHz thumbwheel switch on frequency C-7207/GRC.		Switch A3S2 rotates to corresponding number on drive gear. Also note slight rotation of capacitor C1.

Step No.	Test equipment control settings	Test procedure	Performance standard
5	*a.* Set C-7207/GRC to 2.000 MHz. *b.* Rotate MegaHertz thumbwheel switch on C-7207/GRC.		Switch A3S1 rotates to corresponding number on drive gear. Also note positioning of capacitor C1 and switch S1 on main chassis.
6	Turn off PP-3514/U	Replace cover on digital-to-analog converter module A3.	

4-6. Tracking and Bandpass Test

a. Test Equipment and Materials. Signal Generator AN/GRM-50, 56-ohm, 0.5-watt resistor, tee-adapter, Multimeter ME-26(*)/U, Radio Receiver R-1433/UR (receiver), PP-3514/U, C-7207/GRC, and cooling air supply.

b. Test Connections and Conditions. Connect equipment as follows (fig. 4-1):

(1) Connect AN/GRM-50 RF OUTPUT connector to connector P1A-A2, using Tee Connector UG-274/U.

(2) Connect 56-ohm, 0.5-watt resistor across connector P1B-A1.

(3) Connect ME-26(*)/U across 56-ohm, 0.5-watt resistor ((2) above). Adjust ME-26(*)/U controls to indicate 3V-AC full scale.

(4) Connect unused leg of Tee Connector UG-274/U to receive ANT connector.

(5) Connect PP-3514/U and C-7207/GRC to F-1138/GRC as outlined in paragraph 2-6.

(6) Connect cooling air supply to F-1138/GRC.

*c. **Procedure.***

Step No.	Test equipment control settings	Test procedure	Performance standard
1	Set AN/GRM-50 and C-7207/GRC to 2.000 MHz.	Adjust AN/GRM-50 controls for a 1.0 volt-indication on ME-26(*)/U.	
2		Vary AN/GRM-50 frequency above and below 2.000 MHz until ME-26(*)/U indicates 0.89 volt (-1.0 db point).	The frequency difference between 2.000 MHz and each -1.0 db point shall be no less than 3.0 kHz as indicated on receiver.
3		Vary AN/GRM-50 frequency above and below 2.000 MHz until ME-26(*)/U indicates 0.79 volt (-2.0 db points).	The frequency difference between 2.000 MHz and each -2.0 db point shall be no less than 6.0 kHz.
4		Repeat steps 2 and 3 at F-1138/GRC center frequencies of 2.500 MHz, 3.999 MHz, 4.000 MHz, 6.000 MHz, 7.999 MHz, 8.000 MHz, 12.000 MHz, 15.999 MHz, 16.000 MHz, 20.000 MHz, 24.000 MHz, and 29.000 MHz.	The F-1138/GRC shall track correctly and shall have a minimum bandwidth of 6.0 KHz to the -2.0 db point for each frequency measured.

4-7. Gain Test

a. Test Equipment and Materials. Signal Generator AN/GRM-50; Multimeter ME-26(*)/U; Attenuator CN-970/U (attenuator); resistor 56-ohm, —0.5-watt; PP-3514/U; C-7207/GRC; and cooling air supply.

b. Test Connections and Conditions. Connect equipment as follows:

(1) Connect AN/GRM-50 RF OUTPUT connector to one side of 50-ohm attenuator as shown in A, figure 4-2.

(2) Connect ME-26(*)/U ac probe to other side of 50-ohm attenuator as shown in A, figure 4-2. Set attenuator for minimum attenuation.

(3) Connect 56-ohm, 0.5-watt resistor between ME-26(*)/U AC probe and alligator clip attached to probe as shown in A, figure 4-2.

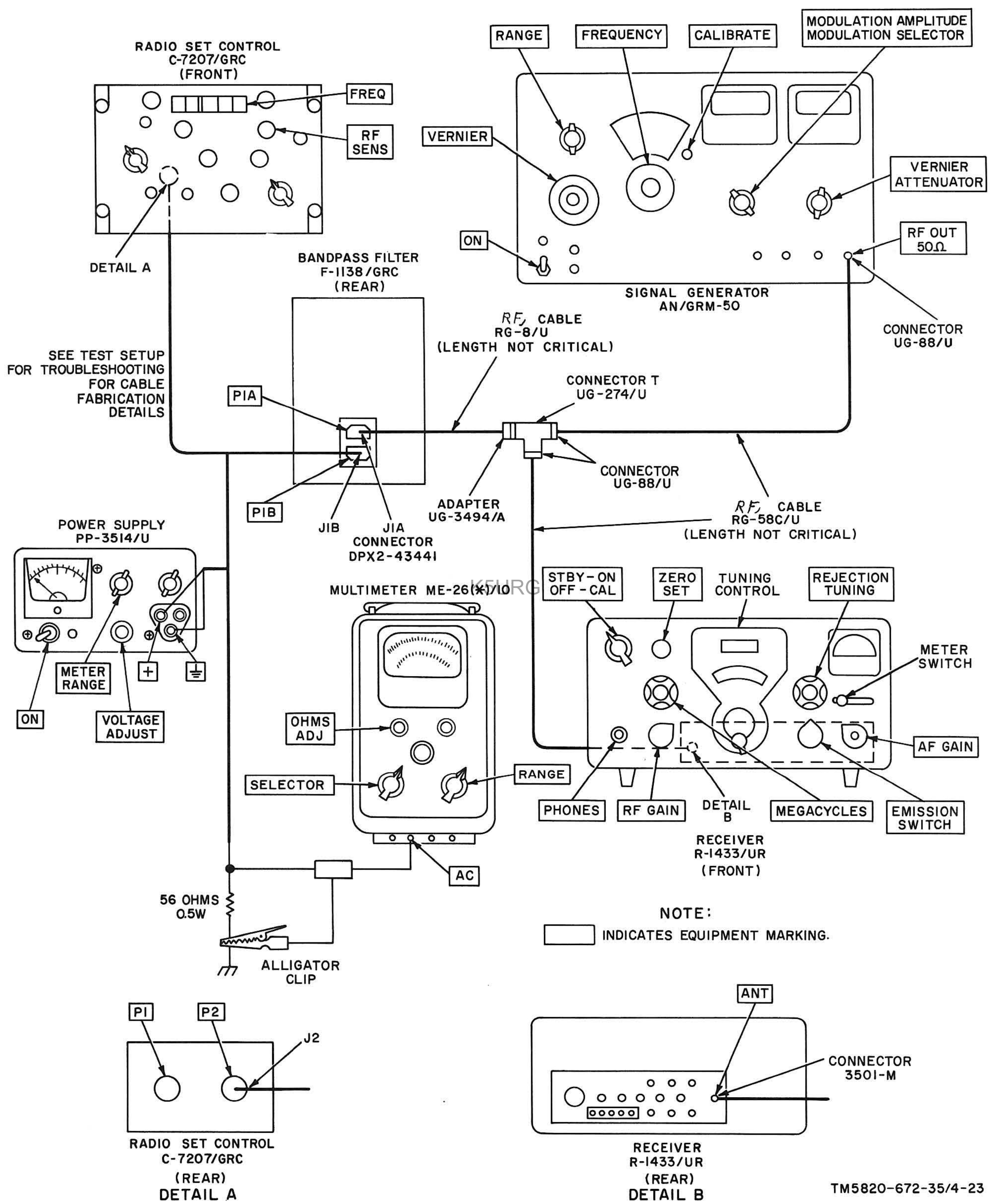


Figure 4-1. Tracking and bandpass test connections.

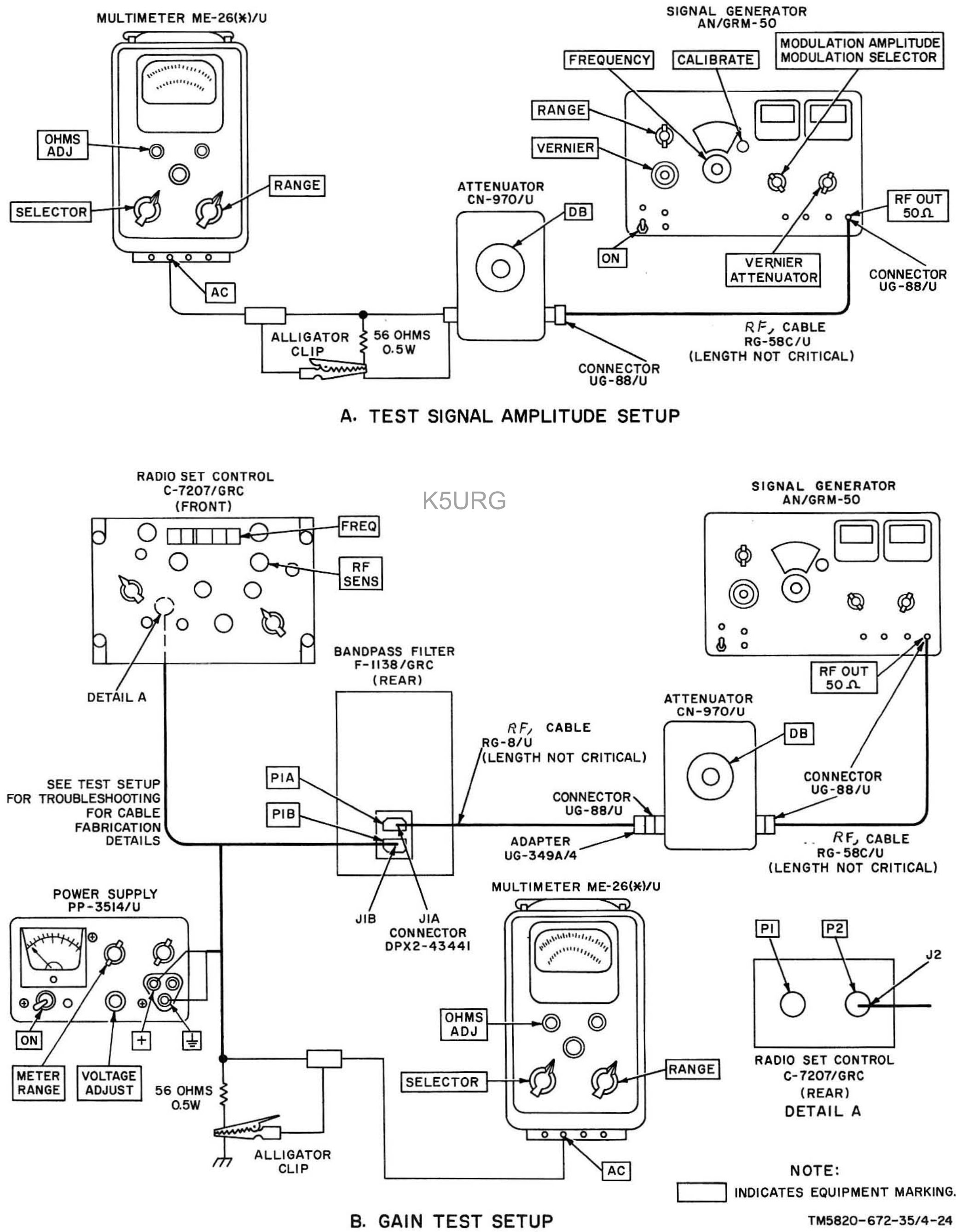


Figure 4-2. Gain measurement test connections.

(4) Connect PP-3514/U and C-7207/GRC to F-1138/GRC as outlined in paragraph 2-6 (B, fig. 4-2.

(5) Connect cooling air supply to F-1138/GRC.

c. Procedure.

Step No.	Test equipment control settings	Test procedure	Performance standard
1	*a.* Connect equipment as shown in A, figure 4-2. *b.* Set AN/GRM-50 controls to provide 2.000-MHz test signal at 1.0 volt as indicated on ME-26(*)/U.		
2	*a.* Connect equipment as shown in B, figure 4-2 without changing amplitude of AN/GRM-50 test signal. *b.* Set frequency on C-7207/GRC to 2.000-MHz and HI-LO switch to HI.	Increase attenuator setting until ME-26(*)/U indicates 1.0 volt.	The gain in db as indicated by change in attenuator db setting shall be not more than 18 nor less than 6.
3		Repeat step 2 at 3.000 MHz, 6.000 MHz, 12.000 MHz, and 23.000 MHz.	Results shall be as stated in step 2.

4-8. Sensitivity Test

a. Test Equipment and Materials. Multimeter ME-26(*)/U, Radio Receiver R-1433/UR (receiver), Signal Generator SG-419/U (noise generator), PP-3514/U, C-7207/GRC, and cooling air supply.

b. Test Connections and Conditions. Connect equipment as follows (fig. 4-3):

(1) Connect noise generator OUTPUT connector to connector P1-A2. Set noise generator OUTPUT control to OFF.

(2) Connect receiver ANT connector to connector P1B-A1.

(3) Connect ME-26(*)/U AC probe to receiver IF OUTPUT connector at rear of receiver.

(4) Connect PP-3514/U and C-7207/GRC to F-1138/GRC as outlined in paragraph 2-6.

(5) Connect cooling air supply to F-1138/GRC.

NOTE

The following sensitivity test shall be performed in interference-free environment.

c. Procedure.

Step No.	Test equipment control setings	Test procedure	Performance standard
1	*a.* Set C-7207/GRC and receiver to same frequency. *b.* Set C-7207/GRC HI-LO switch to LO. *c.* Set receiver controls as follows: OFF-ON-STBY-CAL switch to ON, REJECTION TUNING switch to OFF, EMISSION switch to AM, and RF GAIN control for minimum gain (fully counterclockwise).		
2		Rotate receiver RF GAIN control clockwise (increasing) until IF output increases by 10 db (3.0 vac) as indicated on ME-26(*)/U.	
3	Set C-7207/GRC HI-LO switch to HI.		ME-26(*)/U indication of step 2 shall increase an additional 10 db (10.0 vac).
4	Press ON pushbutton switch on noise generator.	Increase noise generator output until ME-26(*)/U indication of step 3 increases by 3.0 db (1.5 voltage change). *Note.* In case of spurious signal, change frequency setting of C-7207/GRC and receiver by approximately 50 kHz and repeat steps 1 through 4.	Noise figure as read on noise generator shall be not more than 10 db at 2.000 MHz and increase to not more than 17 db (8.5 vac) at 30.000 MHz.

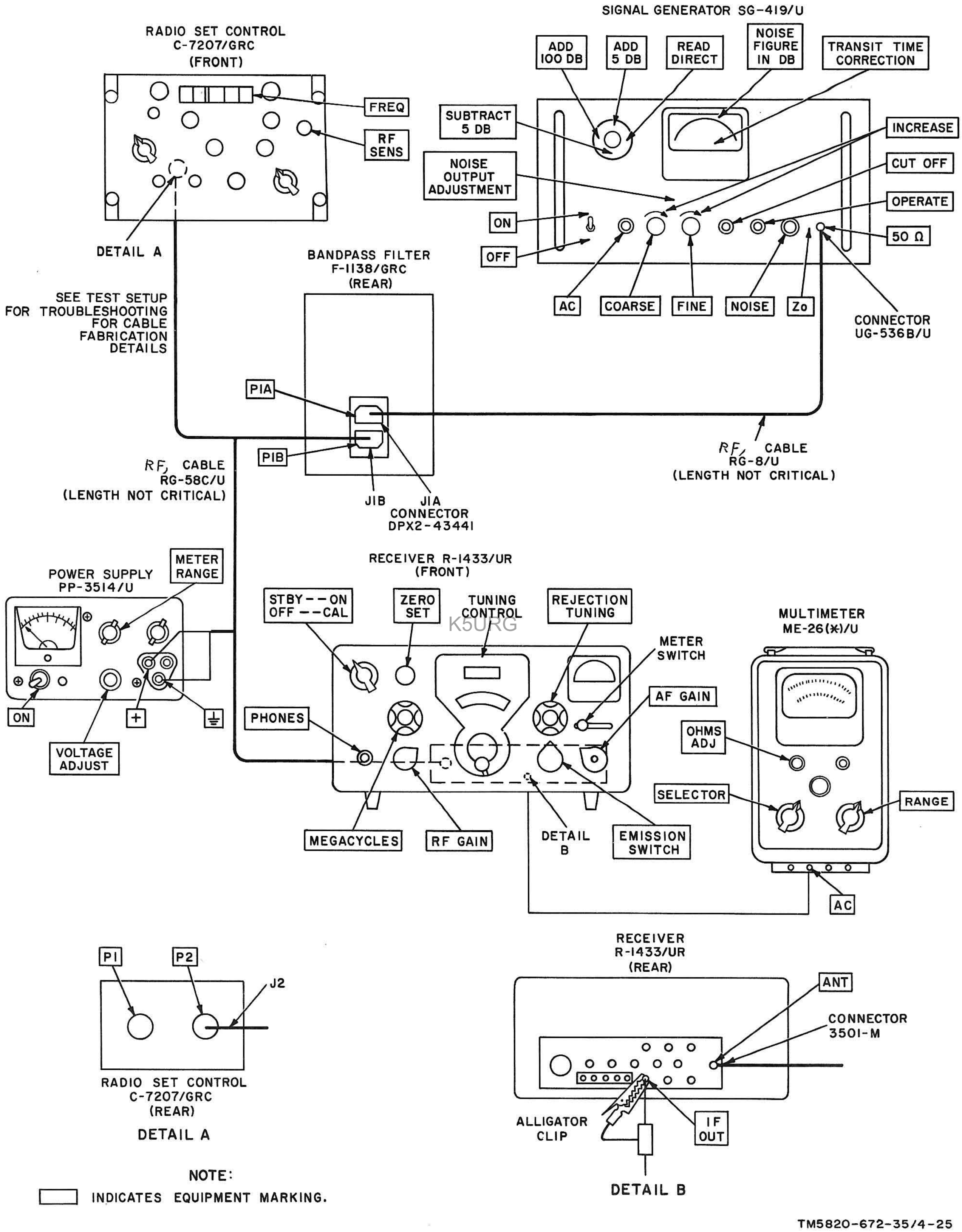


Figure 4-3. Sensitivity test connections.

4-9. Summary of Test Data

Personnel may find it convenient to arrange the checklist in a manner similar to that shown below.

1. Servo Operation

	Test Data	*Performance standard*
a. 3.000 MHz		Capacitor rotor plates are positioned to approximately one-half mesh with respect to stator plates.
b. 2.000 MHz		Capacitor rotor plates are positioned to approximately 9° from fully meshed with stator plates.
c. 3.999 MHz		Capacitor rotor plates are positioned to within approximately 9° from fully open position.
d. Tuning time back to 2.000 MHz position.		Less than 10 seconds at room temperature and less than 15 seconds cold.

2. Digital-Analog Converter Operation

	Test Data	*Performance Standard*
a. 1.0 kHz tuning		Switch A3S4 rotates to corresponding number on drive gear and capacitor C1 rotates slightly.
b. 10.0 kHz tuning		Switch A3S3 rotates to corresponding number on drive gear and capacitor C1 rotates slightly.
c. 100.0 kHz tuning		Switch A3S2 rotates to corresponding number on drive gear and capacitor C1 rotates slightly.
d. MHz tuning		Switch A3S1 rotates to corresponding number on drive gear and capacitor C1 and switch S1 on main chassis rotate.

3. Tracking and Bandpass Operation

	Test Data	*Performance Standard*
a. −1.0-db points		Difference between center frequency and each −1.0-db point is less than 3.0 kHz.
b. −2.0-db point		Difference between center frequency and each −2.0-db point is less than 6.0 kHz.

4. Gain

	Test Data	*Performance Standard*
a. Normal gain		Normal gain of filter is not more than 18 and not less than 6.

5. Sensitivity

	Test Data	*Performance Stdndard*
a. Noise figure		Noise figure is less than 10 db at 2.000 MHz and increases to not more than 17 db at 30.000 MHz.

CHAPTER 5
DEPOT OVERHAUL STANDARDS

5-1. Applicability of Depot Overhaul Standards

a. The tests outlined in this chapter are designed to measure the performance capability of a repaired equipment. Equipment that is to be returned to stock should meet the standards given in these tests.

b. Applicable procedures of the Army depots performing these tests and the general standards for repaired electronic equipment given in TB SIG 355-1, TB SIG 355-2, and TB SIG 355-3 form a part of the requirements for testing this equipment.

5-2. Test Procdures

a. The test equipment and power required for depot overhaul standards are the same as indicated in paragraph 4-2.

b. The operational tests for depot overhaul standards are the same as the tests given in paragraphs 4-4 through 4-8. Perform the tests in the order in which they are given, and observe that the results meet the minimum standard indicated in each test.

Figure 5-1. Color code marking for MIL-STD resistors, inductors and capacitors.
[Located in Back of Manual]

Figure 5-2. Bandpass Filter F-1138/GRC, block diagram.
[Located in Back of Manual]

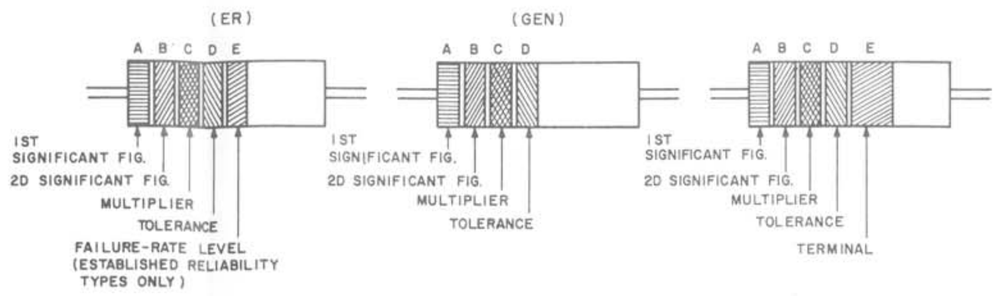
Figure 5-3. RF circuits, simplified schematic diagram.
[Located in Back of Manual]

Figure 5-4. On- or off-frequency protection circuits, simplified schematic diagram.
[Located in Back of Manual]

Figure 5-5. Frequency selection circuits, simplified schematic diagram.
[Located in Back of Manual]

Figure 5-6(1). Bandpass Filter F-1138/GRC, overall schematic diagram.
[Located in Back of Manual]

Figure 5-6(2). Bandpass Filter 1138/GRC, overall schematic diagram.
[Located in Back of Manual]



COLOR CODE MARKING FOR COMPOSITION TYPE RESISTORS.

COLOR-CODE MARKING FOR FILM-TYPE RESISTORS.

TABLE I
COLOR CODE FOR COMPOSITION TYPE AND FILM TYPE RESISTORS.

BAND A		BAND B		BAND C		BAND D		BAND E		
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)	COLOR	FAILURE RATE LEVEL	TERM.
BLACK	0	BLACK	0	BLACK	1			BROWN	M	
BROWN	1	BROWN	1	BROWN	10			RED	P	
RED	2	RED	2	RED	100			ORANGE	R	
ORANGE	3	ORANGE	3	ORANGE	1,000			YELLOW	S	
YELLOW	4	YELLOW	4	YELLOW	10,000	SILVER	±10 (COMP. TYPE ONLY)	WHITE	....	SOLDERABLE
GREEN	5	GREEN	5	GREEN	100,000	GOLD	±5			
BLUE	6	BLUE	6	BLUE	1,000,000	RED	±2 (NOT APPLICABLE TO ESTABLISHED RELIABILITY).			
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7							
GRAY	8	GRAY	8	SILVER	1.01					
WHITE	9	WHITE	9	GOLD	0.1					

BAND A — THE FIRST SIGNIFICANT FIGURE OF THE RESISTANCE VALUE (BANDS A THRU D SHALL BE OF EQUAL WIDTH.)

BAND B — THE SECOND SIGNIFICANT FIGURE OF THE RESISTANCE VALUE.

BAND C — THE MULTIPLIER (THE MULTIPLIER IS THE FACTOR BY WHICH THE TWO SIGNIFICANT FIGURES ARE MULTIPLIED TO YIELD THE NOMINAL RESISTANCE VALUE.)

BAND D — THE RESISTANCE TOLERANCE.

BAND E — WHEN USED ON COMPOSITION RESISTORS, BAND E INDICATES ESTABLISHED RELIABILITY FAILURE-RATE LEVEL. ON FILM RESISTORS, THIS BAND SHALL BE APPROXIMATELY 1-1/2 TIMES THE WIDTH OF OTHER BANDS, AND INDICATES TYPE OF TERMINAL.

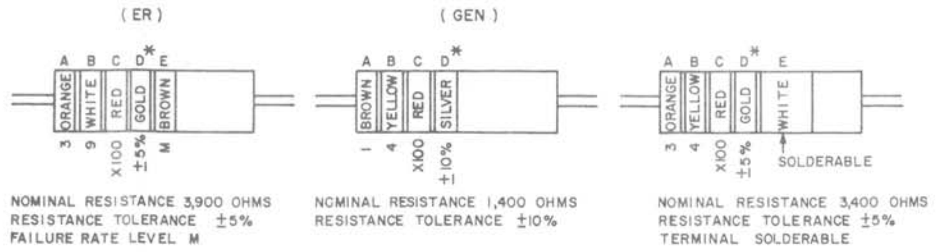
RESISTANCES IDENTIFIED BY NUMBERS AND LETTERS
(THESE ARE NOT COLOR CODED)

SOME RESISTORS ARE IDENTIFIED BY THREE OR FOUR DIGIT ALPHA NUMERIC DESIGNATORS. THE LETTER R IS USED IN PLACE OF A DECIMAL POINT WHEN FRACTIONAL VALUES OF AN OHM ARE EXPRESSED. FOR EXAMPLE:

2R7 = 2.7 OHMS   10R0 = 10.0 OHMS

FOR WIRE-WOUND-TYPE RESISTORS COLOR CODING IS NOT USED, IDENTIFICATION MARKING IS SPECIFIED IN EACH OF THE APPLICABLE SPECIFICATIONS.

EXAMPLES OF COLOR CODING



NOMINAL RESISTANCE 3,900 OHMS
RESISTANCE TOLERANCE ±5%
FAILURE RATE LEVEL M

NOMINAL RESISTANCE 1,400 OHMS
RESISTANCE TOLERANCE ±10%

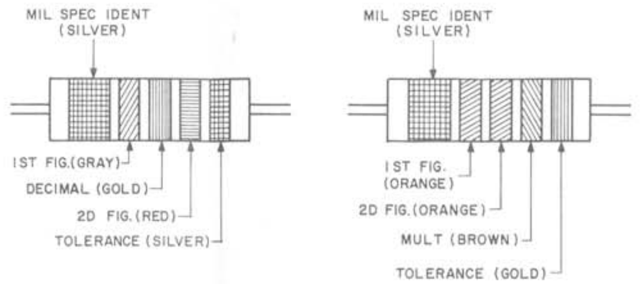
NOMINAL RESISTANCE 3,400 OHMS
RESISTANCE TOLERANCE ±5%
TERMINAL SOLDERABLE

COMPOSITION-TYPE RESISTORS

FILM-TYPE RESISTORS

* IF BAND D IS OMITTED, THE RESISTOR TOLERANCE IS ±20% AND THE RESISTOR IS NOT MIL-STD.

A. COLOR CODE MARKING FOR MILITARY STANDARD RESISTORS.



(A) 8.2UH ±10%

(B) 330UH ±5%

COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES. AT A, AN EXAMPLE OF OF THE CODING FOR AN 8.2UH CHOKE IS GIVEN. AT B, THE COLOR BANDS FOR A 330UH INDUCTOR ARE ILLUSTRATED.

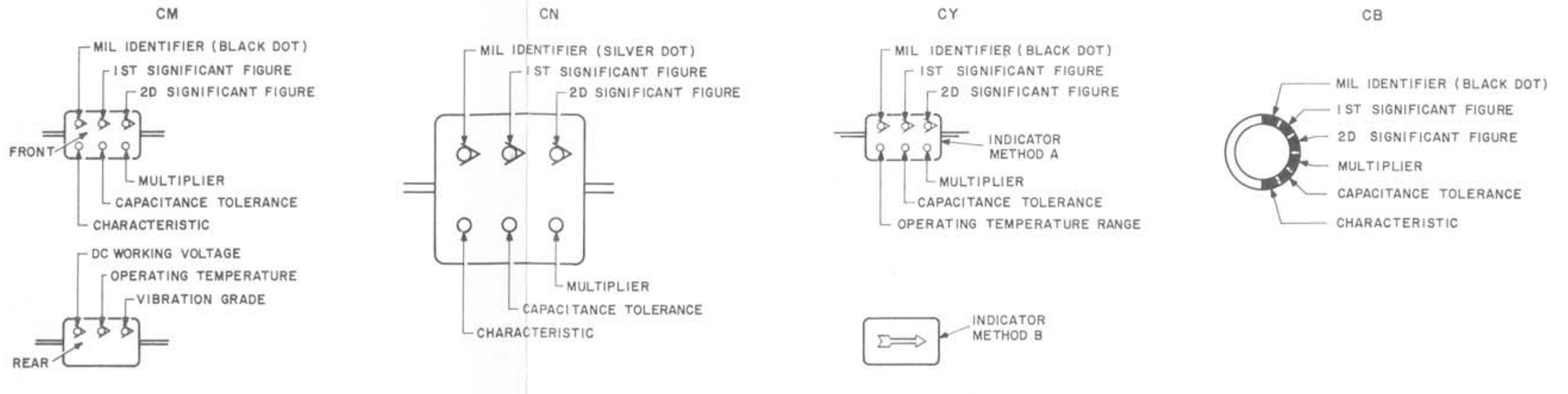
TABLE 2
COLOR CODING FOR TUBULAR ENCAPSULATED R.F. CHOKES.

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	INDUCTANCE TOLERANCE (PERCENT)
BLACK	0	1	
BROWN	1	10	1
RED	2	100	2
ORANGE	3	1,000	3
YELLOW	4		
GREEN	5		
BLUE	6		
VIOLET	7		
GRAY	8		
WHITE	9		
NONE			20
SILVER			10
GOLD	DECIMAL POINT		5

MULTIPLIER IS THE FACTOR BY WHICH THE TWO COLOR FIGURES ARE MULTIPLIED TO OBTAIN THE INDUCTANCE VALUE OF THE CHOKE COIL.

B. COLOR CODE MARKING FOR MILITARY STANDARD INDUCTORS.

CAPACITORS, FIXED, VARIOUS-DIELECTRICS, STYLES CM, CN, CY, AND CB.

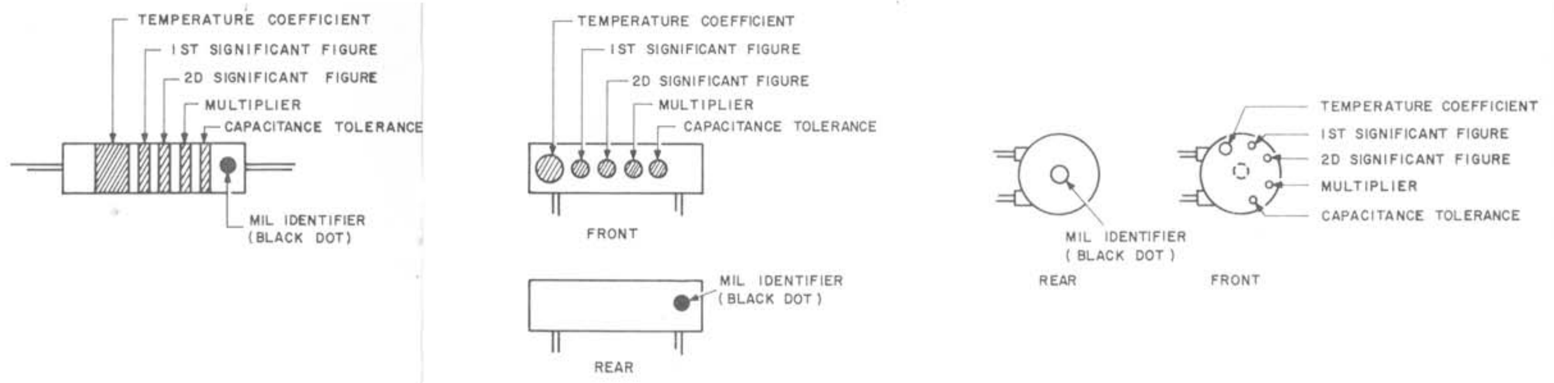


MICA-DIELECTRIC

PAPER-DIELECTRIC

GLASS-DIELECTRIC, GLASS CASE

MICA, BUTTON TYPE



AXIAL LEAD

RADIAL LEAD

DISK-TYPE

TABLE 3 — FOR USE WITH STYLES CM, CN, CY AND CB.

COLOR	MIL ID	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE				CHARACTERISTIC[2]			DC WORKING VOLTAGE	OPERATING TEMP. RANGE	VIBRATION GRADE
					CM	CN	CY	CB	CM	CN	CB	CM	CY, CM	CM
BLACK	CM, CY CB	0	0	1			±20%	±20%		A			$-55°$ TO $+70°C$	10-55 HZ
BROWN		1	1	10					B	E	B			
RED		2	2	100	±2%		±2%	±2%	C				$-55°$ TO $+85°C$	
ORANGE		3	3	1,000		±30%			D		D	300		
YELLOW		4	4	10,000					E				$-55°$ TO $+125°C$	10-2,000HZ
GREEN		5	5		±5%				F			500		
BLUE		6	6										$-55°$ TO $+150°C$	
PURPLE (VIOLET)		7	7											
GREY		8	8											
WHITE		9	9											
GOLD				0.1			±5%	±5%						
SILVER	CN				±10%	±10%	±10%	±10%						

TABLE 4 — TEMPERATURE COMPENSATING, STYLE CC.

COLOR	TEMPERATURE COEFFICIENT[4]	1ST SIG FIG.	2D SIG FIG.	MULTIPLIER[1]	CAPACITANCE TOLERANCE		MIL ID
					CAPACITANCES OVER 10 UUF	CAPACITANCES 10 UUF OR LESS	
BLACK	0	0	0	1		±2.0 UUF	CC
BROWN	−30	1	1	10	±1%		
RED	−80	2	2	100	±2%	±0.25 UUF	
ORANGE	−150	3	3	1,000			
YELLOW	−220	4	4				
GREEN	−330	5	5		±5%	±0.5 UUF	
BLUE	−470	6	6				
PURPLE (VIOLET)	−750	7	7				
GREY		8	8	0.01			
WHITE		9	9	0.1	±10%		
GOLD	+100					±1.0 UUF	
SILVER							

1. THE MULTIPLIER IS THE NUMBER BY WHICH THE TWO SIGNIFICANT (SIG) FIGURES ARE MULTIPLIED TO OBTAIN THE CAPACITANCE IN UUF.
2. LETTERS INDICATE THE CHARACTERISTICS DESIGNATED IN APPLICABLE SPECIFICATIONS: MIL-C-5, MIL-C-25D, MIL-C-11272B, AND MIL-C-10950C RESPECTIVELY.
3. LETTERS INDICATE THE TEMPERATURE RANGE AND VOLTAGE-TEMPERATURE LIMITS DESIGNATED IN MIL-C-11015D.
4. TEMPERATURE COEFFICIENT IN PARTS PER MILLION PER DEGREE CENTIGRADE.

C. COLOR CODE MARKING FOR MILITARY STANDARD CAPACITORS.

ESC-FM 4113-69

Figure 5-1. Color code marking for MIL-STD resistors, inductors and capacitors.

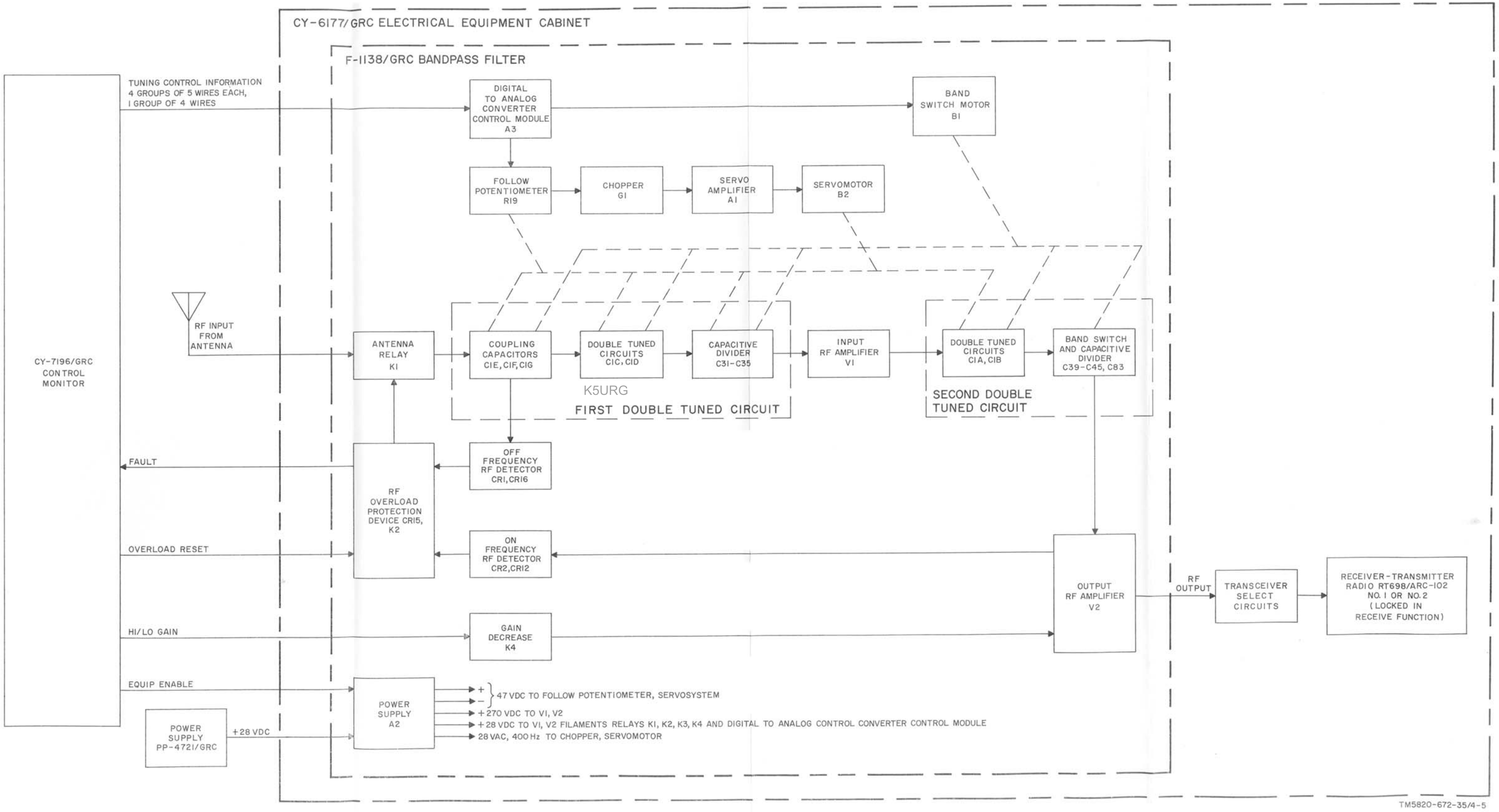


Figure 5-2. Bandpass Filter F-1138/GRC, block diagram.

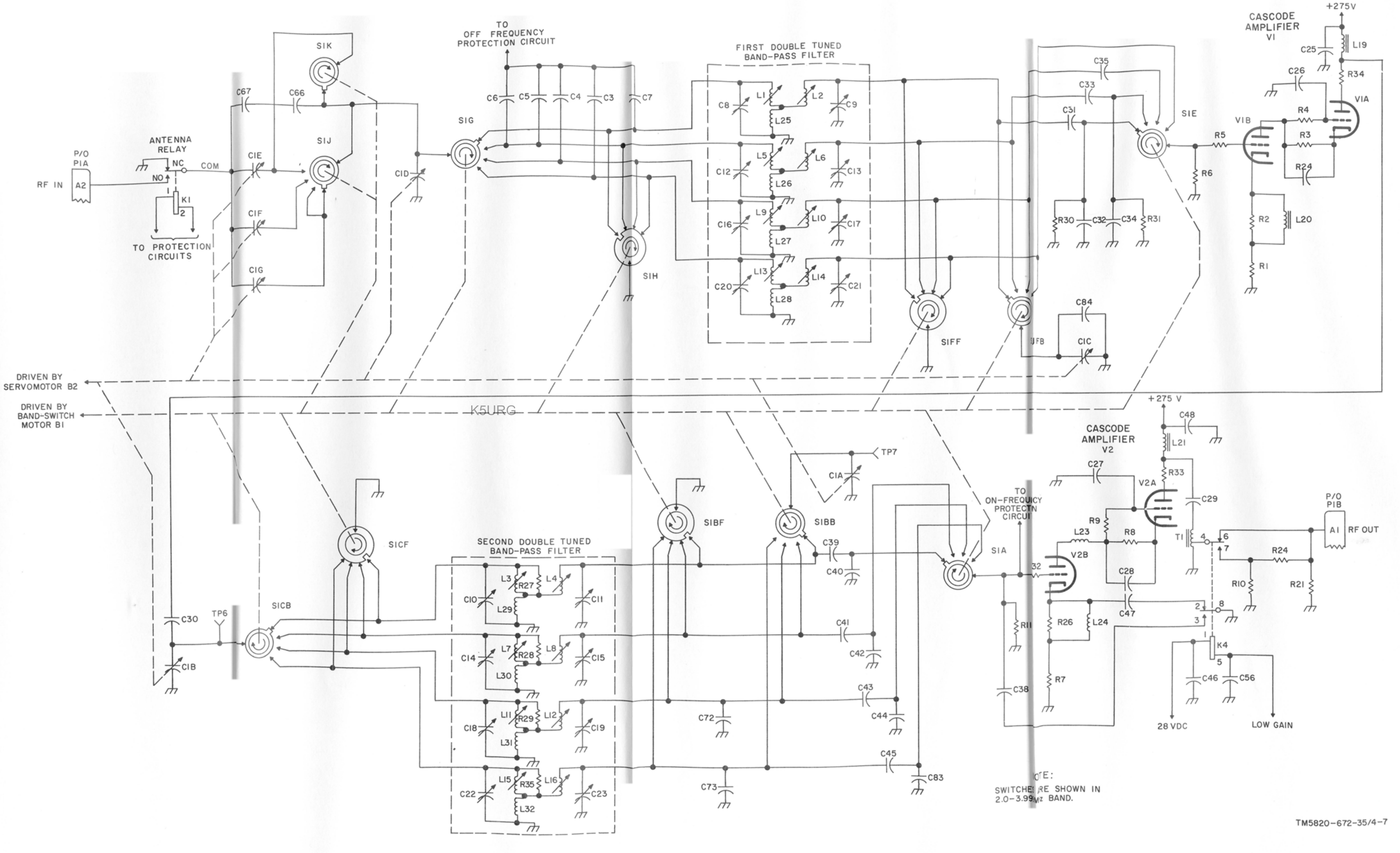


Figure 5–3. RF circuits, simplified schematic diagram.

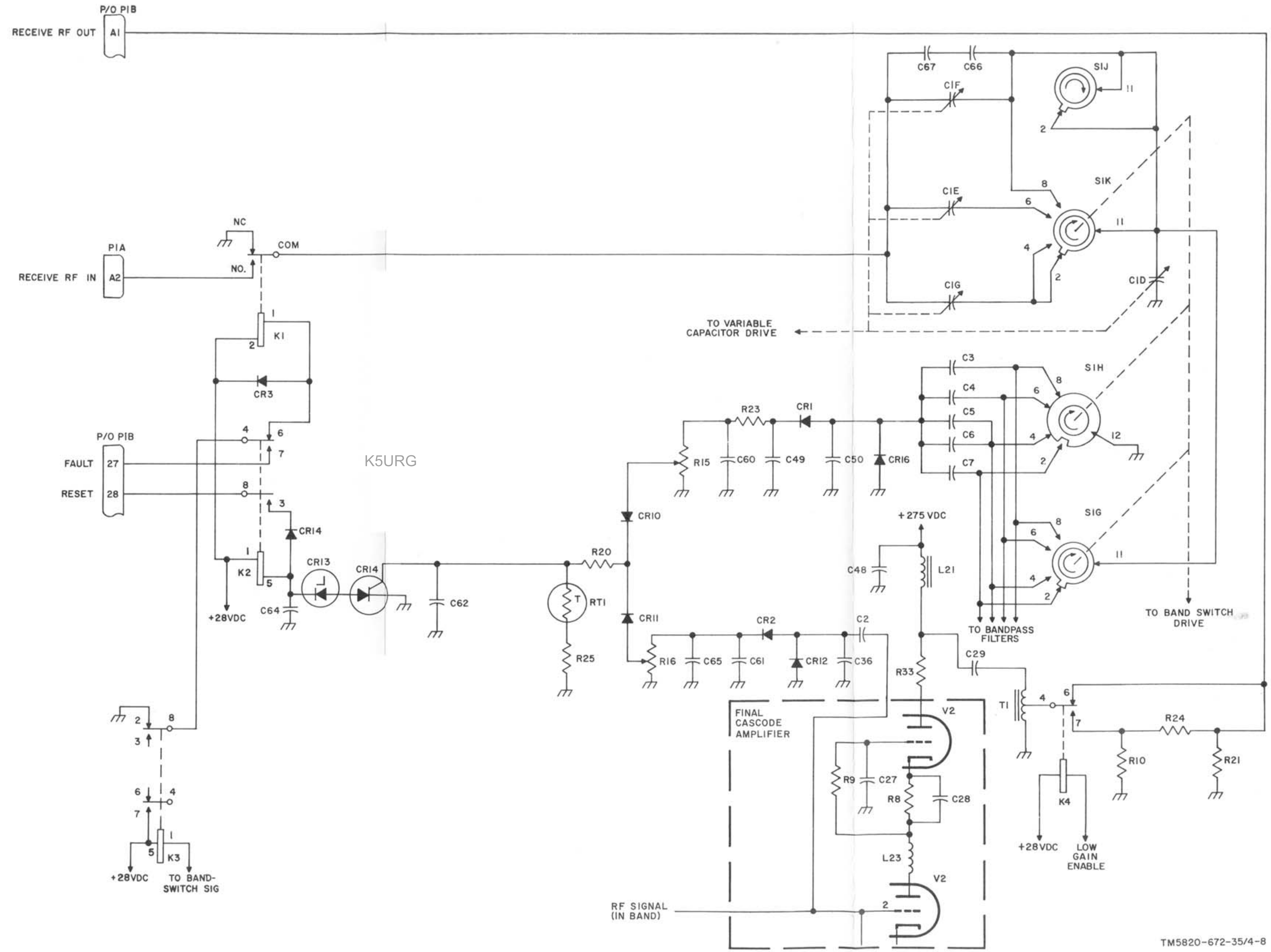


Figure 5-4. On- or off-frequency protection circuits, simplified schematic diagram.

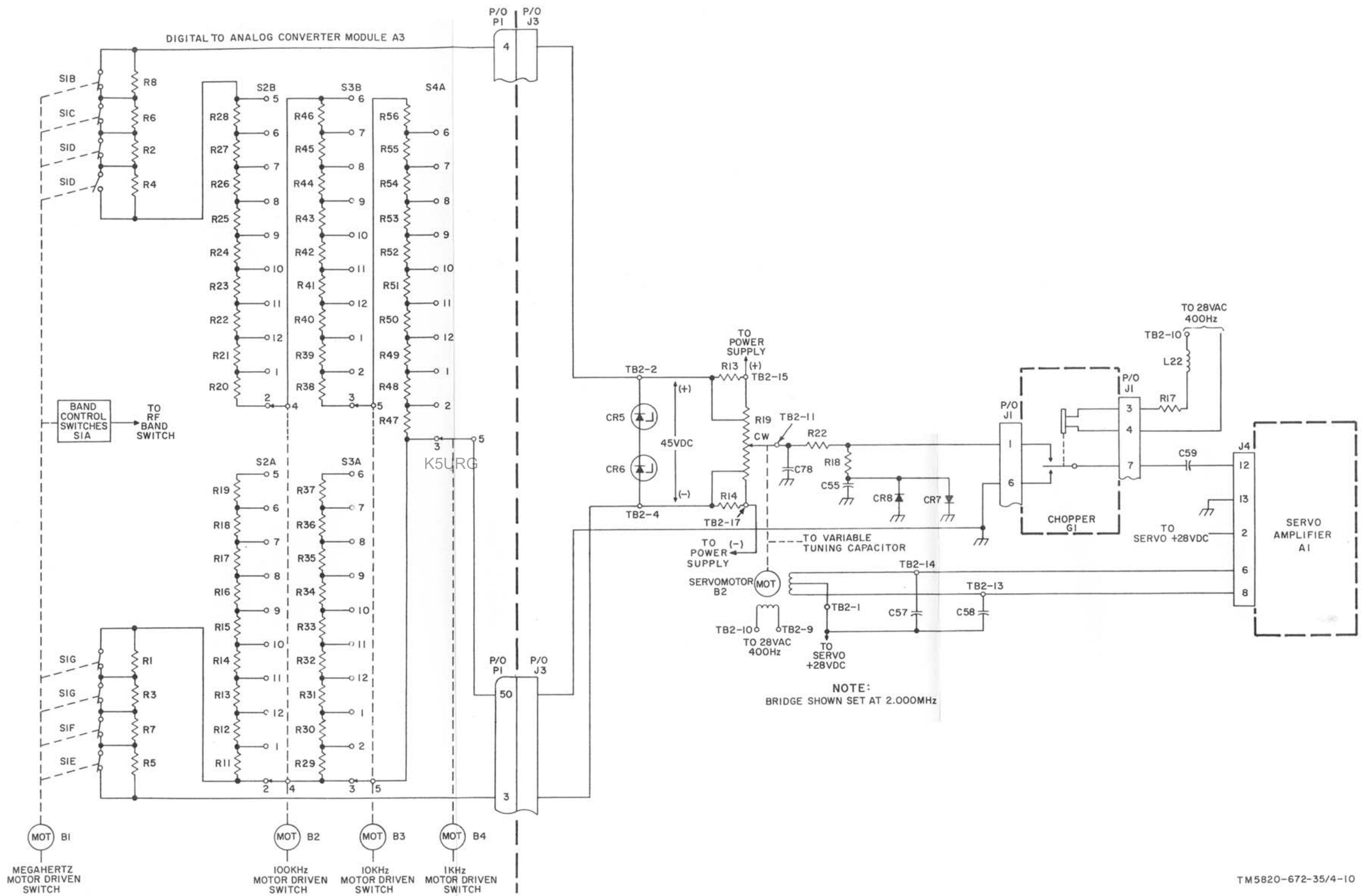


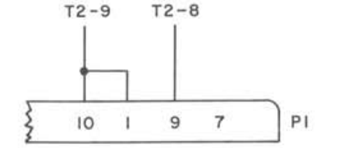
Figure 5-5. Frequency selection circuits, simplified schematic diagram.

Figure 5-6(1). Bandpass Filter F-1138/GRC, overall schematic diagram.

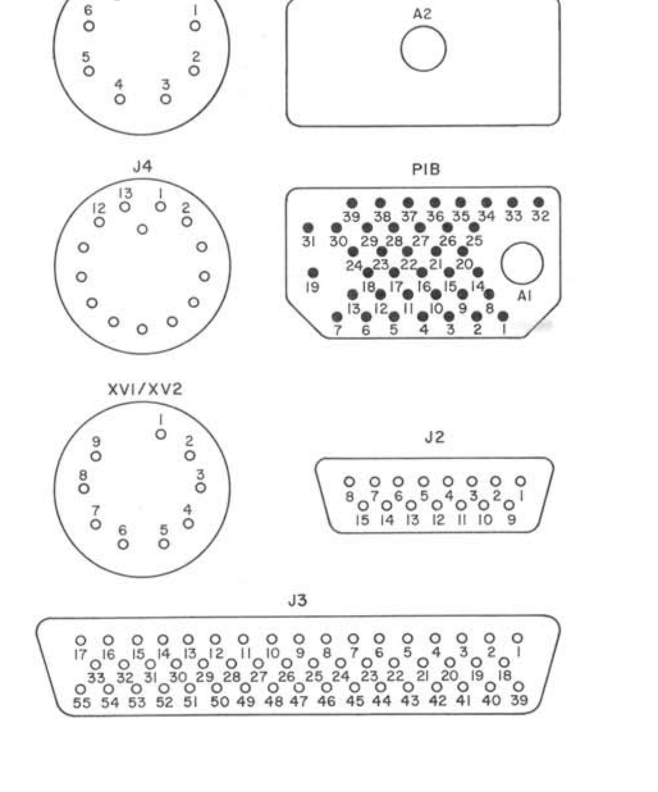
NOTES:

1. UNLESS OTHERWISE INDICATED, ALL RESISTANCE VALUES ARE IN OHMS, ALL CAPACITANCE VALUES ARE IN MICROMICROFARADS, AND ALL INDUCTANCE VALUES ARE IN MICROHENRYS.
2. ALL SWITCHES VIEWED FROM THE KNOB OR DRIVEN END AND SHOWN AT 2.0MC POSITION.
3. DETAIL A APPLIES TO COLLINS PART NUMBER 528-0527-000, MCN 429 AND BELOW.

DETAIL A



4. COLLINS PART NUMBER 768-3916-001 SHOWN (USED ON MCN 1270 AND SUBSEQUENT). FOR MCN 1269 AND BELOW, SEE SERVO AMPLIFIER (COLLINS PART NUMBER 270-2059-010), SCHEMATIC DIAGRAM.
5. CONNECTORS VIEWED FROM PIN OR RECEPTACLE SIDE.



TM5820-672-35/4-26 (2)

Figure 5-6(2). Bandpass Filter F-1138/GRC, overall schematic diagram.

APPENDIX A
REFERENCES

The following is a list of applicable references which are available to the DS, GS, and depot maintenance categories for the repairman of Bandpass Filter F-1138/GRC.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.
DA Pam 310-7	U.S. Army Equipment Index of Modification Work Orders.
SC-5180-91-CL-R07	Tool Kit, Electronic Equipment TK-105/G.
SC-5180-91-CL-S21	Tool Kit, Electronic Equipment TK-100/G.
TB SIG 355-1	Depot Inspection Standard for Repaired Signal Equipment.
TB SIG 355-2	Depot Inspection Standard for Refinishing Repaired Signal Equipment.
TB SIG 355-3	Depot Inspection Standard for Moisture and Fungus Resistant Treatment.
TM 11-5820-514-35	DS, GS, and Depot Maintenance Manual: Radio Set AN/MRC-95.
TM 11-5820-672-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Radio Sets AN/GRC-158 and AN/MRC-117.
TM 11-5820-672-35-1	DS, GS, and Depot Maintenance Manual: Cabinet, Electrical Equipment CY-6177/GRC.
TM 11-5820-672-35-2	DS, GS, and Depot Maintenance Manual: Control-Monitor Radio Set C-7196/GRC.
TM 11-5820-672-35-3	DS, GS, and Depot Maintenance Manual: Power Supply PP-4721/GRC.
TM 11-5821-248-12	Organizational Maintenance Manual: Radio Set AN/ARC-102.
TM 11-5821-271-15	Organizational, DS, GS, and Depot Maintenance Manual: Couplers CU-1658/A and CU-1669/GRC.
TM 11-6625-200-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Multimeters ME-26A/U, ME-26B/U, ME-26C/U, and ME-26D/U.
TM 11-6625-413-10	Operators Manual: Thermal Noise Generator SG-419/U.
TM 11-6625-537-15	Operator, Organizational, Field, and Depot Maintenance Manual: Differential Voltmeter ME-202/U.
TM 11-6625-573-15	Operator, Organizational, DS, GS, and Depot Maintenance Manual: Signal Generator AN/GRM-50.
TM 11-6625-610-15	Organizational, DS, GS, and Depot Maintenance Manual: Voltmeter, Electronic ME-227/U.
TM 11-6625-617-12	Organizational Maintenance Manual Including Repair Parts List: Power Supply PP-3514/U.
TM 11-6625-683-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual: Signal Generator AN/URM-127.
TM 11-6625-700-10	Operator's Manual: Digital Readout, Electronic Counter AN/USM-207.
TM 38-750	The Army Maintenance Management System (TAMMS).

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