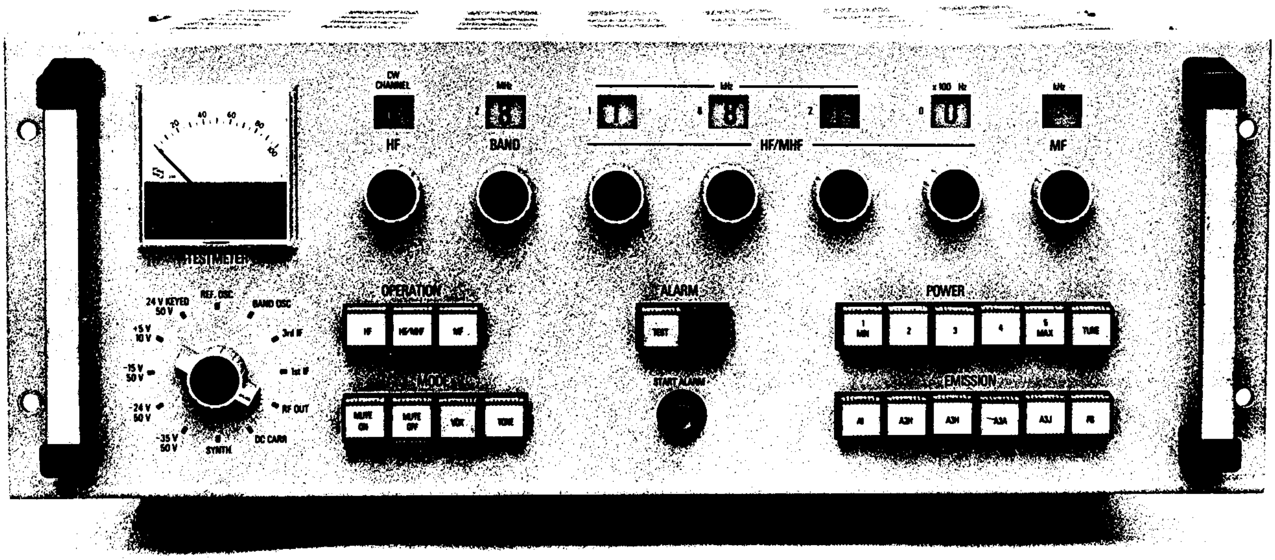

Exciter B22130 & B22140

Technical handbook

Manual no. B 22130 1000

ITT Marine

EXCITER MANUAL B22130 1000: CORRECTIONS

Date: 1975-06-25

page 4-8 Figure 4.8 - Frequency Generation: correct misprint on OUTPUT line " = 12.175 + .. "

page 9-4 9.4 SYNTHESIZER OSCILLATOR B22130 3201:

a) Integrated circuit series 64 replaces series 74. Old and new types may be mixed, only that IC 16 should always be type SN6400:

IC1,2	SN6474	8100 0110
IC3-7,26	SN6473	8100 0104
IC8-11	SN6472	8100 0264
IC12,13	SN6430	8100 0107
IC14	SN6410	8100 0106
IC15-19	SN6400	8100 0105
IC20	SN6442	8100 0447
IC21-25	SN6490	8100 0103

b) Choke L8: delete "8" from "L1,7,8" and add after L6

" L8 Choke, rf 2.7 uH 10 % 6600 0241 "

page 9-10 9.7.6 3rd IF AMPLIFIER B21141 3150:
add before L1-2,5,6 : " IC 1 Integrated circuit SN6490 8100 0103
Note: SN6490 is preferred to SN7490, which may be employed as a substitute.

page 10-1 Figure 10.1 Exciter B22130 0000
-Exciter Voltage Stabilizer B22130 3300:

a) Resistor R34 from pin 30 is connected to the base of Y4, refer to fig. 10.2.

b) The supply of -24 V to other circuits is from pin 21, not from pin 23.

- Connector P211: correct destinations from the bottom of the circuit diagram

Pin 57	cable runs to	11P210 (HF A1 Exciter)
41	"	12P210
40	"	13P210
39	"	14P210
38	"	15P210

- U1 SWITCH UNIT:

a) TUNE CARR potentiometer is "R14, 1 kohm"

b) Switch S12 SI-button contacts 5-6 are bridged for unswitched muting output

c) For external control of FS carrier, the connection between S13 FS button pin 12 and S12 TONE button pin 9 to be broken (factory-made from May 1975).

page 10-4 Fig. 10.4 Synthesizer B22130 3201:

a) IC No. 26 to be changed to number (20) (BCD to Decimal converter)

b) IC No. 20 - near "DIVIDER 2:1 and AMPLIFIER" - to be changed to (26) on two flip-slops

c) Diodes Z1 and Z2 (BA182): change symbol polarity, cathodes to face junctions of L6, L7 and L8.

d) L8: change value to " 2.7u "

page 10-12 Fig. 10.12 Output Amplifier:

a) R2 change value to "33" ohm

b) Capacitor C11 10 uF - refer to fig. 10.7 for location in the circuit.

page 10-16 Fig. 10.16 Exciter MF Generator:

U4 500 Hz Oscillator - refer to fig. 10.20 for Z1,Z3 diode circuit change.

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DESIGNED & MANUFACTURED BY:

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

This technical manual describes ITT Marine SSB Exciter type B22130, employed as the drive unit for radio transmitters type ST1600A and ST1610A. Information is provided to allow qualified service technicians to maintain and repair the unit, and advises about routine maintenance, which can be carried out by the radio operator.

The exciter covers the marine radio bands from 1.6-26 MHz (MHF and HF) and externally housed circuits for the MF channels 410-512 kHz. Thus three main sections are recognized:

MF-	telegraphy, crystal control of seven channels
HF/MHF-	telephony and telegraphy, synthesizer control of desired channels
HF-	A1 telegraphy only, crystal control of up to 4 channels per band (4-25 MHz)

The exciter unit is basically the same for the two possible applications: driving the manually tuned ST1600 transmitter or the automatically tuned ST1610. The only electric difference is focussed around the TUNE push button, being springloaded for ST1610 applications while double-push for ST1600. Exterior-wise, the exciter for ST1600 is normally fitted with a 22 in. panel to be installed in the transmitter cabinet. The auto-tuned ST1610 is in general controlled from a remote operation room, and thus the exciter to be employed is provided with a standard 19 in. front panel.

NOTE

The basic type designation for ST1600A application of this exciter is B22140.

1.2 GENERAL DESCRIPTION

HF/MHF Exciter
Intelligence signals are fed to the exciter, amplified, shaped or filtered to the required degree and then modulate a 9 MHz carrier. This carrier is mixed with other rf signals, which are derived from internal oscillators, and which frequencies relate to the band of operation and the specific channel to be used. Finally a fully processed signal is available at the exciter output, with a very high frequency stability and carrying the intelligence which is to be transmitted.

MF Exciter
The morse key output controls an audio oscillator and a keyed dc voltage to the modulator (A2H and A1, respectively). The oscillator employs different crystals for A1 and A2H operation, respectively.

Because the MF Exciter circuits are housed in the transmitter cabinet, the exciter rf output is taken straight to the power amplifier driver, and selected there by a relay controlled from the exciter front panel. Choice of channel and emission is made from the exciter (alternatively from the MF Local Control Panel, see Transmitter technical handbook).

HF A1 Exciter
This is a subunit of the main HF/MHF exciter, and may be locked upon as a redundancy facility on HF telegraphy. Up to four quartz crystals may be installed on each band, providing "programmed" telegraphy channels. Each channel requires a specific crystal, adjusted to operate on the output frequency.

The HF A1 exciter is powered from the main exciter, and the output is relay-selected when the HF push button is pressed.

The main exciter unit is powered from 220 V AC and derives stabilized voltages for feeding internal circuits. Starting-up from a remote location requires -24 V, approx. 100 mA. The MF exciter is supplied stabilized dc voltages from the low tension power supply of the transmitter.

1.3 SPECIFICATIONS

Refer to table 1.1 for the performance specification.

Frequency Range		410-512 kHz 1.6 – 3.8 MHz 4-26 MHz (marine bands)
Number of Channels	MF	7
	HF/MHF	synthesized, 100 Hz increments
	HF	4 channels/band, 4-26 MHz
Frequency Tolerance	(±) MF & HF	50×10^{-6}
	HF/MHF	long term 50 Hz short term 5 Hz
Types of Emission	MF	A1, A2H
	HF/MHF	A1, A3H, A3A, A3J, FS tone
	HF	A1
Power Output		25 mW nom., 50 ohm
Power Reduction (in PA driver)		in 4 steps of approx 5 dB
Audio Passband		350 to 2700 Hz (CEPT)
Audio Compression		to CEPT specification
Audio Sensitivity		about 50 mV for full Pp
Microphone		Carbon, 50 ohm nominal
Carrier Levels ref Pp	A3H	-4.5 to -6 dB
	A3A	-18 ±2 dB
	A3J	below -45 dB
Occupied bandwidth	A1	200 Hz
(30 Baud keying)	A2H	1450 Hz
Keying Speed		exceeds 50 Baud
Alarm Signal		1300 Hz/2200 Hz, ±1 % timed period min 30/max 60 s
Temperature Range		-10° C to +55° C
Mains Supply		220 V ±10 %, 50-60 Hz

Table 1.1 - Exciter Specification

CHAPTER 2

INSTALLATION

2.1 GENERAL

The exciter described in this manual is specifically designed to operate with transmitters type ST1600 and ST1610.

The exciter connects to the cabling of the transmitter in the cabinet (ST1600) or through the remote control cable (ST1610) between the exciter and the screw terminal block in the bottom of the cabinet.

2.2 MOUNTING

The exciter unit is designed to be mounted on telescopic runners, either in the transmitter cabinet (22 in. panel) or in a rack or radio console (19 in. front panel).

Refer to figure 2.1 for outline dimensions.

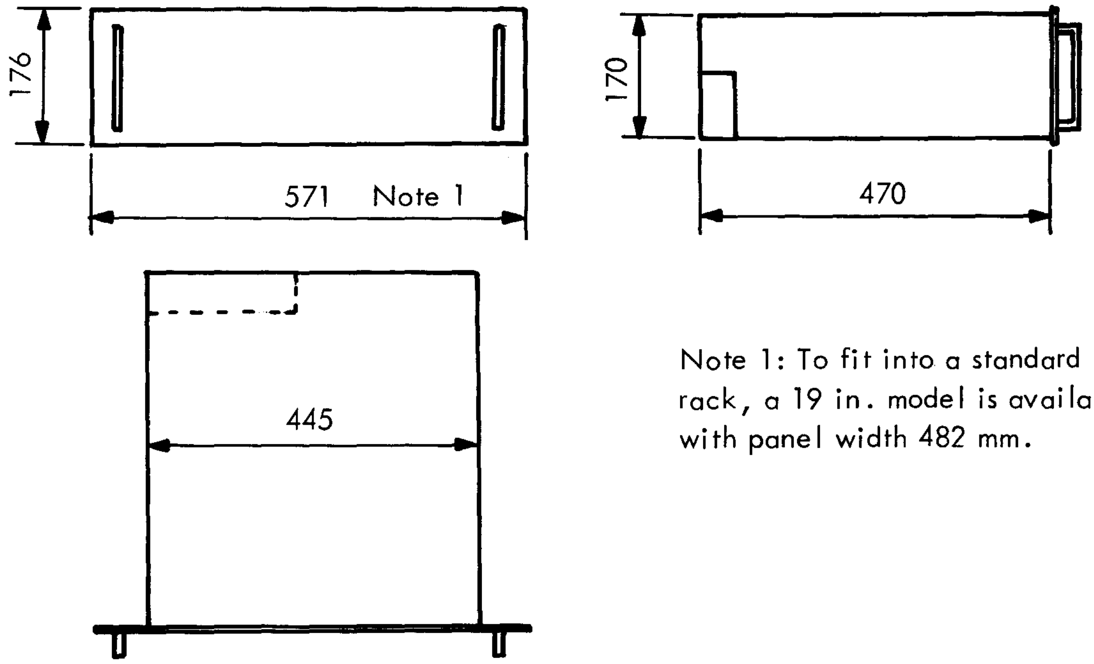
2.3 EXTERNAL CONNECTIONS

The external connections are specifically detailed in the technical manual of the transmitter unit.

Generally external connections are through four connectors, as given in table 2.1.

Designation (chassis part)	Service	Cable connector to match/SRT part no.
P206	RF output, coaxial	8600 0362 (P6)
P207	AC mains, 3 core with ground	8600 1272 (P7)
P208	Interunit controls exciter to transmitter, 47 way	8600 1533 (P8)
P209	Exciter external control & info inputs, 23 way	8600 1548 (P9)

Table 2.1 - Exciter external connections



Note 1: To fit into a standard rack, a 19 in. model is available with panel width 482 mm.

Figure 2.1 - Exciter Outline Dimensions

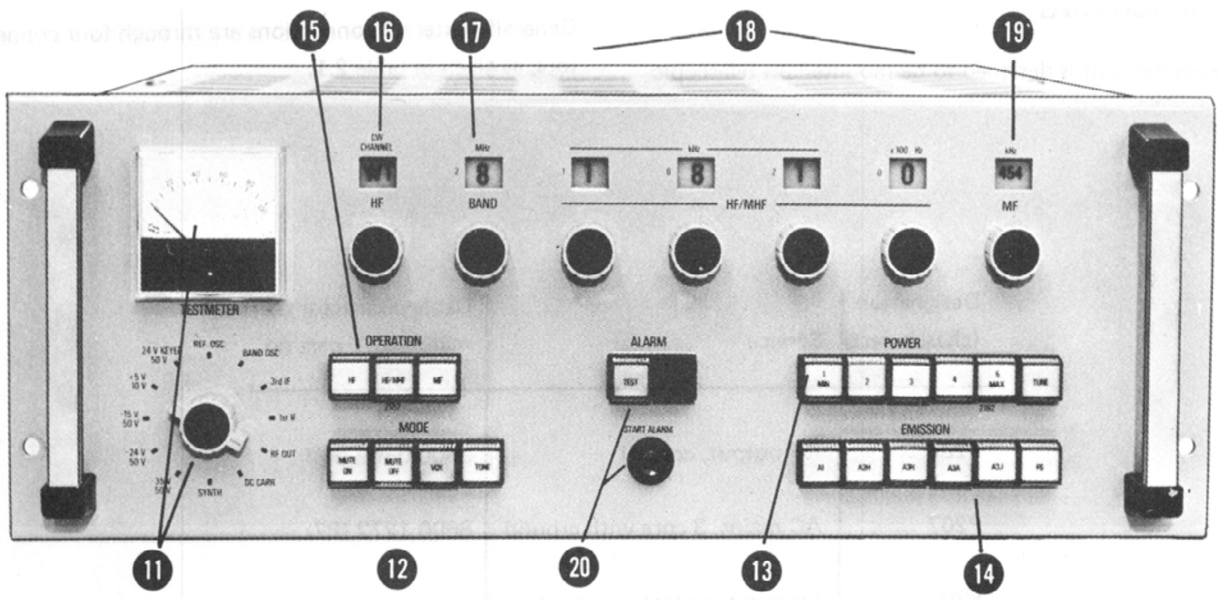


Fig. 3.1 - EXCITER, front view

CHAPTER 3

OPERATION

3.1 OPERATING CONTROLS

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

12 MODE

MUTE OFF / MUTE ON — Control of muting output vol tage Normally muting volta ge is permanently connected (simplex position bridged by wire jumper)

VOX — Voice control of the transmit ter

TONE — Tone modulation of the carrier from the morse key The car rier is not keyed

13 POWER

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

TUNE — Push button control to obtain a pilot signal for tuning pur poses Signal lamp alight when the button is depressed

14 EMISSION

A1 — Selects A1 emission (MF & HF)

A2H — Selects A2H emission and blocks the transmitter on HF if pressed

A3H — Selects A3H emission Uncon ditionally chosen on 2182 KHz

A3A — Selects A3A (reduced carrier) emission

A3J — Selects A3J (suppressed car rier) 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 tele graphy exciter

17 BAND MHz — Band selector, for HF and HF/MHF exciter sections

18 Channel Selectors — Set the frequency of the syn thesizer 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.

3.2 OPERATING INSTRUCTIONS

Operating instructions are detailed under the corresponding chapter of the transmitter, where the particular exciter forms a sub-unit.

CHAPTER 4

THEORY OF OPERATION

4.1 GENERAL

In this chapter the principles of operation are discussed, starting from the functional block diagram of the complete exciter, figure 4 1 Functional block diagrams of the three separate generators for MF, HF/MHF and HF are in figures 4 2, 4 3 and 4 4 The signal flow in each system is then analyzed in the following three figures, 4 5, 4 6 and 4 7 The principles of frequency generation are discussed with reference to figure 4 8 The synthesizer oscillator block diagram is discussed using figure 4 9

The operation of individual circuits or assemblies is then analyzed, with reference to the circuit diagrams of chapter 10

Simplified circuit diagrams will be included in chapter 6, Troubleshooting, to assist in locating operational problems

4.2 FUNCTIONAL DESCRIPTION

The block diagram fig 4 1 explains the organization of the three exciter sections The MF exciter is independent to a very high degree the transmitter LT power supply supplies the circuits and command only is provided from the exciter front panel

The HF/MHF exciter is the main exciter unit, with synthesized channels for all services, telegraphy as well as telephony Power supplies and controls are shared with the HF telegraphy exciter, which requires channel crystals and a relay energized simultaneously with the HF exciter selects the output to be passed to the PA driver

Block diagram fig 4 2 shows the four functional units of the MF exciter The oscillator circuit is equipped for seven MF channels, is followed by a divider and then drives the modulator Low frequency inputs to the modulator are either keyed dc pulses (A1) or keyed 500 Hz audio from the tone oscillator (A2H) The MF control pc board is responsible for relay control and input switching The rf output is delivered to the transmitter driver compartment

Main functional blocks of the HF/MHF exciter are evident from figure 4 3 There are a number of leads woven between the switch unit and the input/output circuits The "switch unit" functions are concentrated to the front panel assembly while the other sub unit blocks are housed on the main chassis Note the central role of the reference oscillator, directly in command of the channel frequencies via the synthesizer, and indirectly controlling the band oscillator as well (refer to para 4 3 4) The output signals from the three oscillators are mixed in the RF Unit, which comprises 6 pc boards, to produce a modulated and highly stable rf signal to drive the transmitter On the audio side, the input signal from the microphone (or line) is passed through the AF Unit VOGAD ("Voice Operated Gain Adjusting Device"), which levels out widely differing input levels, and through an amplifier with sharp cutoff low pass response to limit the audio bandwidth

A1 kHz tone oscillator is included in the AF Unit, and voice controlled transmitter keying is feasible through the VOX unit The audio Alarm Generator (1300/2200 Hz) is included in this exciter as well

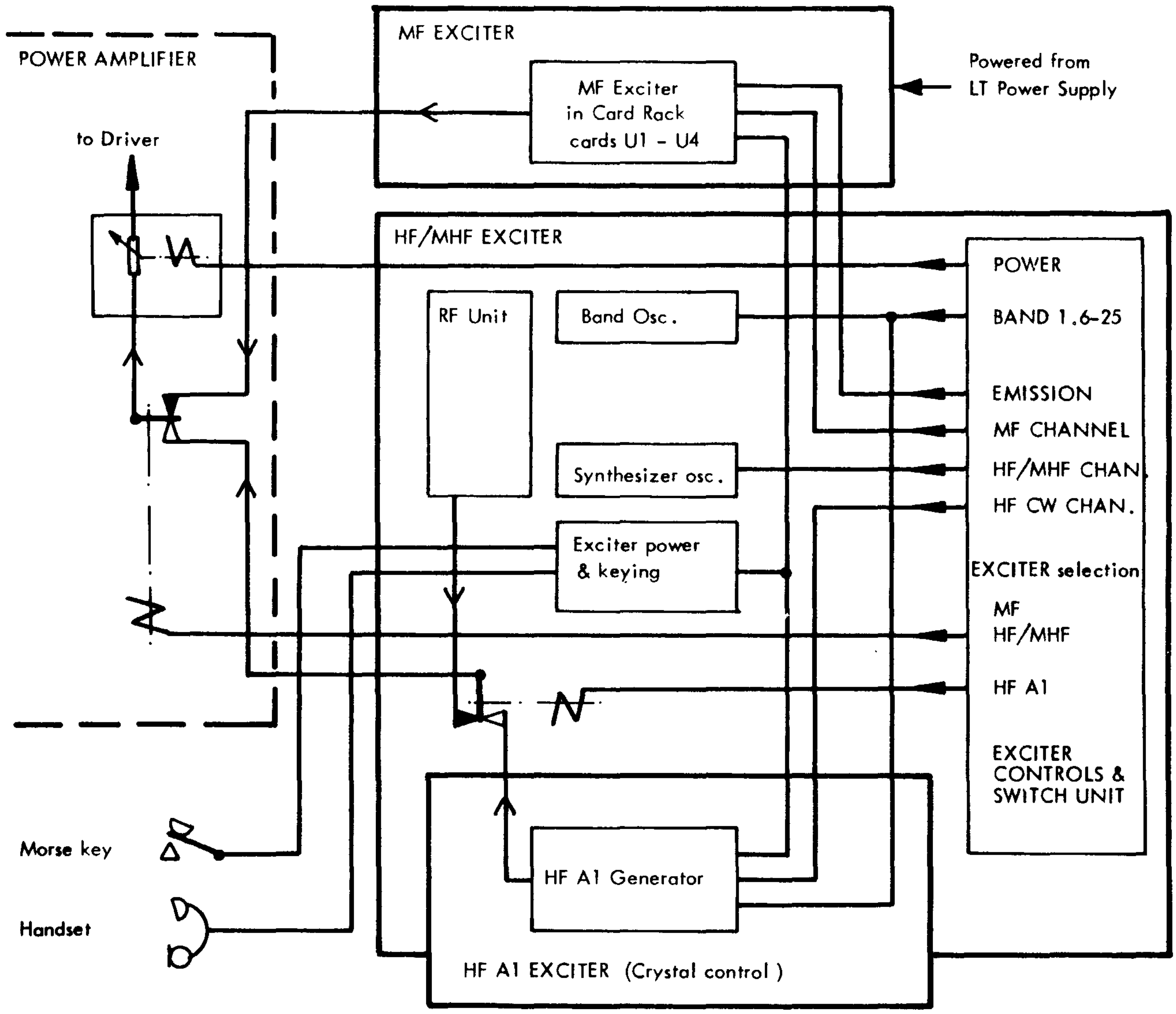


Fig. 4.1 - EXCITER SYSTEM - Block Diagram

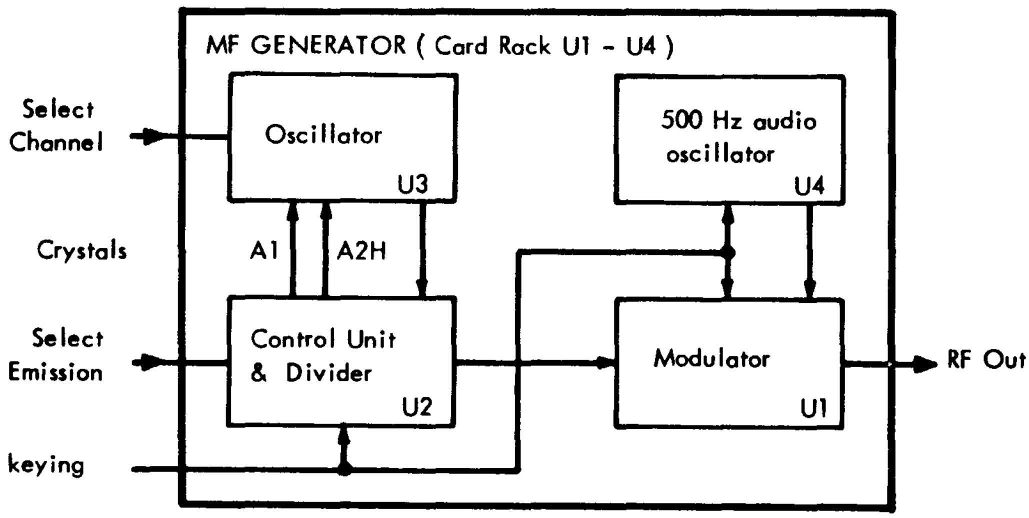


Fig. 4.2 - MF GENERATOR - Block Diagram

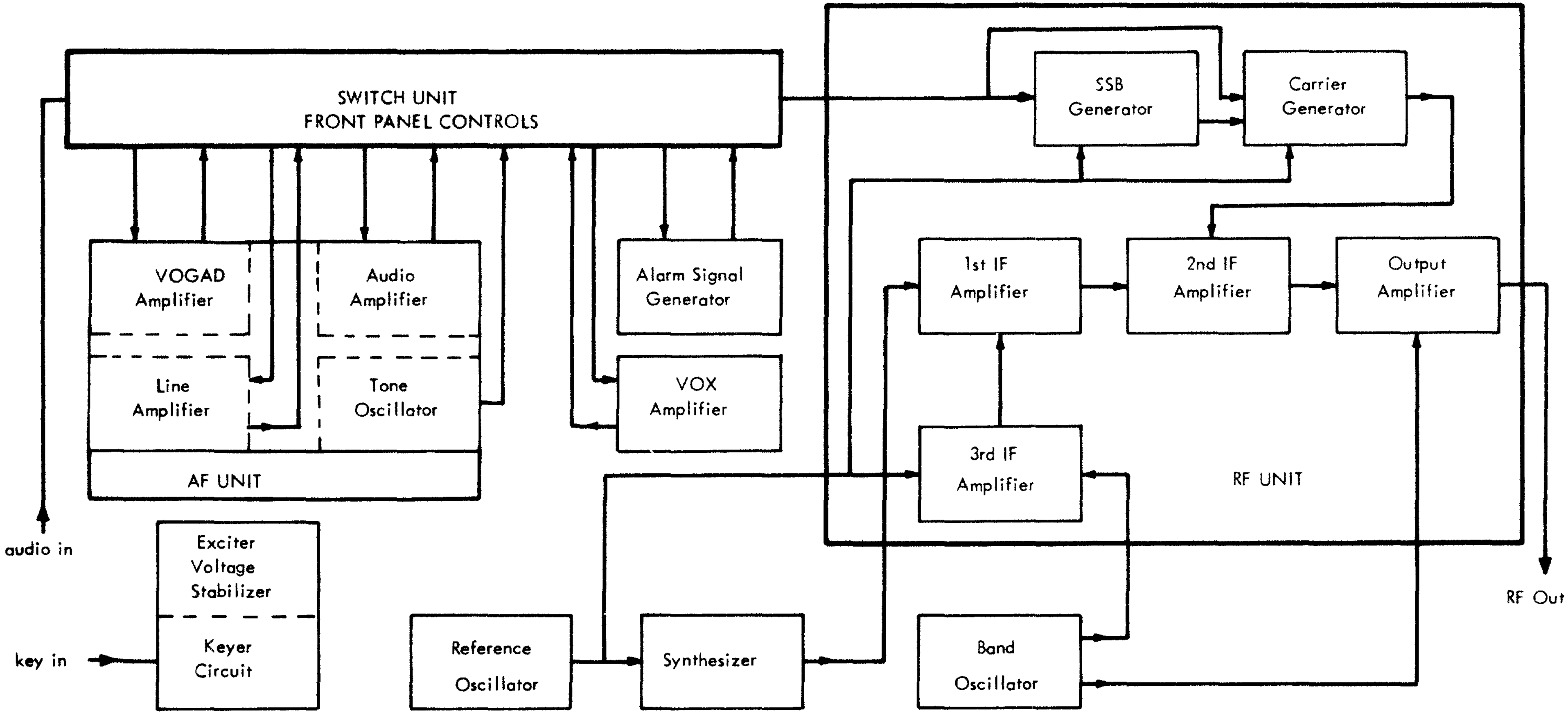


Figure 4.3 - HF/MHF EXCITER - Block Diagram

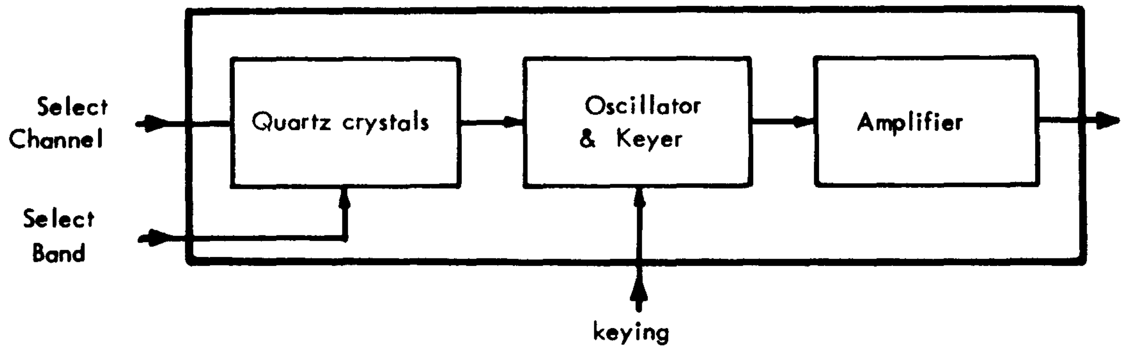


Fig. 4.4 - HF TELEGRAPHY GENERATOR - Block Diagram

Morse key inputs are connected to the keyer circuit and produce an instantaneous muting voltage for the control of the transmitter and external receivers. As already explained, these circuits are common to all exciter sections.

The third section, for A1 telegraphy on the HF bands, may be employed for the purpose of redundancy in frequency generation. But the fact that quartz crystals are employed to define the actual output frequencies implies a "programmed channel" and offers a quick change between four channels in each band. From a circuit view – see figure 4.4 – the circuit is quite straightforward. The band selection is coupled to the main HF/MHF exciter control.

4.3 EXCITER SIGNAL FLOW

The signal flow in the exciters is discussed with reference to figures 4.5, 4.6 and 4.7, respectively. The heavy signal lines in the diagrams indicate the intelligence signal flow.

4.3.1 MF SIGNAL FLOW

Starting from the oscillator on fig. 4.5, the two banks of crystals for A1 and A2H operation, respectively, are selected through relay K1. Crystals are 10 times the channel frequency, and A2H crystals are offset 5 kHz because the balanced modulator will suppress the carrier and only pass two sidebands ± 500 Hz – the lower sideband on the assigned frequency and the upper sideband as an 1 kHz modulation.

The divider output is thus in the range 410-512 kHz, filtered in the low-pass filter and applied to the modulator carrier input.

The keyed intelligence signals affect the output from the 500 Hz audio oscillator via the keyer/amplifier, and switched by K1 to modulate the carrier on A2H. When emission A1 is chosen the modulator input is the keyed dc signal.

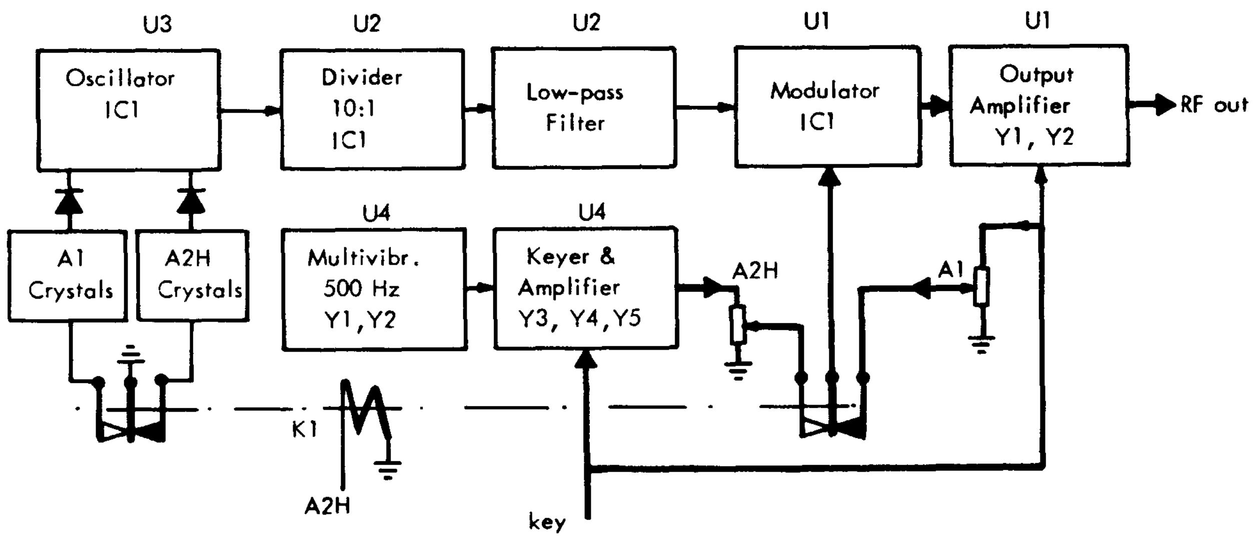


Fig. 4.5 - MF SIGNAL FLOW DIAGRAM

The modulated signal is amplified in the output amplifier and then passed to the driver of the power amplifier. To ensure a high key-up attenuation the amplifier is keyed in unison with the modulation.

4.3.2 HF/MHF SIGNAL FLOW

Refer to the flow diagram, figure 4.6.
Audio input is from the ordinary carbon microphone, energizing the microphone relay to initiate the keying order when the pressel switch is held closed. Other ways to achieve keying are discussed below. An alternative input is through the line amplifier of the AF Unit, and the Alarm Generator delivers its output in parallel with the microphone output.

The audio signals are passed to the VOGAD circuits for compression: starting with a peak limiter and followed by a variable attenuator to keep the mean level constant over a considerable range of input levels. The amplifier Y3-Y5 raises the signal level before passing to the potentiometers for setting up the proper voice and tone levels (the tone level from the tone oscillator, keyed in unison with the morse keying). The potentiometer output is amplified in Y11-12, and filtered to obtain a sharp cutoff above 2700 Hz.

The AF Unit delivers the signal to the modulation potentiometers for A3H and A3J – another one is the FS potentiometer to set the audio frequency shift level from an optional generator. The emission controls select the desired output, which is passed to the modulator of the SSB Generator.

Accompanying the audio signals are dc signals as a result of the transmitter keying. Inputs are either a negative dc fed to the keyer Y2-5 (on the Voltage Stabilizer) or grounding of the "TT Control" terminal. Voice-controlled keying is facilitated through the VOX-circuits: a buffered audio signal is taken to the VOX amplifier via the level control. When thus energized by a preselected audio level, the amplifier delivers -24 V to the keyer input. The keyer output is a stabilized -24 V, employed for muting receivers, keying the transmitter and feeding the Carrier Level and TUNE controls. The emission selected implies a specific dc signal which is passed to the modulator of the Carrier Generator.

The two modulators are supplied switch voltage from the 9 MHz Reference Oscillator, which is a precision controlled quartz crystal oscillator. The crystal is maintained in a constant temperature of +75° C and the heating power is applied over an electronic switch to eliminate switching transients. The oven is constantly in operation when the exciter is connected to a mains supply. – The Reference Oscillator is feeding the Synthesizer and 3rd IF Amplifier as well, see below.

Both modulators are followed by amplifiers:
- the SSB Generator amplifier contains the SSB filter, which suppresses 9 MHz carrier and the upper sideband from the modulator;
- the Carrier Generator amplifier is provided with means to control the amount of 9 MHz carrier on A3A and A3J (full suppression).

The Carrier Generator final circuit is a hybrid to combine the two outputs and amplify the combined signal before passing it to the 2nd IF Amplifier.

The frequency generation system is responsible for locating the combined signal of 9 MHz in the spectrum. To achieve this, three oscillators are employed – Reference, Band and Synthesizer. The Reference oscillator is master, the others are slaves.

The modulated 9 MHz signal is passed to mixer Z1-4 of the 2nd IF amplifier. The IF bandwidth is 1 MHz and the passband 40.2–41.2 MHz. The fixed-frequency 9 MHz is additively mixed with the 1st IF signal which is a singular frequency in the band 31.2–32.2 MHz.

The 1st IF frequency contains the channel frequency, and thus what remains is to position the signal in the proper MHz band. After another mixing, in the Output Amplifier, the 2nd IF signal is transferred to the desired MHz band. The subtractive mixing with the Band oscillator moves the frequency, in steps of one or several MHz, to the wanted band. The final signal is filtered and amplified in Y2-6 before passed to exciter relay K1 and then to the output terminal of the exciter. – Alternative input to relay K1 is from the HF A1 exciter, when crystal-controlled CW channels are used.

The 1st IF Amplifier starts with mixer Z1-4, where the channel frequency from the Synthesizer and the 3rd IF carrier are subtractively mixed. The intermediate frequency falls in the range 31.2–32.2 MHz, because the 3rd IF is 34.2 MHz and synthesizer output is from 2.0–2.999 MHz. The IF signal is carefully filtered and amplified in stages Y1-5, before being fed to the 2nd IF amplifier.

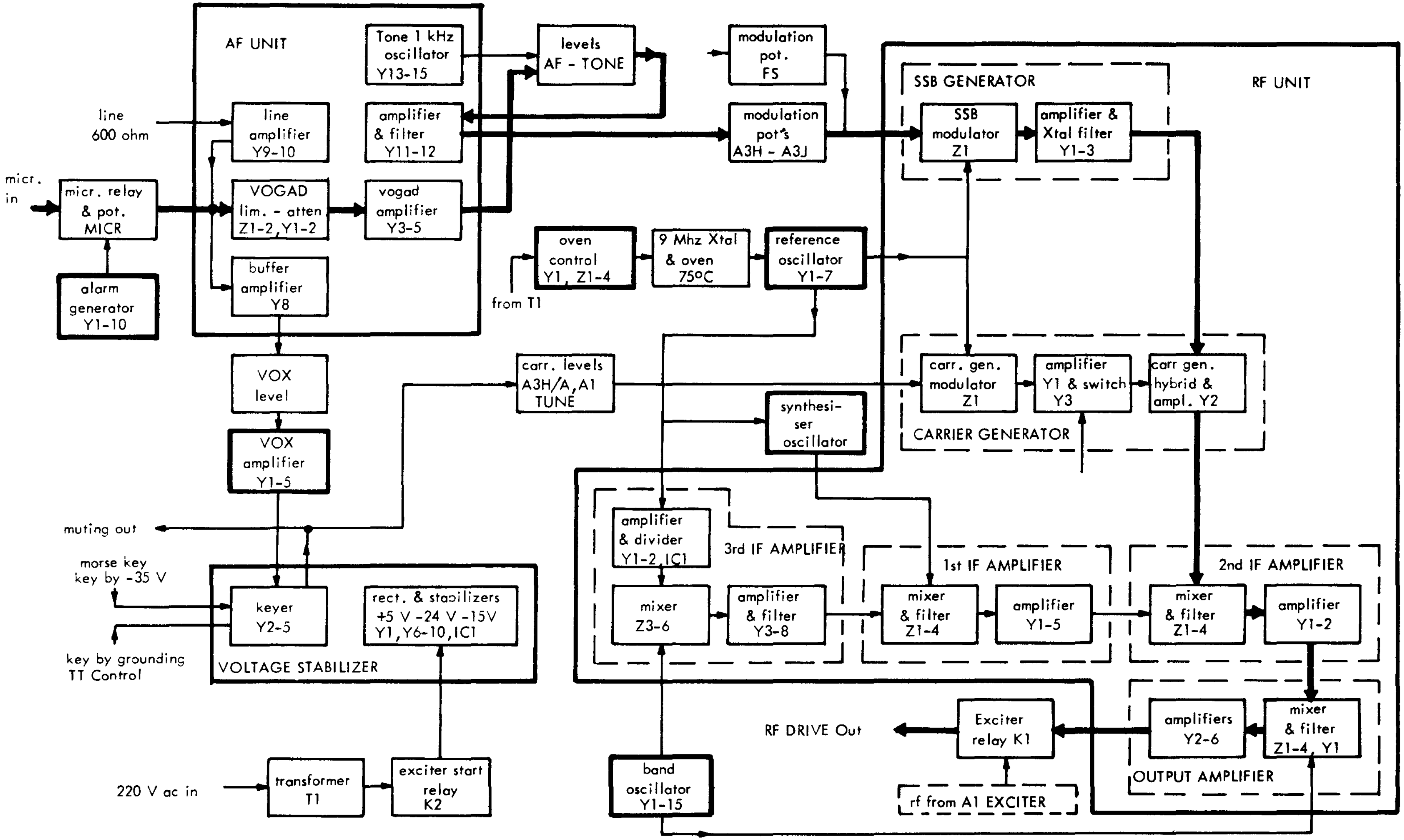


Figure 4.6 - HF/MHF EXCITER - Signal Flow Diagram

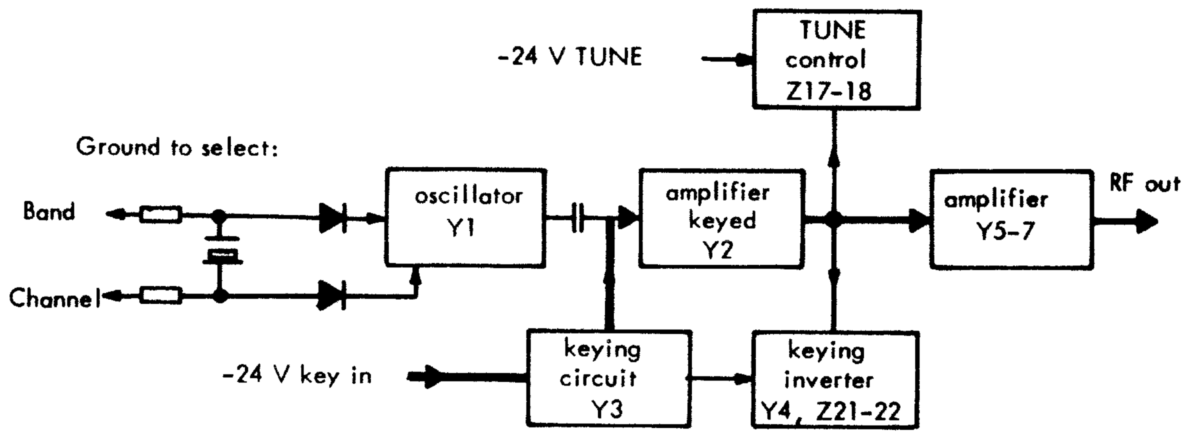


Fig 4 7 HF A1 GENERATOR Signal Flow Diagram

The 3rd IF is derived from two sources the Reference oscillator and the Band oscillator 9 MHz signals from the Reference oscillator are amplified and divided by 9 to obtain 1 MHz This signal is employed to generate a wide spectrum of 1 MHz harmonics In mixer Z3-6 the band oscillator mixes with the 1 MHz harmonics, and the product 34 2 MHz is filtered and amplified in stages Y3-8 Band oscillator frequencies are from 41 2 to 66 2 MHz

The Synthesizer is locked to the Reference oscillator, and the oscillator output frequencies are selected by BCD switches for each decade The kHz figures are significant, that is they are directly appearing in the output frequency of the exciter

4.3 3 HF A1 GENERATOR SIGNAL FLOW

The signal flow of the HF telegraphy (crystal control) generator is shown in figure 4 7

The oscillator can be switched to 7 banks of crystals (4 25 MHz bands) and to one of four channels in each band. Selection is through diodes, which conduct when the selected band/channel terminal is grounded

The morse keying is applied to the keying circuit (Y3) which controls keyed amplifier Y2 After inverting in Y4, diodes Z21–22 are kept conducting on key up, and then short any signals to ground which may pass the blocked transistor Y2

On key down, Y2 conducts and Z21–22 are non conducting The output is then passed to final amplifier Y5 7

The coupling capacitor between oscillator Y2 and amplifier Y2 has been selected for proper keying waveform

On TUNE, a 5 dB reduction of signal level is obtained by the Tune control, which shunts the output to ground through diodes Z17–18 and a preset resistor

4.3 4 FREQUENCY GENERATION

The frequency generation system of the main exciter is analyzed in figure 4 8

The three oscillators are required to generate the radiated frequency

- the Synthesizer oscillator, operates in the range 2 0–2 999 MHz
- the Reference oscillator, 9 MHz with oven controlled high stability quartz crystal, and tunable to precise 9 MHz
- the Band oscillator, crystal controlled and operates from 42.2 MHz to 66 2 MHz

The Band oscillator frequency is not adjustable, but nevertheless the frequency error (deviation of actual frequency from the nominal) is eliminated through "double mixing" in the system

With the example given in figure 4 8, it is evident that the error of the band oscillator is fed back to the 3rd IF The word "error" is justified because the band oscillator frequency is compared with true 1 MHz harmonics from the

Reference oscillator, The overtone spectrum from the harmonic generator produces a large number of mixing products from Mixer No 4, when mixed with the band oscillator signal. One of these is always 34.2 MHz ±Δ f, selected by a narrowband filter with crystals (approximately 10 kHz, to allow for normal band oscillator variations).

The Signal "34.2 +Δ f" constitutes the 3rd intermediate frequency, and is "modulated" with the band oscillator error. When mixed with the 1st IF the error is introduced in the signal path, ahead of the Band Oscillator. Nothing is changed in the 2nd IF, adding 9 MHz (considered to have no error at all). When the final subtractive mixing is performed, the signals carry the same positive or negative error, which is therefore cancelled in the output from Mixer No 3.

The Band oscillator is effectively in a closed loop which eliminates any error, and therefore the band oscillator will not add an error to the output frequency.

The synthesizer is fully controlled from the Reference oscillator and may be assumed to have a zero error when the reference is right.

That leaves the frequency stability entirely to the Reference oscillator. Cycling variations are usually about 10^{-7} and ageing (between retuning) can easily be kept within $\pm 1 \times 10^{-6}$ (1 PPM). An error of 1 PPM means 25 Hz on 25 MHz – a period of at least 6 to 12 months will be required to obtain that ageing.

4.3.5 SYNTHESIZER OSCILLATOR

The synthesizer oscillator operation will be analyzed using the block diagram, figure 4.9.

Locking to the stability of the 9 MHz Reference oscillator signal is obtained by using this signal to generate an accurate 10 millisecond sawtooth sweep. To achieve this, the 9 MHz signal from the buffer amplifier is divided in fixed dividers, down to 100 Hz. The 100 Hz output pulses are shaped and differentiated to create a sawtooth wave, which thus has a period of 10 milliseconds. This signal is one input to the phase detector.

The other input to the phase detector is derived from the voltagecontrolled oscillator (VCO). The oscillator signal is analyzed in the variable frequency divider, counting the number of periods (pulses) fed in during 10 milliseconds. The counter is fitted with a scaler, and when the number of pulses counted coincides with the scaler programme, a reset pulse is sent out, and a new count starts. At this very moment, the output from the last counter flip-flop is passed to the phase detector circuit and controls a sampling pulse.

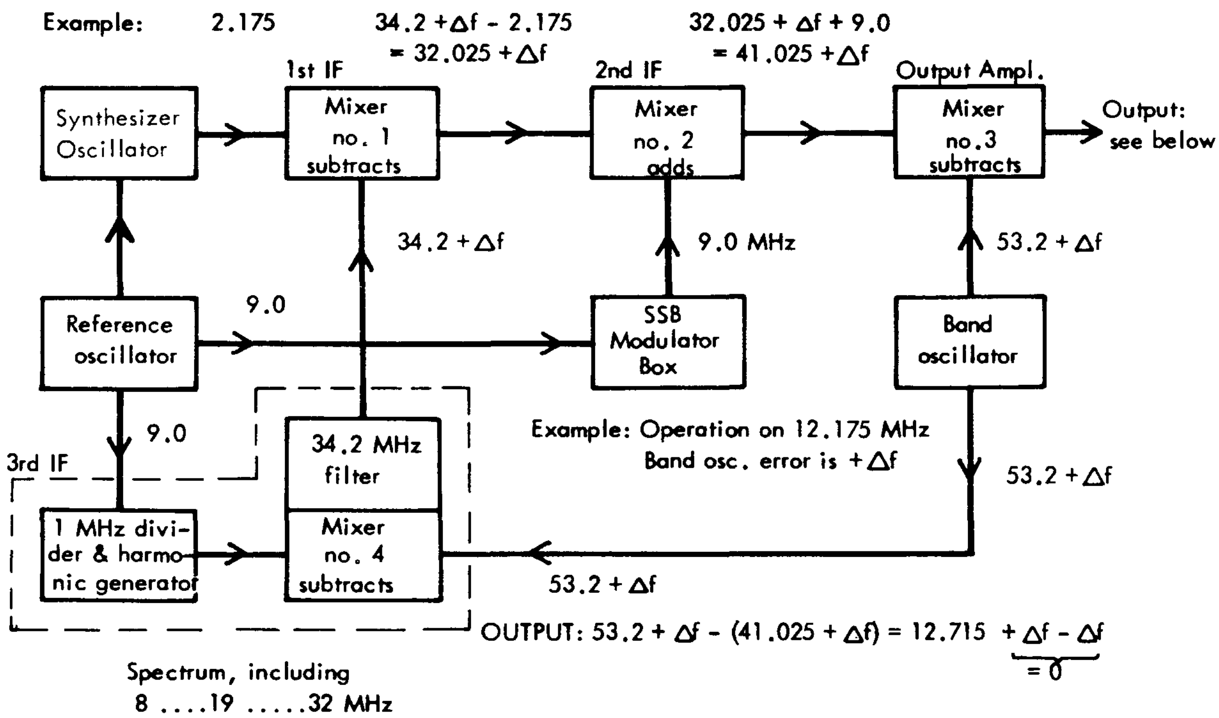


Figure 4.8 - FREQUENCY GENERATION

The sample is taken from the instantaneous voltage of the 10 ms sawtooth wave If samples are timed to precisely 10 ms intervals, a constant output will be obtained from the detector, but if the sampling intervals are longer or shorter, the output will increase or decrease, and becomes an error signal

The sampled voltage level controls the VCO through varicap diodes, and thus a phase detector error voltage will correct the VCO frequency to reduce the error signal to zero That means that the VCO frequency is exactly the number of periods set up on the scaler controls

The VCO operates between 4000.0 to 4999.8 kHz, and is followed by a divide-by-two circuit to deliver 2000.0 to 2999.9 kHz. Counting the number of periods over 10 ms means 20000 to 29999 counts. Because the first figure is a constant, it has been set internally, leaving four decades as variables and to be set through the Binary Coded Decimal (BCD) switches.

The VCO is fitted with an electronic range switch, to obtain three subranges. A decoder senses the setting of the 100 kHz decade and controls the subranges accordingly

4.4 CIRCUIT DESCRIPTION

References are to the circuit diagrams and assembly drawings of chapter 10. The description starts from the General Circuit Diagram, and then the sub-units are analyzed

4.4.1 EXCITER TYPE B22130 0000

Refer to figure 10.1 for a general discussion of the main exciter unit

The exciter is divided in two major sections
- the front panel section with the switch unit, the controls and the interunit wiring connector P208.

- the main body housing all oscillators, amplifiers and supplies, including external control & info input connector P209.

Mating connectors P11/P211 completely separate the two

Switch Unit – U1

The pc board assembly contains the push button switches for the Mode selection and the Emission selection. Three relays are identified. the Microphone relay, the 2182 Relay and the TUNE relay

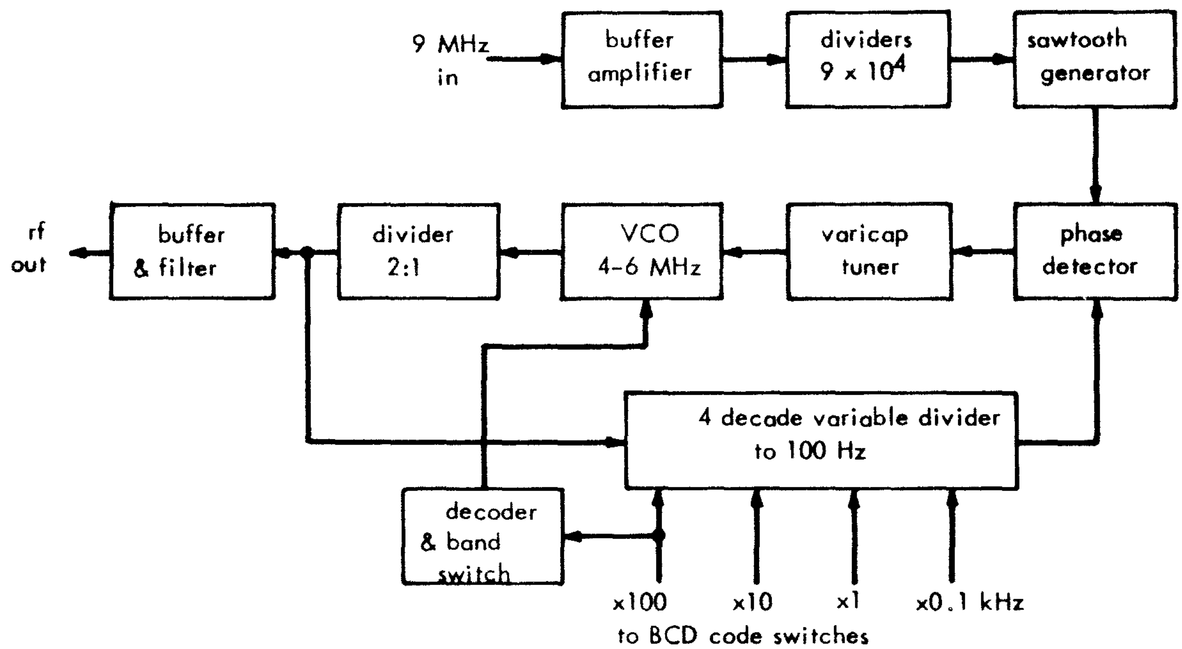


Fig 4 9 SYNTHESIZER BLOCK DIAGRAM

The trimmer potentiometers for the alignment of signal levels are on this assembly:

- MICR. and VOX are primary controls,

- AF and TONE are intermediate controls to set proper input levels for the audio amplifier

- A3J MOD, A3H MOD and FS are final controls to align modulation levels

- A1 and A3H/A CARR are carrier controls to align carrier levels

- TUNE carr. is the control to set up the proper level of the TUNE dc signal.

NOTE

The MICR. and VOX controls are the only ones which may be altered when a new installation is made. The others are factory-aligned and should not be touched.

The microphone relay K1 is energized when the microphone circuit is closed – usually through the pressel switch – and then closes to send -24 V to the keyer (wire "g" – 16P11 – 13 Stab). – Another way of energizing K1 is through the ALARM push button, S2b.

The 2182 relay (K2) is energized on HF/MHF, provided that the Band and Synthesizer decade switches are on 2182.0 kHz. The relay contacts then assure that emission type A3H is unconditionally selected.

The TUNE relay (K3) is energized from 18P208 on ST1610 applications (-24 V externally switched) but via the TUNE push button on ST1600 (-24 V from 30U1 to TUNE 3/2 – 15 U1/18P208). The relay selects the TUNE CARR level and switches -24 V to different circuits.

Mode Switch S12

The four push buttons enable different operational modes to be selected: SI (or MUTE ON) and DU (or MUTE OFF) only control the output to 3P209 Muting. The signal is -24 V and is the internal keying voltage. Pushing DU (Mute off) or VOX,TONE releases SI (Mute on) and no muting is externally available. However, in most applications muting voltage is always desired and the decision to mute or not is taken at the receiver control panel. Therefore, the SI switch closing contacts 5/6 are short-circuited (under the pc board) when delivered.

VOX puts the voice-controlled keying in operation. The audio is always connected to the VOX amplifier – now -24 V is applied to feed the amplifier (line "C") and the response when audio signals enter is -24 V on line "d", which replaces the ordinary -24 V keying closed by the microphone relay.

TONE disconnects the microphone signal from the audio amplifier and replaces it with the tone oscillator signal, as keyed by the morse key. Simultaneously, a steady -24 V is switched to the carrier to keep this on continuously.

Emission Switch S13

Types of emission are A1, A2H, A3H, A3A, A3J and FS. The emission selected is indicated by the signal light in the button – this is especially valuable when the selection of emission is determined internally (such as A3H on 2182 kHz, A1 on HF bands, A1 priority on MF channels). Lamps are controlled through diode gates to indicate the actual emission despite the fact that other push buttons may have been depressed.

Emission switches connect the signals to the proper trimmer potentiometers and switch the output to the SSB and carrier modulators (7P11 and 4P11, respectively). The keying signals are simultaneously switched, like other controls to affect the operation of the RF Unit.

The FS push button selects audio FS signals, applied to 1P209 from an external source (600 ohm, 0 dB). Although the circuit originally places a constant key on the transmitter (contacts 11/12 are responcible for the fixed key), this may be modified and the transmitter keyed from an external keying source when "simplex" operation is possible ("TT Control"). The FS position is emission-wise the same as A3J, that is a fully suppressed carrier and the upper sideband is radiated.

NOTE

To prevent operation on A2H when a shortwave band has been selected, the BAND switch S5 wafer B completes a shortcircuit path on 4-25 MHz of the input keying order (58P11 to 12 Stab, grounded through 17/18 A2H – 9/8 MF/MHF. The implication is that there will be no drive signal at all, not even to tune the transmitter on the channel selected. Operation will return to normal as soon as A2H is switched off.

Alarm Generator

The alarm generator circuit is controlled from switches S2 and S14: ALARM/TEST ALARM and START ALARM. TEST ALARM does not key the transmitter as ALARM does. 24 V is switched to the thyristor Z18 which is triggered to conduct when S14 is pushed. The alarm signal then continues for about 45 seconds, before being internally cut off. Audio signals are fed in parallel with the microphone signals.

Power Control

The exciter switch S3, POWER, controls the signal level in the power amplifier driver – refer to the transmitter manual. To control the attenuator relays, S3 energizes the outputs 31, 32 and 33 (P208) to achieve attenuations of -5, -10, -15 and -20 dB. Note that button "2" just releases the others, placing -24 V on 32 as well as on 33 (-15 dB).

Coarse Tune and Fine Tune

These circuits are expecially designed for the autotuned ST1610 transmitter to inform the tuning logic of the requirement to tune the set, and to what extent (fine tuning, or a complete cycle, coarse tuning).

Both coarse (1P208) and fine (3P208) operate on the principle that they are normally grounded and any circuit change makes the appropriate terminal "high" (they are externally fed from -24 V through currentlimiting resistors).

The Coarse tune path is from 1P208 via the TUNE push button to the MF channel switch S10, through Z8-3P12-1P10 to black HF and HF/MHF contacts and ground. This was on MF. To follow on HF and HF/MHF, do not pass S10 but follow through S5, BAND MHz, wafers C and D.

Wafers C on S5, S6 and S7 order coarse tune on bands 1 through 3 MHz for steps down to 10 kHz. The path ends at 3P13, where is further gated to 1P13 for the HF/MHF bands and to 2P13–2P10 for the HF (telegraphy) bands. On bands 4-25 MHz, the D wafer of S5 only orders coarse tuning when a new band has been selected.

The Fine tune path is through two alternative circuits:

- through the HF CW channel switch (S4) and Z7 to 2P10, the HF path to ground,
- through decade switches 100 kHz, 10 kHz and 1 kHz via Z6 to 1P13, the HF/MHF path to ground.

Band Selection

The BAND switch, S5, is involved in the control of internal as well as external circuits. Wafers B, C and D have already been dealt with, Wafer A is responsible for the control of the Band Oscillator, grounding the band selected. Simultaneously, this control is effective on the HF A1 Exciter as well (4-25 MHz bands).

External band control employs wafers E and F and wafer E of the 100 kHz decade switch, S6. -24 V is fed from the transmitter LT power supply to 40P208 MF push button 11/10 to 22ES6. The 24 V output appears on one of pins 5 through 15 of P208, and is then identifying 12 different frequency bands (in contrast to 10 on the MHz band switch). This accomplishes the utilization of sub-bands in the servo circuits and that the PA bands do not have to follow the exciter bands (7 bands in the power amplifier, including MF).

The main chassis contains the subunits, which are separately described in following paragraphs. A few components are mounted outside these units, such as mains fuses F1, F2, transformer T1, relays K1, K2 and some rectifiers.

Rectifiers feed the voltage stabilizer, described in following paragraphs. The feed is controlled by Start Relay K2, energized from a remote source. This may be derived from the ac voltage on 22/23 P209 after rectification (e.g. in the Remote Control Panel, see transmitter manual).

Another ac feed from T1 is constantly applied to the Oven Control circuit, to achieve that the crystal oven is always kept at operating temperature. The oven thermostat controls transistor Y1, which triggers thyristor Z3. The thyristor is supplied rectified half-wave voltage, and switching in or out always occurs when the voltage is near zero to avoid switching transients from affecting the oscillator.

4.4.2 EXCITER VOLTAGE STABILIZER

Refer to figure 10.2 for the exciter voltage stabilizer circuit diagram and assembly drawings.

The voltage stabilizer is fed rectified voltages from the two bridge rectifiers Z1 and Z2.

Z2 delivers about -35 V unstabilized to Y1, which is a series regulator transistor controlled from Y7–Y8–Y6.

R16 is aligned to -24 V at the output and any variations are fed back through Y6 to keep the output constant. Transistor Y8 is responsible for limiting the output current to 1.5 A maximum — the voltage drop across the 1 ohm resistor (R9) is sensed by Y8. The stabilized -24 V is then fed to other circuits on the pc board and to other exciter loads.

Transistors Y9, Y10 and zener diode Z9 form another series stabilizer to derive -15 V from -24 V. This is entirely consumed by the synthesizer oscillator. Y9 is further biased from +5 V, to make the -15 V supply interdependent from the +5 V integrated circuit supply.

The +5 V stabilized supply is actually not on the pc board: rectifier bridge Z2 and integrated regulator IC1 are on the exciter chassis. The pc board houses the two resistors R30—R31 to set the output dc level to +5.2 V (compensation for RFI chokes in the synthesizer). A filter capacitor, C8, and the testmeter 10 V range resistor R28 terminates the +5 V circuit before the voltage feeds the synthesizer.

Independent of the voltage stabilization is the keyer with transistors Y5 through Y2. Y5 input is on 14 Stab ("external key") or 13 Stab ("internal key" or TUNE-). Both inputs will turn Y5 on and consequentially Y4, Y3 and Y2, and deliver -24 V (almost) at terminal 10 Stab for keying exciter and transmitter. The external key simultaneously gives rise to a stabilized voltage at pin 16 Stab, which is used to key the built-in 1 kHz tone oscillator (se para. 4.4.5).

Pin 12 — if grounded — will cut off Y5 and thus the output from Y2. This is utilized to block operation on HF bands, if A2H should have been selected. An alternative way of keying this circuit is by taking pin 30 to ground. This will make Y4 conduct and therefore Y3 and Y2 will conduct. Pin 30 is wired to exciter connector P209, pin 13.

4.4.3 REFERENCE OSCILLATOR

The 9 MHz reference oscillator is shown in figure 10.3. The full circuit, including crystal oven and oven control, is given in figure 10.1.

The high precision quartz crystal is maintained at +75° C in the oven. The crystal operates at parallel resonance, and may be precisely tuned to 9 MHz through the coarse and fine controls, trimmer capacitors C1 and C2, respectively.

Oscillator transistor Y1 is provided with variable bias from dc amplifier Y6/Y7, which adjusts the bias from the signal amplitude at the output of Y4. The result is a clear sinewave of almost constant amplitude.

The oscillator output is coupled to dc stabilized amplifier Y2 via divider network C5/C6 and C8, and further amplified in Y3 and emitter follower Y4. The final amplifier Y5 is provided with matching transformer T1, adapting the output to 50 ohm.

A rectified sample of the output power for the testmeter is taken by Z1 and available at pin 16.

4.4.4 SYNTHESIZER OSCILLATOR

The synthesizer circuit diagram and assembly drawing is given on figure 10.4.

NOTE

> Positive logic, that is "1" is a high level (up to +4 V) and "0" is low, +0.3 or less.

Signal input to P2 from the 9 MHz reference is coupled to buffer amplifier Y18 and then to the divider chain IC21 through IC25. Output frequency is 100 Hz, and the pulses are amplified in Y9 and Y10, differentiated in the following stages to obtain a sharp discharge of capacitor C19 by Y12 conduction. C19 is charged through constant current generator Y13 and thus a sawtooth voltage is obtained. The sweep time is 10 milliseconds, and the instantaneous voltage will be sampled by the phase detector.

The oscillator circuit is type Butler, with Y3 and Y5 as a feedback amplifier. The tuned circuit in the collector of Y3 consists of three coil sections, a fixed capacitor and two varicap diodes. Selection of suitable inductance value is from decoder IC26 through current drivers Y1 and Y2 for diodes Z1 and Z2, respectively. The number set on the x100 kHz decade is decoded and thus determines the oscillator subrange (three, no alignments are required).

The feedback path from Y5 is through R11—C6 to the emitter resistor R7 of Y3. Output to pulse-forming transistor Y6 is from the same point. Further the voltage level is rectified by diodes Z10, Z11 to control dc-amplifier Y4. This transistor provides a variable bias of Y3 which is fix-biased by R8–R9. The variable bias controls the gain to stabilize the output of the oscillator, while a high initial gain is possible – a clean signal is thus obtained.

The pulseformer Y6 drives flip-flop divider 1-IC26 and subdivided output is taken to analysis section, the variable divider chain. The output from the synthesis oscillator is however first passed through the second flip-flop of IC26, which is not dividing. Using the clock input as well, a very symmetrical square wave is obtained, almost void of 2nd harmonic. 3rd and higher harmonics are stopped in the filter sections following IC26.

The (divided) VCO output is to coincide with the numbers set up on the four decades by front panel switches (or possibly from a program unit). A fixed division by two follows after the 100 Hz decade. The strategy of the variable divider, which counts the VCO frequency, is as follows. Let us assume that the number selected is (2)937.2 kHz.

Through the variable diver 29372 counts are to be performed during every 10 milliseconds. At the end of the 10 ms period, the decoder zero-sets through a reset pulse. The VCO frequency is adjusted – through the phase descriminator error signal – to ascertain that this number of counts are obtained in exactly 10 ms.

The first divider (IC1 and IC2) starts every cycle dividing by 11, and this carries on until the two last figures have been counted in the two divide-by-ten decades, IC (3+8+9) and IC (4+5+10). A total of 72x11 cycles have then entered the counter, and the sum may be written as 72+720 counts. Now the coincidence gate IC12, which checks the output from the two dividers through other gates, detects all "1" at the input and issues a "0", which causes the first divider to change to "divide-by-ten".

The situation is therefore that of all the required number of pulses to count, 72+720 have been counted, and there remains:

$$
\begin{aligned}
29372-(72+720) &= 29372-72-720 \\
&= 29300-720 \\
&= 10x(2930-72)
\end{aligned}
$$

Number	A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Table 4.1 - BCD Code

It is evident from this that when counting the last figures (7 and 2), simultaneously 720 pulses were counted and are already stored in the divider IC (4+5+10) and IC (5+6+11) continue to count (930–72) counts and finally the fixed figure of 2 is included in divide-by-two flip-flop IC7. When the predetermined number of counts has been reached, coincidence gate IC13 issues a reset pulse, which starts a new counting cycle, and flip-flop IC7 delivers a pulse to the phase discriminator.

The variable divider employs IC blocks of two kinds: flip-flop dividers and Nand-gates. For understanding the operation of the circuits, the following basic characteristics are given:

– positive logic: "1" is a high voltage, +4 V
"0" is a low voltage, +0.3 V

– nand-gate logic: "1" out when one or several inputs are "0"
"0" out when all inputs are "1"

– flip-flop: "Q" and "$\bar{Q}$" outputs are inverse, i.e. when Q is "0", $\bar{Q}$ is "1".

Every decade has four inputs, controlled from a BCD coded switch marked 0 through 9 The code is given in table 4 1 The logic levels are applied to dual-input de coder gates, e g IC15 and IC16, from the 100 Hz and 1 kHz decades Assuming the frequency (2)937 2 kHz, the two decoders set IC15 and IC16 inputs to

IC15 pin	IC15 level	IC16 pin	IC16 level
1	0	1	1
4	1	4	1
13	0	13	1
10	0	10	1
(decimal 2)		(decimal 7)	

IC15 and 16 are connected to 8 input nand-gate IC12, which is normally "1" at output pin 8 because one or several inputs are 0 To obtain a "0" from gate 12 all inputs must be simultaneously high The gates which were 0-set from the decade switches fill this require ment immediately, whereas those 1-set must wait for a 0 from the flip-flop Q output This is obtained when the two dividers have counted 72 pulses from the first divider (IC1+IC2) Then coincidence gate IC12 issues a 0-pulse on pin 8

As already mentioned, the divider IC1+IC2 divides by either 11 or 10, as switched through a set-reset flip flop (part of IC19 and IC14) The input signal to control the division factor is applied to IC14 pin 1

when 1 IC14 is zero division is 11
when 1-IC14 is one division is 10

To analyze the operation, assume that the dividers are being reset by a 0 pulse from final decoder gate IC13, pin 8 Pin 9 of IC19 is then 0 and holds the output at pin 8 high Simultaneously IC12 output at pin 8 is high and gate output 6IC9 becomes zero – therefore the first divider divides by 11 The circuit continues 11-dividing for the number of pulses set on the first two decoders – in this particular example 11 x 72

When the 72 11-divisions are counted, output 8 of IC12 goes to 0, gate IC19 pin 6 becomes 1, and switches the divider to 10-divisions.

Now a number of 10-divisions are counted, as set by the 10 kHz and 100 kHz decades, in the example assumed (930–72) x 10.

The fourth gate of IC18 (output on pin 8) must give 1 out, but the circuits is not as on the 1 kHz fourth gate A gating control of the 2-divider is included through IC14 (8–11) When inputs 9 and 11 are both high (pin 10 is permanently high from +5 V), pin 8 goes 0, is inverted in the next gate to 1, and applied to IC13 pin 12 Then all inputs to the gate IC13 are high, and a 0-pulse is delivered from pin 8, to reset flip-flops and switch the first divider to 11-divisions again

The phase detector is a "sample and hold" detector From the analyzis of the fixed divider chain is recapitulated that the 100 Hz output was differentiated to obtain a sawtooth sweep wave at the collectors of transistors Y12 and Y13 The sawtooth is obtained across capacitor C19, and the voltage varies between -0 V and -10 V – the cycle time is exactly 10 milliseconds

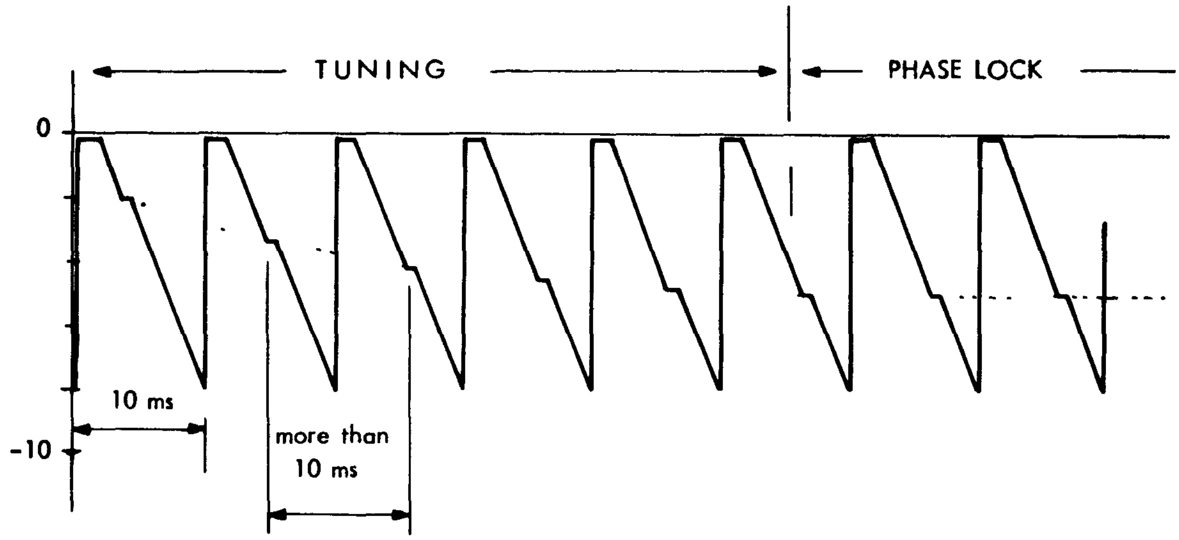


Fig 4 10 PHASE DISCRIMINATOR WAVEFORMS

The variable divider output is an asymmetric squarewave, applied to the base of Y14 through RC-network C24—R33. Transistor Y14 is normally cut-off, but the positive flank of the pulse drives Y14 into saturation for a time set by C24—R33. The collector is therefore taken towards -15 V.

The sweep transistor Y13 is fixed-biased, but the negative Y14 pulse cuts off conduction shortly, causing a horisontal step in the sawtooth — see figure 4.10. Simultaneously transistor Y15 is driven to cutoff, taking the collector towards 0 V. This voltage step is transferred to the gate of FET transistor Y16, which then conducts. During the conduction period, which is a small part of the full 10 ms cycle, C19 charge is transferred to capacitor C21. The operation is repeated every cycle, and a steady voltage will be obtained across C21, if the sampled momentary sawtooth voltage is constant.

A certain ripple appears across C21, but is efficiently removed in the RC filters inserted before varicap diodes Z3, Z4. The dc applied to the varicap tuning diodes therefore does not create hum sidebands, and a positive phase lock is obtained around the loop. Figure 4.10 shows the voltage waveform at the Y12 collector (or Y13), i.e. the voltage across capacitor C19. The sampling incidents are easily recognized.

4.4.5 AF UNIT

The AF unit circuit diagram and assembly drawings are given in figure 10.5. Reference is made to chapter 6 as well, for a simplified circuit diagram of the audio signals and their corresponding levels.

Carbon microphone input signals enter at pin 5 and pass filter R2—C1 and peakclipping diodes Z1, Z2. These limit the peak-to-peak signal amplitude to about 1.4 V. The VOGAD amplifier operation depends on the variable attenuator which is formed by series resistors R2—R3 and shunting transistors Y1—Y2. The resistance of the transistors is controlled by a dc signal which is derived from the output — after the signal has been amplified in cascaded stages Y3, Y4 and Y5 — and given suitable characteristics as to attack and decay time in the network following diodes Z3, Z4. The negative signal controls transistors Y6 and Y7 and finally the bias of Y1, Y2.

The compressed signal leaves the pc board over pins 1—2, after passing a fixed attenuator R48, R49.

Another signal input to the Vogad amplifier is through the Line amplifier, pins 8—9—10. Cascaded amplifiers Y10— Y9 isolate and provide an output level similar to that of the carbon microphone. The gain of the line amplifier can be set to compensate for different input levels — the negative feedback resistor R27 (1.5 kohm) is further wired to pins 11 and 12, and a resistor in parallel will therefore decrease the gain. The value 1.5 kohm is suitable for low input levels (-20 dbm), and should be paralleled with 150 ohm when 0 dbm is available.

The Vogad input signal — from the microphone or from the line — is further connected to amplifier Y8, an emitter follower to buffer the signal to the VOX unit.

The audio signals will return for additional amplification and filtering. They enter pins 15—16 and are amplified in cascaded amplifier Y12—Y11. Then the lowpass filter follows, to achieve a sharp cutoff above 2700 Hz. The filter employes derived sections to achieve this.

The AF Unit finally houses a tone oscillator, delivering 1 kHz output when -24 V is applied to pin 20. The oscillator proper is a multivibrator, Y13—Y14, with squarewave output to amplifier Y15. A tuned circuit in the collector circuit restores the signal to a clean sinewave, available at pins 19—18. Frequency trimmer R38 facilitates alignment to 1 kHz, and keying the oscillator is through the 24 V supply voltage.

4.4.6 BAND OSCILLATOR

The band oscillator assembly is shown in figure 10.6. All oscillators are basically equal, differing only in components selected for operation on the particular frequency.

The collector circuit is tuned and feedback to the emitter is via a series resonance overtone crystal. The base is decoupled to ground. All emitters are connected via diodes Z1 through Z10 to transformer T1, and galvanically to -24 V via T1/R32. Base voltage dividers are also footed on -24 V, and the other ends brought to pins 1 through 10 for oscillator control.

As long as a base voltage divider is left open at the control terminal, the oscillator is completely cut-off because base-emitter voltage is zero. When the divider is grounded, the transistor is no longer cut-off, and oscillations start. Simultaneously the emitter diode conducts and couples the output to the common bus bar.

The oscillator output is amplified in transistor Y11 with transformer T2 in the collector. Output signal is taken to pin 17 (and feeds the last mixer, in the Output Amplifier). Further amplification (of the output to the 3rd IF Amplifier) is obtained in cascode stage Y12/Y13 with matching transformer T3. Z11 rectifies the output, for Testmeter display.

A gain control loop is included, to limit the amplitude of oscillation and provide a constant output level. Oscillator signal is fed via C25 to diodes Z12, Z13, and a certain negative bias is built up across C29. This bias controls the current through Y14 and Y15. The latter transistor acts as a shunt voltage regulator with resistors R32 and R46, to vary the supply voltage to the oscillator transistor in operation. Initially, when oscillations are to start, full voltage is applied, with gradual reduction when oscillations build up a dc bias across C29.

4.4.7 RF UNIT

The circuit diagram of the RF Unit assembly is given in figure 10.7.

The RF Unit houses all circuits engaged in the frequency mixing and modulation system:

- the Carrier Generator to produce a variable carrier level from dc input,
- the SSB Generator to produce 9 MHz SSB signals from modulation input,
- the 1st IF Amplifier to produce the 1st intermediate frequency from channel oscillator and 3rd IF signals,
- the 2nd IF Amplifier to produce the 2nd intermediate frequency from 1st IF and 9 MHz SSB signals,
- the Output Amplifier to produce the radiated signal from 2nd IF and band oscillator signals, and to amplify this signal to a nominal 25 mW output power,
- the 3rd IF Amplifier to produce the frequency correcting 3rd intermediate frequency from band and reference oscillator signals.

Internal connections are evident from figure 10.7.

Note that the reference oscillator input is isolated from the loads of the RF Unit through transformer T1, and the ferrite tubes are employed to form baluns on several coaxial cables, in order to avoid undesired coupling between the different circuits.

CARRIER GENERATOR

The carrier generator is shown in figure 10.8. Ring modulator Z1 is provided with switch voltage from the 9 MHz input over transformer T1. The modulator can be balanced with the aid of C3 and R5, to obtain a minimum carrier at the output without modulation input. DC levels to unbalance the modulator are applied at pin 22, and the output signal – carrier and two sidebands if an audio component is introduced as well – is passed from tuned transformer T2 to amplifier Y1.

The collector load of Y1 consists of R11 and R10, and the output is taken from trimmer potentiometer R13. Resistors R16, R14 and R15 make a T-network to combine the signals from the SSB generator and the carrier generator, and the combined signal is then amplified in Y2 with tuned transformer T3 as the collector load.

On A3A emissions, the carrier is to be reduced 12 dB, as compared to A3H. To achieve this, diode-connected transistor Y3 is made to conduct through a voltage applied at pin 11, reducing the AC load to R11, and therefore the carrier output is also reduced. On A3J, minimum carrier insertion is obtained by switching off the supply voltage to Y1 (from pin 18).

SSB GENERATOR

Figure 10.9 shows the SSB Generator assembly and circuit diagram. – (Disregard the 400-numbers on components, if on the circuit diagram).

Ring modulator Z1 is provided with switch voltage from the 9 MHz input over transformer T1. The modulator is fitted with R5 and C3 to enable the switch voltage to be balanced out as far as practicable. Modulating voltage is applied across one diagonal of the ring modulator, through L1.

The double sideband suppressed carrier signal from the modulator is applied to tuned transformer T2, and then drives cascode amplifier Y1/Y2. The amplified signal is matched to FX1, the lower sideband crystal filter. The filter passes the lower sideband, attenuates the carrier further and rejects the upper sideband. The filtered signal is amplified in Y3, and coupled to the Carrier Generator over capacitor C14.

1st IF AMPLIFIER

Refer to figure 10.10 for circuit diagram and assembly drawing.

The mixer Z1–Z4 at the input is fed with 34.2 MHz 3rd IF signal at pins 12/11, and channel oscillator signal at pins 14/13. After the mixer, the difference frequency is selected in bandpass filter T4 through T7, with a total bandwidth of 1 MHz. Further amplification takes place in cascode stage Y1/Y2, followed by L7 and series resonance circuit T8. Final amplification of the 1st IF signal is performed by Y5 and tuned transformer T9 matches to 50 ohm output.

The output signal is rectified by Z6 to obtain a dc signal for Testmeter indication. Diode Z5 also rectifies the output, to control Y4 and Y5, which in turn control the gain characteristic of the cascode amplifier.

2nd IF AMPLIFIER

In the 2nd IF Amplifier – see figure 10.11 – the 1st IF signal serves as the switch voltage of modulator Z1–Z4, while the 9 MHz SSB signal enters as the modulating (linear) input.

The additive signal component at the mixer output transformer T2 passes two bandpass filters (L1/L2 and L3/L4 with associated components), to obtain a full 1 MHz bandwidth. Cascode amplifier Y1/Y2 is inserted between the two filters, and the output is matched to approx. 50 ohm with transformer T4. The signal level can be adjusted with potentiometer R8.

OUTPUT AMPLIFIER

The circuit diagram and assembly drawing is given in figure 10.12.

At the input, mixer Z1–Z4 is fed with 2nd IF signal and switch signal from the band oscillator, via emitter follower Y1. The difference frequency at the output is the desired signal, and is filtered in lowpass filters L1–L2–L3.

Amplification to the required output level is then performed in broadbanded amplifiers Y6 through Y2. The signal level after matching transformer T5 is 25 mW (nominal) in 50 ohm.

3rd IF AMPLIFIER

Refer to figure 10.13 for circuit diagram and assembly drawing.

9 MHz input from the reference oscillator enters at pins 11/12, and passes buffer amplifier Y1 before being fed to flip-flop divider IC1, which divides by 9. The output from the integrated circuit is a very sharp 1 MHz pulse, which is further sharpened by diode Z2 to obtain a spectrum rich of 1 MHz harmonics to feed the mixer Z3–Z6. Transistor Y2 is a series stabilizer to provide a stabilized 5 V supply to the integrated circuit.

The mixer is also driven with band oscillator signal from pins 13/14 over transformer T3. Because of the 1 MHz harmonics, it is always possible to find a difference signal of the frequency 34.2 MHz, which is selected by the crystal filter T4 and T5, amplified in cascode stages Y3/Y4 and Y5/Y6. Then filter T6 matches to a second crystal filter assembly, T7, before a final cascode amplifier Y7/Y8 amplifies the signal to the correct output level.

Testmeter survey of 3rd IF signal level is possible through the dc output at pin 17, rectified by Z7.

4.4.8 VOX AMPLIFIER

The circuit diagram and assembly drawing of the VOX circuit is given in figure 10.14.

The signals applied at the input pin 13 are amplified in cascaded amplifiers Y1, Y2. From the emitter resistors R8/R7 a portion of the signal is used as negative feedback to the input, when the amplitude exceeds the bias presented by the forward conduction voltage drop of diodes Z1, Z2.

The amplified voice signals at the emitter of Y2 are coupled via C5 and R9 to diodes Z3 and Z4. Diode Z3 conducts on the positive peaks, while the negative peaks are applied to the base of Y3 through Z4.

In the absence of signal input, pnp transistor Y3 is not conducting, and therefore also npn-transistor Y4 is non-conducting. A final consequence is that keying transistor Y5 is also cut-off – output voltage is 0 V at pin 14.

When voice signals cause negative peaks to appear at the base of Y3, conduction is quickly initiated in the chain Y3 to Y5, and -24 V becomes available at pin 14 (Z5 is to prevent current from the outside to affect operation).

Capacitor C6 and potentiometer R10, resistor R12 and resistor R13, determine a time constant which controls the release time of the circuit. C6 discharges through Y3 when conducting. When Y3 is returning towards the cut-off stage, C6 starts to charge again, which keeps Y3 collector voltage low and base voltage high for a short time. The release time can therefore be controlled by R10 to some extent.

4.4.9 MF EXCITER

For detailed illustrations of the MF Exciter circuit and the printed circuit board assemblies refer to figures 10.16 through 10.20.

Figure 10.16 is the General Circuit Diagram of the four boards. All external connections are via multipole connector P515, located in the Card Rack unit.

MF oscillator Card (figure 10.17)

The MF oscillator channels are selected when grounding one of pins 7 to 13, switching one crystal terminal to the oscillator. Every channel is equipped with two quartz crystals, for A1 and A2H, respectively. The appropriate one is then selected from relay K1 of the MF Control Unit, energized on A2H from the exciter emission control, and grounding the selected busbar.

The oscillator is built from an IC-unit: a quadruple 2-input NAND gate with two gates in the oscillation loop and two as output amplifiers.

MF Control Card (figure 10.18)

The oscillator output frequency is 10 times the assigned frequency, and is subsequently divided by 10 in IC1 on the MF Control Unit. A careful filtering of the subdivided signal takes place in the three filter sections L1–L3, before the output appears on pin 8. The assembly houses two relays and the A1 and TUNE level controls, potentiometers R4 and R6 respectively. Relay K1 is energized on A2H and selects the A2H crystal bank and the 500 Hz audio signal for modulation. Relay K2 is energized on TUNE to select the TUNE carrier level from R6.

Stabilized positive voltages from +28 V input are derived from the zener diodes Z1 and Z2 on the card. Z1 stabilizes to +12 V and feeds the integrated modulator circuit on Card U1, while the oscillator IC and divider IC are supplied +5.1 V from Z2.

Note that -24 V is the general supply voltage for all other circuits engaged in control, diode switching and amplification.

MF Modulator Card (figure 10.19)

The modulator employs integrated circuit IC1 (type MC1596), to which the rf carrier is fed over potentiometer R3 and the modulation signal from pin 16. Zener stabilized -8.2 V on balance potentiometer R5 enables the carrier to be outbalanced when audio signals are fed in – when dc signals (A1) are fed to the modulator this balance is purposely offset.

The modulator output from terminal 6 drives the final amplifier, transistors Y1 and Y2. These are supplied -24 V from the key and thus inoperative when unkeyed. Transformer T1 matches the output to 50 ohm for subsequent delivery to the PA unit driver amplifier.

500 Hz Oscillator Card (figure 10.20)

The oscillator is a 500 Hz symmetrical multivibrator with transistors Y1 and Y2. The constantly operating oscillator delivers its output over R8–C3 to switch transistor Y3 and then via C5–R10 to the tone level control, potentiometer R11. R11 sets the proper level to be sent to the modulator from final amplifiers Y4/Y5.

The switch transistor Y3 controls the transfer of signal from the oscillator to the amplifier. Without a negative input to pin 18, the transistor is heavily conducting and efficiently shortcircuits the signal to ground. When the key input is energized – terminal 19 gets -24 V – transistor Y3 is cutoff and the signal passes Y3 unattenuated. Zener diode Z1 places the emitter 5 V below the supply rail to secure that the keying signal – which may be 1–2 V below 24 V – will suffice to cut off Y3.

4.4.10 HF A1 TELEGRAPHY EXCITER

The circuit diagram and assembly drawing is shown on figure 10.21.

The Oscillator transistor Y1 connects to the appropriate quartz crystal when one set of diodes Z1–Z7 (Band) and Z8–Z11 (Channel) becomes forward-biased because the proper control leads have been grounded. Coils L1–L7 are tuned to the centre of the telegraphy bands.

Oscillator output is applied to field effect transistor Y2, which is keyed to switch the signal on and off. When no input appears on pin 11, transistor Y3 is held cutoff and -24 V (almost) on the gate of Y3 will cut off Y3 as well. Simultaneously transistor Y4 is held conducting and the collector voltage less negative. Thus diodes Z22 and Z21 are forward-biased and conduct, which implies that the drain terminal of Y2 is decoupled to ground through Z21–C38 and Z22–C36.

The keyer conditions are reversed once -24 V is applied on pin 11: Y3 conducts and forward-biases Y2, Y4 is cut off and likewise diodes Z21 and Z22 – the signal is amplified in Y2 and the gain set by R66. The signal from Y2 is amplified in final amplifier Y5–Y6–Y7 to a nominal 25 mW in 50 ohm.

Diodes Z17, Z18 are normally reverse-biased and do not attenuate the output from Y2. However, on TUNE a 6 dB reduction is required, and obtained when the diodes are forward-biased from pin 1 and thus load resistor R62 will be shunted by variable resistor R59.

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. The possibilities to use other radio equipment instead of test meters is indicated, as an example of on-board testing by the radio operator.

Should troubles occur which are not covered under the scope of this shapter, 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.

5.2 PARTS 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

Items a. through j. contain the basic setup for maintenance work.

Items k. through l. list test equipment to realign narrow-band and board-band filters and amplifiers. This kind of work is not considered as routine alignment, because once aligned at the factory the circuits normally stay within specifications for the lifetime of the equipment.

Item n. is a valuable aid when fault-finding logic integrated circuits, used together with reference samples of the same type of circuits.

A combination meter like CONWAY Masteranger 639 adequately covers the measurements in the exciter where meters to items a., b. and j. would be involved (with RF Probe and T-connector). Other probes are available to extend the use to high voltages (ac and rf), currents, temperature et cetera. RF measurements are possible down to 150 mV – the meter then reads about 10% too low. Readings below 120 mV rf are merely to be regarded as indications.

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

b. RF electronic voltmeter for low level measurements, with T-connector and 50 ohm termination plug. – BOONTON ELECTRONICS model 91C or MARCONI TF2504.

c. Handset with carbon microphone. – SRT Part Number 7200 0079.

d. Test Connector and Control Box – refer to figure 5.2.

e. Oscilloscope, bandwidth 15 MHz min.

f. Electronic frequency counter, min. 80 MHz, long time accuracy 1 x 10^{-6}. – HP5382, option 001.

g. MF Control Box with Test connector – refer to figure 5.3.

h. Power supply for MF testing, -24 V, 100 mA and +28 V, 100 mA.

i. Audio signal generator

j. Audio mV-meter. BRUEL & KJAER type 2409 or equivalent.

k. RF signal generator, to 50 MHz.

l. RF Sweep generator and display, 1–100 MHz, min.

m. Radio receiver, with beat oscillator.

n. Logic comparator, for logic IC testing – FLUKE Trendar 200–01.

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 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

Take the exciter out of its cabinet and disconnect the rear panel connectors.

The equipment is provided with top and bottom cover plates, held by quick-release fasteners. The RF Unit is on the top, it rests on two pivot taps to the left and is held by one screw, near the right side centre. Release the screw and the RF unit swings out. It connects over plug and sockets to the cable form and can be removed after disconnecting these, and disengaging from the pivots through the slots provided.

Below the RF Unit, on the main chassis, are the following units (refer to chapter 7 for photographs):

– the synthesizer unit, screwed to the chassis with non-metallic screws and connects over plugs and sockets,

– the reference oscillator pc board, with Fine and Coarse tuning controls,

– the AF Unit pc board,

– the oven control pc board, near the crystal oven,

– the VOX unit pc board.

The crystal oven socket is near the reference oscillator, with the oven installed from the underside.

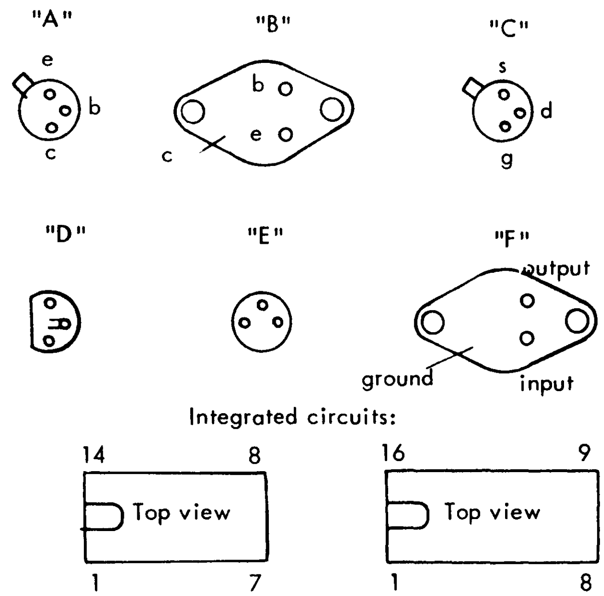


Figure 5.1 - SEMICONDUCTOR BASE VIEWS

semicond.	type	base view	case type
2N1613	npn	A	M
2N2219A	npn	A	M
2N2222A	npn	A	M
2N2905A	pnp	A	M
2N2907A	pnp	A	M
2N3054	npn	B	M
2N4393	n-chan fet	C	M
BC107B	npn	A	M
BC327	pnp	D	D
MJ1001	npn	B	M
U1837E	n-chan fet	E	M
LM309	IC	F	M

type	Vcc.	Gnd
SN7400 Quad.2-input Nand gate	14	7
SN7410 Triple 3-input Nand gate	14	7
SN7430 8-input Nand gate	14	7
SN7442 BCD-to-Decimal decoder	16	8
SN7472 J-K master-slave flip-flops	14	7
SN7473 Dual J-K ma-sl flip-flops	4	11
SN7474 Dual D-type edgetrigg f-f	14	7
SN7490 Decade counters	5	10

Table 5.1 - SEMICONDUCTOR TYPES

In front of the main chassis is the front panel with the switch unit pc board, housing the carrier and modulation controls for alignment and adjustment. The front panel section connects via connector P11 (to the left) to the main chassis, and is mechanically held by 4 screws. Rear panel connector P208 is wired from the front panel section only and may be removed as well to facilitate dismounting.

The underside of the exciter is fitted with another cover plate. The MF A1 Generator Unit is installed as a subunit, held by 3 quick-release fasteners and connects over one socket connector. When dismounted, the alarm signal generator becomes accessible. Other circuits on the chassis under side are:

- the band oscillator, with cover above its pc board,
- the voltage stabilizer pc board,
- the rectifiers and stabilizers of the power supply, mounted on the main chassis or on cooling fins,
- the RFI filters of the input/output rear connectors.

The 9 MHz reference crystal is in the oven on the underside, and channel crystals for A1 telegraphy on HF bands may be installed in the HF A1 Generator.

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 relays
- reference oscillator frequency check, in intervals of not more than 12 months

Rotary switches:

apply a minor 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.

NOTE

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

The application of a contact oil is rarely justified and it must under no circumstances contain silicon components. ELECTROLUBE Brand 2A can be used.

Relays:

inspect contacts occasionally to detect signs of contact buring. If deemed necessary (i.e. to clear a real fault) polish the contacts with a contact burnisher (P.K. Neuses Inc., model 3–316). Do not use files or other abrasives.

Reference oscillator:

align the frequency to compensate for the ageing of the quartz crystal. The procedure is given under section 5.8, Performance Test.

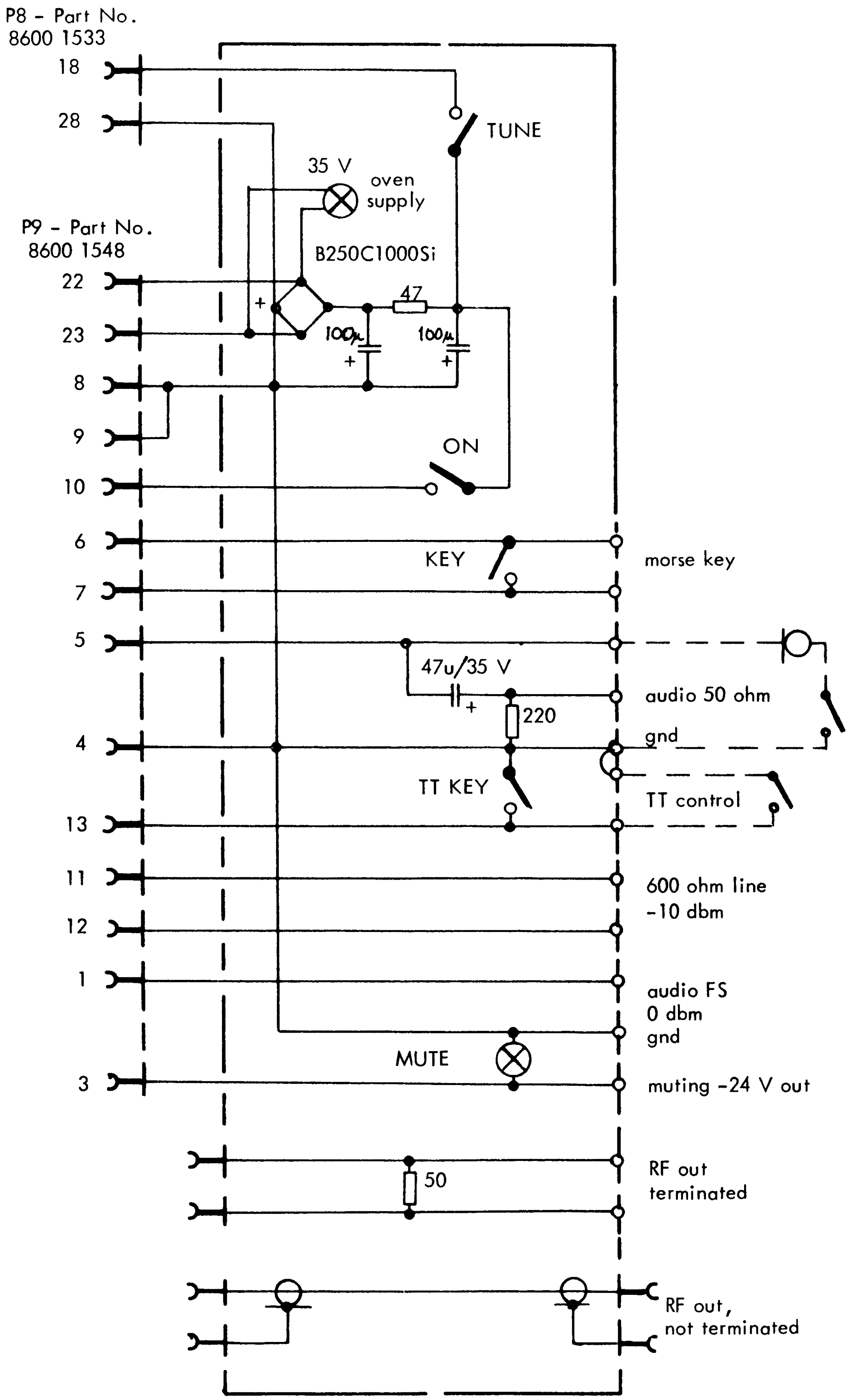


Figure 5.2 - EXCITER TEST BOX

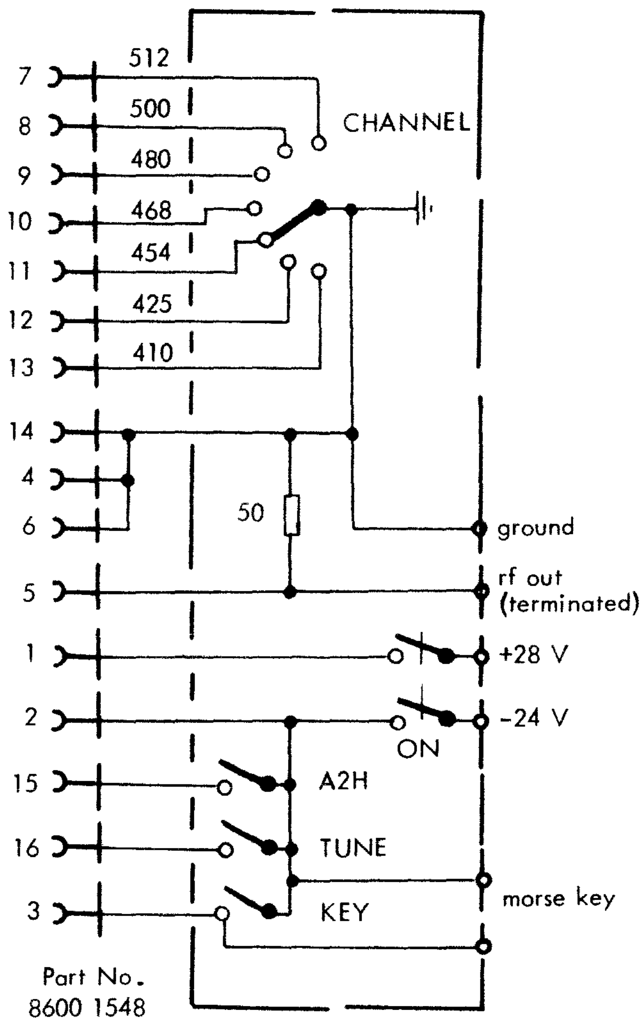


Fig 5 3 - MF GENERATOR TEST BOX

5.7 ADDING NEW CHANNELS (A1)

This applies only to the HF A1 Generator where up to 4 channels per band may be fitted with quartz crystals

Take the exciter out of its cabinet and turn it upside down Remove the bottom cover plate and locate the A1 Generator Take off the cover plate which is held by 4 screws and install the crystals in appropriate locations. Replace the two cover plates

Observe that cyr

Observe that crystals oscillate directly on the output frequency and that they are marked according to specification B03074 1044

5.8 PERFORMANCE TEST

The performance test of the exciter may be carried out either utilizing a simplified and less accurate scheme, suitable onboard a ship, or at workshop level utilizing calibrated test instruments In the first case the exciter will operate with the transmitter, making the special Test Box unnecessary If the exciter is operated on its own in a workshop, a Test Box has to be employed

NOTE

Always switch the transmitter to STANDBY mode

The TUNE order will be obtained in two different ways, depending on whether the exciter is adopted to ST1600A (manually tuned transmitter) or to auto-tuning ST1610A

- ST1600A TUNE order is obtained from the exciter, pushing the TUNE button

- ST1610A set the transmitter on MANUAL TUNING (switch in the Power Amplifier, behind removable front panel cover plate) and set companion switch in PA on TUNE LEVEL ON.

5.8.1 TESTMETER READINGS

The very first thing is always to check the testmeter readings, see table 5 2

Operate the exciter under the conditions given in the heading of table 5.2 and note the differences from the normal values Other frequency bands than 8 MHz will usually show similar figures, but observe that the Band oscillator reading will normally vary with the bands

When all readings are within the tolerances to be expected – ±20% – there are reasons to belive that the exciter is working properly If readings are considerably outside normal tolerances, a fault condition may exist or is developing

Note specifically the basic dc levels displayed in the DC carr position – these are fundamental levels set up by internal alignment controls When the dc input produces an appropriate RF OUT reading most circuits must be in order, leaving out only modulation input path to the SSB Generator

Measurement & full scale defl.	Position	8 MHz HF/MHF exc.		8 MHz HF	MF	8 MHz HF/MHF	
		A1 key up	A1 key down	A1 key down	A1 key down	A3H no mod.	A3J whistle
-35 V unstabilized (50 V)	-35 actual:	70	67	70	73	70	70
-24 V stabilized (50 V)	-24 actual:	50					
-15 V stabilized (50 V)	-15 actual:	30		—	—	30	
+5 V stabilized (10 V)	+5 actual:	50					
keying line output (50 V)	24 V keyed actual:	0	48	48			
reference osc. output	Ref. actual:	80		—	—	80	
band osc. output, see Note 1 below.	Band actual:	15 to 80		—	—	15 to 80	
3rd IF output	3rd IF actual:	73		—	—	73	
1st IF output	1st IF actual:	48		—	—	48	
RF Output from exc.	RF Out actual:	0	50-70	60-70	---	≃30	60-70
Dc input to carrier generator	DC Carr. actual:	0	40	45	45	26	0
synthesizer rf output	Synth. actual:	25 to 30		—	—	25 to 30	

Note 1: Varies over the range 1 - 25 MHz, note down actual value on e.g. 8 MHz.

Table 5.2 - EXCITER TESTMETER, Normal Readings

OBSERVE

The HF A1 exciter section will produce output only from channels fitted with quartz crystals The MF Generator output will not be read on the exciter testmeter (but as DRIVE on the PA testmeter)

5 8 2 ON-SITE PERFORMANCE TEST

a Switch the transmitter to STANDBY and check that the exciter is energized as well

b Check the testmeter readings on the first four positions

35 V – 70 div
24 V – 50 div
15 V – 30 div
+5 V – 50 div

c Set the exciter controls
– Emission A1,
– Exciter section HF/MHF
– Band 8 MHz and channel figures

d When TUNE or Key is switched on and off, testmeter position "24 V keyed" should indicate 48 (on) and 0 (off)

e Switch TUNE ON and check the "DC Carr" reading it should be about 22 divisions Simultaneously the RF OUT should read 30 divisions

f Switch off TUNE and close the key Check the "DC Carr" reading – should be 40 and "RF OUT" between 50 to 70 div

g Check the positions "REF", "BAND", "3rd IF", "1st IF" and "SYNTH" Compare actual reading with those previously noted as normal readings

NOTE

This concludes the testing of the telegra phy operation over the synthesizer derived channels (HF/MHF exciter section)

h Switch EMISSION to A3H, MUTE OFF and check that "24 V KEYED" reads 48 when the handset pressel switch is closed Simultaneously "DC Carr" is to read 26

i Observe the "RF OUT" reading with just the A3H carrier about 30 divisions Talk into the microphone should bring the needle to about 35–40 div

j Change EMISSION to A3J and whistle into the microphone the deflections (on RF OUT) should read 60–70 div

k Push TONE and key the internal audio oscil lator from the morse key RF OUT readings should be about 50 div

l Push VOX and talk into the microphone Check that the voice input keys the exciter immediately (keep pressel switch closed)

m Select the frequency 2182 0 kHz and check the two tone alarm generator, first on TEST ALARM and then on ALARM TEST ALARM must not produce drive from the exciter, only the audio from the built in sound transducer ALARM must produce rf drive and switch off automatically within 30 to 60 seconds

CAUTION

Be careful not to test the alarm when the transmitter is in TRANSMIT and avoid testing during periods of silence

NOTE

This concludes the performance checks of the HF/MHF exciter

n Switch to the HF A1 exciter and EMISSION A1 Select a channel (C, W1, W2 or W3) which is equipped with crystal

o Close the key and check
– DC CARR – 45 divisions
– RF OUT – 60–70 divisions

p Check that the output follows the morse key

NOTE

This concludes the HF A1 Generator performance check

q Finally switch to MF and check the output from the MF generator on the PA testmeter, position DRIVE Operate on POWER 5, EMISSION A1 and A2H, respectively. Following readings are considered normal

TUNE	40 divisions[x]
A1	40 divisions
A2H	30 divisions

[x]DRIVE-servo adjusted level in PA driver.

The absolute A1 and A2H levels may differ and be higher or lower depending on the antennas and adjustments made when installed. The relative relation between the two will be retained, however.

NOTE

This concludes the performance check of the complete exciter.

5.8.3 PERFORMANCE TEST – WORKSHOP LEVEL

Under the circumstances it is assumed that the exciter is operated from the Test Box, figure 5.2 for checking out the HF and HF/MHF exciter sections. Similarly the MF Test Box, figure 5.3, is employed for testing on its own the 4 MF cards of the Card Rack. – This does by no means imply that these tests cannot be carried out with the equipment connected to the transmitter in the ordinary way.

a. Connect the exciter to the test box and terminate the rf output with 50 ohm (test box load). Switch on.

b. Check testmeter readings: -35, -24, -15 and +5.

c. Set exciter controls accordingly
- Emission A1
- Exciter section HF/MHF
- Band 8 MHz and channel figures

d. Switch TUNE (or key) on and off, note reading in position "24 V keyed": 48 on, 0 off.

e. Set on TUNE and check the "DC Carr" reading: to be about 22 divisions. Simultaneously "RF OUT" reads 30 and an rf mV-meter 600 mV (the dc input has been set to obtain 600 mV rf drive).

f. Switch off TUNE, close the key. "DC Carr" should read 40 and the rf output across 50 ohm 1100 mV.

g. Check remaining testmeter positions and compare with normal readings (±20 %).

NOTE

This concludes the synthesizer-derived telegraphy channel tests.

h. Select A3H emission, MUTE OFF and check "-24 V keyed": 48 when pressel switch is held closed, 0 when open. At the same time, check that "DC Carr" reads 26 div.

i. Check the rf output A3H carrier: about 720 mV. Push TONE, close the key and watch the composite signal on an oscilloscope: the modulation factor 80 to 90% is to be expected.

j. Select A3J and key the internal TONE. RF output should be about 900 mV.

NOTE

These tests assume that the tone oscillator has been properly adjusted, to deliver 90 mV to pin 15 of the AF Unit.

k. Push MUTE OFF and whistle into the microphone. An output of about 1100 to 1300 mV is to be expected.

l. Push VOX and talk into the microphone. Check that the voice input keys the exciter immediately (keep pressel switch closed).

m. Refer to 5.8.2, para. m.

NOTE

This concludes the performance tests of the HF/MHF exciter.

n. Switch to the HF A1 exciter and EMISSION A1. Select a channel fitted with crystal.

o. Close the key and check rf output, to be 1100 mV. Push TUNE and note that the level drops about 50%.

p. Check that the output follows the morse key.

NOTE

This concludes the HF A1 Generator Tests.

q. Operate the MF generator and check the output across the terminating resistor of the Test Box figure 5.3:

TUNE	600 mV
A1	600 mV
A2H	450 mV

Check with oscilloscope that the modulation factor is 100%.

NOTE

This concludes the performance tests of the af and rf circuits.

5.8.4 REFERENCE OSCILLATOR

The easiest way to check the frequency of the reference oscillator is to use an electronic counter. The counter itself must be accurate to 1×10^{-6}, as verified against a reliable external standard.

Another way to check the 9 MHz frequency is based on comparison with a WWV standard frequency. Both methods are described below.

a. Connect the electronic counter to coax.connector P9 (e.g. with clips from the under side).

b. Allow at least 30 minutes for oven heating-up before reading the frequency. The frequency shall then be 9 000 000 Hz ±10 Hz.

c. In order to realign the oscillator frequency, swing the RF Unit aside (release the screw at the right hand side). The reference oscillator cover is marked FINE and COARSE.

d. Realign the frequency to 9 000 000 ±1 Hz with the aid of the FINE trimmer capacitor (and COARSE if the range of the FINE trimmer is not sufficiently large).

e. Replace the RF Unit, disconnect the counter and reinstall top and bottom cover plates.

NOTE

This concludes checking and realigning of the reference oscillator with the aid of an electronic counter.

To check the reference oscillator against a standard frequency station, proceed as follows:

a. Tune a receiver to a standard frequency station (e.g. WWV) on 5, 10 or 15 MHz.

b. Note the relative field strength on the S-meter.

c. Prepare an insulated wire from the receiver to the exciter unit. The exciter end of the wire must be completely insulated.

d. Disconnect the antenna from the receiver and connect the wire to the antenna terminal instead.

e. Open the exciter, release the cover of the RF Unit (4 quick-release fasteners). Place the insulated wire end close to the 3rd IF Amplifier (in the corner where the integrated circuit is located). Watch the receiver S-meter — a strong signal should be indicated.

f. Vary the coupling to obtain an S-meter reading which is roughly the same as in step b. above. Do not alter the gain of the receiver!

g. Connect the antenna to the receiver as well. A beat note may be heard if the frequency difference is high enough. Usually the beat frequency is less than 20 Hz. When approaching zero, the S-meter will first flicker, then swing heavily and finally "pump" with a cycle time of seconds.

h. Decide from the response in g. above if realignment is required.

i. To realign, swing the RF Unit aside to get access to the trimmer capacitors of the reference oscillator: FINE and COARSE.

j. Watch the S-meter and turn the FINE (and possibly the COARSE) control to obtain strong deflections. Realignment is satisfactory when a cycle time of at least 1 second has been obtained.

k. Replace all cover plates after the realignment is finished.

CAUTION

When the RF Unit is swung up, check that the coupling to the receiver is preserved. Equal signal levels to the receiver makes the test and realignment easier, because S-meter indications are more pronounced under such circumstances.

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 trouble-shooting 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, especially if the power source has a voltage different from the nominal rated input voltage of the set. Some voltages are affected 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 trouble-shooting 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 troub-leshooting.

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 other-wise 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 chould 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 exciter, in the transmitter cabinet or from the external power supplies as desribed in para. 5.8.

b. Perform the tests listed in para. 5.8. Use figure 6.1 to determine how to proceed.

NOTE

> Try to find out what is characteristic of the fault, especially if it is restricted to specific frequency bands, exciter subsections or type of emissions.

6.3.2 OVERLOAD PROTECTION

Power supplies for -24 V and +5 V are equipped with shortcircuit or overload protection. Because of this the output falls to very near zero on overload and may be mistaken for unability to deliver output.

To make certain that the load current is normal and within the rating of the supply, proceed as below:

a. Check that the input voltage from the rectifier to the stabilized supply is approximately correct.

b. Disconnect external loads, for instance by unplugging a strategically located connector, or disconnecting by unsoldering circuit by circuit. Watch the stabilizer output voltage.

c. If no or low output voltage, although the external loads have been removed, the problem is likely to be in the stabilizer itself.

6.3.3 SYNTHESIZER OSCILLATOR

A detailed check of the synthesizer requires a good knowledge of digital technique and should be trusted a specialized service workshop. A less experienced person

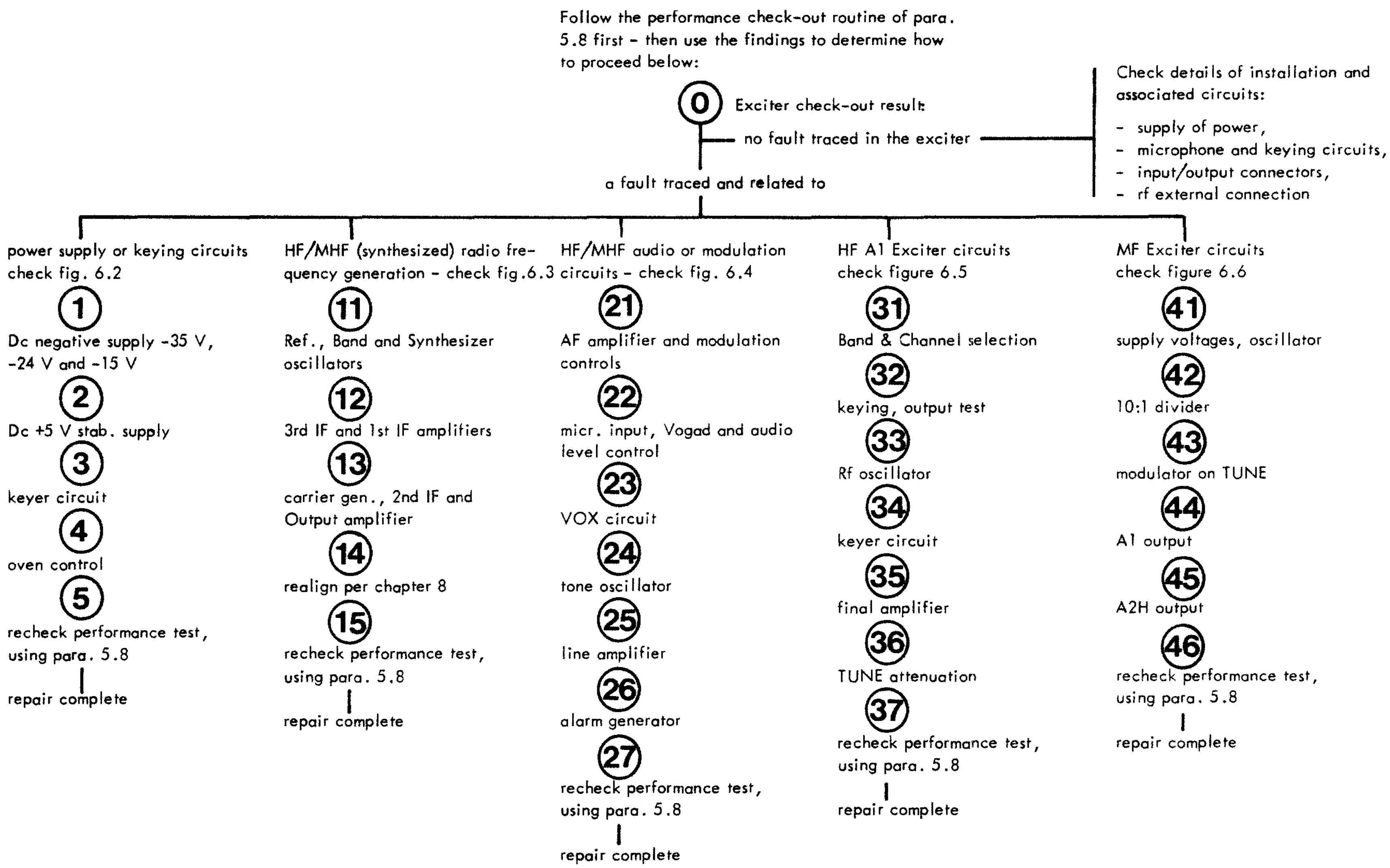


Figure 6.1 -
REPAIR SEQUENCE GUIDE

can easily provoke a major failure due to a shortcircuit or excessive supply voltage.

Another reason for letting the specialist take over is that the number of pulse combinations is very great in the variable counter, and therefore requires a good understanding of the operation of these divieders. Component-level servicing will however be feasible, because IC units are plugged into sockets, and a circuit suspected to have failed may be replaced with a good one from the supply of spares.

NOTE

Always switch off the supplies before replacing integrated circuits! Observe the location of the key on the body to install the units properly.

A similar and modern method is to employ a comparator test instrument and a set of good IC units, facilitating in-circuit testing and indicating every difference between the sample and the pc board IC.

The procedure below aims at locating basic faults inside the oscillator, for subsequent workshop repair. In order to obtain repetitive and characteristic waveforms for oscilloscope display, set all the dials on zero figures. The VCO output to the divider chain is then to be 2000.0 kHz, and 10-divisions are effective overall. Confer waveforms with those shown on figure 6.7.

NOTE

Connect by preference the test probe tip to the circuit where a shortcircuit can best be avoided. For transistor collectors, use the metal case, and for base and emitter signal tests, find the lead of another component which connects to the same transistor terminal.

a. Check the input signal level of the reference oscillator at P2: about 150 mV rf.

b. Check the synthesizer output signal at P1: not less than 180 mV, normally about 250 mV rf.

c. Connect the oscilloscope probe to Y13 collector and analyze the sawtooth wave ("A" on figure 6.7):

- the horisontal step must be fully stable for any combination of the BCD controls,
- the horisontal step will move up or down when changing the controls,
- there must always be a margin left on the slope when band limits are selected.

NOTE

This concludes the synthesizer performance test. If reasons are found to retune the oscillator for better margins, refer to para. 8.2.3.

d. The sawtooth signal is controlled from the fixed divider chain IC21—IC25. Check waveforms B, C and D.

e. When VCO output is obtained but no horisontal step is visible in the sawtooth, check that a 2—2.999 MHz signal is applied to variable divider input 3/11 IC1. Then check if pulses are delivered from (7, 10, 12) IC7: if they are but not generating the proper "E" response, check transistor Y14.

f. When under the conditions in e. above no output is obtained from IC7, a fault is located to the divider chain IC1-2-3-8-9-4-5-10-5-6-11-7.

g. For a quick check of where the signal is lost, set all dials on "0" and study output signals E through J in figure 6.7.

NOTE

A fault in another circuit, such as decoder or coincidence gates may affect the operation of a divider circuit as well. But 8IC12 output is held a steady "0" when the last two dial figures are zeros (frequency ending 0.0 kHz), and this will hold the first divider (IC1 + IC2) permanently on divide-by-ten.

h. The reset pulse from 8IC13, which is to repeat itself every 10 ms when phase lock has been established, is only about 50 ns long and may thus be difficult to view on the oscilloscope.

i. DC levels on the transistors should be checked from the circuit diagram to isolate faulty transistors.

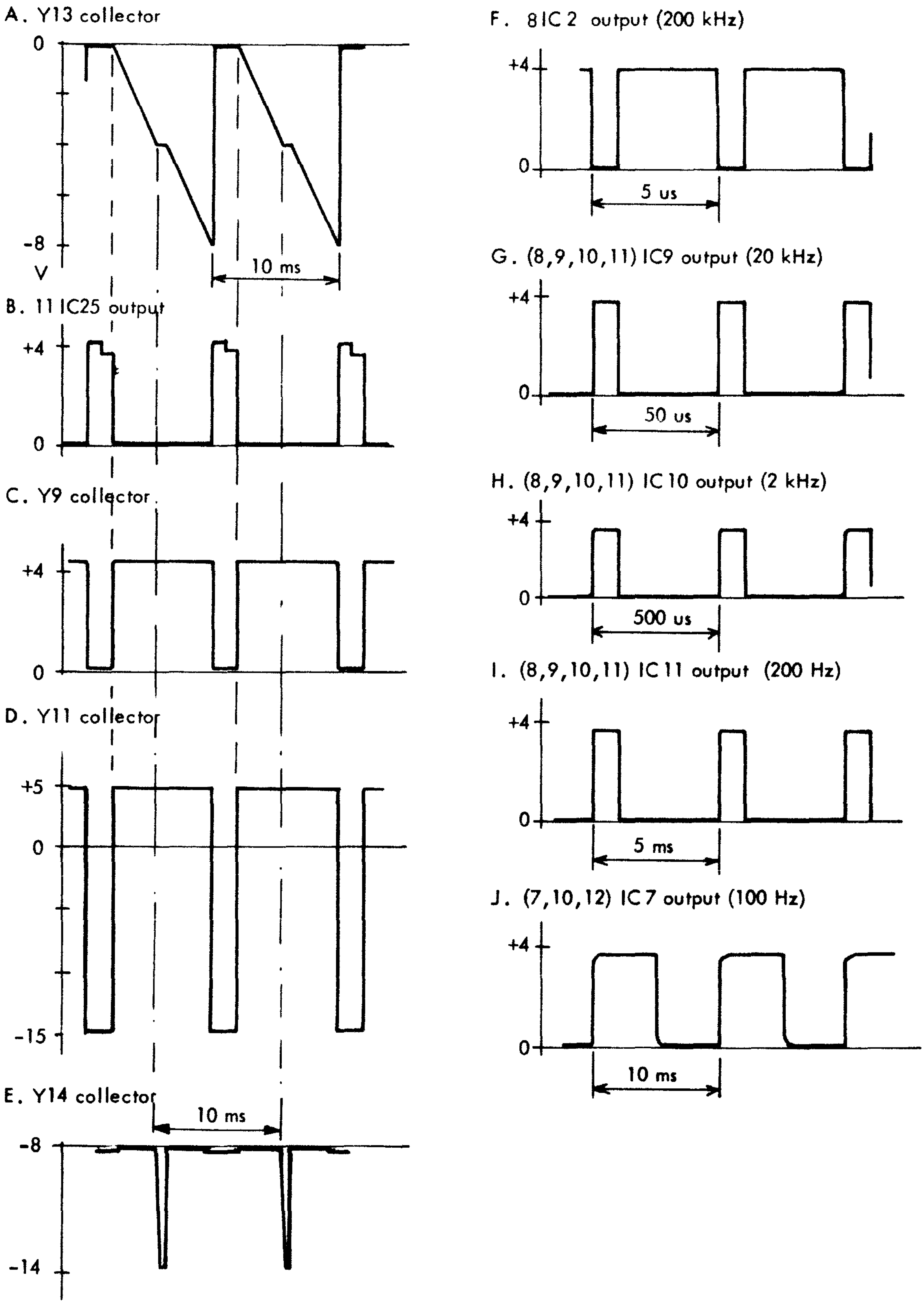


Figure 6.7 - SYNTHESIZER WAVEFORMS

6.3.3.1 FREQUENCY ERRORS

Below typical effects of synthesizer malfunction are listed for recognition:

– a flickering output signal from the synthesizer and from the exciter as well: no phase lock,

– steady pulses in a receiver tuned to a frequency near the radiated frequency: no phase lock,

– a steady frequency delivered, but not on the dialled number: divider, gate or BCD input problems.

When a fault condition exists, select different frequencies from the controls, to find out if the problem is associated with outside-controlled (variable) circuits or not.

6.3.4 AUDIO TESTING

Audio testing may utilize built-in oscillators, provided that they are operable. Refer to the simplified circuit diagram of figure 6.8.

a. For the first test, push the TONE button and close the morse key. An operable oscillator and a properly adjusted TONE level will give about 90 mV input to the amplifier. If not, do not alter the level, but calculate the gain of the audio amplifier.

b. If the Alarm generator is used instead of an external audio generator, the input to the Vogad will be higher. It may be reduced towards 100 mV by changing the MICR. control, but remember to reset MICR. after the test, to its previous position. The higher input will not give a higher output from an operational Vogad amplifier. – The knee of the in/out characteristic is at 20–30 mV in.

c. Testing the gain of the Line amplifier must take into consideration the possible adjustments done to the feedback, through a resistor connected between terminals 11–12. Refer to table 6.1.

6.3.5 ALARM GENERATOR TEST

Push the TEST ALARM button and then START ALARM. Count the number of full tone sequencies over 20 seconds. Nominal number is 40 (i.e. 500 ms each) with acceptable deviations +10 or –7 counts.

6.3.6 MF EXCITER

In order to get access to the pc board assemblies, use the Extension Service Card. Note that all supplies to this exciter subsection are from the transmitter LT Power supply. Operate the transmitter on Standby. If fitted with MF Local Control Panel, verify that full command facilities are available from this panel as well as from the remote exciter.

Line nominal level, dbm	Feedback resistor between pins 11/12	Circuit gain
-20	no resistor	1
-10	1000 ohm	0.5
0	150 ohm	0.16

Table 6.1 - Line Amplifier Gain vs Input

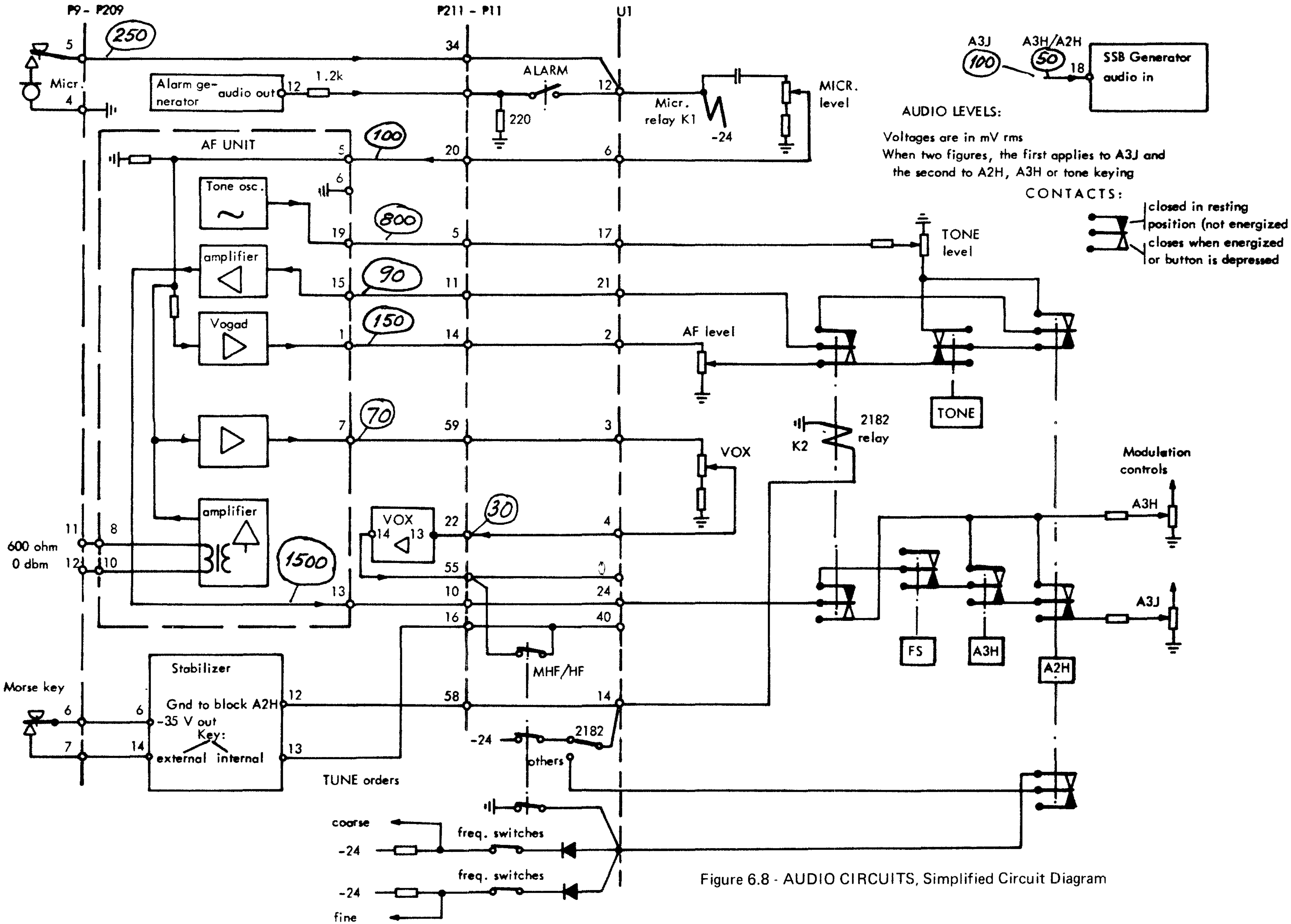


Figure 6.8 - AUDIO CIRCUITS, Simplified Circuit Diagram

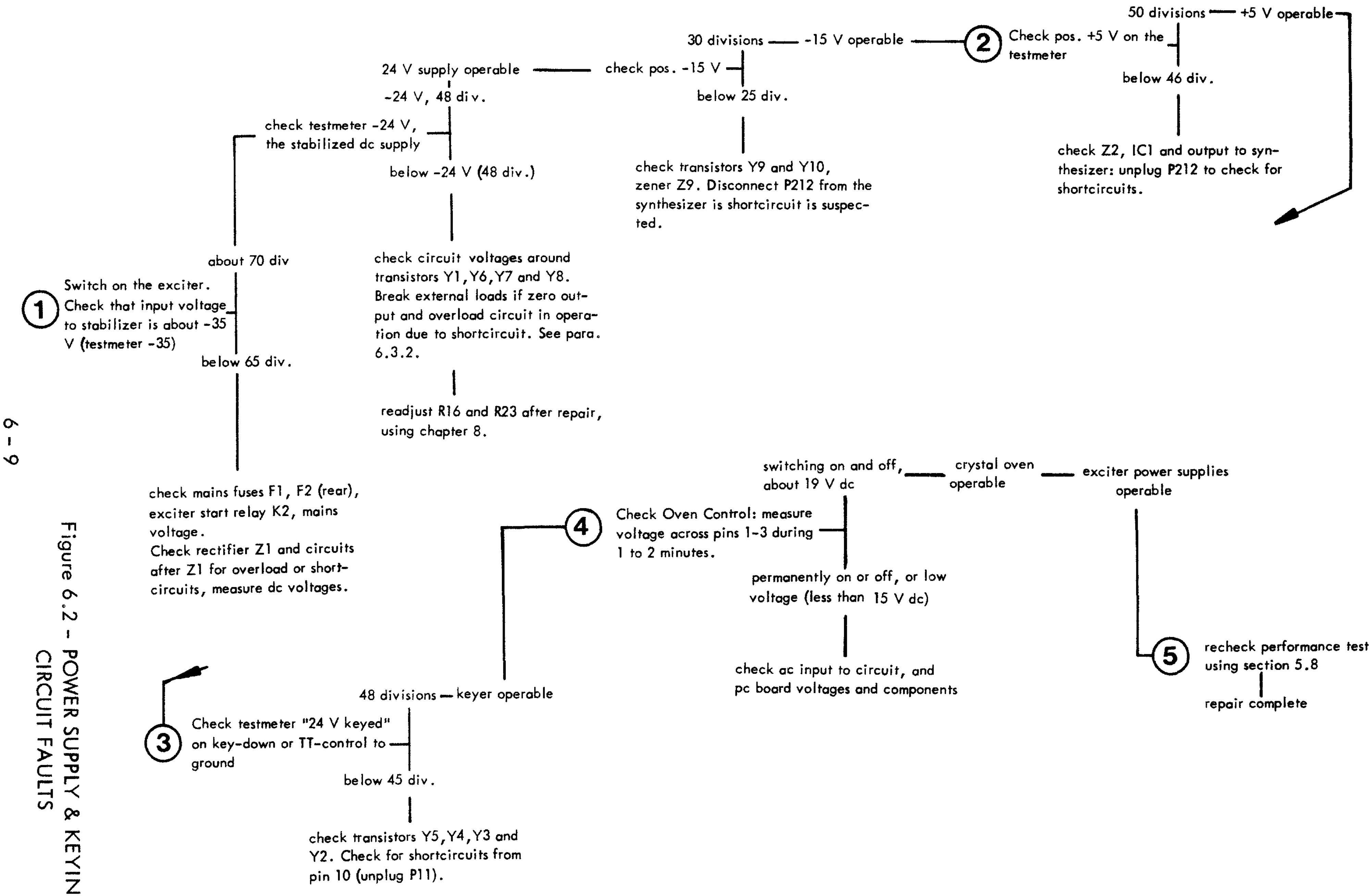


Figure 6.2 - POWER SUPPLY & KEYING CIRCUIT FAULTS

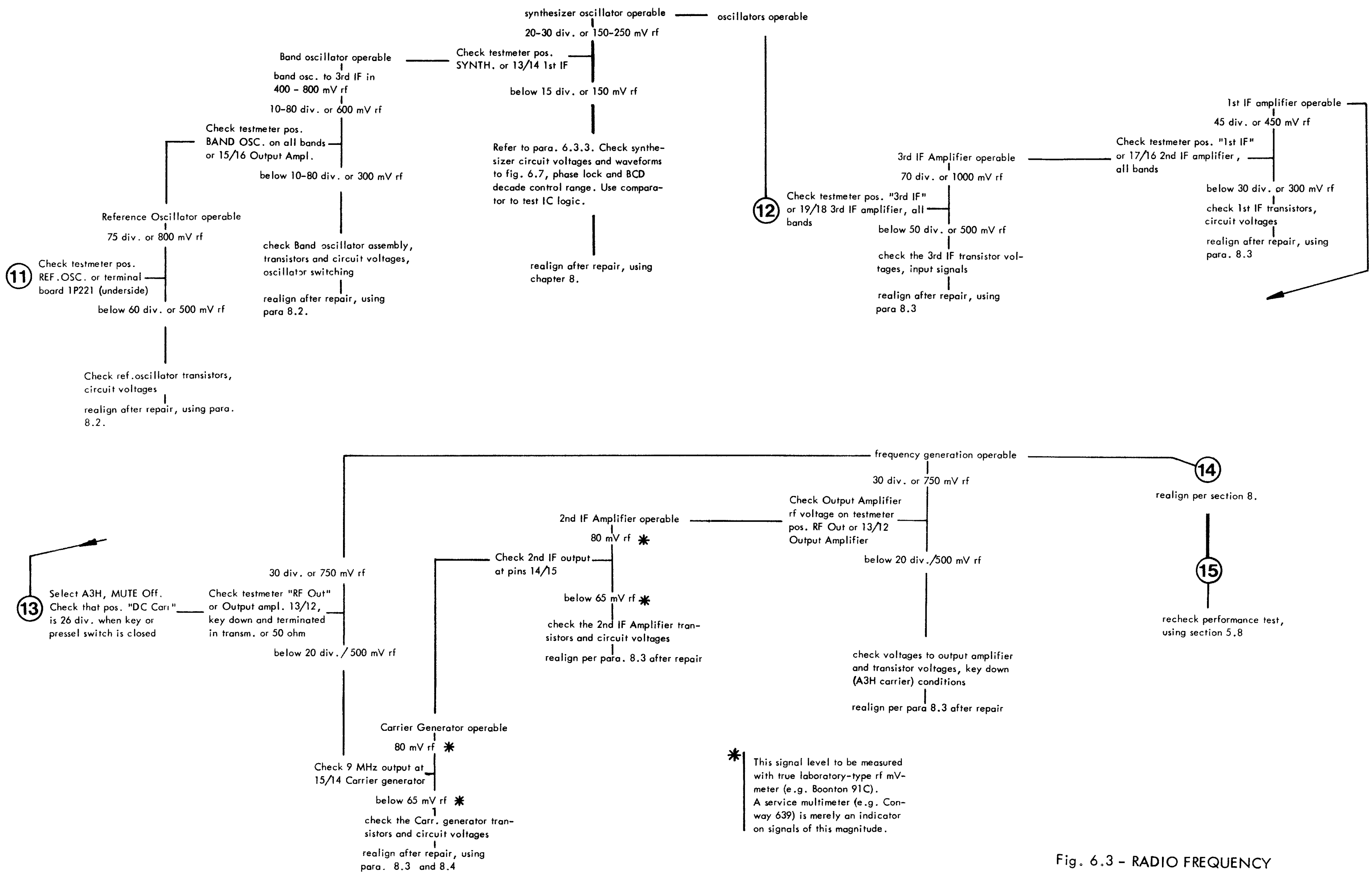


Fig. 6.3 - RADIO FREQUENCY GENERATION FAULTS - HF/MHF

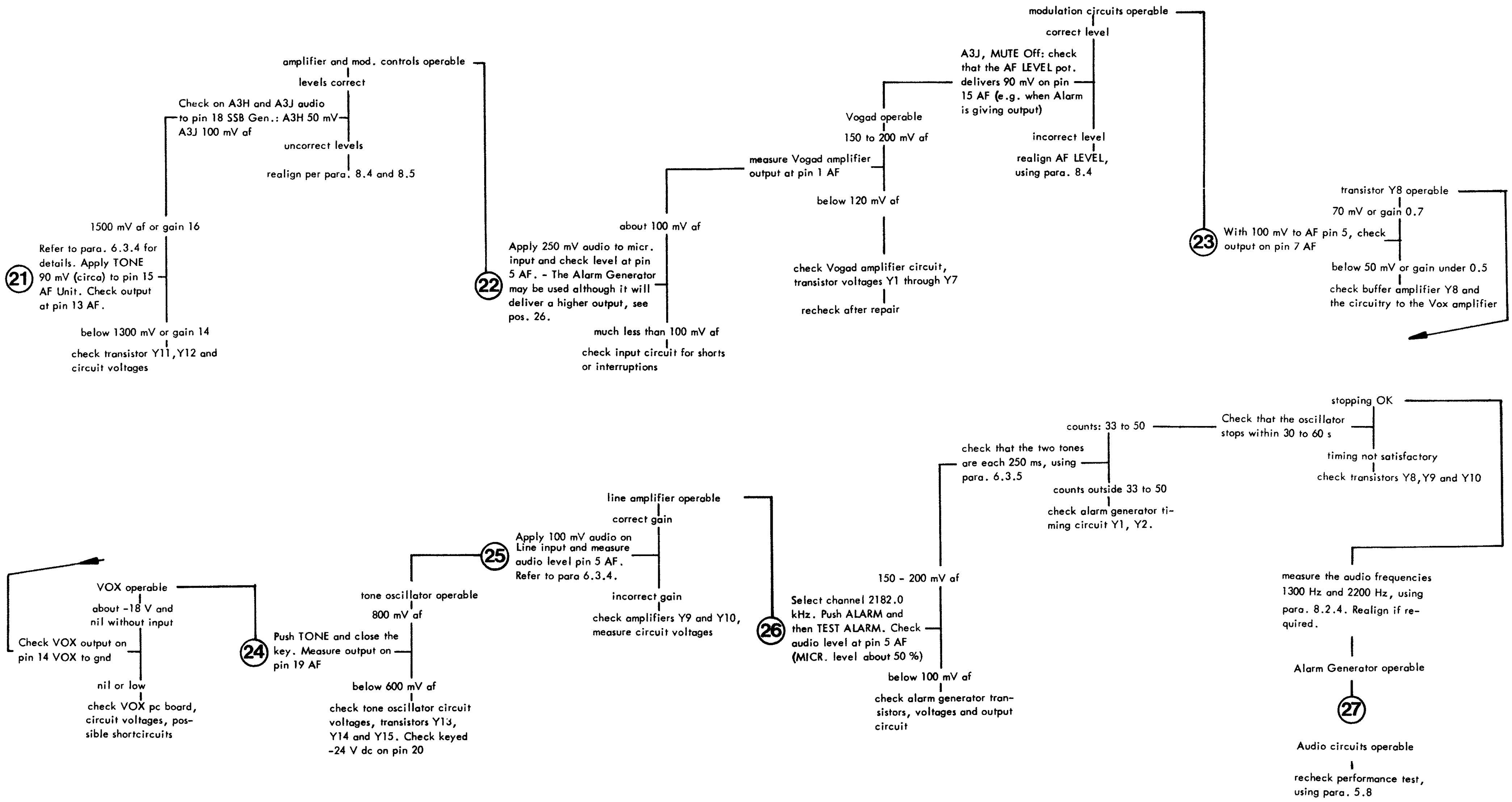


Fig. 6.4 - HF/MHF EXCITER MODULATION FAULTS

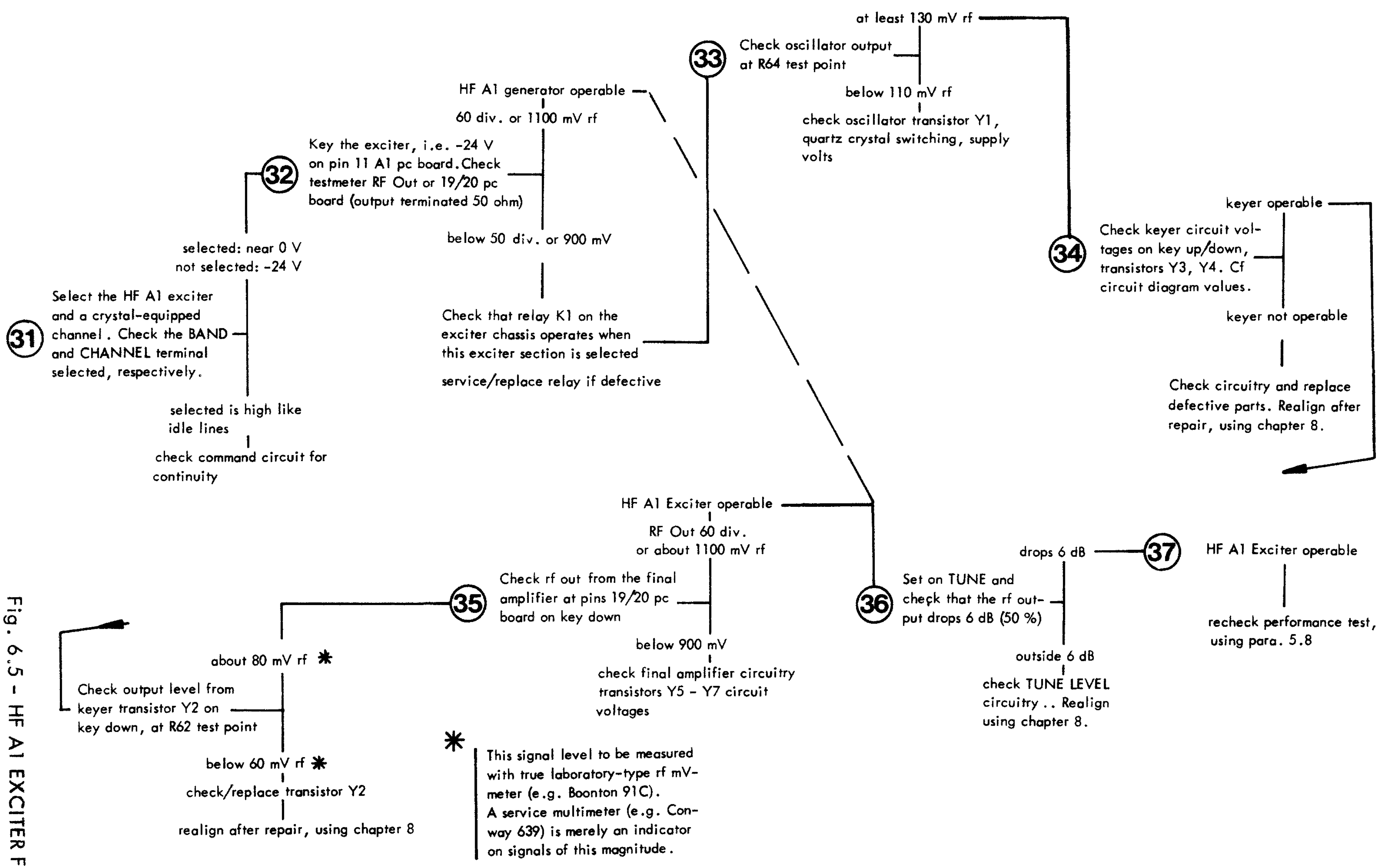


Fig. 6.5 - HF A1 EXCITER FAULTS

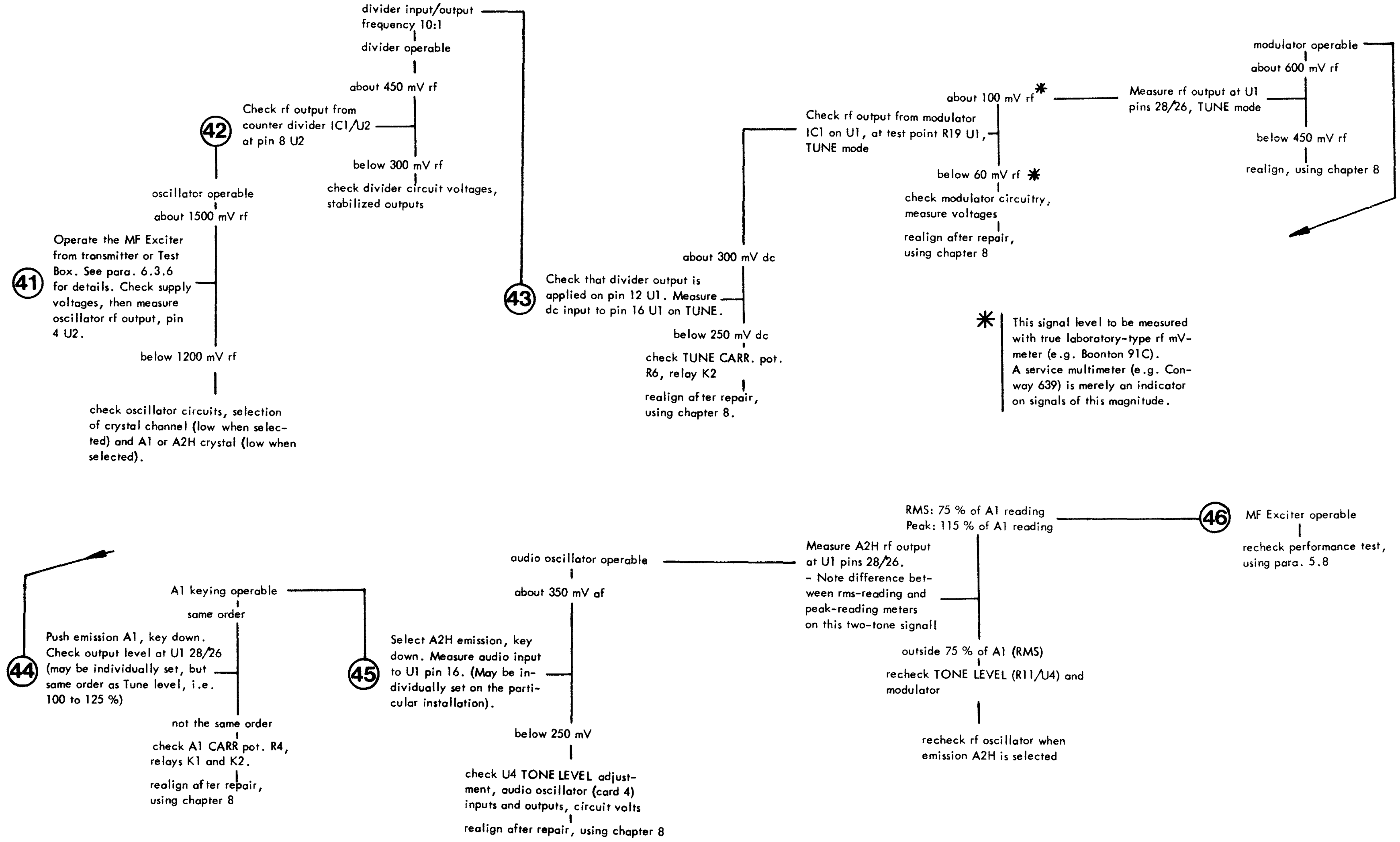


Figure 6.6 - MF EXCITER FAULTS

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 RF UNIT

The assembly contains 6 printed circuit boards, all mounted on a metal framework with internal screening partitions. The assembly is fitted with two slots which match short stubs on the main chassis, to allow the assembly to pivot and also to be easily removed. A set screw at the right hand side secures the assembly to the main chassis.

7.2.1 ACCESS TO ASSEMBLY

a. Undo the four quick-release fasteners which hold the top cover. Remove the cover plate.

b. Unscrew the fixing screw at the right, to allow the assembly to be swung up.

c. For access to the under side, undo the four screws which secure the bottom cover.

d. Note that the left hand slots provide a locked position when the RF Unit chassis has been turned up almost 90°.

e. To release from the locked position, lift chassis slightly.

7.2.2 REMOVAL OF ASSEMBLY

NOTE

Printed circuit boards may be replaced without removing the RF Unit – they become accessible after removing the top cover. Refer to para. 7.2.3 below.

a. To remove the assembly – dismantled or not – unplug the multipole connector and the five coaxial connectors from the main chassis.

b. Unscrew the fixing screw to the right, and swing up the assembly. Lift to disengage slots to the left from the pivot pins of the main chassis. Remove the RF Unit.

7.2.3 PC BOARDS

a. To remove a specific printed circuit board assembly, unsolder the leads to the terminals of the board. Then remove the four screws which secure the circuit board to the chassis.

b. To install a replacement PC board, first fasten the board with the four screws, and then resolder the leads to the assembly.

7.3 BAND OSCILLATOR

The band oscillator printed circuit board assembly is located on the under side of the main chassis.

7.3.1 REMOVAL

a. Remove the underside cover, the HF A1 Generator (3 quick-release fasteners) and then the cover of the band oscillator (4 screws).

b. To remove the pc board, first unsolder all leads to the solder terminals, and unscrew the screws which secure the pc board.

7.3.2 REINSTALLATION

a. Install the pc board, using the four screws provided.

b. Solder the connections to the proper terminals of the pc board.

c. Install the cover plate over the pc board assembly.

7.4 REFERENCE OSCILLATOR

The reference oscillator consists of the pc board assembly (below the RF Unit) and the crystal oven, which is mounted on the main chassis, plugged to an octal socket from the under side.

7.4.1 REMOVAL/REINSTALLATION OF PC BOARD

a. Take off the cover plate, undoing four screws.

b. Unsolder the leads to the pc board terminals, and remove the screws which secure the board.

c. To reinstall, work the opposite way. Do not forget to replace the cover over the pc board.

7.4.2 CRYSTAL OVEN

The crystal oven is fitted with a plug which mates an ordinary octal socket. A clamp prevents the oven assembly from falling out under vibration and shock.

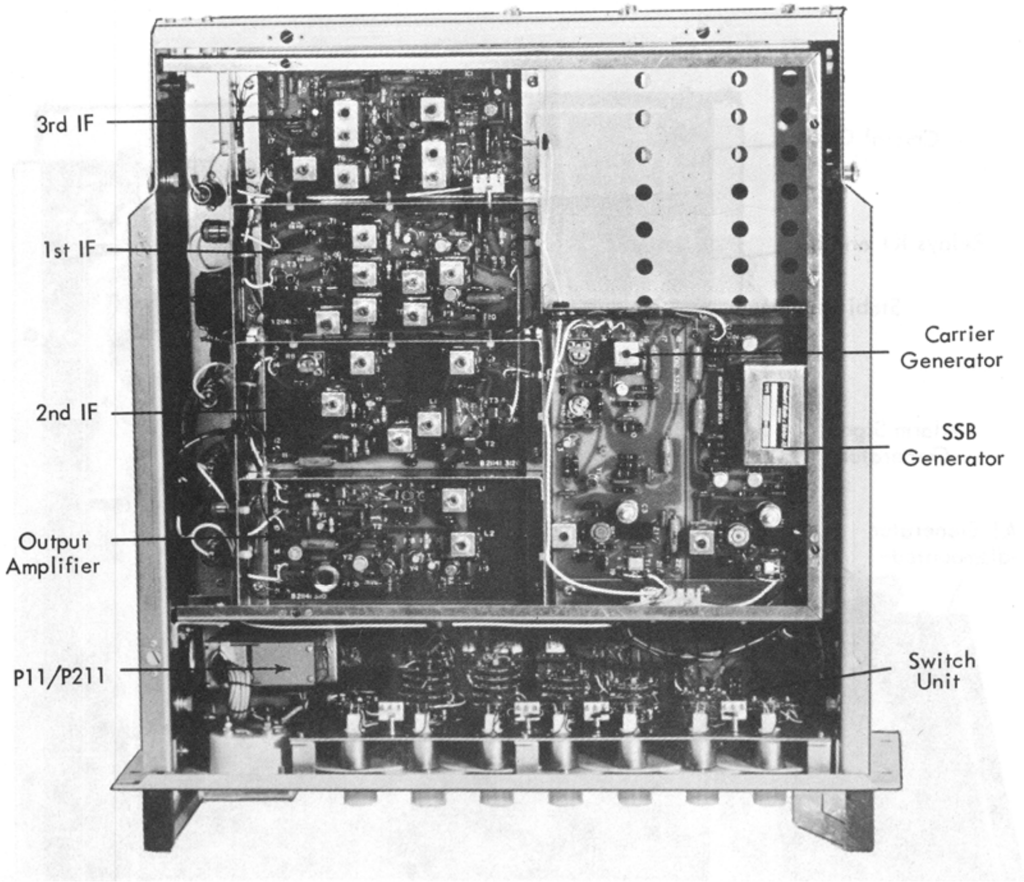


Figure 7.1 - EXCITER, top view - RF Unit

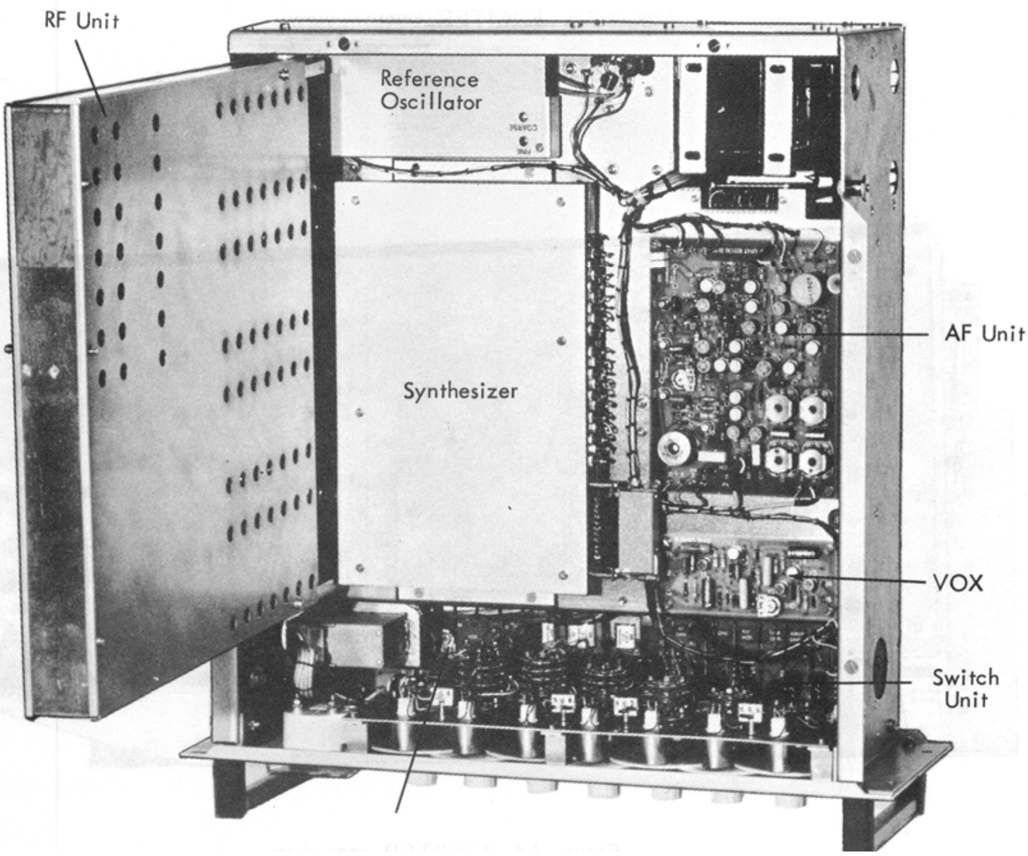


Figure 7.2 - EXCITER, top view - Main chassis

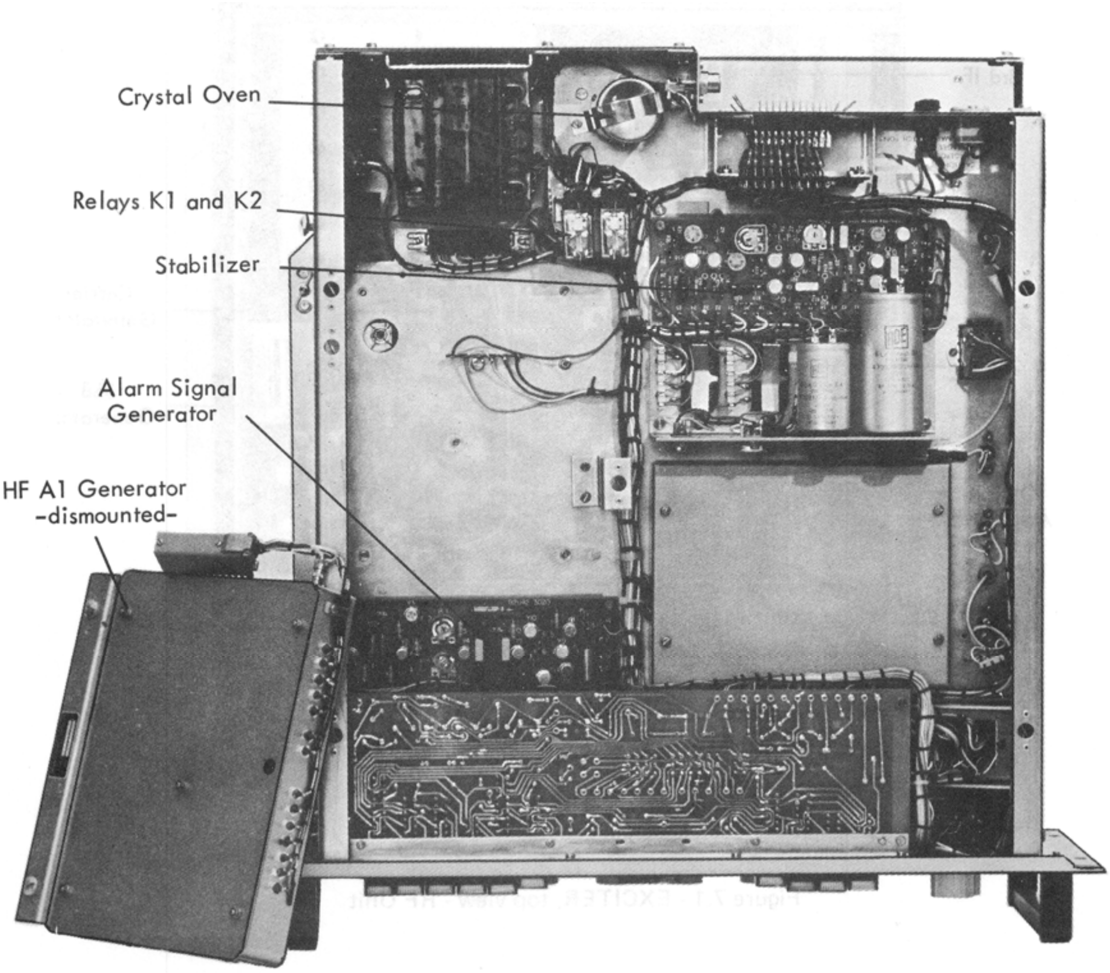


Figure 7.3 - EXCITER, bottom view

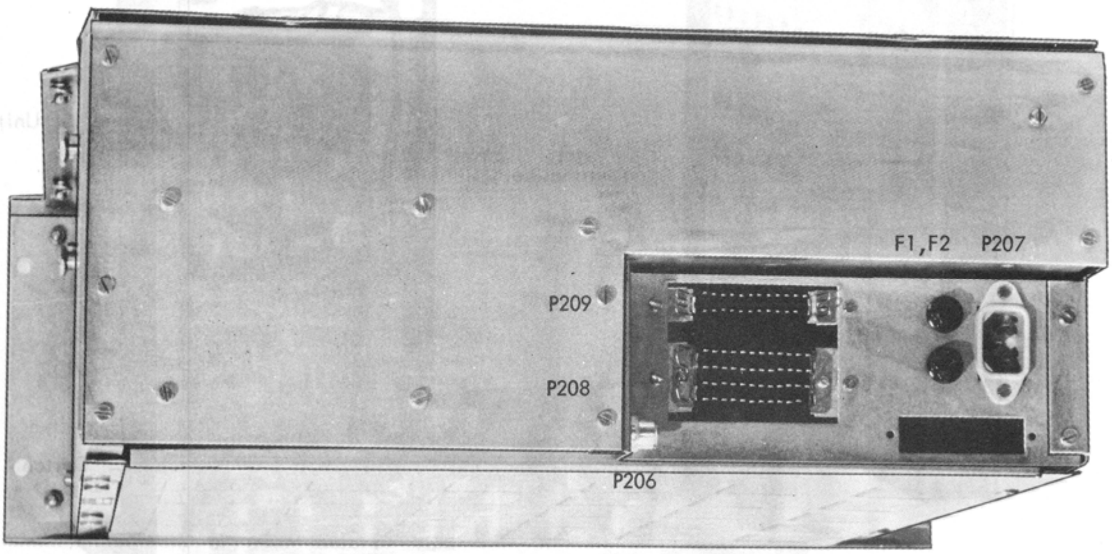


Figure 7.4 - EXCITER, rear view

a. To remove the oven, first take away the screws of the clamping device.

b. Unplug the oven. The quartz crystal is accessible after a number of copper tubes have been dismantled.

c. Note that two crystals may be accommodated. The correct crystal position is the one which connects to terminals 2 and 8 (bottom view).

d. Replace all copper tubes of the oven carefully, or the temperature stability will be impared.

e. After the oven has again been plugged in, replace the clamp over the oven.

NOTE

The quartz crystal is mounted in a glass envelope and is therefore liable to crack if excessive force is used when removing the unit.

7.5 SYNTHESIZER OSCILLATOR

The synthesizer oscillator is located on the main chassis, under the RF Unit.

a. Open the exciter, swing up the RF Unit, and unplug the synthesizer multiplug and two coaxial connectors.

b. To remove, undo the four screws (non-metallic!), which secure the unit to the main chassis. Observe the sheet of insulating material between the chassis and the synthesizer case.

c. When reinstalling the unit, do not forget to place the insulating sheet between the chassis and the oscillator, and use the non-metallic screws.

7.6 FRONT PANEL/SWITCH UNIT

To remove the front panel completely, proceed as follows:

a. Unscrew connector P208, complete with RFI filters, from the rear panel, and take out the cable harness.

b. Unplug connector P11 from the main chassis.

c. Remove the two screws at the left and right side, respectively, which secure the front panel assembly to the main body of the exciter.

d. The front panel assembly is now free to be removed.

7.7 MAIN CHASSIS

Components located on the main chassis are readily accessible for testing or service.

7.7.1 POWER TRANSISTORS

Two power transistors, Y1 and Y2, are mounted on the chassis, but collectors (case) are isolated from chassis. Therefore be careful to replace insulating washers in case of transistor replacement.

CHAPTER 8

ALIGNMENT

8.1 GENERAL

This chapter contains procedures for alignment, divided into individual assemblies or assemblies in cooperation. The final adjustment of the exciter concludes the information.

NOTE

> 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 it is generally assumed that the exciter is operated from external power supplies via the test connector (refer to chapter 5). In the event of a pc board assembly being serviced on its own, supply voltages, input signals and terminations should as far as practicable be made equal to those in normal operation in the exciter.

8.2 OSCILLATOR ADJUSTMENTS

8.2.1 REFERENCE OSCILLATOR

a. Connect the set to the proper supplies of power to energize transistor circuits and the crystal oven heaters.

b. Allow a heating time of not less than 30 minutes before adjustments commence.

c. Connect a frequency counter of known accuracy (not less than $\pm 1 \times 10^{-6}$) to the oscillator output (e.g. between P9 to ground).

d. Swing up the RF Unit to expose the reference oscillator with its adjustment controls C1 (coarse) and C2 (fine).

e. Adjust the frequency of the oscillator to 9000.000 kHz ±1 Hz, using the FINE control (and COARSE, if required).

NOTE

> This concludes the reference oscillator adjustments.

8.2.2 BAND OSCILLATOR

The different band oscillators are all based on one circuit configuration. The nominal frequency of the oscillator is related to the frequency band (1 MHz wide) as follows:

Oscillator frequency (MHz) =
= output frequency band + 41.2 MHz

E.G.: To operate in the band 8 (to 9) MHz, band oscillator frequency is 8 + 41.2 = 49.2 MHz

a. Connect the oscillator (or exciter, when in situ) to the proper power sources.

b. Connect a frequency counter to one of the output terminals, e.g. pins 15/14 (or to coax. connector P4) and an rf vtvm to terminals 17/16 (or coax. connector P7).

c. Switch to band 1, and align L1 (at control terminal pin 1) to obtain maximum output voltage and simultaneously a frequency which is 42.2 MHz ±2 kHz. Be sure to locate oscillator operation on a flat portion of the characteristic, not close to the point where the amplitude falls rapidly.

d. Proceed with the other bands, in the same way as in c. above.

e. The output voltage – when outputs are terminated to the circuits connected to Output No. 1 (17/16) and No. 2 (15/14) – is approximately:

– No. 1 – pins 17/16 – connector P7 0.7–0.9 V rms
– No. 2 – pins 15/14 – connector P4 1.0–2.5 V rms

NOTE

A frequency counter may introduce an additional load, therefore measure rf voltage when the counter is not connected.

NOTE

This concludes band oscillator alignments.

8.2.3 SYNTHESIZER OSCILLATOR

To align the synthesizer oscillator a calibrated oscilloscope is required. Make sure that the reference input signal, 9 MHz, is adequately stable and of proper amplitude.

a. Select the frequency 2599.9 kHz on the BCD dials, and connect the oscilloscope to transistor Y13 collector (test point "A", see fig. 6.7 and the circuit diagram).

b. Use a vertical scale of 2 V/cm and a horisontal sweep or 10 ms/cm.

c. Note that the total Y-axis deviation is at least 9 V. For the frequency selected, the horisontal step should occur at -8 V. Align trimmer capacitor C3 to achieve this.

d. Check the position of the step for frequencies 2299.9 and 2999.9 kHz, respectively. None of these must fall beyond -8 V. If so, repeat the C3 alignment on the frequency where the most negative reading was obtained, to relocate the step to -8 V.

e. Check the low end of the three bands: 2000.0, 2300.0 and 2600.0 kHz. None of these should place the step in the 0 to -1 V region.

NOTE

This concludes the synthesizer oscillator alignment.

8.2.4 ALARM GENERATOR ALIGNMENT

a. Test on channel 2A.01 (2182 kHz), but be careful not to radiate a signal over the transmitter.

b. Connect an oscilloscope for Lissajou figure display: the Y-axis to the generator output at the telephone receiver, and the X-axis to a variable audio generator. Read the audio generator frequency on an electronic counter.

c. Turn the switch to TEST ALARM and push START ALARM. Count the number of full tone sequencies over 20 seconds. Correct number is 40 (+10 –7) counts.

d. Adjust the tone generator frequency to about 2200 Hz to get a steady figure on the screen. Align potentiometer R12 to obtain 2200 ±2 Hz.

e. Adjust the tone generator around 1300 Hz to get a steady figure again. Align potentiometer R11 to obtain 1300 ±2 Hz.

f. Check that the alarm generator stops in less than 60 seconds after START ALARM has been pushed.

NOTE

This concludes alignment of the alarm signal generator.

8.2.5 TONE OSCILLATOR ALIGNMENT

The oscillator frequency should be 1000 ±200 Hz, as controlled by R10. Tune transformer T2 for resonance on this frequency.

8.3 RF UNIT SUBASSEMBLIES

IMPORTANT

The RF Unit subassemblies should be aligned only when proper test equipment is available, such as a good sweep generator and display. Many circuits are broadbanded and adjusted to close tolerances. The circuits are designed to retain their properties, normally over a considerable number of years. Instructions below also assume that the subassemblies are installed in the exciter during alignments.

8.3.1 3rd IF AMPLIFIER

The amplifier is to be aligned for a passband of 34.2 MHz ±4 kHz, flat within 0.5 dB.

a. Apply the 9 MHz reference signal on pins 11/12 over coax. connector P19, min. 600 mV.

b. Inject a variable band oscillator signal of 63.2 MHz from a sweep or signal generator on pins 13/14 via connector P14, amplitude about 600 mV rms.

c. The sweep display is connected to the amplifier output, pins 19/18, where the final signal level is to be minimum 500 mV in 50 ohm.

d. A frequency counter will be required to verify that the variable band oscillator frequency is 63.2 MHz and that the narrow passband of ±4 kHz at 34.2 MHz is obtained.

e. Align the cores of T5, L10 and T8 for maximum response.

f. Align the core of L3 (in filter box T4) and the core of L12 (in filter box T7) for best flatness over the passband.

g. When aligning the amplifier, observe the flank attenuation. A figure of 70 dB below the passband should be obtained at ±200 kHz from the centre frequency.

NOTE

This concludes the 3rd IF Amplifier alignment.

8.3.2 1ST IF AMPLIFIER

The amplifier passband is to be 31.2 – 32.2 MHz with a ripple of less than 0.5 dB.

a. Apply the 3rd IF signal of 34.2 MHz at pins 11/12, signal level more than 500 mV.

b. Apply a signal from a signal generator or sweep generator on pins 14/13 via connector P15. The frequency of the signal is to be varied 2.5 ±1 MHz minimum.

c. Keep the "channel oscillator" input over P15 at about 50 mV during alignment.

d. The display is connected to pins 17/16.

e. Align the trimmers of T5 through T9, and L7 for a passband of 31.2 – 32.2 MHz within about 1 dB, and with steep flanks and high ultimate attenuation. Especially the response at 34.2 MHz should be observed (-50 dB below the passband).

f. Finally increase the 2 – 3 MHz input to 150 mV, check that the output is 500 mV or more. The passband should now be flat within 0.5 dB (internal agc operative).

NOTE

This concludes 1st IF alignments.

8.3.3 2ND IF AMPLIFIER

The amplifier passband is to be 40.2 – 41.2 MHz, within 0.5 dB.

a. For the 9 MHz signal at pins 19/20, a type A1 emission can be used (or the Tuning signal).

b. Connect the sweep generator to pins 17 and 16, signal level about 400 mV. – Note that no crystal must be in the channel oscillator.

c. The display can preferably be connected to the exciter output or else to pins 14/15. – Note that the potentiometer R8 is n o t on minimum.

d. Align L1, L2, L3 and L4 for maximum response and 1 MHz bandwidth 40.2 – 41.2 MHz, within 0.5 dB.

e. The gain of the amplifier is to be set to 1, i.e. 150 mV output for 150 mV of 9 MHz input signal.

NOTE

This concludes 2nd IF alignments.

8.3.4 OUTPUT AMPLIFIER

The amplifier bandwidth is approximately from 0.4 MHz to 26 MHz, within 0.5 dB.

a. Apply about 150 mV 2nd IF signal (e.g. a Tuning signal) on pins 17/18.

b. A sweep generator replaces the band oscillator at pins 15/16 via connector P17. The signal level should be about 600 mV and the upper frequency of the sweep in the order of 100 MHz.

c. The display is connected to the exciter output or pins 13/12.

d. Align the two cores L1 and L2 to obtain a flat response and an attenuation outside the passband at 40 MHz of -40 dB or better:

L1 controls attenuation at 40 MHz,
L2 controls flatness to 26 MHz

e. Recheck L1 to obtain the best flatness while keeping the 40 MHz attenuation.

f. The gain of the amplifier is about 7, that is about 1 V rf out in 50 ohm for 150 mV input at pins 17/18.

8.3.5 CARRIER AND SSB GENERATOR

The filters of these subassemblies are tuned to 9 MHz and for maximum output.

a. Apply 9 MHz drive, about 900 mV, to the "carrier" input terminals of the circuit.

b. To open the modulator, apply a dc signal to the Carrier generator modulator, e.g. from the Tuning position of the Power switch. The normal dc level is 360 mV dc.

On the SSB Generator modulator, an audio signal of about 100 mV should be applied to terminals 18/17 to open the modulator.

c. Align T2 and T3 on the Carrier Generator and T2 on the SSB Generator, for maximum response at 9 MHz.

d. Balance of the modulators is treated in para. 8.4 as part of the RF Unit alignments.

8.4 RF UNIT ALIGNMENT

The RF Unit alignment operations cover basic adjustments, which are prerequisitions for the final adjustment of exciter output levels on different emissions.

8.4.1 CARRIER AND MODULATION ALIGNMENT

This procedure serves to set the rf signal levels from the two modulators for carrier signal and modulation signal, respectively, applied to the common amplifier on the Carrier Generator board.

a. Connect an rf vtvm to terminals 15/14 on the Carrier Generator and measure the carrier and modulation signal output.

b. On A3J emission, apply 1 kHz audio signal to the SSB Generator terminals 18/17. Signal level 100 mV terminal voltage. – Refer to para 8.5 for initial audio level adjustment.

c. The output signal from terminals 15/14 (Carr. Gen.) shall be 150 mV. Adjust pc board trimmer potentiometer R17 if required.

d. Switch to A1 emission, adjust potentiometer R9 "A1 CARR." to obtain a testmeter reading of 40 on position Carr.dc. This corresponds to about 360 mV dc at the Carrier Generator input terminals 22/21.

e. The A1 output signal at terminals 15/14 shall be 140 mV. Adjust pc board trimmer potentiometer R13 if required.

f. Repeat steps b. through e. to compensate for possible trimmer potentiometer interaction on signal levels.

NOTE

This concludes carrier/modulation adjustments on the RF Unit.

8.4.2 AMPLIFICATION ADJUSTMENT

a. Terminate the exciter in 50 ohm load and with an rf vtvm connected to read output level.

b. Operate on the 8 MHz band, emission A1. Use same input as in para. 8.4.1 above, i.e. Testmeter to read 40 on CARR. DC, and Carrier Generator output signal 140 mV.

c. Adjust the gain trimmer on the 2nd IF Amplifier to obtain 1100 mV at the exciter output.

NOTE

This concludes the adjustment of amplification on the RF Unit.

8.4.3 MODULATOR BALANCE

The procedure to balance the two modulators for minimum carrier leakage is described below. It is necessary to use a selective voltmeter or a receiver, tuned to 9 MHz, as indicator of the result obtained.

a. Before any balance operations are tried, check the 9 MHz frequency with a counter (refer to para 8.2.1), and adjust the frequency if more than ±2 Hz off 9 MHz.

b. Select emission type A1. Connect the selective voltmeter to the 9 MHz output signal on terminals 15/14 (Carrier Generator) and tone to 9 MHz.

c. Turn potentiometer R9 A1 CARR. to zero.

d. On the Carrier Generator, align potentiometer R5 and trimmer capacitor C3 to obtain a deep minimum of carrier signal (more than 50 dB below the A1 level). Due to interaction, the adjustment cycle must be repeated several times, to be sure that the best minimum has been obtained.

e. Repeat the balance procedure on the SSB Modulator, with no audio signal in (e.g. set the emission switch on FS). The minimum shall be at least 50 dB below the A1 signal level.

f. Recheck the balance of the Carrier Generator modulator, and then once more the SSB Modulator balance.

g. Select A1, and reset the A1 CARR. potentiometer to read 40 on testmeter pos. CARR. DC.

h. Replace the cover over the RF Unit assembly.

NOTE

This concludes the modulator carrier balance.

8.5 EXCITER FINAL ADJUSTMENT

8.5.1 CARRIER AND MODULATION LEVELS

a. Apply 250 mV 1 kHz to the microphone input terminals. – Generator resistance should be less than 150 ohm to energize the microphone relay.

b. Set potentiometer MICR. (R1) about 50% to deliver 100 mV at pin 5 AF.

c. Adjust AF LEVEL (R3) to obtain 1500 mV on pin 13 AF.

d. On A1, adjust A1 CARR (R9) to read 40 divisions on the testmeter pos. CARR DC.

e. Check that the output over 19/20 2nd IF is again 140 mV (cf 8.4.1 step e.).

f. Select A3J and adjust A3J MOD (R12) to 100 mV audio on pins 18/17 SSB.

g. Check that the output over 19/20 2nd IF is again 150 mV (cf 8.4.1 step c.).

h. Select A3H, adjust A3H/A CARR (R16) for 26 divisions on testmeter pos. CARR DC.

i. Adjust A3H modulation to 50 mV across pins 18/17 SSB, from potentiometer R18, A3H MOD.

j. Select A2H, adjust TONE (R11) to 50 mV across pins 18/17 SSB.

k. Check – preferably on a spectrum analyzer – that the A3H carrier is about 2 dB higher than the sideband. On an oscilloscope, make sure that the apparent modulation factor is between 80 to 90% (reduce the modulation amplitude to demonstrate that the carrier is the highest component).

l. Select FS, apply 780 mV 1.7 kHz to the FS input terminals. Adjust control FS (R21) to 140 mV across pins 19/20 2nd IF.

m. Select A1, turn potentiometer R8 2nd IF to zero (counterclockwise). Measure the rf signal across R8 – to be at least 200 mV.

n. Measure the output voltage of the exciter across the 50 ohm termination, emission A1. Adjust R8 2nd IF to read 1100 mV rf on 8.5 MHz.

o. Set the exciter on TUNE and adjust the output voltage to 600 mV with control R14, TUNE CARR.

NOTE

This concludes the carrier and modulation adjustments.

8.5.2 VOX ADJUSTMENT AND MICROPHONE LEVEL

The VOX circuit is to be given a release time of about 250 ms, controlled by potentiometer R10 on the pc board.

The actual sensitivity requirements of the VOX and audio circuits varies with the microphone characteristic and ambient noise level. For a preliminary adjustment, both potentiometers MICR. (R1) and VOX (R5) should be left in mid position.

8.5.3 OVERALL CHECK

To finalize, check the exciter on all bands and on different types of emission, and compare results with the testmeter readings logged in table 5.2, chapter 5.

8.6 A1 EXCITER ADJUSTMENT

8.6.1 OSCILLATOR ALIGNMENT & OUTPUT

a. Align the corresponding coils of the different bands for maximum output. Use these frequencies (crystals) in the centre of the telegraphy bands: 4.2, 6.3, 8.35, 12.5, 16.7, 22.2 and 25.1 MHz.

b. Set the output voltage on 12.5 MHz – from the exciter when terminated with 50 ohm – to 1100 mV rf, adjusting gain control R66, SET LEVEL.

c. Check that the output voltage over the bands is 1100 ±300 mV rf.

8.6.2 TUNE LEVEL

a. Set the exciter on TUNE and read the rf output voltage in 50 ohm termination.

b. Adjust potentiometer R59, TUNE LEVEL, to obtain 600 mV rf over the load.

NOTE

This concludes the adjustments of the HF A1 exciter.

8.7 MF EXCITER ADJUSTMENT

8.7.1 MF OSCILLATOR

a. Connect an electronic counter to pin 8 Card U2.

b. Operate all channels on A1 and A2H. Check the output frequency – note that A2H frequencies are 500 Hz above the assigned frequency of the channel.

8.7.2 MF MODULATOR

a. Place the MF Modulator card (U1) in the service card for access.

b. Operate 468 kHz, A1, and measure the rf volts from R3, CARR AMPL, wiper to ground.

c. Adjust R3 to read 20 mV rf on the meter.

d. Connect an oscilloscope across the terminated output of the exciter (50 ohm).

e. Select A2H and balance the modulator by R5, BAL. Balance for best symmetry, with a minimum of envelope distortion.

f. The nominal output level on A2H is 2.0 V peak-to-peak, as set by the TONE LEVEL (R11) control on the 500 Hz oscillator (U4). At the same time adjust the frequency to 500 Hz by potentiometer R4 on the oscillator card.

g. The nominal A1 output is to be 600 mV, set by R4, A1 CARR, on card U2 MF Control.

8.7.3 TUNE LEVEL

a. Using the same set-up as in 8.7.2, set the MF exciter on TUNE.

b. Read the output voltage across 50 ohm. Set to 600 mV using card U2 potentiometer R6, TUNE CARR.

NOTE

This concludes the adjustments of the MF Exciter.

CHAPTER 9

PARTS LISTS

9.1 EXCITER B22130 0000 Main Frame

C4	Capacitor, mica	560 pF	5 %	300 V	6200 0161
C5-7	Capacitor, mplfo	100 nF	20 %	100 V	6200 3764
F1,2	Fuse, cartridge	630 mA slow,5x20			8300 0264
K1,2	Relay	3 pole co, 24 V			6800 0196
L1-6	Choke, VHF				4800 0601
L10-17	Choke, rf	100 uH	5 %		6600 0124
L20-53	Choke, rf	100 uH	5 %		6600 0124
MT1	Meter	0-100 uA			7500 0199
O1	Crystal oven				6900 0006
P4,7-9	Connector, coax	L604/S/Ni			8600 0552
P5,15	Connector, coax	L734/P/Ni			8600 0362
P6	n.a.				
P10,12-14	Term. board				8700 0327
P11	Connector, male				8600 1553
P206	Connector, coax	L604/S/Ni			8600 0552
P207	Connector, male				8600 1268
P208	Connector, male	47 way			8600 1541
P209	Connector, male	23 way			8600 1549
P210	Connector, female	23 way			8600 1511
P211	Connector, female				8600 1552
P212	Connector, male	23 way			8600 1548
P216	Connector, female	12 way			8600 0442
P220,221	Term. board				8700 0327
R1	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R2-12	Resistor, carbon	330 ohm	5 %	0.50 W	6000 0331
R17	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R18	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R19	Resistor, carbon	1.2 kohm	5 %	0.12 W	6000 6487
R20	Resistor, carbon	150 ohm	5 %	0.12 W	6000 5277
R21	n.a.				
R22-24	n.a.				
R25	Resistor, carbon	68 ohm	5 %	0.12 W	6000 5519
R26	Resistor, w-w	220 ohm	5 %	2 W	6000 8446

EXCITER Main Frame, continued

SL1-19	Lamp, incand	24 V 42 mA socket W2x4.6	8200 0212
S1	Switch, push button		8400 1038
S2	Switch, push button		8400 1039
S3	Switch, push button		8400 1074
S4	Switch, rotary		8400 1044
S5	Switch, rotary		8400 1043
S6	Switch, rotary		8400 1045
S7	Switch, rotary		8400 1046
S8	Switch, rotary		8400 1047
S9	Switch, rotary		8400 1056
S10	Switch, rotary		8400 1057
S11	Switch, rotary		8400 1048
S12,13	See 9.1.1		
S14	Switch, push button		8400 1030
TL1	Telephone receiver		9200 7257
T1	Transformer		A51130 1153 4
U1	Switch Unit	9.1.1	B22130 3020
X1	Crystal, quartz	9 MHz	7400 0220
Z1-10	Diode, si	1N645	7800 1020
Z11	Diode, ge	AAZ18	7800 0031

9.1.1 SWITCH UNIT B22130 3020

C1	Capacitor, mplfo	3.3 uF	10 %	100 V	6200 6108
C2	Capacitor, ellyt	10 uF	-10+100%	63 V	6300 0961
C3	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
K1	Relay	2 pole co, 24 V			6800 0452
K2	Relay	6 pole co, 24 V			6800 0446
K3	Relay	4 pole co, 24 V			6800 0313
R1	Potentiometer, trimmer	100 ohm	20 %	0.15 W	6100 0152
R2	Resistor, carbon	33 ohm	5 %	0.12 W	6000 5289
R3,5,9 11,12,14,16,18,21	Potentiometer, trimmer	1 kohm	20 %	0.15 W	6100 0153
R4	Resistor, carbon	56 ohm	5 %	0.12 W	6000 5279
R6,10	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R7,8,37	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R13,15,23 24,36	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R17,22	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R19	Resistor, carbon	390 ohm	5 %	0.12 W	6000 5523
R20	n.a.				
R25	Resistor, carbon	8.2 kohm	5 %	0.12 W	6000 5323
R26-35	Resistor, carbon	120 ohm	5 %	0.12 W	6000 6156
S12	Switch, push button				8400 1041
S13	Switch, push button				8400 1042
SL1-10	Lamp incand	24 V 42 mA W2x4.6			8200 0212
Z3-17,19-21	Diode, si	1N645			7800 1020
Z18	Thyristor	TIC44			7800 1361

9.2 EXCITER POWER SUPPLY B22130 3020

C1	Capacitor, ellyt	4700 uF	-10+50 %	63 V	6300 0509
C2	Capacitor, ellyt	4700 uF	-10+50 %	25 V	6300 0297
C3	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C4	Capacitor, ellyt	4.7 uF	-10+100%	63 V	6300 0808
C5,10	Capacitor, cer	1 nF	20 %	400 V	6200 6298
C6,9	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C7,8	Cpacitor, ellyt	47 uF	-10+100%	40 V	6300 0824
IC1	Integrated circuit	LM309K			8100 0442
R1	Resistor, w-w	4.7 ohm	10 %	2 W	6000 2237
R2,8	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R3	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R4,20,29,30	Resistor, carbon	470 kohm	5 %	0.12 W	6000 5877
R5,6,9,10	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R7,14,22,34	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R11	Resistor, carbon	220 ohm	5 %	0.50 W	6000 0950
R12,13	Resistor, carbon	12 kohm	5 %	0.12 W	6000 5324
R15,18	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R16	Potentiometer, trimmer	500 ohm	20 %	0.15 W	6100 0529
R17	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322
R19	Resistor, w-w	1 ohm	5 %	5 W	6000 0739
R21	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R23	Potentiometer, trimmer	1 kohm	20 %	0.15 W	6100 0153
R24	Resistor, carbon	820 ohm	5 %	0.12 W	6000 6250
R25	Resistor, carbon	39 kohm	5 %	0.12 W	6000 5527
R26	Resistor, carbon	68 ohm	5 %	0.50 W	6000 0783
R27	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R28	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304
R30	Resistor, carbon	330 ohm	5 %	0.12 W	6000 5290
R31	Resistor, carbon	10 ohm	5 %	0.12 W	6000 6486
R33	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
Y1	Transistor, si npn	MJ1001			8000 0649
Y2	Transistor, si npn	2N3054			8000 0436
Y3,5,7,8,10	Transistor, si pnp	2N2905A			8000 0360
Y4,6,9	Transistor, si npn	2N2219A			8000 0389
Z1,2	Rect., bridge	B80C3200-2200			7800 1455
Z3,4	Diode, si	1N645			7800 1020
Z5	Diode, zener	1N3029B, 24 V 5 %			7800 0042
Z6,7,8	Diode, zener	1N753A, 6.2 V 5 %			7800 0592
Z9	Diode, zener	1N965B, 15 V 5 %			7800 1151

9.3 REFERENCE OSCILLATOR B21140 3130

C1	Capacitor, trimmer	2 - 25 pF			6400 0121
C2	Capacitor, trimmer	1.7 - 9 pF			6400 0122
C3	Capacitor, mica	22 pF	5 %	500 V	6200 0556
C4	Capacitor, mica	680 pF	5 %	300 V	6200 0567
C5	Capacitor, cer	47 pF	5 %	400 V	6200 5127
C6	Capacitor, mica	56 pF	5 %	500 V	6200 0247
C7,9-14, 16,18	Capacitor, mplfo	100 nF	20 %	250 V	6200 0569
C8	Capacitor, mica	560 pF	5 %	300 V	6200 0161
C15	Capacitor, cer	3.3 nF	-20+80 %	500 V	6200 3191
C17	Capacitor, ellyt	4.7 uF	-10+50 %	63 V	6300 0236
C19	Capacitor, ellyt	47 uF	-10+100%	40 V	6300 0824
L1	Choke, VHF				6600 0156
L2	Choke, rf	100 uH	10 %		6600 0236
R1	Resistor, carbon	33 kohm	5 %	0.25 W	6000 2841
R2	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R3,24,26	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R4,9,17	Resistor, carbon	470 ohm	5 %	0.25 W	6000 3087
R5,11,22	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R6	Resistor, carbon	47 ohm	5 %	0.25 W	6000 3492
R7	Resistor, carbon	2.7 kohm	5 %	0.25 W	6000 3104
R8	Resistor, carbon	680 ohm	5 %	0.25 W	6000 3088
R10	Resistor, carbon	120 ohm	5 %	0.25 W	6000 2844
R12	Resistor, carbon	4.7 kohm	5 %	0.25 W	6000 2529
R13,21	Resistor, carbon	220 ohm	5 %	0.25 W	6000 3110
R14	Resistor, carbon	8.2 kohm	5 %	0.25 W	6000 2778
R15	Resistor, carbon	47 kohm	5 %	0.25 W	6000 3099
R16	Resistor, carbon	27 ohm	5 %	0.25 W	6000 3775
R18	Resistor, carbon	150 kohm	5 %	0.33 W	6000 1001
R19,23	Resistor, carbon	22 kohm	5 %	0.25 W	6000 3494
R20	Resistor, carbon	100 kohm	5 %	0.25 W	6000 3498
R25	Resistor, carbon	1.8 kohm	5 %	0.25 W	6000 2535
T1	Transformer				B21140 5131
Y1-4,6,7	Transistor, si npn	2N2222A			8000 0405
Y5	Transistor, si npn	2N2219A			8000 0389
Z1-2	Diode, ge	AAZ18			7800 0031

9.3.1 OVEN CONTROL B21140 3400

C1,2,5,6,7	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C3	Capacitor, mplfo	22 nF	10 %	250 V	6200 6226
C4	Capacitor, ellyt	47 uF	-10+100%	63 V	6300 1038
L1	Choke, VHF				6600 0156
R1,3	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R2	Resistor, w-w	2.2 kohm	5 %	2 W	6000 7547
R4	Resistor, carbon	820 ohm	5 %	0.25 W	6000 2849
R5,6	Resistor, carbon	33 ohm	5 %	0.25 W	6000 2779
Y1	Transistor, si npn	2N2222A			8000 0405
Z1	Rect., bridge	B250C1000Si			7800 1032
Z2,4	Diode, si	1N645			7800 1020
Z3	Thyristor	CRS 1/05AF			7800 1190

9.4 SYNTHESIZER OSCILLATOR B22130 3201

C1-19	Capacitor, cer f-th	1 nF	-20+80 %	500 V	6200 4881
P1,2	Connector, coax.	L604/S/CD			8600 0421
P12	Connector, male	23 way			8600 1549
U1	PC board assembly				B22130 3210

9.4.1 SYNTHESIZER PC BOARD Assembly B22130 3210

C1,2,4,10 13,25	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C3	Capacitor, trimmer	10-60 pF			6400 0097
C5,6	Capacitor, mica	330 pF	2 %	500 V	6200 5967
C7,8,11,21 23,24,30,33	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C9	Capacitor, cer	1 nF	-20+80 %	40 V	6200 5355
C12	Capacitor, ellyt	47 uF	-10+50 %	25 V	6300 0216

SYNTHESIZER PC BOARD, continued

C14,16	Capacitor, mica	680 pF	5 %	300 V	6200 0567
C15	Capacitor, mica	470 pF	2 %	500 V	6200 5408
C17	Capacitor, mica	68 pF	2 %	500 V	6200 5404
C18	Capacitor, mica	47 pF	2 %	500 V	6200 5403
C19,22,32, 34	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C20	Capacitor, mica	150 pF	2 %	500 V	6200 5405
C26,31	Capacitor, tantal	150 uF	20 %	6 V	6300 0272
C27,28,29	Capacitor, tantal	10 uF	20 %	20 V	6300 0270
C35	Capacitor, mica	100 pF	2 %	500 V	6200 0130
IC1,2	Integr. circuit	SN7474			8100 0062
IC3-7,26	Integr. circuit	SN7473			8100 0061
IC8-11	Integr. circuit.	SN7472			8100 0060
IC12,13	Integr. circuit	SN7430			8100 0052
IC14	Integr. circuit	SN7410			8100 0050
IC15-19	Integr. circuit	SN7400			8100 0047
IC20	Integr. circuit	SN7442			8100 0455
IC21-25	Integr. circuit	SN7490			8100 0066
L1,7,8	Choke, rf	3.3 uH	10 %		6600 0203
L2,3	Choke, vhf				6600 0146
L4	Choke, rf	22 uH	10 %		6600 0159
L5	Choke, rf	33 uH	10 %		6600 0191
L6	Choke, rf	10 uH	10 %		6600 0133
R1,3	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R2,4,5,6,17 19,46,50,54	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R7,11,22	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R8,14,15, 35,36	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5521
R9,12,24,26	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R10	Resistor, carbon	330 ohm	5 %	0.12 W	6000 5290
R13,20	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R16	Resistor, carbon	470 ohm	5 %	0.12 W	6000 5748
R18	Resistor, carbon	18 kohm	5 %	0.12 W	6000 5875
R21	Resistor, carbon	1.8 kohm	5 %	0.12 W	6000 5522
R23,25,27	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304
R28,61	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R30	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322

SYNTHESIZER PC BOARD Assembly, continued

R31,34	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R32	Resistor, carbon	6.8 kohm	5 %	0.12 W	6000 5292
R33	Resistor, carbon	680 ohm	5 %	0.12 W	6000 5524
R37	Resistor, carbon	56 kohm	5 %	0.12 W	6000 5295
R38,40	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R41	Resistor, carbon	27 ohm	5 %	0.12 W	6000 5753
R42-45,47, 48,49,51-53,55-57	Resistor, carbon	8.2 kohm	5 %	0.12 W	6000 5323
R58	Resistor, carbon	3.9 kohm	5 %	0.12 W	6000 5647
R59	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R60	Resistor, carbon	820 ohm	5 %	0.12 W	6000 6250
Y1,2,4	Transistor, si pnp	2N2907A			8000 0390
Y3,5,6,9, 10,13-15,18	Transistor, si npn	2N2222A			8000 0405
Y11,12	Transistor, si pnp	2N2905A			8000 0360
Y16	Transistor, fet	2N4393			8000 0560
Z1,2	Diode, si	BA182			7800 1165
Z3,4	Diode, varicap	MV1650			7800 1280
Z5,8-13	Diode, si	1N4148			7800 0594
Z6,7	Diode, zener	1N758A, 10 V 5%			7800 0893
Z14	Diode, ge	AAZ18			7800 0031

9.5 AF UNIT B22130 3120

C1	Capacitor, cer	10 nF	-20+80 %	40 V	6200 4676
C2,5,6,9,15 13,19,21,26	Capacitor, ellyt	22 uF	-10+100%	40 V	6300 0870
C3,7,11,14,	Capacitor, cer	1 nF	-20+80 %	40 V	6200 5355
C4	Capacitor, mica	220 pF	5 %	500 V	6200 0132
C8	Capacitor, tantal	1 uF	20 %	35 V	6300 0863
C10	Capacitor, ellyt	4.7 uF	-10+100%	63 V	6300 0808
C12	Capacitor, mica	560 pF	5 %	300 V	6200 0161
C16,18	Capacitor, mplfo	68 nF	10 %	250 V	6200 6095
C17	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C22,23	Capacitor, mplfo	47 nF	10 %	250 V	6200 6094
C24	Capacitor, mplfo	470 nF	10 %	100 V	6200 6089
C25	Capacitor, ellyt	47 uF	-10+100%	40 V	6300 0824
C27-29	n.a.				
C30,31	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
L1,4	Coil				B21142 5041
L2,3	Coil				B21142 5045

AF UNIT, continued

R1,8,25,31	Resistor, carbon	120 ohm	5 %	0.12 W	6000 6156
R2	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R3	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R4	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R5,29	Resistor, carbon	3.3 kohm	5 %	0.12 W	6000 5291
R6	Resistor, carbon	680 ohm	5 %	0.12 W	6000 3088
R7,17	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R9,11,12, 14,21,30,34	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R10,15,42	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5520
R13	Resistor, carbon	330 kohm	5 %	0.12 W	6000 4834
R16,20,26	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R18,44	Resistor, carbon	100 kohm	5 %	0.25 W	6000 3498
R19,35,36, 40,41	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R221	Resistor, carbon	680 ohm	5 %	0.12 W	6000 5524
R23	Resistor, carbon	330 ohm	5 %	0.12 W	6000 5290
R24	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322
R27	Resistor, carbon selected value	1.5 kohm	5 %	0.12 W	6000 5791
R28,49	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R32,33	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R37,39	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R38	Potentiometer, carbon	10 kohm	20 %	0.15 W	6100 0148
R43	Resistor, carbon	39 kohm	5 %	0.12 W	6000 5527
R45	Resistor, carbon	1.2 kohm	5 %	0.25 W	6000 3103
R46	Resistor, carbon	100 ohm	5 %	0.25 W	6000 2534
R47	n.a.				
R48	Resistor, carbon	3.9 kohm	5 %	0.12 W	6000 5647
T1	Transformer				6600 0026
T2	Transformer				SU30421A8
Y1,2	Transistor, si pnp	BC327			8000 0622
Y3-6,8-12	Transistor, si pnp	2N2905A			8000 0360
Y7	Transistor, si npn	BC107B			8000 0373
Y13-15	Transistor, si npn	2N2222A			8000 0405
Z1-7	Diode, si	1N4148			7800 0594

9.6 BAND OSCILLATOR B21140 3120

C1-3	Capacitor, mica	18 pF	5 %	500 V	6200 0555
C4-5	Capacitor, mica	15 pF	5 %	500 V	6200 0131
C6	Capacitor, mica	12 pF	5 %	500 V	6200 0243
C7-8	Capacitor, mica	10 pF	5 %	500 V	6200 0242
C9-10	Capacitor, mica	5 pF	0.5 %	500 V	6200 0553
C11-17	Capacitor, mica	100 pF	5 %	500 V	6200 0130
C18-20	Capacitor, mica	47 pF	5 %	500 V	6200 0440
C21-23, 25-28	Capacitor, mplfo	22 nF	20 %	250 V	6200 1324
C24,30,31	Capacitor, mplfo	100 nF	20 %	250 V	6200 0569
C29	Capacitor, ellyt	4.7 uF	-10+50 %	63 V	6300 0236
C32	Capacitor, mica	820 pF	5 %	300 V	6200 0245
L1-10	Coil				B21140 5121
L11	Choke, rf	47 uH	5 %		6600 0181
R1-10	Resistor, carbon	2.7 kohm	5 %	0.25 W	6000 3104
R11-20,44	Resistor, carbon	8.2 kohm	5 %	0.25 W	6000 2778
R21-30, 37,46	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R31	Resistor, carbon	27 ohm	5 %	0.25 W	6000 3775
R32	Resistor, carbon	560 ohm	5 %	0.25 W	6000 2527
R33	Resistor, carbon	56 kohm	5 %	0.25 W	6000 3495
R34	Resistor, carbon	330 ohm	5 %	0.25 W	6000 2530
R35	Resistor, carbon	10 ohm	5 %	0.25 W	6000 3490
R36	Resistor, carbon	1.2 kohm	5 %	0.25 W	6000 3103
R38	Resistor, carbon	1.8 kohm	5 %	0.25 W	6000 2535
R39	Resistor, carbon	56 ohm	5 %	0.25 W	6000 3106
R40	Resistor, carbon	120 ohm	5 %	0.25 W	6000 2844
R41-42	Resistor, carbon	3.3 kohm	5 %	0.25 W	6000 3084
R43	Resistor, carbon	470 ohm	5 %	0.25 W	6000 3087
R45	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
T1-2	Transformer				B21140 5124
T3	Transformer				B21140 5127
X1	Quartz crystal	42.2 MHz			7400 0050
X2	Quartz crystal	43.2 MHz			7400 0051
X3	Quartz crystal	44.2 MHz			7400 0052
X4	Quartz crystal	45.2 MHz			7400 0053
X5	Quartz crystal	47.2 MHz			7400 0012

BAND OSCILLATOR, continued

X6	Quartz crystal	49.2 MHz			7400 0013
X7	Quartz crystal	53.2 MHz			7400 0014
X8	Quartz crystal	57.2 MHz			7400 0054
X9	Quartz crystal	63.2 MHz			7400 0055
X10	Quartz crystal	66.2 MHz			7400 0172
Y1-10,13,15	Transistor, si npn	2N2222A			8000 0405
Y11-12	Transistor, si npn	2N2219A			8000 0389
Y14	Transistor, si pnp	2N2905A			8000 0360
Z1-13	Diode, ge	OA47			7800 0649
Z14-20	Diode, si	1N4148			7800 0594

9.7 RF UNIT Chassis B21141 0000

C1-4	Capacitor, cer f-th	5 nF	-20+50 %	500 V	6200 3002
C30,31	Capacitor, plfo	120 pF	5 %	63 V	6200 5642
C32	Capacitor, plfo	270 pF	5 %	63 V	6200 5642
L30	Choke, rf	0.15 uH	10 %		6600 0197
P14-15, 17-19	Connector, coax male	1 pole			8600 0362
P16	Connector, male	12 pole			8600 1139
P20	Terminal board				8700 0214
P21	Terminal board				8700 0226
T1	Transformer				B21141 5117
U1	Carrier Generator				B20112 3220
U2	SSB Generator				B20102 3230
U3	1st IF Amplifier				B21141 3130
U4	2nd IF Amplifier				B21141 3120
U5	Output Amplifier				B21141 3110
U6	3rd IF Amplifier				B21141 3150

9.7.1 CARRIER GENERATOR B20112 3220

C1-6, 8-12,14	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C2	Capacitor, mica	33 pF	5 %	500 V	6200 0439
C3	Capacitor, trimmer	25 pF max			6400 0022
C4-5	Capacitor, mica	820 pF	5 %	300 V	6200 0245
C7	Capacitor, mica	82 pF	5 %	500 V	6200 2158
C13,16	Capacitor, mplfo	100 nF	20 %	250 V	6200 0569
C15	Capacitor, mica	120 pF	5 %	500 V	6200 0246
L1-13	Choke, rf	100 uH	10 %		6600 0236
R1	Resistor, carbon	680 ohm	5 %	0.25 W	6000 0777
R2-3,14	Resistor, carbon	470 ohm	5 %	0.25 W	6000 0775
R4	Resistor, carbon	100 ohm	5 %	0.25 W	6000 0772
R5	Potentiometer, carbon	100 ohm	10 %	0.25 W	6100 0139
R6-7	Resistor, carbon	10 kohm	5 %	0.25 W	6000 0770
R8,20	Resistor, carbon	470 ohm	5 %	0.25 W	6000 0798
R9	Resistor, carbon	27 ohm	5 %	0.25 W	6000 0906
R10,16	Resistor, carbon	120 ohm	5 %	0.25 W	6000 0910
R11	Resistor, carbon	47 ohm	5 %	0.25 W	6000 0766
R12	Resistor, carbon	2.7 kohm	5 %	0.25 W	6000 0793
R13	Potentiometer, carbon	1 kohm lin		0.15 W	6100 0153
R14	Resistor, carbon	470 ohm	5 %	0.25 W	6000 0775
R15,22	Resistor, carbon	560 ohm	5 %	0.25 W	6000 0760
R17	Potentiometer, carbon	100 ohm lin		0.15 W	6100 0152
R18	Resistor, carbon	15 kohm	5 %	0.25 W	6000 0800
R19	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 0763
R21	Resistor, carbon	15 ohm	5 %	0.25 W	6000 0916
T1	Transformer				B20102 5221
T2	Transformer				B20102 5222
T3	Transformer				B20102 5223
Y1-2	Transistor, si npn	2N2219A			8000 0389
Y3	Transistor, si npn	2N2222A			8000 0405
Z1	Diode, ge, quartet	AAZ14			7800 0642

9.7.2 SSB GENERATOR B20102 3230

C1,6,8-14,	Capacitor, cer	10 nF	10 %	250 V	6200 0586
C2	Capacitor, mica	33 pF	5 %	500 V	6200 0439
C3	Capacitor, trimmer	25 pF max.			6400 0022
C4-5	Capacitor, mica	820 pF	5 %	300 V	6200 0245
C7	Capacitor, mica	82 pF	5 %	500 V	6200 2158
L1-3	Choke, rf	100 uH	10 %		6600 0236
R1	Resistor, carbon	680 ohm	5 %	0.25 W	6000 0777
R2,3,12	Resistor, carbon	470 ohm	5 %	0.25 W	6000 0775
R4	Resistor, carbon	100 ohm	5 %	0.25 W	6000 0772
R5	Potentiometer, carbon	100 ohm lin	10 %	0.25 W	6100 0139
R6	Resistor, carbon	6.8 kohm	5 %	0.25 W	6000 0169
R7,15	Resistor, carbon	10 kohm	5 %	0.25 W	6000 0770
R8	Resistor, carbon	22 kohm	5 %	0.25 W	6000 0682
R9	Resistor, carbon	82 ohm	5 %	0.25 W	6000 0909
R10	Resistor, carbon	8.2 ohm	5 %	0.25 W	6000 3751
R11	Resistor, carbon	560 ohm	5 %	0.25 W	6000 0760
R13	Resistor, carbon	220 ohm	5 %	0.25 W	6000 0175
R14	Resistor, carbon	180 ohm	5 %	0.25 W	6000 0918
R16	Resistor, carbon	27 kohm	5 %	0.25 W	6000 0172
R17	Resistor, carbon	680 ohm	5 %	0.25 W	6000 0951
T1	Transformer				B20102 5221
T2	Transformer				B20102 5222
XF1	Crystal Filter	SU 30187B, 9 MHz LSB			9200 6989
Y1-3	Transistor, si npn	2N2219A			8000 0389
Z1	Diode, ge, quartet	AAZ14			7800 0642

9.7.3 1st IF AMPLIFIER B21141 3130

C1	Capacitor, mica	180 pF	5 %	500 V	6200 0244
C2	Capacitor, mica	22 pF	5 %	500 V	6200 0556
C3	Capacitor, mica	5 pF	0.5 pF	500 V	6200 2152
C4,8,10	Capacitor, mica	100 pF	5 %	500 V	6200 0130
C5	Capacitor, mica	5 pF	0.5 pF	500 V	6200 2152
C6	Capacitor, mica	150 pF	5 %	500 V	6200 0443
C7	Capacitor, mica	5 pF	0.5 pF	500 V	6200 2152
C9	Capacitor, mica	5 pF	0.5 pF	500 V	6200 2152
C11-12, 18,19	Capacitor, mplfo	22 nF	20 %	250 V	6200 1324
C13,17	Capacitor, mica	47 pF	5 %	500 V	6200 0440
C14	Capacitor, mica	220 pF	5 %	500 V	6200 0132
C15	Capacitor, mica	5 pF	0.5 pF	500 V	6200 2152
C16	Capacitor, ellyt	4.7 uF	-10+50 %	40 V	6300 0236
C20-22	Capacitor, mplfo	100 nF	20 %	250 V	6200 0569
L1-5	Coils, assembled in T4 - T8				
L6,9	Choke, ferrite				4800 0250
L7	Coil				B21141 5133
L8	Choke. rf	100 uH	10 %		6600 0236
R1	Resistor, carbon	22 ohm	5 %	0.25 W	6000 3491
R2	Resistor, carbon	820 ohm	5 %	0.25 W	6000 2849
R3-5	Resistor, carbon	6.8 kohm	5 %	0.25 W	6000 3100
R6	Resistor, carbon	220 ohm	5 %	0.25 W	6000 3110
R7	Resistor, carbon	22 kohm	5 %	0.25 W	6000 3494
R8	Resistor, carbon	8.2 kohm	5 %	0.25 W	6000 2778
R9,11	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846
R10	Resistor, carbon	680 ohm	5 %	0.25 W	6000 3088
R12	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R13	Resistor, carbon	39 ohm	5 %	0.25 W	6000 4258
R14	Resistor, carbon	47 ohm	5 %	0.25 W	6000 3492
R15	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R16	Resistor, carbon	27 ohm	5 %	0.25 W	6000 3775
T1	Transformer				B21141 5136
T2	Transformer				B21141 5005
T3	Transformer				B21141 5117
T4-8	Filter assembly				B21141 5131
T9	Transformer				B21141 5138

1st IF AMPLIFIER, continued

Y1-2	Transistor, si npn	2N2222A	8000 0405
Y3	Transistor, si npn	2N1613	8000 0131
Y4	Transistor, si pnp	2N2905A	8000 0360
Y5	Transistor, si npn	2N2219A	8000 0389
Z1-6	Diode, ge	AAZ18	7800 0031

9.7.4 2nd IF AMPLIFIER B21141 3120

C1-2	Capacitor, mica	330 pF	5 %	550 V	6200 1396
C3	Capacitor, mica	150 pF	5 %	500 V	6200 0443
C4	Capacitor, mica	82 pF	5 %	500 V	6200 0442
C5	Capacitor, mica	68 pF	5 %	500 V	6200 0441
C6	Capacitor, mica	4.7 pF	0.5 pF	500 V	6200 3202
C7	Capacitor, mica	100 pF	5 %	500 V	6200 0130
C8	Capacitor, mica	82 pF	5 %	500 V	6200 0442
C9	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C10	Capacitor, mplfo	0.1 uF	20 %	250 V	6200 0569
C11	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C12	Capacitor, mica	56 pF	5 %	500 V	6200 0247
C13	Capacitor, mica	5.6 pF	0.5 pF	500 V	6200 5772
C14	Capacitor, mica	100 pF	5 %	500 V	6200 0130
L1-3	Coil				B21141 5121
L4	Coil				B21141 5123
L5	Choke, rf	100 uH	10 %		6600 0236
L6-7	Choke, ferrite				4800 0250
R1	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R2-3	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R4	Resistor, carbon	1.8 kohm	5 %	0.25 W	6000 2535
R5	Resistor, carbon	56 ohm	5 %	0.25 W	6000 3106
R6	Resistor, carbon	330 ohm	5 %	0.25 W	6000 2530
R7	Resistor, carbon	47 ohm	5 %	0.25 W	6000 3492
R8	Potentiometer, carbon	100 ohm lin		0.15 W	6100 0152
R9	Resistor, carbon	33 ohm	5 %	0.25 W	6000 2779

2nd IF AMPLIFIER, continued

T1	Transformer				B21141 5125
T2	Transformer				B21141 5005
T3	Transformer				B21141 5001
T4	Transformer				B21141 5127
Y1-2	Transistor, si npn	2N2222A			8000 0405
Z1-4	Diode, si	1N4148			7800 0594

9.7.5 OUTPUT AMPLIFIER B21141 3110

C1	Capacitor, mica	12 pF	5 %	500 V	6200 0243
C2	Capacitor, mica	47 pF	5 %	500 V	6200 0440
C3	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C4	Capacitor, mica	8 pF	0.5 pF	500 V	6200 3184
C5-6	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C7-8	Capacitor, mplfo	0.1 uF	10 %	250 V	6200 0585
C9	Capacitor, mplfo	10 nF	20 %	250 V	6200 1181
C10	Capacitor, mica	68 pF	5 %	500 V	6200 0441
C11	Capacitor, ellyt	10 uF	-10+100 %	63 V	6300 0961
L1-2	Coil				B21141 5111
L3	Coil				B21141 5114
L4	Choke. rf	100 uH	10 %		6600 0236
R1	Resistor, carbon	82 ohm	5 %	0.25 W	6000 2743
R2	Resistor, carbon	33 ohm	5 %	0.12 W	6000 5289
R3	Resistor, carbon	270 ohm	5 %	0.25 W	6000 2939
R4	Resistor, carbon	82 ohm	5 %	0.25 W	6000 2743
R5	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R6	Resistor, carbon	15 kohm	5 %	0.25 W	6000 3086
R7	Resistor, carbon	820 ohm	5 %	0.25 W	6000 0765
R8	Resistor, carbon	27 ohm	5 %	0.25 W	6000 3775
R9-10	Resistor, carbon	22 ohm	5 %	0.25 W	6000 3491
R11	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R12	Resistor, carbon	150 ohm	5 %	0.25 W	6000 3493
R13	Resistor, carbon	560 ohm	5 %	0.25 W	6000 0760
R14	Resistor, carbon	150 ohm	5 %	0.25 W	6000 3493
R15	Resistor, carbon	330 ohm	5 %	0.25 W	6000 0681
R16	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846

OUTPUT AMPLIFIER, continued

R17-18	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R19	Resistor, carbon	820 ohm	5 %	0.25 W	6000 2849
R20	Resistor, carbon	82 ohm	5 %	0.25 W	6000 2743
R21	Resistor, carbon	820 ohm	5 %	0.25 W	6000 2849
R22	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R23	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
T1	Transformer				B21141 5005
T2	Transformer				B21141 5001
T3-4	Transformer				B21141 5117
T5	Transformer				B21141 5119
Y1	Transistor, si npn	2N2222A			8000 0405
Y2	Transistor, si npn	2N2219A			8000 0289
Y3	Transistor, si pnp	2N2905A			8000 0360
Y4-5	Transistor, si npn	2N2222A			8000 0405
Y6	Transistor, si pnp	2N2905A			8000 0360
Z1-4	Diode, si	FD700			7800 1293

9.7.6 3rd IF AMPLIFIER B21141 3150

C1,11,13, 15,17,23,25	Capacitor, mplfo	22 nF	20 %	250 V	6200 1324
C2-4,12, 16,20,26	Capacitor, mplfo	100 nF	20 %	250 V	6200 0569
C5	Capacitor, mica	82 pF	5 %	500 V	6200 0442
C6	Capacitor, mica	33 pF	5 %	500 V	6200 2156
C7	Capacitor, mica	27 pF	5 %	500 V	6200 3185
C8,10	Capacitor, mica	68 pF	5 %	500 V	6200 0441
C9	Capacitor, mica	8 pF	0.5 pF	500 V	6200 3184
C14	Capacitor, mica	330 pF	5 %	500 V	6200 1396
C18	Capacitor, mica	27 pF	5 %	500 V	6200 3185
C19	Capacitor, mica	3.9 pF	5 %	500 V	6200 3193
C21	Capacitor, mica	27 pF	5 %	500 V	6200 3185
C22	Capacitor, mica	33 pF	5 %	500 V	6200 2156
C24	Capacitor, mica	18 pF	5 %	500 V	6200 0555

3rd IF AMPLIFIER, continued

L1-2,5,6, 9,13,14	Choke, ferrite				4800 0250
L3	(in T4)				
L4	(in T5)				
L7	Coil				B21141 5155
L8,11,15	Choke. rf	100 uH	10 %		6600 0236
L10	(in T6)				
L12	(in T7)				
R1	Resistor, carbon	220 ohm	5 %	0.25 W	6000 3110
R2,17	Resistor, carbon	330 ohm	5 %	0.25 W	6000 2530
R3	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R4	Resistor, w-w	330 ohm	5 %	2 W	6000 7538
R5,8,14	Resistor, carbon	3.3 kohm	5 %	0.25 W	6000 3084
R6	Resistor, carbon	100 ohm	5 %	0.25 W	6000 2534
R7	Resistor, carbon	82 ohm	5 %	0.25 W	6000 2743
R9-10,15,16	Resistor, carbon	6.8 kohm	5 %	0.25 W	6000 3100
R11,23	Resistor, carbon	680 ohm	5 %	0.25 W	6000 3088
R12	Resistor, carbon	22 ohm	5 %	0.25 W	6000 3491
R13	Resistor, carbon	220 ohm	5 %	0.25 W	6000 0175
R18	Resistor, carbon	12 ohm	5 %	0.25 W	6000 3781
R19	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846
R20	Resistor, carbon	1.5 kohm	5 %	0.25 W	6000 3097
R21-22	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R24	Resistor, carbon	15 ohm	5 %	0.25 W	6000 4822
R25	Resistor, carbon	15 kohm	5 %	0.25 W	6000 3086
T1	Transformer				B21141 5005
T2	Transformer				B21141 5156
T3	Transformer				B21141 5117
T4,7	Filter Assembly				B21141 5152
T5	Filter Assembly				B21141 5151
T6	Filter Assembly				B21141 5154
T8	Transformer				B21141 5158
X1,4	Quartz crystal				7400 0016
X2-3	Quartz crystal				7400 0017
Y1,3-9	Transistor, si npn	2N2222A			8000 0405
Y2	Transistor, si pnp	2N2905A			8000 0360

3rd IF AMPLIFIER, continued

Z1,3-7	Diode, ge	AAZ18	7800 0031
Z2	Diode, si	1N5220	7800 1411

9.8 VOX AMPLIFIER B21140 3140

C1,7	Capacitor, mplfo	22 nF	20 %	250 V	6200 1324
C2,5	Capacitor, ellyt	4.7 uF	-10+50 %	63 V	6300 0236
C3,6	Capacitor, mplfo	470 uF	10 %	250 V	6200 2519
C4,8	Capacitor, ellyt	47 uF	-10+50 %	40 V	6300 0599
L1	Choke. rf	100 uH	10 %		6600 0236
R1,8	Resistor, carbon	680 ohm	5 %	0.25 W	6000 3088
R2	Resistor, carbon	3.3 kohm	5 %	0.25 W	6000 3084
R3,13,14	Resistor, carbon	22 kohm	5 %	0.25 W	6000 3494
R4	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R5	Resistor, carbon	56 ohm	5 %	0.25 W	6000 3106
R6,12	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R7,9	Resistor, carbon	220 ohm	5 %	0.25 W	6000 3110
R10	Potentiometer, carbon	10 kohm lin		0.15 W	6100 0207
R11	Resistor, carbon	6.8 kohm	5 %	0.25 W	6000 3100
R15	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846
Y1-3,5	Transistor, si pnp	2N2905A			8000 0360
Y4	Transistor, si npn	2N1613			8000 0131
Z1-5	Diode, si	1N645			7800 1020

9.9 ALARM SIGNAL GENERATOR B21142 3020

C1-2	Capacitor, tantal	4.7 uF	10 %	35 V	6300 0695
C3-4	Capacitor, mplfo	22 nF	5 %	250 V	6200 6827
C5	Capacitor, tantal	150 uF	10 %	15 V	6300 0489
C6	Capacitor, mplfo	10 nF	20 %	250 V	6200 1881
C7	Capacitor, ellyt	47 uF	-10+50 %	40 V	6300 0599
R1,8,14,21	Resistor, carbon	2.2 kohm	5 %	0.25 W	6000 2526
R2,7,15, 20,24	Resistor, carbon	22 kohm	5 %	0.25 W	6000 3494
R3,6,16,19, 25,26	Resistor, carbon	5.6 kohm	5 %	0.25 W	6000 2846
R4-5	Resistor, carbon	68 kohm	5 %	0.25 W	6000 3496
R9	Resistor, carbon	10 kohm	5 %	0.25 W	6000 3085
R10	Resistor, metfilm	3.3 kohm	1 %	0.12 W	6000 4643
R11-12	Potentiometer, carbon	1 kohm lin		0.15 W	6100 0153
R13	Resistor, metfilm	10 kohm	1 %	0.12 W	6000 4759
R17-18	Resistor, metfilm	15 kohm	1 %	0.12 W	6000 5207
R22	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R23	Resistor, carbon	560 kohm	5 %	0.33 W	6000 1005
Y1-2,4,5, 6,9,10	Transistor, si npn	2N1613			8000 0131
Y3,7,8	Transistor, si pnp	2N2905A			8000 0360
Z1,4,5,8	Diode, ge	AAZ18			7800 0031
Z2-3,6,7	Diode, si	1N4148			7800 0594
Z6-7	Diode, si	1N4148			7800 0594
Z9	Diode, si	1N645			7800 1020
Z10	Diode, zener	1N757A, 9.1 V 5 %			7800 0736

9.10.1 MF OSCILLATOR B22100 3120 (U3)

C1,2,4-6	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C3	Capacitor, cer	1 nF	20 %	400 V	6200 6471
C7	Capacitor, plfo	1.5 nF	25 %	63 V	6200 6892
IC1	Intergrated circuit	SN6400			8100 0105
L1-2	Choke. rf	68 uH	5 %		6600 0281
R1-7,17	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R8-14	Resistor, carbon	1.8 kohm	5 %	0.12 W	6000 5522
R15,16	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R18-22,24, 25,29	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R23,26	n.a.				
R27	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R28	Resistor, carbon	390 ohm	5 %	0.12 W	6000 5523
X1	Crystal, quartz	4100 kHz			7400 0294
	General Spec. is B03074 1045/frequency				
X2	Crystal, quartz	4250 kHz			7400 0294
X3	Crystal, quartz	4540 kHz			7400 0298
X4	Crystal, quartz	4680 kHz			7400 0300
X5	Crystal, quartz	4800 kHz			7400 0302
X6	Crystal, quartz	5000 kHz			7400 0304
X7	Crystal, quartz	5120 kHz			7400 0306
X8	Crystal, quartz	4105 kHz			7400 0295
X9	Crystal, quartz	4255 kHz			7400 0297
X10	Crystal, quartz	4545 kHz			7400 0299
X11	Crystal, quartz	4685 kHz			7400 0301
X12	Crystal, quartz	4805 kHz			7400 0303
X13	Crystal, quartz	5005 kHz			7400 0305
X14	Crystal, quartz	5125 kHz			7400 0307
Z1-9	Diode, si	1N4148			7800 0594

9.10.2 MF CONTROL UNIT B22100 3040 (U2)

C1	Capacitor, mica	270 pF	5 %	500 V	6200 0162
C2,3	Capacitor, mica	470 pF	5 %	500 V	6200 0272
C4-6	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C7	Capacitor, ellyt	22 uF	-10+100%	40 V	6300 0870
IC1	Integrated circuit	SN6490			8100 0103
K1,2	Relay	2 pole co. 24 V			6800 0452
L1,2	Choke, rf	470 uH	5 %		6600 0262
L3	Choke, rf	220 uH	5 %		6600 0194
R1,2	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R3,5	Resistor, carbon	1.2 kohm	5 %	0.50 W	6000 0515
R4,6	Potentiometer, trimmer	100 ohm	20 %	0.10 W	6100 0654
R7	Resistor, w-w	470 ohm	5 %	2 W	6000 1703
R8,9	Resistor, w-w	330 ohm	5 %	2 W	6000 1705
Z1	Diode, zener	1N3022B,12V 5 %			7800 0815
Z2	Diode, zener	1N3826A,5.1V 5%			7800 1444

9.10.3 MF MODULATOR UNIT B22100 3110 (U1)

C1-8	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C9	Capacitor, ellyt	10 uF	-10+100%	63 V	6300 0961
IC1	Integrated circuit	MC1596			8100 0445
L1	Choke, rf	4.7 mH	5 %		6600 0263
R1,9,10	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R2,7,8	Resistor, carbon	47 ohm	5 %	0.12 W	6000 6249
R3	Potentiometer, trimmer	10 kohm	20 %	0.15 W	6100 0148
R4,6	Resistor, carbon	820 ohm	5 %	0.12 W	6000 6250
R5	Potentiometer, trimmer	50 kohm	20 %	0.15 W	6100 0581
R11,12	Resistor, carbon	3.9 kohm	5 %	0.12 W	6000 5647
R13	Resistor, carbon	6.8 kohm	5 %	0.12 W	6000 5292
R14	Resistor, w-w	1 kohm	5 %	2 W	6000 7542
R15	Resistor, carbon	100 kohm	5 %	0.12 W	6000 5304
R16	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R17	Resistor, carbon	470 ohm	5 %	0.50 W	6000 0798
R18	Resistor, carbon	17 kohm	5 %	0.12 W	6000 5293
R19	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R20,25	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R21	Resistor, carbon	39 ohm	5 %	0.12 W	6000 6594
R22	Resistor, carbon	22 ohm	5 %	0.12 W	6000 6136
R23	Resistor, carbon	33 kohm	5 %	0.12 W	6000 5291
R24	Resistor, carbon	150ohm	5 %	0.12 W	6000 5277
T1	Transformer				B21141 5119
Y1	Transistor, si pnp	2N2905A			8000 0360
Y2	Transistor, si npn	2N2219A			8000 0389
Z1	Diode, zener	1N756A,8.2V 5 %			7800 0892
Z2	Diode, zener	1N963B,12V 5 %			7800 1131

9.10.4 500 Hz OSCILLATOR B22100 3130 (U4)

C1-3,5, 7,11	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C4	Capacitor, mplfo	22 nF	10 %	250 V	6200 6226
C6	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C8	Capacitor, ellyt	100 uF	-10+100%	16 V	6300 0869
C9	Capacitor, ellyt	100 uF	-10+100%	40 V	6300 0743
C10	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
L1	Coil				B22100 5130
R1,2,6,7	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R3,5	Resistor, carbon	15 kohm	5 %	0.12 W	6000 5324
R4	Potentiometer, trimmer	10 kohm	20 %	0.15 W	6100 0148
R8,14	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R9,10	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R11	Potentiometer, trimmer	10 kohm	20 %	0.10 W	6100 0655
R12,13	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R15	Resistor, carbon	470 ohm	5 %	0.50 W	6000 0798
R16	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R17	Resistor, carbon	4.7 kohm	5 %	0.12 W	6000 5321
R18	Resistor, carbon	56 kohm	5 %	0.12 W	6000 5295
Y1-4	Transistor, si npn	2N2219A			8000 0389
Y5	Transistor, si pnp	2N2905A			8000 0360
Z1	Diode, zener	1N750A,4.7 V 5 %			7800 0891
Z2	Diode, si	1N4148			7800 0594

9.11 HF A1 EXCITER B22192 0000

C1-7,22-29, 32,33,35,36,38-40,42-44,48-51	Capacitor, mplfo	10 nF	10 %	250 V	6200 5382
C8	Capacitor, plfo	470 pF	5 %	63 V	6200 5638
C9,20	Capacitor, plfo	330 pF	5 %	63 V	6200 5639
C10	Capacitor, plfo	220 pF	5 %	63 V	6200 5636
C11	Capacitor, plfo	120 pF	5 %	63 V	6200 5641
C12	Capacitor, plfo	100 pF	5 %	63 V	6200 5635
C13	Capacitor, plfo	82 pF	5 %	63 V	6200 4602
C14	Capacitor, mica	33 pF	5 %	500 V	6200 0439
C15	Capacitor, plfo	1.5 nF	5 %	63 V	6200 7118
C16	Capacitor, plfo	1 nF	5 %	63 V	6200 5902
C17	Capacitor, plfo	820 pF	5 %	63 V	6200 4788
C18	Capacitor, plfo	470 pF	5 %	63 V	6200 5638
C19	Capacitor, plfo	390 pF	5 %	63 V	6200 5640
C21	Capacitor, plfo	150 pF	5 %	63 V	6200 4605
C30,45-47	Capacitor, mplfo	220 nF	10 %	100 V	6200 6102
C31	Capacitor, mplfo	33 nF	10 %	250 V	6200 6093
C34	Capacitor, plfo	680 pF	5 %	63 V	6200 4787
C37	Capacitor, mplfo	100 nF	10 %	100 V	6200 5924
C41	Capacitor, plfo	82 pF	5 %	63 V	6200 4602
C52	Capacitor, trimmer	10-60 pF			6400 0097
C61-74	Capacitor, cer f-thr	1 nF	-20+80 %	500 V	6200 4881
L1	Coil				B22192 5100
L2	Coil				B22192 5101
L3	Coil				B22192 5102
L4	Coil				B22192 5103
L5	Coil				B22192 5104
L6,7	Coil				B22192 5105
L8	Choke, rf	39 uH	5 %		6600 0273
L9,10	Choke, rf	100 uH	5 %		6600 0124
L11	Choke, rf	1.8 uH	10 %		6600 0269
L12	Choke. rf	10 uH	10 %		6600 0133
P1	n.a.				
P2	Connector, coax.	L1465/CS			8600 0733
P3	Connector, coax.	L1465/FP			8600 0732

HF A1 EXCITER, continued

P10	Connector, male	23 way			8600 1527
R1-28,58	Resistor, carbon	560 ohm	5 %	0.12 W	6000 5237
R29-35	Resistor, carbon	1.8 kohm	5 %	0.25 W	6000 2535
R36-42	Resistor, w-w	1 kohm	5 %	2 W	6000 0743
R43,62	Resistor, carbon	220 ohm	5 %	0.12 W	6000 5749
R44-47	Resistor, carbon	47 kohm	5 %	0.12 W	6000 5529
R48-51	Resistor, carbon	3.9 kohm	5 %	0.25 W	6000 3096
R52,69,76	Resistor, carbon	1 kohm	5 %	0.12 W	6000 5302
R53,54	n.a.				
R55,75	Resistor, carbon	390 ohm	5 %	0.12 W	6000 5523
R56,60	Resistor, carbon	10 kohm	5 %	0.12 W	6000 5303
R57	Resistor, carbon	2.2 kohm	5 %	0.12 W	6000 5489
R59	Potentiometer, carbon	500 ohm	20 %	0.10 W	6100 0700
R61	Resistor, carbon	3.3 kohm	5 %	0.25 W	6000 3084
R63	Resistor, carbon	4.7 kohm	5 %	0.25 W	6000 2529
R64,70	Resistor, carbon	22 kohm	5 %	0.12 W	6000 5294
R65	Resistor, carbon	56 ohm	5 %	0.12 W	6000 5279
R66	Potentiometer, carbon	2.5 kohm	20 %	0.15 W	6100 0650
R67,68,71	Resistor, carbon	56 kohm	5 %	0.12 W	6000 5295
R72,73	Resistor, carbon	5.6 kohm	5 %	0.12 W	6000 5268
R74	Resistor, carbon	1.2 kohm	5 %	0.12 W	6000 6487
R77	Resistor, carbon	1 kohm	5 %	0.25 W	6000 2531
R78	Resistor, carbon	100 ohm	5 %	0.12 W	6000 5236
R79	Resistor, carbon	150 ohm	5 %	0.12 W	6000 5277
R80	Resistor, carbon	47 ohm	5 %	0.12 W	6000 6249
R81	Resistor, carbon	1.8 kohm	5 %	0.12 W	6000 5522
R82	Resistor, carbon	2.7 kohm	5 %	0.12 W	6000 5322
R83	Resistor, carbon	1.5 kohm	5 %	0.12 W	6000 5791
R84	Resistor, carbon	15 ohm	5 %	0.12 W	6000 6140
R85	Resistor, carbon	270 ohm	5 %	0.50 W	6000 0687
R86	Resistor, w-w	220 ohm	5 %	2 W	6000 0658
Y1,4-6	Transistor, si npn	2N2222A			8000 0405
Y2	Transistor, n-ch fet	U1837E			8000 0493
Y3	Transistor, si pnp	2N2905A			8000 0360
Y7	Transistor, si npn	2N2219A			8000 0389
Z1-15,17-22	Diode, si	1N4148			7800 0594
Z16	Diode, zener	1N967B, 18 V 5 %			7800 1118
Z23	Diode, Zener	1N752A, 5.6 V 5 %			7800 0817
Z24	Diode, si	1N645			7800 1020

CHAPTER 10

CIRCUIT DIAGRAMS and ASSEMBLIES

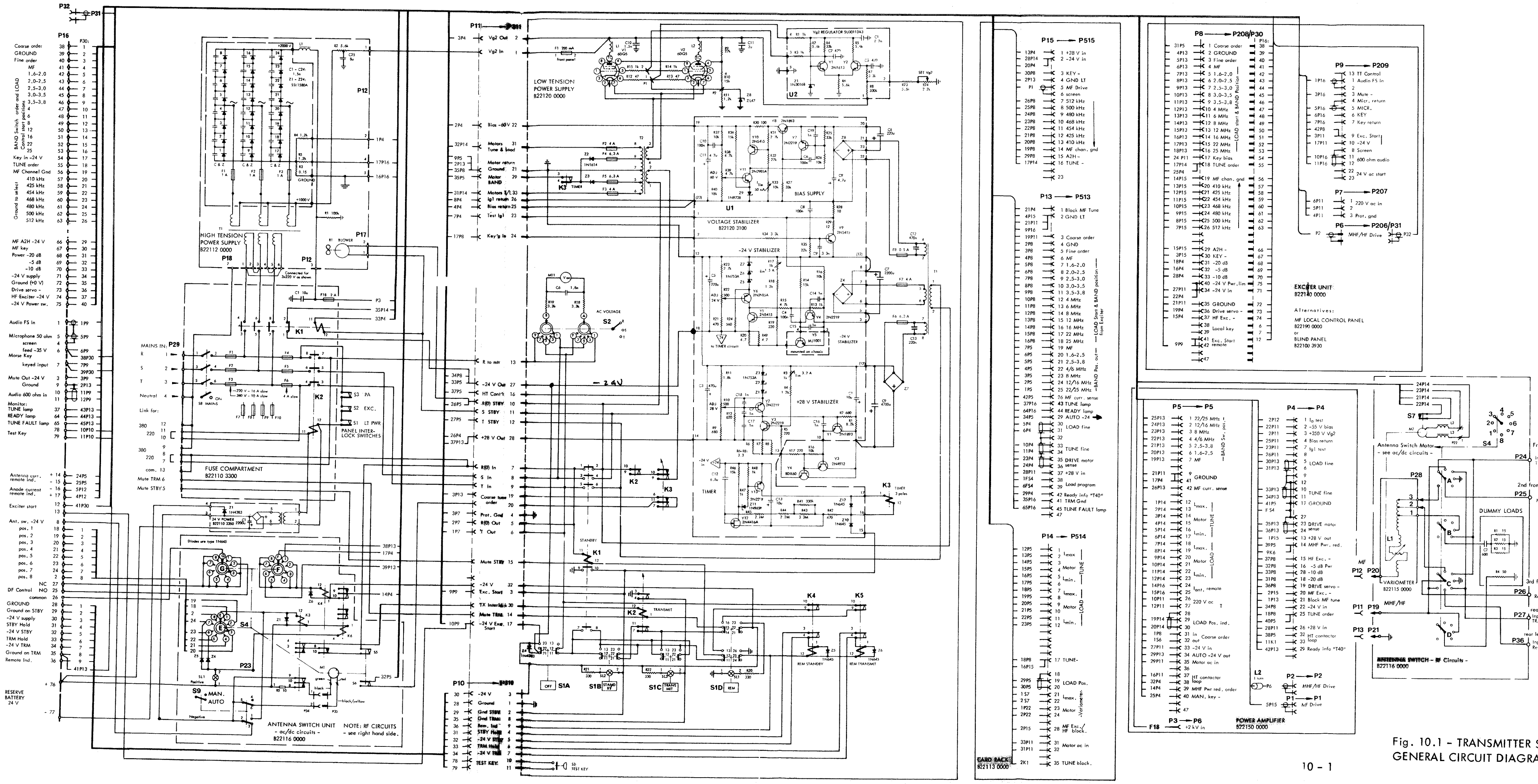


Fig. 10.1 - TRANSMITTER ST 1610A
GENERAL CIRCUIT DIAGRAM

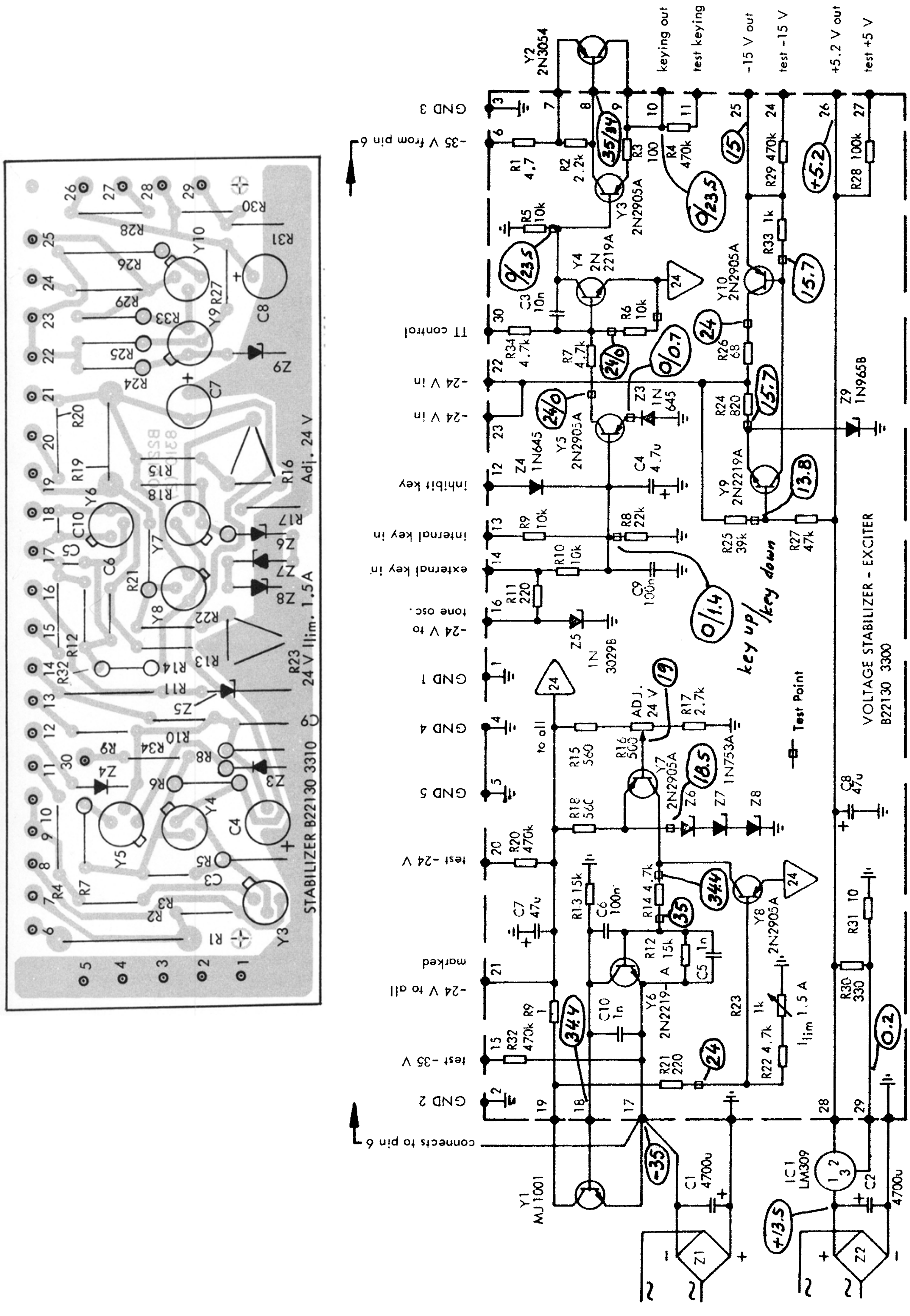
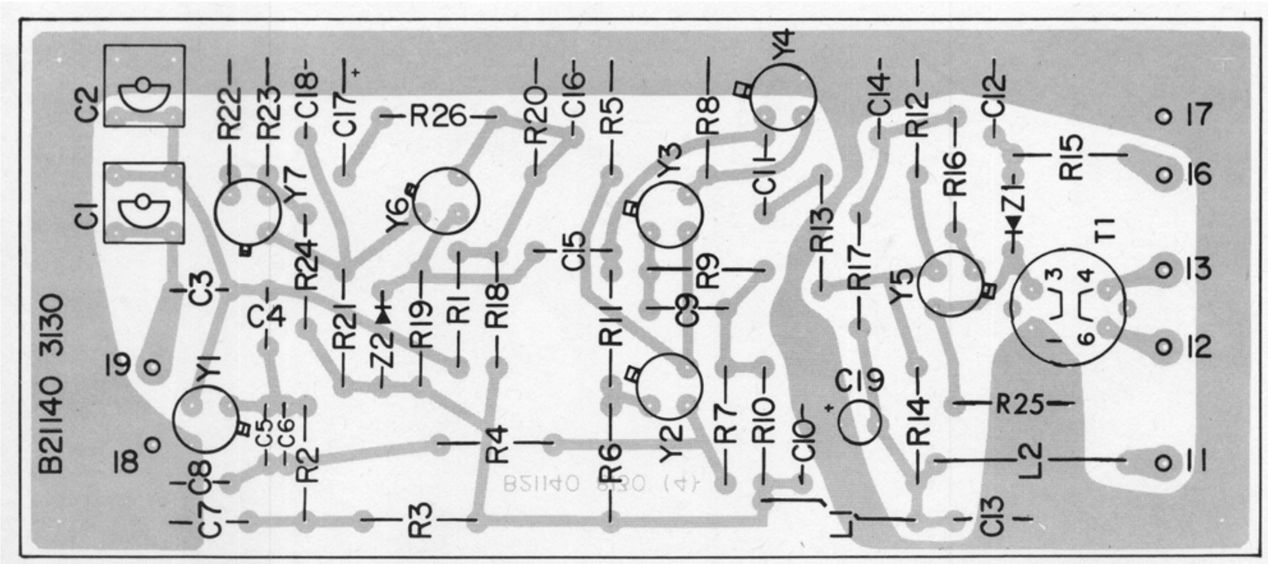


Fig. 10.2 - EXCITER POWER SUPPLY B22130 3300
Circuit Diagram & Assembly Drawing



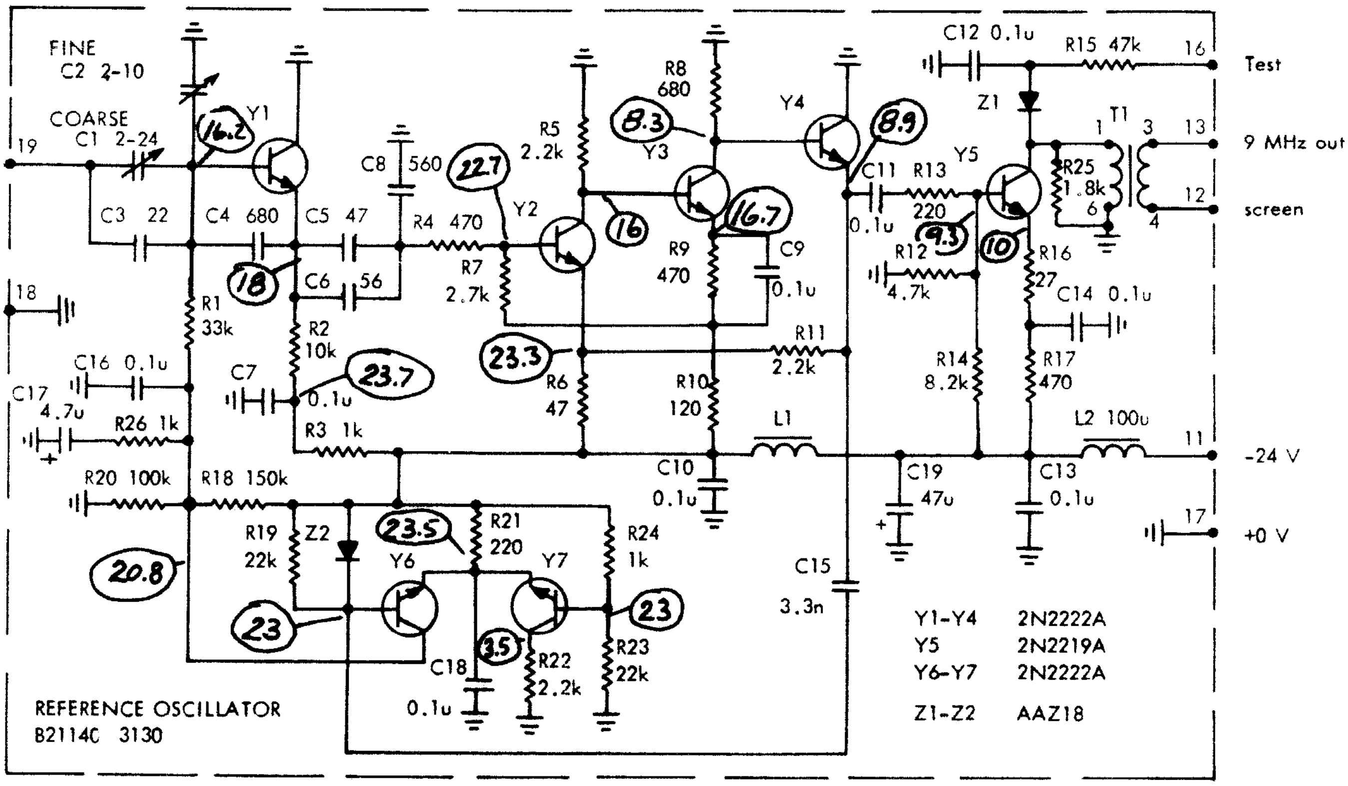


Fig. 10.3 - REFERENCE OSCILLATOR
B21140 3130
Circuit Diagram & Assy Drwg

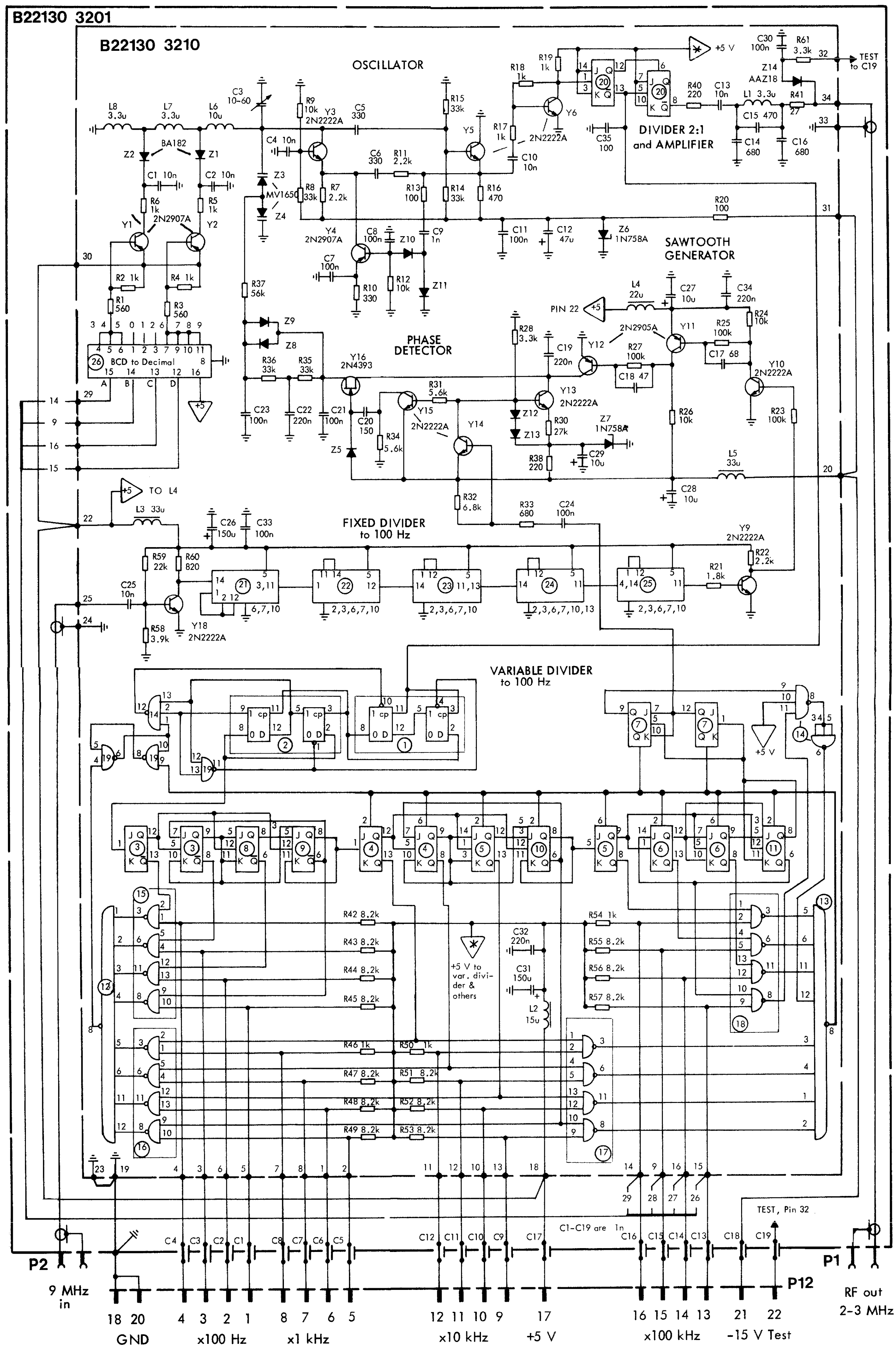


Fig. 10.4 - SYNTHESIZER B22130 3201
Circuit Diagram & Assembly Drawing

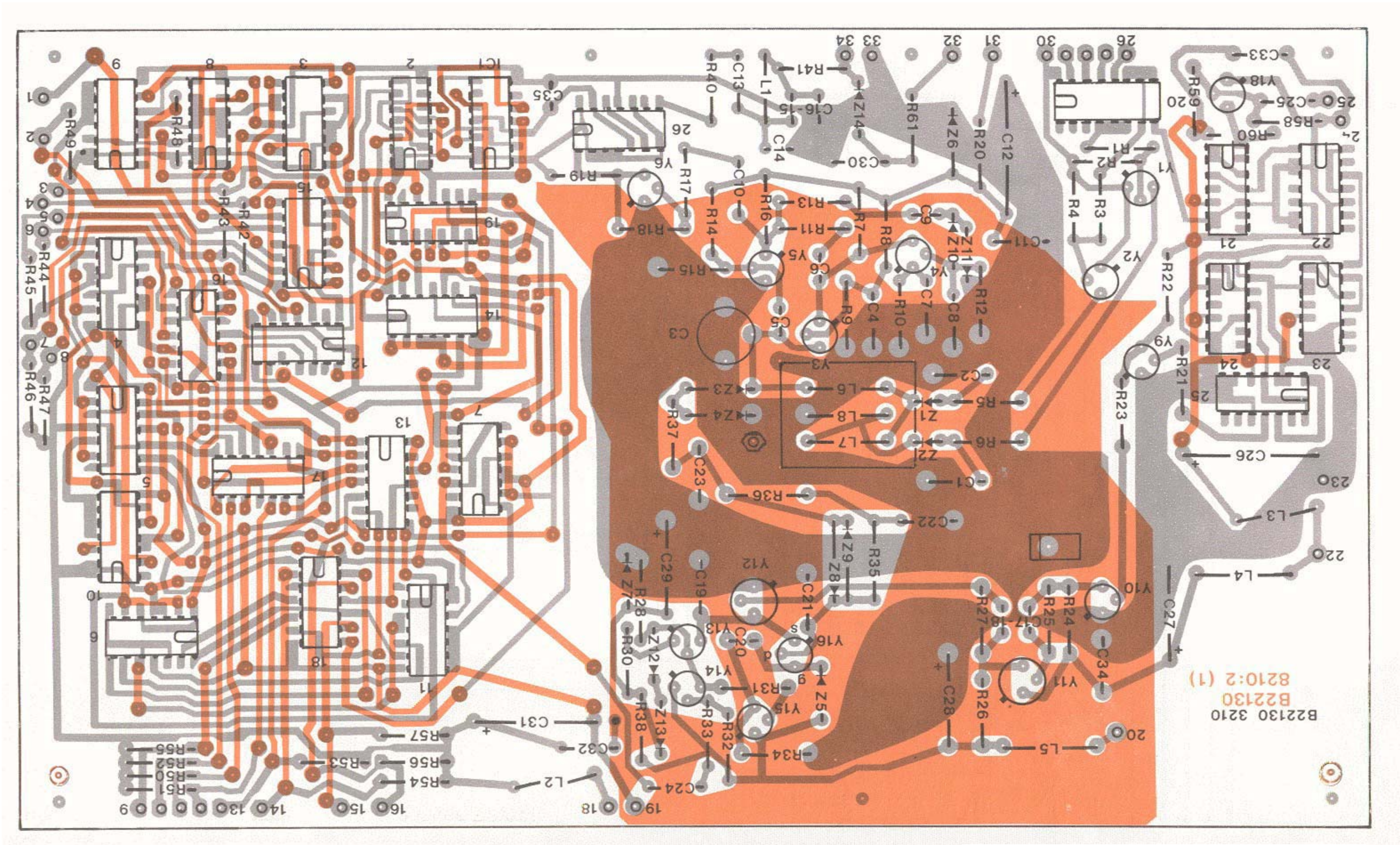
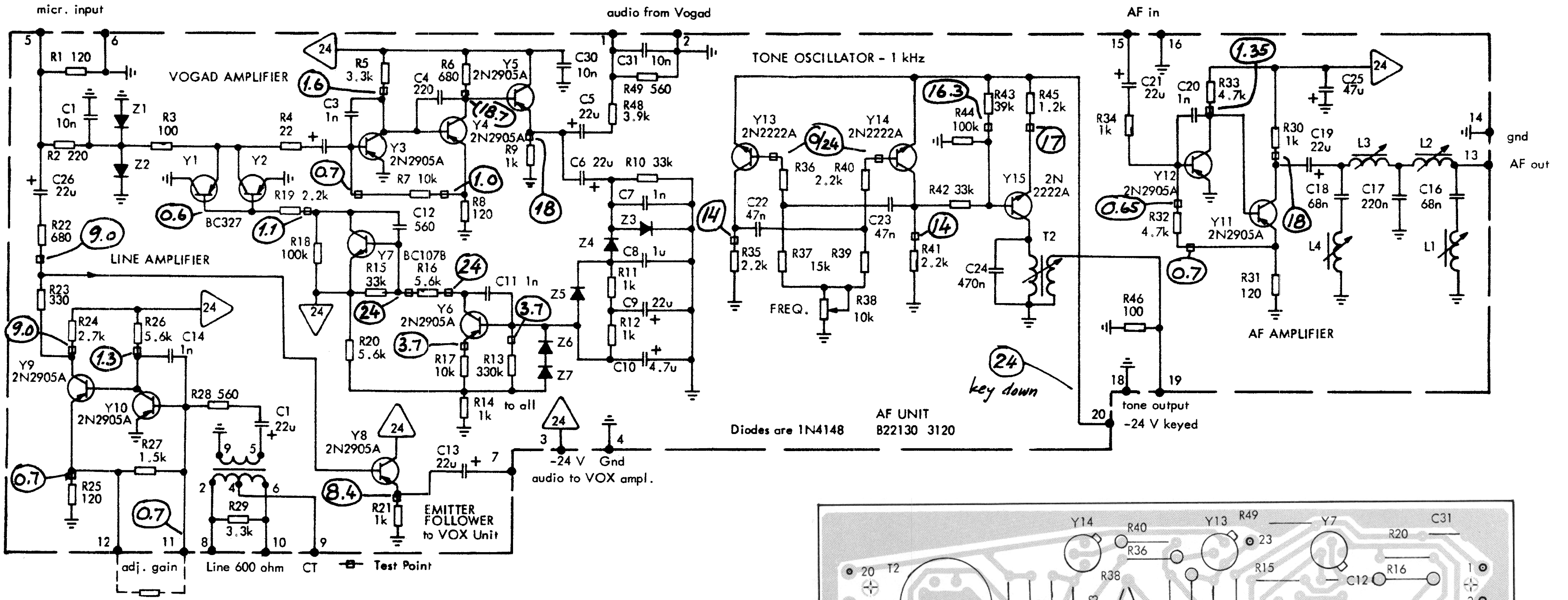


Fig. 10.4 – SYNTHESIZER B22130 3201

Circuit Diagram & Assembly Drawing



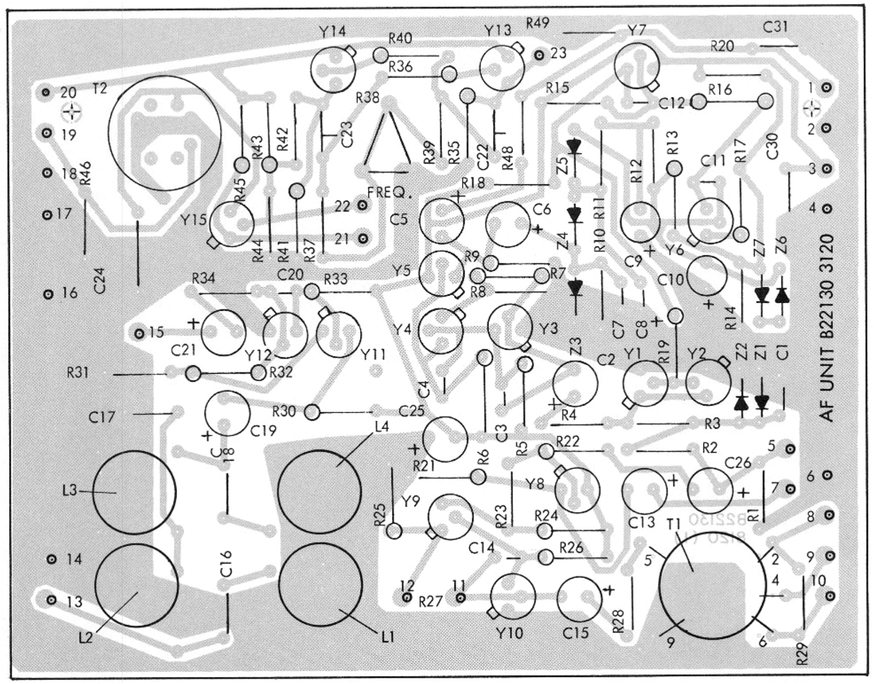
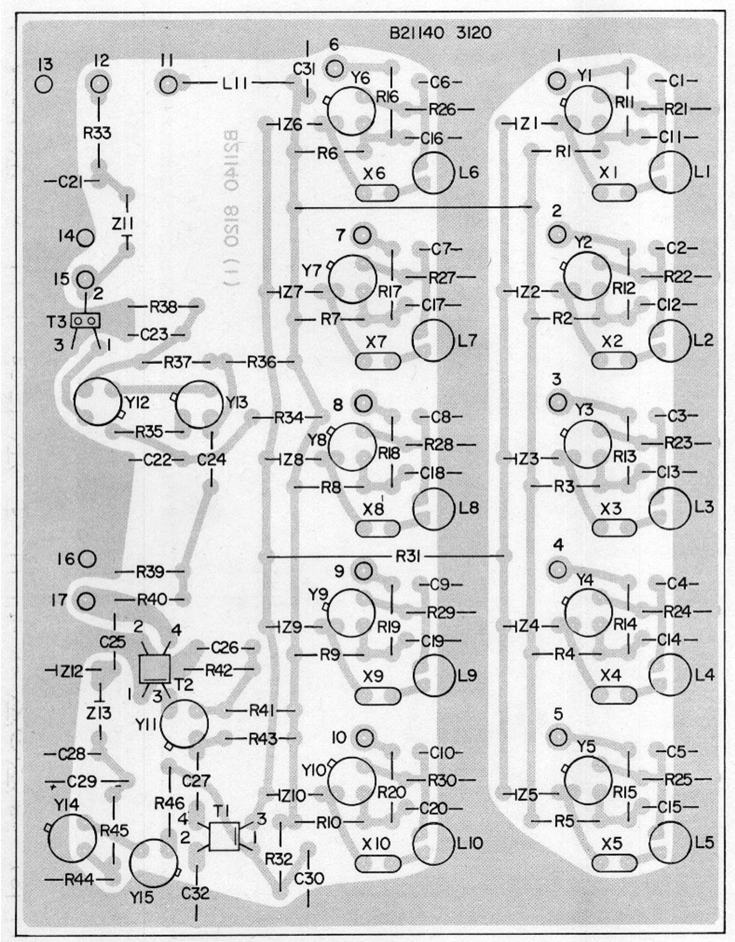


Fig. 10.5 - AF UNIT B22130 3120
Circuit Diagram & Assembly Drawing



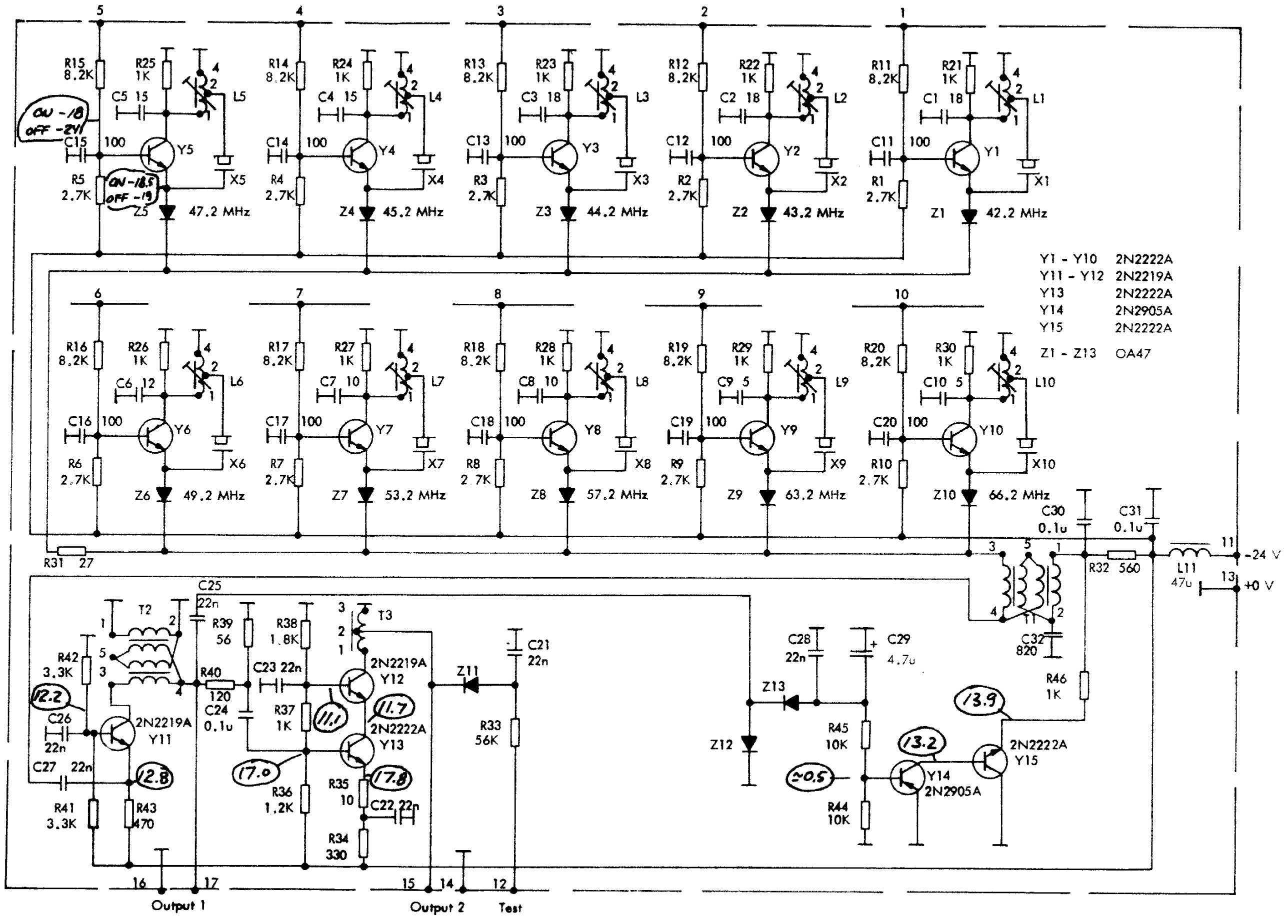


Fig. 10.6 - BAND OSCILLATOR
B21140 3120
Circuit Diagram & Assy. Drwg

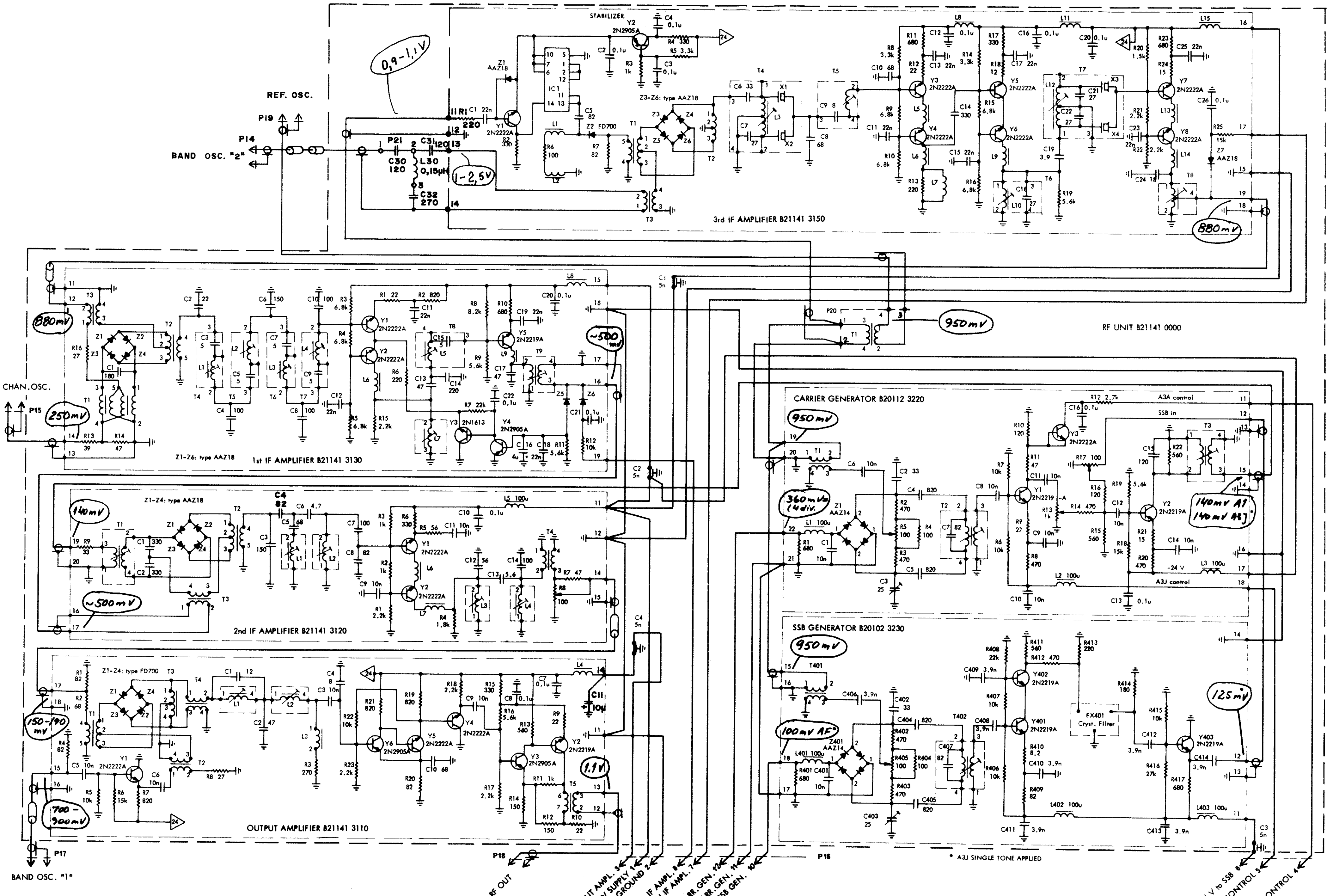
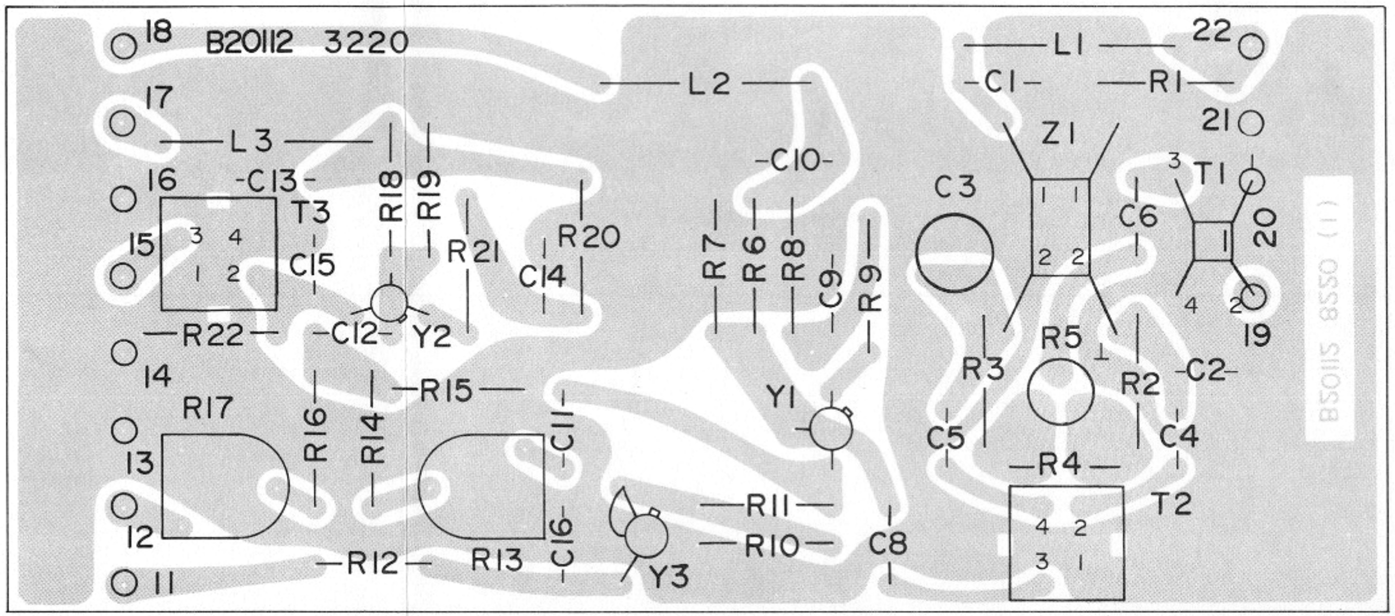


Fig. 10.7 - RF UNIT B21141 0000 CIRCUIT DIAGRAM



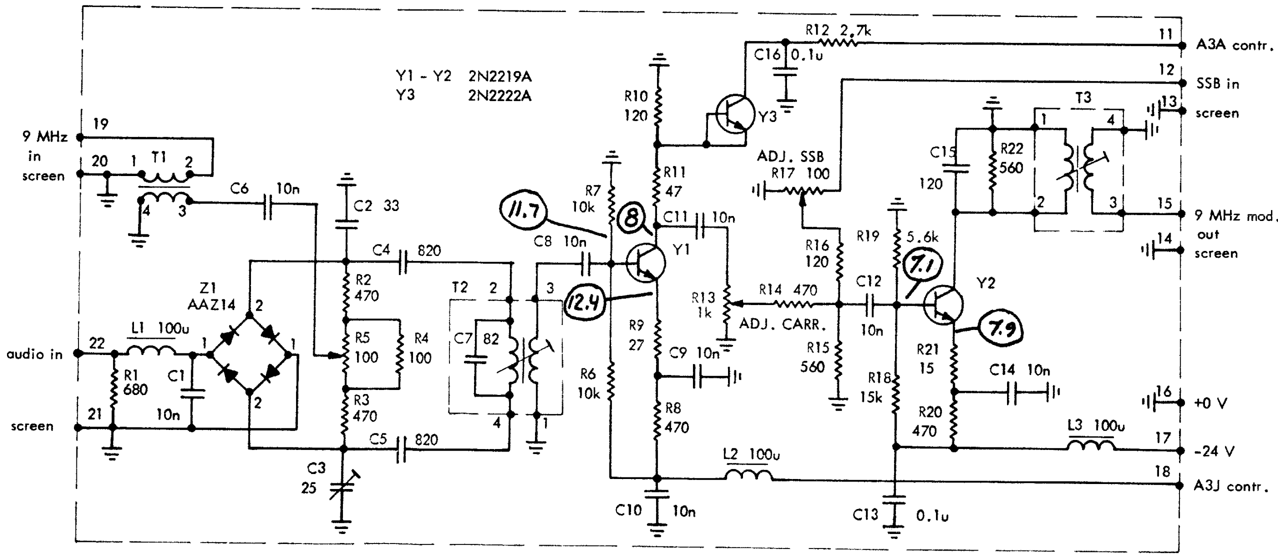
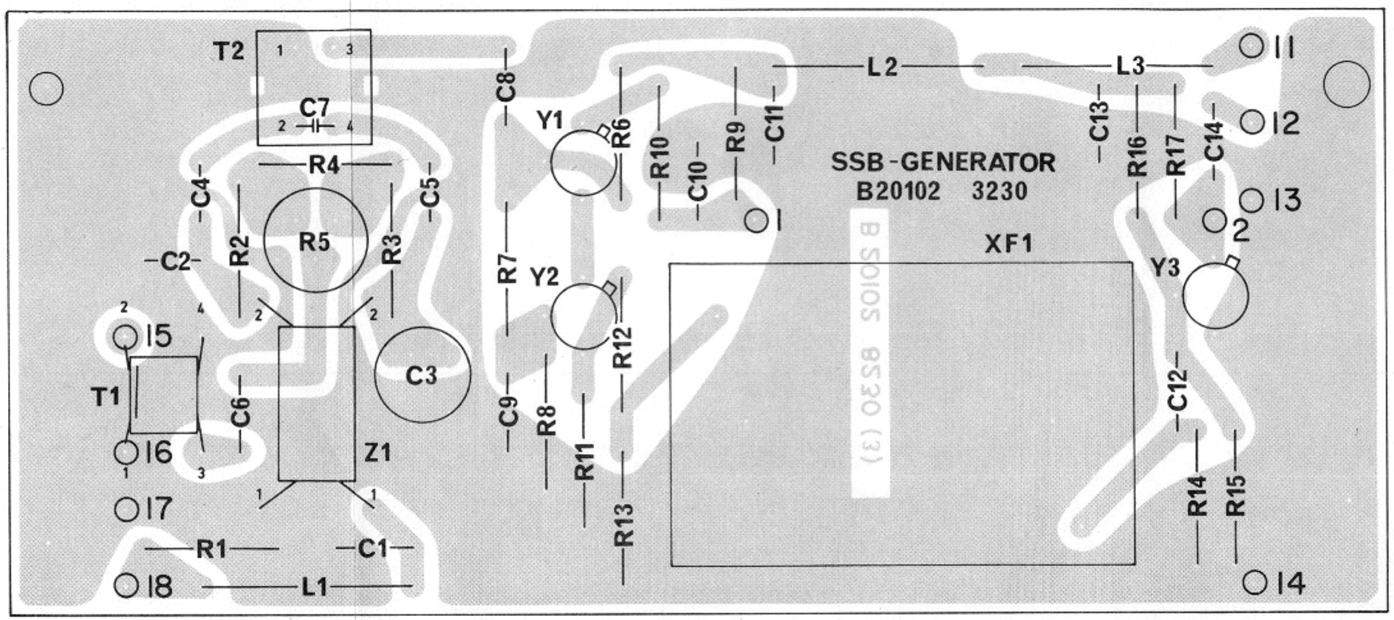
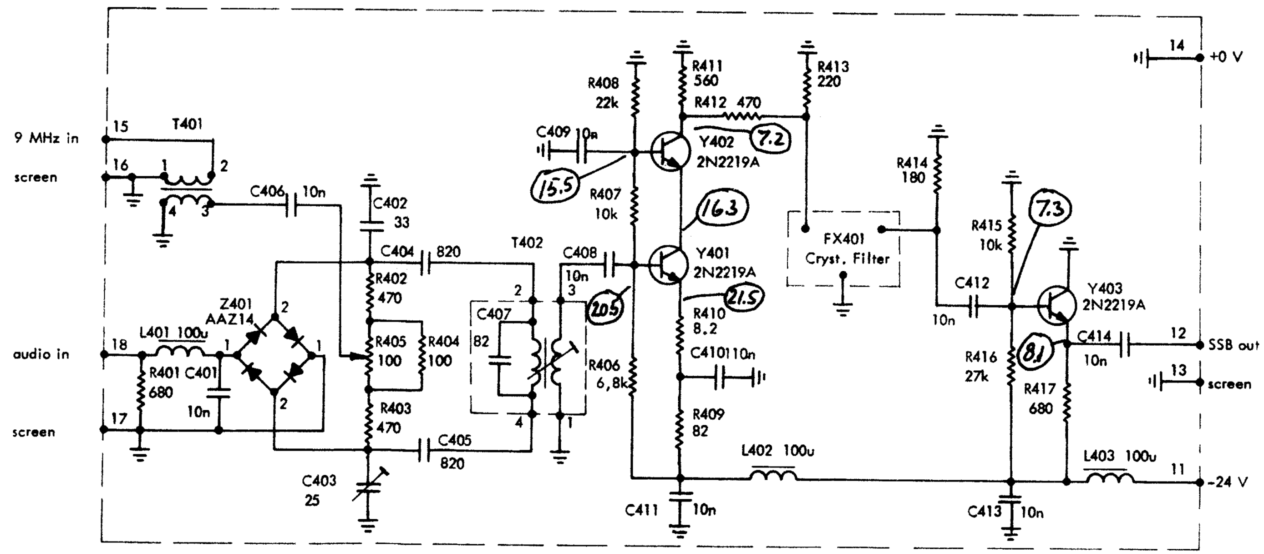


Fig. 10.8 - CARRIER GENERATOR
B20112 3220
Circuit Diagram & Assembly Drwg





10 - 9

Fig. 10.9 - SSB GENERATOR
B20102 3230
Circuit Diagram & Assembly Drwg.

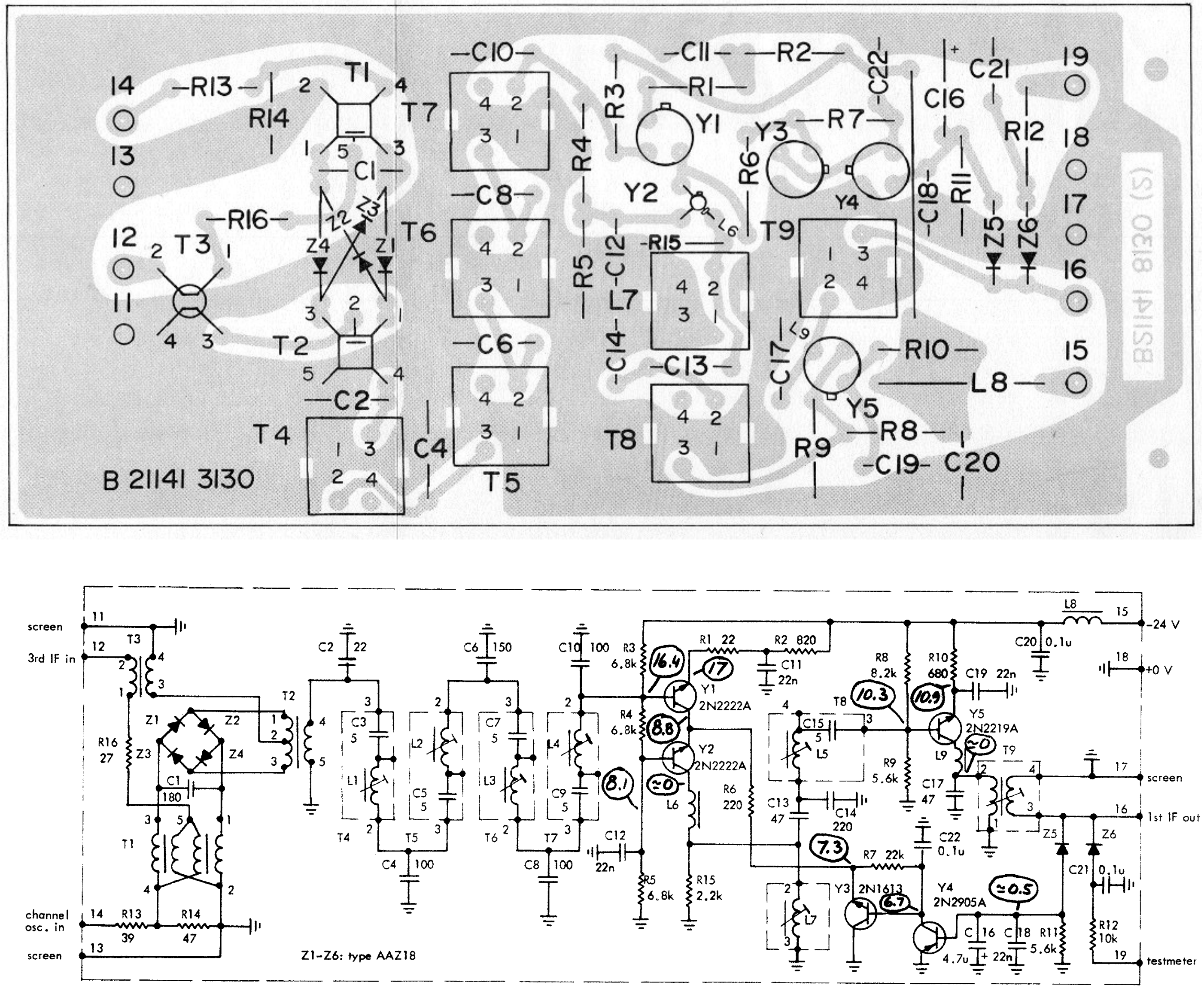
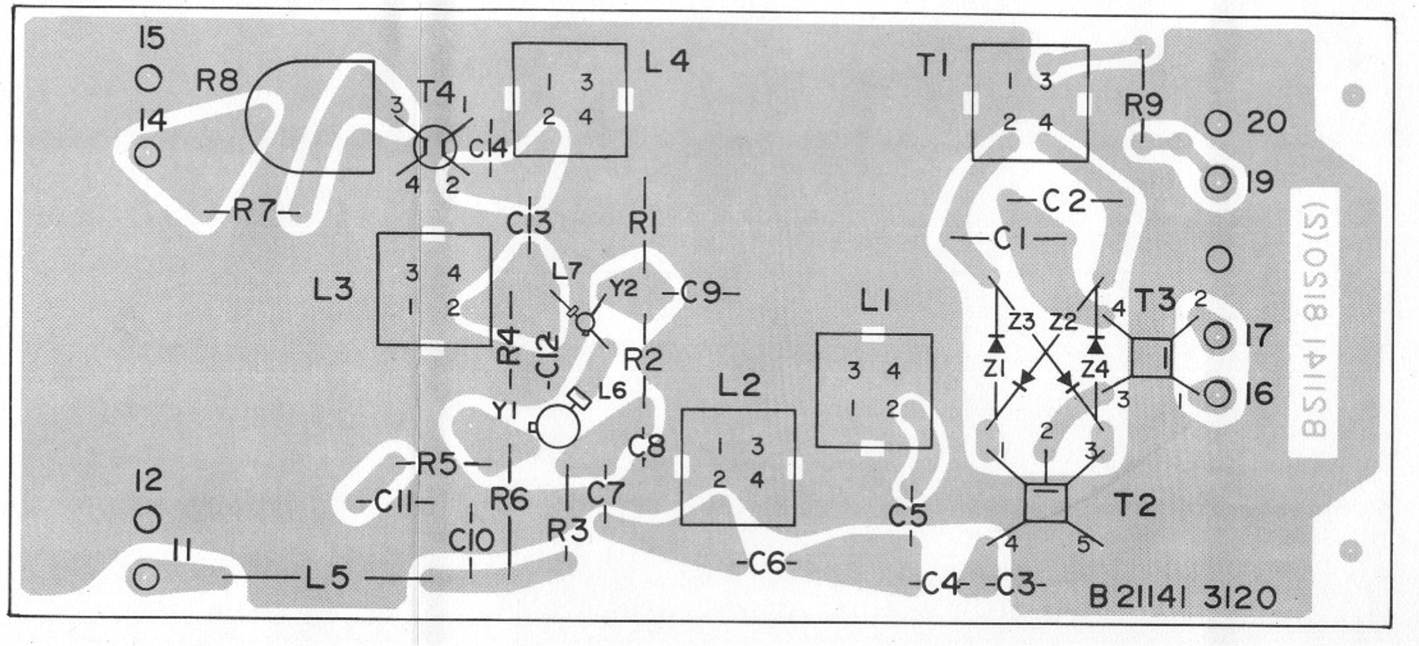


Fig. 10.10 - 1st IF AMPLIFIER
B21141 3130
Circuit Diagram & Assembly Drwg.



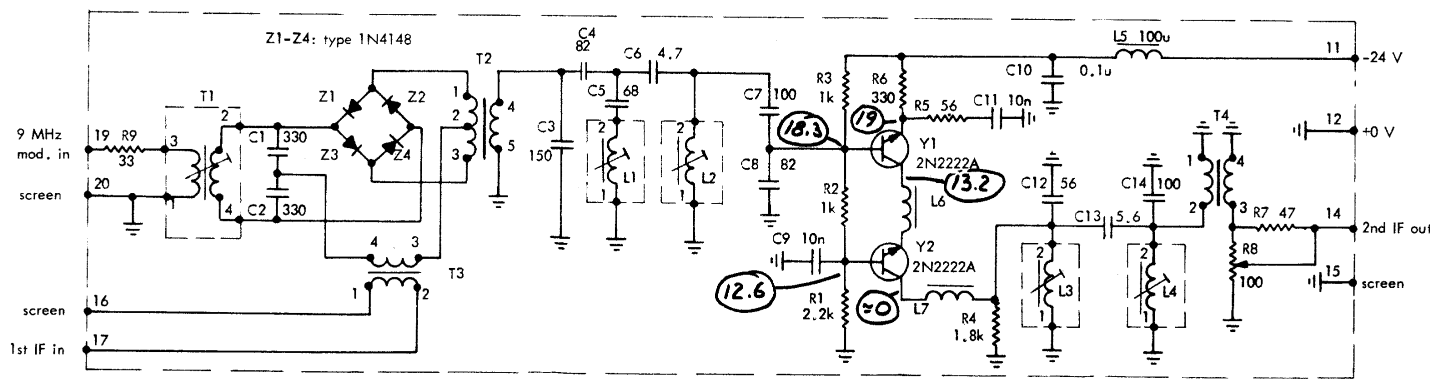
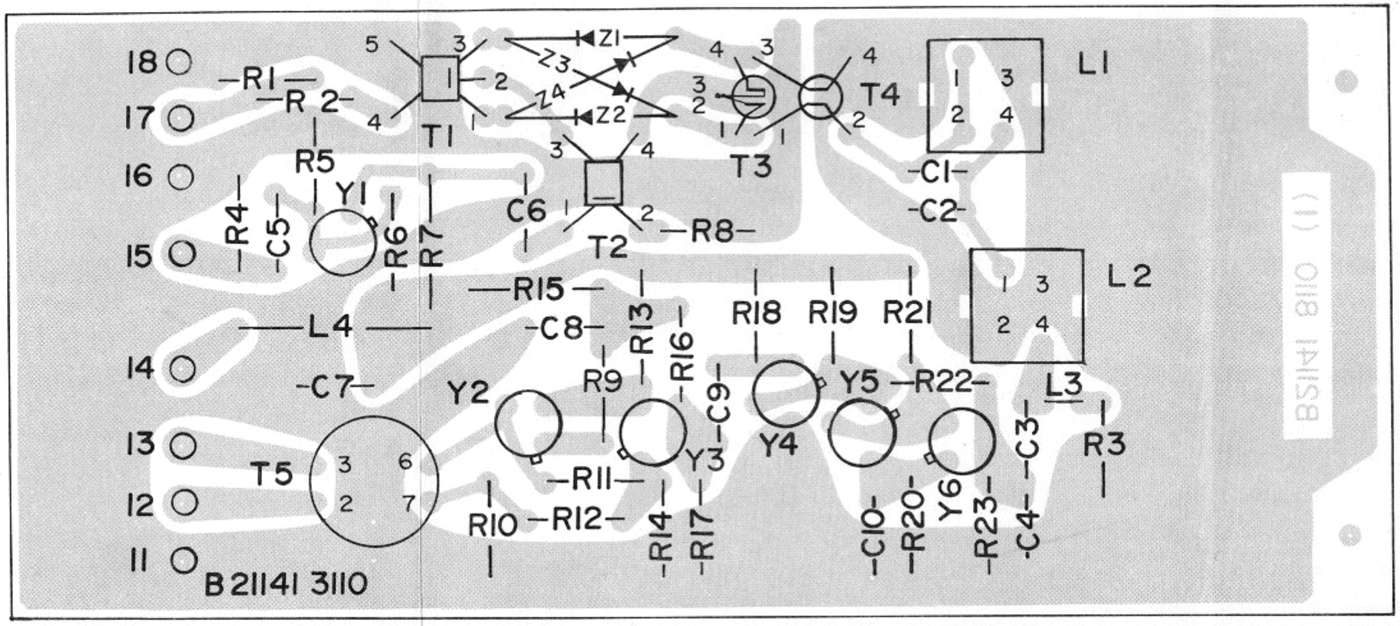


Fig. 10.11 - 2nd IF AMPLIFIER
B21141 3120
Circuit Diagram & Assembly Drwg.



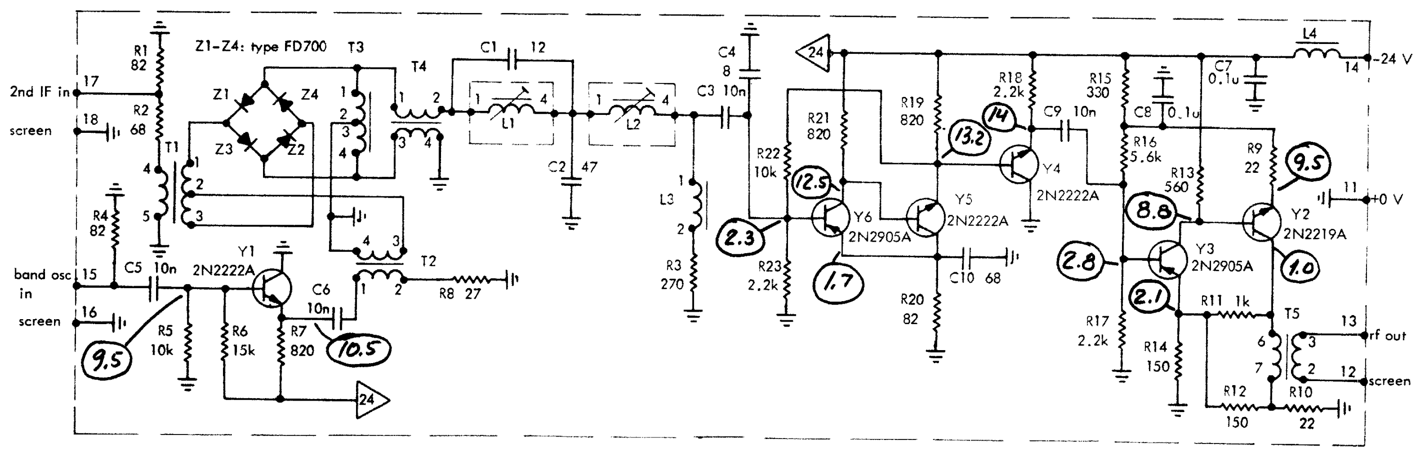
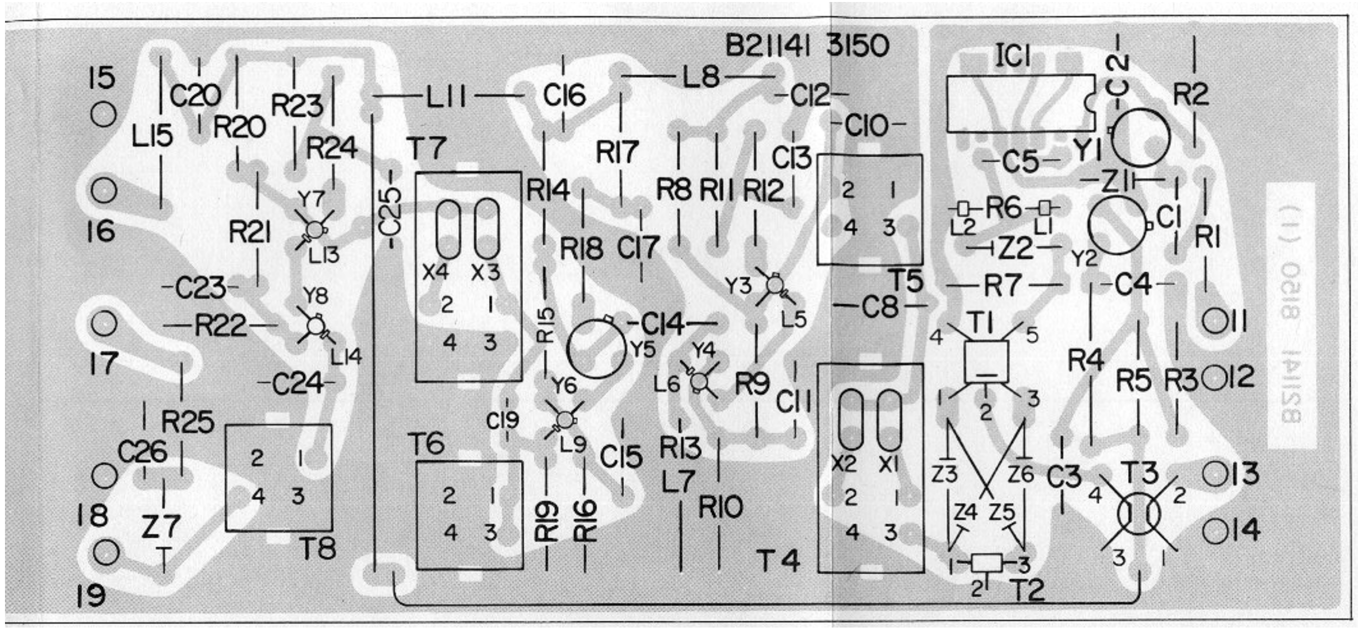


Fig. 10.12 - OUTPUT AMPLIFIER
B21141 3110
Circuit Diagram & Assembly Drwg.



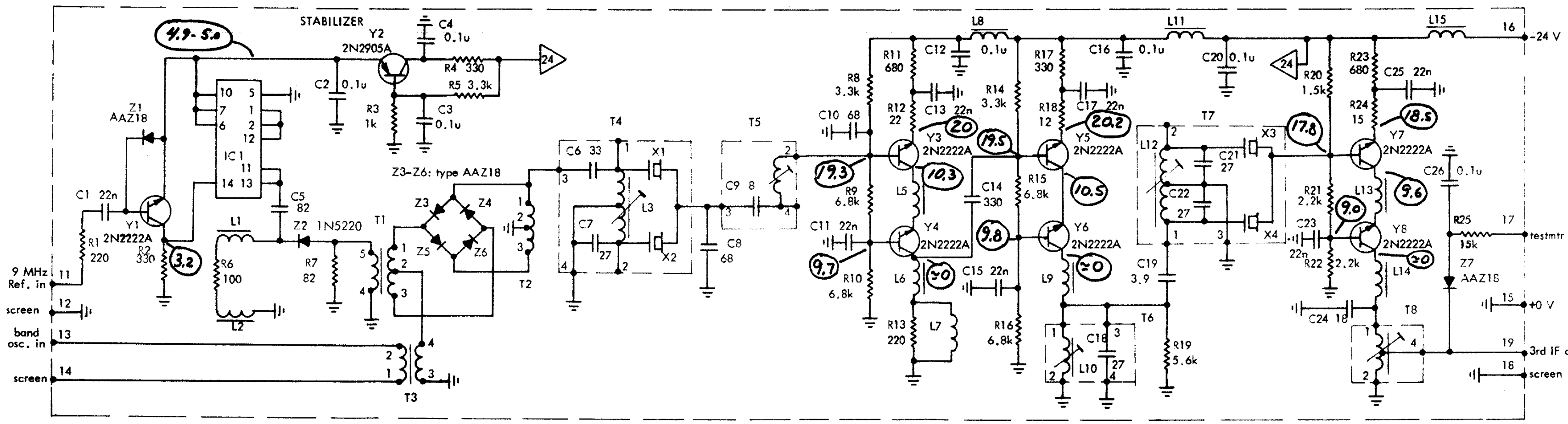
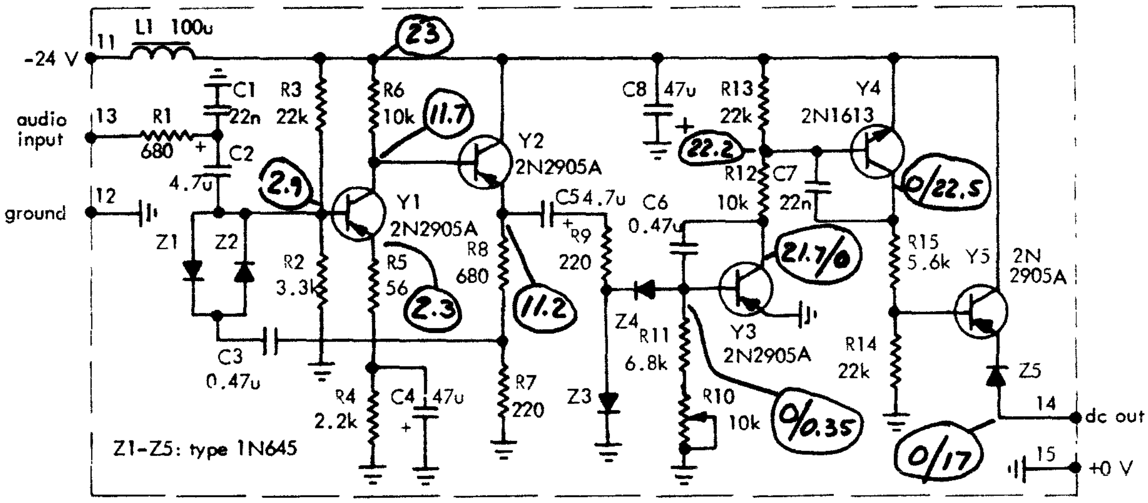


Fig. 10.13 - 3rd IF AMPLIFIER
B21141 3150
Circuit Diagram & Assembly Drwg.



NOTE: when two figures are given
- first figure with no input signal
- second figure with input to trigger dc output

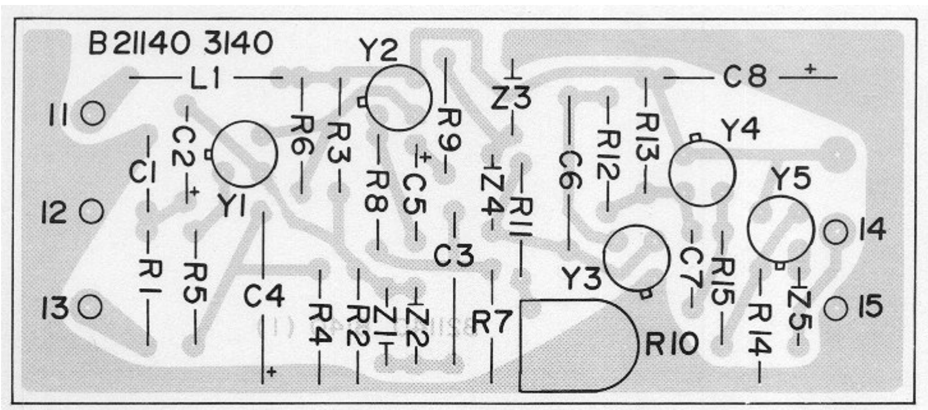


Fig. 10.14 - VOX AMPLIFIER
B21140 3140
Circuit Diagram & Assembly Drwg.

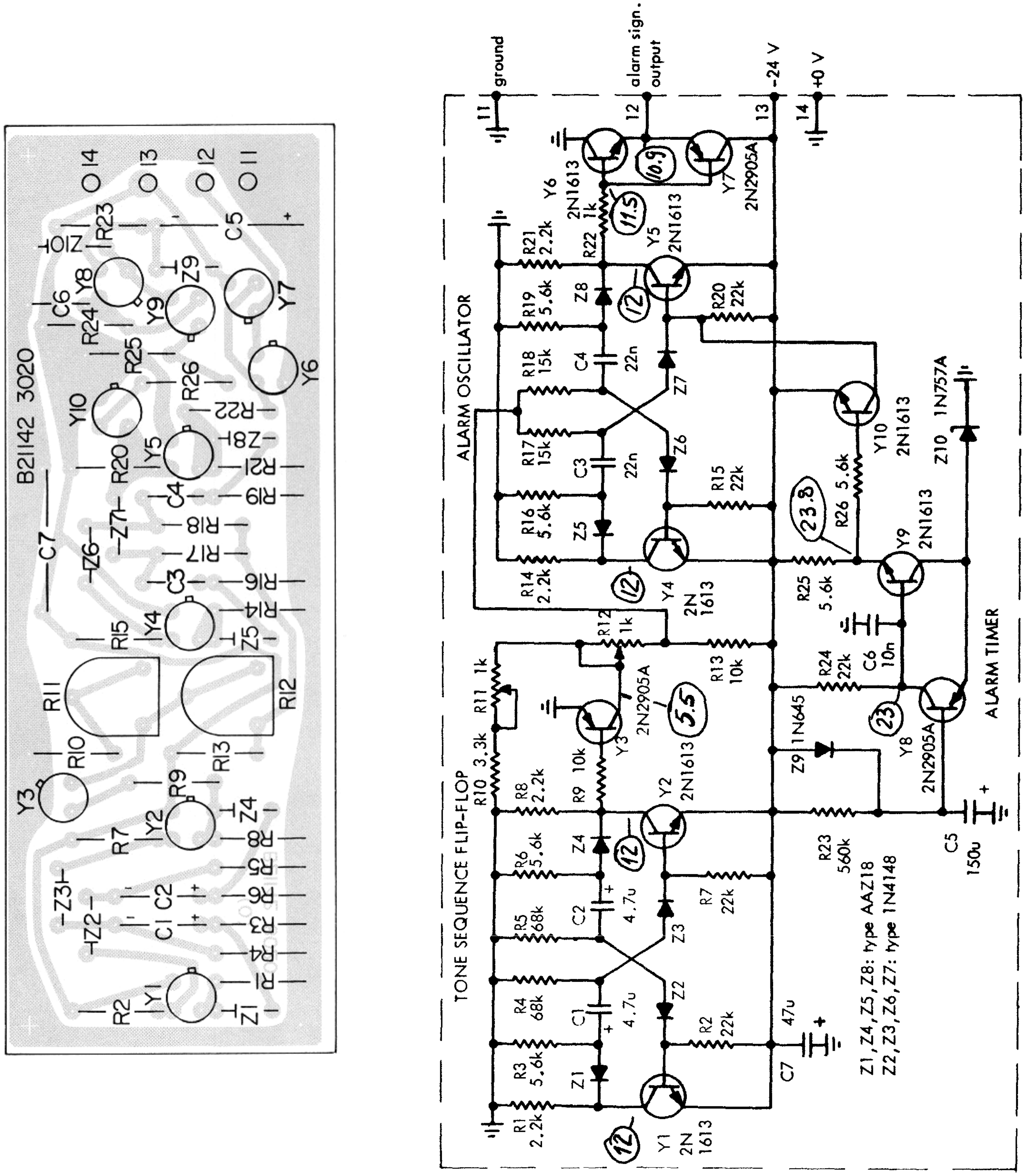
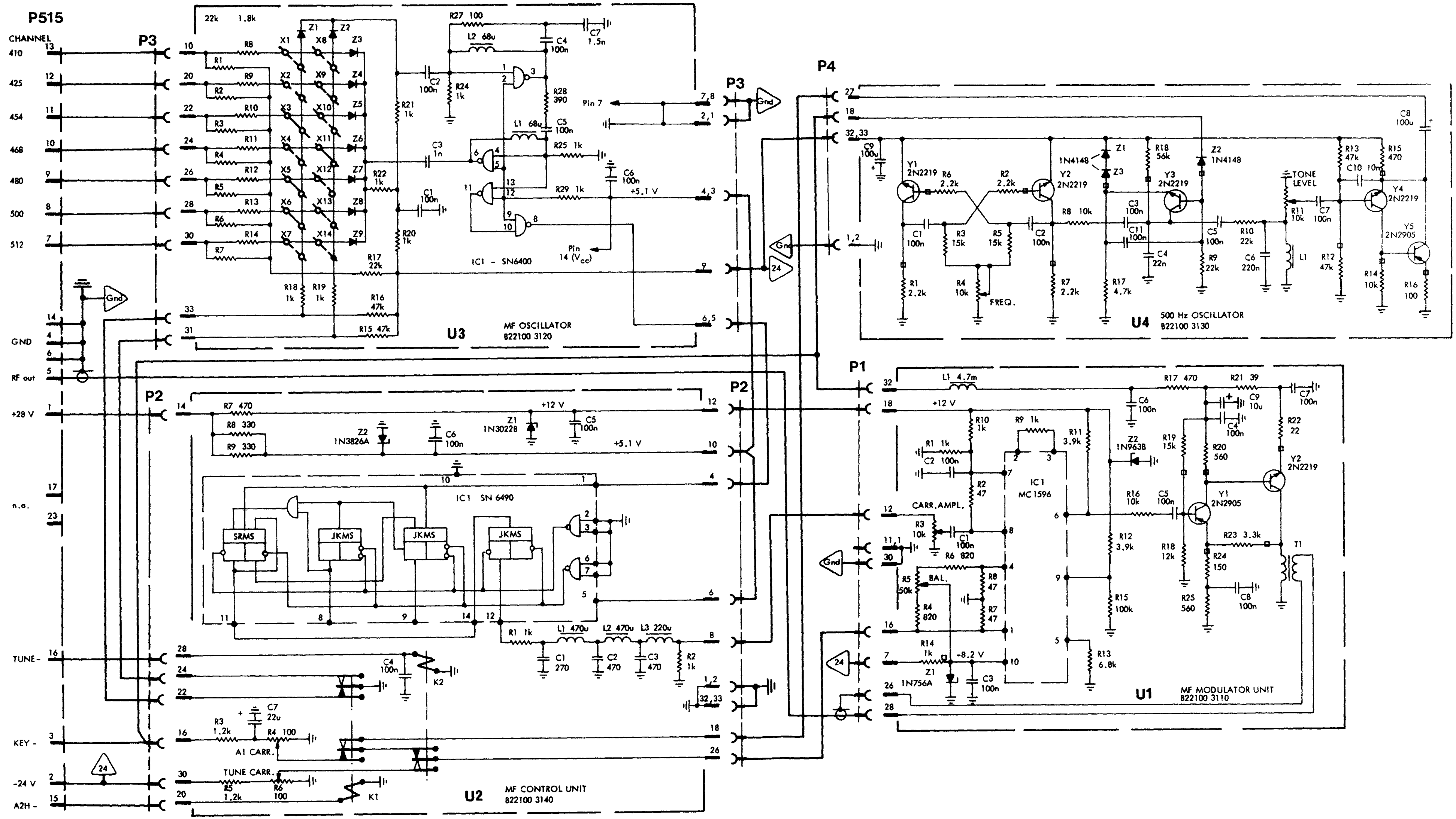


Figure 10.15
ALARM SIGNAL GENERATOR B21142 3020
Circuit Diagram & Assembly Drawing



NOTE: Transmitter Servo Circuits are on figure 10.8, Transmitter Handbook.

Figure 10.16 - EXCITER MF GENERATOR
Part of Transmitter Card Rack B22113 0000
Circuit Diagram

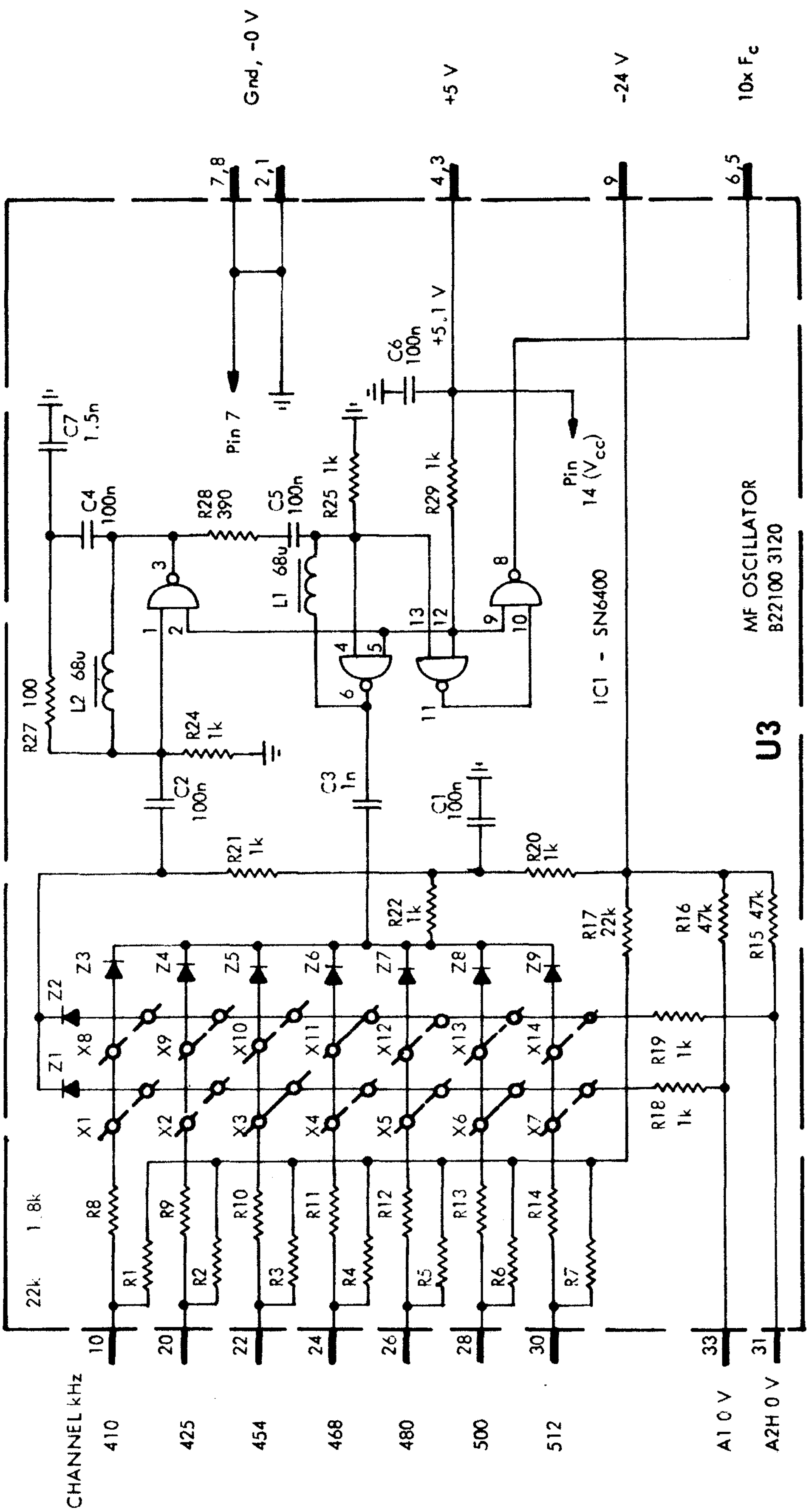


Fig. 10.17 - MF OSCILLATOR B22100 3120
Circuit Diagram

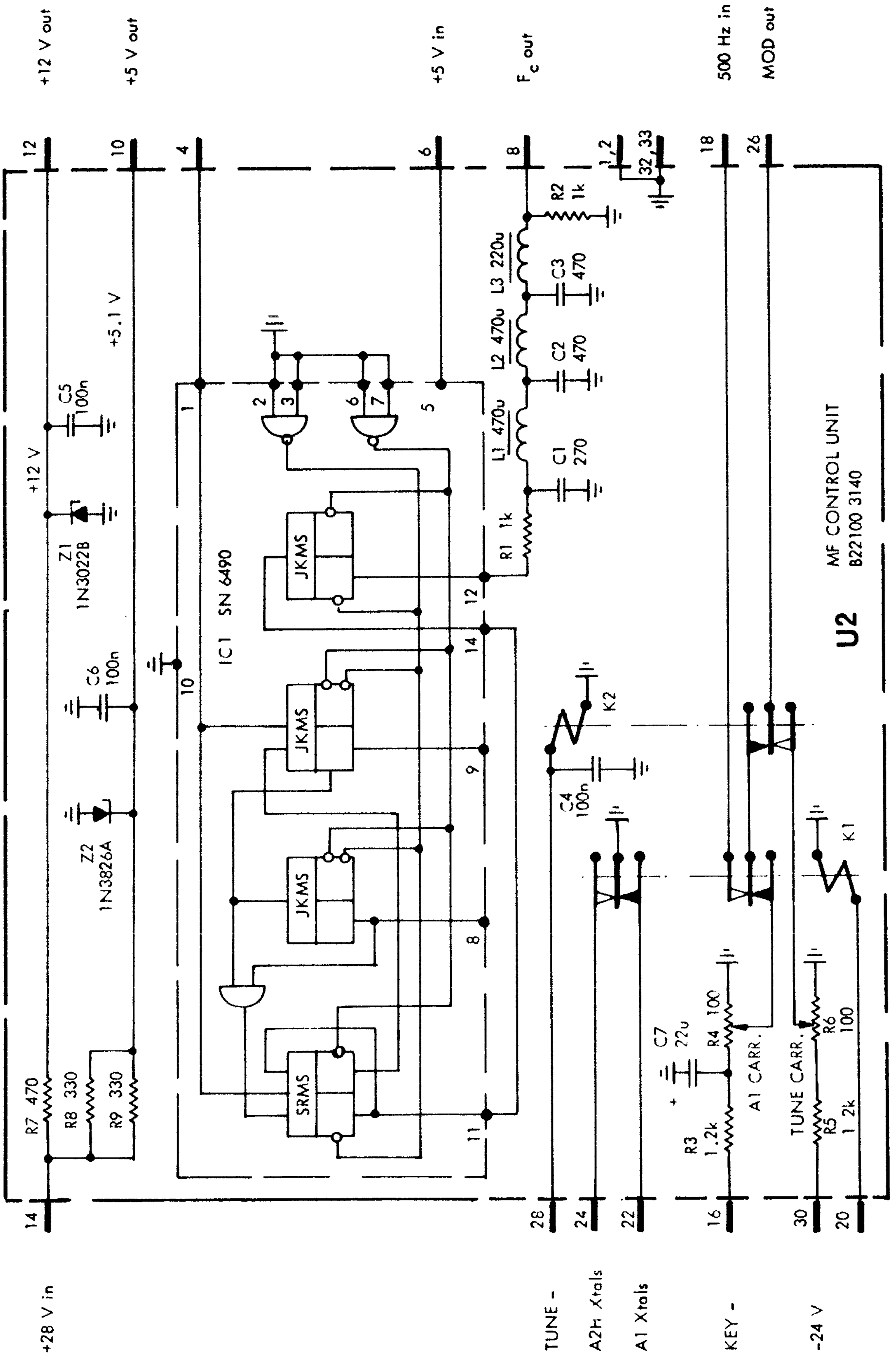


Fig. 10.18 - MF CONTROL B22100 3140
Circuit Diagram

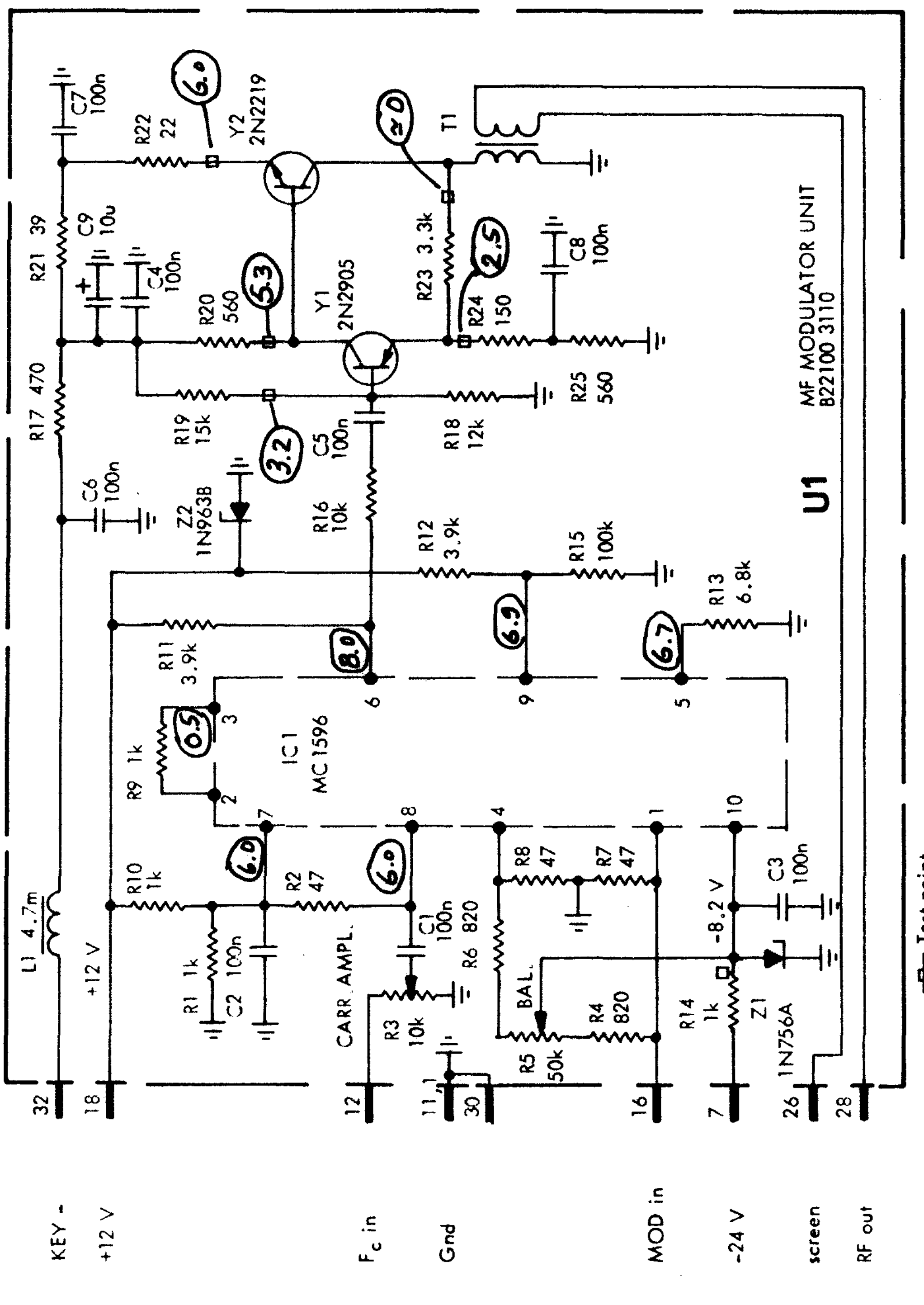


Fig. 10.19 - MF MODULATOR B22100 3110
Circuit Diagram

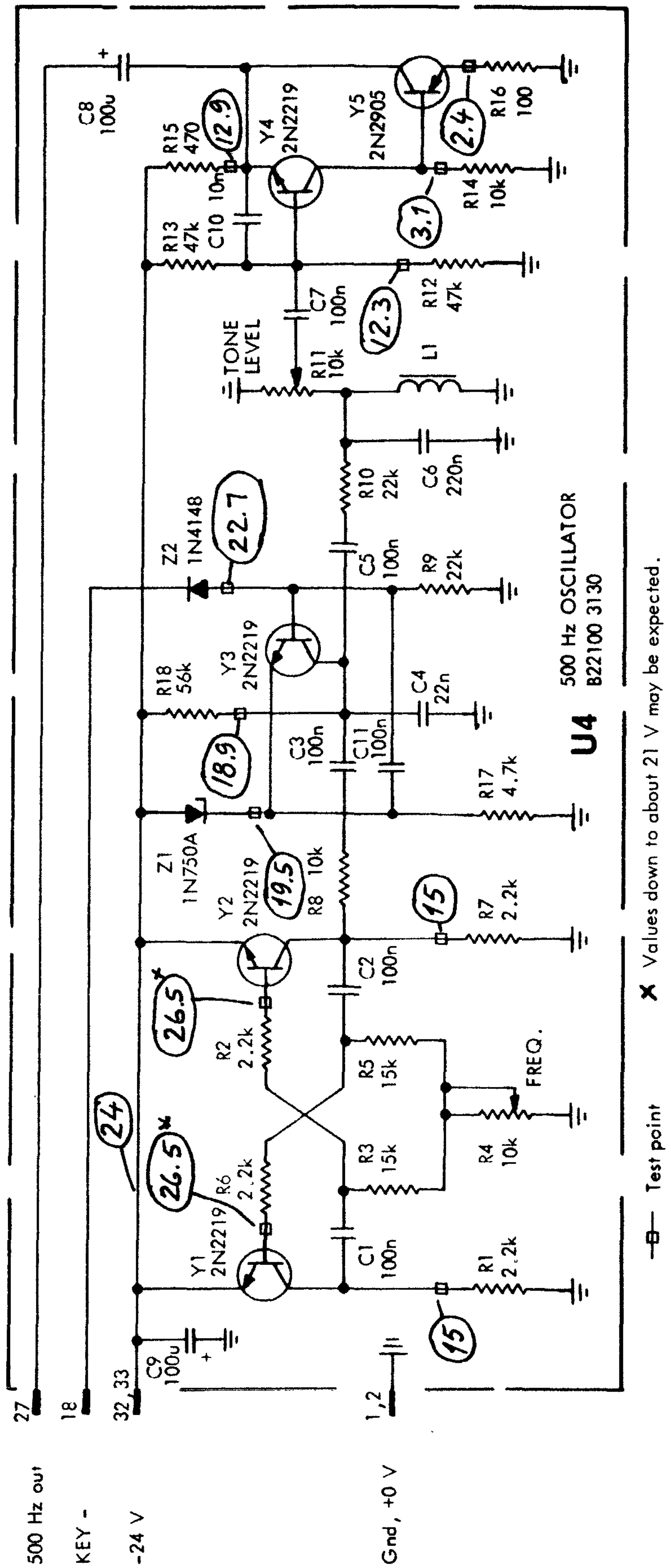


Fig. 10.20 - 500 Hz OSCILLATOR B22100 3130
Circuit Diagram

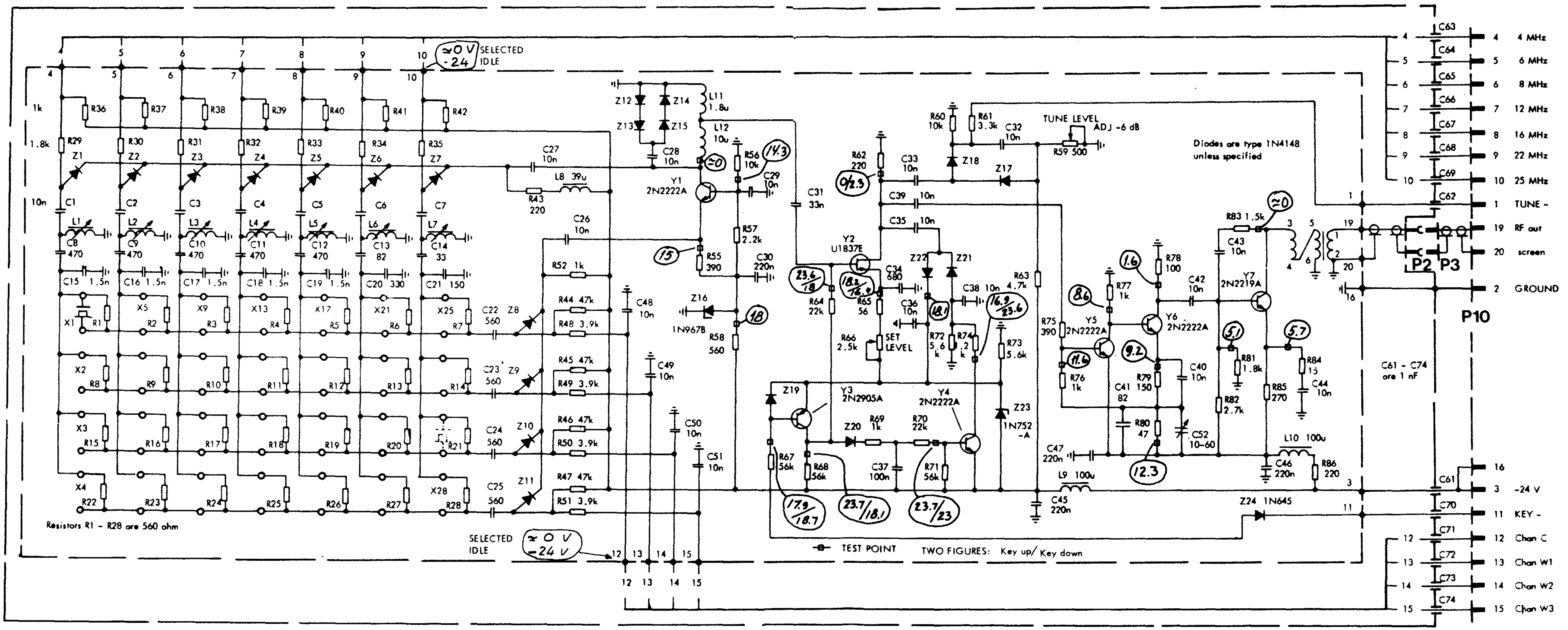


Fig. 10.21 - HF A1 TELEGRAPHY EXCITER B22192 0000