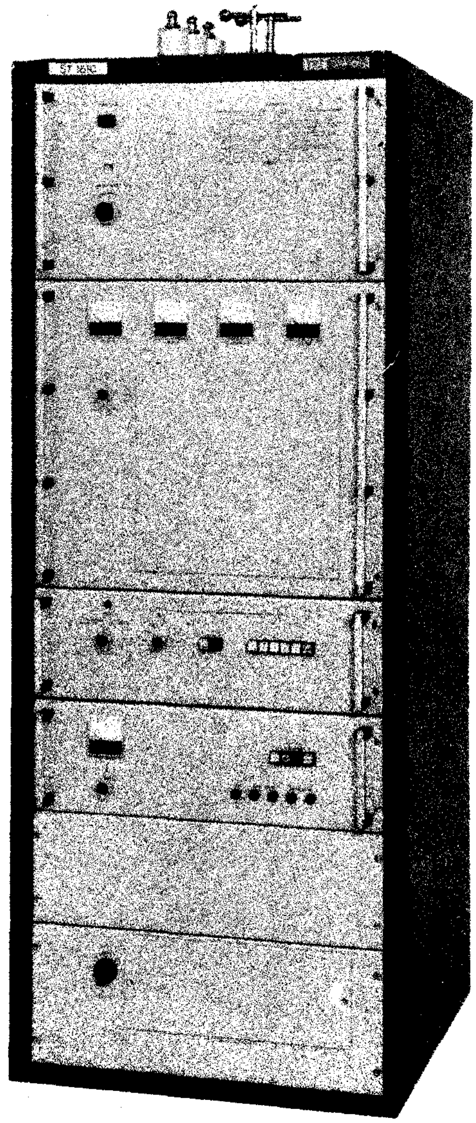

Radio Transmitter ST 1610A

Technical handbook

Manual no. B 22100 1000

ITT Marine

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

This technical manual describes ITT Marine SSB Radio Transmitter type ST1610. Information is provided to allow qualified service technicians to maintain and repair the equipment, and advices about routine maintenance, which may be performed by the radio operator.

A special chapter deals with installation and commissioning, to aid in radio station planning and advices of procedures for the initial tuning-up of the equipment.

This technical manual covers the transmitter in general, with power supplies and power amplifier. Due to the relative complexity of the exciter drive unit, a separate technical handbook will be provided, bound together with this manual.

1.2 GENERAL DESCRIPTION

The ST1610 transmitter is a general purpose marine radio transmitter for telegraphy and single sideband telephony in marine MF and HF bands. The frequency bands covered are in the range 400 kHz to 26 MHz.

The transmitter is founded on the well-proven technique of its predecessor, the ST 1400C equipment, and from there many circuits have been adopted more or less in original state. Others have been improved or re-packed. For example, the frequency generation scheme is still the same, only that in ST 1610 the frequency synthesizer is responsible for all MHF and HF channels, irrespective of class of emission. Redundancy may be obtained through the utilization of the optional AI telegraphy quartz crystal oscillator, which is part of the ordinary exciter.

The incorporation of auto-tuning devices accounts for new ease in operation and practically limits the task of the operator to select frequency, emission and output power level. The servo-operated controls ensure accurate and fast tuning of the transmitter.

Another consequence of the auto-tuning facility is that remote control of the equipment is within easy reach. To arrive at remote control, the exciter (then on a 19 in. panel) is located at the Operator's desk and the transmitter cabinet in the transmitter room, which should be in close vicinity to the antennas. If desired, local operation on MF from the transmitter room can be offered, using the MF Local Control panel.

All units are housed in one steel cabinet, with the possible exception of the remotely located exciter unit. From top to bottom, units are:

- Antenna selector – for two antennas, main and reserve transmitters, and including MF and HF dummy loads. The switch shares the compartment with the MF variometer.

- Power amplifier – with broad-banded solid state driver, four vacuum tubes type 4CX250B in the final amplifier and servomotor operated Band, Tune and Load controls for matching.

- Exciter unit – deriving all channels on MHF/HF from a reference oscillator for excellence in frequency stability, processing the intelligence signals applied and modulating same on the desired output frequency.

- Low Tension Power supply — feeding all circuits with stabilized or unstabilized voltages, and including ac control circuits and final amplifier screen grid voltage (Vg2) stabilizer.

- Card Rack — a package for plug-in pc cards, engaged in MF Generation (via quartz crystals) and in the servo systems.

- HT power supply — in the cabinet rear, delivers 2000 V dc for the anodes of the final amplifier, supplies the Vg2-regulator 1000 V for subsequent stabilization to 350 V.

- Fuse Compartment — behind lowest panel, with terminal boards for mains, external cables and mains voltage adaptation, equipment fuses and fuses for external ac loads, main switch for disconnecting the radio station.

1.3 SPECIFICATIONS

Refer to table 1.1 for specification of technical data.

GENERAL	Power Supply	Three phase AC, 50 – 60 Hz – 3 x 220 V without neutral or – 3 x 380 V with neutral
	Mains voltage or frequency variation	± 10 %
	Power Consumption	Max. 3 kVA, power factor 0.9
	Temperature Range & Environmental Conditions	– 10^{o} C to + 55^{o} C + 40^{o} C/95 % relative humidity
	Physical Dimensions	H1750 x W650 x D 528 (+35)
	Weight	230 kg

Table 1.1 - PERFORMANCE SPECIFICATION

TRANSMITTER	Frequency Range	MF	405 – 525 kHz
		MHF	1.6 – 3.8 MHz
		HF	4, 6, 8, 12, 16, 22 and 25 MHz marine mobile bands
	Number of Channels	MF	7, crystal controlled
		MHF/HF	Synthesized channels, in steps of 100 Hz, for telephony and telegraphy
		HF telegraphy	4 – 25 MHz: Up to 4 crystal controlled channels in each band
	Types of Emissions & Frequency Tolerance	MF	A1, A2H – better than ± 50 ppm
		MHF/HF telephony & telegraphy	A1, A3H, A3A and A3J – long term better than 100 Hz, – short term typically 5 Hz
		HF telegraphy	A1 – better than ± 50 ppm
	Carrier Levels	A3H	– 5 ± 1 dB
		A3A	– 16 ± 2 dB
		A3J	below – 45 dB
	Spurious Suppression		better than 50 dB
	Output Power	MF A1	400 W Pm
		A2H	600 – 800 W Pp
		MHF/HF A1	1200 W Pm (MHF 400 W max.)
		A3H/A3J	1500 W Pp (MHF 400 W max.)
	Intermodulation (2-tone test)		less than – 25 dB, all power levels
	Power Levels		5 levels, steps of approx. 5 dB
	Antenna Impedance		tunable to all normal ship's antennas
	Keying Speed		50 Baud (approx. 60 words per minute)
	Audio Inputs		50 ohm (carbon micr.) 600 ohm line, + 0 to – 20 dbm
	Alarm Signal Generator		included
	Retuning Period		between bands max. 15 s inband max. 5 s

Table 1.1 - PERFORMANCE SPECIFICATION, continued

CHAPTER 2

INSTALLATION

2.1 GENERAL

In order to provide for effective results, the transmitter with antennas and associated equipments must be installed properly. The paragraphs below outline requirements for proper installation and inform about material and procedures. Observe precautions and suggestions in the paragraphs to ensure that your installation will provide troublefree and efficient operation.

2.2 UNPACKING AND INSPECTION

The transmitter with subunits is usually shipped in two containers. Remove the equipment from the shipping containers. Inspect carefully for signs of damage. If any is evident, save the packing material and notify the carrier immediately.

Then check the equipment to ascertain that the desired channels are installed and that the correct options (if any) have been supplied.

2.3 SITING

2.3.1 GENERAL

The planning of a radio station employing the auto-tuned transmitter ST 1610 gives a choice between local control and remote control. The two alternatives will be discussed below.

Irrespective of how the control of the transmitter is executed, the following rules apply

- The radio equipment should be located in heated and well ventilated rooms, where it is readily accessible and protected from splashwater.

- The distance from antenna lead-ins to the transmitter must be kept as short as possible, preferably less than 2 meters

- Bring antennas to the transmitter as straight as possible, and avoid the use of trunks for the downlead.

- Provide adequate space for access to the subunits of the transmitter in their withdrawn positions, to enable adjustments to be carried out Especially for the Power Amplifier access to both sides of the chassis must be observed Following minimum distances should be provided under all circumstances

Cabinet top to ceiling	– 125 mm min
Cabinet front, for unit withdrawal	– 600 mm
Power amplifier chassis, left side	– 400 mm
right side	– 100 mm

- Unobstructed ventilation must be provided In the transmitter room it is recommended to incorporate means to extract the hot air from the transmitter top.

2.3.2 LOCAL CONTROL

The term »local control» is used to denote the case where the transmitter cabinet houses all sub-units, and thus operation is carried out from the site of the transmitter cabinet.

Figure 2.1 (B06105 1113 4) shows the general arrangement of a local control installation It is assumed that all information control circuits are brought to a Distribution Panel (in this drawing ITT Marine type B20610)

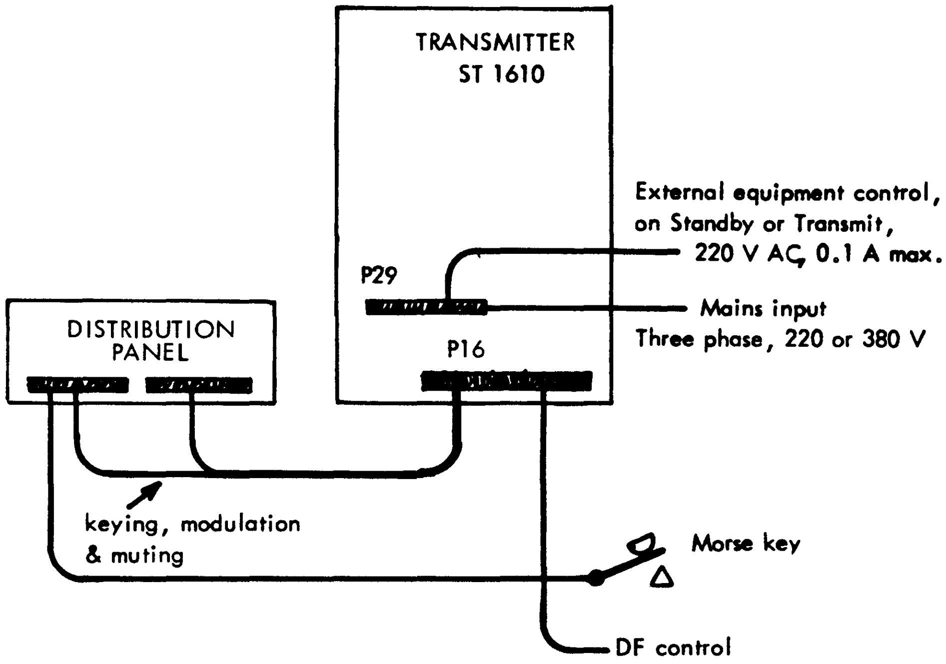


Figure 2.1 - ST 1610 LOCAL CONTROL

As can be seen, there is no need for any special control cables to the transmitter. Use the 220 V AC outputs which become energized on STANDBY and TRANSMIT, respectively, for external relays or contactors to control external devices, such as community antenna amplifiers, an exhaust blower or others.

2.3.3 REMOTE CONTROL

The term »Remote Control» denotes the case where the Exciter sub-unit has been removed from the transmitter cabinet. Instead the exciter — then fitted with a 19" panel — is located in a radio console which constitutes the workbench of the operator. The transmitter itself may be installed in the same room or further away in a transmitter room with direct access to antennas.

Figure 2.2 (B06105 1111 3) shows the equipment and wiring plan in this case. For convenience, the Exciter and associated Remote Control Panel should be installed in a Radio Console together with receivers, distribution panel and other equipment. Two multicore cables (a common type has 37 cores) and one coaxial cable are required between the two sites.

For the coaxial cable, type RG58 may be employed for lengths up to 15 meters. Up to 50 meters, type RG-213 (RG-8) is adequate and to 100 meters the thicker cable type RG17 has to be employed. In the event that RG213 or RG17 are installed, between-systems adaptor plugs/ sockets should be mounted where the cable enters the Radio Console. The part of the cable that finally plugs to the exciter must be RG58 for connector reasons.

The multicore cable type recommended is adequate for up to 100 meters cable runs. When laid, the need of protection against mechanical damage must be observed.

When the transmitter is installed in a remote transmitter room, local MF operation can be catered for by installing the MF Local Control Panel in the space normally reserved for the Exciter. This gives full command of the MF Transmitter facilities from the cabinet and with a suitable receiver added a reserve operation room is obtained. The possible addition of this panel will not interfere with the wiring diagram in figure 2.2.

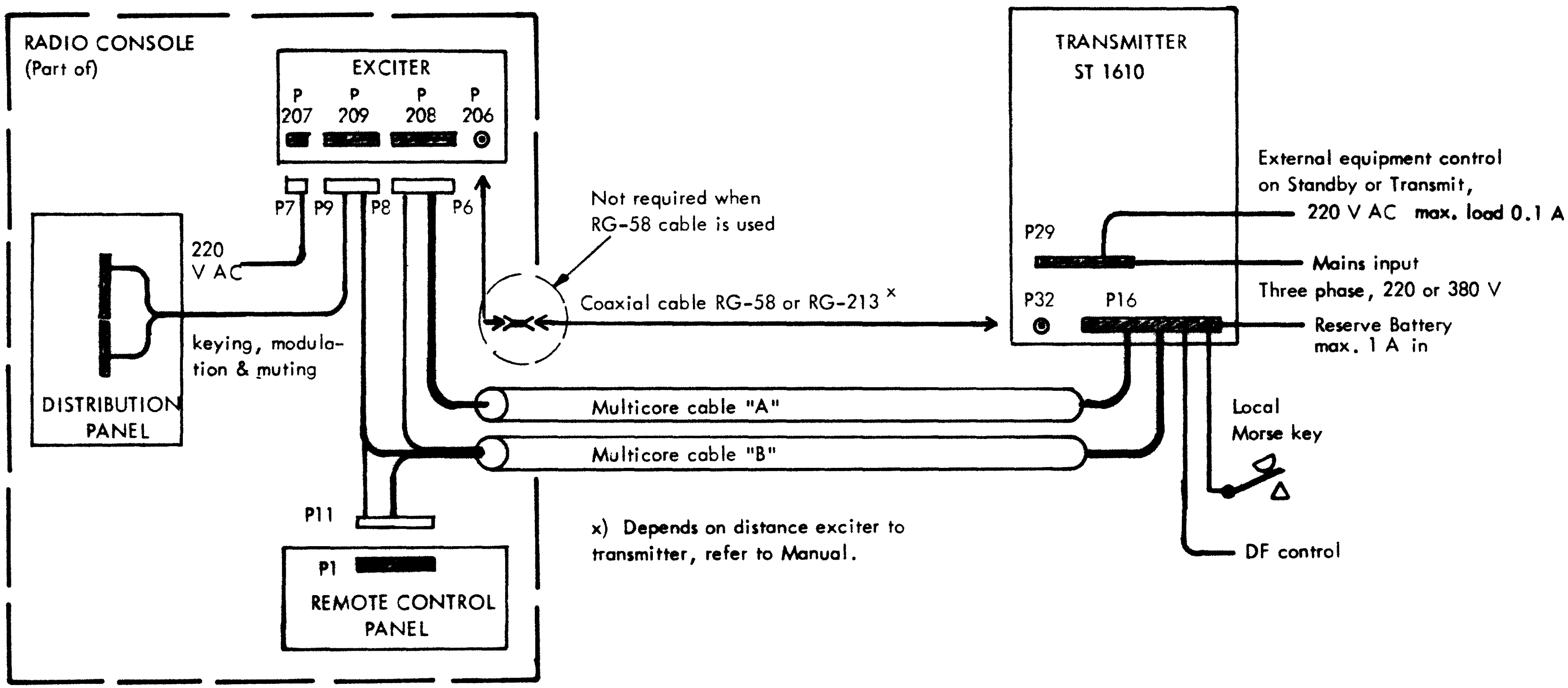


Figure 2.2 - ST 1610 REMOTE CONTROL

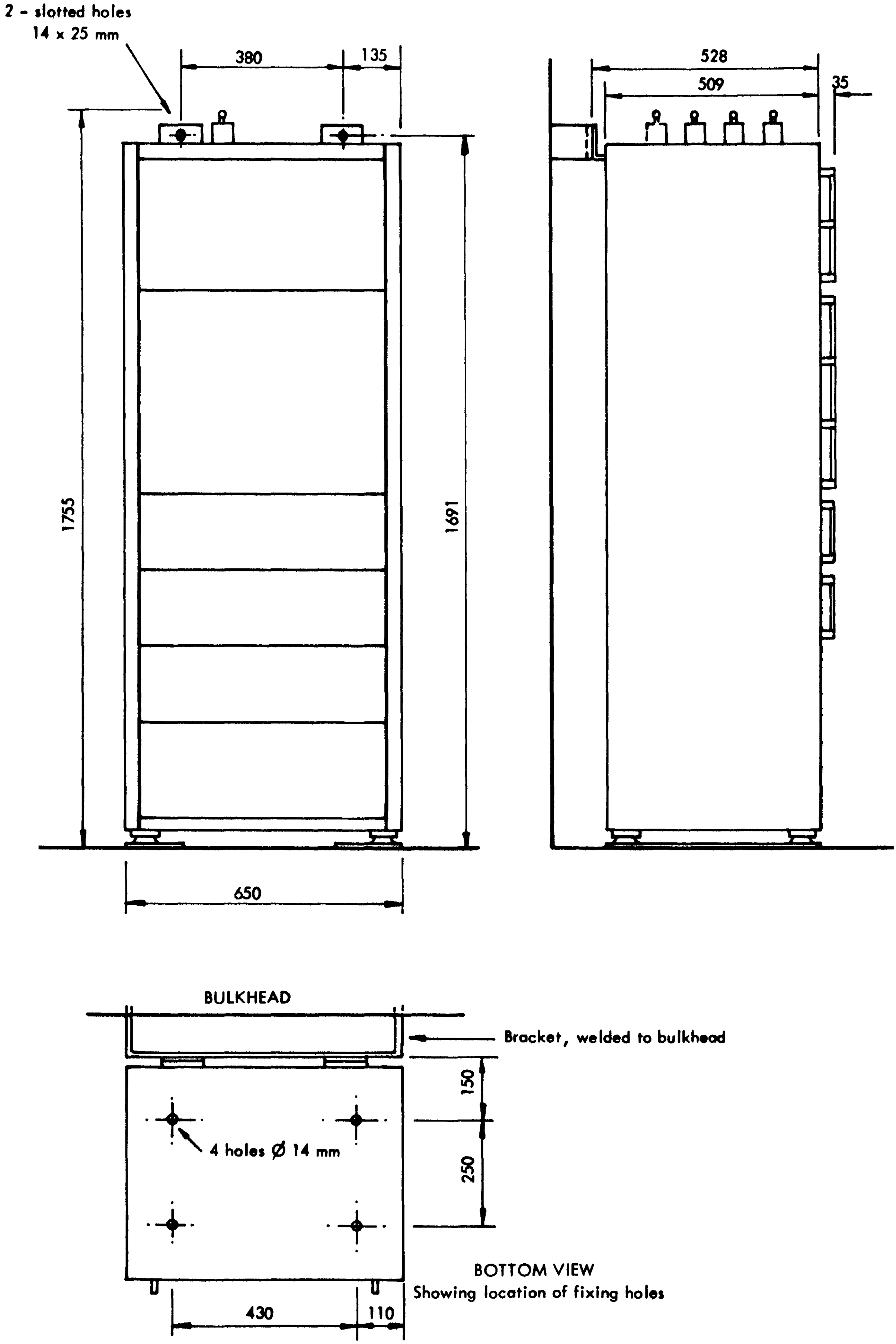


Fig. 2.3 - OUTLINE DIMENSIONS - Transmitter Cabinet

2.4 MOUNTING

Outline dimensions are given in figure 2.3 (B06105 1110 3) for the transmitter cabinet and in figure 2.4 for the exciter and remote control panel. These two units are on 19 in. panels, the exciter panel height is 4 panel units and the control panel height is 2 units.

Figure 2.3 indicates a suitable way to fix the cabinet top to a bulkhead-welded bracket, matching the top shock absorbers. This same bracket is a convenient termination for the copper ground strip, which is installed in the cabinet, and with one top and one bottom tail coming out of the case (refer to paragraph 2.5.1).

Against the deck, a plinth or pedestal could conveniently be arranged, to correct for camber and raise the base to desired level. Four bolts are to be employed, using the 14 mm diameter holes shown in figure 2.3.

The weight of the equipment, including exciter unit, is 230 kg. The exciter accounts for about 20 kg.

2.5 EXTERNAL CONNECTIONS

2.5.1 GROUNDING

Connect the cabinet to ground using copper strip 120 to 150 mm wide, about 1 mm thick. Install one from the bottom of the cabinet to the earth stub arranged in the deck, and one from the top of the cabinet to the welded upper bracket of the bulkhead. Note that the transmitter cabinet is fitted with this copper strip, and tails are usually of adequate length to be clamped directly to the stubs or equivalent. Refer to figure 2.5 for details of design.

The grounding should never be conceiled, but be readily available for inspection.

2.5.2 MAINS CONNECTION

Refer to figure 2.6 for details of mains connections. The procedure to switch mains voltage is described on the same figure – the transmitter is normally delivered for 3 x 220 V AC.

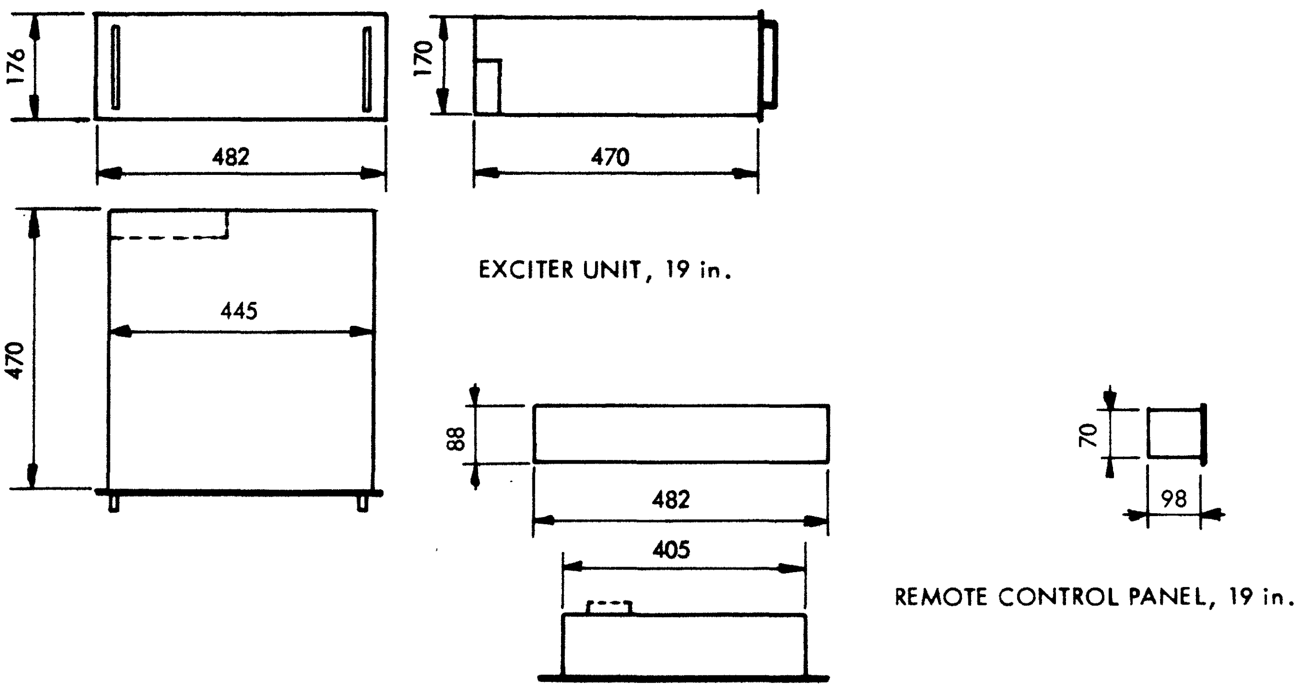
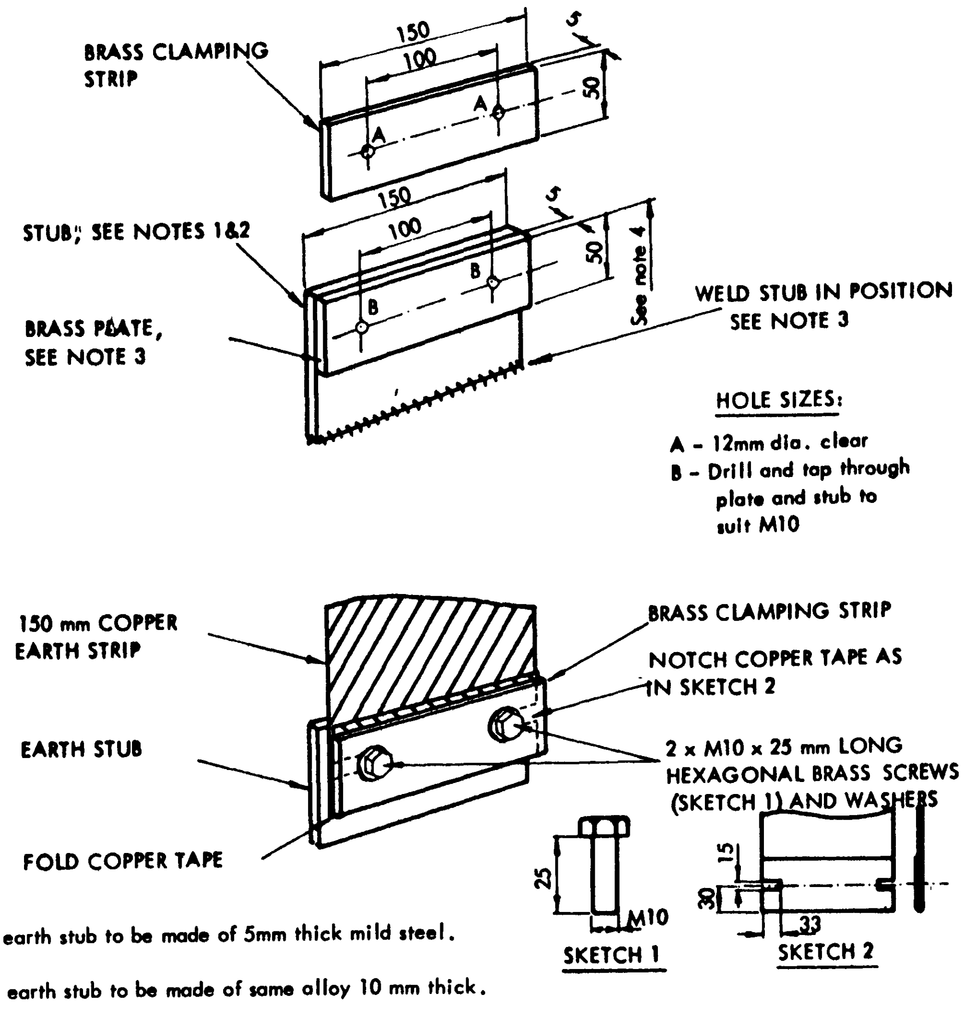


Fig. 2.4 - OUTLINE DIMENSIONS - Exciter & Remote Control Panel

It is recommended in all circumstances to install an isolating transformer for feeding the radio equipment. This measure will efficiently reduce the amount of interference, and is often required to transform the mains voltage of the ship to a voltage, which is suitable for the radio equipment.

When connected to three phase 220 V (phase-to-phase) the neutral is not required in the transmitter. If, however, 3 x 380 V (phase-to-phase) is available, the neutral must be provided from the supply (transformer) because single phase loads are 220 V and switched between phase and neutral.

The adaptation to different mains voltages is made on two units: the HT transformer primary and screw terminal board P29, where the mains supply enters. The exciter unit – if operated on its own – is to be fed 220 V AC.



NOTES:

1. For steel decked vessels earth stub to be made of 5mm thick mild steel.
2. For alloy decked vessels earth stub to be made of same alloy 10 mm thick.
3. Brass plate must be brazed to stub before welding stub in position (not required with alloy stub).
4. When fitted to deck, top edge of stub must be minimum of 50mm above deck covering.
5. Copper earth strip only supplied by ITT, all other items shipyard supply.
6. Do not paint.

Figure 2.5 - GROUND BOLT

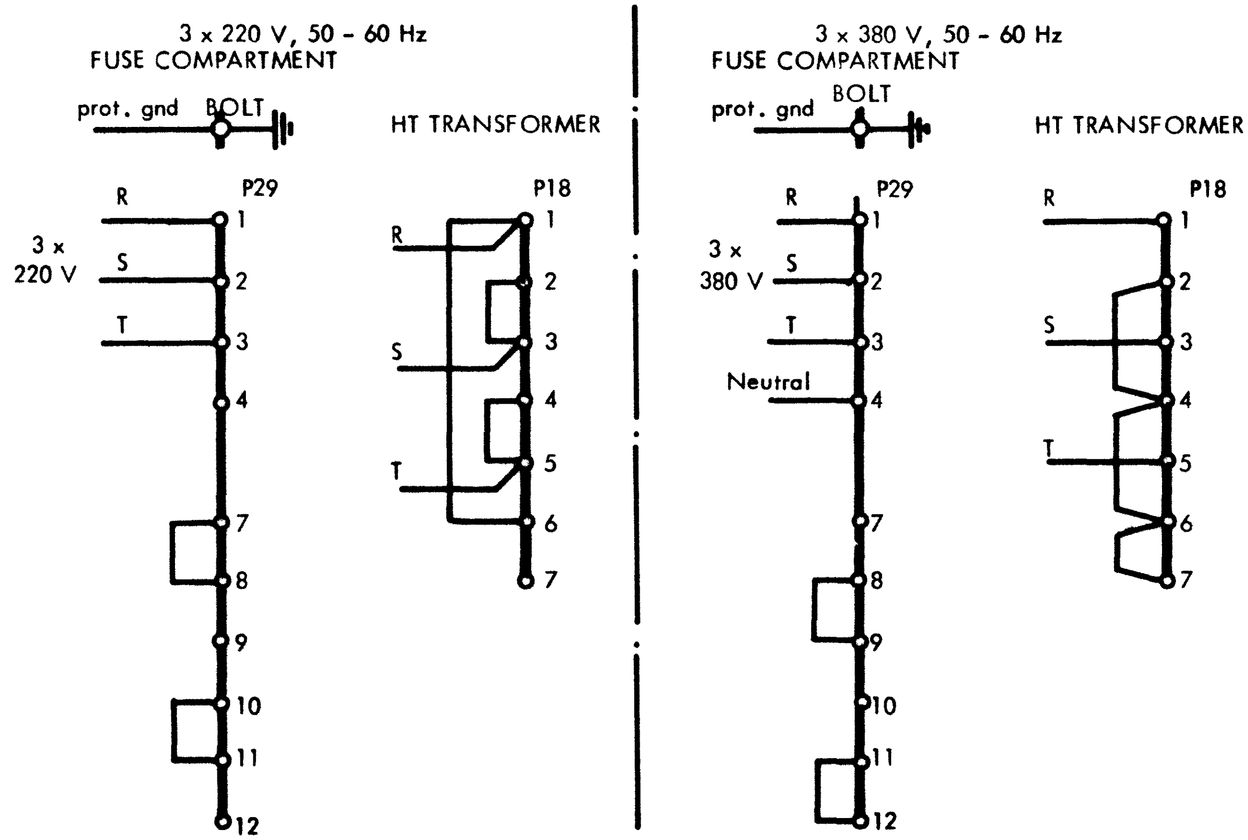


Figure 2.6 - MAINS VOLTAGES

When the transmitter is installed in a separate location and remotecontrolled from the radio operation control room, the mains supply from the station transformer to the control room equipment might be arranged:

- either via the transmitter main switch and fuses F7–F10
- or directly from the transformer to a distribution box, equipped with a main disconnector switch and fuses to protect the different loads.

In the second network the transformer feeds the transmitter room in parallel with the control room and every location is fitted with a disconnector switch of its own.

Cable areas, for different length of cable and supply voltages, are indicated in table 2.1. They are based on a 2% voltage drop at full load, and includes additional loading from commonly employed radio equipment, fed from the transmitter fuse panel. Fuse ratings to go with voltages are included in table 2.1.

Mains voltage	Fuse ratings type DII slow blow F1–F3	F4–F6	Rec. max. length vs area 2.5 sq mm	4 sq mm
3 x 220 V	16A	4A	70 m	110 m
3 x 380 V	10A	4A	200 m	350 m

Table 2.1 Fuse and cable ratings

2.5.3 LOCAL CONTROL CABLES

Local control cables are given in figure 2.7 (B06105 1114 4). The distribution panel shown is ITT Marine type B20610, and note that FS and 600 ohm line are options, not derived from the panel. The connection field of the panel will, however, suffice to connect these functions, if provided.

2.5.4 REMOTE CONTROL CABLES

Refer to figure 2.8 (B06105 1112 3) for the remote control cables. The distribution panel is as in 2.5.3 above. Mains supply to the exciter is taken from 220 V single phase, in the Radio Console employed.

Material required or recommended for the remote control installation is detailed on Parts List B06105 1115 (table 2.2).

It is recommended to include the Test Key facility when fitted, to enable keying the transmitter on full power from the transmitter room. When the Remote Control Panel is equipped with "traffic lights", the additional leads should be connected as well.

Control cable screens should be grounded at the transmitter end or else in such a way that vagabonding rf currents do not interfere with the operation over the full range of frequency bands.

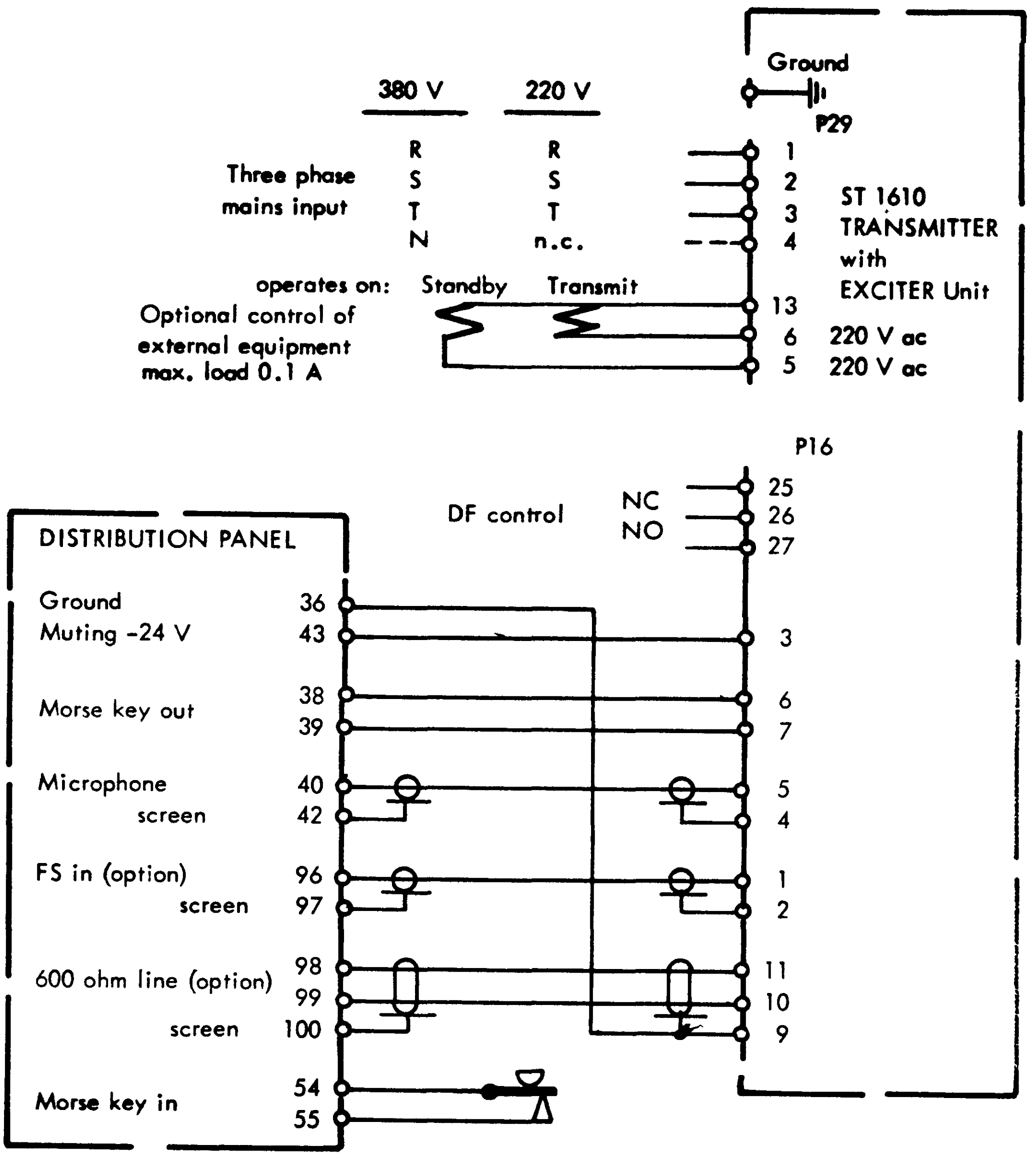


Fig. 2.7 - LOCAL CONTROL - Interunit Wiring Diagram

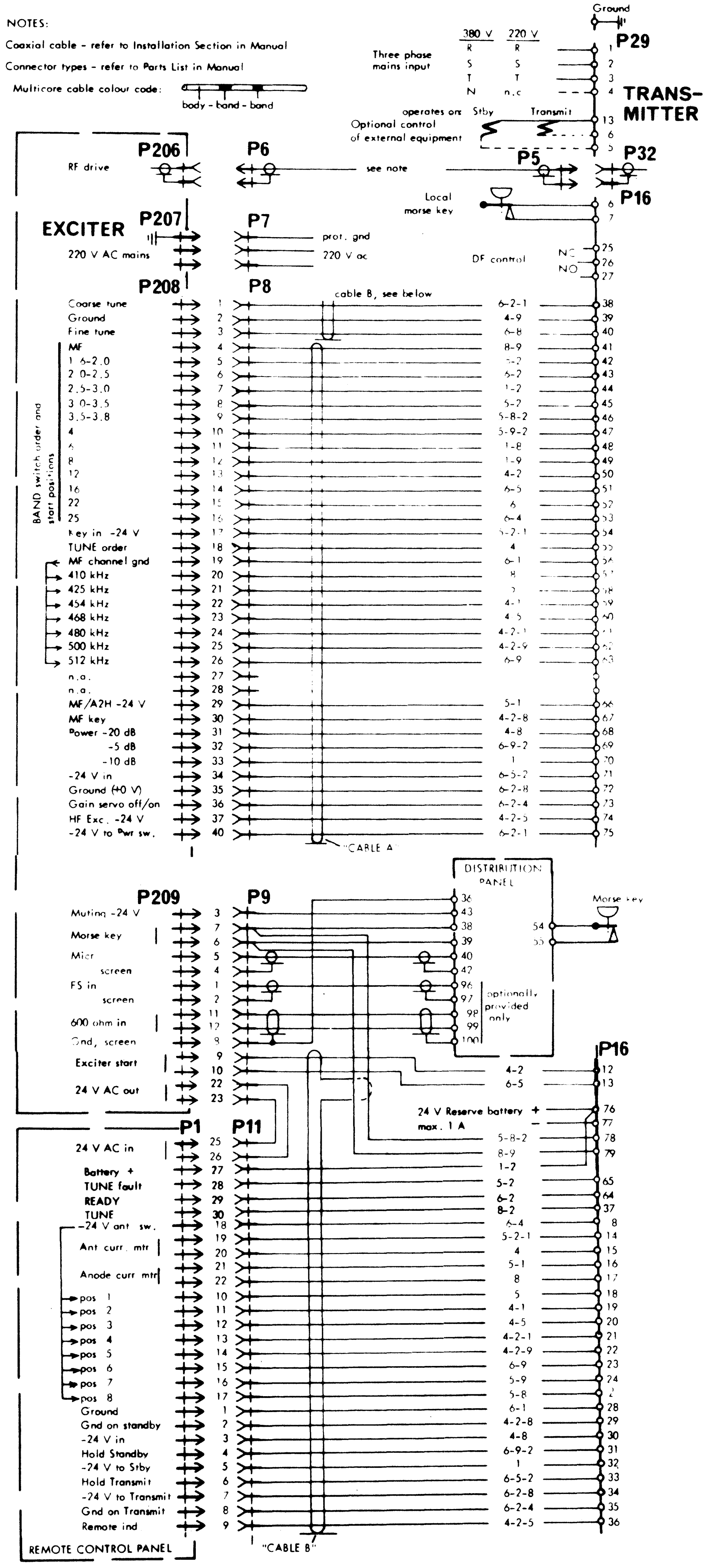


Fig. 2.8 - REMOTE CONTROL - Interunit Wiring Diagram

2 - 10 not assigned

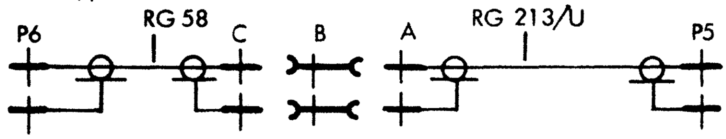
Design	Specification	Type, Manufacturer	Part No.
P5	Connector, coaxial, for RG 58 with Reducing adapter	PL–259/A UG–175/U	8600 1307 8600 0363
P6	Connector, coaxial, for RG 58	L734/P/Ni B&L	8600 0362
P7	Connector, female, mains complete with cable RKK 3 x 0.75 and mains plug: Multikomp 165 452	3-way	8600 1272
P8	Connector, female, 47 way	Plessey 74/10/4751/10	8600 1533
P9	Connector, female, 23 way	Plessey 74/10/2351/10	8600 1548
P10	not assigned		
P11	Connector, female, 31 way	Plessey 74/10/3151/10	8600 1530
–	Coaxial cable RG58 C/U	Normal delivery 10 meters	2400 1337
Cable A Cable B	Multicore cable, screened – Length to order	PXOP N37 x 0.22	2400 1768

OPTIONS:

Coaxial Cable type B (RG 213/U), 15 to 50 m length, see drawing

P5	Coaxial connector UHF angle – alternatively PL–259/A and Angle Adapter M–359A	83–67 Amphenol
A, C	Connector, coaxial with one Reducing Adapter	PL–259/A UG–175/U
B	Straight Adapter jack-jack	PL–258
P6	Connector, coaxial	L734/P/Ni B&L

COAX. CABLE Type B



Coaxial Cable type C (RG–17/U), up to 100 m, see drawing

P5	Connector, coaxial, for RG 58 with Reducing Adapter	PL–259/A UG–175/U
A, D	Connector, coaxial, female type N	35025 Amphenol
B, C	Connector, coaxial, male (RG 17)	UG–167D/U
P6	Connector, coaxial	L734/P/Ni B&L

COAX. CABLE Type C

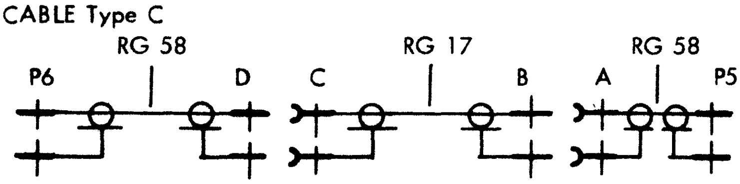


Table 2.2 – PARTS LIST – Interconnection Material

The reserve battery will run the Antenna Switch motor in the event of AC mains failure. The supply should be taken from the Reserve Transmitter, and energized only when this transmitter is switched on. The source fuse should be rated at least 3 A.

2.6 ANTENNAS

2.6.1 GENERAL

The ordinary installation of a ship's radio station requires one main and one reserve antenna. With long-wire antennas it is recommended to design the main antenna with respect to MF band operation, and the reserve antenna somewhat shorter, matching the MF reserve transmitter. This gives a choice between two antennas, often valuable in the MHF or low HF bands (approx. 3 to 6 MHz) when the longer antenna hits a halfwave or fullwave resonance. These resonances usually show a very high impedance in this range, and may be far higher than the matching ability of the transmitter.

The matching range of the transmitter has been demonstrated for many years in the predecessor, ST1400. For the selftuning ST 1610, the servo circuits have taken over from the radio operator and some important characteristics should be observed as a consequence:

- Servos cannot think — they only respond to orders. It is enough that one reply is wrong to arrive at a »servo fault».

- Servos cannot accept a »near good» result — a radio operator may do this very well. Therefore ambiguities in antenna characteristics should be avoided as far as possible.

2.6.2 ANTENNA DESIGN RECOMMENDATIONS

a) Make every effort to locate the transmitter immediately at the antenna lead-in. The distance should be less than 2 meters.

b) Separate the down-leads of the two antennas as far as practicable, to avoid mutual coupling.

c) Avoid the use of trunks for the downlead. Use the remote-control potentiality to locate the transmitter close to the antenna! Lead-in trunks act as transmission lines and transform the antenna characteristic badly, especially when they approach a quarter wavelength.

d) Design the antennas carefully. Give special attention to the quarter wave and half wave resonances. Observe that a quarter wave section downlead of the antenna may continuate in a section of high or low impedance. This situation should certainly be avoided in the marine bands where the antenna is to be operated.

e) The length of a main wire antenna might be in the order of 20 to 40 meters.

f) A reserve antenna (long-wire) suitable for HF (MHF) operation as well as MF reserve operation might have half wave resonance around 5 MHz. Depending on downlead, coupling to masts etc. and lead-in to the transmitter, outer length will be in the order of 15 to 25 meters.

g) Remember: it is the antenna *height* more than anything else that accounts for good radiation.

h) For the antenna, use a copper litz of about 20 sq. mm. Too thin outside diameter results in a high-Q antenna i.e. with high impedance peaks, which may cause tuning problems.

2.7 LOCATION OF CRYSTALS

Quartz crystals are utilized for the generation of channel frequencies on the MF band 410-512 kHz. In the HF band crystals may be used for A1 telegraphy to obtain redundancy — ordinarily these channels as well as others are derived from the synthesizer.

2.7.1 MF CRYSTALS

The 7 MF channels require 7 + 7 quartz crystals. These are factory installed on the MF oscillator pc board (Card Rack). Note that one crystal per channel is for A1 with the nominal frequency (after division by ten) right on the assigned frequency. On A2H, the second crystal is put in operation, with the divided frequency 500 Hz above the assigned frequency.

2.7.2 HF CRYSTALS FOR A1 TELEGRAPHY

The special A1 Exciter (in the Exciter Unit) may be equipped with up to 4 crystals in each band 4-25 MHz. Crystals are according to specification B03074 1044.

They are working right on the output frequency (not multiplied) and thus between-band channels do not have to be harmonically related. One quartz crystal is required for every single channel.

2.8 INITIAL ACTIVATION

2.8.1 GENERAL

Check the installation carefully before power is initially switched on. Make sure that proper fuses are fitted and that ac mains voltage is correct. Measure the voltage, check that tappings are right on the terminal boards of the HT Transformer and of the Fuse Compartment.

Before switching on, remove the front panel cover plate of the Power Amplifier and locate the TUNING toggle switch to the right. Set switch on MAN.

In this state, do not proceed any further than assuring that the equipment operates on HEAT, STANDBY and TRANSMIT with key-up. Compare testmeter readings with the normal values given in chapter 5.

2.8.2 TESTMETERS

Testmeter readings are generally listed in chapter 5 (Transmitter and Exciter, respectively).

Use values listed to evaluate equipment performance, and note down in the tables, in the space left for »actual», the figures actually read, for future reference.

2.9 PA TUBE ADJUSTMENT

Before tuning the transmitter, adjust the power amplifier vacuum tubes for proper operating conditions.

a) Be sure to set the TUNING switch (Power Amplifier) on MAN.

b) The adjustment is to be made without rf drive to the power amplifier. For simplicity, set on FS emission, provided that no input is applied to these terminals. If in doubt, unplug the coaxial connector from the Exciter rear.

c) Open the LT Power Supply and withdraw the Power Amplifier. Set the panel interlock switches in service position.

d) Switch to STANDBY and allow about 5 minutes for tube heater equilibrium.

e) Set PA testmeter on Vg2 and push TRANSMIT. Adjust R34 SET Vg2 (LT Power supply chassis, to the right) to read 70 divisions on the meter (350 V).

f) On the Power Amplifier driver chassis, locate the four holes of the bias controls.

g) Switch PA testmeter successively to positions V1 Ic through V4 Ic and read the standing feed of the tube. Correct value is 18-20 divisions (90-100 mA). Realign simultaneously, on the appropriate tube bias control, using a small screw-driver. (Potentiometer shafts are made from plastic and visible behind the holes in the cover plate.)

h) When all four tubes have been aligned, switch off and reinsert the PA and LT Power Units.

2.10 TUNING INSTRUCTIONS - GENERAL

The transmitter servo systems will tune the transmitter automatically to an antenna, from a TUNE order issued when a new channel has been selected or when going from OFF to TRANSMIT.

The initial tuning procedure is demanded to try out tuning conditions and verify tuning ability on all channels, using antennas designated. This test may call for manual operation and antenna modifications. Although it may not be feasible to meet entirely the demands below, always try to commission the transmitter under conditions which are as near the actual ones as possible.

- Before any tuning commences, the ship's superstructure must be fully completed, including masts, stays, halyards, antennas etc.

- Check that the vessel is as far away as practicable from buildings, cranes or other steel structures when the tuning-up is performed.

2.10.1 GENERAL

This paragraph will discuss characteristics which are important to observe when tuning the transmitter for the first time to new antennas, and inform about recommended procedure.

a) There is a choice between manual and automatic tuning in the Power Amplifier. It is generally quicker to use AUTO as long as the antennas do not cause any problems.

b) Using the remote control facilities, operate locally from the transmitter. Means for voice communication to the site of the remote exciter is advantageous.

c) For each antenna a particular LOAD Start Card is prepared. START Program Cards are located in the Card Rack. The duty of the card is to set the start position of the LOAD control, mainly from two reasons

- to save time and avoid unnecessary wear;
- to avoid »false» responses which might otherwise occur if starting from maximum inductance on high frequency bands.

The tuning criteria may be met with more than one final LOAD position, with appreciable difference in number of turns employed. Then the proper position is the one which stands for minimum inductance (LOAD POS. reading lower). The task of the LOAD Start adjustment on the PC card is to avoid the false position by indicating an intermediate setting of LOAD from which servo operation will start.

d) The program job will progress much quicker using a special Installer's Start Card, available from the manufacturer on special order. This card is equipped with a switch and simplifies the selection of the proper start point. Once determined, the original LOAD Start program card setting is made, soldering-in diodes.

2.10.2 BAND and DRIVE CHECKS

Before trying rf output, check PA band switch synchronism and check that the DRIVE servo operation range is properly centered on 8.5 MHz.

a. Remove the PA front panel cover plate and push STANDBY. Wait for the timer, approximately 30 seconds.

b. Push the Exciter Selector button MF. Check that the band thus obtained on the PA Band switch is MF, as advertised behind the rectangular window on the switch front.

c. Then select HF/MHF and check all bands. Note dual bands on 4/6, 12/16 and 22/25 MHz, and MHF ranges 1.6–2.499 and 2.5–3.8 (3.99) MHz.

d. Check that the driver gain is adequately set with the length or coaxial cable employed. Use instructions given in para 8.3.1 first, working steps a. through e., and including the MF band.

e. If R3 had to be considerably aligned, it may be necessary to check the matching of the exciter sub-systems, using para. 8.3.5. Note that the MF drive is not subjected to the added attenuation of a long coaxial cable between the exciter and transmitter: the factory made matching uses a moderate length of cable and thus the specific installation has to be aligned when commissioning the transmitter.

NOTE

This concludes the pre-tuning preparations.

2.11 MF TUNING

2.11.1 GENERAL

The main objectives when tuning the MF band are

1. To determine the proper variometer tap on main and reserve antenna, respectively. Antenna switch positions are:
   - Main antenna – 1
   - Reserve antenna – 4

2. To verify operation on 500 kHz on both antennas and on all channels using the main antenna.

3. To adjust the output power if necessary to avoid arcing over on low-capacity antennas.

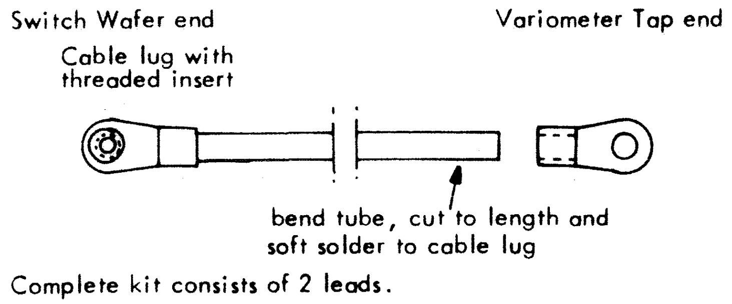


Fig. 2.9 - ANTENNA SWITCH - Solid Conductor Assembly Kit

4. To prepare and install — after the taps have been determined upon — new copper tube conductors from the variometer to the antenna switch. The PVC insulated wires installed at the factory are only meant to be temporary. Material for the preparation of permanent conductors is delivered with the set (see figure 2.9).

2.11.2 MF Tuning

Refer to figure 2.10 for a view of the Antenna Switch unit.

a. Remove the front panel lid of the Power Amplifier and the front panels of the Card Rack and the Antenna Switch.

b. Select Main Antenna: position No. 1 of the Antenna Selector (wafer A).

c. Set the Exciter controls:

EMISSION	– A1
POWER	– 4
CHANNEL	– 410 kHz
Testmeter	– RF Out

d. Set the Transmitter controls

Mode	– STANDBY
TUNING (PA)	– MAN.
SERVO (Card Rack)	– NORMAL
Testmeter	– LOAD POS.

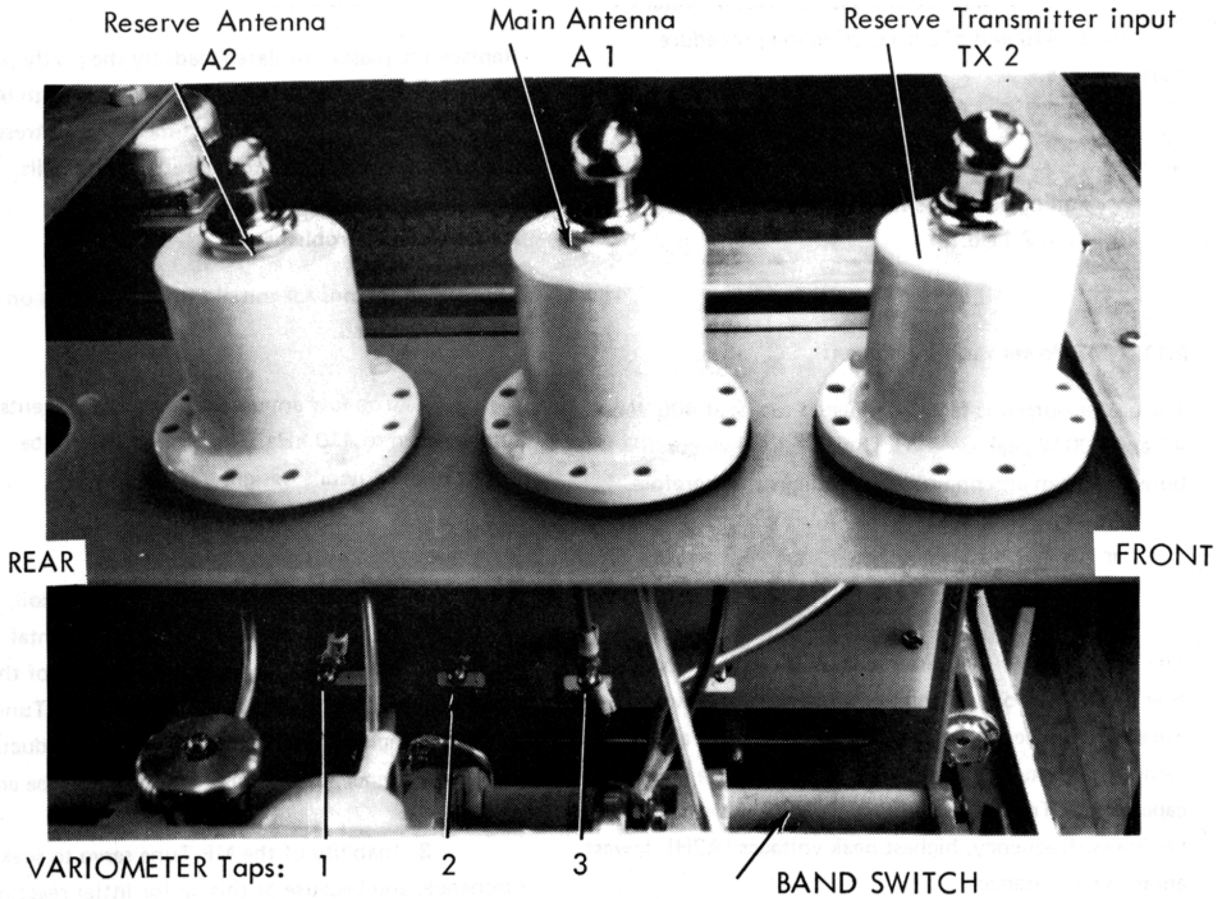


Fig. 2.10 - ANTENNA SWITCH - left hand view

e. Proceed to TRANSMIT, switch TUNING to AUTO. Start, pushing TUNE (PA unit) and watch the tuning progress. If a suitable variometer tap was selected proper tuning will be accomplished and the TUNE order automatically switched off. Read the variometer dial: on 410 kHz the reading should be low.

f. Select another tap if the variometer keeps running. Note that "0" is maximum inductance and "10" is minimum. Press TUNE anew.

NOTE

Transmitters from the first production are generally operating with "10" as maximum inductance and "0" as minimum. Therefore 410 kHz will tune to a high dial figure and 512 kHz to a lower number.

g. Select 512 kHz and tune the transmitter. A successful tuning will give servo stop and a dial number which is higher than on 410 kHz. Adequate margin is 0.5 to 1 div. from the 10 mark.

h. Before trying on full power, tune to the reserve antenna as well: Select position No. 4 (wafer C) and tune to 410 and 512 kHz, using the procedure outline above.

NOTE

Tuning problems will be discussed under para. 2.11.6.

2.11.3 MF Power Level Alignment

The power output is factory-adjusted to about 400 W on A1 and 600 W peak on A2H. Under key-down conditions the mean antenna current readings are therefore

A1 to A2H = 1:0.87
or
A2H to A1 = 1:1.16

The output power may have to be reduced if arcing-over is obtained on the antenna which has the lowest capacitance. The power can be increased, up to a cathode current of 1 A on A1, if antennas have a high capacitance. Try out the power level on the worst case, i.e. lowest frequency, highest peak voltages (A2H), lowest antenna capacitance.

a. Tune the transmitter. Key the transmitter on POWER 4, using A1 and A2H. No arcing-over is allowed.

b. Proceed on POWER 5, keying A2H from the morse key. If arcing is observed, locate pc card U4 with potentiometer R11, TONE LEVEL, and reduce gradually, till no arcing can be obtained. Read the antenna current.

c. Turn to A1 and set the rf power to scale with A2H on pc board U2, potentiometer R4, A1 LEVEL. Calculate the A1 antenna current as

(A2H current) x 1.16

d. Verify that the powers set are not causing any tendencies to arcing, in the transmitter or in the antenna circuit.

2.11.4 MF Channel Log

Use the servos to tune all channels on the main and on the reserve antennas. Record all significant figures on the Tuning Chart which is fixed to the back of the front panel removable cover. LOAD figures are obtained from the PA Testmeter on LOAD POS. (– To "freeze" other testmeter readings, refer to paragraph 2.12.2, item o.).

2.11.5 Permanent Taps

Replace the plastic-insulated leads by the partly prefabricated copper tube leads. Bend with smooth bends and to perfect fit – do not exert mechanical stress on the switch wafers. Refer to figure 2.9 for details.

2.11.6 Tuning Problems

Three main reasons for initial tuning problems on MF may be identified:

1. Too low antenna capacitance prevents tuning down to 410 kHz. The problem has to be solved in the antenna design.

2. An antenna with built-in loading coil, and self-resonating on a harmonic of the fundamental. The solution of the problem is again in the design of the antenna, and aided by the strategy of the MF Tune servo (parking the variometer on maximum inductance). As a consequence, only approved models can be accepted.

3. Inability of the MF Tune servo to seek resonance, and because of this no (or little) reaction from the LOAD coil.
This problem must be solved in the transmitter itself.

It may be found on real antennas as well as on the dummy load, and on one or several frequencies.

To identify the problem, check the following characteristics:

a. Step No. 1 is normal, when the variometer runs anticlockwise to its parking position and the LOAD coil anticlockwise to maximum inductance (Load Pos. 100).

b. In Step No. 2 the variometer is to seek circuit resonance, which is seen on the TUNEMETER as a maximum, higher than 40 divisions. Now, should the servo stop and the indication remain below 40, there can be no action from the LOAD servo in Step 3, because the servo finds that the amplifier is already loaded well below 40 (and the proper action would be to unload, which for obvious reasons cannot be done).

c. In Step No. 3, the LOAD starts to rotate clockwise, increasing the loading, which is noticed on the TUNEMETER as a decrease towards 40. Simultaneously the variometer follows to preserve the resonance in the circuit.

d. Under normal conditions, Step No. 2 should have taken the variometer to a dial figure which is higher than the final reading. That is the variometer reverses slightly (ccw rotation) when the loading increases.

e. The real problem is faced when the variometer servo (in Step No. 2) starts gayly but then looses torque and stops before reaching resonance, as described in b. above. The explanation is that the initial biasing voltage is switched off before the phase discriminator output is strong enough to take command of the tune servo amplifier.

The best method to overcome the problem may be a combination of adjustments to the characteristics of the servo. Adjustments to be considered are in following order

1. The friction brake on the motor shaft
2. Increase of amplifier input damping on card U13, TUNE SERVO-MF (see NOTE 1 on the circuit diagram).
3. Modification of switching instant from bias to phase discriminator input (resistor R27, card U13).

To adjust, proceed as follows:

a. Tuning in Step No. 2, lift the brake slightly or aid the motor manually towards resonance (block the servo program in Step 2).

b. The assistance should result in the servo being controlled entirely from the phase discriminator and resonance found.

c. Then bend the spring of the friction brake slightly to unload. Try again and let continue till the end of Step No. 3.

d. If servos start hunting in the last moments of the tuning, connect a strap between two solder spills on Card U13 (putting R33, C25, Z10 and Z11 as input damping network).

e. As a final resort, select a new value for resistor R27 (560 ohm). A higher value will delay the disconnection of the offset voltage, a lower value will advance the disconnection. Resistor values to be considered are 470 and 680 ohms, respectively.

2.12 MHF/HF TUNING

2.12.1 GENERAL

Tuning the transmitter to the antenna is the one and only objective. On these bands there should be no question of changing the factory-set power levels. The tuning procedure below describes the ordinary conduct. Tactics to overcome antenna problems are discussed, and a separate paragraph is devoted to modification suggestions, principally in the matching network.

On the MHF to HF bands, it should be remembered that operation on both antennas on every band is not absolutely prescribed. One antenna, usually the longer main antenna, may be less suitable on HF bands, e.g. due to half or full wave resonance phenomena. This fact may lead to abandoning operation on the particular antenna on that band, instead of fighting. Only remember to make this known to the operatoroff the transmitter – complete the Antenna Selector Chart by crossing out these bands.

2.12.2 Installer's blueprint

a. Preferably, let the servo motors do the job, that is: work on AUTO TUNING.

b. Only if tuning problems become too intricate, gear down using manual tuning. The procedures for manual tuning are discussed in paragraph 2.13.

c. The start position of the LOAD variable inductor is to be determined on every band. The position is expressed as a binary number 0 to 15.

d. Convert the final figure – as read from the PA Testmeter on LOAD POS. – to nearest binary figure in table 2.3.

e. Subtract 1 or 2 from the figure above and read the Program Code. Install on the pc board – at the particular band – diodes for "1". Figure 2.11 shows the program card before programming.

f. When trying out the program, the LOAD start point can be very easily manipulated using a special Installers LOAD Start Gear.

g. If this tool is not available, borrow the dummy load programmed U5 (approx 50 ohm) – it will assist on most HF bands but less likely on MHF. Use the Extension Card supplied to bypass the location tag, and insert in position U6 (Reserve antenna) or in U7 (Main antenna).

h. In the event that tools to f. or g. above are not available or giving unsatisfactory results, revert to manual tuning.

i. On the higher frequency bands, two LOAD final positions may be obtained. Always select the one which implies that the minimum number of turns are in the circuit. Once programmed, the false position should fall "below" the start point.

j. The loading of the amplifier is to increase for clockwise rotation of the LOAD inductor. This may reverse on a false response, which cannot be accepted by the servo circuits.

LOAD POS. Reading	Binary number	PROGRAM CODE »1» = diode			»0» = no conn.
		A	B	C	D
100	0	0	0	0	0
93	1	1	0	0	0
88	2	0	1	0	0
82	3	1	1	0	0
75	4	0	0	1	0
69	5	1	0	1	0
63	6	0	1	1	0
56	7	1	1	1	0
50	8	0	0	0	1
45	9	1	0	0	1
38	10	0	1	0	1
32	11	1	1	0	1
25	12	0	0	1	1
20	13	1	0	1	1
10	14	0	1	1	1
0	15	1	1	1	1

To fix a start point:

- enter LOAD POS. reading – read binary number – subtract 1 or 2 – read Proper Code

Table 2.3 LOAD Start table

k. The question of full command of the tuning procedure when the exciter is remotely located is resolved in this way:

- before ordering a new channel from the exciter, switch TUNING to MAN
- set the new channel on the exciter
- return TUNING to AUTO and start the process pushing TUNE

l. You have a further tool of command in the SERVO switch (on the Card Rack). If the switch is thrown from NORMAL to BLOCKED, the tuning program stops after the step ordered has been completed.

m. Then to proceed again from the blocked position, return switch to NORMAL.

n. The tuning program consists of four individual steps:

1. Start positioning: TUNE on maximum inductance, LOAD to predetermined (programmed) turn.

2. Resonance tuning of the circuit with TUNE, the TUNEMETER peak reading should be well above 40 divisions when the LOAD Start turn (inductance) has been properly chosen.

3. LOAD turns clockwise to increase the loading, and TUNE follows, keeping circuit resonance. The TUNEMETER pointer is to land on 40 divisions.

4. "Microtuning", as in step 3 above but with increased sensitivity for maximum accuracy. After a short delay, when motors stopped, the TUNE order is retired.

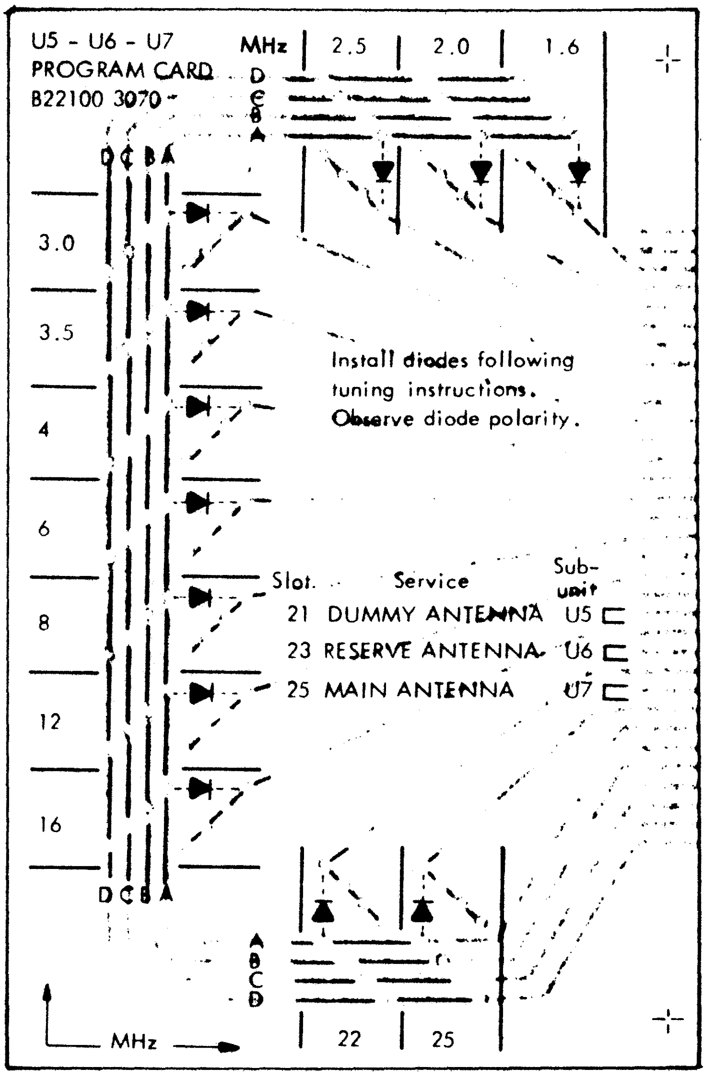


Fig. 2.11 - LOAD Start Card

o. You can "freeze" the program by switching SERVO to BLOCKED, meaning that the program stays on the step in process. On step 4 then, you get ample time to read the TUNE testmeter figures.

p. You can always stop the process pressing STANDBY.

q. Finalize programming cards U6 and U7, and record TUNE position/LOAD reading on the Tuning Chart/Manual Tuning Instruction.

r. The program figures for the two antennas should be recorded for future reference, considering that one leaking diode may upset several bands.

2.12.3 Tuning Procedure

a. Start on a medium band, preferably 8 MHz. Install a program card (the Dummy or a Variable Start card) in the appropriate position (U6 or U7, depending on antenna employed) via the Extension Card. Set binary number 7 or 8 as the start point.

b. Select the proper antenna:

U6	– Reserve antenna (A2)	– Selector pos. 1
U7	– Main antenna (A1)	– Selector pos. 4

c. Set the transmitter on TRANSMIT, TUNING on MAN and select a frequency in the band. PA Testmeter is switched to LOAD POS. and SERVO on NORMAL.

d. Switch TUNING to AUTO, press TUNE.

e. If the tuning process was successful, neither LOAD nor TUNE hits a limit stop. Read the testmeter LOAD POS.

f. Enter table 2.3, read the nearest binary number, subtract 1 or 2. Note down for future use.

g. Use the new binary number to determine a new start position. Check validity by repeated tuning cycles, using frequencies belonging to the band limits. (SERVO NORMAL, AUTO TUNING, push TUNE).

h. Failure to come to a halt is most likely caused by an unsuitable start position. Modify one or two numbers, tune again. Watch the Tunemeter to observe whether the resonance reading in step 2 exceeds 40 or not.

i. A low reading may be due to a heavy loading – check by modifying the start position. Other causes could be low drive to the final amplifier, or unsuitable fixed capacitors (true resonance cannot be obtained). In the first case check drive levels, in the second the matching network may require a slight rearrangement, which is a natural measure on the MHF and low HF bands and sometimes on the 22/25 MHz band.

2.12.4 Tuning Continuance

After having established satisfactory tuning conditions on one band, continue with those remaining.

a. Use the experience from the first band to select LOAD start positions, towards higher figures on higher bands and towards 0 on MHF bands.

b. Make a quick evaluation of all bands to get an idea to which extent tuning problems will occur. Include both antennas in this appraisal.

c. For bands with a problem, analyze the situation before taking further actions, for example:

- are both antennas causing problems
- are problems caused by antennas or by inadequate matching flexibility
- if one of the antennas is without problems, is it necessary to match both?

d. Matching network modifications are discussed later, in paragraph 2.14. Antennas have been discussed in paragraph 2.6. Before taking actions, additional tests may be required to make sure that antenna extreme values are not causing the problem. The matching network will most likely fail to succeed, if so, due to "impossible" demands.

2.13 MANUAL TUNING

2.13.1 GENERAL

The instructions below cater for two different situations:

- The BAND servo motor is operating normally but TUNE and LOAD servos are not working properly – Section 1 applies.

- All servo motors — including BAND — are out of function — instructions in Section 2 below are added to Section 1.

2.13.2 SECTION 1 - Band Switch Operable

HF/MHF BANDS

a. Remove the front panel lid of the Power Amplifier and switch on, pushing STANDBY.

b. Set the TUNING switch on MAN., and wait for the timer to close.

NOTE

Transmitters with serial numbers L101 to L130 should be modified to keep the Band switch servo in operation on MAN. as well as on AUTO (strap switch S2 terminals 1 to 3).

c. Select channel on the exciter. — If the Band switch does not follow (on AUTO and on MAN), the switch has to be turned by hand — see below in Section 2.

d. Set PA Switch S3, TUNE LEVEL: ON

e. Use the spanner provided to unlock the centre nut of the two servo gear boxes: hold the disc firmly and unwind nut about 1/2 turn.

f. Turn the TUNE coil (to the left) fully anticlockwise.

g. Check the Tuning Chart for related tuning figures, as recorded when the set was installed. Note especially:

- antenna employed — Main (A1) or Reserve (A2)
- LOAD position reading, — e.g. 75

h. Select the antenna noted on the Chart

i. Turn LOAD approximately to the position given, using the contact wheel as a pointer. "100" is fully anticlockwise, "0" is fully clockwise.

j. Push TRANSMIT

k. Turn the TUNE coil, watching the TUNE-METER. Tune to maximum meter reading.

l. Adjust the LOAD coil to bring the TUNE-METER reading down to 40 ("T40").

m. Readjust TUNE for maximum and LOAD for "T40" — and again check resonance on TUNE. — When finished, TUNE maximum shall land on "T40".

n. Tuning completed switch OFF S3, TUNE LEVEL, and operate the transmitter as usual.

NOTE

This concludes the manual tuning instructions on the HF/MHF bands.

MF BAND

MF tuning follows the same procedure as described above for MHF/HF, only that resonance tuning is done on the variometer (in the Antenna Switch Unit, immediately above the power amplifier). Also, all channels should be logged on both antennas when installed.

a. Remove the front panel lid of the Power Amplifier and the small lid hiding the variometer thumb wheel and dial. Switch on, pushing STANDBY.

b. Set the TUNING switch on MAN., and wait for the timer to close. — See NOTE to Step b. HF/MHF, above.

c. Push MF and select the desired channel. — If the Band switch does not follow (on AUTO and on MAN.) the switch has to be turned by hand — see below in Section 2.

d. Set PA Switch S3, TUNE LEVEL: ON

e. Use the spanner provided to unlock the LOAD centre nut of the gear box (right hand coil). Hold disc firmly by hand, unwind nut about 1/2 turn.

f. Set TUNE VARIOMETER to dial reading given on the Tuning Chart — note different antennas.

g. Read antenna and LOAD position indicator figures from the Chart. Select the antenna.

h. Set LOAD as given on the Chart, using the wheel as a "pointer". – "100" is fully anticlockwise, "0" is fully clockwise.

i. Push TRANSMIT

j. Tune the variometer, watching the TUNE-METER. Tune to maximum reading.

k. Adjust LOAD to get the TUNEMETER down to 40 ("T40").

l. Readjust TUNE for maximum – should stay near "T40".

m. Tuning completed switch OFF S3, TUNE LEVEL, and operate the transmitter as usual.

NOTE

This concludes the manual tuning instructions on the MF band.

TO RE-ENGAGE MOTORS
To re-engage a servo gear box, work the opposite way: hold the disc firmly and tighten the nut, using the spanner. Do not over-tighten the nut!

2.13.3 SECTION 2 - MANUAL BAND CHANGE

In the event of BAND servo failure, theband switch has to be operated by hand. To facilitate this, remove the band switch motor by undoing the 4 screws which retain the motor to the chassis of the switch. Unplug the supply connector.

Instructions above under para 2.12.2 will have to add under c:

"Turn the PA band switch by hand to the frequency band of the channel selected on the exciter.

IMPORTANT

The band is indicated in the window in the switch front. Check visually that the fixed contacts are well centered with the contacts of the revolving cage."

2.14 NETWORK MODIFICATIONS

Below possible modifications are listed for the MHF to HF bands, with the change towards higher or lower impedances to match.

1.6 - 2.5 MHz:

Higher – install a series capacitor (150 pF) between moving contacts 1 – 2 (remove the link). NOTE: C13 cannot be employed in double duty.

2.5 - 3.8 MHz:

Low – remove C13 (150 pF) and link contacts 1 – 2 on the rotor of the switch.

4 - 6 MHz:

Higher – connect C12 (250 pF) to rotor terminal 1, alternatively link to C13 150 pF on previous band (double duty is now possible). If both parallel and series capacitor is tried, a new C13 must be provided.

8 MHz:

Higher – a new series capacitor of 50 pF between 1 – 2.

12 - 16 MHz:

Lower – connect C1 47 pF to stator contact 3A.

Higher – a new 50 pF series capacitor in series with contacts 1 – 2.

22 - 25 MHz:

Higher or inductive – a 50 pF series capacitor between 1 – 2.

IMPORTANT

When working in the band switch, never use force on the rotor. That might cause a mechanical displacement of the contacts or the motor clutch. To free the rotor, dismount the motor which is held by four screws. Observe the distances to other components to avoid arcing-over.

Before put into operation, inspect carefully to secure that everything is in order. Especially check the leads which are in parallel with the long rod rf chokes – these leads are easily bent towards the winding if touched.

NOTE

One series capacitor may be used on more than one band, provided that neither of the terminals 1 and 2 have a parallel capacitor connected to ground.

2.15 TUNING CHARTS and METERS

To terminate your job, record on the Tuning Chart all channels normally required, and identify the antenna used.

Check the Testmeter Charts and note the figures actually read from the meters of this equipment, for onboard reference.

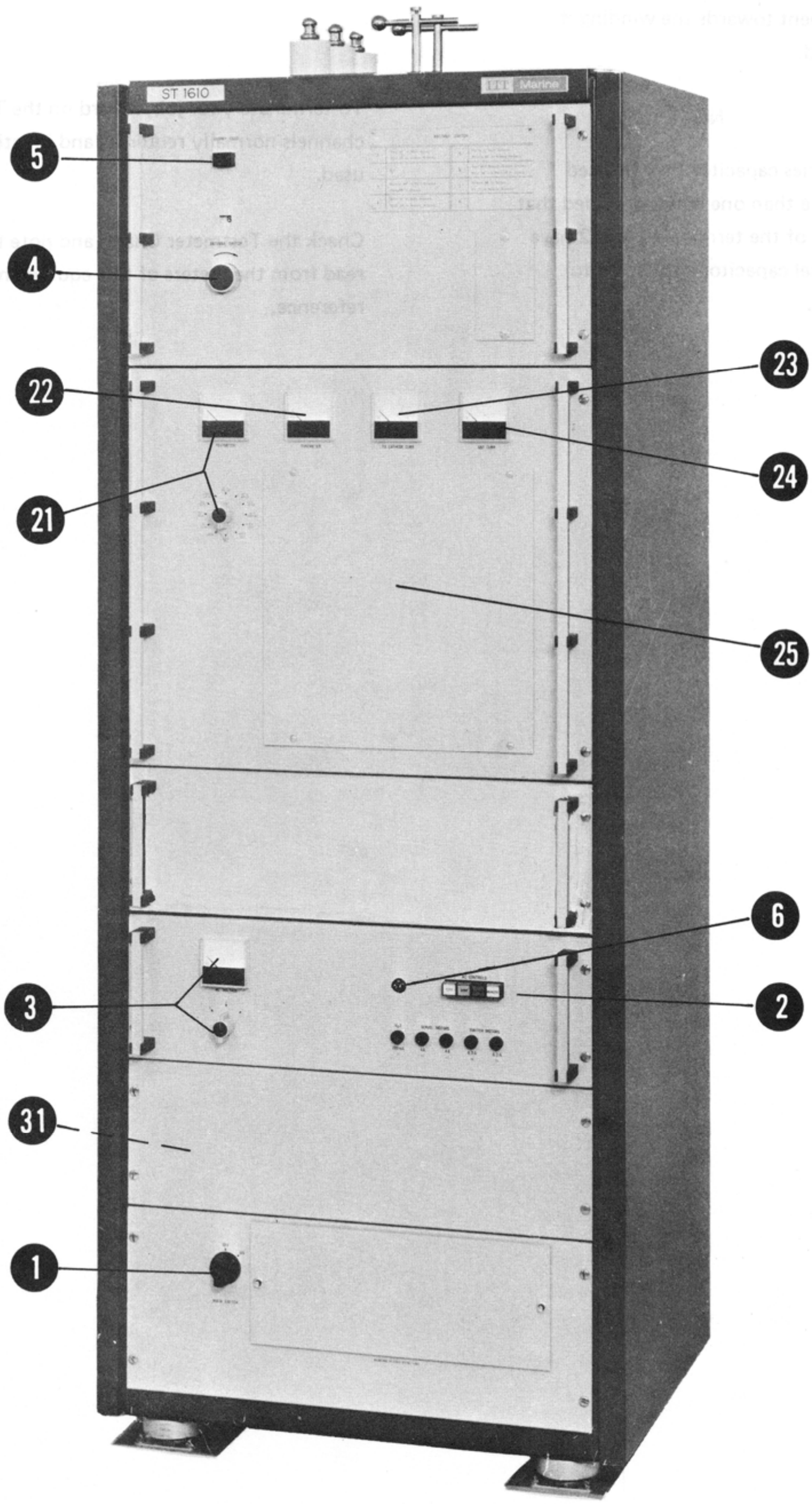


Fig. 3.1 - TRANSMITTER ST 1610A, front view

CHAPTER 3

OPERATION

3.1 CONTROLS

3.1.1 GENERAL

1 MAINS ON/OFF — Main supply switch, disconnects transmitter and other equipment fed from the fuse compartment.

2 AC CONTROLS

- OFF — Transmitter off, crystal oven energized.
- STANDBY — All circuits energized, except HT and screen grid voltage. Timer ready 30 seconds after switching STANDBY on.
- TRANSMIT — Operation position. If pressed directly, timer delays HT automatically.
- REMOTE — Remote Control Panel in command of AC Control.

3 AC VOLTAGE R, S, T — Voltmeter to check the three phases of the mains input.

4 ANTENNA SWITCH

- & Chart, — Switches in 8 different positions to circuits given on the Chart.
- AUTO/MAN — On MAN, the motor drive is disconnected for full manual control.

5 DUMMY LOAD — Lights when a dummy load is connected through the antenna switch.

6 TEST KEY — Push button to facilitate keying of the transmitter (via the Exciter).

3.1.2 EXCITER UNIT

11 TESTMETER 12 pos. — Meters characteristic circuit signal levels and supply voltages. Refer to Testmeter Table in Chapter 5.

12 MODE

- MUTE ON / MUTE OFF — Control of muting output voltage. Normally muting voltage is permanently connected (simplex position bridged by wire jumper).
- VOX — Voice-control of the transmitter.
- TONE — Tone modulation of the carrier from the morse key. The carrier is not keyed.

13 POWER

- 1 - 5 — Five different power levels. "5" is maximum.

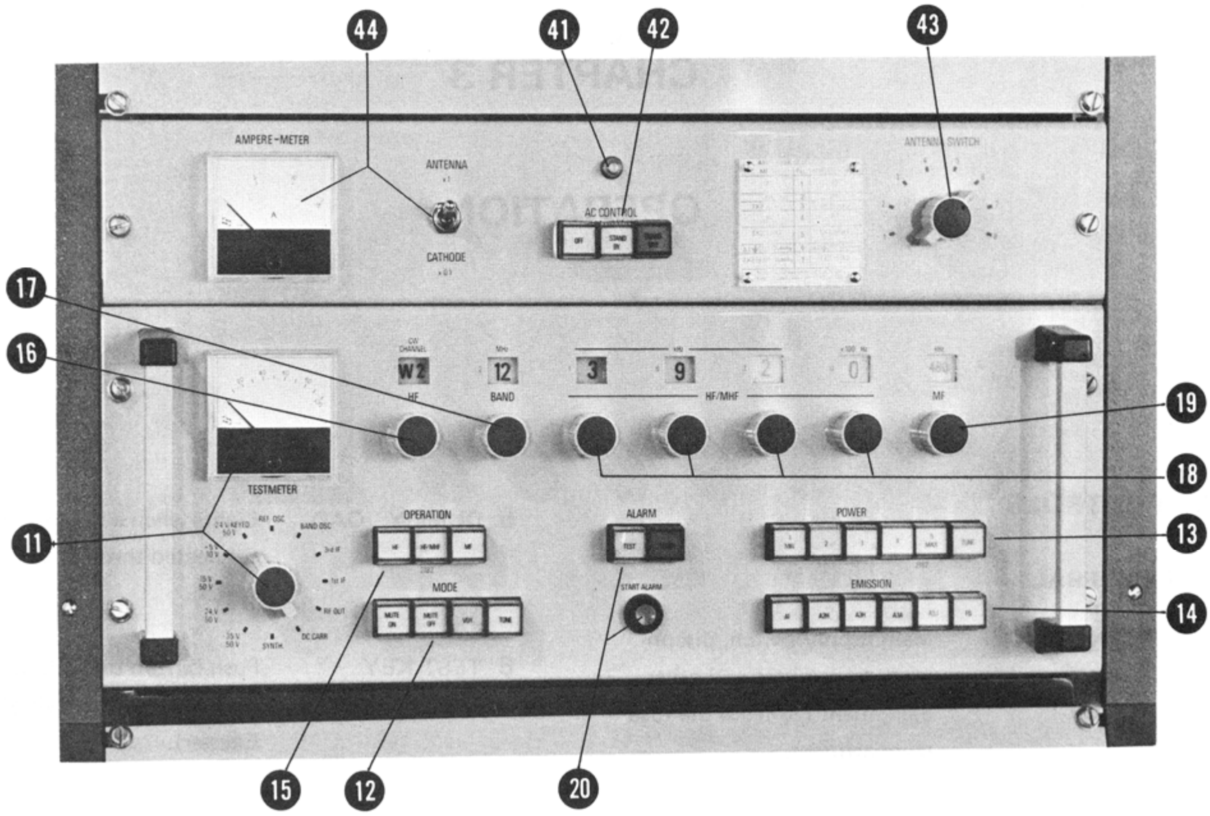


Fig. 3.2 - REMOTE CONTROL PANEL (top) and
EXCITER Unit (below), installed in Radio Console

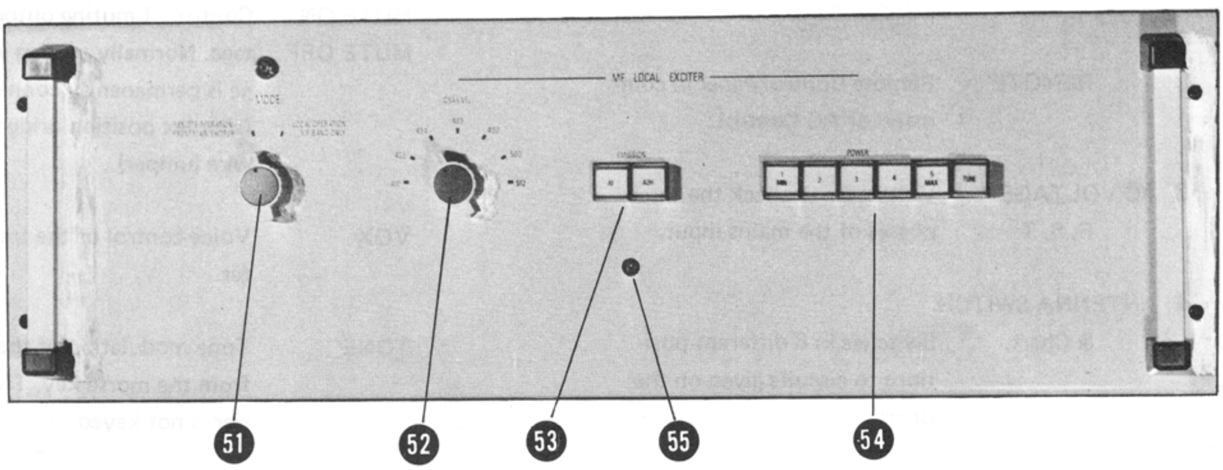


Fig. 3.3 - MF LOCAL CONTROL Panel, front view

	TUNE	Push button control to order a new tuning cycle. Signal lamp alight in TUNE button shows tuning in process.
14	EMISSION	
	A1	Selects A1 emission (MF & HF).
	A2H	Selects A2H emission and blocks the transmitter on HF if pressed.
	A3H	Selects A3H emission. Unconditionally chosen on 2182 KHz.
	A3A	Selects A3A (reduced carrier) emission.
	A3J	Selects A3J (suppressed carrier) emission.
	FS	Selects input for optional audio tone shift generator for direct printing operation.
15	Exciter Selector	
	HF	Selects the HF telegraphy exciter (crystal control, max. 4 channels per band 4-25 MHz).
	HF/MHF	Selects the main synthesized exciter unit for telegraphy and telephony.
	MF	Selects the MF exciter for telegraphy, actually located in the transmitter Card Rack.
16	HF - cw channel	Channel selection of A1 telegraphy exciter.
17	BAND MHz	Band selector, for HF and HF/MHF exciter sections.
18	Channel Selectors	Set the frequency of the synthesizer on HF/MHF operation.
19	MF kHz	Selects one of 7 MF channels.
20	ALARM START ALARM	Push buttons to select the two-tone alarm signal and start the alarm. TEST ALARM is non-radiating.

3.1.3 PA UNIT

21	TESTMETER 12 pos.	Meters characteristic voltages and currents of the PA amplifier unit.
22	TUNEMETER	Meters the rf anode voltage. To indicate 40 when the tuning process is complete.
23	PA CATHODE CURR.	Indicates the total current drawn from the HT power supply, including the Vg2 regulator.
24	ANT. CURR.	Meters the antenna current in amperes.
25	Cover plate	Removable cover plate, held by four quick-release fasteners. Back of plate: Tuning Chart with instructions for manual tuning.
	Behind:	
	AUTO/MAN	Servo operation on and off.
	MAN KEY	When on manual, closes the key to obtain a pilot signal for tuning.
	TUNE & LOAD variable coils	Manually operated after releasing the center nut about one turn. TUNE to the left, LOAD to the right.
	BAND switch	Pa band switch, motor driven. The band in operation is shown in the window in the front.

3.1.4 CARD RACK

31 SERVO switch, behind panel:

NORMAL	Tuning program stepped by servo Tuning Logic card - normal operation.
BLOCKED	The program does not progress after the current step is finished, but held waiting and with circuits energized. Use for test and service only.

3.1.5 REMOTE CONTROL PANEL

41 Signal lamp — Lights when the exciter is connected to a mains supply.

42 AC CONTROL: OFF, STANDBY, TRANSMIT — Push button switches to select state of operation from the remote position.

43 ANTENNA SWITCH — Remote control of transmitter antenna selector.

44 Test meter — Meters Antenna current or Cathode current, depending on position of meter switch.

3.1.6 MF LOCAL CONTROL PANEL

51 LOCAL/REMOTE — Selects the main exciter on remote and on local gives control of all MF channels.

52 CHANNEL kHz — Selects one of 7 MF channels.

53 EMISSION A1, A2H — Selects one of the two types of emission available on MF.

54 POWER

1 - 5	Selects one of five power levels, "5" is maximum.
TUNE	Manual control to order repetition of tuning, and signal light to show tuning in progress.

55 KEY — Jack for the connection of a morse key (MF telegraphy).

3.2 OPERATION - REMOTE CONTROL

a. Push the REMOTE button (2) at the transmitter cabinet and then operate from the Remote Control Panel (RCP). If MF Local Exciter is fitted, set switch (51) on REMOTE as well.

b. Start the transmitter from the RCP: push STANDBY (42). Alternatively push TRANSMIT (42) to make the transmitter ready as soon as the timer closes.

c. On the exciter, select the proper generator for MF telegraphy, HF/MHF telephony and telegraphy or HF telegraphy from quartz crystals (51).

d. Select frequency band on HF/MHF (17).

e. Select channel using the appropriate control: 16, 18 or 19.

f. Select the proper type of emission (14).

g. Choose the antenna to be employed from the RCP antenna switch (43). – The antenna switch itself must be on AUTO.

h. Switch high tension on, pushing TRANSMIT (42).
– The transmitter now tunes itself automatically, indicated by the alighted TUNE lamp (13).

i. When the TUNE lamp is switched off, tuning is complete.

j. For transmitting, select power level (13) consistent with the conditions of propagation.

IMPORTANT

Always follow the tuning procedure to observe deviations from normal conduct, such as prolonged period, tuning lamp staying on, or panel meter readings which are different from normal.

If the Tune lamp stays on, check that controls have been properly set for the Band, Channel and Emission selected.

If the Tune lamp ceases to light, check

while transmitting that normal meter readings are obtained. It is generally better to read the Cathode current than the Antenna current, because between-band variations in cathode current are very small, in contrast to the Antenna current.

If you are uncertain of the proper outcome of the first tuning, order a new tuning procedure, pushing the TUNE button. For a Tune light which persists to light, reset all controls or try on a different channel/band/emission.

For "traffic lights", refer to para. 3.8.

3.3 CHANGE OF FREQUENCY

To select another channel on a different band, just set the appropriate controls and wait for the TUNE lamp to switch off.

IMPORTANT

Select the proper antenna to go with the channel chosen.

It is not necessary to switch to STANDBY from TRANSMIT, nor to order tuning manually.

When the new channel is in the same MHF of HF band, only the Fine Tuning procedure is required. Selection of Fine or Coarse tuning is automatically done from the exciter frequency control switches.

3.4 MF OPERATION - LOCAL CONTROL

This applies only to equipments fitted with the MF Local Exciter Unit.

a. Set the Antenna Switch on MANual control, select the proper antenna.

b. Push STANDBY or TRANSMIT (2).

c. Through switch (51) on LOCAL.

d. Select Channel, Emission and Power on 52, 53 and 54.

e. The transmitter tunes itself when on TRANSMIT.

f. Operate, using the local morse key provided (only for MF operation).

g. To return to remote operation, set

– Antenna switch on AUTO,

– MF Local Exciter on REMOTE,

– LT Power AC Controls on REMOTE.

3.5 NOTES ON LOCAL OPERATION

a. When remote-operated, HT always returns even when changing bands or antennas. If local control of AC CONTROLS has been chosen, the equipment trips to STANDBY when the antenna switch is turned, and TRANSMIT has to be pushed anew.

b. The internal AUTO/MAN switch of the PA unit disconnects TUNE and LOAD motors when set on MAN. Transmitters L101–L130 switched off the Band switch motor as well on Manual, and thus the switch had to be set on AUTO to change bands. To overcame this disadvantage, refer to para. 2.13.2, NOTE under item b.

3.6 OPERATION FINISHED

When the transmission is finished, let remain on STANDBY for 2 to 3 minutes to cool the tubes, before switching OFF.

3.7 TESTING ON DUMMY LOAD

To test the transmitter, use the dummy loads provided. Keep a record of significant meter readings under these conditions, and check regularly to get an early warning of deteriorating performance.

3.8 TUNE MONITOR

Transmitters fitted with Remote Control Panels featuring the "traffic light" lamp display on the front panel will inform the Operator about the actual state of the tuning procedure

- TUNING – yellow – lights during the time a TUNE order is in force

- READY – green – lights up when a TUNE order has been successfully carried out (to "T40")

- TUNE FAULT – red – lights up when a TUNE order has failed to achieve a proper result. The failure may consist in inability to reach "T40" or in a TUNE order not terminated within about 80 seconds.

If a TUNE FAULT signal is obtained:
- check if controls are properly selected,

- check if the appropriate antenna is used

- push TUNE and follow the procedure closely,

- then analyze the findings if a consistent fault condition is confirmed.

CHAPTER 4

THEORY OF OPERATION

4.1 GENERAL

In this chapter the principles of operation are discussed starting from the functional block diagram, figure 4.1. Then the signal flow is analyzed, with the aid of the signal flow diagram, figure 4.2. A special analysis of the MF circuit is based on figure 4.3, including the normally Exciter-controlled MF generator of the Card Rack.

The LT Power Supply is discussed from figure 4.4, and interlock chains from figure 4.5. Then servos are analyzed, starting from a flow diagram (figure 4.6.) and using the Sequence Chart figure 4.7 and the simplified diagram of figure 4.8. The circuits are described, with reference to the circuit diagrams and assembly drawings of chapter 10.

4.2 FUNCTIONAL DESCRIPTION

The transmitter main functional units are shown in figure 4.1.

The Exciter Unit is trusted the generation of rf signals and modulating these with the desired information. Full control over the range MF through HF is exercised from the exciter front panel controls, although the MF generator is separately located, in the Card Rack (four cards U1-U2-U3-U4). For practical reasons, the exciter unit is described in a technical handbook of its own – in this section the exciter will be considered as a building block in the full system. – Remote location of the exciter is foreseen.

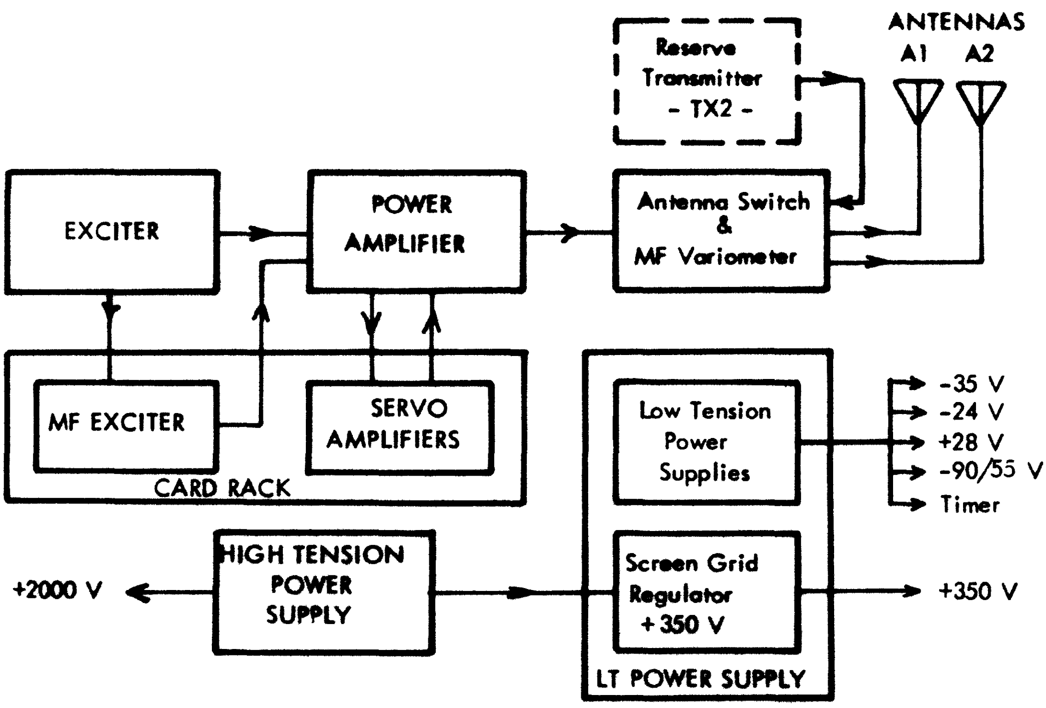


Fig. 4.1 - FUNCTIONAL BLOCK DIAGRAM

The Power Amplifier Unit contains a linear final amplifier with four tubes in parallel, a broadbanded driver amplifier and the antenna matching network. Continuously varaible inductors for tuning and loading, rf drive control attenuator and the band switch are operated by servo motors. The sensors are in the power amplifier unit, while servo amplifiers with associated control circuits are housed in the Card Rack.

The Antenna Switch Unit not only carries the switch to connect the transmitter output to any of two antennas. The switch accepts the reserve transmitter output for antenna selection, and includes a dummy load for MF and another dummy load for HF. In this unit, the MF variometer is controlled by a servo motor for tuning to resonance, while the loading control is the common LOAD inductor in the power amplifier unit.

The equipment is powered from three phase ac mains, protected by fuses in the transmitter cabinet bottom.

The High Tension Rectifier unit is a three phase full wave rectifier, powering the vacuum tubes with 2000 V anode voltage. From the rectifier center tap, 1000 V is brought separately to the adjustable screen grid regulator, for stabilization to + 350 V.

This Vg2 stabilizer is located in the Low Tension Power Supply, where the remaining low tension supplies are installed. These include – 35 V for common supplies, stabilized – 24 V for common supplies, stabilized – 24 V and + 28 V for transistor circuits, tube bias voltage – 90/– 55 V (through keying) and the electronic delay timer.

4.3 SIGNAL FLOW DIAGRAM

4.3.1 TRANSMITTER SIGNAL FLOW

Figure 4.2 follows the signal in the transmitter, from the power amplifier to the antenna switch.

The MF and HF drive signals are delivered from the particular exciter circuits, to relay K2 which becomes energized when HF is ordered on the exciter. In the HF path, relay K1 will be held energized on MHF bands through – 24 V to Y9, but a TUNE order will inhibit the order temporarily by – 24 V on the base.

The path from K2 is via resistive attenuators, switched by relays K3, K4 and K5 to obtain fixed steps of power reduction (– 5 to – 20 dB), ending up in continuously variable resistor R38 which is controlled by the drive servo motor, M1.

After the attenuators the signal enters the driver amplifier stages Y1 and Y2. Stage Y2 feeds a push-pull drive to Y3, Y4, which then drives the four parallel vacuum tubes V1 through V4.

Each tube is provided with an adjustable control grid bias of its own, in order to set the proper working point. The stabilized screen grid voltage, nominally + 350 V, is fed to all tubes and + 2 kV anode voltage through rf chokes to the common anode bus bar.

The anode-to-antenna matching network is a π – L circuit on 1.6–26 MHz, with fixed capacitors (switched by the Band Switch) and variable inductors L10 (TUNE) and L12 (LOAD). A dc path to ground is obtained with choke L11. In the output lead antenna current is measured through a current transformer, before the signal is coupled to the antenna switch.

The matching on the MF band resembles an autotransformer, with the anodes connected to a variable tap – the junction of the LOAD inductor (to ground) and the variometer (to antenna).

The circuits to achieve the automatic tuning and to feed different panel meters are indicated in figure 4.2 as well.

These signals are all taken from the grid and anode circuits of the final amplifier. Thus the rf grid voltage is rectified by Z1 and the filtered dc used for three purposes

1. as input to the drive servo amplifier
2. for the testmeter, position DRIVE
3. as one component of the LOAD error signal

The rf sample taken from the anode is rectified by Z2 and the filtered dc connected to the TUNEMETER via alignment potentiometer R25, and as the second component of the LOAD error signal.

Alignment potentiometer R22 enables the correct amount of anode signal to be selected from the LOAD bridge, for zero error volts on proper anode loading.

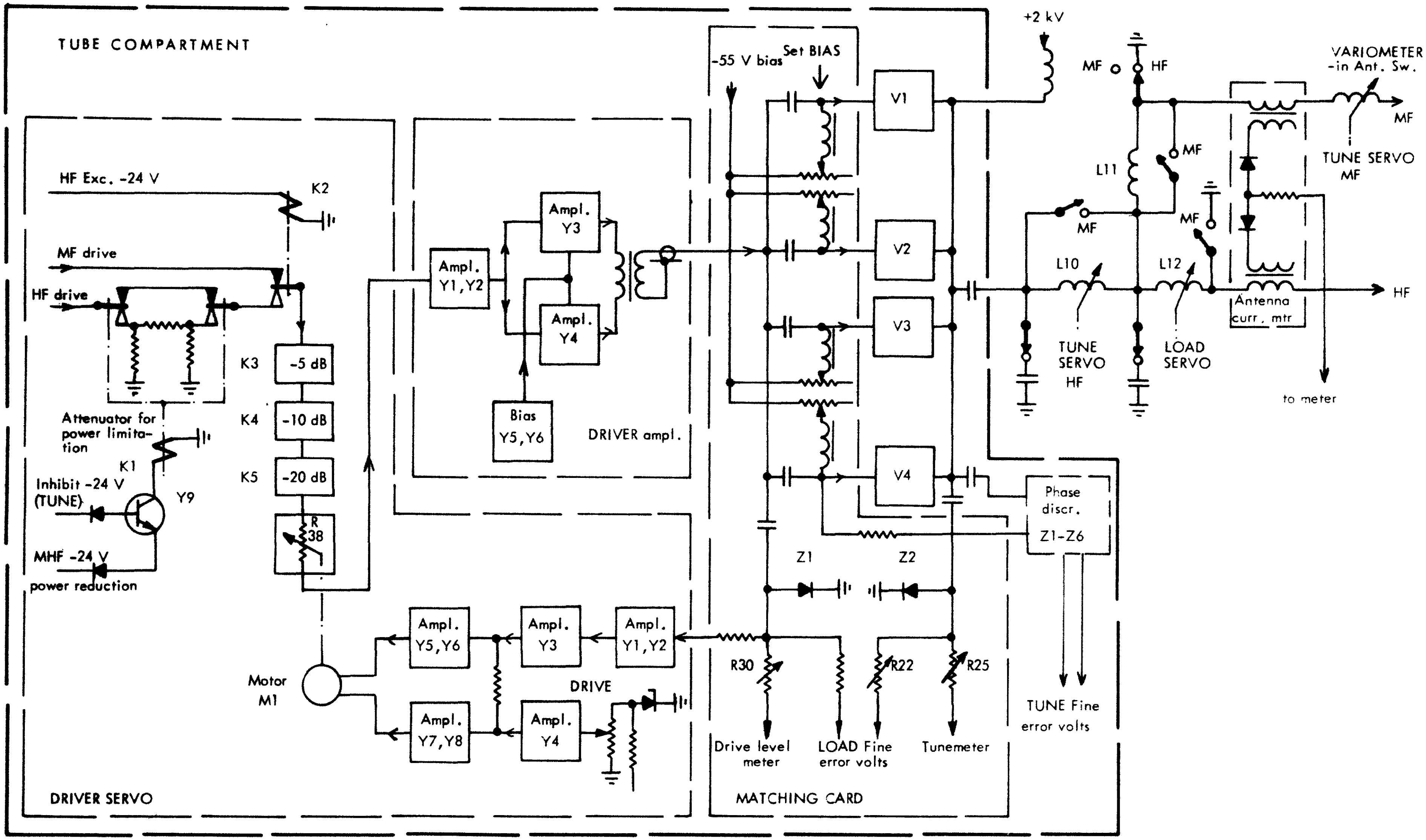


Fig. 4.2 - TRANSMITTER SIGNAL FLOW

The phasemeter circuit compares the phase relation between the grid and anode voltages and gives zero output when exactly 180° out of phase, that is the anode circuit is purely resistive.

The two error voltages – from the phasemeter and from the Load bridge circuit – are connected to the servo amplifiers, which then control the motors of the TUNE and LOAD inductors. Note that the LOAD inductor is common to MF and HF, while the TUNE servo is divided, in HF TUNE and MF TUNE, respectively.

The actual servo circuits will be analyzed below, in paragraph 4.3.5. The Band Switch of the power amplifier belongs to the motorized parts of the equipment, being controlled from the exciter unit via a homing circuit (stops when sensing – 24 V).

4.3.2 MF FLOW DIAGRAM

Because the MF Generator section of the Exciter is entirely located in the transmitter Card Rack Unit, the signal flow diagram will be analyzed below, with the aid of figure 4.3.

The exciter control functions comprise

- grounding the lead of the selected channel
- feeding – 24 V for keying purposes
- feeding – 24 V on TUNE
- switching – 24 V to relay K1 for A2H emission

The appropriate crystal (for A1 or A2H) is switched to the oscillator via diodes. Quartz crystal frequency is 10 times the output frequency (4.10 to 5.12 MHz), and the A2H crystal frequency is A1 + 5 kHz (4.105 to 5.125 MHz).

The oscillator output is fed to the 10:1 divider on the MF Control pc board and followed by a low-pass filter before being applied to the modulator. The modulated signal is amplified in keyed stages Y1, Y2 and then goes straight to the power amplifier.

The MF Control card is fitted with relays to switch between A1 and A2H, selecting carrier dc level from the keying input and tune carrier on TUNE order.

Modulating voltage, 500 Hz audio, is delivered from the tone oscillator – a multivibrator with keyed output (transistor Y3) and amplifiers Y4, Y5. Oscillator output is a clean sinewave after filtering, and the A2H output is set by the TONE LEVEL potentiometer.

4.3.3 LT POWER SUPPLY SIGNAL FLOW

The LT Power Supply delivers all low voltages to the transmitter and controls the state of operation through push buttons OFF, STANDBY and TRANSMIT. A fourth locking push button, REMOTE, connects the unit for remote control.

The arrangement of the power supplies is analyzed with reference to figure 4.4.

Starting from the top, 1000 V is taken from the HT Power supply via an RC filter (in the HT Power unit) to shunt regulator V1, V2, which is controlled from the Vg2 regulator pc board. + 350 V will be delivered to the screen grids of the PA tubes from this stabilizer.

The transformer (T2) which provides the heater voltage to V1 and V2 feeds the band switch motor rectifier Z2, Z3 as well. The motor supply is not immediately available at the motor, because the timer must first run its 30 second delay after switching on.

The grid bias stabilizer is adjusted to deliver – 60 V on key down when the bias switch transistor Y9 conducts and takes the positive terminal of the supply to ground. When the transmitter is unkeyed, transistor Y9 is not conducting and the supply is effectively connected to the unstabilized – 35 V rectifier, and therefore blocking the tubes with about – 95 V.

– 35 V is stabilized to – 24 V for general supply of transistor circuits (Drive servo, MF exciter). The last power supply on the pc board stabilizes to + 28 V for the PA driver amplifier and for the MF exciter. Both supplies are overload protected by electronic means.

The electronic timer starts when – 24 V is applied to the circuit, and energizes relay K3 approximately 30 seconds thereafter.

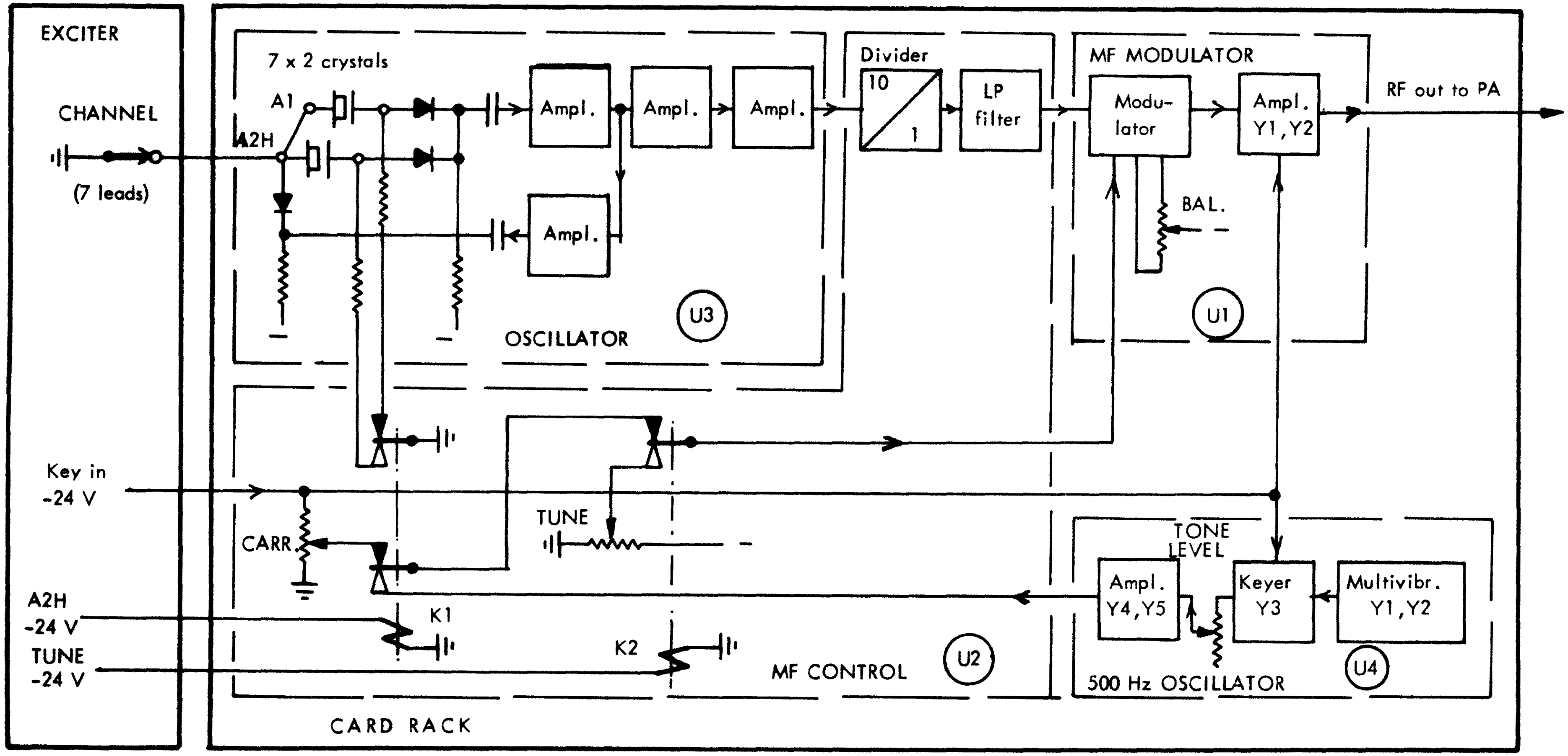


Fig. 4.3 - MF SIGNAL FLOW DIAGRAM

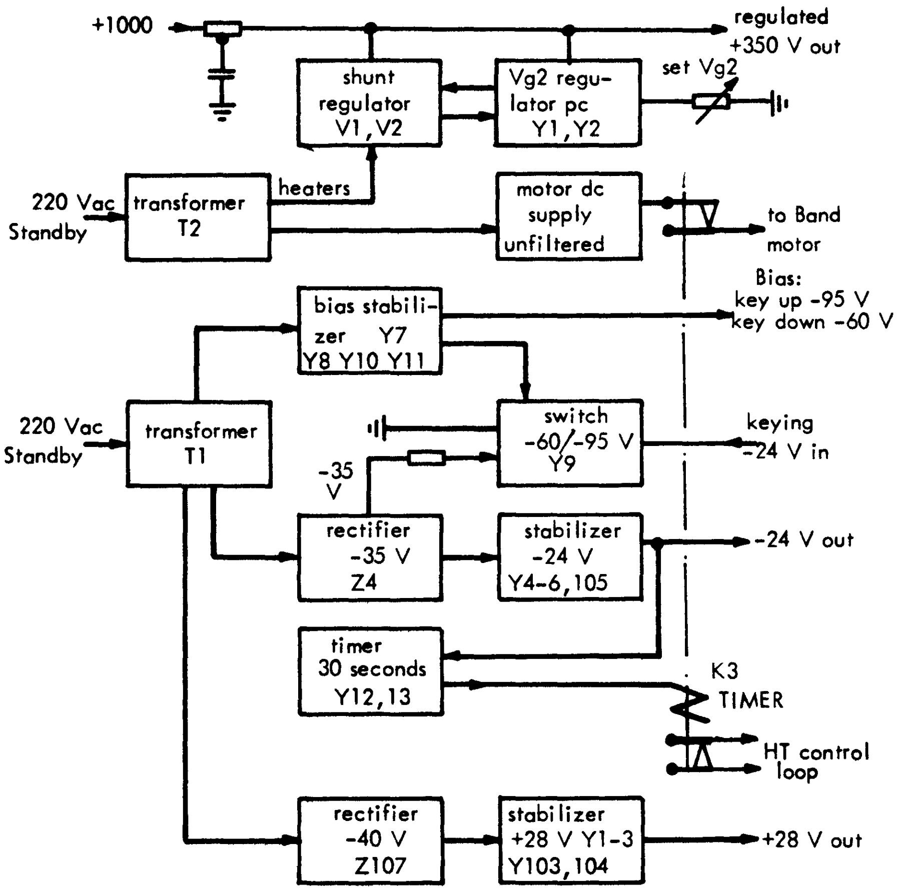


Figure 4.4 - LT POWER SUPPLY SIGNAL FLOW

4.3.4. INTERLOCKS

The simplified circuit diagram figure 4.5 shows the principal interlock functions.

Starting in the Fuse Compartment, the primary safety interlock employs contactor K2 and the three front-panel-actuated switches behind these units: Power Amplifier, Exciter and LT Power Supply.

Note: With remote – installed exciter, the Exciter Compartment switch is actuated by a blank panel or the MF Local Control panel.

On STANDBY and local control, contactor K1 is energized from S1b STANDBY and takes hold over contacts 7/8. On remote control relay K4 is energized and completes the circuit from R-solenoid K1–S1d 12/13–K4 9/10 to phase T.

In TRANSMIT mode auxiliary relay K2 stores the order received and this order is carried out by the HT contactor K1 provided that the interlocks of the circuit are all held closed.

When the TRANSMIT push button S1c is pressed – signifying local control conditions because S1d REMOTE is held released – contacts 22/23 close to energize K1 (STANDBY) if this has not been done previously. Contacts 12/13 close and phase T is connected to K2 solenoid terminal 1 through S1d 14/15. Terminal 12K2 reaches the S phase via the Antenna Switch interlocks:

- K3 closed contacts 3/4, K3 being the antenna switch motor relay,
- K4 break contacts 9/10, K4 being held energized when the antenna switch is in non-transmitting position,
- S5 closed, S5 being a cam-actuated microswitch on the antenna switch shaft.

Because S1c is non-locking (as S1a and S1b) K2 must take hold over 7/11K2 via normally closed S1b contacts and the hold contacts of K1: 7/8.

On REMOTE (S1d pushed) the actions described will be initiated when relay K5 10/9 close and thus phase T is coupled to 1K2 via S1d 16/15.

Note that on Local control K2 will not be re-energized automatically after an interruption in the K3/K4/S5

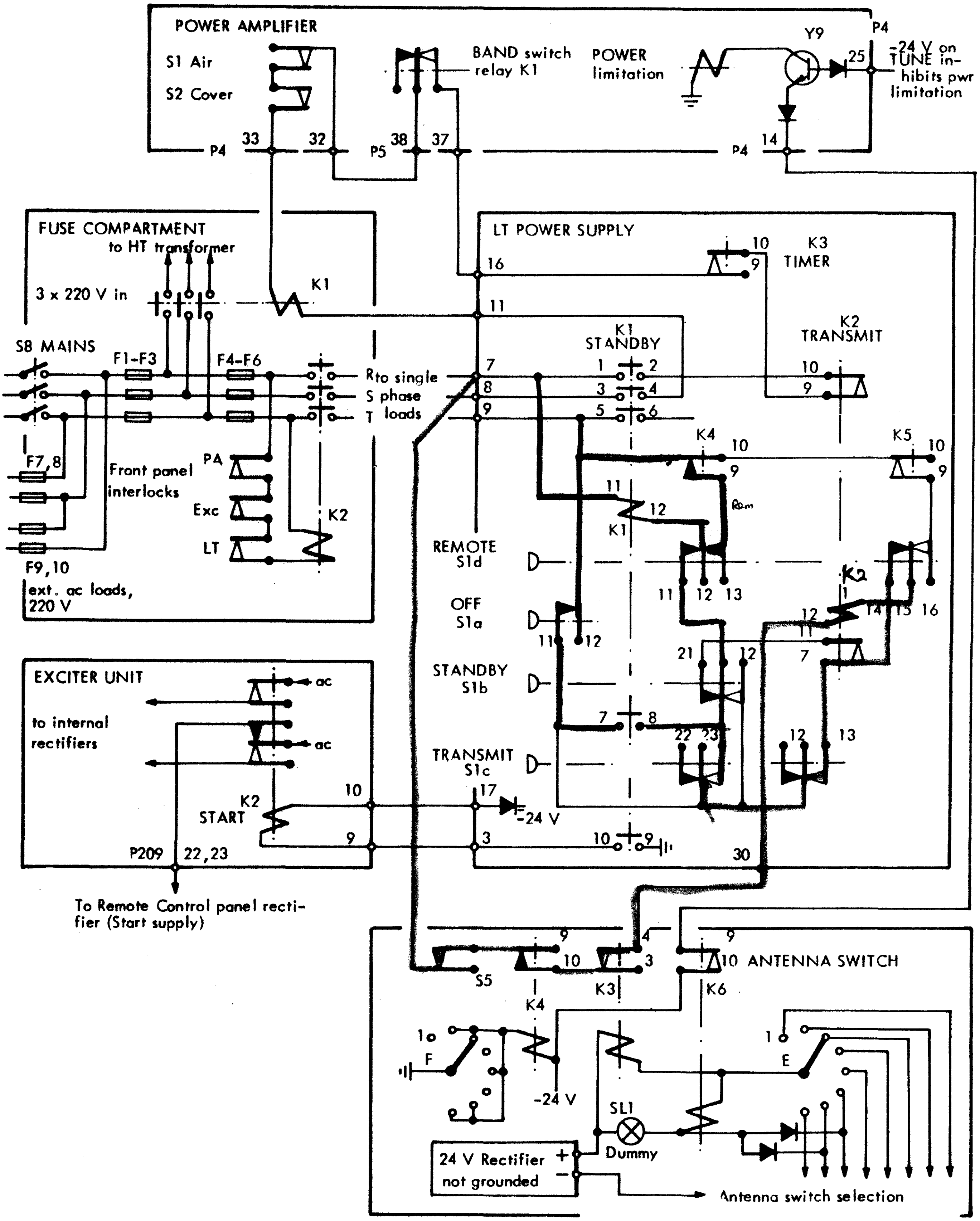


Figure 4.5 - INTERLOCKS - Signal Flow Diagram

circuit – TRANSMIT S1c has to be pushed anew. This is contrary to the Remote control operation where K2 will re-energize as soon as the interruption ceases, because 10/9 K5 is held closed from the push buttons of the Remote Control panel.

The TRANSMIT order is held by the energized K2 as contacts 10/9 closed and HT contactor K1 will then energize provided that these additional interlocks are closed:
- in the PA Tube Compartment: air stream control S1 and cover control S2
- in the Power amplifier: Band Switch relay K1 energized, signifying that the switch is "at home"
- in the LT Power Supply: timer relay K3 closed, from the electronic timer circuit of the pc board.

A temporary interruption – e.g. because a new band has been ordered – causes K1 to switch and disable HT for the length of the interruption.

The Exciter unit is started when the STANDBY mode is selected (the unit is connected to 220 V ac permanently) because – 24 V is fed to the Start relay K2 and closed to ground over 10/9 K1. Relay K2 contacts then apply ac to internal rectifiers and disconnect the ac volts fed to the Remote Control panel rectifier. This rectifier is trusted to provide the initial energy to remote-control relays K4 and K5 of the LT power unit.

Another interlock circuit prevents full power from being applied to the HF dummy load. – 24 V is switched by 10/9K6 to transistor Y9 of the PA Tube Compartment to energize the power limitation relay, K1. The limitation is effective on the Dummy Load positions (6, also 7). Note that K6, K3 (and the Antenna Switch motor) operate from an independent and floating 24 V power unit. On TUNE, however, the power limitation order is inhibited through – 24 V on the base of Y9.

4.3.5 SERVO CIRCUIT SIGNAL FLOW

The servo circuits to be analyzed below are those for tuning and loading the transmitter. Most of these circuits are located on the Card Rack. In this paragraph, figure 4.8 shows one of the servos (LOAD) with its associated logic and executing functional blocks, figure 4.7 summarizes the operation sequence of the servos, and figure 4.6 gives a simplified circuit diagram of all units involved.

Operation is always initiated from a Coarse Tune order – for the full tuning program – or a Fine Tune order. The latter is issued from the exciter when the frequency change is minor, that is confined within the same band. The coarse tune order is originated from different actions: major frequency change, band change, antenna switch change, TRANSMIT ON from OFF (but not from STANDBY), pushing TUNE button.

The short break – the coarse tune order – turns on transistor stages Y2, Y4 and Y6. Motors are ready to run when relay K1 energizes. This occurs via Y6 energizing K2. K2 normally closed contacts 5/6 open and remove the reset signal to the tune timer, which then switches Y3 (Monitor) on and because of this K1 is energized. Simultaneously the timer is started because 6/7 K2 takes the trigger to ground – if the tuning process has not been completed within about 80 seconds the timer output will trip and disable K1. Note that K2 must return to ground via contacts on the energized TRANSMIT relay (LT Power Unit) and that K1 when drawn issues a – 24 V TUNE order to the system and switches the ac supply voltage to the motor circuits.

In the LOAD SERVO relay K1 is energized from Y4 and the coarse error voltage is applied to the amplifier. Amplifier output is available to trigger one of the thyristor paths, and negative pulses are fed to the servo motor, running in one direction. Triggering the other thyristor will reverse the rotation of the motor. Two extra diodes sense the counter-emf of the motor to provide input to the speed control circuit.

Because the LOAD motor is to start from a variable predetermined turn, the coarse error voltage is the difference between the output from the LOAD POS. potentiometer (ganged to the load coil) and the selected start turn, expressed in binary form and converted to an analogue voltage in the D/A converter. When the error is reduced to zero, the motor stops.

The running motor is sensed by the LOAD sensor (Motor Sensor Card, U10) and – 24 V delivered to Y8 during operation. This causes Y8 to deliver – 24 V via contacts on the actuated relays to the Y2, Y4 and Y6 stages – in fact a kind of latching. When finally the motor stops due to nil error volts, Y8 output collapses and Y4 is cut off. Y6 has a somewhat longer time constant and will hang on till motor operation again turns Y8 on.

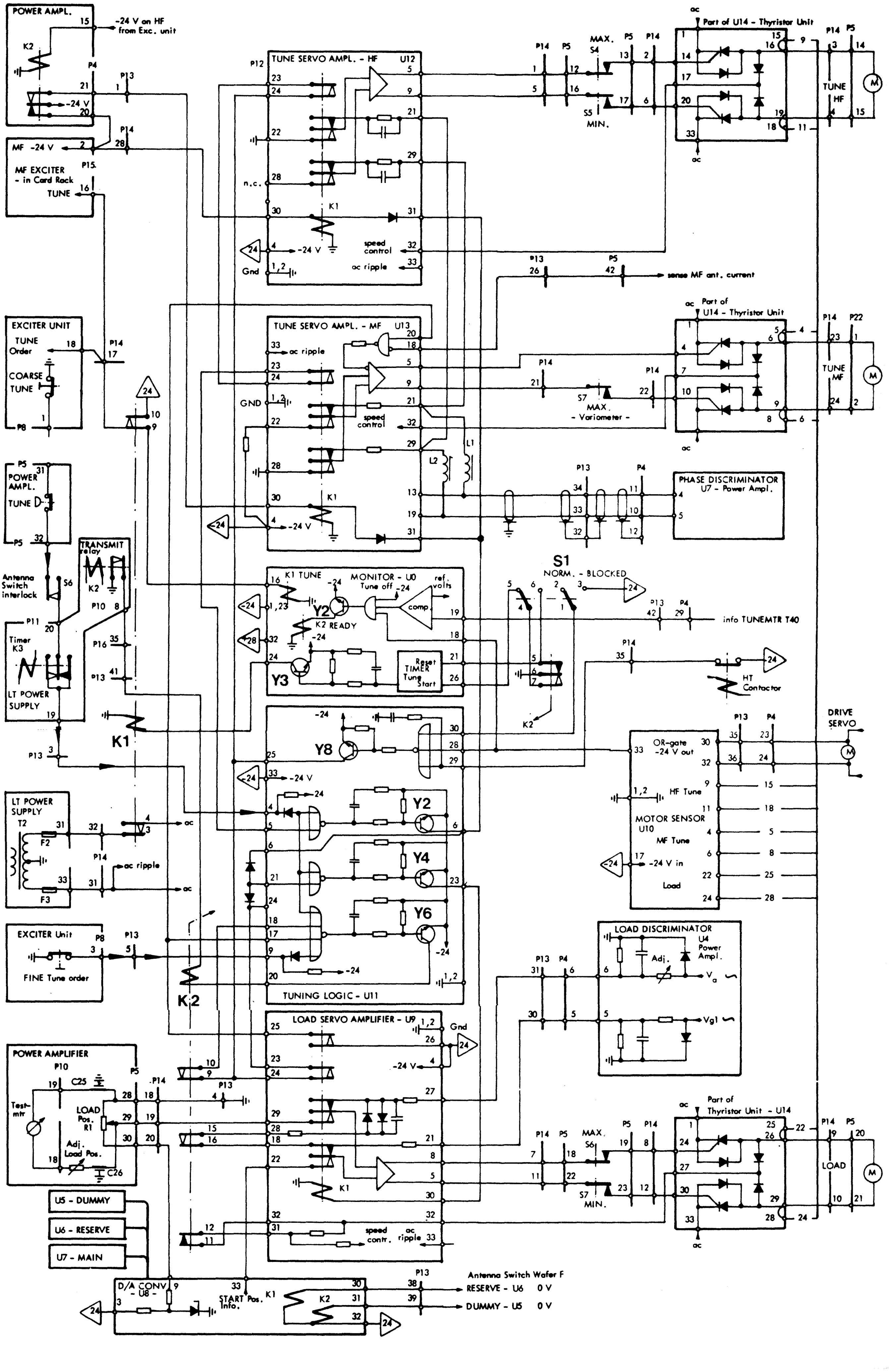


Fig. 4.6 - SERVO SYSTEM - Simplified Circuit Diagram

4 - 10 not assigned

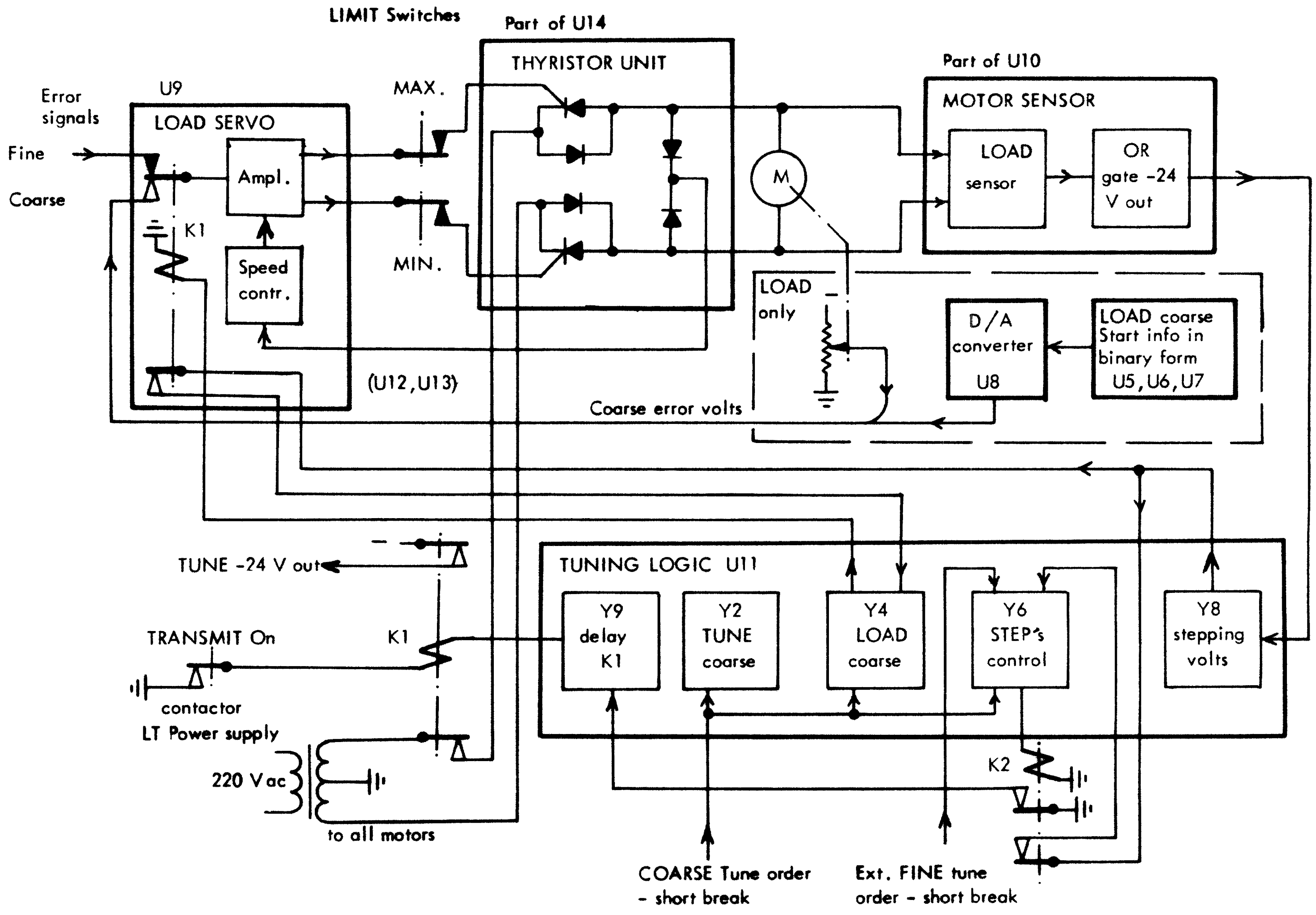


Fig. 4.8 - Servo Signal Flow (LOAD)

Because Y4 is now non-conducting, Load servo relay K1 falls and the Fine error signal from the power amplifier replaces the coarse volts. The motor starts to operate, Y8 is turned on, latching Y6. The process is carried on, with LOAD (and TUNE) operated from Fine signals, till the error is nil.

When motors come to a stop, the disappearing Y8 output makes Y6 non-conducting, relay K2 falls and its contacts 5/6 reset the tune TIMER, i.e. relay K1 will fall and withdraw the TUNE order and switch off the motors.

Specially for LOAD, in the short delay when K2 has dropped out but not K1, sensitivity and speed are increased for this servo, to achieve a very accurate tuning and loading.

A TUNE servo differs slightly from the LOAD servo: while the LOAD control start position is usually set on different turns, a TUNE servo is unbalanced in step 1 to max. counterclockwise position of the inductance (maximum L). In step No 2 & 3 they are fed the phase discriminator output. Note however that the MF TUNE servo in step No 2 first is unbalanced for CW rotation, and this is effective until enough antenna current is sensed to block the gate which controls this CW bias (see fig. 4.8).

The servo sequence canbe studied in figure 4.7, with "Order" and "Action" blocks. Of the two tune servos, only one is in operation at a time, as guided from exciter band choice (only the parking of Step 1 is effective for both servos when first changing between MF and HF/MHF or vice versa).

4.4 CIRCUIT DESCRIPTION

References are in general to the circuit diagrams and assembly drawings in chapter 10. The description starts from the General Circuit Diagram, figure 10.1

4.4.1 TRANSMITTER ST1610A

The sub-units of the transmitter cabinet are all interconnected over a common cable form, which terminates in the cabinet bottom on screw terminal board P16. This carries all control leads required between the transmitter and the remote exciter and the remote control panel. Another screw terminal board in the cabinet bottom is P29, for the Fuse Compartment. P29 serves for the connection of mains supply voltage and the strapping of the single phase loads in star (when input is 380 V) or delta (when 220 V input).

The Fuse Compartment houses contactor K2, controlled from the front panel interlock switches, and HT contactor K1. High tension filter capacitor C1 and HT fuse F18 are on this unit as well. Fuses F7 to F10 are available for connection to the Main switch S8 output, to feed external equipment in the radio station.

Operational mode switching is from the LT Power supply (Local operation) front panel switches OFF, STANDBY and TRANSMIT, and the various states are described below. When the REMOTE push button is pressed, these modes are controlled from the remote control panel.

OFF Transmitter completely inoperative, but the Exciter unit supplied 220 V ac from separate mains lead.

STANDBY LT Unit contactor K1 energized and takes hold over 7/8, R-S-T phases applied to power rectifiers, HT and PA blowers, PA tube heaters. Timer starts and closes relay K3 after about 30 seconds. K1 contacts 9/10 complete exciter start relay circuit to ground, making the exciter operable. Band switch motor homing to selected band when timer relay K3 closes.

TRANSMIT Relay K2 (LT unit) energizes and takes hold provided that the Antenna Switch is on a "transmit" position (Nos 1, 4 & 6) and the switch does not turn. Pushing TRANSMIT directly from OFF will energize the Standby contactor K1 as well as K2. Then the HT contactor will energize provided that the timer relay K3 is closed ant that the PA interlocks are closed. Thus +2 kV becomes available from the HT rectifier and +350 V from the Vg2 stabilizer.

The Antenna Switch motor M1 is normally supplied – 24 V from an internal and floating rectifier, and with provisions to supply the motor from the reserve battery on mains failure (and when required to operate the reserve transmitter).

In the space not utilized by the exciter unit there are provisions to install the MF Local Control panel, which gives full local control of the MF channels 410-512 kHz.

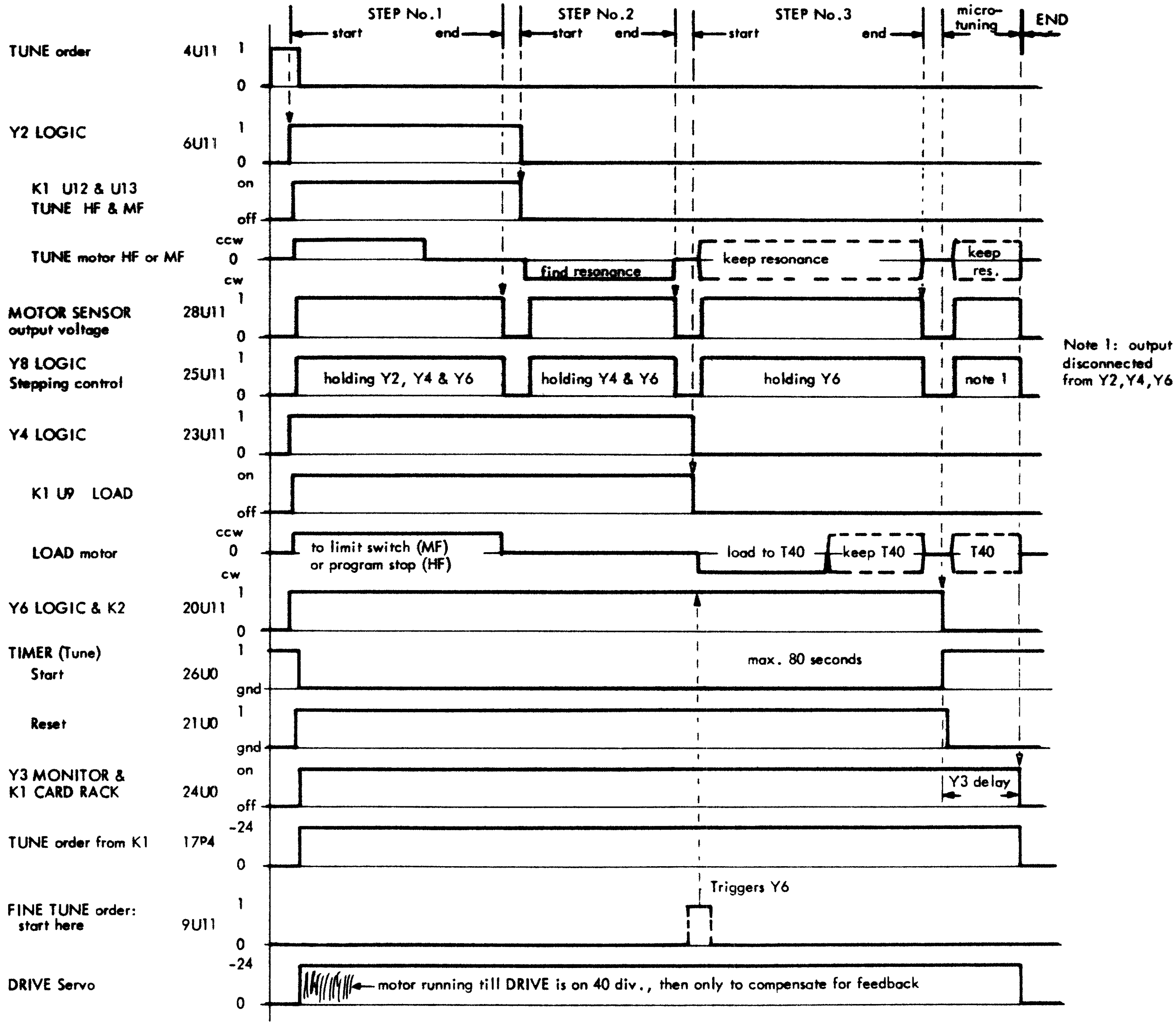


Figure 4.7 -
Servo Operation Sequence

4.4.2 HT POWER SUPPLY

Refer to figure 10.2 for the circuit diagram of the 2 kV power supply.

Three phase transformer T1 is provided with terminal board P18 for the mains input and for switching to the appropriate mains voltage. The secondary is fitted with fuses F1 to F3 before feeding the full wave 3-phase rectifier bridge. Diodes Z1 through Z24 have avalanche-type reverse characteristic to protect against voltage spikes, and are equipped with parallel capacitors to secure an equal voltage distribution along the chain.

The 2 kV output is filtered by swinging choke L1 – capacitor C1 and protected by fuse F18 (C1 and F18 are not on the HT Power unit chassis). The ground return is through 0.15 ohm resistor R3, to measure the current drawn from the rectifier.

The transformer secondary centre terminal has a dc voltage of about 1000 V, and feeds the Vg2-regulator through series dropping resistor R2 and filter capacitor C25.

Blower B1 serves to cool the transformer and thus contribute to the reliability and long service life of the supply. However, a blower failure can be accepted for a limited time, provided that the duty cycle on TRANSMIT is reduced by 50% (e.g. 15 min. Transmit, 15 min. Standby).

4.4.3 LT POWER SUPPLY

Figure 10.3 gives the circuit diagram of the LT Power unit.

The shunt regulator for +350 V operates from 1000 V dc with dropping resistor R2 (on the HT Power unit) and tubes V1 & V2 as variable shunt resistors. The control grids are controlled from transistors Y1, Y2 which are fed from the zener-stabilized cathode voltage (47 V). A sample is taken from the anodes to Y1 and is adjustable by R24, SET Vg2.

The grid bias supply is fed from rectifier Z8 and is stabilized to – 60 V using transistor Y11, amplifier Y7 and series regulator Y8. The overload current is set to 50 mA by R33 "I lim 50 mA", An overload current will turn Y10 on and in turn block Y8.

The ground return of the bias supply is through transistor Y9, which conducts when a – 24 V keying signal is applied from the exciter keyer. On key-up Y9 is blocked and the return to ground is through resistor R16 to – 35 V and Z4 to ground: the bias output is then about – 95 V.

The – 24 V stabilizer is fed – 35 V from rectifier Z4. The stabilizer circuit resembles the bias stabilizer circuit in that Y6 senses the 24 V adjustment, Y4 amplifies the control signal and Y5 senses a current overload (R17 is set to limit output current to 1.5 A). A power transistor has to be employed as series regulator, Y105, mounted on a heat radiator.

The third power supply delivers + 28 V stabilized output from Z107 rectified input. Again the same transistor functions can be recognized. The current limiter is set to 3.2 A (R3) and a Darlington circuit with Y103 driving Y104 works as series regulator. The power transistors are mounted on a heat radiator.

The timer is designed to close relay K3 about 30 s after the application of – 24 V (on Standby). The time constant of C12 and R41, 43, 44, 45 is selected to turn on transistors Y12 and Y13 with this delay. The return to ground for the timer is through contactor K1 10/9.

4.4.4 ANTENNA SWITCH

Refer to figure 10.4 for the circuit diagram of the antenna switch unit.

The antenna switch is provided with outputs to two antennas and inputs for three external transmitters. The inputs are designed to stand:

P24 – an ordinary MF reserve transmitter
P27 – an additional MHF (400 W peak) or HF (1400 W peak) transmitter
P36 – a 2182 kHz reserve transmitter, with less than 100 W peak.

Note that the MF variometer is housed in the antenna switch compartment with motor M2 and limit switch S7. The MF dummy load is always connected to coil tap No. 1, while the two antennas have to select among taps No 1 through No 3.

The motor of the switch is fed 24 V dc from an independent supply, which is not grounded. Wafer E is engaged in the homing circuit with motor relay K3. For manual operation of the switch, S9 disconnects the motor. Diodes Z4 and Z5 signal the two dummy load positions

(No 6 for this transmitter, No 7 for the Reserve Transmitter) to front panel lamp SL1. Simultaneously relay K6 is energized to switch – 24 V to the power limiting circuit in the PA HF/MHF drive input (reduces to 400 W peak).

Wafer F indicates the "non-transmitting" positions 2, 3, 5, 7 and 8, actuating relay K4 which then breaks the HT interlock path (microswitch S5 does the same thing and caters for hand operation while 3/4 K3 signals on automatic operation of the switch). Wafer F position No 1 signals Antenna 1 (Reserve) to the servo program (D/A converter, input relays both drawn) and position No 6 likewise signals Dummy load (D/A relay K2 drawn).

Wafer G is included to signal the DF position, No 2, which is the normally open contact of the switch.

Switch S6 is in the Coarse tune circuit, to activate the tuning facilities when the antenna switch has been turned to a new position.

4.4.5 POWER AMPLIFIER

The power amplifier general circuit diagram is given in figure 10.5, and figure 10,6 shows the drive servo assembly and circuit diagram. Finally the driver amplifier is detailed on figure 10.7.

MF drive is connected to P1 and the HF/MHF drive to connector P2. Each input passes a π-type resistive attenuator, and relay K2 selects the input to be employed (MF when not energized). The HF/MHF path contains another attenuator which is employed for reducing the maximum power when required to 400 W peak, and is controlled by relay K1. Note that K1 is always de-energized on TUNE, when – 24 V is fed to the base of Y9. Observe the other duty of relay K2 – to switch – 24 V and +28 V to the MF exciter.

Following K2 are three relay-switched attenuators of 5, 10 and 20 dB attenuation, and between the output of the Drive servo and the input of the Driver amplifier variable attenuator R38 is located. The operating range of R38 is about ± 5 dB, and the potentiometer is driven from servo motor M1.

The drive servo is fed a rectified sample of the grid voltage at pin 12. The signal is amplified in stage Y1/Y2 and applied as one input to differential stage Y3/Y4. Transistor Y4 is connected to a zener-stabilized reference voltage, adjustable through potentiometer R39. Error volts from Y3/Y4 are driving final amplifiers Y5/Y6 and Y7/Y8 and thus control motor M1.

The driver amplifier is capable of an output power of about 20 W in a 33 ohm load. The bandwidth is from 0.4 to 26 MHz.

Two cascaded amplifiers head the driver, Y1 and Y2. Potentiometer R3 acts as a gain control: through adjustment of R3 and R30 in the drive servo it is possible to centre the variable attenuator and avoid operation near the limits of operation. Such an adjustment is preferably made on 8 MHz as a suitable band centre.

Transistor Y2 drives push-pull amplifier Y3–Y4 which then delivers drive over transformer T7 to the grid matching network. The transistor power amplifier is biased from Y5, Y6 and potentiometer R19, BIAS. Y6 senses the temperature of the power transistors and guarantees that temperature stability is preserved under all conditions.

The final amplifier employs four tubes in parallel, V1 through V4, forced aircooled tetrodes type 4CX250B. On the grid side, in the closed tube compartment, circuits are grouped on the Matching network pc board. The driver output arrives over transformer T1 and terminating network C12-L5-L6-R(8 to 17). L5 and L6 have been physically formed when aligning the amplifier in order to attain as flat a response as possible from 0.4 to 26 MHz. The resistance value is as low as 82 ohm, securing stable amplifier operation without neutralisation.

The drive to the four grids is in parallel, and diode Z1 meters the drive voltage. One rectified signal is returned to the drive servo for the control of the variable attenuator, another one is available for PA testmeter display on position DRIVE. This is calibrated to 40 divisions by potentiometer R30 when the TUNE signal is of proper amplitude. A third output is brought to 5P4 as one component of the load error.

Control grid bias is obtained from the stabilized bias supply and fed each grid individually through potentiometers R1 to R4, BIAS. These adjustments are essential to align the four tubes to a common standing feed – the screen grid voltage is kept the same for all tubes.

The Matching network board further houses diode Z2, which is fed a sample of the rf anode voltage. The rectified and filtered signal drives meter MT2, the TUNEMETER, calibrated by potentiometer R25 to read 40 on TUNE when the amplifier has been properly tuned and loaded. Another output is passed as the second component of the load error volts, balanced to zero error on proper loading with potentiometer R22. For the Monitor, a third output has been taken to 29P4.

The phase discriminator is on a small pc board, located on the Matching network assembly. The circuit senses the phase relationship between grid and anode voltage, via R31 and C28, respectively. The output is then passed to 10/11 P4 and applied to the tune servos.

The antenna matching network is built around the two variable inductors, L10 TUNE and L12 LOAD, and the band switch which houses a number of fixed ceramic capacitors. Except on MF, the circuit is built as a π-L filter. Anode chokes L9, L1 and L2 are switched with the frequency band selected, L11 is included to provide a dc ground return for the antenna circuit, and L13/L14 is a parasitic stopper.

The numbers given the fixed terminals on the band switch circuit diagram – 1 through 8 – are as counted from the front of the switch. The ground wiper, 0, is at the rear left.

Before analyzing the MF matching, let us follow the HF/MHF output from terminal 2, passing current transformer T2 on its way to terminal P11 – this connects to the Antenna switch when the PA unit is installed in its cabinet. The Antenna Current Meter further senses the MF output current by T1. The current samples are rectified by Z1 and Z2, respectively, and combined in two identical outputs: one driving the Antenna Current meter and another for remote indication. The adjustment potentiometers R3 and R4 calibrate the readings of the dial in amperes.

The MF matching network is made up of the LOAD coil (L12) from anode to ground and the variometer (cf figure 10.1) in the Antenna Switch, from anode to antenna. The circuit resembles an autotransformer which tunes to resonance utilizing the antenna capacitance, and with the load coil as an impedance-matching tap towards the anodes.

The band switch is motor-driven from M3, which is controlled from relay K1. The relay is in a homing circuit with band switch wafer A (rear of switch) and the exciter band selection: selection of a new band de-energizes normally energized K1, M3 starts and stops when wafer A completes the circuit to K1 again. Note that 3/4 K1 opens to interrupt +2 kV when the motor operates.

The PA Testmeter, S9 and MT4, facilitates the checking of characteristic signals in the PA unit and the supply voltages. All leads are taken through the rfi filter of connector P3 to avoid instability problems.

The servo systems are inoperative with S2 on MAN., because – 24 V is not supplied to the servos in the Card Rack (see 4.4.6). Instead – 24 V is available at toggle switch S3, TUNING LEVEL, which when switched on energizes the TUNE circuits with – 24 V. When on AUTO, this TUNE voltage is switched by a relay in the Card Rack. Push button switch S1, TUNE, is in the tuning order circuit, and initiates a full tuning operation when momentarily breaking the circuit.

The Tune and Load coils are equipped with end limit switches, which break the thyristor trigger pulses when opening. The Load coil is coupled to a multiturn servo potentiometer, R1, to signal the actual turn number to the Load Servo amplifier, and displaying the same signal as LOAD POS. on the PA testmeter.

The MF section of the Antenna Current Meter is fitted with an extra output to 42P5, which signals existence of current to the MF Tune servo amplifier (to disconnect a temporary offset voltage).

4.4.6 CARD RACK

The Card Rack houses the main servo circuits, which are assembled on figure 10.8, the general circuit diagram. Printed circuit cards U1 through U4 form the MF Exciter, and are described in the exciter manual.

The Card Rack circuits have one control only, the SERVO switch (S1) which on BLOCKED places – 24 V on stepping gate transistor Y7 (card U11), and is thus blocking further program steps. Relay K2 is responsible for internal switching and controls the second relay, K1, which is issuing the – 24 V TUNE signal and switching the ac supply to the motor circuits.

Figure 10.8 shows specifically how the Band information is handled from the exciter and gated to the PA Band Switch. The band information is – 24 V on one of terminals 6 through 18/P513. These 13 bands are gated to 7 bands on the PA band switch, using diodes Z1 through Z13 (connector P7 employed as solder lug terminal).

The Load Start program cards are all paralleled on the band input side, that is – 24 V is applied on all the program codes of the specific band. Outputs are of course individually brought to the D/A converter.

4.4.6.1 Tune Servo – MF

Balanced amplifier Y1, Y2 is fed an unbalanced input signal when relay K1 is energized (step 1). When K1 falls, the PA phase discriminator output becomes the input signal.

The output from Y1/Y2 is biased as long as transistor Y8 is conducting and this occurs on Step No 2 until an antenna current is detected and of sufficient (rectified) amplitude to cut Y7 and Y8 off. This stops the variometer motor clockwise rotation, and the phase discriminator output takes complete command.

The output from Y1/Y2 control Y4/Y3 and unbalance finally drives either Y5 or Y6 into conduction. The implication is that the gate of the appropriate thyristor is grounded, to allow the thyristor to fire on the negative halfcycles.

A small ac voltage is fed to transistor Y2. This ripple voltage masks the info signal when passing through zero, and is equivalent to reducing the gain of the servo loop, avoiding hunting.

Speed info is fed to pin 32 (diodes Z8 and Z9 on the Thyristor card are sensing the counter-e.m.f. of the motor in the positive halfcycles). The signal is charging capacitor C6 and the voltage gated to the transistor bases to achieve a suitable speed characteristics.

4.4.6.2 Tune Servo – HF

Balanced amplifier Y1, Y2 is fed an unbalanced input signal when relay K1 is energized (Step No 1). When K1 falls the PA phase discriminator output becomes the input signal.

The output from Y1/Y2 controls Y4/Y3 and unbalance finally drives either Y5 or Y6 into conduction. The implication is that the gate of the appropriate thyristor is grounded, to allow the thyristor to fire on the negative halfcycles.

A small ac voltage is fed to transistor Y2. This ripple voltage masks the info signal when passing through zero, and is equivalent to reducing the gain of the servo loop, avoiding hunting.

Speed info is fed to pin 32 (diodes Z12 and Z13 on the Thyristor card are sensing the counter-e.m.f. of the motor in the positive halfcycles). The signal is charging capacitor C6 and the voltage gated to the transistor bases to achieve a suitable speed characteristics.

4.4.6.3 Tuning Logic

Refer to figure 10.11 for the circuit diagram of the tuning logic and figure 10.8 for its role in the servo system.

Transistors Y1, Y3 and Y5 are attributed to program step Numbers 1, 2 and 3, respectively. They are normally held cutoff because the base of each is held low (zero) due to the fact that Fine and Coarse order circuits from 9P11 and 4P11 are closed to ground. Interrupting the circuit will take the base high (Fine only Y5 high) and the second transistor (Y2, Y4 and Y6) is turned on as well. Y2 feeds unbalance relays fo the Tune servos, Y4 feed the Load servo unbalance relay and Y6 energizes Card Rack relay K2 which in turn energizes relay K1 (via the timer circuit of the Monitor card).

As a result of the first order, motor drive volts are sensed by the Motor Sensor card, issuing a high signal which turns on Y7 and thus Y8. The Y8 output will stay high until the input to Y7 goes zero, and during this time keeps Y1 through Y6 on. Then Y7 stops conducting when its input signal disappears (motor standstill) and causes Y1, Y2 to drop out (the time constant is shorter for this pair). The new phase, No 2, starts a motor and thus output from the motor sensor switches on Y7, Y8 again, and keeps the Load Servo as in Step No 1. – Y3 through Y6 conduct.

Next motor stop causes Y3, Y4 to drop out and finally the program comes to an end: Y8 output disappears and the input via 9/10 K2 to 18P11 goes zero – Y5/Y6 stops conducting and relay K2 is switched off. Relay K1 will follow K2 with a short delay, determined by the time constant of the base circuit of Y3 (Monitor Card).

The stepping of the program is blocked if the input signal to Y7 is not allowed to go to zero: such is the case when S1 is thrown on BLOCKED or when the HT contactor (K1, Fuse Compartment) is not energized.

4.4.6.4 Motor Sensor

The circuit diagram of the motor sensor pc board is on figure 10.12.

Inputs 4/6, 9/11, 22/24 and 30/32 are connected to the four servo motors – MF Tune, HF Tune, Load and Drive. A voltage detected biases the appropriate transistor (Y1 through Y4) to conduction and the voltage drop across resistor R37 makes Y5 conduct and switch – 24 V to 33P10 and the tuning logic stepping control. When no input is sensed, Y5 is switched off and output it zero.

4.4.6.5 Load Servo

The Load Servo circuit diagram is on figure 10.13 and its place in the full servo system is evident from figure 10.8.

The balanced amplifier is similar to the tune servo amplifiers in that unbalance signals from Y5/Y6 drive Y8/Y7 and thus bias Y9 or Y10 to conduction. Even the ac ripple voltage and the way of speed control are the same (refer to 4.4.6.1).

Input signals are pre-amplified in the pairs Y1/Y2 and Y3/Y4 to obtain the gain required. However, the gain and speed characteristics of the amplifier is changed due to the action of Card Rack relay K2 which connects attenuating network R31/Z10/Z11/C20 across the input when energized. Simultaneously the speed info is taken through additional resistor R29. When K2 falls, the input sensitivity is raised because the attenuator is removed and at the same time 11/12K2 bypasses R29 to increase the speed feedback.

4.4.6.6 D/A Converter

The digital-to-analog converter circuit is shown on figure 10.14.

The converter is based on the 2R-R method, that is an individual load of 2R (10 + 10 kohm) and R (10 kohm) in the common lead. The digital input to each transistor is 0 or 1, and thus the analog voltage steps (16 in this case) are built up over the chain of common resistors: R1, R2, R19 and R20.

4.4.6.7 Thyristor Unit

The thyristor unit – see figure 10.15 for the circuit diagram – is equipped with 3 pairs of thyristors to control the servo motors. Firing a thyristor results in negative halfcycles being delivered to the motor, and with the shunt diode of the paired thyristor responsible for circuit continuity.

The thyristor gate electrode is controlled from a servo amplifier – opencircuited the thyristor is blocked, when taken to ground potential the thyristor fires on the negative halfcycles.

Diodes Z8/Z9, Z12/Z13 and Z16/Z17 are sensing the counter-e.m.f. of the motor, for the speed feedback.

4.4.6.8 Monitor Unit

The circuit diagram of the monitor unit is given on figure 10.6, and figure 10.8 shows the circuits associated with the monitor.

The monitor senses following conditions for a proper tuning
– Tunemeter reading 40 divisions
– all motors at standstill
When these conditions are checked and both found valid, the READY relay (K2) is energized and the green READY lamp of the remote control panel lights up when the TUNE relay (K1) is switched off. If Ready has not drawn, the TUNE FAULT light comes on. The tuning period is likewise signalled because the TUNE lamp is held energized when K1 is actuated.

The monitor timer section surveys the length of the tuning period and prevents that the TUNE order stays on for more than 80 seconds – then TUNE FAULT will be signalled.

Tunemeter "T40" input to the differential amplifiers (inputs 4 and 7) is compared with the reference level to inputs 5 and 6. The comparator output is high (– 24 V) for all input levels which are above or below the "T40" level (The proper tuning of the PA is indicated as 40 divisions on the Tunemeter dial – under these conditions the Monitor reference voltage is adjusted by potentiometer R2 to obtain zero output from the comparator).

The comparator output is gated by Z1 to appear across resistor R7. The output from the Motor Sensor assembly is connected to the same resistor via diode Z2, and the de-energized Tune relay K1 switches – 24 V to R7 via diode Z3. The signals fed to R7 are either – 24 V (wrong) or 0 V (right). The high level blocks diode Z4 and differential amplifier IC1/3 output stays low, Y1 is blocked and Y2 as well.

Zeros to Z1 and Z2 cause Z4 to conduct, Y1 and Y2 are biased to conduct and the relay K2 is energized. The logic will now withdraw the TUNE order, K1 falls and K2 takes hold from – 24 V via 2/1K1 – 6/5K2.

Diode Z3 tests the validity of the "T40" check by gating – 24 V to R7 when the tune order is released. If K2 then is properly closed it cannot drop out because simultaneously it takes hold due to the same 24 V.

On the other hand, in the event that K2 has not been energized – because T40 stayed high or low – the gated voltage will efficiently prevent K2 from being actuated, even if T40 was high and, when collapsing, causes the comparator to issue a zero when passing through T40.

The Timer output at pin 3 is set to zero when the grounding of the reset line is removed. Therefore Y3 conducts and holds relay K1 (Card Rack) closed. Closing the start line to ground initiates the timed period, which at the end takes terminal 3 high and blocks transistor Y3 – K1 is disconnected.

The SERVO switch (S1, Card Rack) disconnects the timer circuit when on BLOCKED and by-passes Y3, because – 24 V is fed via 3/1S1 to 31Mon. and reaches K1 Card Rack over Z12 and pin 24Mon.

4.4.7 MF LOCAL CONTROL PANEL

Refer to figure 10.17 for the circuit diagram of this control panel.

The cable form in the transmitter cabinet which is addressed to the exciter unit connects two ways:
– either through plugs and sockets directly to the terminals located in the bottom of the cabinet (and then through the remote control cable to the exciter)
– or via the MF Local Control panel, before being passed to the terminals of the cabinet bottom.

Connector P308 faces the transmitter, while connector P330 connects the exciter. When switch S1 is set on MF LOCAL, the exciter is fully disconnected, and only MF is operative, using the controls if this panel.

MF Channel: the ground return is switched from the exciter to switch S4, wiper 18.
Coarse Tune: switched from the exciter to channel selector S4 and via the TUNE push button to ground.
Tune order: energizes relay K1 which then feeds –24 V to the Drive servo and –24 V as keying input. When the tune order is recalled, K1 switches –24 V to S3 POWER.
Power output: controlled from S3, the signals to the attenuator relays are gated through diodes Z1 to Z3 – the corresponding orders when sent from the exciter are using diodes Z4 to Z6, but –24 V to 40P330 is switched off on MF Local.
Band selection: the MF wire to 4P308 i made high via Z7 as soon as S1 is set on MF local. Because of this the PA band switch will home on MF. The selection of MF from the exciter is gated by diode Z8.
Keying: is from a morse key plugged into jack J1, and will only affect MF.

4.4.8 REMOTE CONTROL PANEL

The remote control panel, figure 10.18, contains the push button switches S1a, b, c to select OFF, STAND-BY and TRANSMIT (via relays K4 and K5 of the LT Power unit).

Rectifier Z4 is fed 24 V ac from the exciter when the transmitter is off, and then supplies a rectified voltage to S1 to energize the standby or transmit relays, before the feed is taken over by the LT Power unit – 24 V supply.

Meter MT1 is connected to indicate either the antenna of the transmitter or the current drawn from the HT rectifier (Cathode Curr).

The Antenna switch, S2, is fed – 24 V from the un-grounded power unit of the transmitter, and selects one of the 8 positions, making the line high. LED lamps SL1–SL8 display the position selected at the front panel chart giving operation instructions.

Three "traffic lights" located on the panel are signalling the operational state of the autotuning devices:
Green light – READY: tuning successfully completed
Red light – TUNE FAULT: tuning failed (try a new TUNE order)
Yellow light –TUNE: tuning order effective.

CHAPTER 5

ROUTINE MAINTENANCE

5.1 GENERAL

This chapter contains information about service test equipment required and routine maintenance procedures which can be performed by anyone with a good general knowledge of radio equipment.

Should troubles occur which are not covered under the scope of this chapter, consult a qualified service agent. He will be able to troubleshoot, repair and align the set with the aid of the following chapters of this manual. The operator, however, is requested to study the first part of the Troubleshooting Instructions, in order to localize the fault as far as possible, and therefore be able to convey the best possible fault description to the service agent in advance.

5.2 PART REPLACEMENT

Common items listed in the parts lists should be obtained locally or from a service agent. Special components used should be ordered from the manufacturer. Identify components by Part Numbers as given in the Parts List. When in doubt or when ordering parts which are not listed, order by complete description, model of equipment, serial number or date when unit was delivered.

5.3 TEST EQUIPMENT AND SPECIAL TOOLS

Following is a list of test equipment and special tools necessary for maintenance of the radio equipment. Equivalent substitutes are acceptable.

NOTE

Instruments item a. and b. are prime requirement for servicing this equipment.

A combination multirange meter such as CONWAY 639 with RF probe and suitable attenuator probes may be a good compromise – confer the exciter requirements.

Other meters items d. through f. should be available at well-equipped service workshops to be able to undertake major repairs.

a. General purpose ac/dc testmeter, sensitivity 20 kohm/volt or higher. – METRIX MX202B.

b. Rf electronic voltmeter, for low to medium level measurements, with T-connector and 50 ohm termination plug. – BOONTON ELECTRONICS model 91C.

c. Earthing stick, with banana plug termination. – ELIT

d. Oscilloscope, bandwidth 15 MHz min.

e. Rf signal generator, 1 V output, min. 25 MHz.

f. Dummy load for 50 ohm, min. 1 kW continous, complete with power meter. – BIRD Tenuline and Thruline.

5.4 TRANSISTORS AND INTEGRATED CIRCUITS

Be careful not to damage transistors and integrated circuits when testing or servicing. These components are easily damaged when electrodes are shortcircuited by too heavy test prods. Another cause of damage is when a potential exists between a soldering iron or test equipment and the equipment chassis.

Do not remove or replace components with power switched on. Always seek the real cause of a failure – it may not be the transistor in itself.

Transistor and integrated circuit base configurations are given in figure 5.1 and table 5.1 lists semiconductors by type, references the case type (metal or plastic e.g.) and references the corresponding base view in figure 5.1.

5.5 ACCESS TO INTERIOR

Access to the units which are mounted on telescopic runners is immediate once the front panel screws have been unscrewed. The runners lock automatically when fully extended. The LT Power unit, the Exciter and the Power Amplifier units are mounted this way.

Fuse compartment fuses become accessible when the removable cover on the lowest front panel is taken away. The HT Power Supply is installed in the cabinet bottom, and behind the fuse compartment/Card Rack. For access, either remove the LT Power unit and/or the Card Rack.

The Card Rack is behind the second panel from the bottom, and is held by 4 screws.

The Antenna Switch/MF Variometer becomes accessible after removing the uppermost front panel.

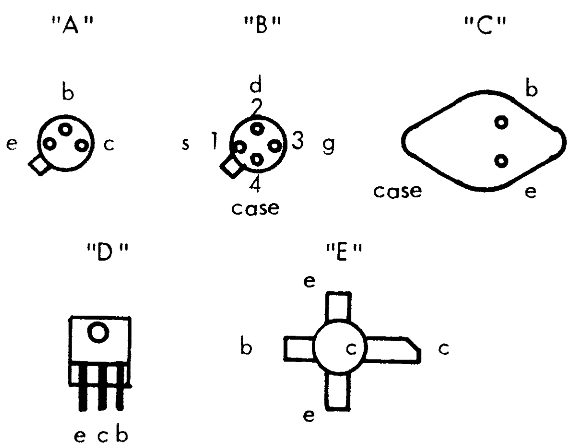


Fig. 5.1 - Semiconductor Base Views

5.6 PREVENTIVE MAINTENANCE

Preventive maintenance should involve items as per below:

- mechanical parts subjected to wear, such as rotary switches,
- Electromechanical components, such as contactors or relays,
- Components subjected to dust or contaminations, such as blowers.

Rotary switches:

apply a small amount of grease on the detent mechanism if the switch tends to stick. If contacts are stained to the extent that operation is harmed, use carbon tetrachloride sparingly to clean.

CAUTION

Do not allow a dissolvent such as carbon tetrachloride to spread to plastic parts.

Semicond.	Type	Base view	Case type
2N1613	npn	A	M
2N1893	npn	A	M
2N2219A	npn	A	M
2N2905A	pnp	A	M
2N3553	npn	A	M
2N4036	pnp	A	M
2N4416A	n-ch fet	B	M
2N4912	npn	C	M
2N5415	pnp	A	M
BC107B	npn	A	M
BCY30	pnp	A	M
BD137	npn	D	Tab
BDX60	npn	C	M
BLX13	npn	E	capstan
MJ1001	npn	C	M

Table 5.1 - Semiconductor Types

The application of a contact oil is rarely justified, and it must then not contain silicon components. ELECTRO-LUBE Brand 2A may be employed.

Relays:

inspect contacts occasionally to detect signs of contact burns. If deemed necessary (for instance to clear a real fault) polish the contacts with a contact burnisher (PK Neuses Inc., model 3-316). Do not use files or other abrasives.

Blowers:

inspect for smooth running and remove dust and other contaminents accumulated in the rotor. Use a small brush for cleaning.

Variable Inductors:

sliding contacts running on the front contact disc should be cleaned if contaminated. If dry apply some high grade vaseline (non-acid) or possibly Electrolube Brand 2A to the disc contact area.

WARNING

Never oil the contact wheel, its bearings or the rod carrying the wheel. Oil will immediately destroy the contact properties necessary for proper operation.

Wipe off contaminents from the contact wheel and from the rod, using a dry linen cloth. Refer to chapter 7 for repair instructions.

Servo Motors:

Servo motors and associated gears have been adequately greased when manufactured and should not normally require routine service. Inspect them when operating to check that they run smoothly and evenly both in clockwise (CW) and counterclockwise (CCW) direction. Should regreasing be required, use only ROCOL A.S.P. Special grease.

Sub-unit and Location	Fuse design	Rating & Dimension	Function, remarks
Fuse compartment, behind removable front cover	F1,2,3	16 A DII slow/220 V	Transmitter main fuses (10 A/380 V)
	F4,5,6	4 A DII slow	Transmitter single phase loads
	F7,8 · F9,10	depends on assigned service, type DII	External radio equipment
	F18	2 A, 8.3x85 mm	2 kV output protection
HT Power Supply pc board on transformer	F1,2,3	1 A, 8.3x85 mm	HT transformer secondary protection
LT Power Supply front panel	F1	200 mA, 5x20 mm	1000 V output protection
	F2,3	4 A, 5x20 mm	Motor ac supply prot. (Tune & Load)
	F4,5	6.3 A, 5x20 mm	Motor dc supply prot.(Band switch)
top of transformer T1	F6	6.3 A, 5x20 mm	+28 V rectifier protection
	F7	4 A, 5x20 mm	-24 V rectifier protection
	F8	0.5 A, 5x20 mm	bias supply rectifier protection
Exciter Unit, rear panel	F1,2	630 mA, slow,5x20 mm	AC mains input protection

Table 5.2 LOCATION OF FUSES

5.7 LOCATION OF FUSES

Fuses are located in different places in this equipment. Figure 5.2 summarizes locations, type, rating and functions.

5.8 PERFORMANCE TEST

The performance test of the transmitter is usually carried out using the built-in dummy loads or possibly the antenna. Note that on the HF bands, the output is limited to 400 W peak when the dummy load is switched in.

NOTE

It is always presumed that the exciter has been tested on its own and found good before the performance of the transmitter is evaluated.

The complete performance test covers the operation of the servo circuits and the operation of the transmitter power amplifier. Thus it is possible to distinguish three levels of performance: all systems, servo systems and rf amplifier systems.

5.8.1 SERVO SYSTEMS

Operate the transmitter on AUTO, using the dummy loads for MF and HF/MHF bands. Remove the lid from the PA front panel to be able to watch the operation of the motors and to reorder TUNE from the power amplifier. Should it be necessary to study the individual steps of the servo program closely, remove the front cover plate of the Card Rack to get access to the SERVO switch.

While the tuning process is progressing, watch closely to check that the behaviour is fully normal:

Step No 1:	TUNE & LOAD to start positions
Step No 2:	TUNE to resonance, above 40 on the TUNEMETER. LOAD inoperative.
Step No 3:	LOAD starts, loading to T40 and TUNE simultaneously operating to keep resonance.
Microtuning:	after Step No 3 and during a short moment, TUNE and LOAD fine-tuning.

If blocked by the SERVO switch on Step No 3, the Test-meter readings on 8 MHz should conform to those given in table 5.3 under the TUNE column.

5.8.2 RF POWER AMPLIFIER

Tune the power amplifier – automatically or manually in the event of a servo failure – and check the meter readings against table 5.3, using the appropriate column.

5.8.3 ALL SYSTEMS

This test is merely a combination of para 5.8.1 and 5.8.2, and represents the ordinary conduct.

5.9 REPLACING TUBES

To replace a faulty or worn-out rf power amplifier tube, use the procedure described below.

Note that holes are provided in the PA unit side bracket to allow a screwdriver to be inserted and reach the set screws of the tube anode connectors. Unfortunately when hanging in the telescopic runners, the holes are blocked and the PA chassis has to be lifted slightly to unblock the four holes.

WARNING

The anodes are at 2000 V dc in operation. Therefore always shortcircuit to ground before touching the anode circuit. Do not relay on the proper operation of switches or contactors or interlocks – one mistake may be fatal!

a. Loosen the set screw holding the tube anode connector. Extract the slotted metal tube to free the socket, taking care to locate the key properly: do not turn the tube in the socket. Replace the anode connector, fasten the set screw and proceed with adjustments.

b. The adjustment is to be made without rf drive to the power amplifier. Therefore, set controls accordingly.

Tuning	–	MAN (PA unit)
Emission	–	FS (not driven)
Key	–	Morse key or Test key closed

If in doubt, unplug the coaxial connector from the exciter (HF/MHF, yellow).

Measurement & full scale defl.	Position	8 MHz no drive Note 1	TUNE	Power 5 key down	key up	MHF A3H carr.	Dummy Load MF A1 Note 3	8 MHz A1 Note 4
RF drive to PA grids	Drive actual:	0	40	70	0	25	40	45
PA grid current	Ig1 actual:	—	—	≈2	—	—	—	—
screen grid voltage (500 V)	Vg2 actual:	70	70	68	70	70	70	70
grid bias voltage (200 V)	Vg1 actual:	30	30	30	47	30	30	30
anode voltage (2500 V)	2000 actual:	82	80	78	82	80	78	78
Cathode currents of the individual PA tubes (500 mA)	V1Ic actual:	18-20	30	53	0	26	35	35
	V2Ic actual:	18-20	30	53	0	26	35	35
	V3Ic actual:	18-20	30	53	0	26	35	35
	V4Ic actual:	18-20	30	53	0	26	35	35
+28 V supply (50 V)	+28 V actual:	60	60	58	60	60	60	60
-24 V supply (50 V)	-24 V actual:	48					48	48
Load coil position, see Note 2.	Load Pos.							
TUNEMETER	div.	---	40	X	---	X	(50)	(50)
PA CATHODE Curr.	mA	530	800	1200	150	700	1000	960
ANT. CURR.	A						9.7	

Note 1: Test with the Exciter on FS and no external drive applied.

Note 2: Only on ST 1610A, gives Load coil position from "100" (CCW stop) to "0" (CW stop).

Note 3: Figures refer to factory-set output power - observe possible onboard adjustment.

Note 4: Same conditions as in column No. 5, but now POWER 4.

Table 5.3 - PA TESTMETER, Normal Readings

c. Open the LT Power Supply and withdraw the Power Amplifier. Set the panel interlock switches in service position.

d. Switch to STANDBY and allow about 5 minutes for tube heater equilibrium.

e. Set PA testmeter on Vg2 and push TRANSMIT. Adjust R34 SET Vg2 (LT Power supply chassis, to the right) to read 70 divisions on the meter (350 V).

f. On the Power Amplifier driver chassis, locate the four holes of the bias controls.

g. Switch PA testmeter successively to positions V1 Ic through V4 Ic and read the standing feed of the tube. Correct value is 18–20 divisions (90–100 mA). Realign simultaneously, on the appropriate tube bias control, using a small screw-driver. Potentiometer shafts are made from plastic and visible behind the holes in the cover plate).

h. When all four tubes have been aligned, switch off, set Tuning on AUTO and reinsert the PA and LT Power Units.

NOTE

A tube failure due to an internal short-circuit may blow the cathode resistor of the tube. Therefore inspect the cathode resistor (made up from four 10 ohm resistors in parallel for each tube, dc resistance to ground thus 2.5 ohm), if abnormal results are obtained.

CHAPTER 6

TROUBLESHOOTING

6.1 GENERAL

The first step in troubleshooting a defective radio set is to isolate the fault to a particular section or assembly. The second step is to localize the fault or defective part responsible for the trouble. Some faults, such as burned-out resistors, arcing and shorted circuits may be found through visual inspection. However, the majority of problems will have to be located by logical troubleshooting procedures, including checking stage output levels and dc voltages.

Dc voltages significant for troubleshooting are given in the circuit diagrams. Significant signal levels are given in this chapter along with necessary details for set up and are arranged in logical sequence to facilitate effective troubleshooting. Both dc and ac levels may deviate to some extent from the nominal values given, expecially if the power source has a voltage different from the nominal rated input voltage of the set. Some voltages are effected by control settings, and all voltages may vary by as much as the tolerances of the components in the circuit. These deviations are to be expected and are of no major consequence.

Paragraph 6.3 provides a generalized troubleshooting procedure to help in locating the faulty functional section and some simple problems.

6.2 PRECAUTIONS

Following are some general rules to observe in troubleshooting the set. Due to the wide use of transistors and printed circuit boards, it is suggested that these rules be observed closely to prevent damage and to aid in troubleshooting.

1. In solid state circuits, the resistances and impedances are generally of much lower values than in tube type circuits. A discrepancy of a few ohms can affect performance. Also, transistors can be damaged by high current of high voltage ohmmeter circuits. Therefore, use only the low resistance ranges of the ohmmeter, and use a meter with a sensitivity rating of 20 kohm/volt or greater to make accurate measurements and to avoid damaging transistors or integrated circuits.

2. Transistors are best checked in the circuit, using ac and dc voltage indications for troubleshooting. Ac signal levels are given in the remaining paragraphs of this chapter together with test setup information, and dc voltages are marked on circuit diagrams in chapter 10. Be sure to check the emitter resistor voltage drop and the base bias. Change in transistor bias may be causing a problem if a resistor has been overheated or has otherwise changed value or is shorted or open.

3. A transistor can be checked out of the circuit with a sensitive ohmmeter as follows:

To check a PNP transistor, connect the positive lead of the ohmmeter to the base of the transistor, connect the negative lead to the emitter and then to the collector. Generally a resistance reading of 50 kohm or more should be obtained. Reconnect the meter with the negative lead to the base and the positive lead connected to the emitter. A resistance of 500 ohm or less should be obtained. When the positive lead is connected to the collector, a value of 500 ohm or less should likewise be obtained. With the positive lead on the collector and the negative lead on the emitter, the resistance should be high.

Similar tests are made on an NPN transistor, and in that case should produce similar results with opposite polarity. With the negative lead on the base and the positive lead on the emitter or collector, the resistance should be high. With the positive lead on the base and the negative lead on the emitter or collector, the resistance should be low. With the negative lead on the collector and the positive lead on the emitter, the resistance should be high.

NOTE

If a transistor is found defective, make certain that the circuit is in operating order before installing a replacement transistor. If the malfunction is not corrected, putting in another transistor will most likely result in burning out the new component. Do not depend upon fuses to protect transistors. Never remove or replace a semiconductor device with the voltage applied. Transients thus produced can damage them.

4. Do not use grounded test instrument with sets operated from positive ground dc systems, since a ground connection to a COMMON 1 or 2 line can short the power source. If necessary, completely isolate the set from ground before connecting test equipment.

5. Care must be exercised, when checking transistor circuits, not to short the leads to the case or surrounding circuits. It is usually convenient to use the lead of a resistor connected to the transistor element as a test point. This is preferred to trying to get at the transistor lead itself. Suitable test points are marked on the pc board and in the circuit diagram.

6. The equipment was accurately aligned at the factory. Many of the adjustments are critical, and are not necessarily adjusted for maximum output indication. Some require special test equipment and test set-ups. Random adjustment of controls and tuned circuits does not aid in troubleshooting or in "optimizing performance". Alignment should be performed only when necessary after repair or accidental disturbance and then only according to chapter 8.

6.3 LOCATING THE FAULTY FUNCTIONAL SECTION

6.3.1 GENERAL

Following is a logical procedure for isolating the fault to a functional group. This procedure will lessen the amount of work in finding the problem by leading to one particular circuit area. The dc and ac signal level checks should reveal the faulty component.

a. Operate the transmitter from its normal power supply.

b. Carry out performance tests, as indicated in para. 5.8. Enter the results of the test in figure 6.1 to determine how to proceed.

6.3.2 TRANSMIT & NO DRIVE TEST

Under certain conditions it is essential to operate the transmitter with 2 kV switched on and positively avoid signals which would drive the power amplifier to deliver output. One example of this is when setting up the quiescent current in the four power tubes.

The most convenient way of assuring that a channel is not driving the PA (or only driving to the A3J carrier level, less than 100 mV output power), is to select "FS" on the exciter, and of coarse disconnect any audio modulation fed to the FS input terminals.

Note that the FS mode may be switched to key the transmitter continously (duplex) or to key the transmitter externally, preferably through the "TT Control" terminals of the exciter (simplex operation).

If during the testing the HT fuse blows, refer to para. 6.3.6 for additional information.

6.3.3 INTERLOCK TESTS

Failure to execute a command given will usually be due to an opencircuited interlock function. Check circuits using the simplified circuit diagram, figure 4.5.

Note that other problems could be due to an interlock refusing to disconnect the circuit when it should be broken. Try these problems using figure 4.5 as well. Examples of this type of failure are: Mechanically blocked or distorted switches, a contactor which refuses to break immediately due to armature adhersion to the core, or shortcircuited leads.

6.3.4 DRIVER TESTS

The objective with the tests is to check the operation of the Driver Servo and the Driver Amplifier gain, relaying on Testmeter DRIVE reading and the TUNEMETER reading.

The drive servo operates on TUNE only, and has been adjusted on 8 MHz to the centre of its range of control (attenuator potentiometer R38). This position has been marked in ink on the motor shaft and the body of R38.

When R38 is turned to the opposite position, a quick change between maximum and minimum attenuation is obtained. This may be noticed on DRIVE and anyway on the TUNEMETER when tuning the PA (the loading of the circuit due to DRIVE may prevent the extreme situation to arise).

The transmitter cannot be properly tuned if the Drive servo cannot come to a stop.

Realignment procedures are described in para. 8.3. It is, however, very important not to touch these controls:

– the potentiometer R30, "Grid excitation", on the Driver Servo

– the potentiometer R30, "Drive level meter", on the Matching network,

– the potentiometer R25, "Tunemeter", on the Matching network.

If any of these has been changed, important calibration points are lost, and a full recalibration to para. 8.3 must be performed.

6.3.5 DRIVE CONTRA LOAD ERRORS

When the power amplifier drive level is correct, the grid current on A1, Power 5, is zero or low, below 10 divisions on testmeter pos. Ig1. On A3J and full modulation, up to 30 divisions is acceptable. Grid current in excess of the figures mentioned above suggests an improper drive level. The fault may be attributed to wrongly adjusted drive level or Drive meter controls.

A loading error may be obtained although the grid rf drive is properly applied. It is either the case of too heavy loading, causing excessive cathode current to float, or too light loading, causing a distinctive Vg2 drop. Both conditions may be explained by a wrong TUNEMETER calibration.

6.3.6 TUBE PROBLEMS

a. The four tubes are normally within 10% with respect to cathode currents under drive conditions. If one tube is definitely outside, replace by a new one.

b. Observe that an internal shortcircuit in the tube may damage the cathode resistors of the specific tube. If so the testmeter Ic reading will deflect the meter needle heavily – be cautious! Visual inspection or resistance check will reveal the faulty resistor(s).

c. The decoupling mica capacitor which is built into the tubeholder may break-through and shortcircuit the screen grid to ground. When testing for insulation, remember that the screen grid is brought to an external ring which in the tubeholder connects to the finger springs of the capacitor (when the tube is not seated there is no connection at all to the capacitor from pin No. 1, the screen grid terminal).

6.3.7 SERVO TEST STEP NO 1

First prepare the equipment for the test:

a. Operate on the Dummy Load unless there are reasons to suspect that the problems are associated with a particular antenna.

b. Set the Tuning Switch of the power amplifier (behind the removable lid) on MAN.

c. Select frequency and emission on the Exciter. Start on the 8 MHz band unless the problems are specifically related to another band.

d. Switch on TRANSMIT.

e. Set Tuning on AUTO. – In this way the automatically issued TUNE order has been avoided, but will be obtained when pushing the TUNE push button.

When the change of frequency is from the MF band to the HF band or vice versa, both TUNE servos will be involved in Step No 1 the first time tuning is ordered (then the servo not to be used is parked CCW).

For the load servo, specific start turns have been selected on HF and set on the program cards. Check that the Testmeter LOAD POS. readings are the same on all bands as when originally programmed. The Dummy load start is given below in table 6.1.

Unless the binary number has been changed (check the diode combination on the pc card, confer table 2.3) the readings must be the same as when first installed. A fault condition may be attributed to a leaky diode on the program card, affecting several bands, a faulty or maladjusted Load coil servo potentiometer or faults in the digital-to-analog (D/A) converter. The proper program to go with the antenna selected is ordered from the Antenna Switch.

6.3.8 SERVO TEST STEP NO 2

There are three definite prerequisitions for this step to work:

a. Rf drive from the exciter and from the driver amplifier. The PA Testmeter on DRIVE must show 40, and the reading must be steady, proving that the Drive servo has stopped.

b. Anode and screen grid voltage: check the Testmeter positions "2000" and "Vg2".

c. A proper load at the output of the power amplifier: the dummy load or one of the ordinary antennas.

Note that as a general rule the initial loading of the amplifier – as set in Step No 1 on the LOAD control – chould be light enough to achieve that the resonance peak takes the Tunemeter reading above 40 divisions.

If the peak is slightly below 40, the LOAD coil must unload (go CCW) in Step No 3.

Especially on MF, if the Tunemeter stops below 40, check manually if this is consistent with true circuit resonance. When not resonance, try Step No 2 again, but then push lightly on the brake of the MF Tune servo motor to increase the torque and possibly stop on the true resonance. Refer to para. 2.11.6 for a discussion of means to improve operation in such cases.

On the other hand, should resonance be passed, the MF Tune servo may keep turning until the TUNE order is withdrawn. Check the MF Tune Amplifier balance, using chapter 8.5.

6.3.9 SERVO TEST STEP NO 3

As mentioned in para. 6.3.8, the Load start normally has secured that the coil will have to increase the loading, that is go clockwise (CW). The Tunemeter reading then starts high and drops to "T40".

A reading below "T40" signifies too high loading and therefore the LOAD coil has to go counterclockwise (CCW). This is possible, unless the coil is already on maximum inductance – which is the rule on MF – in that event there will be no action at all in Step No 3 (but a TUNE FAULT signalled when the Monitor is employed).

Band	Binary No.	LOAD POS.
1.6 - 1.99	0	100
2.0 - 2.49	3	82
2.5 - 2.99	0	100
3.0 - 3.49	3	82
3.5 - 3.99	6	63
4	5	69
6	10	38
8	10	38
12	11	32
16	11	32
22	11	32
25	11	32

Table 6.1 - Dummy Load Start

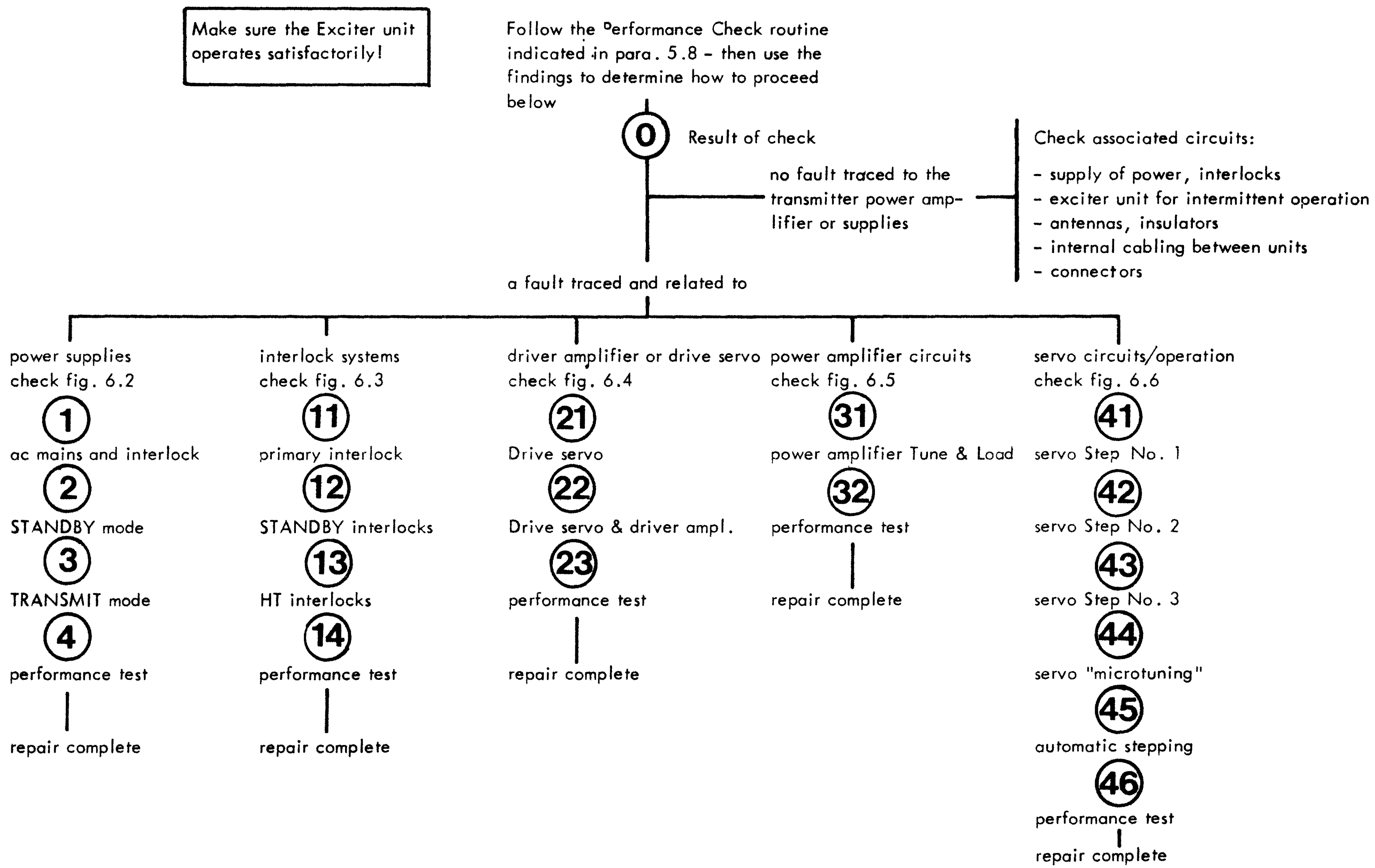


Figure 6.1 - REPAIR SEQUENCE GUIDE

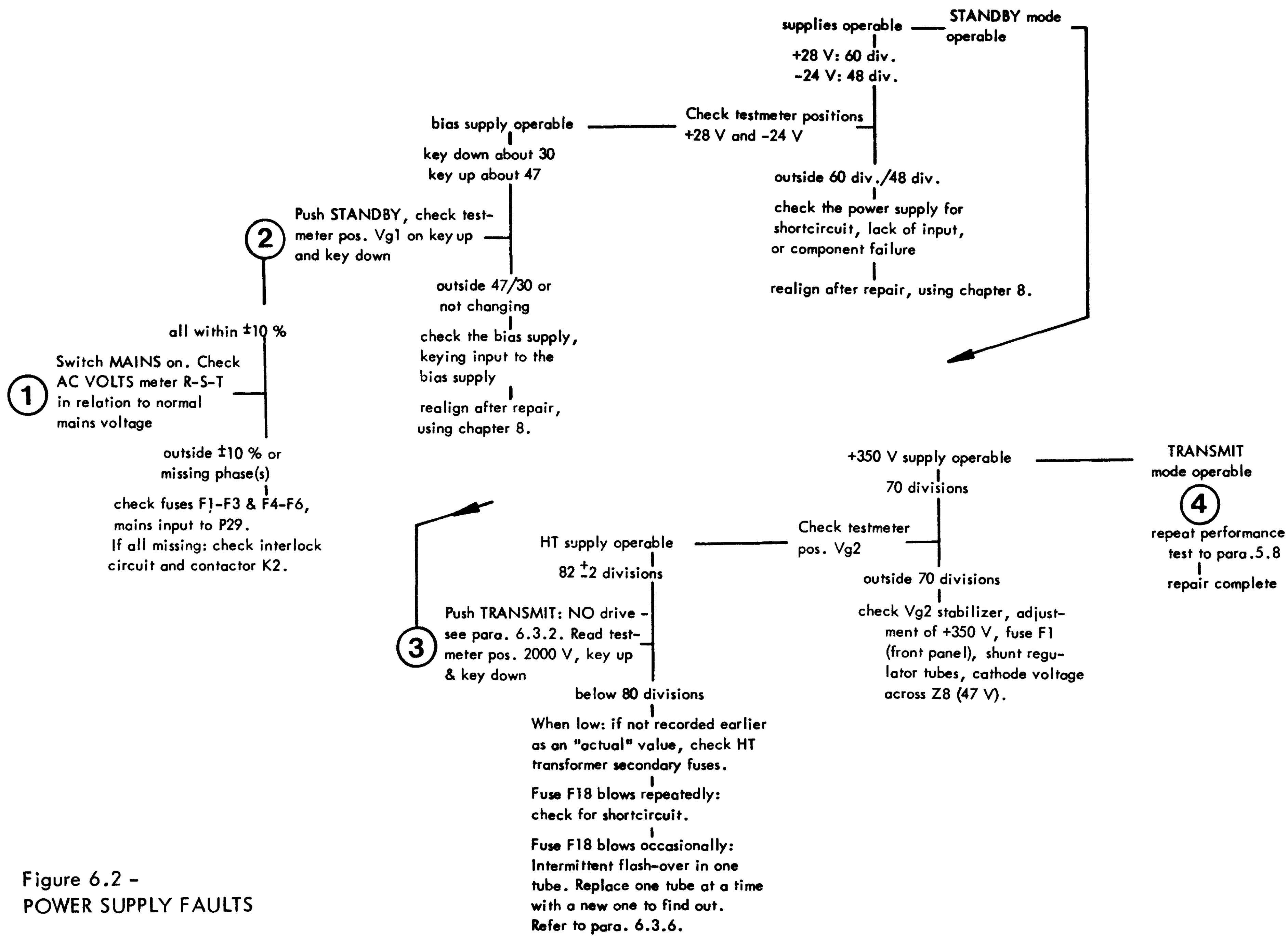


Figure 6.2 -
POWER SUPPLY FAULTS

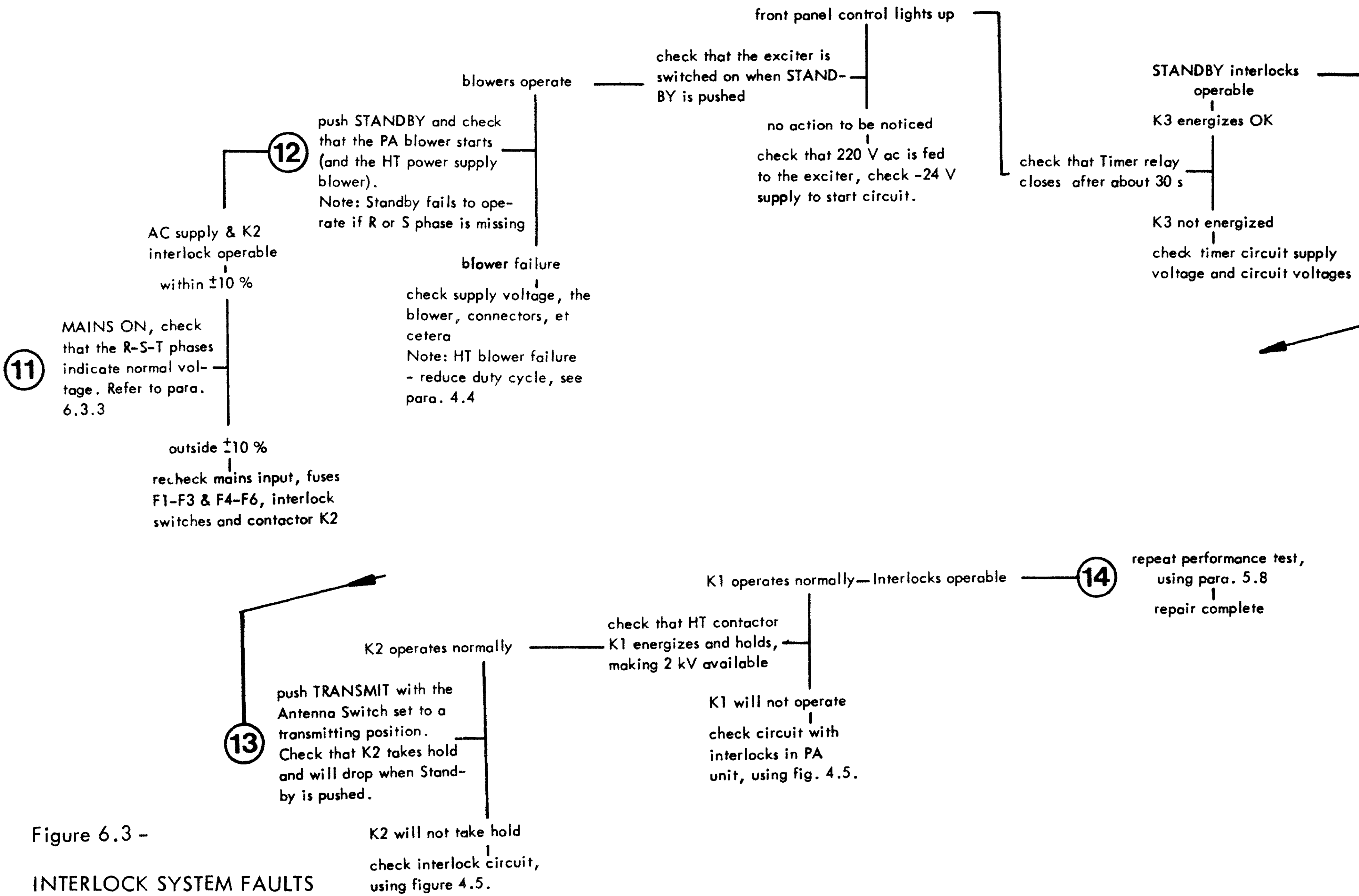


Figure 6.3 -

INTERLOCK SYSTEM FAULTS

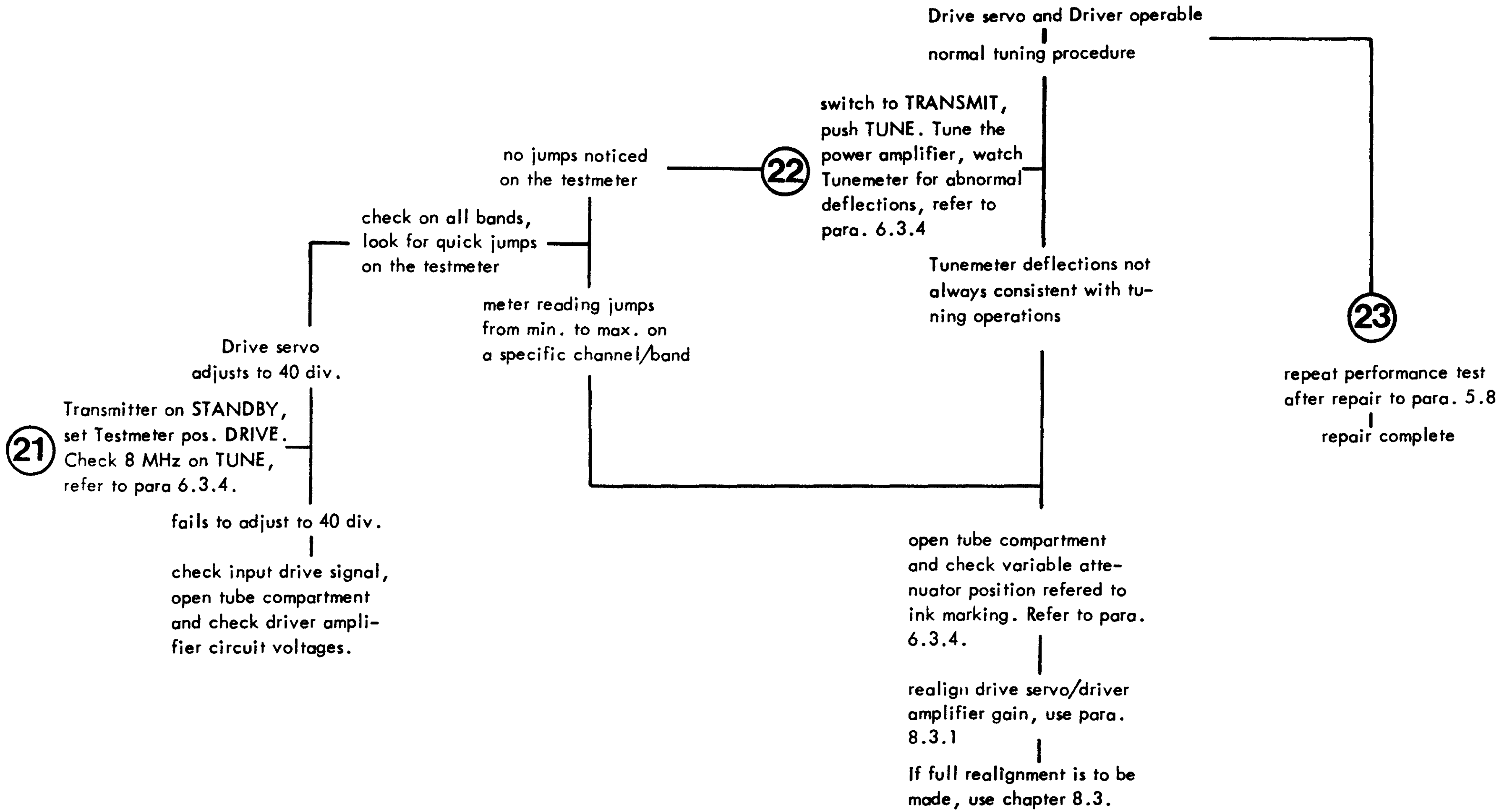


Figure 6.4 - DRIVER AMPLIFIER or DRIVE SERVO FAULTS

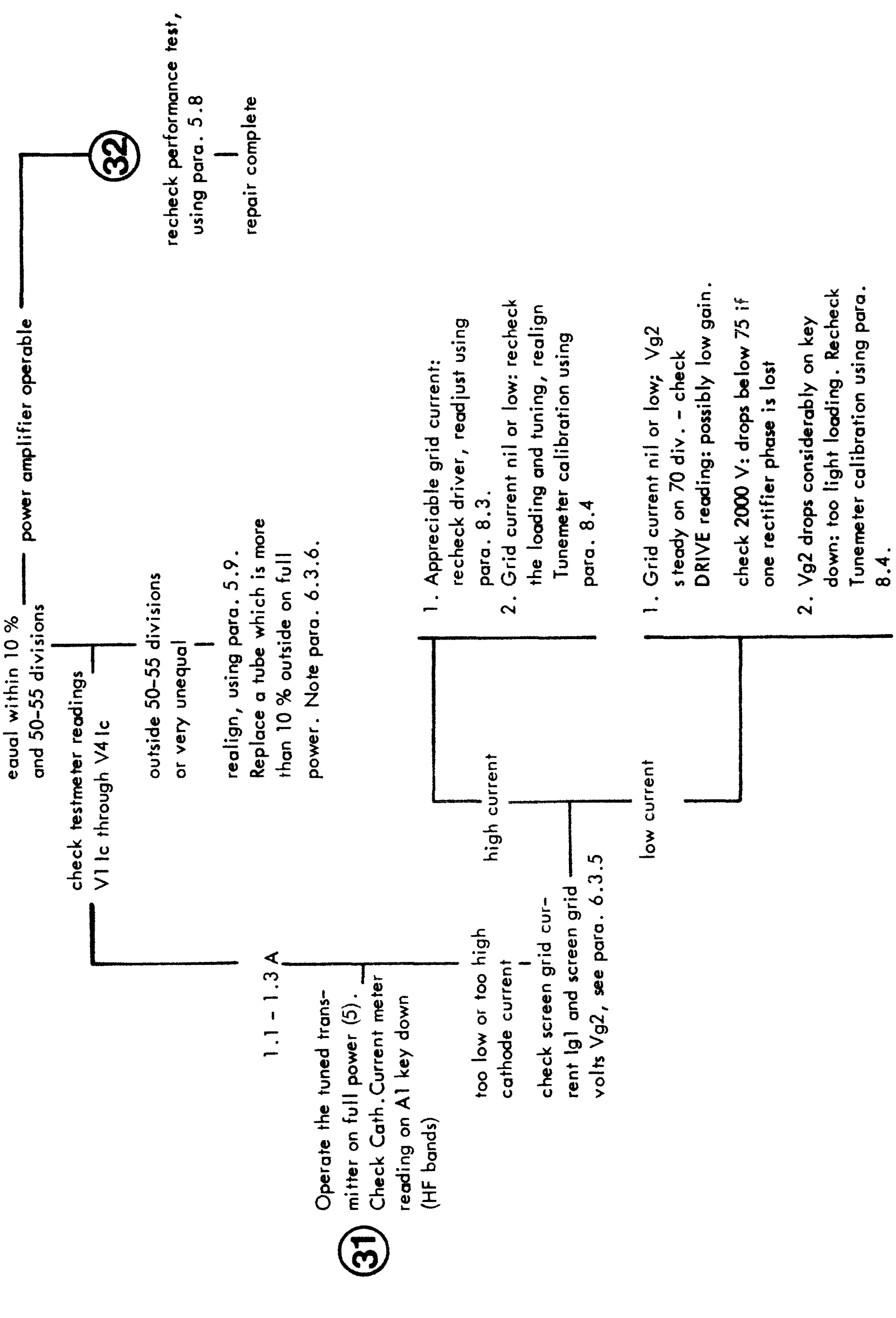


Figure 6.5 - POWER AMPLIFIER FAULTS

(6 - 10 not assigned)

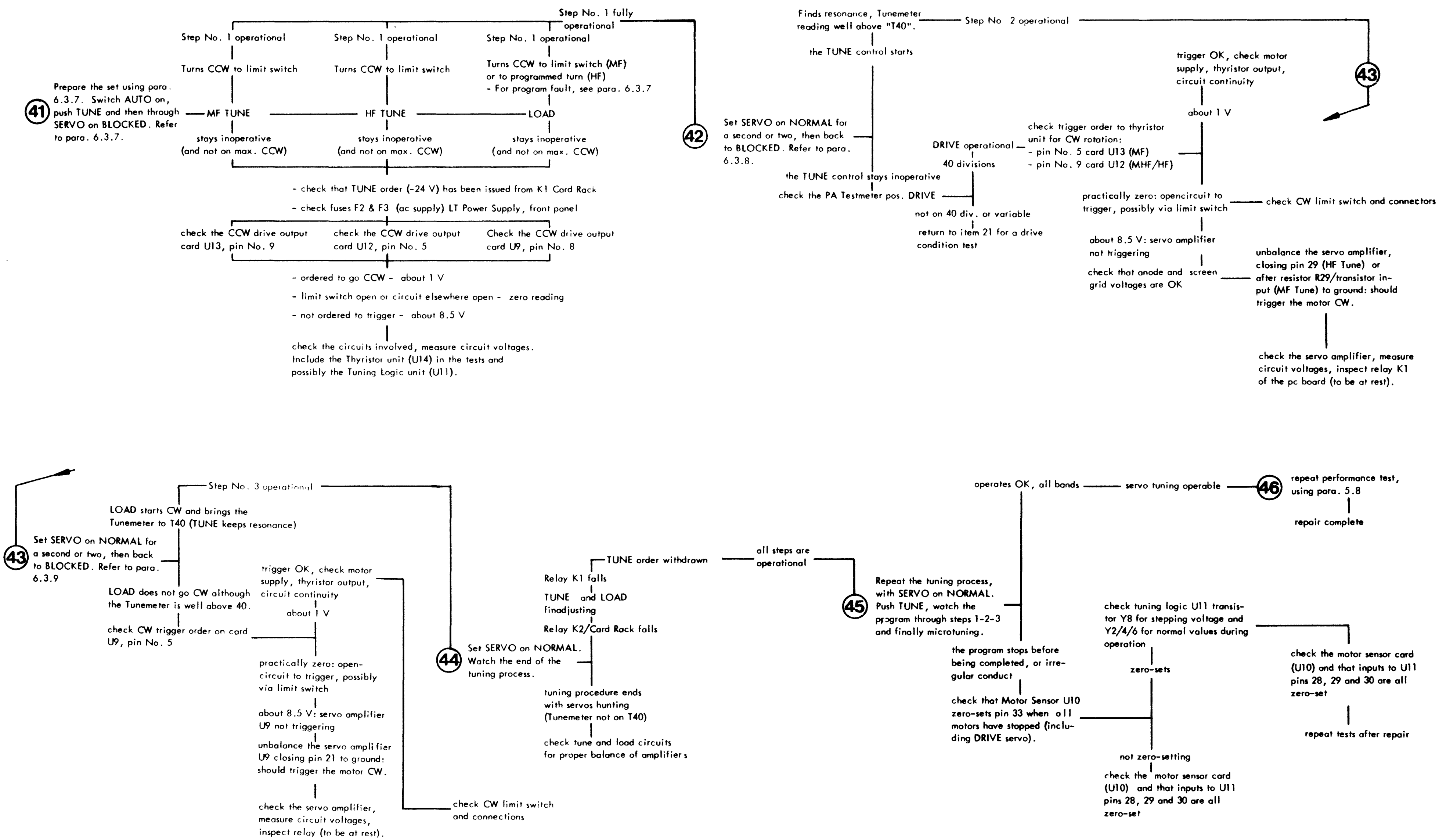


Figure 6.6 -
SERVO OPERATION FAULTS

CHAPTER 7

REPAIR

7.1 GENERAL

This chapter contains information to aid in repairing the set after the problem has been discovered. This paragraph contains some general information on repairing solid state equipment, and the remaining paragraphs each describe methods for removing, dismantling and replacing a particular assembly in the equipment.

Special handling of printed circuit boards and semiconductors is necessary to avoid damaging these parts. Use only a low-heat soldering iron when installing or removing soldered-in parts. When removing a part from a printed circuit board, first unbend the crimped leads. Use only the necessary amount of heat to unsolder the part. Clear excess solder from mounting eyelets, making sure that mounting holes are clear before installing the new part. When removing a transformer or other part having a multiple of leads, straighten all leads first and then heat leads one at a time, working around the part, until the part can be gently rocked out. A solder sucker type of desoldering iron will greatly simplify removal of multiple lead components.

Note e.g. that a toothpick can be used to clear molten solder from holes.

When installing or removing a soldered-in semiconductor, grasp the lead, to which heat is being applied, between the solder joint and the semiconductor with long-nose pliers. This will dissipate some of the heat that would otherwise conduct into the semiconductor device from the soldering iron. Make certain that all wires soldered to semiconductor terminals have first been properly tinned, so that the necessary connection can be made quickly. Excessive heat will permanently damage a semiconductor.

If the copper-foil wiring is damaged, a piece of small buss wire can be used to bridge the gap. Bridging by tin only is not adequate. It is seldom necessary to replace a board because of foil breakage.

Capacitors, resistors, and other two lead components can be replaced without removing the old leads, using the following procedure. This method is not as good as when removing old leads, but can sometimes be used to advantage if access to the printed side of the board is difficult.

a. Cut the component in half with diagonal cutters.

b. Crush the remains of the component, and break the pieces away from the leads. This will leave the maximum lead length remaining.

c. Bend the leads close to the board to form a terminal loop.

d. Connect the leads of the new component to the terminals formed by the old leads, and solder the connection. Be careful to dress the leads so they do not contact nearby leads.

7.2 HT POWER SUPPLY

a. To take out the HT Power supply, first dismount the Card Rack, the LT Power supply, and the Exciter (or MF Local Control panel).

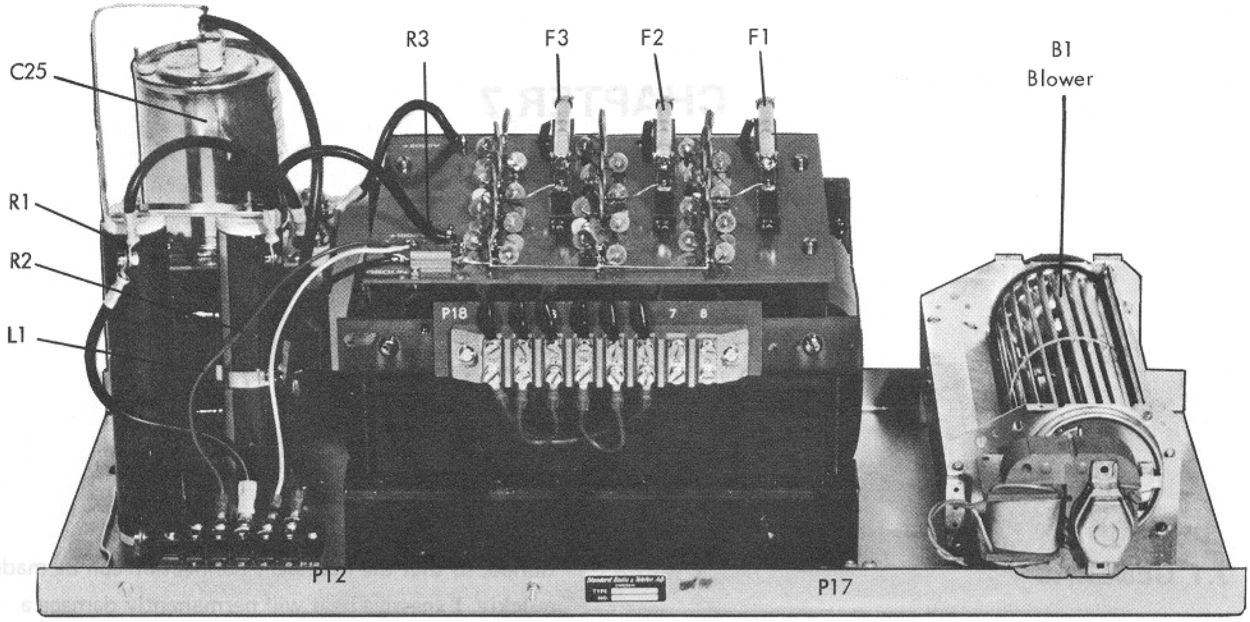


Fig. 7.1 - HT Power Supply

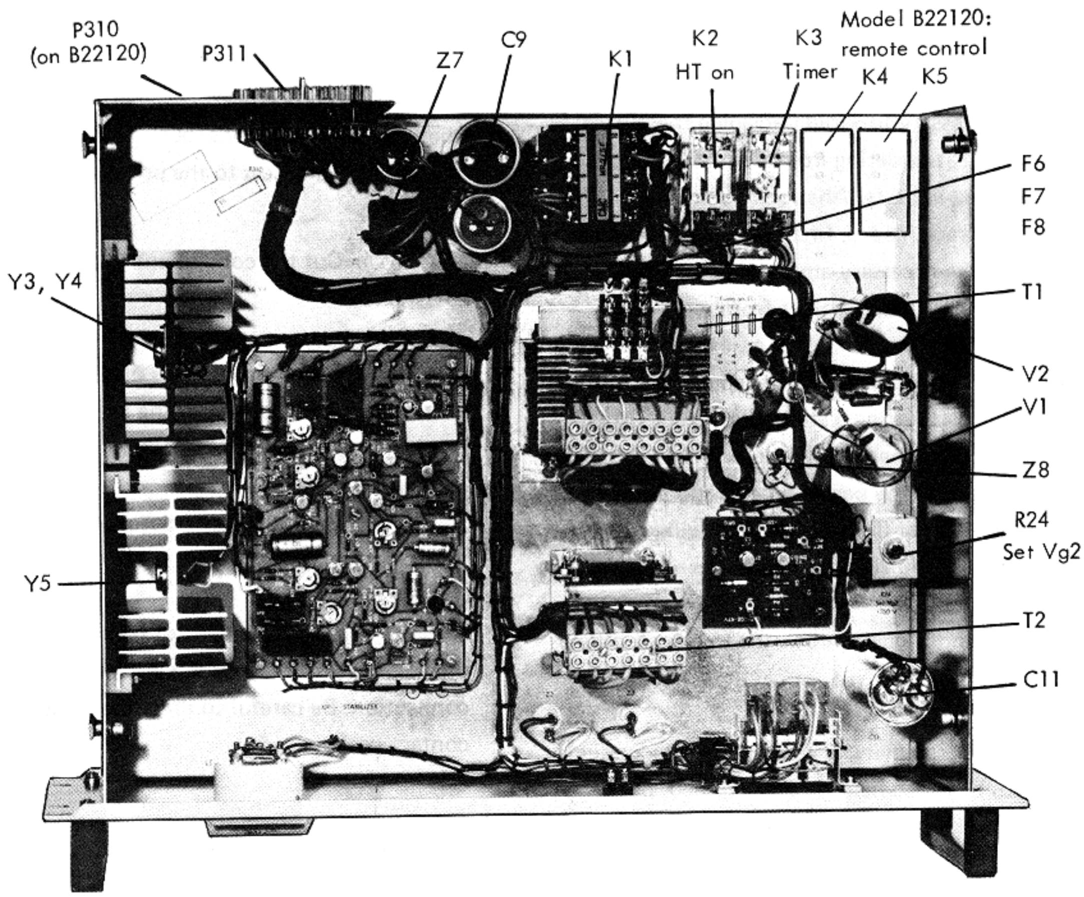


Fig. 7.2 - LT Power Supply, top view

b. Dismount the protective plastic glass behind the Fuse Department and disconnect the leads from the HT unit terminal boards.

c. Unscrew the four screws which secure the chassis of the unit to the cabinet. There are no nuts to come loose, but threaded inserts pressed into the outfits of the cabinet.

7.3 DRIVER AMPLIFIER

The driver amplifier pc board is mounted on a heat dissipating chassis and power transistors are screwed directly to this as well as soldered to the pc board. Thus great care must be exercised when disassembling and assembling the unit.

7.3.1 DISMOUNTING

a. Unsolder the input and output coaxial cables, the +28 V and ground leads.

b. Identify the two screws which secure the unit to the tube compartment chassis. Unscrew and take the driver assembly out.

7.3.2 REPLACING rf POWER TRANSISTORS

To replace an rf power transistor, proceed as follows:

a. Unsolder the screen plate which covers Y3 and Y4 to expose the transistors.

b. From the under side of the chassis, unscrew the nut of the appropriate transistor, using a suitable spanner.

c. From the pc board side, unsolder the leads of the capstan type transistor. Remove the transistor.

d. Note how the terminals were dressed. Prepare the new transistor to the same fashion, but leave out the final bends to match the pc board until the transistor has been seated.

e. Locate the new transistor in the chassis, observing the proper position of the emitter terminal. Secure the nut with the spanner and check that the transistor does not turn when being tightened — if so clamp the flat end of the screw, not the case of the transistor.

f. Now, form the transistor leads to fit the pc board: there must be no physical stress on the leads between the seated transistor and the pc board. Then solder the terminals.

g. Replace the screen plate, soldering it across the rf power transistors.

7.3.3 REPLACING BIAS TRANSISTORS

a. Unsolder the transistor terminals from the pc boards.

b. Remove the screw and nut assembly securing the transistor to the chassis. Note location of insulating washers and torque washer. The transistor collector is insulated from chassis.

c. Install the new transistor in the same fashion, taking care to keep the collector insulated from chassis.

d. Dress the leads to fit the seated pc board (no stress) and solder to the board.

7.4 DRIVER SERVO

The repairs to be described cover the Drive servo motor and variable attenuator, potentiometer R38. The two are mounted on brackets fixed to the pc board assembly, and connects over a flexible coupling.

To identify the centre of the potentiometer operating range, an ink mark has been made on the potentiometer body. The moving mark is placed on the body of the shaft and coupling. These marks should be available even after repairs.

REMARK

Be careful when dealing with the servo motor and coupling. The motor is fitted with a high ratio gear which is likely to be damaged if the drive shaft is turned by hand at anything but a very slow rate. When dismounting or mounting the isolated coupling, torque must be prevented from being applied to the shaft of the motor gear.

7.4.1 DISMOUNTING

a. Let the Driver Servo assembly remain in the Tube Compartment.

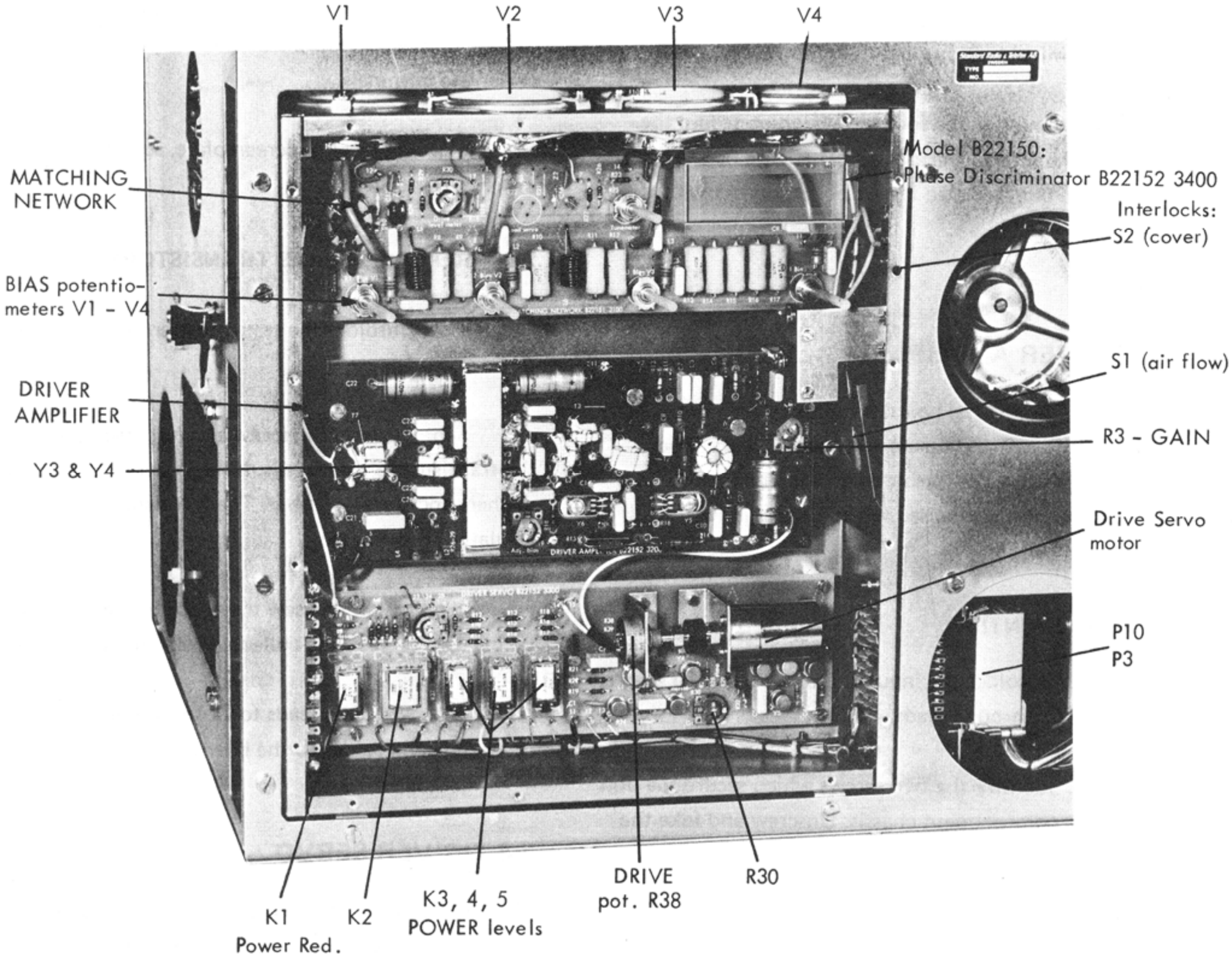


Fig. 7.3 - Tube Compartment, inside view

b. Dismount the coupling between motor and potentiometer: use two spanners to grip the nuts of the expanders of the coupling. Hold the one facing the motor as fixed as possible and turn the other one counterclockwise till one of the nuts will come loose.

c. To free the nut (shaft) which is still not loose, hold the black body of the coupling in a firm grip (if a tool is used — do not crack this part) and undo the nut.

d. Now dismount the servo potentiometer and remove the coupling.

e. To dismount the servo motor, first mark the leads and unsolder ("+" to 21, "—" to 20). Using a small screwdriver, unscrew the three screws fixing the motor to the frame.

7.4.2 REINSTALLATION

If a new servo potentiometer is to be installed, prepare the new one exactly as the one which was removed: install the two coaxial cables, the shunt resistor R39 (470 ohm) and mark the body with an index line.

a. On a new component, set the resistance through the potentiometer to 150 ohm. Mark the shaft with a dash to coincide with the index on the body.

b. If the old potentiometer is to be reinstalled, set the shaft mark against the body index as well.

c. Install the servo motor, slide the coupling on to the motor, install the potentiometer without turning the shaft.

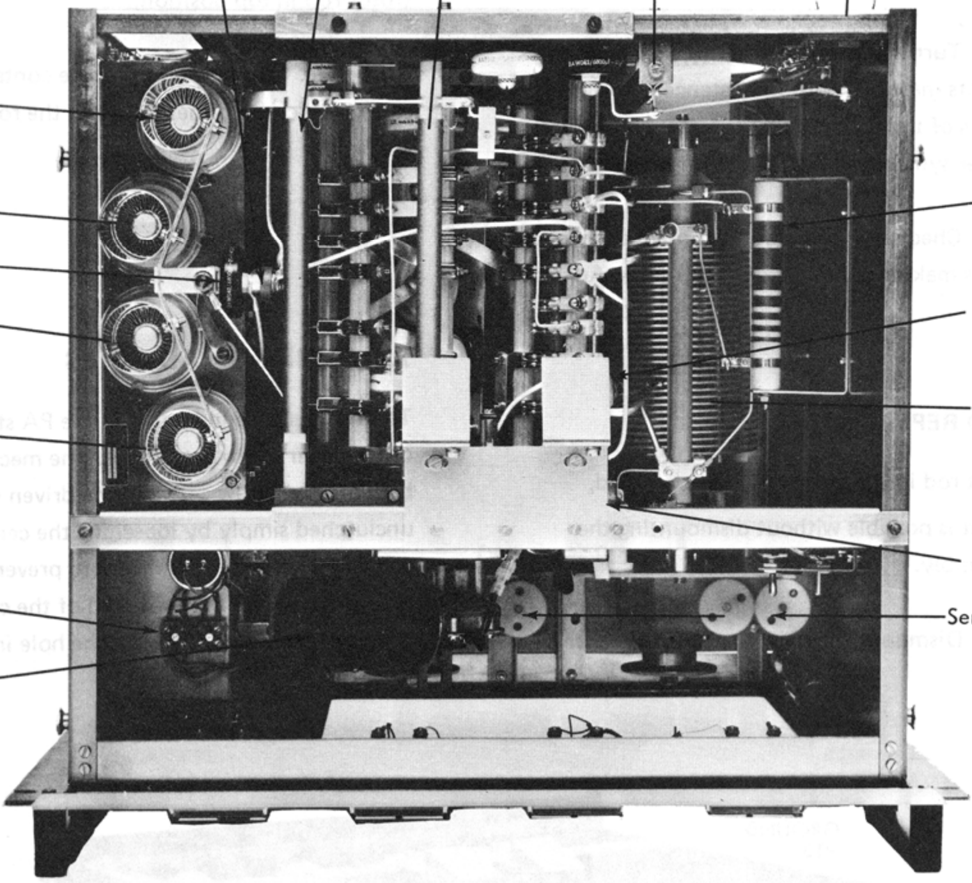


Fig. 7.4 - Power Amplifier, top view

d. Locate the coupling with the ink mark coinciding with the mark on the shaft. Fix the coupling to the potentiometer shaft, holding the body in a firm grip. Use two spanners to tighten the expanders of the coupling – keep the spanner at the motor fixed not to turn the motor.

e. Be sure to install this assembly without axial force between motor and potentiometer.

f. Resolder leads unsoldered. Test electrically, using chapter 8.

7.5 BAND SWITCH

The motor-driven band switch carries a number of insulated rods with knife and fork contacts which engage in operating positions. The stop positions are controlled from the homing wafer at the switch rear.

7.5.1 MOTOR REPLACEMENT

To replace the motor proceed as below:

a. Unplug the connector to the motor leads.

b. Unscrew the four screws which secure the motor to the front plate of the switch. Take out the motor, note the position of the shaft coupling.

NOTE

In this state the rotor is free to turn.
Thus always dismount the motor when it is required to work in the band switch.
Never try to turn the rotor by brute force!

c. When reinstalling the motor, turn the rotor to achieve that the coupling engages. Then screw the motor to the chassis, and reconnect the supply leads.

7.5.2 CONTACT ALIGNMENT

a. Dismount the motor to free the rotor cage.

b. Turn the rotor to each position and check how contacts mate. The proper distance between the silver pellets of the fork contact is 1 mm and knives should enter symmetrically. Adjust if required.

c. Check that the ground contact at the rear rotor disc is making contact from both sides. Adjust if required.

7.5.3 ROD REPLACEMENT

If a contact rod in the rotor has been damaged, replacement is possible without dismounting the switch assembly.

a. Dismount the motor to free the rotor cage.

b. Note the holes provided in the rear panel of the switch and in the rear panel of the PA unit chassis (rotor rod in top position).

c. Unscrew all the knife contacts, and the screws which hold the rod. Take the rod out through the holes.

7.6 TUNE & LOAD COILS

The two variable inductors in the PA stage are motor-droven over screw gear boxes. The mechanical coupling between the screw gear and the driven shaft may be unclutched simply by loosening the centre nut less than one turn (hold the disc firmly to prevent rotation). Figure 7.6 shows the front end of the coils with motors and gears, as viewed through the hole in the PA front panel.

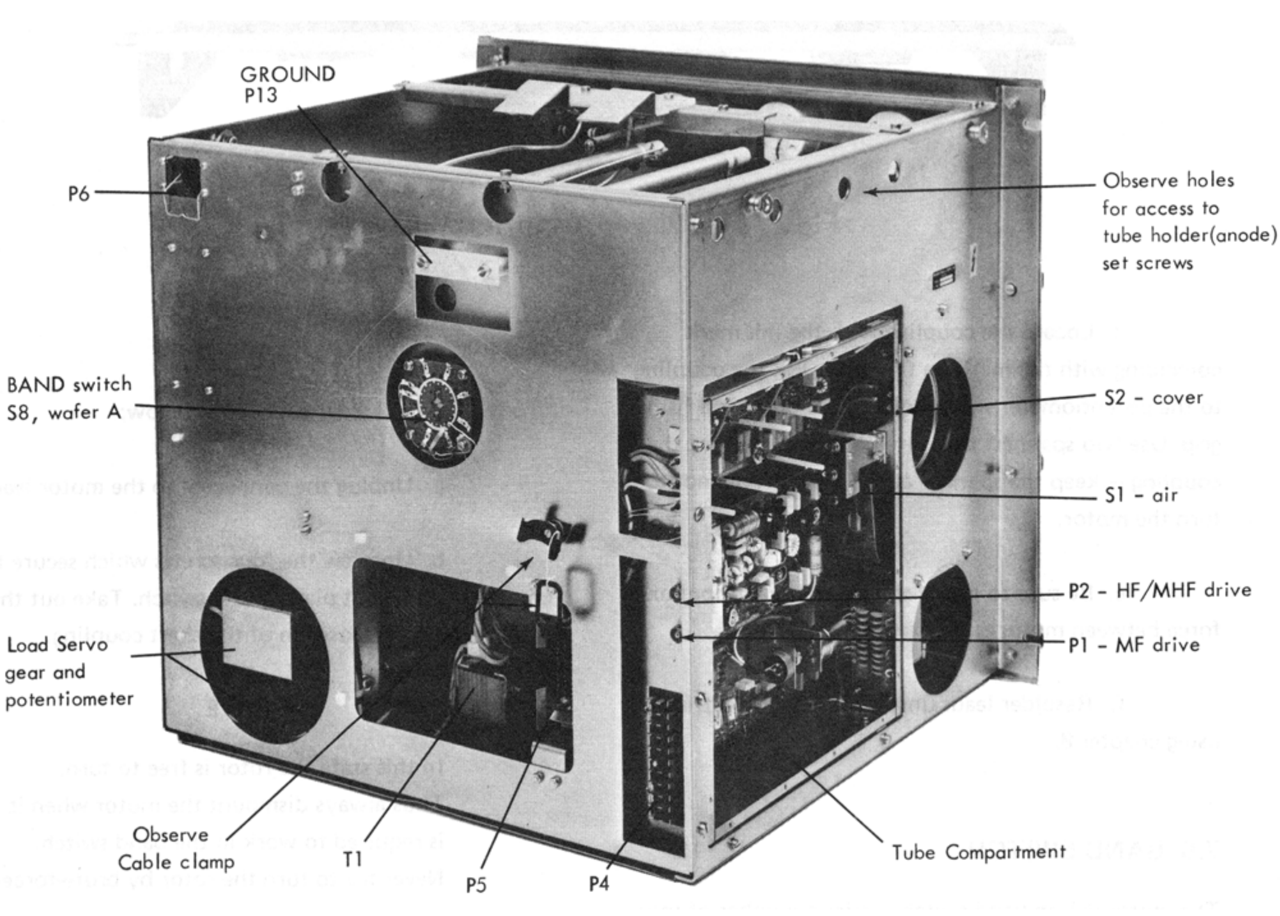


Fig. 7.5 - Power Amplifier, rear view

7.6.1 REMOVAL OF GEAR & MOTOR ASSEMBLY

To remove the assembly, use this procedure:

a. Unsolder the leads to the motor, after they have been duly identified and marked. Do not loose the ferrite bead chokes.

b. Unscrew the four screws which secure the gear box to the front plate of the coil.

c. Take out the gear box — the coupling to the shaft of the coil is automatically disengaged.

d. Inspect the gears. Clean if contaminated or dry, and apply new grease. Use only ROCOL A.S.P (contains molybdenum).

7.6.2 REINSTALLATION

Work the opposite way. Position the coil coupling shaft to engage with that of the gear box. Install the screws and resolder the motor leads, taking care not to mix them (motors must always run counterclockwise in Tuning Step No 1). Make sure that the ferrite bead chokes are still on the leads.

7.6.3 COIL REPAIRS

If a coil has to be taken our for repairs, proceed as outlined below:

a. Withdraw the power amplifier on its telescopic runners and dismount the bottom cover plate.

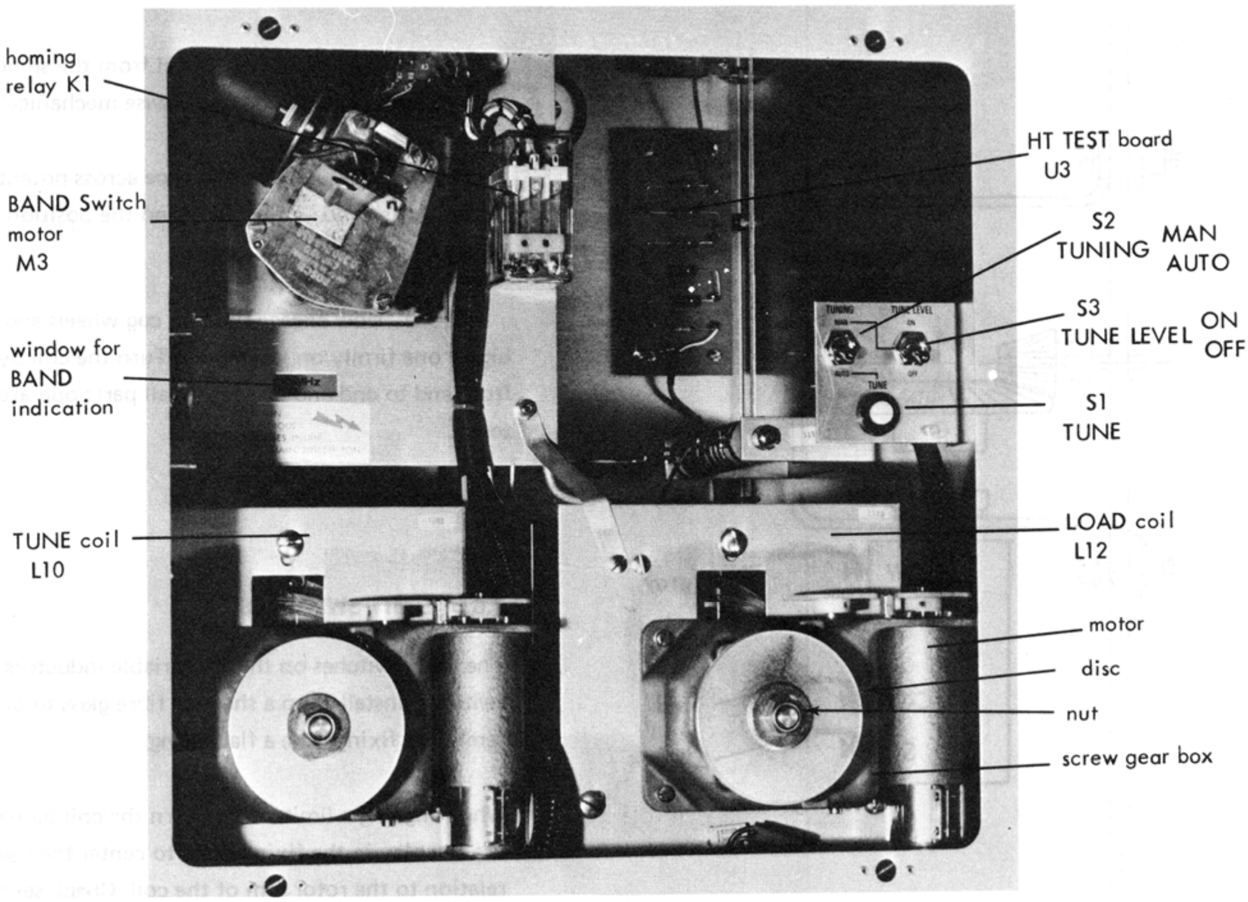


Fig. 7.6 - Power Amplifier, front inside view

b. Identify and mark properly the connections to the limit switches and to the motor. Unplug/unsolder and then disconnect the coil proper from the circuit.

c. Take the coil out through the front panel cutout. Inspect for mechanical or electrical damages.

d. Check the condition of the sliding contact assembly (front coil rotor disc). If contaminated or dry, clean carefully and regrease, using acidfree vaseline (or possible Electrolube brand 2A).

NOTE

Under no circumstances must the spindle or contact wheel inside the coil be greased or oiled. This will quickly ruin the coil, becoming overheated due to increased contact resistance.

e. Adjustment of limit switches is treated in para. 7.6.5. It is generally not required to dismount the coil when these are to be adjusted.

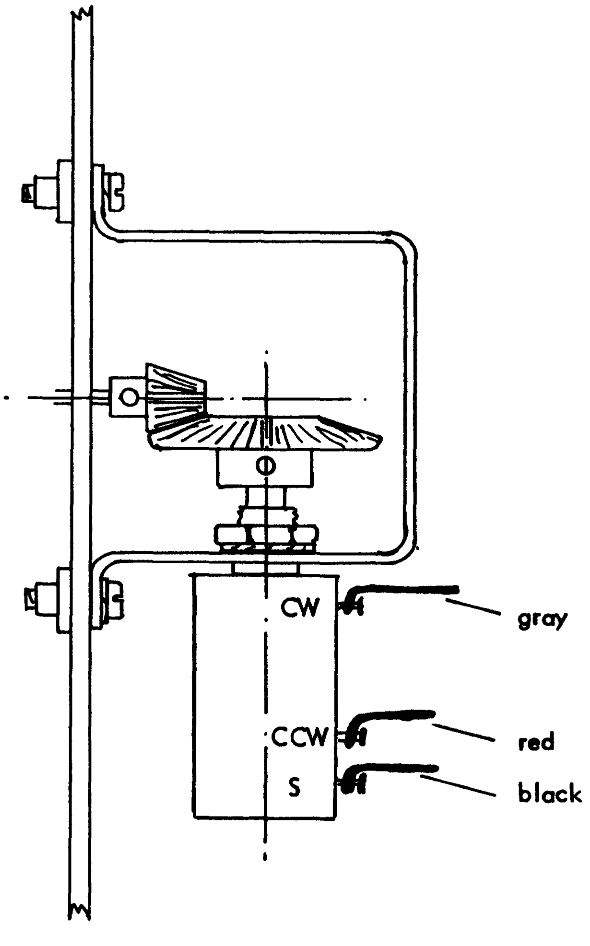


Fig. 7.7 - LOAD Coil Servo Potentiometer Assembly

f. When dismounting the LOAD coil, observe that three leads to the servo potentiometer at the coil rear have to be unsoldered as well. Mark them positively to assure that they can be reconnected to proper terminals.

7.6.4 LOAD COIL SERVO POTENTIOMETER

The servo potentiometer at the rear of the LOAD coil must be properly installed and aligned to secure correct operation. Observe the instructions given below:

a. The 90° gear drive must have the cog wheels correctly aligned, that is the cogs of both wheels shall be fully engaged — refer to figure 7.7. To achieve this, the potentiometer fixing hole in the bracket allows a certain horisontal play and the big cog wheel may be adjusted vertically on the spindle of the potentiometer.

b. Adequate overplay must be secured both ends of the potentiometer, after the mechanical stops of the coil have operated. If not the potentiometer may stop before the coil is stopped.

c. Unlock the big wheel from the spindle and turn the coil to its counterclockwise mechanical stop.

d. Measure the resistance across potentiometer terminals "s" and "CCW" and find the position when this is 23 ohm.

e. Now engage the two cog wheels and fix the bigger one firmly on its spindle. Turn the coil by hand from end to end and check that all parts operate satisfactorily.

7.6.5 LIMIT SWITCHES

The limit switches on the PA variable inductors are toggle switches, installed on a sheet of fibre-glass to obtain a semi-rigid fixing (like a flat spring).

When aligning a limit switch, turn the coil by hand and use the play in the fixing holes to center the switch in relation to the rotor arm of the coil. Check several times that the switch trips positively when the arm passes over the switch and confirm this when finally testing with the servo motor driving the coil.

CHAPTER 8

ALIGNMENT

8.1 GENERAL

This chapter contains procedures for alignment, divided into individual assemblies or assemblies in cooperation.

IMPORTANT

Alignment should be done only when necessary, only for circuits necessary, and only according to instructions. There are circuits which are adjusted for critical parameters and not merely maximum output.

For the alignment procedures where rf drive is required, it is generally assumed that the exciter is operable. In the event of a pc board being serviced on its own, supply voltages, input signals and terminations should as far as practicable be made equal to those found in normal operation.

8.2 PA TUBE ADJUSTMENT

Refer to chapter 5, para. 5.9 for the adjustment of the PA tube quiescent conditions.

8.3 DRIVE SERVO/DRIVER GAIN

Adjustments described below cover two levels of complication:

- 8.3.1 describes how to correct for a simple off-centering of the variable attenuator.
- 8.3.2 gives the full alignment routine, necessary after a major repair or when meters have to be recalibrated.

8.3.1 DRIVER GAIN ADJUSTMENT

a. Take out the PA unit on its telescopic runners, set the interlock in service position, dismount the Tube Compartment cover plate.

b. Operate the equipment on STANDBY, 8.5 MHz, TUNE.

c. Watch the ink mark on the motor and the potentiometer body. They should match under the circumstances.

d. Locate potentiometer R3, Set Gain, on the Driver Amplifier pc board. Turn R3 to achieve that the two marks coincide.

IMPORTANT

Do not touch any other controls in these circuits!

e. Before replacing the lid, try all bands on TUNE to verify that deviations from the centre are acceptable, i.e. R38 does not stop with the mark in opposition, 180° away.

NOTE

Another method is described in para 8.3.5 and based on watching the DRIVE reading when the DRIVE servo keeps turning (because the signal input terminal 12 has been short circuited to terminal 11, Ground).

8.3.2 DRIVER AMPLIFIER BIAS

The purpose of this alignment is to secure that the push-pull driver final amplifier standing feed is correct. Especially after driver circuit repairs the bias has to be set up.

a. Operate the transmitter on STANDBY, Power 5, key up (no drive).

b. Connect the dc voltmeter (range 50 to 100 mV) across one of the emitter resistors (4 in parallel). Adjust R19, to read 20 mV on the meter.

c. Check the emitter-to-ground voltage on the other leg of the amplifier: to be 20 ±5 mV.

8.3.3 DRIVER GAIN ALIGNMENT

This alignment starts from the factory-made ink marks on variable attenuator R38, which should match on 8.5 MHz and TUNE. The purpose of the alignment is to restore the match which may have been lost due to

- a different amplifier gain after component replacement
- decrease of signal input level due to a longer coaxial cable between transmitter and exciter.

a. Make sure that the exciter output level on TUNE is the nominal 600 mV rf (8.5 MHz).

b. Operate on STANDBY, Power 5, 8.5 MHz, A3J one tone full modulation.

c. Switch on TUNE and adjust R3, SET GAIN, till the ink marks coincide.

d. Go to POWER 5, key down. Read the grid current, Ig1 on the testmeter. Recommended grid current is 30 divisions – set this value by R3.

e. Now return to TUNE and reset – if necessary – the ink marks to coincide, adjusting potentiometer R30 "Grid Excitation", on the Driver Servo Assembly.

f. Then calibrate the DRIVE testmeter position to read 40 under TUNE conditions, aligning potentiometer R30 "Drive Level Meter", on the Matching Network Assembly.

NOTE

This consludes the driver gain adjustment. Additional checks are described below to align the driver for a flat response over the range of frequencies covered, and for equalizing the MF exciter and HF/MHF exciter outputs.

8.3.4 GRID MATCHING NETWORK

Coils L5 and L6 are effective to ensure as flat a frequency response as possible. Alignment is carried out modifying their physical form (length of winding).

a. Connect a signal generator to P2 instead of the exciter signal. Output level 0.5 V (terminal volts).

b. Operate on STANDBY. Set on TUNE to approximately match the two ink marks. Then return to Power 5.

c. Connect an rf voltmeter to one of the PA tube control grids, range 30 V rms. The output is about 20 V for 0.5 V in.

d. Adjust L5 and L6 to achieve maximum flatness over the frequency range 0.4—26 MHz, within 3 dB.

8.3.5 MATCHING OF EXCITER SUB-SYSTEMS

This is to assure that the outputs from the three exciter sub-systems are adequately set to allow the drive servo to compensate for inevitable variations in output level over the range. Especially with a remote-controlled exciter, the length of the coaxial cable will account for a higher signal attenuation on HF bands than on MF, where the length of the cable is unchanged.

a. Remove the cover of the Tube Compartment. Operate on STANDBY, MANual, 8.5 MHz from HF/MHF (synthesizer). TUNE LEVEL switched on. Shortcircuit Drive servo B22152 3300 terminal 12 to 11 (ground) to make the motor run continously.

b. Watch maximum and minimum deflections on the testmeter position DRIVE:

- must be higher than 55 div.
- must be lower than 30 div.

c. If required, adjust R3, SET GAIN, to center the range of operation of R38 (refer to para 8.3.3).

d. Switch to the HF A1 exciter (if fitted with crystals). Let the DRIVE servo spin around, shortcircuiting pins 11/12. Same rules for maximum and minimum deflections should be applied.

e. When not according to the requirements, the TUNE level from the A1 exciter has to be adjusted to obtain the proper figures. Before any adjustment is done, allow DRIVE to stop on 40, switch TUNE LEVEL OFF and read the DRIVE-meter on power 5 and key down. Note this figure.

f. Now adjust the TUNE LEVEL, potentiometer R59, to obtain the best centering on the 8 MHz band (DRIVE motor running).

g. Stop the motor, removing the shortcircuit, and observe that it stops on 40. Switch TUNE off, and check the DRIVE reading on power 5, key down. This must be set to exactly the original figure, from step e., using the SET LEVEL potentiometer, R66.

h. Finally select MF A1 and TUNE LEVEL. Let the motor run again and note the max-, and minimum deflections. Same requirements as under step b. apply.

i. If required to change MF Tune level, first let the motor stop on DRIVE 40, then read on power 5, key down the A1 and A2H figures. Note them down.

j. With the motor spinning round again, adjust potentiometer R6, TUNE, on Card U2 (Card Rack), to achieve the best centering on 454 kHz.

k. Remove the strap between 11/12 on the Driver Servo card. The DRIVE reading on TUNE is to be 40, and then on power 5, key down, readjust A1 CARR, R4 on card U2, to the original full power value. Similarly, switch to A2H and correct the reading to the original figure with potentiometer R11, TONE LEVEL, on card U4.

NOTE

This concludes the drive alignment of the power amplifier.

8.4 MANUAL TUNING/TUNEMETER CALIBRATION

a. Tune the power amplifier in the ordinary way and then switch to A1, Power 5, a channel in the 8 MHz band.

b. Readjust Tune for Tunemeter maximum and Load for a cathode current of 1.25 to 1.30 A. Grid current should be nil or very low. – If terminated in a 50 ohm dummy load, the power should amount to 1200 W.

c. Return to TUNE and calibrate the Tunemeter to read 40 – adjust trimmer R25 "Tunemeter" in the tube compartment.

8.5 AUTOMATIC TUNING

Operate on 8.5 MHz and start checking the LOAD POS calibration and then balance the servo amplifiers.

a. Switch to AUTO, SERVO BLOCKED and remove the program card for the load selected (preferably the Dummy Load with program card U5). Switch TRANSMIT on.

b. Note that the Load coil runs maximum CCW. Switch to STANDBY, take out the PA unit and return to STANDBY. Calibrate the LOAD POS testmeter reading to 100, using potentiometer R35, LOAD POS, on the Drive Servo

c. Place the PA in normal operating position, operate a full tuning cycle setting SERVO on NORMAL but block when Step No. 3 has begun.

d. Disconnect the coaxial cable from the exciter in the cabinet bottom (at P32) to remove the drive. Adjust Tune Servo HF (U12) potentiometer R7, first to cause TUNE to run CW till the limit switch, then reverse a few turns and then leave it where the motor is fully balanced (standstill).

e. Proceed with the LOAD servo balance, potentiometer R13 on card U9. The motor must remain at standstill on any turn.

8.5.1 LOAD CALIBRATION

For this test the PA unit must be operated fully withdrawn and a temporary cable connecting the output to the antenna switch.

a. Allow the servos to tune the transmitter, but block the procedure in Step No. 3.

b. Adjust the LOAD SERVO potentiometer R22 (Matching Network assembly) to achieve that the Tunemeter reads 40.

c. Then return S1 to NORMAL and let the servos complete the tuning.

d. Switch to MAN and TUNE LEVEL On. Watch the Tunemeter while the Tune control is turned by hand to check that the circuit was simultaneously on resonance ("T40"). If not adequate, recheck the balance of the HF Tune servo (potentiometer R7).

8.5.2 MF BALANCE

a. Operate the transmitter on 454 kHz and use the Dummy Load.

b. Through SERVO on BLOCKED as soon as Step No 3 commences, that is when a proper resonance has been obtained (higher than T40).

c. Disengage card U3, MF Oscillator, to remove the drive and balance MF Tune Servo (U13) potentiometer R7 till the Load motor is at standstill.

d. Return to NORMAL and replace the MF oscillator. Order a new tuning and then switch to MAN. and TUNING LEVEL on. Check turning the variometer control by hand that the true resonance was found.

NOTE

This concludes the balancing of the servo amplifiers.

8.6 MONITOR ADJUSTMENT

On the Monitor Card (U0) potentiometer R2 is to be aligned to center the acceptance range on T40. The procedure is as follows:

a. Let the transmitter tune automatically. Terminated the green Ready lamp lights.

b. Check that no "traffic light" is on when set on MAN and TUNING LEVEL on. When reset to AUTO and Off, Ready will come on again.

c. Go to MAN and TUNING LEVEL On. Turn the cog wheel of the Load motor by hand till the Tunemeter shows 30 divisions.

d. Return to AUTO: TUNE FAULT shall light.

e. Perform a new tuning. Go to MAN and TUNING LEVEL On. Turn the Load motor wheel till the Tunemeter indicates 50 divisions.

f. Return to AUTO: TUNE FAULT shall light.

g. If the operating range is not centered properly, adjust potentiometer R2 to obtain the correct conditions.

8.7 LT POWER SUPPLIES

The LT Power Supply contains three stabilized supplies to be aligned using instructions given below. The Vg2-supply is set to +350 V in connection with para 8.2, Tube Adjustment. Operate the transmitter on STANDBY for the alignments below.

8.7.1 -24 SUPPLY

a. Connect a reliable voltmeter to the output of the power supply and a variable load in series with an am-meter to check the overload adjustment. (about 15 ohm).

b. Adjust R22, "ADJ. 24 V". to read -24 V.

c. Connect the load to draw 1.5A and set R19 "I_{lim} 1.5A" to achieve that the output voltage just starts to collapse.

8.7.2 +28 V SUPPLY

a. Connect a reliable voltmeter to the output of the power supply and a variable load in series with an am-meter to check the overload adjustment (about 9 ohm).

b. Adjust R10 "Adj. 28 V", to obtain +30 V.

c. Connect the load to draw 3.2 A and R3 "I_{lim} 3.2A" to accomplish that the output voltage just starts to collapse.

8.7.3 -60 V SUPPLY

a. Connect as above a voltmeter, an am-meter and prepare a load of about 1.2 kohm.

b. Adjust R33 "Adj. 60 V" to read -60 V, key down.

c. Connect the load to draw 50 mA and set R33 to accomplish that the voltage just starts to collapse.

d. Release the key and notice that the dc output voltage increases to nearly -100 V.

CHAPTER 9

PARTS LISTS

9.1 TRANSMITTER B22100 0000

Subunits with Parts Lists:					
HT Power Supply		9.2			B22112 0000
LT Power Supply		9.3			B22120 0000
Antenna Switch Unit		9.4			B22116 0000
Power Amplifier		9.5-9.7			B22150 0000
Card Rack		9.8-9.15			B22113 0001
Exciter Unit: see separate handbook					B22140 0000
MF Local Control Panel		9.16			B22190 0000
Remote Control Panel		9.17			B22191 0000
24 V Power Supply		9.1.1			B22110 3350
Fuse Compartment		9.1.2			B22110 3300
C1	Capacitor, mp	10 uF	10 %	2 kV	6200 3035
K1,2	Contactor	220 V, 4no/1nc			6800 0511
P1,2,6	Connector, coax				8600 0362
P3	Connector, HT	1 pole			8600 0303
P4,11	Connector, female	33 way			8600 1554
P5,8,13	Connector, female	47 way			8600 1533
P7	Connector, female	mains, 3 way			8600 1272
P9,15	Connector, female	23 way			8600 1548
P10	Connector, female	15 way			8600 1532
P12,17,18	n.a. (on HT Power Supply)				
P14	Connector, female	35 way			8600 1550
P16	Terminal board assy.				B22110 3320
	Terminal block only				8700 0469
P19-28	(on Antenna Switch)				
P29	Terminal board (mains)				B22110 3305
P30	Connector, male	47 way			8600 1565
P31	Connector, coax				8600 1567
P32	Connector, coax	SO-239			8600 1568
P33	n.a.				
P34,35	See 9.4				
S1-3	Switch, interlock				8400 0164
S4-7,9	See 9.4				
S8	See 9.1.2				

9.1.1 24 V RECTIFIER B22110 3350

C1	Capacitor, ellyt	2200 uF	-10+50 %	40 V	6300 1058
T1	Transformer	220/24 V			6500 0484
Z1	Diode. si	1N4383			7800 0847
Z2	Rectifier bridge	B80C3200-2200			7800 1455

9.1.2 FUSE COMPARTMENT B22100 3300

F1-3	Fuse, cartridge	DII 16A slow - 220 V			8300 0068
	alternatively:	DII 10A slow - 380 V			8300 0067
F4-6	Fuse, cartridge	DII 4A slow			8300 0172
F7-10	Fuse, cartridge	(to be decided at installation)			
F18	Fuse, cartridge HT	2A, 8.3x85 mm			8300 0198
P29	(see 9.1)				
P32	(see 9.1)				
S8	Switch, mains				8400 1050

9.2 HT POWER SUPPLY B22112 0000

B1	Blower				6900 0015
C1-24	Capacitor, cer	1.5 nF	20 %	3 kV	6200 2630
C25	Capacitor, mplfo	8 uF	10 %	1.6 kV	6200 3031
F1-3	Fuse, cartridge	1A, 8.3x85mm			8300 0179
L1	Choke				A58432 0186
P12	Terminal board	5 way			8700 0474
P17	Terminal board	2 way			
P18	Terminal board	8 way			KS87507/08
R1	Resistor, w-w	100 kohm	10 %	220 W	6000 1381
R2	Resistor, w-w	5.6 kohm	10 %	130 W	6000 5048
R3	Resistor, w-w	0.15 ohm	1 %	10 W	6000 7697
R4,5	Resistor, metox	1.2 kohm	1 %	0.12 W	6000 4679
T1	Transformer, assembly				B22112 3010
Z1-24	Diode, si	SSI 1580A			7800 0823

9.3 LT POWER SUPPLY B22120 0000

C6	Capacitor, cer	1.8 nF	20 %	1.5 kV	6200 [illegible]
C7	Capacitor, ellyt	2200 uF	-10+50 %	63 V	6300 [illegible]
C8	Capacitor, ellyt	220 uF	-10+50 %	250 V	6300 1012
C9	Capacitor, ellyt	4700 uF	-10+50 %	63 V	6300 0509
C10	Capacitor, cer	1.5 nF	20 %	3 kV	6200 2630
C11	Capacitor, mp	2 uF	10 %	1.6 kV	6200 2631
C12	Capacitor, mp	470 nF	10 %	250 V	6200 7208
C13	Capacitor, mp	220 nF	10 %	250 V	6200 7207
F1	Fuse, cartridge	200 mA, 5x20 mm			8300 0276
F2,3,7	Fuse, cartridge	4A			8300 0034
F4,5	Fuse, cartridge	6.3A, 5x20 mm			8300 0327
F6	Fuse, cartridge	6.3A, 5x20 mm			8300 0243
F8	Fuse, cartridge	500 mA, 5x20 mm			8300 0036
K1	Contactor	5 pole 220 V ac			6800 0323
K2	Relay	3 pole 220 V ac			6800 0512
K3-5	Relay	3 pole 24 V dc			6800 0492
L1,2	Choke, VHF				4800 0083
MT1	AC Voltmeter				7500 0201
P1,2	Terminal board	2 way			8700 0088
P310	Connector, plug	15 way			8600 1543
P311	Connector, plug	33 way			8600 1557
R9	Resistor, w-w	27 kohm	5 %	25 W	6000 4526
R10	Resistor, w-w	15 kohm	5 %	4 W	6000 4524
R11	Resistor, w-w	1.2 kohm	5 %	2 W	6000 6142
R12,13	Resistor, carbon	47 ohm	5 %	0.25 W	6000 3492
R14,15	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R16	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R17	Resistor, carbon	200 ohm	5 %	0.12 W	6000 5749
R18,19	Resistor, carbon	3.3 kohm	5 %	0.50 W	6000 0921
R20-22	Resistor, carbon	330 ohm	5 %	0.50 W	6000 0331
R23	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846
R24	Potentiometer, carbon	2.2 kohm	10 %	2 W	6100 0305
S1	Switch assembly	4 buttons			8400 1059
S2	Switch, rotary				8400 1058
S3	Switch, push button				8400 1149

LT POWER SUPPLY, continued

SL1-3	Lamp, incand	30 V 40 mA	T 4.6	8200 0217
T1	Transformer			A51130 1154 4
T2	Transformer			A51130 1155 4
U1	Voltage stabilizer pc board			B22120 3100
U2	Vg2 Regulator			SU30113A3
V1,2	Tube, vacuum	6DQ5		7600 0131
Y3 (103)	Transistor, si npn	2N4912		8000 0656
Y4 (104)	Transistor, si npn	BDX60		8000 0657
Y5 (105)	Transistor, si npn	MJ1001		8000 0649
Z1	n.a.			
Z2,3	Diode, si	1N1614		7800 0019
Z4	Diode, si	1N4383		7800 0847
Z5,6	Diode, si	1N645		7800 1020
Z7 (107)	Rectifier bridge	MDA 980-3		7800 1416
Z8	Diode, zener	ZL47, 47 V		7800 0639

9.3.1 VOLTAGE STABILIZER B22120 3100

C1,13	Capacitor, ellyt	10 uF	-10+100 %	63 V	6300 0961
C2,14-19	Capacitor, cer	1 nF	20 %	400 V	6200 6298
C3	Capacitor, ellyt	470 uF	-10+50 %	40 V	6300 0829
C4,6,8,10	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C5	Capacitor, ellyt	220 uF	-10+50 %	63 V	6300 0732
C7,11	Capacitor, ellyt	4.7 uF	-10+50 %	250 V	6300 1013
C9	Capacitor, cer	3.3 uF	-20+80 %	40 V	6200 5557
C12	Capacitor, mplfo	6.8 nF	10 %	100 V	6200 6110
R1	Resistor, carbon	8.2 kohm	5 %	0.12 W	6000 5323
R2,9	Resistor, carbon	680 ohm	5 %	0.12 W	6000 5524
R3,17	Potentiometer, carbon	1 kohm	20 %	0.15 W	6100 0153
R4	Resistor, carbon	1.2 kohm	5 %	0.50 W	6000 0515
R5,19	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749

VOLTAGE STABILIZER, continued

R6,7,8	Resistor, w-w	3.3 ohm	10 %	2 W	6000 7677
R10,22	Potentiometer, carbon	500 ohm	20 %	0.15 W	6100 0529
R11	Resistor, carbon	1.8 kohm	5 %	0.12 W	6000 5522
R12	Resistor, carbon	820 ohm	5 %	0.12 W	6000 6250
R13,47,48	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R14,36,46	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R15,38	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R16,26,37	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R18	Resistor, carbon	1.2 kohm	5 %	0.12 W	6000 6487
R20,49	Resistor, w-w	4.7 ohm	10 %	2 W	6000 2237
R21	Resistor, carbon	470 ohm	5 %	0.12 W	6000 5748
R23,31	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322
R24	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R25,27	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5521
R28	Resistor, carbon	10 ohm	5 %	0.12 W	6000 6486
R29	Resistor, carbon	12 ohm	5 %	0.12 W	6000 5750
R30	Resistor, carbon	100 ohm	5 %	0.50 W	6000 0803
R32	Resistor, carbon	27 kohm	5 %	0.12 W	6000 5526
R33	Potentiometer, carbon	10 kohm	20 %	0.15 W	6100 0148
R34	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R35	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5294
R39	Potentiometer, carbon	4.7 kohm	20 %	0.15 W	6100 0660
R40	Resistor, carbon	18 kohm	5 %	0.12 W	6000 5875
R41	Resistor, carbon	330 kohm	5 %	0.12 W	6000 5255
R42	Resistor, carbon	470 ohm	5 %	0.12 W	6000 5748
R43	Resistor, carbon	3.3 Mohm	5 %	0.50 W	6000 1690
R44	Resistor, carbon	2.2 Mohm	5 %	0.50 W	6000 7657
R45	Resistor, carbon	2.7 Mohm	5 %	0.50 W	6000 7658
Y1,8	Transistor, si npn	2N1893			8000 0141
Y2-4,7,13	Transistor, si npn	2N2219A			8000 0389
Y5,9,10	Transistor, si pnp	2N5415			8000 0541
Y6,11	Transistor, si pnp	2N2905A			8000 0360
Y12	Transistor, Fet	2N4416A			8000 0565
Z1-3,5-7	Diode, zener	1N753A/6.2 V 5 %			7800 0592
Z4	Rectifier bridge	B80C3200-2200			7800 1375
Z8	Rectifier bridge	B250C1000 Si			7800 1032
Z9	Diode, zener	1N973B/33 V 5 %			7800 1338
Z10,12	Diode, si	1N645			7800 1020
Z11	Diode, zener	1N965B/15 V 5 %			7800 1300

9.3.2 Vg2 REGULATOR SU30113A3

C1	Capacitor, cer	8.2 nF	-10+50 %	500 V		6200 0128
C2,3	Capacitor, cer	470 pF	20 %	500 V		6200 2626
R1,3	Resistor, carbon	1 kohm	5 %	0.25 W		6000 2531
R2,5,6	Resistor, carbon	5.6 kohm	5 %	0.25 W		6000 2846
R4	Resistor, carbon	33 kohm	5 %	0.25 W		6000 2841
R7	Resistor, carbon	3.3 kohm	5 %	0.25 W		6000 3084
R8	Resistor, carbon	330 kohm	5 %	0.50 W		6000 0814
Y1,2	Transistor, si npn	2N1613				8000 0131
Z1	Diode, zener	1N3016B/6.8 V 5 %				7800 0965

9.4 ANTENNA SWITCH B22116 0000

C2	Capacitor, cer	600 pF	10 %	10 kV	6200 2278
K3,4	Relay	2 pole co, 24 V			6800 0492
K5	n.a.				
K6	Relay	2 pole co, 24 V			6800 0196
L1	Variometer				B22115 0000
L2,3	Choke, VHF				4800 0601
M1	Motor, complete				B22116 3200
M2	Motor, complete				B21154 0004
P19					
P20	RF outputs				
P21					
P22	Terminal board				8700 0323
P23	Solder lug on E-S4				
P24-26,27	Antenna outlets				
P28	Variometer taps				
P34	Connector, female	2 pole			4600 0695
					8600 1417

ANTENNA SWITCH, continued

P35	Connector, male	2 pole			4600 0696
					8600 1417
P36	2182 kHz Res. Transm. input				
R1-3	Resistor, w-w	15 ohm	5 %	100 W	6000 7650
R4	Resistor assembly, w-w				6000 8255
R5	Resistor, w-w	10 ohm	3 %	25 W	6000 8445
S4	Antenna Switch Assembly				B22116 0000
S5-7	Microswitch				8400 0162
S9	Switch toggle	2 pole co			8400 0274
SL1	Lamp, incand	24 V 50 mA			8200 0170
Z1,4-6	Diode, si	1N645			7800 1020
Z2,3	n.a.				

9.5 POWER AMPLIFIER B22150 0000

B1	Blower assembly				B22150 3020
	Motor only	220 V ac			6900 0014
C1,2	Capacitor, mplfo	100 nF	20 %	250 V	6200 3869
C3,4	Capacitor, cer	15 pF	10 %	5 kV	6200 6639
C5	Capacitor, mplfo	1 uF	10 %	480 V	6200 3017
K1	Relay	24 V 2 pole co			6800 0492
L1-8	Choke, VHF				4800 0601
L9	Choke, RF				SU30104A25
L10	Inductor, TUNE				B22153 0000
L11	Choke, RF				SU30104A23
L12	Inductor, LOAD				B22153 0100
L13	Core, toroid				4800 0252
L14	Coil, hairpin				SU30114-9-18

POWER AMPLIFIER, continued

M1,2	Motor assembly				B22154 0000
M2	Motor assembly				B22154 0000
M3	Motor assembly				B22116 3200
MT1	Meter	0-100 uA			7500 0202
MT2	Meter	0-100 uA			7500 0200
MT3	Meter	0-100 uA			7500 0203
MT4	Meter	0-100 uA			7500 0199
P1,2	Connector, coax	L604/S/Ni			8600 0552
P3	Connector: see Tube Compartment				
P4	Connector: see Tube Compartment				
P5	Connector, plug	47 way			8600 1541
P6	Connector, HT	L623/P			8600 0302
P7,8	Terminal board				8700 0323
P9	Terminal board	4 way			8700 0307
P10	Connector, plug	23 way			8600 1527
P11	Connector, MHF/HF				
P12	Connector, MF				
P13	Connector ground				
P14	Terminal stud				
P15	Connector assembly	2 way			8600 1417
R1	Potentiometer	1 kohm	5 %	1.5 W	6100 0656
R2	Resistor, carbon	12 kohm	5 %	0.25 W	6000 0931
S1	Switch, push-button	1 pole nc			8400 1055
S2,3	Switch, lever	2 pole co			8400 0274
S4	Switch, toggle	1 no/1 nc			8400 1054
S5-7	Switch, toggle	1 no			8400 1138
S8	Band switch assembly	(see 9.7)			B22155 0000
S9	Switch, rotary				8400 1048
T1	Transformer				A51130 1158 4
U1	**Tube compartment**	9.6			B22152 0000
U2	**Antenna Curr. Meter**	9.7.1			B22155 3100
U3	**HT Test**	9.7.2			SU30114 A3
U4	**Matching Network**	9.6.3			B22152 3100

POWER AMPLIFIER, continued

U5	**Driver Amplifier**	9.6.2			B22152 3200
U6	**Drive Servo**	9.6.1			B22152 3300
U7	**Phase Discriminator**	9.6.4			B22152 3400
Z1,2,3	Diode, si	1N645			7800 1020
Z4	Diode, si	1N5624			7800 1417

9.6 TUBE COMPARTMENT B22152 0000

C1-19	Capacitor, cer	1.5 nF	20 %	400 V	6200 6714
C20-26	Capacitor, cer F-Th	1 nF	-20+80 %	500 V	6200 4881
C27	Stand-off insulator	2 pF, M6			4500 0070
C28	Stand-off insulator	2 pF, M4			4500 0092
C29	Capacitor, cer	6.8 nF	-20+40 %	3.5 kV	6200 0341
L1-20	Choke, rf	100 uH			6600 0124
L21-23	Choke, VHF				4800 0601
P1,2	Connector, coax	L604/S/Ni			8600 0552
P3	Connector, socket	23 way			8600 1511
P4	Connector, plug	33 way			8600 1557
P5	Terminal board				8700 0327
R1,2	Resistor, carbon	10 Mohm	5 %	0.50 W	6000 7357
R3-18	Resistor, metox	10 ohm	2 %	0.50 W	6000 7251
S2	Microswitch (cover)				8400 1061
S3	Microswitch (air)				8400 1062
V1-4	Tube, vacuum	4CX250B			7600 0073

9.6.1 DRIVE SERVO B22152 3300

C1	Capacitor, cer	3.3 nF	-20+80 %	40 V	6200 5557
C2	Capacitor, mplfo	47 nF	10 %	100 V	6200 6174
C3	Capacitor, mplfo	68 nF	10 %	100 V	6200 6101
C4-7	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
K1,3-5	Relay	2 pole co			6800 0452
K2	Relay	3 pole co			6800 0313
M1	Motor	3-9 V dc		420 mW	6900 0044
R1,4	Resistor, carbon	68 ohm	5 %	0.12 W	6000 5519
R2,3,5,6	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R7,9,31	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R8	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R10,12	Resistor, carbon	150 ohm	5 %	0.12 W	6000 5277
R11	Resistor, carbon	33 ohm	5 %	0.12 W	6000 5289
R13-15	Resistor, carbon	82 ohm	5 %	0.12 W	6000 5284
R16,18	Resistor, carbon	56 ohm	5 %	0.12 W	6000 5279
R17	Resistor, carbon	330 ohm	5 %	0.12 W	6000 5290
R19,22,23 26,29	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R20	Resistor, carbon	1 Mohm	5 %	0.25 W	6000 5332
R21	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R24,28	Resistor, carbon	68 kohm	5 %	0.12 W	6000 5530
R25,27	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R30	Potentiometer trim, carbon	1 kohm	20 %	0.15 W	6100 0153
R32	Resistor, carbon	820 ohm	5 %	0.50 W	6000 0432
R33,34	Resistor. carbon	33 kohm	5 %	0.12 W	6000 5521
R35	Potentiometer trim, carbon	50 kohm	20 %	0.15 W	6100 0581
R36,37	Resistor, metal	470 kohm	1 %	0.25 W	6000 1174
R38	Potentiometer, carbon	1 kohm	10 %	1 W	6100 0681
R39	Resistor, carbon	470 ohm	5 %	0.12 W	6000 5748
Y1,3,4,6,7	Transistor, si pnp	2N2905A			8000 0360
Y2,5,8,9	Transistor, si pnp	2N2219A			8000 0389
Z1	Diode, zener	8.2 V/1N756A			7800 0892
Z2-4	Diode. si	1N645			7800 1020

9.6.2 DRIVER AMPLIFIER B22152 3200

C1	Capacitor, mica	470 pF	5 %	500 V	6200 0272
C2,3,6,7,9 10,12-20,23-27	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C4,11,22	Capacitor, ellyt	470 uF	-10+50 %	40 V	6300 0829
C5	Capacitor, mica	560 pF	5 %	300 V	6200 0161
C8	Capacitor, mplfo	15 nF	10 %	250 V	6200 6575
C21	Capacitor, mplfo	470 nF	10 %	100 V	6200 6089
L1	Choke, rf	0.1 uH	10 %		6600 0196
L2-4	Choke, VHF				6600 0156
R1,17,18	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R2	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R3	Potentiometer trim, carbon	100 ohm	20 %	0.15 W	6100 0152
R4	Resistor, carbon	120 ohm	5 %	0.12 W	6000 6156
R5	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R6,12	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R7,13	Resistor, carbon	18 ohm	5 %	0.12 W	6000 5518
R8	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R9	Resistor, carbon	330 ohm	5 %	0.5 W	6000 0331
R10	Resistor, w-w	820 ohm	5 %	2 W	6000 1660
R11	Resistor, carbon	150 ohm	5 %	0.12 W	6000 5277
R14	Resistor, w-w	22 ohm	10 %	2 W	6000 7534
R15	Resistor, w-w	470 ohm	5 %	2 W	6000 1703
R16	Resistor, carbon	470 ohm	5 %	0.12 W	6000 5748
R19	Potentiometer trim, carbon	1 kohm	20 %	0.15 W	6100 0153
R20,21	Resistor, carbon	10 ohm	5 %	0.12 W	6000 6486
R22-29	Resistor, carbon	1 ohm	5 %	0.12 W	6000 6816
T1	Transformer				B22152 5200
T2	Transformer				B22152 5201
T3	Transformer				B22152 5202
T4	Transformer				B22152 5203
T5	Transformer				B22152 5204
T6	Transformer				B22152 5205
T7	Transformer				B22152 5206

DRIVER AMPLIFIER, continued

Y1	Transistor, si npn	2N2219A			8000 0389
Y2	Transistor, si npn	2N3553			8000 0658
Y3,4	Transistor, si npn	BLX13			8000 0655
Y5,6	Transistor, si npn	BD137			8000 0608
	Heat radiator for Y1				7300 0094
	Heat radiator for Y2				7300 0090
	Mounting kit for Y5,6				7300 0080/0081

9.6.3 MATCHING NETWORK B22152 3100

C1-8	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C9	Capacitor, mica	150 pF	5 %	500 V	6200 0443
C10	Capacitor, mica	22 pF	5 %	500 V	6200 0556
C11	Capacitor, mica	100 pF	5 %	500 V	6200 0130
C12	Capacitor, mica	33 pF	5 %	500 V	6200 0439
C13-17	Capacitor, cer	10 nF	-20+80 %	40 V	6200 4676
C18	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
L1-4	Choke, rf	2.2 mH	5 %		6600 0280
L5,6	Coil				B22152 5110
P1	Connector, coax	L1465/CS			8600 0733
R1-4	Pot. trimmer, carbon	2.5 kohm	20 %	0.8 W	6100 0662
R5	Resistor, w-w	2.7 kohm	5 %	2 W	6000 7676
R6,7	Resistor, carbon	1 Mohm	5 %	0.25 W	6000 5332
R8-17	Resistor, metal	820 ohm	5 %	3 W	6000 7655
R18,28	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R19,21	Resistor, carbon	82 kohm	5 %	0.12 W	6000 5520
R20	Resistor, carbon	39 kohm	5 %	0.12 W	6000 5527
R22	Pot. trimmer, carbon	50 kohm	20 %	0.8 W	6100 0658
R23	Resistor, carbon	15 ohm	5 %	0.12 W	6000 6140
R24	Resistor, carbon	33 ohm	5 %	0.12 W	6000 5289
R25	Pot. trimmer, carbon	100 kohm	20 %	0.8 W	6100 0659
R26	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R27	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R29	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304

MATCHING NETWORK, continued

R30	Pot. trim, carbon	50 kohm	20 %	0.15 W	6100 0581
R31	Resistor, metox	560 ohm	5 %	3 W	6000 7656
R32	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
T1	Transformer				B22152 5100
Z1,2	Diode, si	1N4148			7800 0594

9.6.4 PHASE DISCRIMINATOR B22152 3400

C1,3,4,5	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C2	Capacitor, cer	1 nF	20 %	400 V	6200 6298
R1	Resistor, carbon	47 ohm	5 %	0.12 W	6000 6249
R2,3,5,6	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R4	Resistor, carbon	270 ohm	5 %	0.12 W	6000 5980
R7,8	Resistor, metal	4.7 kohm	1 %	0.12 W	6000 5209
T1	Transformer				B22152 5400
Z1-6	Diode, si	1N4148			7800 0594

9.7 BAND SWITCH B22155 0000 (S8)

C1,4	Capacitor, cer	47 pF	10 %	5 kV	6200 6839
C2	Capacitor, cer	10 pF	5 %	5 kV	6200 2592
C3	Capacitor, cer	3.3 nF	-20+40 %	3.5 kV	6200 0349
C5	Capacitor, cer	70 pF	10 %	5 kV	6200 0344
C6	Capacitor, cer	160 pF	10 %	5 kV	6200 0346
C7	Capacitor, cer	430 pF	10 %	6 kV	6200 6987
C8,9	Capacitor, cer	500 pF	10 %	6 kV	6200 0348
C10,11	Capacitor, cer	1 nF	10 %	5 kV	6200 2111

BAND SWITCH, continued

C12	Capacitor, cer	250 pF	10 %	5.5 kV	6200 0342
C13	Capacitor, cer	150 pF	20 %	5.5 kV	6200 2666
C14	Capacitor, cer	100 pF	10 %	5 kV	6200 0345
C15	Capacitor, cer	6.8 nF	-20+40 %	3.5 kV	6200 0341
L1	Choke, rf				SU30142A37
L2	Choke, rf				SU30142A26
S8A	Switch wafer				8400 1109

9.7.1 ANTENNA CURRENT METER B22155 3100

C1,2,3,4	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
R1	Resistor, carbon	270 ohm	5 %	0.5 W	6000 0687
R2	Resistor, carbon	82 ohm	5 %	0.5 W	6000 0691
R3,4	Potentiometer, carbon	10 kohm	20 %	0.15 W	6100 0148
R5,6	Resistor, metal	56.2 kohm	1 %	0.12 W	6000 5537
R7,8	Resistor, carbon	220 kohm	5 %	0.25 W	6000 4824
T1	Transformer				B22155 5000 4
T2	Transformer				B22155 5001 4
Z1,2	Diode, si	BAV21			7800 1419

9.7.2 HT TEST BOARD SU30114A3

R3-7	Resistor, carbon	1 Mohm	5 %	0.50 W	6000 0564
R8	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R9	Resistor, carbon	39 kohm	5 %	0.25 W	6000 2842

9.8 CARD RACK B22113 0001 Main Frame

Note Parts Lists for U1 through U4 are in the Exciter manual.

K1	Relay	3 pole co, 24 V			6800 0492
K2	Relay	4 pole co, 24 V			6800 0196
L1,2	Choke, rf	1.5 mH	5 %		6600 0281
P1-14	Connector, card	33 way			8600 0154
P513	Connector, male	41 way			8600 1541
P514	Connector, male	35 way			8600 1528
P515	Connector, male	23 way			8600 1549
R1	Resistor, carbon	56 kohm	5 %	0.12 W	6000 5295
S1	Switch, toggle	2 pole co			8400 0274
Z1-17	Diode, si	1N645			7800 1020
For programme preparation:					
	Diode, si	1N4148			7800 0594

U0	Monitor Unit	9.16	B22100 3150
U1	MF Modulator Unit		B22100 3110
U2	MF Control Unit		B22100 3140
U3	MF Oscillator Unit		B22100 3120
U4	500 Hz Oscillator		B22100 3130
U5	Load Start Dummy Ant.		B22100 3070
U6	Load Start Reserve Ant. (not programmed)		B22100 3071
U7	Load Start Main Ant. (not programmed)		B22100 3071
U8	D/A Converter	9.9	B22100 3060
U9	Load Servo Ampl.	9.10	B22100 3050
U10	Motor Sensor	9.11	B22100 3040
U11	Tuning Logic	9.12	B22100 3030
U12	HF Tune Servo Ampl.	9.13	B22100 3020
U13	MF Tune Servo Ampl.	9.14	B22100 3010
U14	Thyristor Unit	9.15	B22100 3090

9.9 D/A CONVERTER B22100 3060 (U8)

C1-10 12-17	Cap, mplfo	10 nF	10 %	250 V	6200 5382
C11	Cap, ellyt	47 uF	-10+100%	40 V	6300 0824
K1,2	Relay	4 pole co, 24 V			6800 0313
R1,2,6-9,11, 17-21,23	Resistor, metal	10 kohm	1 %	0.12 W	6000 5550
R3,12,14,24	Resistor, carbon	8.2 kohm	5 %	0.12 W	6000 5323
R4,13,15,25	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R5,10,16,22	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R26	Resistor, carbon	1.8 kohm	5 %	0.50 W	6000 0516
R27	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
Y1-4	Transistor, si pnp	BCY30			8000 0685
Z1-4	Diode, ge	AA143			7800 1279
Z5,6,8	Diode, si	1N4148			7800 0594
Z7	Diode, zener	1N756A,8.2V 5 %			7800 0892

9.10 LOAD SERVO B22100 3050 (U9)

C1	Cap, ellyt	47 uF	-10+100%	40 V	6300 0824
C2-7,15-20	Cap, mplfo	10 nF	10 %	250 V	6200 5382
C8	Cap, ellyt	4.7 uF	-10+100%	63 V	6300 0808
C9-12	n.a.				
C13	Cap, mplfo	1 uF	10 %	100 V	6200 6105
C14	Cap, mplfo	680 nF	10 %	100 V	6200 6104
C21	Cap, mplfo	100 nF	10 %	100 V	6200 5924
K1	Relay	4 pole co, 24 V			6800 0313
R1,3,9 16,17,28	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R2,4	Resistor, carbon	120 kohm	5 %	0.25 W	6000 4644
R5	Resistor, carbon	1.8 kohm	5 %	0.50 W	6000 0516
R6,8	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R7,10	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R11	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5521
R12,31	Resistor, carbon	6.8 kohm	5 %	0.12 W	6000 5292
R13	Potentiometer, trimmer	100 ohm	20 %	0.15 W	6100 0152
R14,15	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R18	n.a.				
R19	Resistor, carbon	270 ohm	5 %	0.50 W	6000 0687
R20,29	Resistor, carbon	220 ohm	5 %	0.50 W	6000 0950
R21,22	n.a.				
R23	Resistor, carbon	220 kohm	5 %	0.25 W	6000 4824
R24	Resistor, carbon	12 kohm	5 %	0.12 W	6000 5293
R25,26	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R27,30	n.a.				
Y1,3,5,6	Transistor, si pnp	2N2905A			8000 0360
Y2,4,7,8	Transistor, si upn	2N2219A			8000 0389
Y9,10	Transistor, si pnp	2N4036			8000 0371
Z1-4	Diode, si	1N4148			7800 0594
Z5	Diode, zener	1N752A,5.6V 5 %			7800 0817
Z6	n.a.				
Z7,8	Diode, si	1N645			7800 1020
Z9	Diode, zener	1N967B,18 V 5 %			7800 1118
Z10,11	Diode, ge	AAZ18			7800 0031

9.11 MOTOR SENSOR B22100 3040 (U10)

C1-9	Cap, mplfo	10 nF	10 %	250 V	6200 5382
C10-17	Cap, ellyt	22 uF	-10+100%	40 V	6300 0870
C18	Cap, mplfo	100 nF	10 %	100 V	6200 5924
R1,2	n.a.				
R3,4,21,22	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R5,8	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R6,7,15,16, 24,25,28	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R9,18,27,33 34,36	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R10,11	n.a.				
R12,13	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R14,17,23,26	Resistor, carbon	18 kohm	5 %	0.12 W	6000 5875
R18-20	n.a.				
R28,29	n.a.				
R30,31,37	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R32,35	Resistor, carbon	6.8 kohm	5 %	0.12 W	6000 5292
Y1-4	Transistor, si pnp	2N2905A			8000 0360
Y5	Transistor, si npn	2N2219A			8000 0389
Z1,2,7,8, 13,14,19,20	Diode, si	1N645			7800 1020
Z3-6,9-12, 15-18,21-24	Diode, si	1N4148			7800 0594

9.12 TUNING LOGIC B22100 3030 (U11)

C1,20	Capacitor, ellyt	47 uF	-10+100 %	40 V	6300 1014
C2	n.a.				
C3,9,12,18	Capacitor, ellyt	22 uF	-10+100 %	40 V	6300 0870
C4-8,10,11 13,14,16,17	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C15	n.a.				
C19,21	Capacitor, ellyt	100 uF	-10+100 %	40 V	6300 1033
L1	Choke, rf	1.5 mH	5 %		6600 0281
R1	Resistor, w-w	680 ohm	5 %	2 W	6000 2443
R2-4,6,9,10 12,15-17,19,27,32	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R5,11,18	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R7,13	Resistor, carbon	18 kohm	5 %	0.12 W	6000 5875
R8,14,22-24 29,30	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5489
R20,28,33	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R21	Resistor, carbon	2.2 kohm	5 %	0.50 W	6000 0619
R25,26	n.a.				
R31	Resistor, carbon	47 ohm	5 %	0.12 W	6000 6249
R34	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R35	n.a.				
R36	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
Y1,3,5,7	Transistor, si pnp	2N2905A			8000 0360
Y2,4,6,8,9	Transistor, si npn	2N2219A			8000 0389
Z1-8	Diode, si	1N4148			7800 0594

9.13 HF TUNE SERVO B22100 3020 (U12)

C1,6	Capacitor, ellyt	47 uF	-10+100%	40 V	6300 0824
C2-5,13-16	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C7-10	n.a.				
C11,12	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C17-21	n.a.				
C22,23	Capacitor, mplfo	470 nF	10 %	100 V	6200 6089
K1	Relay	4 pole co, 24 V			6800 0313
R1-4,6,8,9	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R7	Potentiometer, trimmer	100 ohm	20 %	0.15 W	6100 0152
R8,9	n.a.				
R10,11	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R12,13	n.a.				
R14	Resistor, carbon	180 ohm	5 %	0.50 W	6000 0688
R15	Resistor, carbon	390 ohm	5 %	0.50 W	6000 0799
R16,17	n.a.				
R18	Resistor, carbon	100 kohm	5 %	0.25 W	6000 3498
R19,21,22	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5521
R20	n.a.				
R23-27	n.a.				
R28,29	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R30	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304
Y1,2	Transistor, si pnp	2N2905A			8000 0360
Y3,4	Transistor, si npn	2N2219A			8000 0389
Y5,6	Transistor, si pnp	2N4036			8000 0371
Z1-5	Diode, si	1N4148			7800 0594
Z6,7	Diode, si	1N645			7800 1020
Z8	Diode, zener	1N965B, 15 V			7800 1300

9.14 MF TUNE SERVO B22100 3010 (U13)

C1,6	Capacitor, ellyt	47 uF	-10+100%	40 V	6300 0824
C2-5,13-21	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C7-10	n.a.				
C11,12	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C22-24	n.a.				
C25	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
K1	Relay	4 pole co, 24 V			6800 0313
R1-4,6	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R8,9	n.a.				
R7	Potentiometer, trimmer	100 ohm	20 %	0.15 W	6100 0152
R10,11,26	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R12,13	n.a.				
R14	Resistor, carbon	180 ohm	5 %	0.50 W	6000 0688
R15	Resistor, carbon	150 ohm	5 %	0.50 W	6000 0950
R16,17	n.a.				
R18	Resistor, carbon	220 kohm	5 %	0.25 W	6000 4824
R19,21-23	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5521
R20	n.a.				
R24	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R25	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R27	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R28,29	Resistor, carbon	68 kohm	5 %	0.12 W	6000 5530
R30	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304
R31	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R32	n.a.				
R33	Resistor, carbon	1.8 kohm	5 %	0.12 W	6000 5522
Y1,2,8	Transistor, si pnp	2N2905A			8000 0360
Y3,4	Transistor, si npn	2N2219A			8000 0389
Y5,6	Transistor, si pnp	2N4036			8000 0371
Y7	Transistor, si npn	BC107B			8000 0373
Z1-5,9	Diode, si	1N4148			7800 0594
Z6,7	Diode, si	1N645			7800 1020
Z8	Diode, zener	1N965B, 15 V			7800 1300
Z10,11	Diode, ge	AAZ18			7800 0031

9.15 THYRISTOR UNIT B22100 3090 (U14)

C1-9	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
L1-6	Choke, rf	1.5 mH	5 %		6600 0281
R1,3,5, 7,9,11	Resistor, w-w	330 ohm	5 %	2 W	6000 1705
R2,4,6, 8,10,12	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
Z1-6	Thyristor	BT101-300R			7800 1415
Z7,10,11, 14,15,18	Diode, si	1N5624			7800 1417
Z8,9,12, 13,16,17	Diode, si	1N645			7800 1020

9.16 MONITOR B22100 3150 (U0)

C1,2,7	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C3	Capacitor, ellyt	10 uF	-10+100 %	63 V	6300 0961
C4	Capacitor, mplfo	680 nF	10 %	100 V	6200 6104
C5,6,9	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C8	Capacitor, tantal	15 uF	20 %	16 V	6300 1001
C10	Capacitor, ellyt	100 uF	-10+100 %	16 V	6300 0869
IC1	Integr. circuit	MC3302P			8100 0581
IC2	Integr. circuit	555			8100 0526
K1	Relay	24 V			6800 0313
K2	Relay	24 V			6800 0452
P1	Connector, male	33 way			8600 0023
R1	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322
R2	Potentiom. trimmer	5 kohm	10 %	0.50 W	6100 0630
R3	Resistor, carbon	820 ohm	5 %	0.12 W	6000 6250
R4	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R5	Resistor, carbon	1.5 kohm	5 %	0.12 W	6000 5791
R6,8-10, 16-19,25	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R7,11	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R12,23	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R13,21,22	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R14	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R15	Resistor, carbon	560 ohm	5 %	0.50 W	6000 0582
R20	Resistor, carbon	2.7 Mohm	5 %	0.25 W	6000 3060
R24	Resistor, carbon	8.2 kohm	5 %	0.12 W	6000 5323
Y1	Transistor, si pnp	2N2905A			8000 0360
Y2,3	Transistor, si npn	2N2219A			8000 0389
Z1-6, 8	Diode, si	1N4148			7800 0594
Z7,11,12	Diode, si	1N4383			7800 0847
Z9	Diode, zener	1N963B, 12 V	5 %		7800 1131
Z10	Diode, zener	1N971B, 27 V	5 %		7800 1309

9.17 MF LOCAL CONTROL PANEL B22190 0000

J1	Jack	2 pole		8600 1512
K1	Relay	2 pole co, 24 V		6800 0196
P308	Connector, male	47 way		8600 1541
P330	Connector, female	47 way		8600 1566
R1-8	Resistor, carbon	330 ohm	5 % 0.50 W	6000 0331
S1	Switch, rotary			8400 1070
S2	Switch, push button			8400 1069
S3	Switch, push button			8400 1074
S4	Switch, rotary			8400 1088
SL1-9	Lamp, incandescent	24 V 42 mA, W2x4.6d		8200 0212
Z1-8	Diode, si	1N645		7800 1020

9.18 REMOTE CONTROL PANEL B22191 0002

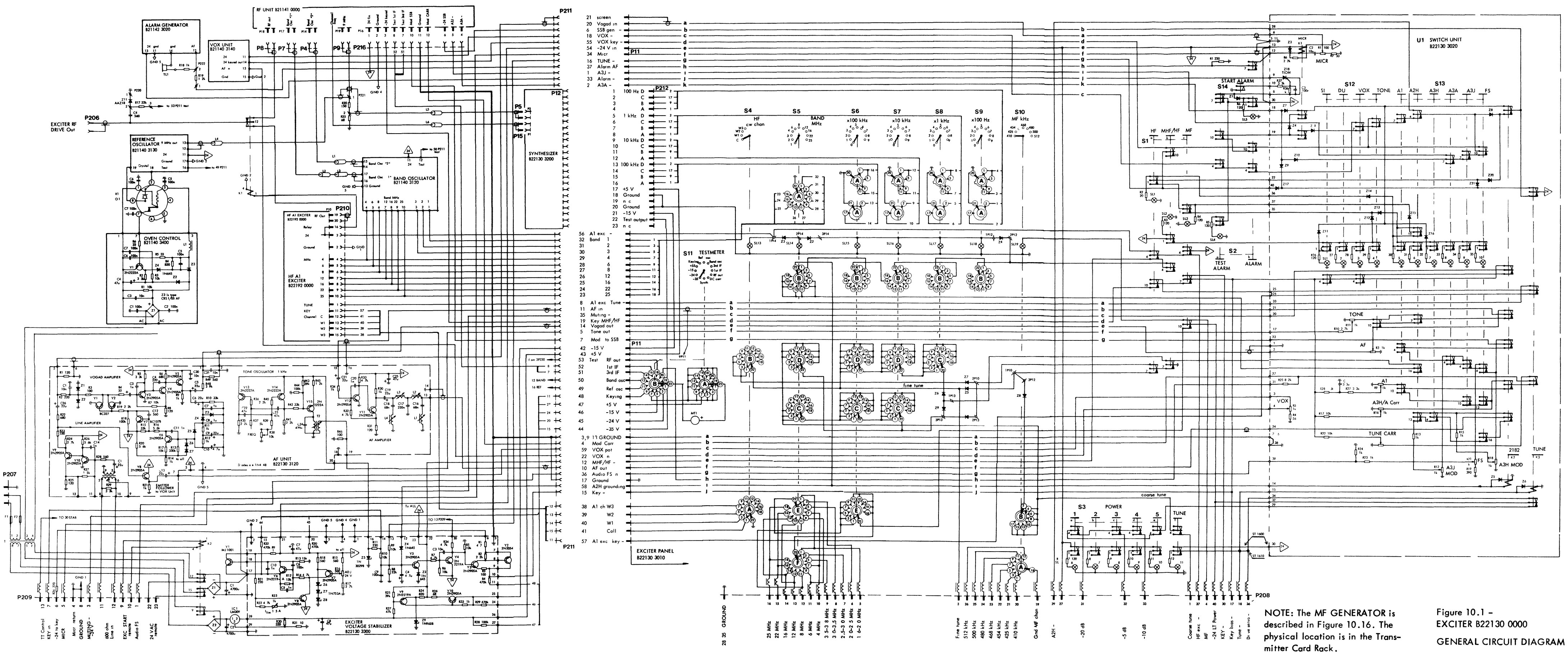
MT1	Meter	100 uA		7500 0193
P1	Connector, male	31 way		8600 1544
	mating female connector:			8600 1530
P2	Solder lug terminals			8700 0105
R1-5	Resistor, carbon	330 ohm	5 % 0.50 W	6000 0331
S1	Switch, push button			8400 1066
S2	Switch, rotary			8400 1067
S3	Switch, toggle			8400 0274
SL1-6	Lamp, incand.	24 V 42 mA W2x4.6d		8200 0212
U1	Lamp Display	-see below-		B22191 3100
Z1-3	Diode, si	1N645		7800 1020
Z4	Rectifier bridge	B80C3200-2200		7800 1375

LAMP DISPLAY B22191 3100

R1-8	Resistor, carbon	1.8 kohm	5 % 0.50 W	6000 o516
Z1,2,4-8	LED lamp	HP5082-4584, yellow		8200 0247
Z3	LED lamp	HP5082-4684, red		8200 0245

CHAPTER 10

CIRCUIT DIAGRAMS and ASSEMBLIES



NOTE: The MF GENERATOR is described in Figure 10.16. The physical location is in the Transmitter Card Rack.

Figure 10.1 -
EXCITER B22130 0000

GENERAL CIRCUIT DIAGRAM

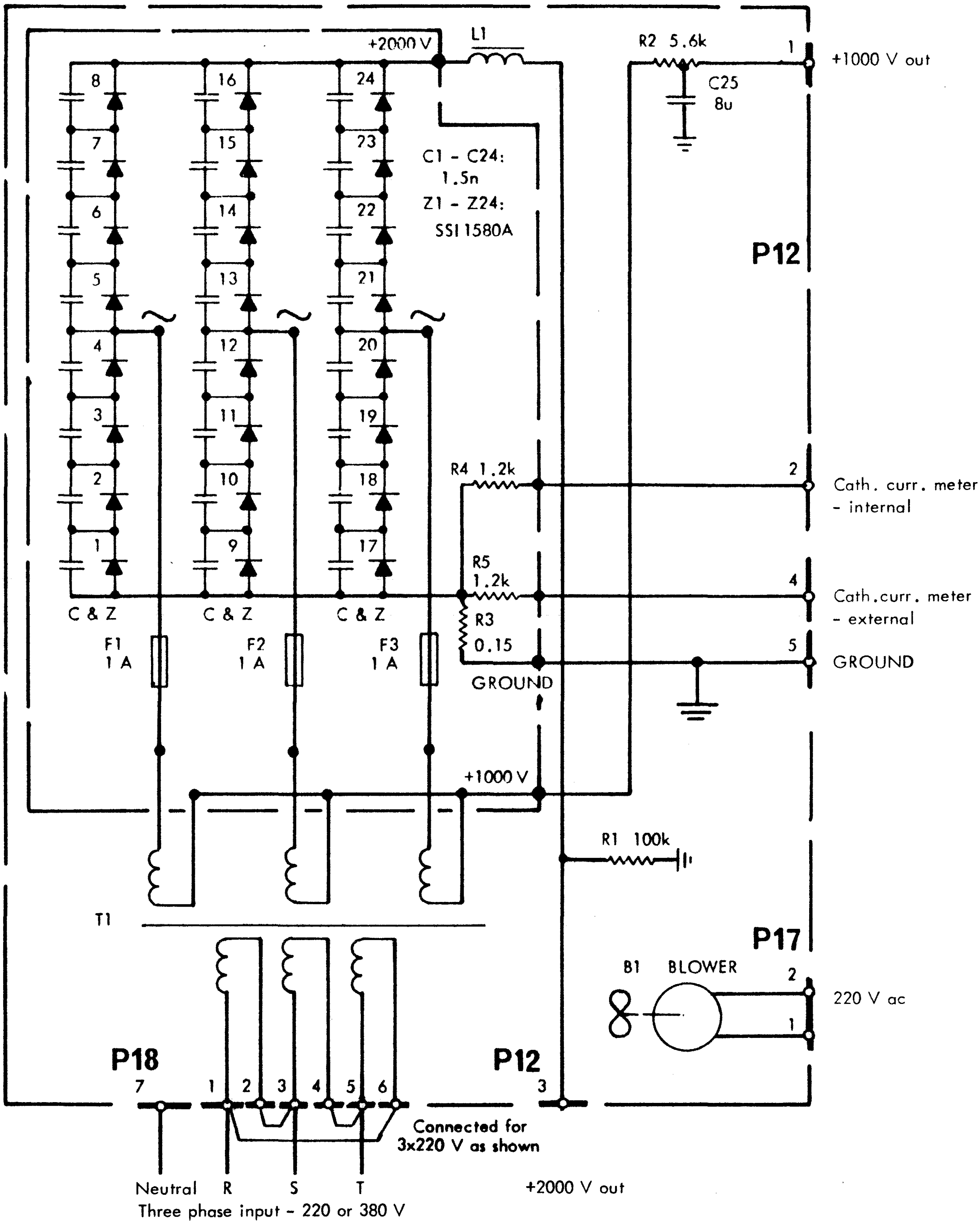


Fig. 10.2 - HT POWER SUPPLY B22112 0000
Circuit Diagram

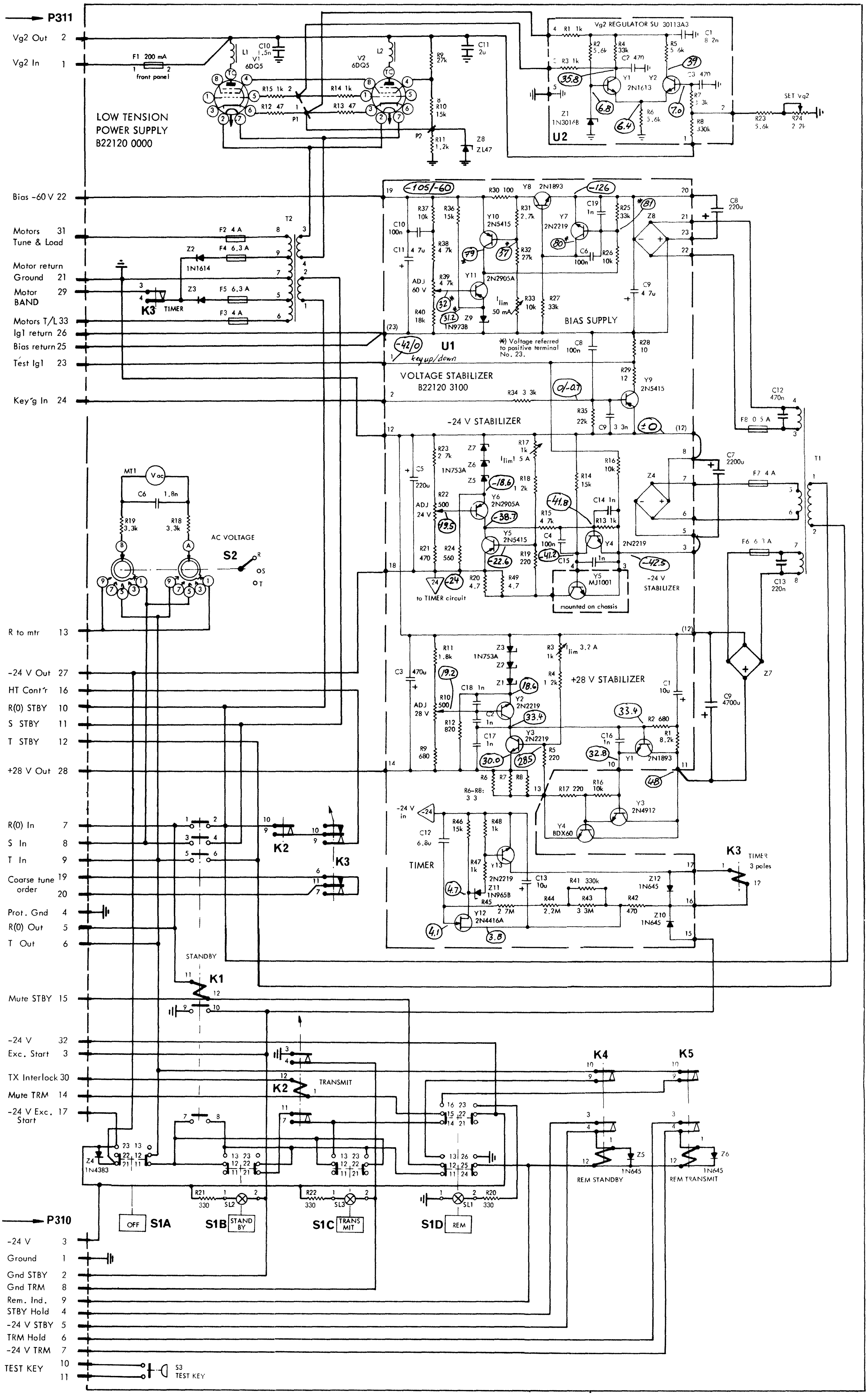


Fig. 10.3 - LT POWER SUPPLY B22120 0000
Circuit Diagram

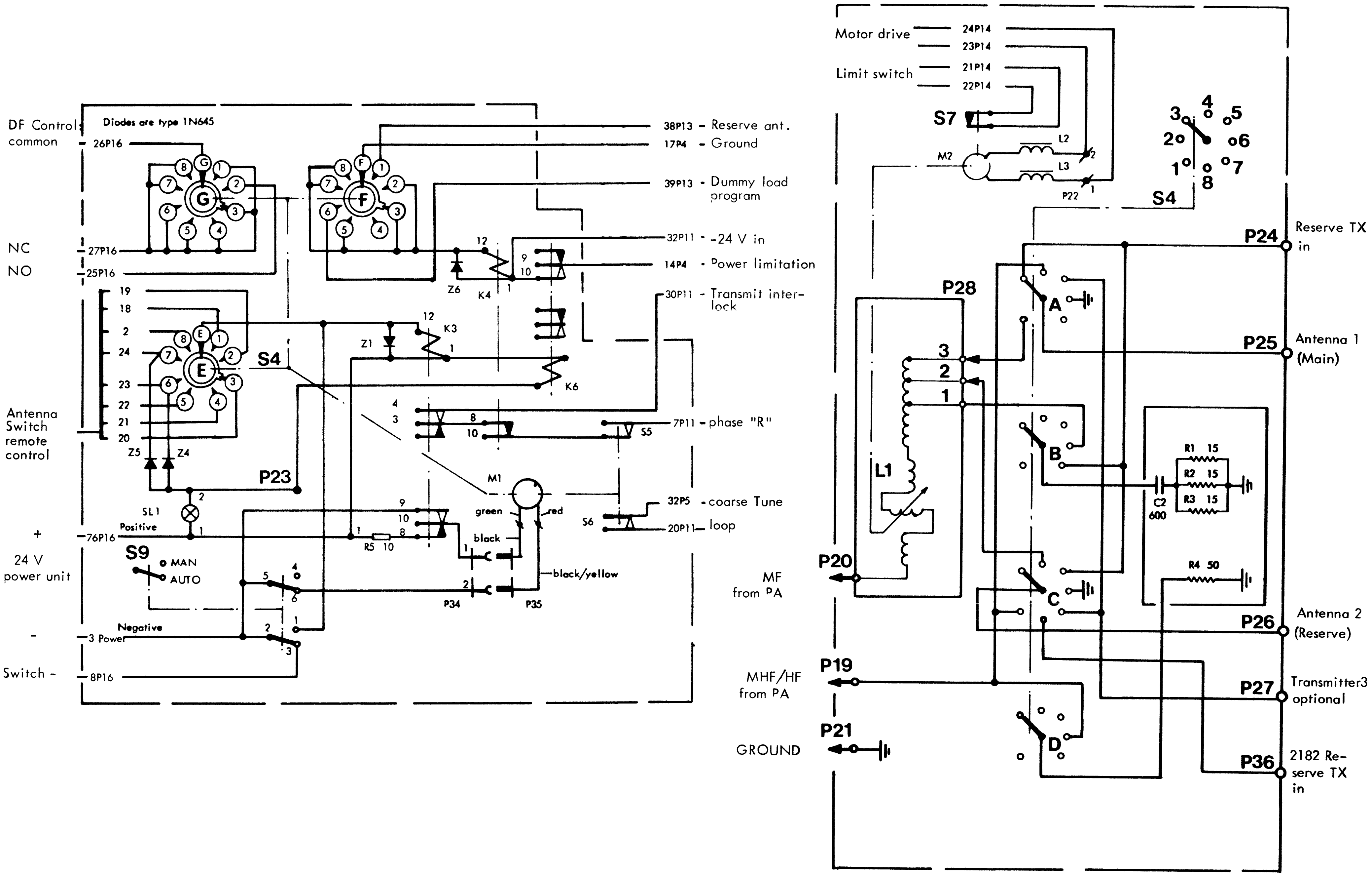


Fig. 10.4 - ANTENNA SWITCH B22116 0000
Circuit Diagram

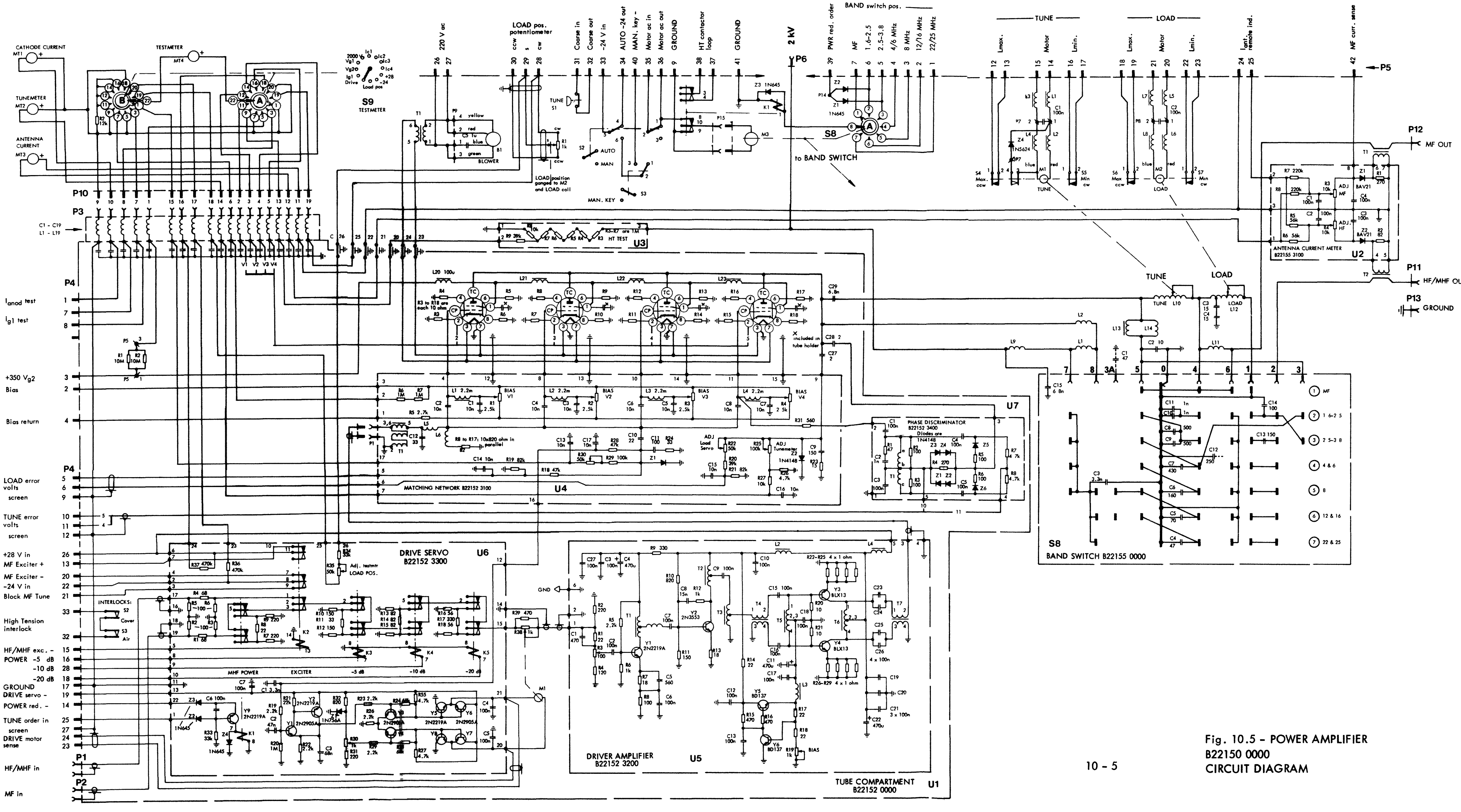
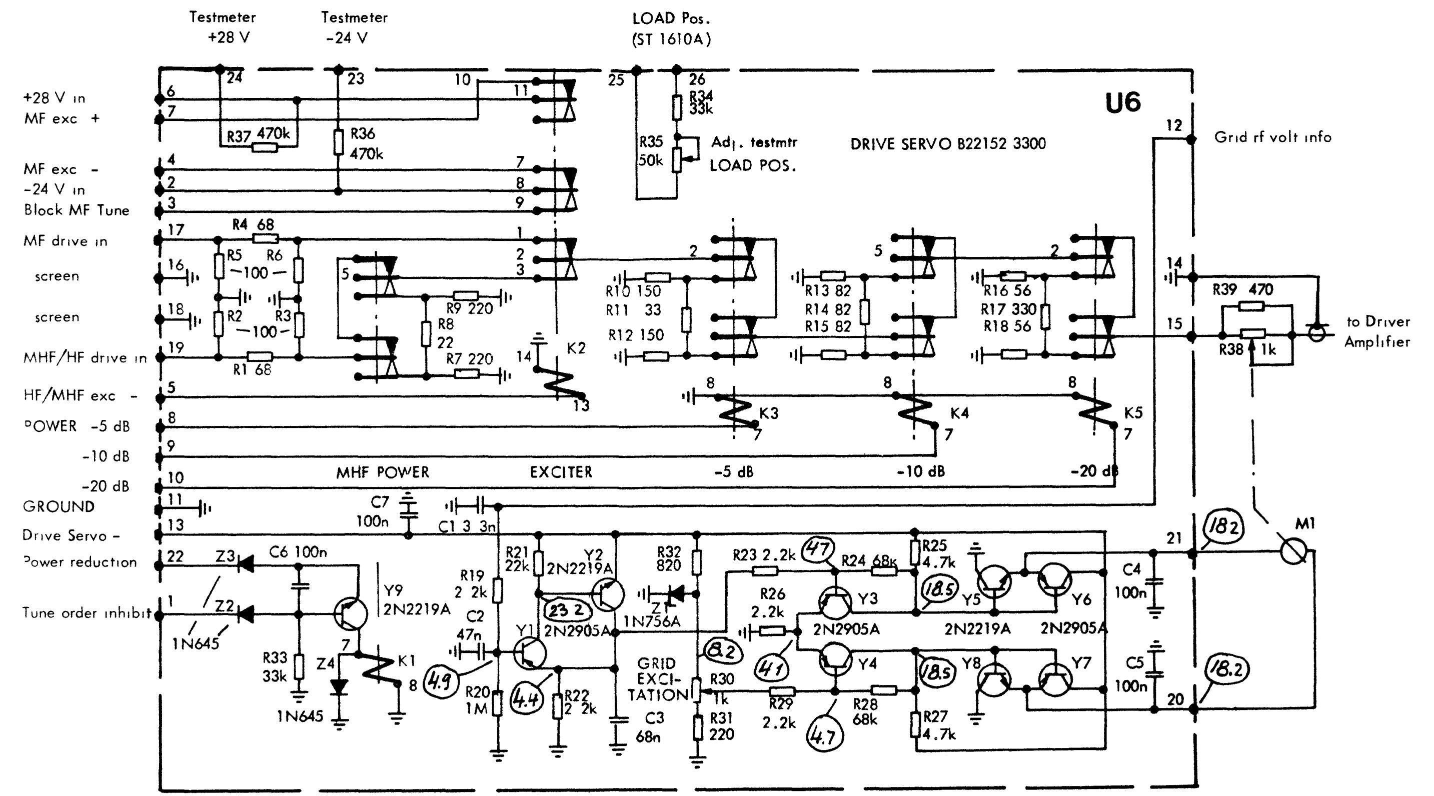


Fig. 10.5 - POWER AMPLIFIER
B22150 0000
CIRCUIT DIAGRAM



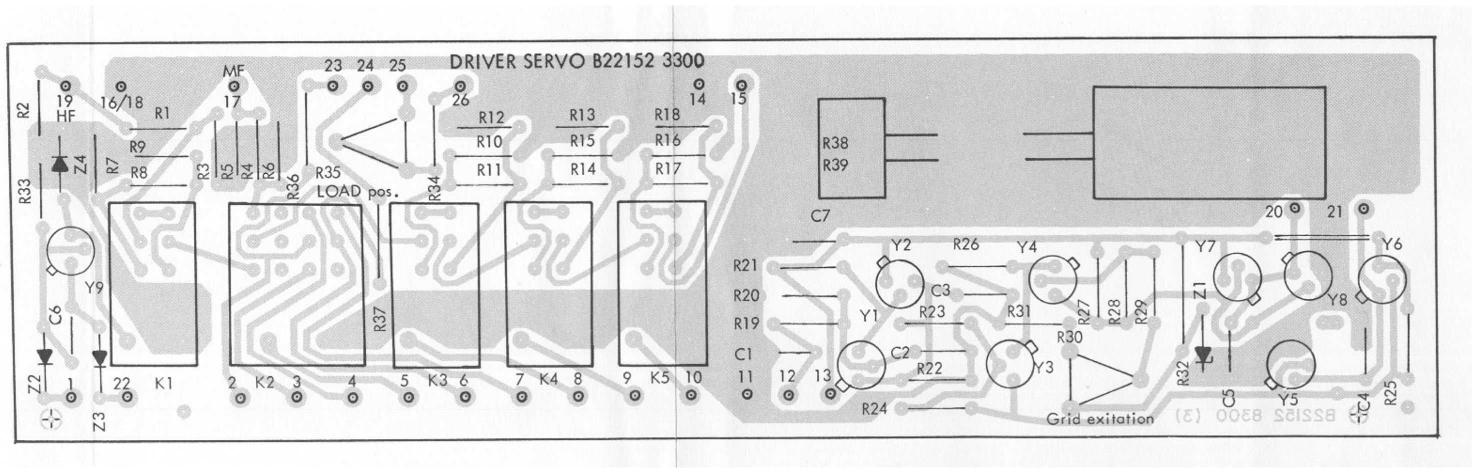


Fig. 10.6 - DRIVE SERVO B22152 3300
Circuit Diagram & Assembly Drawing

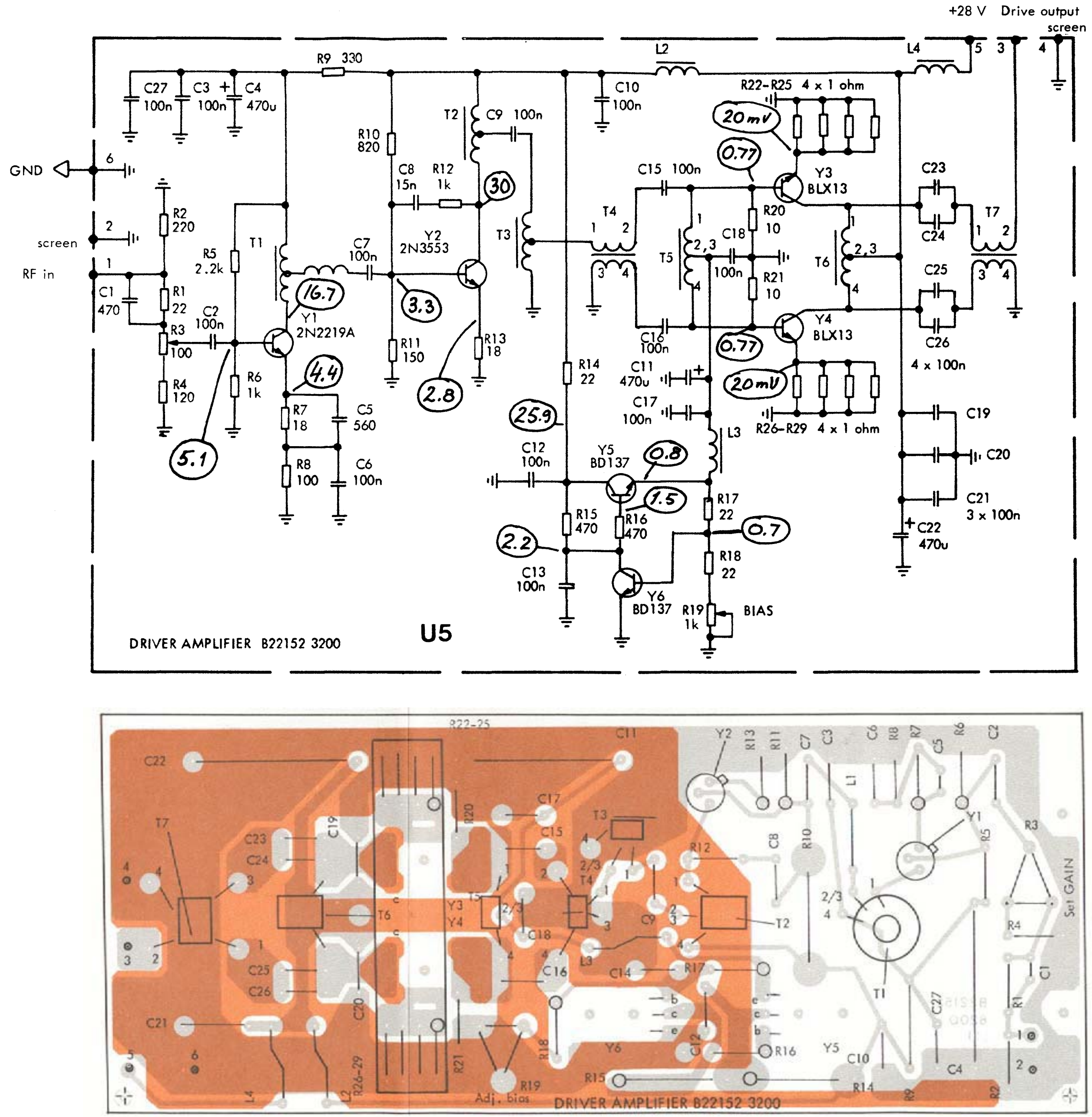
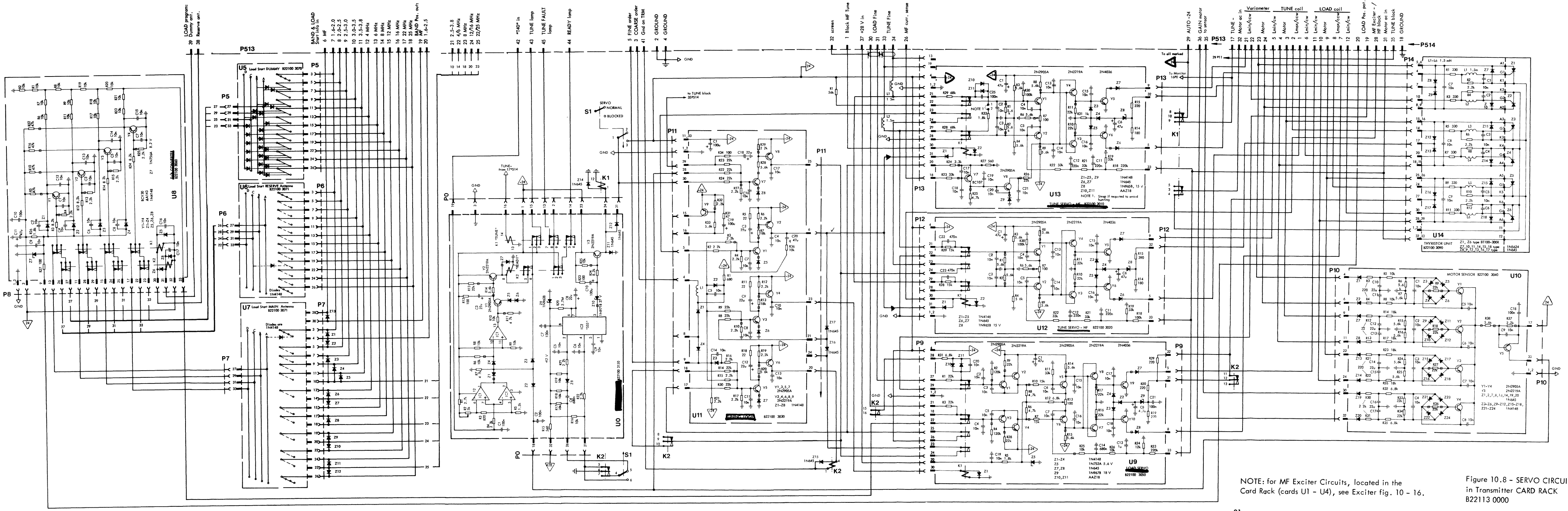


Fig. 10.7 - DRIVER AMPLIFIER B22152 3200
Circuit Diagram & Assembly Drawing



NOTE: for MF Exciter Circuits, located in the Card Rack (cards U1 - U4), see Exciter fig. 10 - 16.

Figure 10.8 - SERVO CIRCUITS in Transmitter CARD RACK
B22113 0000
General Circuit Diagram

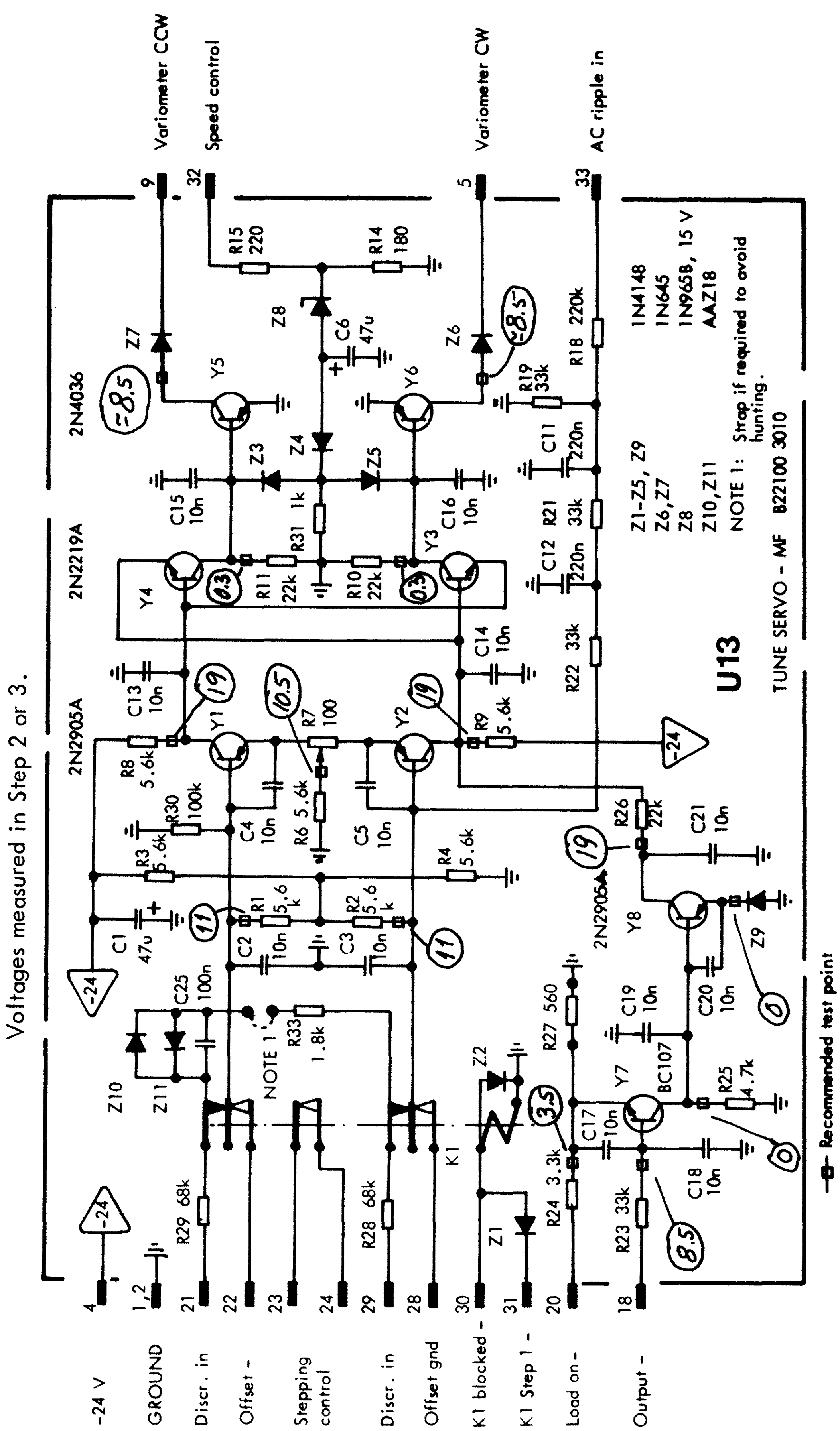


Figure 10.9

MF TUNE SERVO B22100 3010

Circuit Diagram

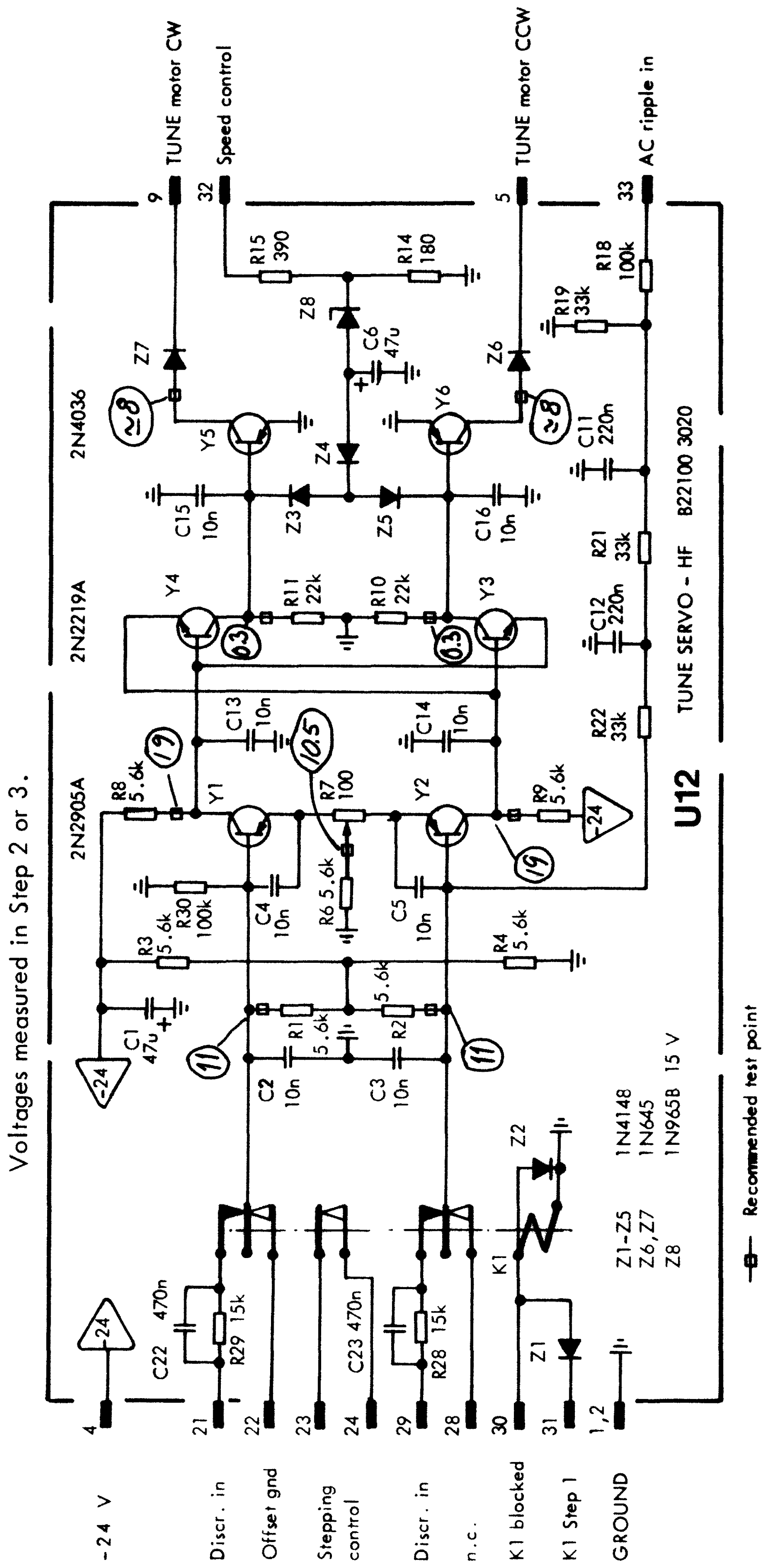


Figure 10.10
HF TUNE SERVO B22100 3020
Circuit Diagram

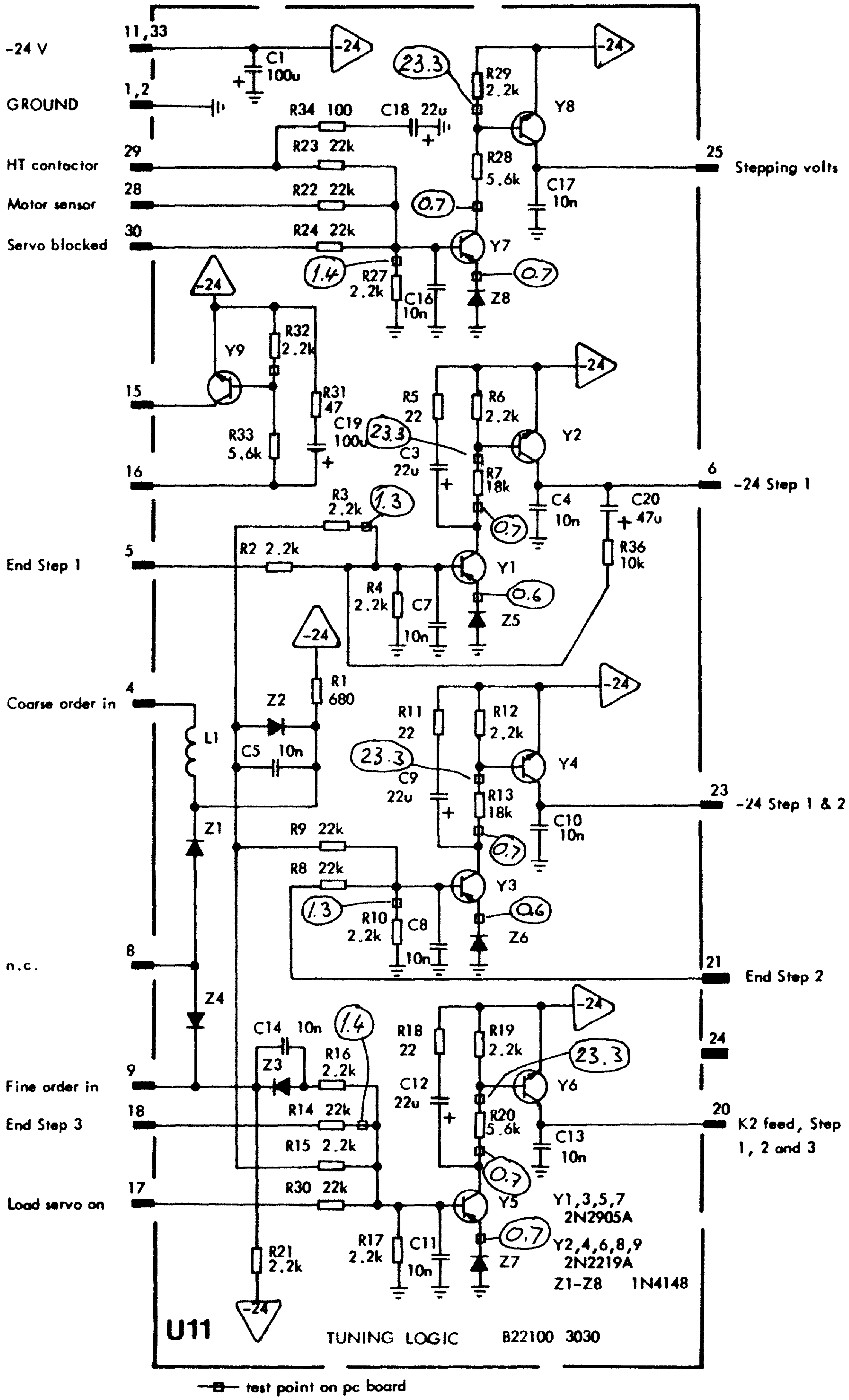


Figure 10.11
TUNING LOGIC B22100 3030
Circuit Diagram

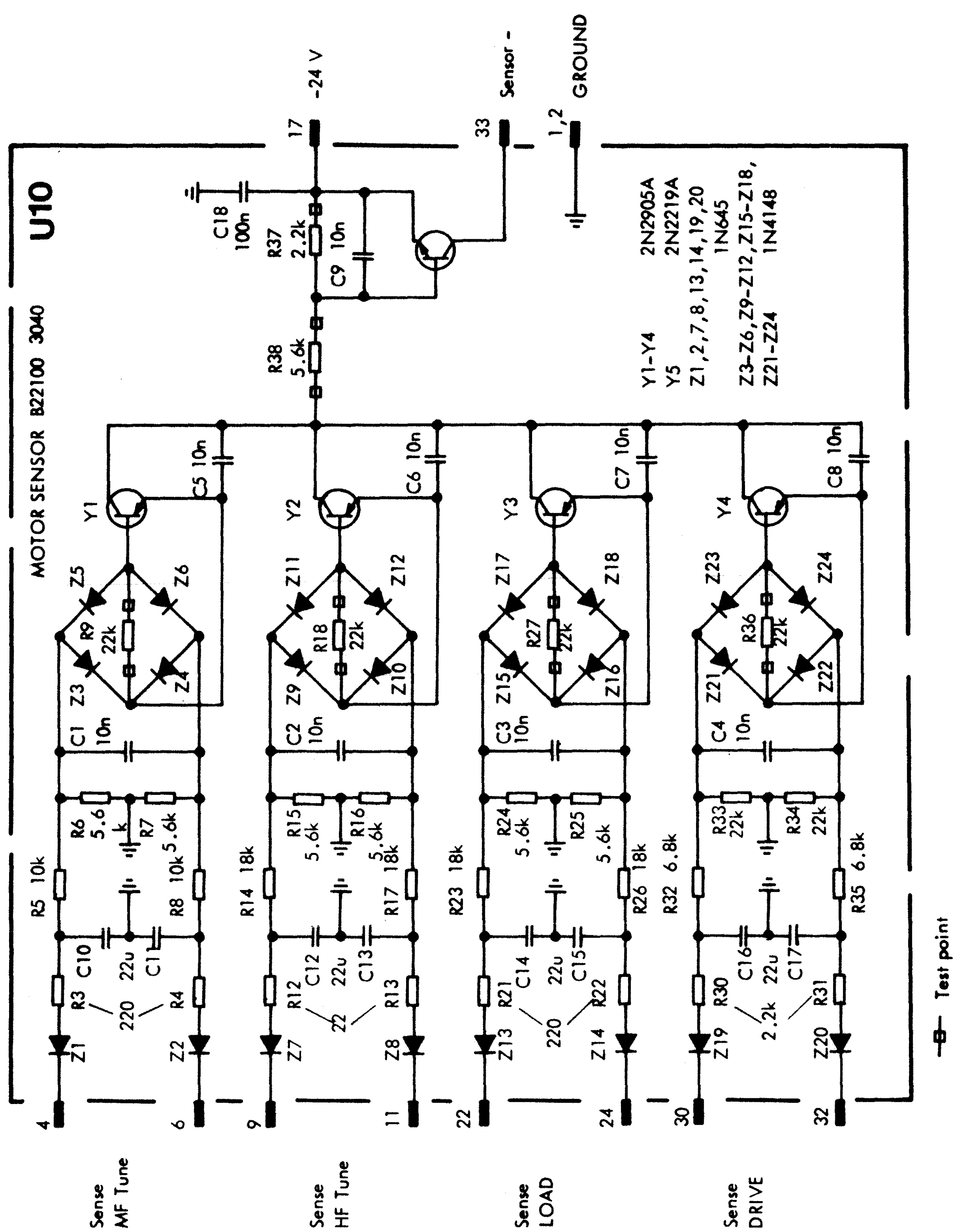


Figure 10.12
MOTOR SENSOR B22100 3040
Circuit Diagram

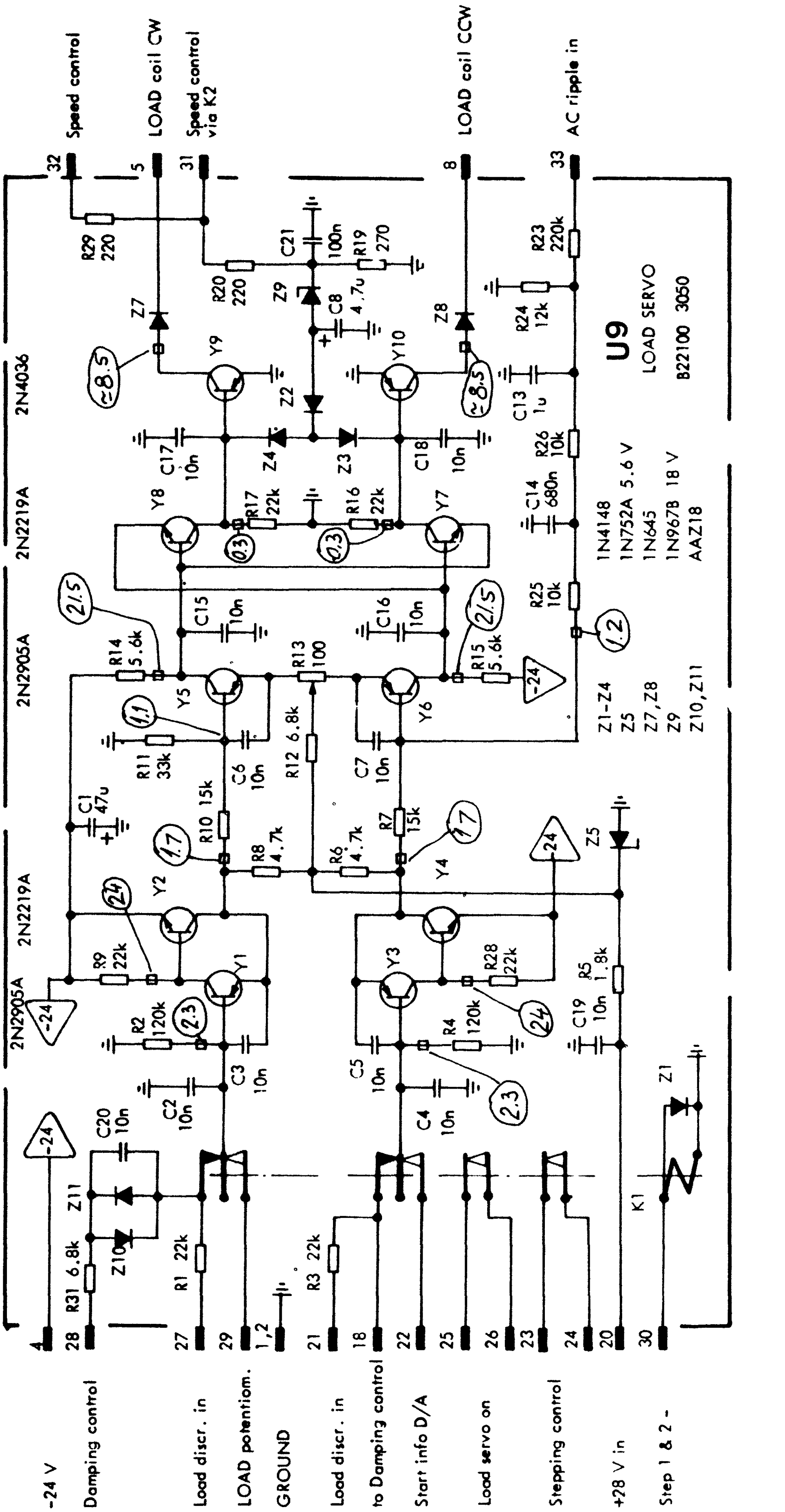


Figure 10.13
LOAD SERVO B22100 3050
Circuit Diagram

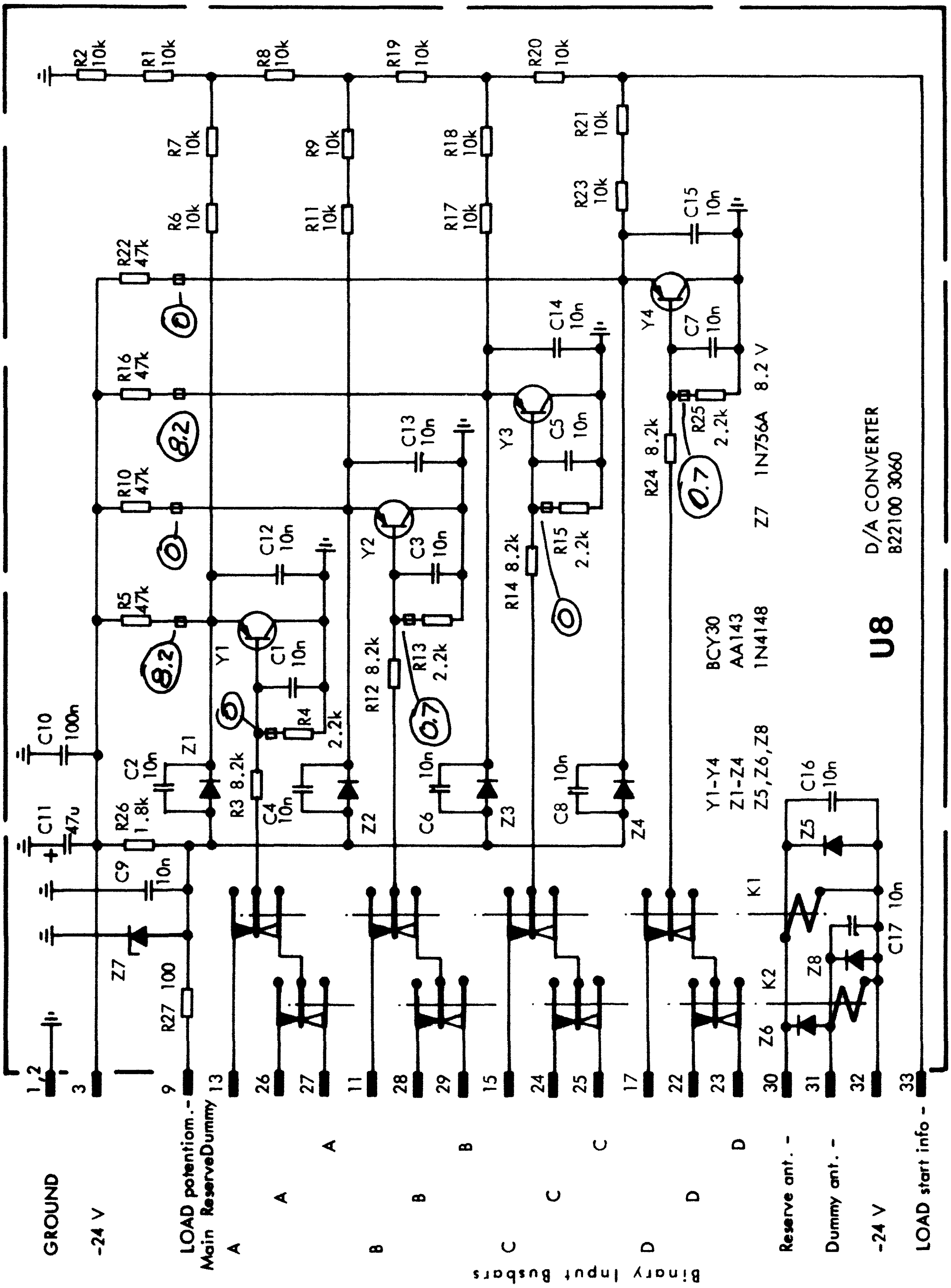


Figure 10.14
D/A CONVERTER B22100 3060
Circuit Diagram

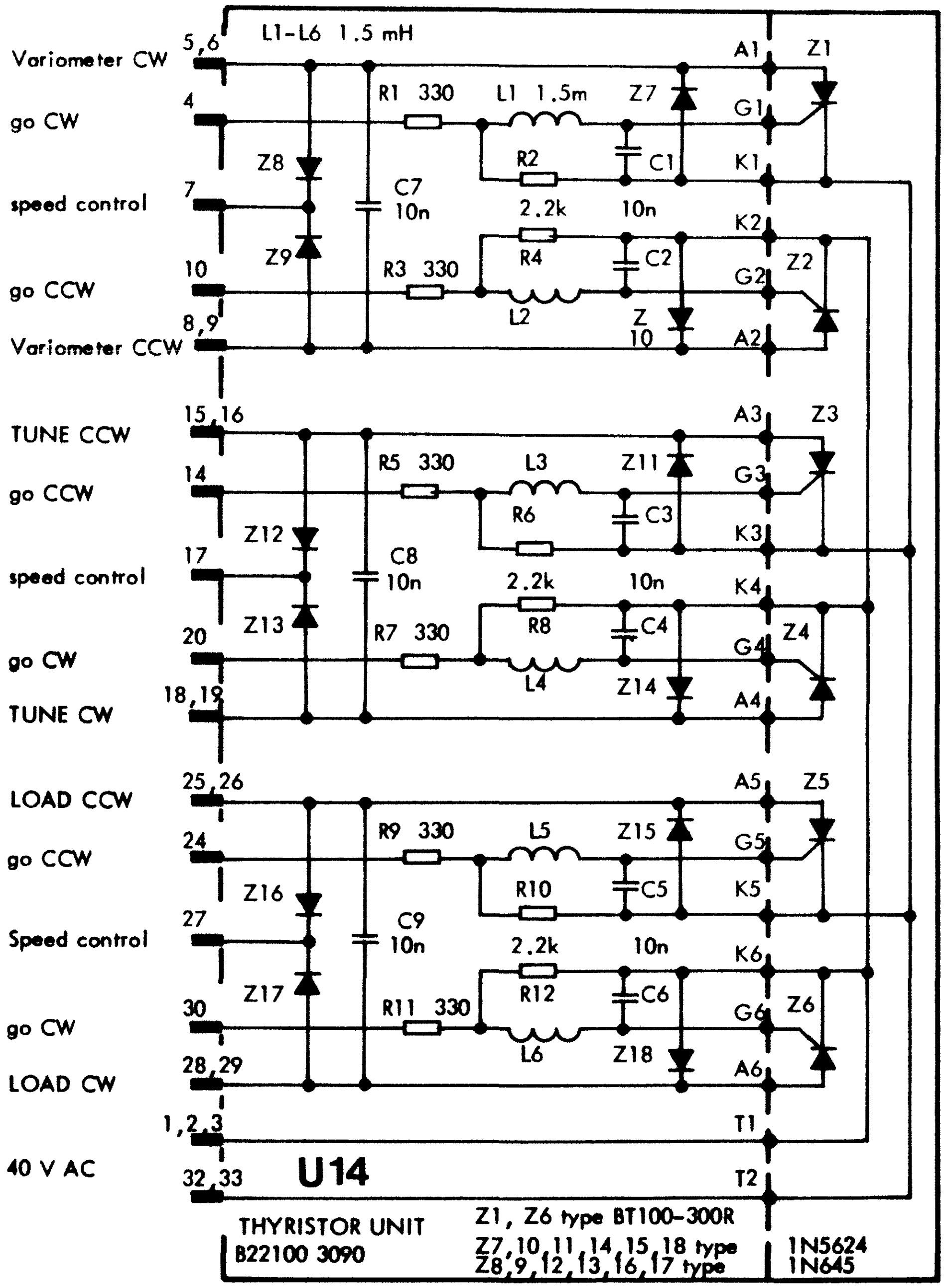


Figure 10.15
THYRISTOR UNIT B22100 3090
Circuit Diagram

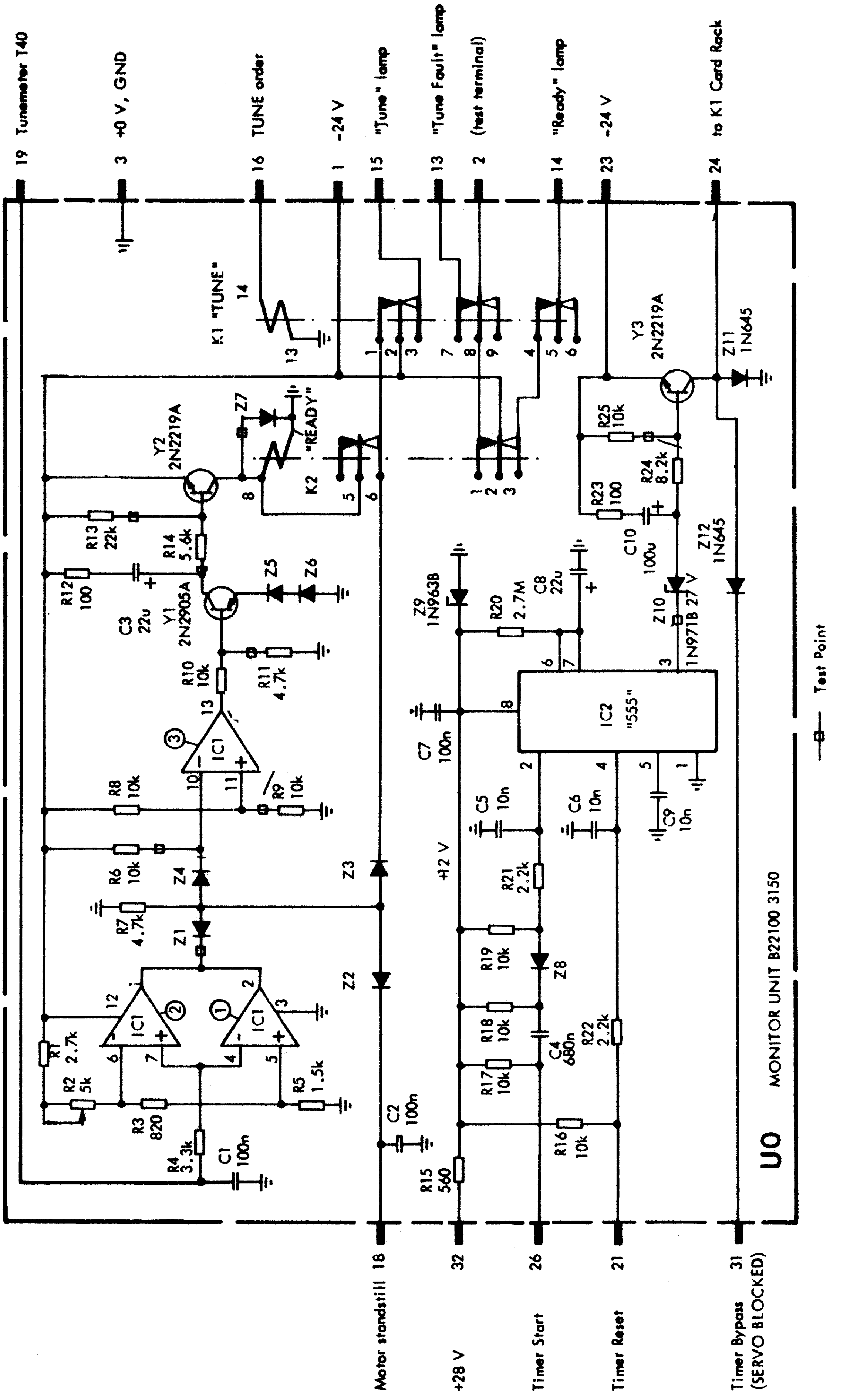


Figure 10.16
MONITOR UNIT B22100 3150
Circuit Diagram

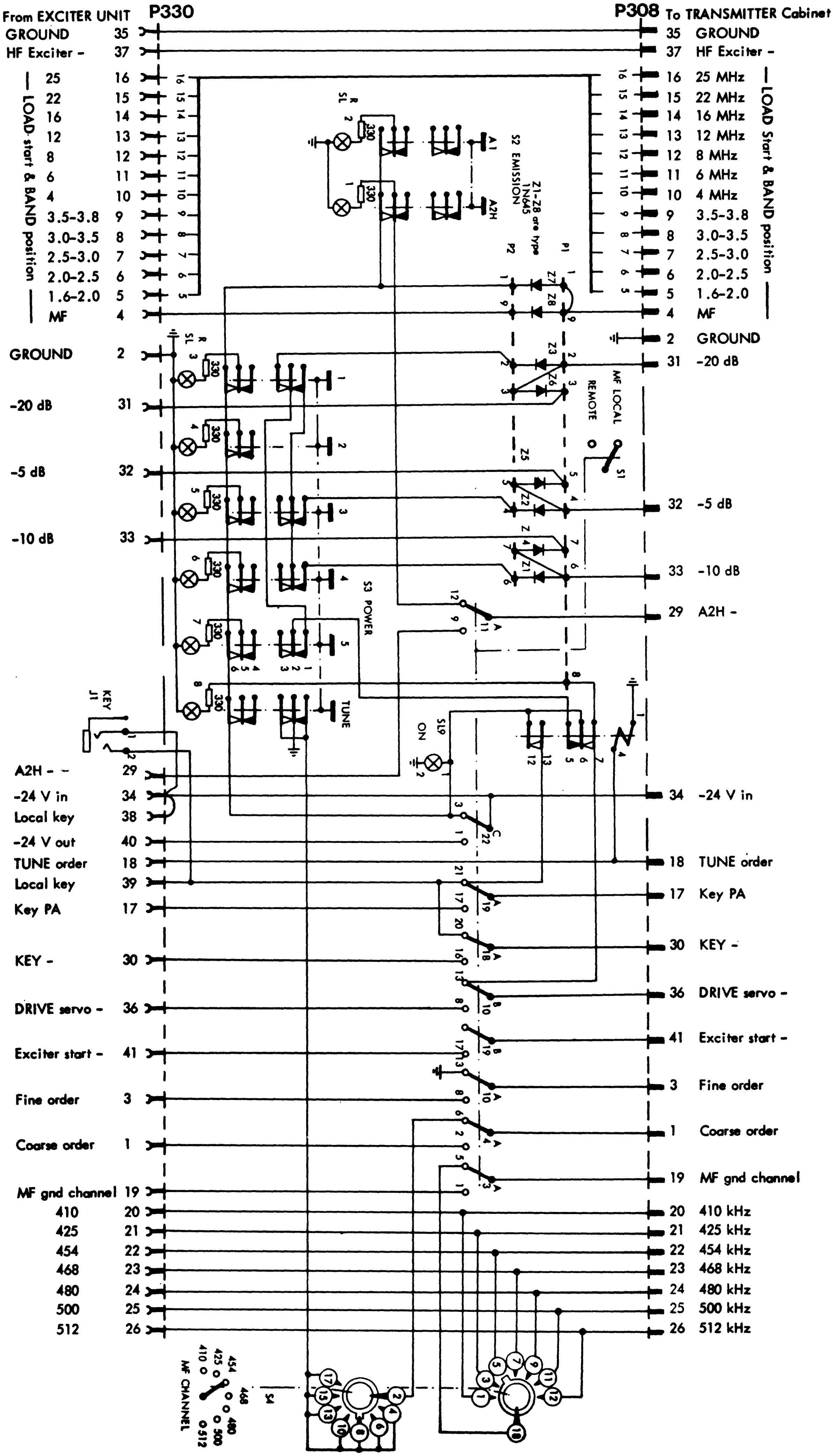


Figure 10.17
MF LOCAL CONTROL PANEL B22190 0000
Circuit Diagram

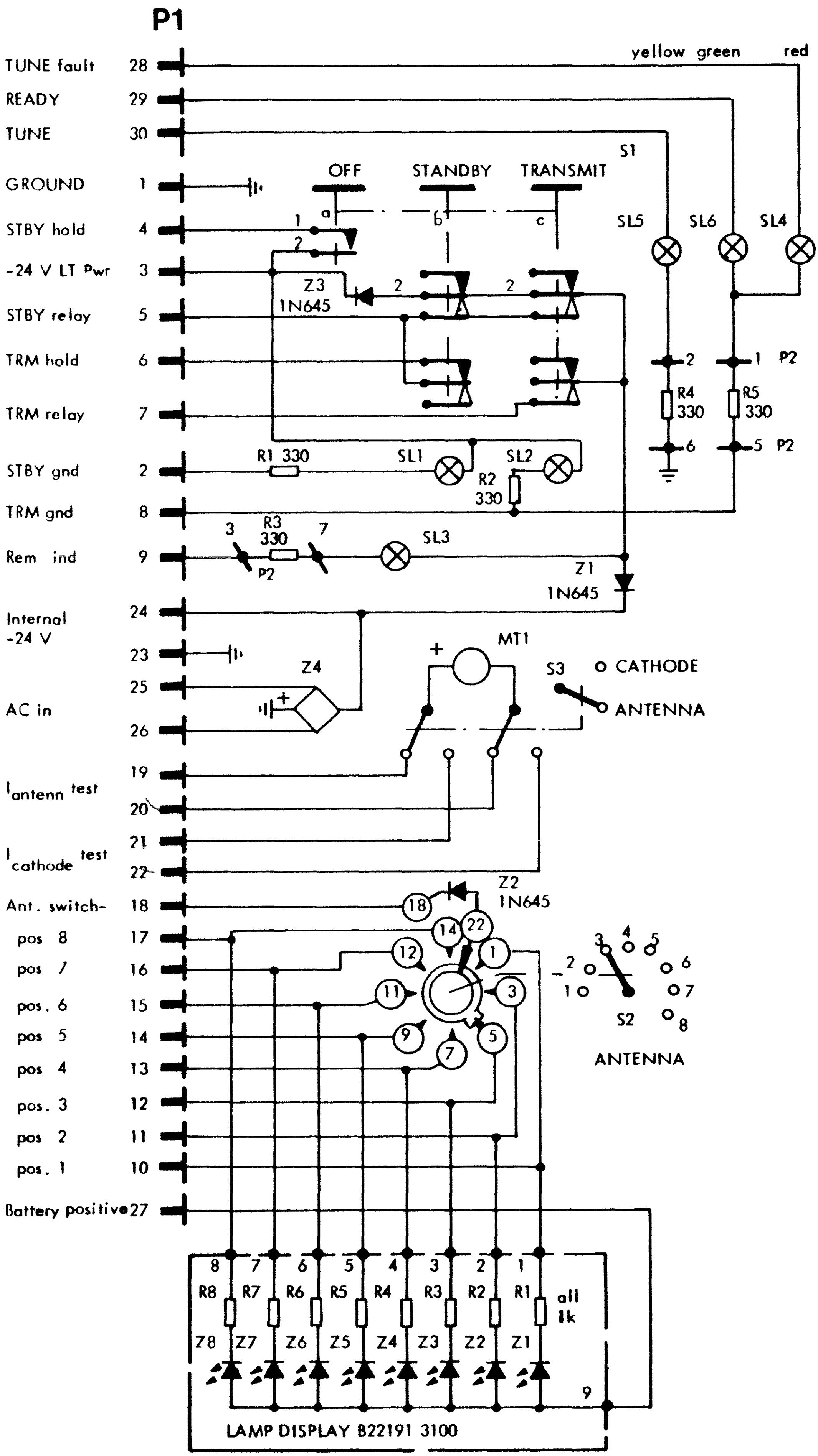


Figure 10.18
REMOTE CONTROL PANEL B22191 0002
Circuit Diagram