Operators manual

RA. 1778/DA78120/B
HF Communications Receiver

1976
THE QUEEN'S AWARD
FOR EXPORT ACHIEVEMENT
TO RACAL COMMUNICATIONS LTD.

RACAL
The Electronics Group

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'POZIDRIV' SCREWDRIVERS

Metric thread cross-head screws fitted to Racal equipment are of the 'Pozidriv' type. Phillips type and 'Pozidriv' type screwdrivers are not interchangeable, and the use of the wrong screwdriver will cause damage. POZIDRIV is a registered trade mark of G.K.N. Screws and Fasteners Limited. The 'Pozidriv' screwdrivers are manufactured by Stanley Tools Limited.

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TECHNICAL SPECIFICATION

The performance as stated in this specification is applicable to the wideband condition. If the optional RF tuning unit is fitted an additional 20dB of protection is given at ± 12½% off-tune.

Frequency Range:	15kHz - 30MHz.
Modes of Reception:	A1, A2, A2H, A2J, A3, A3A, A3J, A3H with the following options: (1) Choice of USB or LSB. (2) Provision for reception of A3B or F1. (3) Provision of AFC.
Tuning:	(1) 12 Programmable Channels. (2) Continuously tunable synthesizer in 10Hz, 20Hz or 1kHz increments over the full frequency range. Seven digit electronic readout.
Tuning Accuracy:	± 5Hz relative to the frequency of the wanted signal.
Frequency Stability:	(1) The following optional alternative frequency standards may be fitted: (a) Frequency Standard Type 9400 (i) Temperature: ± 1 in 10^8/°C. (ii) Long Term: ± 1.5 in 10^7 over a 30 day period or ± 5 in 10^9 per day. (b) Frequency Standard Type 9420 (i) Temperature: ± 6 in 10^{10}/°C. (ii) Long Term: ± 1.5 in 10^8 over a 30 day period or ± 5 in 10^{10} per day. (2) Provision is made for the use of an external frequency standard.
Antenna Input:	(1) Wideband: 50 to 75 nominal. BNC coaxial connector. (2) RF tuning is available within the receiver. This is provided by five automatically

selected bandpass filters covering the frequency range 1MHz to 30MHz. Manual RF peak tuning is provided over each pre-selected band of frequencies. Each tuned range provides a nominal attenuation of 20dB at 12½% off-tune. A low pass filter is used below 1MHz.

(3) Receiver muting is provided to protect the receiver from local emissions on the tuned frequency. The operation of the muting circuits permits 'break in' or 'listen through' operation when keying at a rate of up to 20 bauds.

(4) The receiver will withstand without damage RF input signals of 30V (EMF) continuously. A fuse and spark gap is provided for protection against higher voltages.

(5) Re-radiation with the antenna input terminated in 50Ω is less than 10 μV.

Sensitivity:

(1) CW and SSB (A1, A2H, A3A, A3H, A3J)

In a 3kHz bandwidth the signal-to-noise ratio is better than:

500kHz-30MHz, 15dB with 1 μV (EMF) input.
50kHz-500kHz, 15dB with 3 μV (EMF) input.
15kHz-50kHz, 15dB with 10 μV (EMF) input.

(2) DSB (A2, A3)

In a 3kHz bandwidth the signal-to-noise ratio is better than:

500kHz-30MHz, 15dB with 1.5 μV (EMF) input 70% modulated.

50kHz-500kHz, 15dB with 5 μV (EMF) input 70% modulated.

15kHz-50kHz, 15dB with 15 μV (EMF) input 70% modulated.

IF Selectivity:

(1) SSB (A3A, A3J)

Passband at -6dB: 250Hz to 3000Hz.
Passband at -60dB: -650Hz and +4100Hz.
or alternatively
Passband at -6dB: 250Hz to 6000Hz.
Passband at -60dB: -300Hz and +8000Hz.

(2) ISB (A3B)

Passband at -6dB: 250Hz to 3000Hz.
Passband at -60dB: -400Hz and +4100Hz.
or alternatively
Passband at -6dB: 250Hz to 6000Hz.
Passband at -60dB: -300Hz and +8000Hz.

(3) CW/MCW/AM/FSK (A1, A2, A3, A2H, A3H, F1)

Standard Receivers. In addition to the mode-selected SSB or ISB filters, up to four optional IF filters may be fitted although certain combinations of facilities will permit only three filters to be fitted. IF filters of the following nominal passbands are available:

0.3kHz, 1kHz, 3kHz, 6kHz, 8kHz, 13kHz.

Alternative filters can be supplied to special order.

Cross Modulation: With a wanted signal greater than 300 μV EMF, in a 3kHz bandwidth, an unwanted signal, 30% modulated, removed not less than 20kHz, will be greater than 300mV EMF, to produce an output 20dB below the output produced by the wanted signal.

Reciprocal Mixing: With a wanted signal of less than 100 μV EMF, in a 3kHz bandwidth, an unwanted signal more than 20kHz removed will be greater than 70dB above the wanted signal level to give a noise level 20dB below the output produced by the wanted signal.

Blocking: With a wanted signal of 1mV EMF, an unwanted signal more than 20kHz removed must be greater than 500mV to reduce the output by 3dB.

Intermodulation Products:

(1) Out of Band

With two 30mV EMF signals separated and removed from the wanted signal by not less than 20kHz the third order intermodulation products are not less than -85dB below either of the interfering signals and typically better than -90dB.

(2) In Band

Two in band signals of 30mV EMF will produce third-order intermodulation products of not greater than -40dB.

Spurious Responses:

(1) External

External signals, 20kHz removed from the wanted signal, must be at least 80dB above the level of the wanted signal to produce an equivalent output.

(2) Internal

The specified sensitivity figures in the CW/SSB modes are not reduced by more than 3dB as a result of any internally generated spurious signals.

AGC:

(1) Range

An increase in input of 100dB above 2 μV EMF will produce an output change of less than 6dB.

(2) Switched selection of AGC 'off', 'short' and 'long' time constants is provided.

AFC (A3A, A3B):

(1) AFC is available as an optional internal facility and is provided with a front panel switch for switching AFC in or out of operation.

(2) Capture range: ± 50Hz.

Follow range: ± 500Hz or beyond.

Residual Error: 2Hz max.

Memory: In the event of carrier failure, or worsening of the carrier to noise/modulation level of 10dB, no re-tuning is necessary for fades of up to 1 minute.

BFO Range: ± 3kHz variable by a slow motion control.

IF Output (AGC On): 1.4MHz, nominally 100mV (EMF) into 50Ω.

Audio Characteristics:

(1) Output Levels:

(a) Line outputs, 1mW nominal into 600Ω balanced, adjustable by preset level control on front panel to +6dBm.

(b) Phone outputs unbalanced, 10mW nominal into 600Ω.

(c) 50mW into an internal loudspeaker which is capable of being switched in or out of operation.

(d) Connection for external speaker 1 watt into 8Ω.

(e) Two 3mW, 600Ω outputs

(2) AF Response:

(a) Line outputs. Within 1dB from 100Hz to 6000Hz relative to the level of a standard 1000Hz tone.

(b) The overall AF response will be dependent upon the IF bandwidth selected.

(3) AF Distortion:

(a) Line outputs. Not greater than 2% at specified output of 1mW nominal.

(b) Loudspeaker outputs. Not greater than 5% at 50mW output to internal loudspeaker, and 1W output to external speaker.

(c) Phone outputs. Not greater than 5% at specified output of 10mW nominal.

Cross Talk (A3B): With a wanted signal at a level of 1mV and the AF output adjusted to 1mW, the cross talk from an equal signal in the opposite sideband, at greater than 400Hz from the carrier, is not greater than -50dB relative to 1mW.

Frequency Shift Demodulation (optional):

(1) Frequency shift range, 85Hz to 850Hz.

(2) Maximum keying speed 200 bauds.

(3) Telegraph distortion not greater than 5% up to 100 bauds.

(4) Telegraph output. Polar (double current) DC output approximately 100mA with choice of 6-0-6V or 80-0-80V. Normally positive on 'Mark'. Provision is made by internal adjustment for neutral (single current) operation.

(5) Mark/space reversal is available to the operator and a 'tune' switch position is provided to permit tuning of the receiver without operating the teleprinter.

Metering: A meter is provided on the front panel to indicate RF level, AF level to line, FSK tune, and suitable performance or supply test levels.

Power Supply: 100V-125V or 200V-250V, ± 10%, 45-65Hz.

Power Consumption: Approximately 60VA (Basic receiver).
Approximately 90VA (Fully equipped).

Environmental Conditions:	The equipment is designed to meet certain of the requirements of the British Defence Specification DEF.133, L2, for ambient temperature range of:	
	Operating Temperature -10°C to +55°C.	
	Storage Temperature -40°C to +70°C.	
	Relative Humidity 95% at +40°C.	
Dimensions:	Rack Mounted	In Bench Cabinet
	Height: 178mm (7 in.)	220mm (8.65 in.)
	Width: 483mm (19 in.)	495mm (19.5 in.)
	Depth: 410mm (16.15 in.)	445mm (17.5 in.)
Weight (approx):	22kg (48.5lb)	28kg (61.5lb)

FRONT PANEL CONTROLS AND FITTINGS

12 way Rotary Channel Selector Switch
Rotary VFO Type Frequency Control
Tuning Rate Switch (Fast, Medium, Slow and Lock)
RF Tuning Control
AGC Time Constants Switch
AFC On/Off Switch (Optional)
AFC Lock Lamp (Optional)
Mode Switch
Meter Facility Switch
Meter
Channel, Tune, Load
Loudspeaker
Loudspeaker Switch
Headphone Socket
IF Gain Control
AF Gain Control
BFO Slow Motion Control
Line Level Preset Adjusters
Filter Switch
Power On/Off Switch

REAR PANEL CONNECTIONS AND FACILITIES

Antenna Input Socket (BNC)
Antenna Input Fuse
Power Input Socket
Mains Voltage Adjuster Panel
Power Input Fuse
Teleprinter Supply Fuse
Teleprinter Supply Selector Switch

Ground Terminal
34MHz Input/Output Socket
34MHz Input/Output Switch
Frequency Standard Input/Output Socket
Frequency Standard Internal/External Switch
35.4MHz to 65.4MHz Input/Output Socket
35.4MHz to 65.4MHz Input/Output Switch
AGC Output (for diversity operation)
Line Output(s) (2 outputs for ISB version only)
Loudspeaker Output
Two 3mW, 600-ohm outputs
Mute Line
} Terminal Strip
FSK Output
1.4MHz IF Output Socket

CHAPTER 1

GENERAL DESCRIPTION

INTRODUCTION

1. The RA.1778 is a fully synthesized solid state communications receiver providing reception facilities for LSB/USB (A3A, A3H, A3J), AM(A3) and CW(A1). Facilities for ISB(A3B), FSK(F1) and AFC are provided by optional, internally fitted, modules.

2. The receiver is fully synthesized and tunable over the range 15 kHz to 30 MHz, with a built-in memory facility which can be programmed with up to 12 frequencies for rapid channel changes. Frequencies can be re-programmed from the front panel at any time.

BRIEF TECHNICAL DESCRIPTION

3. A three position memory switch is provided on the front panel. In the 'Channel' position the programmed channels are selected by the multi-way channel switch with the channel number clearly displayed, the main tuning control acting as a clarifier with a range of ±500 Hz. The LED frequency readout is linked to the switch in the 'Channel' position giving the option of displaying the frequency or inhibiting the display for security reasons.

4. To programme a channel on the receiver, the appropriate channel is selected and the switch is turned to the 'Tune' position. This transfers full control to the main tuning control and the receiver is then tuned to the required channel frequency which is displayed on the seven digit LED readout. This tuned frequency is programmed into the memory unit by turning the switch to the 'Load' (spring biased) position. A rechargeable nickel-cadmium battery provides the power for the memory circuits to ensure that the programmed frequency information is unaffected by mains switching or during extended main power supply failures.

5. In addition to the programming facility, the single knob frequency control allows the receiver to be tuned across the complete band from 15 kHz to 30 MHz. Three rates of tuning may be electronically selected (fast 1 kHz steps, medium 20 Hz steps and slow 10 Hz steps) and once the required frequency has been set the single knob may be electrically disengaged to eliminate any accidental frequency changes due to vibration or movement. Unbroken frequency-search facilities are achieved throughout the full frequency range without the need for MHz switching.

6. Up to six IF bandwidth filters may be selected. Of these, two are normally sideband filters automatically selected by the MODE switch. If AFC is fitted, one of the filters must be a carrier filter. The symmetrical filters fitted are selected by a filter switch and may be chosen from the nominal filter bandwidths available, which are 0.3 kHz, 1 kHz, 3 kHz, 6 kHz, 8 kHz and 13 kHz. A slow motion BFO control is provided for CW operation. A built-in meter may be switched to indicate RF and AF levels as well as supply voltage levels. A further meter switch position provides for a tuning indication when the AFC facility is fitted.

7. A switched monitor loudspeaker is provided and a front panel socket permits headphone monitoring of the sideband selected by the MODE switch. A coaxial antenna socket is mounted on the rear panel for the connection of a coaxial antenna feeder.

8. The built-in power unit is capable of operating from a 100 to 125V or 200 to 250V, 45 to 65 Hz supply. For FSK operation an integral 6V-0-6V or 80V-0-80V signalling supply, selected by a rear panel switch, is provided for the associated teleprinters.

9. The receiver is phase-locked to a reference frequency, and one of three available frequency standards is fitted internally. The Temperature Compensated Crystal Oscillator (TCXO) provides a stability of 1.5 ppm over the entire temperature range and is adequate for most services where SSB speech or wide-shift telegraphy is used, or where the operating temperature is stable. The Type 9400 frequency standard provides a higher stability to meet the requirements of narrow-shift telegraphy operation, while the Type 9420 frequency standard provides a very high order of stability, both short and long term.

MECHANICAL DESCRIPTION

10. A rigid, die-cast, full-width chassis provides the basis for the main frame of the receiver. Mounted within compartments on the underside of this chassis are the mixer boards and part of the frequency generation system. Mounted on the top of the chassis is an aluminium box structure, which houses up to nine (dependent on the options fitted) printed circuit boards, each individually screened. These printed circuit boards may be hinged out and then locked into position for maintenance purposes. Also mounted on top of the chassis is the frequency standard module and the power supply transformer. A solid-state high speed relay and a current limiting ballast lamp are included in FSK versions of the receiver. The power supply printed circuit board is mounted on the inside of the rear panel and adjacent to this board are mounted the power supply smoothing capacitors. The power supply regulator output transistors are mounted on a heatsink attached to the rear panel. Further printed circuit boards, containing memory and decoder logic circuits are mounted on the inside of the front panel.

TRANSIT SCREWS

11. Where a receiver is mounted in a table-top cabinet, two transit screws are provided; these are painted red to assist identification and are shown in Fig. 3. To avoid damage to a receiver transported within a table-top cabinet, it is important to ensure that both of these screws are securely in position.

IDENTIFICATION OF VARIANTS

12. Because of the various options available numerous differing versions of the RA.1778 may be derived. In order to identify the optional facilities fitted to a particular receiver, a series of suffix characters are added to the RA.1778 type number on the type/serial number plate attached to the rear of the receiver chassis. The meanings of the suffix characters are described below:-

Variant Suffixes

13. First Suffix: Alphabetical identification of symmetrical and sideband filters fitted, according to Table 1, which gives examples of the more common variants of filter combinations.

NOTE: A total of six filters may be fitted. In standard production models five symmetrical filter positions are selectable and are wired to the FILTER switch although certain combinations of facilities will limit the symmetrical filters fitted to three. For example, an ISB version with AFC is limited to three symmetrical filters as the other three filter positions are occupied by the USB, LSB and carrier filters. On the other hand, a receiver equipped with USB only has space for four symmetrical filters and one carrier filter.

Second Suffix: Frequency standard fitting.
O indicates no internal frequency standard fitted; receiver operates from external frequency standard.
S1 indicates 1.5 ppm TCXO.
S2 indicates Type 9400.
S3 indicates Type 9420.

Third Suffix: RF Tuning Unit.
O indicates not fitted.
R indicates is fitted.

Fourth Suffix: ISB filter identification.
O indicates not required.
B3 indicates 3 kHz filter (2.7 kHz minimum bandwidth).
B6 indicates 6 kHz filter (5.7 kHz minimum bandwidth).

Fifth Suffix: Frequency Shift Keying.
O indicates FSK facility not fitted.
F indicates FSK facility is fitted.

Sixth Suffix: Automatic Frequency Control.
O indicates AFC facility not fitted.
C indicates AFC facility is fitted.

TABLE 1

Examples of Filter Options

First Suffix	Symmetrical Filters (kHz)					Sideband Filter (kHz)	
						USB	LSB
A	0.3	3	8	-	-	3	3
B	0.3	1	8	-	-	3	3
C	0.3	1	3	8	-	3	-
D	0.3	1	3	8	-	2.7	-
E	0.3	3	8	-	-	6	6
F	0.3	1	8	-	-	6	6
G	1	3	13	-	-	6	6
H	1	3	8	-	-	3	3

IMPORTANT NOTE

INTERNAL BATTERY SUPPLY

1. The RA.1778 receiver contains a rechargeable battery which supplies power to the various circuits which maintain the stored frequency/channel settings during breaks in the supply of up to approximately 24 hours. A two-position link is fitted to the decoder board (PM694) to allow the battery to be disconnected for maintenance purposes.

2. Before a receiver is installed, ensure that the link on the decoder board is set to the BATTERY ON position. Before undertaking any maintenance work on either the decoder board or the memory board (PM693) set the battery link on the decoder board to the OFF position. Failure to do so may cause damage to the battery and other components.

NOTE: Removal of the battery link may cause stored frequency or channel data to be lost.

3. The battery is charged, whilst the receiver is switched on and power is applied, from an internal supply. A fully discharged battery will be fully re-charged in approximately 15 hours. The life of the battery is approximately three years.

CHAPTER 2

INSTALLATION

INTRODUCTION

1. This Chapter contains instructions for power supply preparation, receiver connections, teleprinter preparation and functional checks. The contents of the Chapter must be carefully studied and all necessary preparations completed before proceeding to the switch-on at para. 25.

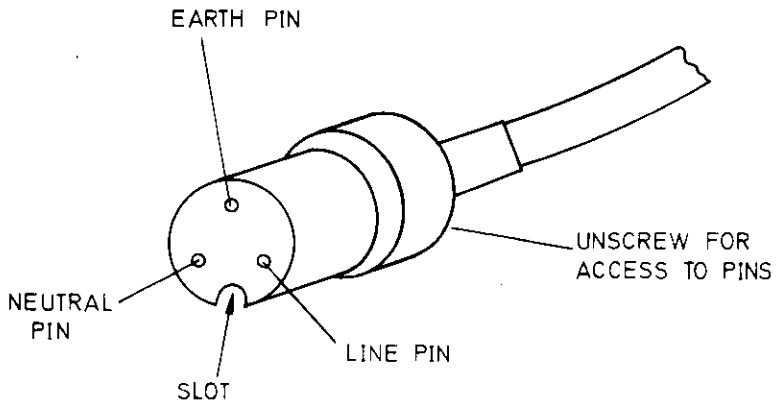
POWER SUPPLY PREPARATION

Mains Connector

2. The receiver is supplied with a mains lead and plug assembly. It is essential that the Earth wire of the mains lead is wired to a reliable earth point. The details of the mains plug are given in fig. 2.1. The normal colour code is:-

Brown	Line
Blue	Neutral
Green/Yellow (or Green)	Earth (ground)

When assembling the cable to the plug ensure that the earth pin is located diametrically opposite to the slot in the plug body.



Mains Supply Plug Fig. 2·1

Fuselinks

3. Check that fuselinks of the correct rating are fitted to the rear panel as follows:-

Fuse	Rating	Replacement Type
ANTENNA	500 mA	Belling Lee L754
POWER	1A (anti-surge)	Beswick TDC134
STANDBY	2A (anti-surge)	Beswick TDC134
TEL	150 mA	Belling Lee 562

Supply Voltage Selection

4. Check that the voltage selector, located on the rear panel, is correctly set to suit the local source of a.c. power. The arrow on the plug-in selector should point to the nominal voltage of the supply.

NOTE: The supply voltage must remain within 10% of that selected since a low voltage will cause the internal regulation circuits to trip and a high voltage will give rise to increased internal temperatures.

INTERNAL BATTERY

5. The RA.1778 receiver contains a rechargeable battery which supplies power to the various circuits which maintain the stored frequency/channel settings during breaks in the supply of up to approximately 24 hours. A two-position link is fitted to the decoder board PM694 to allow the battery to be disconnected for maintenance purposes. The location of the board is shown in Fig.4.

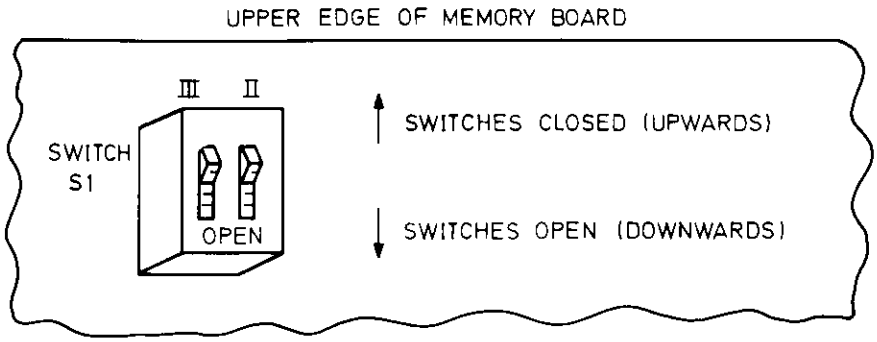
CAUTION:

Before a receiver is installed, ensure that the link on the decoder board is set to the BATTERY ON position. Before undertaking any maintenance work on either the decoder board or the memory board (PM693) set the battery link on the decoder board to the OFF position. FAILURE TO DO SO MAY CAUSE DAMAGE TO THE BATTERY AND OTHER COMPONENTS. Since removal of the battery link may cause stored frequency or channel data to be lost, appropriate re-tuning should be carried out on completion of maintenance.

6. The battery is charged from an internal supply whilst the receiver is switched on and power is applied. A fully discharged battery will be fully re-charged in approximately 15 hours. The life of the battery in normal use is approximately three years.

TUNING/DISPLAY OPTION SELECTION

7. The dual switch assembly S1, mounted on the Memory Board, can be preset to give the functions listed in Table 2 when the MEMORY switch is set to CHANNEL operation. The switch assembly comprises two rocker switches (identified by the markings II and III on the board.) mounted in a single block. See Fig. 4 for location. Fig. 2.2 below shows the closed and open positions, and Table 2 gives the various tuning and display facilities which are available when operating on CHANNEL. Remove the dust cover from the switch block in order to operate.



Tuning/Display Selection Fig. 2·2
(SEE TABLE 2)

TABLE 2

Tuning/Display Selection

Option	Switch Positions See Fig. 2.2	Tuning/Display Facility
1	Both 'Open'	Display permanently off and tuning range restricted to ±500 Hz.
2	Switch II closed: Switch III open.	Display permanently on and tuning range restricted to ±500 Hz.
3	Switch II open: Switch III closed.	(1) Channel 4, display on and full tuning range available. (2) Other channels, as for Option 1.

CONNECTIONS

8. All connections, except headphones, are made at the rear of the receiver. The rear panel details are illustrated in Fig. 3 at the back of the book.

Headphones.

9. Headphones (of 600Ω impedance) may be plugged into the front panel PHONES socket. The required phones jack plug is a Rendar R22600 (Racal Part No.922117).

Antenna

10. The ANTENNA socket will accept a 50Ω or 75Ω unbalanced coaxial line, connection being made via a Transradio BNC type BN1/5 free plug (Racal 900038) or equivalent.

IF Outputs

11. (1) MAIN IF OUT : Provides the 1.4 MHz IF signal at a level of 50 mV p.d. (nominal) into 50Ω.

(2) ISB IF OUT : Supplied from the ISB IF board when this optional board is fitted.

These outputs are used for connecting external equipment which operates at 1.4 MHz, for example Racal RA.1766 RF Signal Display Unit, MS561 100 kHz Adaptor, etc.

Oscillator Inputs and Outputs

12. (1) 1 MHz IN/OUT : With the 1 MHz INT/EXT switch set to INT, a 1 MHz signal of 0 dBm (50Ω) level is available at this socket. This provides an external reference for a digital frequency meter when, for example, checking correct synthesizer operation. The EXT position allows an external 1 MHz reference to be applied when the receiver is operating as a diversity slave receiver.

(2) 34 MHz IN/OUT
LO IN/OUT : These sockets are used in conjunction with the diversity operation of the receiver (refer to Figs. 6,7 and 8). The associated INT/EXT switches are set to INT unless the receiver is operating as a slave in a diversity system.

Earth Terminal

13. A terminal is provided on the rear panel for connection to the earthing system of a cabinet, or to an earth stake.

Terminal Strips TS1 and TS2

14. Two 9 way terminal strips are mounted on the rear panel. Connection details are as follows:-

Identification		Function
TS1		
1, 2	LINE OUTPUT MAIN IF	Audio Line output from main IF (1 mW nominal into 600Ω). SSB Receiver: USB or LSB as selected by MODE switch. ISB Receiver: USB
3	E	Earth.
4, 5	ISB LINE OUTPUT	Audio line output from LSB channel - ISB receiver only. 1 mW nominal into 600Ω.
6	LS	Audio output to external loudspeaker. USB or LSB, as selected at front panel MODE switch. 1W nominal into 8 Ω. Two 3mW, 600Ω outputs derived from LS terminal
7	E	Earth.
8	FSK IN	Used for FSK diversity interconnection. Refer to Figs. 6, 7 and 8.
9	FSK OUT	

Identification		Function
TS2		
1	DIV AGC	For Diversity AGC connection (Figs. 6, 7 and 8).
2	E	Earth.
3	MUTE	An earth connection to this pin mutes the receiver.
4	TEL O/P	Connection (via a series resistor) for teleprinter (FSK versions only, see para. 18)
5	TEL E	
6	+12V	+12V supply for external equipment, current should not exceed 50 mA.
7	STD/+12V	Provision for external standby +12V supply for the internal frequency standard.
8	DIV RL	Diversity relay (FSK versions only). Used in conjunction with the Racal MM.532 audio switching module (see Fig. 9).
9	ISB DIV AGC	ISB diversity AGC connection to second receiver, for diversity reception, ISB version only.

DIVERSITY RECEPTION

15. Interconnection details for diversity reception systems are given in Chapter 5 and Figs. 6, 7 and 8. Before interconnecting the two receivers, each should be individually checked in accordance with the instructions in this Chapter.

16. The LO, 34 MHz and 1 MHz INT/EXT switches on the rear panel should be set to INT for the master receiver and EXT for the slave receiver.

CONNECTION OF TELEPRINTERS

Operating Characteristics

17. Before preparing the receiver the following teleprinter data must be known:-

(1) Its operating voltage and current.

(2) Its voltage polarity.

Typical characteristics are:-

(a) British teleprinters : Voltage, ±80V (polar). Current, 20 mA.

(b) European (continental) teleprinters : Voltage, -80V and 0V (N-). Current, 40 mA.

Receiver Preparation for Teleprinter Operation

18. Carry out the following at the receiver rear panel:-

(1) Set the TEL voltage switch to 6V or 80V, as required.

(2) Set the TEL polarity switch to one of the following:-

(a) N+ for +80V and open circuit.

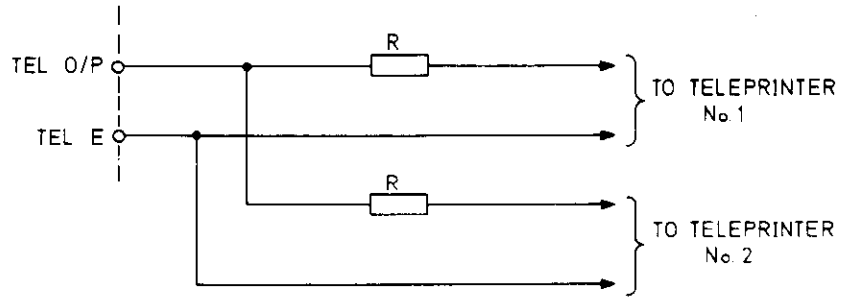
(b) P for ±80V.

(c) N- for -80V and open circuit.

(3) Connect a resistor R whose value (in kΩ) is calculated thus,

$$R = \frac{80}{\text{Teleprinter current (mA)}}$$

in series with the TEL O/P terminal. Fig. 2.3 shows such an arrangement for two teleprinters. Each resistor should be rated at 4 watts and must be fitted where ventilation is adequate.



Teleprinter Limiting Resistors Fig. 2·3

19. For unattended operation it is necessary to prevent the teleprinter from running when transmission ceases, both when a 'hold' tone is being sent and when the transmitter is switched off. When the transmitter sends a continuous tone holding will occur automatically, as long as the MODE switch on the receiver front panel is set to the appropriate N or R position (the appropriate position is most easily determined by switching between the two and observing the teleprinter copy).

20. When the transmitter is switched off, channel noise must not cause the receiver to operate the teleprinter in a random manner. To prevent this the following modifications must be carried out (except for diversity operation):-

(1) On terminal strip TS1 link the FSK IN terminal to the E terminal.

(2) Link together pin 30 and pin 1 on the Main IF board PM674.

21. This will enable the IF gain control to act as a sensitivity control. This means that the lower end of the a.g.c. range is removed, so that if the a.g.c. voltage falls below the threshold determined by the position of the IF gain control, the output to the Teleprinter will revert to the Stop current, and the printer will not print at random.

22. Provided the IF gain control is adjusted so that, with the transmitter off, the teleprinter just does not print at random, the received transmission will operate the teleprinter in the normal way. It should be borne in mind, that some channels are noisier than others and it may be necessary to adjust the IF gain when changing channels.

Teleprinter Supply Selection

23. The TEL 80V/6V and N+/P/N- switches on the rear panel of the receiver, together with the FSK TUNE, N and R positions of the MODE switch, provide the necessary requirements for the majority of teleprinters. Certain polar types of teleprinter, however, require a positive-hold voltage (idle condition) when the MODE switch is set to FSK TUNE, and also when the received transmission is switched off. The positive hold for such teleprinters can be obtained by means of a simple modification, as follows. This modification is essential when using N+ printers.

Modification for Positive Hold Voltage

24. NOTE BEFORE ANY WORK IS CARRIED OUT ON THIS EQUIPMENT ALL POWER SUPPLIES MUST BE DISCONNECTED. POWER SUPPLIES ARE TO BE RECONNECTED ONLY WHEN THE PERSON RESPONSIBLE FOR EMBODYING OR INSPECTING THE MODIFICATION IS SATISFIED THAT ALL ACTION HAS BEEN TAKEN TO MAKE THE EQUIPMENT SAFE FOR RECONNECTION.

(1) Carry out the initial dismantling operations detailed in Racal Handbook RA1778 Part 2, Chapter 21, Paragraph 2.

(2) Lower the front panel assembly as detailed in Part 2, Chapter 21 Paragraph 8.

(3) Referring to Fig.2.4(a) cut and remove the wire link on the front wafer of the mode switch at the points indicated. Unsolder the White/Orange/Blue wire from the switch contact.

(4) Refer to Fig.2.4(c) and remove diodes D8 and D9 and unsolder the White/Brown/Red wire from the contacts on the rear switch wafer.

(5) Using the tinned copper wire, Item 1, and PTFE sleeving, Item 2, make the link on the rear switch wafer as indicated in Fig 2.4(d).

(6) Referring to Fig.2.4(b) solder in the diode with long leads removed in (4) as indicated taking care to observe correct polarity. Solder the White/Orange/Blue wire to the switch contact as shown. Solder the White/Brown/Red wire to the switch contact as shown.

(7) Refit the front by carrying out in reverse the operations detailed in Part 2, Chapter 21, Paragraph 8 of the Handbook.

PARTS REQUIRED

25.

Item	Description	Part No.	Qty.
1	1 mm Tinned Copper Wire	919066	5 cm
2	PTFE Sleeving	900862	5 cm

NOTE: Where local noise interference is experienced it may be advantageous to carry out the AGC manual override modification given in Chapter 2 para.20

FSK Diversity Modifications

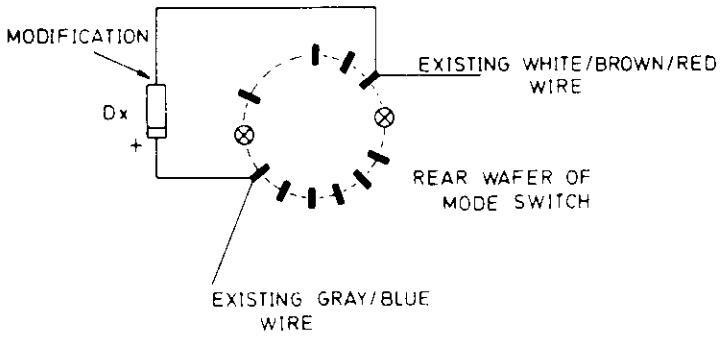
26 For FSK diversity operation do not carry out the modification of para.20, as the FSK IN terminal is now connected to the other receiver. The modification in para.24, however, must be carried out if required by the characteristics of the teleprinter in use.

27. The interconnection of receivers for diversity operation is shown in Figs.6,7 and 8. A more detailed description of diversity reception arrangements is given in Chapter 5.

INITIAL SWITCH ON

28. (1) Set the POWER switch to OFF.

(2) Check that switch S1 on the Memory board is set to Option 2, (see para.7 and Table 2). When preparation checks have been completed the switch may be set as required.



Positive Hold Modification on Mode Switch
(VIEWED FROM REAR)

Fig. 2·4

(3) Check that the power supply preparations (paras.2,3 and 4) have been carried out.

(4) Connect the power socket to the a.c. supply.

(5) Set the MEMORY switch to the TUNE position.

(6) Set the POWER switch to ON.

(7) Check that at least five digits (kHz and Hz) in the display are illuminated (the display will be random until programmed). The OUT OF LOCK lamp may flash momentarily but should then remain extinguished (unless the display reads a number outside the 15kHz to 29.99999MHz operating range).

(8) Set the METER switch, in turn, to DRIVE LEVEL, +20, +12, +5 and -7; ensure that for each voltage setting the meter indication is within the green portion of the meter scale; for the DRIVE LEVEL position check that the meter indication is within the V scale brackets.

TUNING CHECK

29. (1) Set the CHANNEL switch to channel '1' and the MEMORY switch to TUNE.

(2) Switch to each TUNING RATE in turn and rotate the tuning knob, checking that the step size and rate (Hz per revolution of the knob) are as follows:-

Slow:	10Hz steps (1kHz per revolution)
Medium:	20Hz steps (20kHz per revolution)
Fast:	1kHz steps (1MHz per revolution)

(3) Tune to a frequency display of 12345.67kHz, then switch the TUNING RATE switch to LOCK.

(4) Turn the MEMORY switch to the LOAD position: the display will blink off when on, the OUT OF LOCK lamp will flash on briefly, and the final digit will become '0' (this is because the 10Hz digit is not stored in the Memory).

(5) Set the CHANNEL switch to '2' and programme another frequency, using the method described above.

(6) Switch back to CHANNEL '1' and verify that the display again reads 12345.60.

(7) Set the MEMORY switch to the CHANNEL position.

(8) Set the TUNING RATE switch to SLOW and rotate the tuning knob exactly one revolution clockwise, then set the TUNING RATE switch to LOCK. The display should read 123456.10kHz, as 500Hz has been added to the programmed frequency by this 'fine tune' operation.

(9) Repeat (8) but rotate the tuning knob exactly two revolutions anti-clockwise. The display should read 500Hz below the programmed frequency, i.e. 12345.10kHz.

(10) Set the CHANNEL switch to '2' and then back to '1'. This should reset the display to the original programmed frequency (12345.60kHz).

(11) Repeat the procedure (3) to (10) on all channels.

(12) Set the switch S1 on the Memory board to the desired operational facility, (see para.7 on page 2-3).

LINE LEVEL ADJUSTMENT

NOTE: The following settings are suitable for lines in which the peak level must not exceed 1mW (e.g. British Post Office lines). For lines having a higher power limit the settings may be carried out substituting 2μV for 200mV in para.29 (3) thus giving up to 6dB increase in input power to the line.

30. (1) Set the following controls as indicated:-

POWER switch	ON
MODE switch	USB
AFC switch (if fitted)	OFF
AGC switch	OFF
IF GAIN	Fully clockwise
METER switch	AM/USB

(2) Connect a 600Ω load across the MAIN IF LINE OUTPUT terminals (TS1 pins 1 and 2) on the rear panel.

(3) Connect the CW output from a signal generator, set to a frequency of 3.5MHz and an output level of 200mV e.m.f., to the receiver antenna socket.

(4) Set the receiver tuning controls for a frequency of 3.5MHz.

(5) Precisely adjust the receiver kHz tuning for a maximum indication on the front panel meter.

(6) Set the AGC switch to SHORT.

(7) Using a thin-bladed screwdriver, adjust the AM/USB LINE LEVEL control for a 1mW audio output level, as indicated by the red line on the upper scale of the meter.

(8) Repeat the above procedure for the adjustment of the LSB LINE LEVEL control (ISB receivers) but set the MODE switch to LSB, the METER switch to LSB and transfer the 600Ω load to the ISB LINE OUTPUT terminals (TS1 pins 4 and 5).

(9) Switch off and disconnect the signal generator.

(10) Remove the 600Ω load.

CHAPTER 3

OPERATING INSTRUCTIONS

INTRODUCTION

1. Before operating the receiver for the first time, ensure that it has been prepared for service in accordance with the information given in Chapter 2.

FUNCTION OF CONTROLS

2.

(1) RF TUNE: This is a 'front-end' tuning facility usually only required when the receiver is operated in close proximity to strong interfering signals. It is switched out of circuit when set to WB (wide-band).

(2) AGC: (OFF, SLOW, FAST) This is a three position switch. In the OFF position the receiver gain can be manually controlled by the IF GAIN control. The choice of FAST or SLOW a.g.c. will depend upon the operating mode and the propagation conditions. In these two positions, the IF GAIN control is inoperative, but by carrying out the modification described in Chapter 2, para. 20 (2) the IF GAIN control can be used even when AGC is selected.

(3) IF GAIN: See (2) above.

(4) CHANNEL Switch: A 12-position switch selects the required programmed frequency when the MEMORY switch is set to CHANNEL.

(5) MEMORY Switch: A 3-position switch, as follows:-

CHANNEL: in this position the CHANNEL switch is operative and provides display and tuning facilities as described in Chapter 2 para. 7 and Table 2.

TUNE: in this position the display is switched on for tuning (programming) purposes.

LOAD: this position is spring biased and is used to store the displayed frequency in the selected channel.

(6) TUNING RATE Switch: A 4-position rotary switch which operates in conjunction with the display, to give slow, medium or fast tuning rates as specified on page Tech. Spec. (1). The FAST and MEDIUM tuning rates are disengaged when the display is switched off. The SLOW position provides a fine tune facility. (See Chapter 2 para. 5). In the LOCK position the tuning knob is disengaged.

(7) TUNING CONTROL Knob: Provides continuous tuning from 0 - 29.999 MHz (in conjunction with the Tuning Rate switch). A mechanical damping screw for this control is located on the underside of the chassis (Fig. 5).

(8) BFO Control: The slow-motion BFO tuning control provides a variable offset of up to approximately plus or minus 3 kHz. The BFO is switched on only when the MODE switch is set to CW.

(9) MODE Switch: This switch selects the mode of operation and may have up to a maximum of nine positions, as described below. The first two positions (ISB-L and ISB-U) are only operative in ISB versions, the last three positions (R, N, TUNE) are only operative in receivers fitted with the FSK facility.

ISB-L: ISB (A3B) reception with the lower sideband audio output monitored at the PHONES socket, the internal loudspeaker and the loudspeaker terminal on the rear panel.

ISB-U: ISB (A3B) reception with the upper sideband audio output monitored at the PHONES socket, the internal loudspeaker and the loudspeaker terminal on the rear panel.

LSB: Single sideband (A2H, A3A, A3H, A3J) operation with the lower sideband selected. The LSB audio output is available at the PHONES socket, the internal loudspeaker and the loudspeaker terminal on the rear panel.

(9) MODE Switch: (Cont'd).

USB: Single sideband (A2H, A3A, A3H, A3J) operation with the upper sideband selected. The USB audio output is available at the PHONES socket, the internal loudspeaker and the loudspeaker terminal on the rear panel.

CW: CW (A1) operation.

AM: Double sideband AM (A2, A3) operation.

FSK: The last three positions are for FSK (A2, A2H, A2J, F1) operation.

R Reverse output polarity
N Normal output polarity
TUNE Permits tuning of the receiver without operating the teleprinter.

(10) FILTER: Up to five IF symmetrical filter positions may be fitted dependent upon the options fitted. The switch is only in circuit for the CW, AM and FSK positions of the MODE switch.

(11) AF GAIN: The AF GAIN control is used to adjust the audio level to the headphones, the internal loudspeaker, and the external loudspeaker terminals.

(12) AFC: An optional facility, for use with A3A and A3H operating modes, controlled by a three position switch:-

Up: FULL CARRIER (A3H)
Centre: OFF
Down: PILOT CARRIER (A3A)

An associated LOCK lamp illuminates when the AFC is in operation and a carrier signal is present. The front panel meter includes on AFC scale. When the METER switch is set to TUNE CARRIER and the AFC switch is set to OFF, the meter provides an indication of frequency difference and may be used to minimise any tuning error. When the AFC switch is set to FULL or PILOT CARRIER (as appropriate), the meter provides an

(12) AFC: (Cont'd.)

indication of available hold range. It may, therefore, be used to determine whether a slight adjustment of the receiver tuning is required to maintain AFC lock.

(13) METER:

A ten-position meter switch. The operative positions are dependent upon the options fitted. The positions available are as follows:-

TUNE CARRIER:	For accurate tuning of FULL or PILOT carrier signals, used in conjunction with the AFC switch.
RF:	RF level indication, for general tuning purposes.
LSB:	LSB audio output level.
AM/USB:	DSB/USB audio output level (LSB audio output level for SSB receiver).
DRIVE LEVEL:	Output signal to first mixer.
+20 +12 +5 -7	Rail voltage monitoring.
FSK OUTPUT:	Plus and minus FSK output voltage indication.

(14) POWER ON/OFF:

A double pole switch which connects the a.c. supply to the voltage selector unit and mains transformer.

(15) LS Switch:

A single pole switch which switches the loudspeaker on and off.

(16) LINE LEVEL: preset control(s)

One preset control is provided for SSB versions, two preset controls for ISB versions. The adjustment of these controls is given in Chapter 2, para. 29.

RECEIVER TUNING

3. The following procedure is a general guide to the correct operation of the receiver controls and use of the Memory facility.

4. (1) Connect a pair of headphones to the front panel PHONES socket.

(2) Set the Receiver controls as follows:-

RF TUNE	WIDEBAND (WB)
AGC	LONG
TUNING RATE	LOCK
AFC	OFF
CHANNEL	'1'
METER	RF
MEMORY	TUNE

(3) Set the POWER switch to ON.

(4) Using the TUNING RATE switch and the large tuning knob set the frequency to the wanted signal. The FAST tuning rate is used for large, rapid, frequency changes and the SLOW rate for tuning into the signal. The MEDIUM rate will be found especially useful for signal search. A screw is fitted (internally) for adjusting the 'feel' of the tuning knob to suit the operator. (See Fig. 5).

(5) The MODE switch should be set to the appropriate mode and, in CW, AM and FSK modes, the bandwidth is set separately on the FILTER switch. The 8 kHz bandwidth is for AM operation. For CW and FSK operation the 3 kHz bandwidth may be used for signal search and the bandwidth narrowed down to 1 kHz or 300 Hz as the signal is tuned in.

CHANNEL OPERATION

5. Before operating on CHANNEL the Memory must be programmed with the required frequencies in the following manner:-

(1) Set the CHANNEL switch to the required channel number and set the MEMORY switch to TUNE.

(2) Use the Tuning controls (see para. 4) to tune the required frequency.

(3) Set the MEMORY switch to the LOAD position. This stores the tuned frequency in the channel memory.

(4) Repeat steps (1), (2) and (3) to programme other channels.

(5) Having programmed the desired channel(s) the MEMORY switch should be set to CHANNEL, the receiver may then be fine tuned, up to 500 kHz either side of the programmed frequency, by setting the TUNING RATE to SLOW and adjusting the large tuning knob as necessary. When the tuning adjustment is completed the TUNING RATE switch must be returned to the LOCK position.

(6) Except when using the tuning knob for manual tuning it is essential to keep the TUNING RATE switch in the LOCK position. This will ensure that the operating frequency remains unchanged despite vibration, switching off or extended mains supply failure. If it is though that a channel frequency has changed for the above reasons, the original frequency can be restored by changing to another channel and back again.

(7) If, when operating in CHANNEL, the display is not required, the switch on the Memory board may be set to Option 1 (see Chapter 2, para.5 and Table 2).

RF TUNING

6. The RF tuning is not operative below 1MHz. To obtain increased protection against strong interfering signals monitor the wanted signal on phones or loudspeaker, at the same time tune for maximum output on the meter using the RF position of the METER switch, or tune for maximum audio signal.

USE OF OPTIONAL FACILITIES

FSK Demodulation

7. (1) Prepare the receiver for FSK reception as described in Chapter 2, paras.15 to 22.

(2) Check that the TEL switches on the receiver rear panel are correctly set for the teleprinter in use.

(3) Set the MODE Switch to FSK TUNE, the MEMORY switch to TUNE and the FILTER switch to 3kHz (or 8kHz).

(4) Tune in the signal as described in para. 4 until the mark and space tones in the headphones appear to be of identical frequency. Reduce the FILTER bandwidth to the narrowest setting (0.3kHz or 1kHz) which still gives identical tones in the headphones.

(5) Set the TUNING RATE switch to LOCK, and the MODE switch to N or R, whichever is suitable for the teleprinter in use.

AFC Operation

8. (1) Set the METER switch to TUNE CARRIER and the AFC switch to OFF. Carefully adjust the receiver tuning until the meter reading falls towards the TUNE CARRIER position, where it will beat at a rate proportional to the frequency error. (As the range of the meter is only about 100 Hz the beat note heard in the headphones can be used as a guide).

(2) Set the AFC switch to FULL CARRIER or PILOT CARRIER as appropriate to the received signal. Verify that the AFC LOCK lamp illuminates after about 10 seconds.

(3) The AFC lock lamp may flicker on and off occasionally due to the self compensating nature of the frequency locking loop or to fading of the incoming signal. The frequency will be held during these periods and no interruption or distortion of the signal will result.

(4) The meter will now read '0' on the AFC scale. As the transmitter drifts the meter reading will move away from zero. If the drift is very large (e.g. 100 Hz or more) the TUNING RATE switch should be set to SLOW and the Tuning control very slowly adjusted to increase or decrease the receiver frequency (as indicated by the meter) until the meter again reads '0' on the AFC scale.

(5) When changing between programmed channels the AFC may be left switched on as long as the transmitter does not drift by more than ±50 Hz relative to its nominal frequency. If in doubt, switch off the AFC, change to another channel, check for tuning accuracy, then switch AFC on again.

(6) When the tuning knob is used to tune in a new signal the AFC switch must be set to OFF, or misleading results will be obtained.

CHAPTER 4

PRINCIPLES OF OPERATION

INTRODUCTION

1. This chapter, in conjunction with the block diagram Fig. 1, describes the functional principles of the RA.1778 receiver.

RF BOARD

2. The RF board may be operated in the wideband condition (RF TUNE control set to WB) or, where close proximity interferring signals are present, in the tuned condition. The two conditions are described below.

3. (1) Wideband Condition. The received signal, in the frequency range 15kHz to 30MHz, is fed from the antenna to a wideband protection stage. This contains a relay to open circuit the RF input for signals which exceed approximately 3V e.m.f. at the antenna socket. This relay is also used for receiver muting and operates when an earth is connected to the rear panel MUTE terminal. After operation of the relay the receiver is protected from input signals of up to at least 30V e.m.f. with automatic recovery.
A 500mA fuse provides protection from higher input voltages.

(2) Tuned Condition. The RF tuning unit provides added selectivity where the receiver is operated in close proximity to strong interferring signals. The additional protection stage open-circuits the input to the RF amplifier for in-band signals which exceed approximately 3V e.m.f. (at the amplifier input) and the wideband protection stage is set to operate for out-of-band signals which exceed approximately 10V e.m.f. at the antenna socket.

4. Following amplification in a highly linear RF stage, the received signal is passed via the 30MHz low-pass filter to the first mixer board.

LOCAL OSCILLATOR

5. The local oscillator section consists of two sections. The first is a 3.6 to 4.6MHz section consisting of 3 phase locked loops (PM588 and 589 Boards). The BCD information comes from the UP/DOWN counters on the memory board, which may be derived either from the shaft encoder or the memory itself. This information is also used to drive the kHz displays.

6. The BCD information for the MHz digits comes from the same sources and is presented to the Display and Decoder boards. On the Decoder board the BCD is converted to 9's complement BCD for driving the HF and Transfer loops (PS337/338) and into 3 oscillator selecting signals for selecting the correct output oscillator. The 3.6 to 4.6MHz is 'added' to the MHz steps to produce 35.4 to 65.4MHz in 10Hz steps.

7. The final local oscillator output frequency, in MHz, is given by 40 - f_s + N, where f_s is the output of the 3.6 to 4.6 MHz synthesizer in MHz, and N is the setting of the MHz digits.

8. The local oscillator signal is applied to an electronic switch which is controlled by the rear panel LO switch. In the INT position the local oscillator signal is allowed to pass through the electronic switch to the first mixer board and is also available at the LO IN/OUT socket on the rear panel. When the switch is set to EXT, the internal local oscillator signal is replaced by an externally generated signal from a second receiver connected to the LO IN/OUT socket.

FIRST MIXER BOARD

9. The local oscillator signal from the HF loop board is first filtered and amplified before being applied to a high performance mixer. The filter is switchable and a range information signal from the Decoder board selects a passband of 35.415 to 39.4 MHz or 39.4 to 65.4 MHz. The local oscillator signal is mixed with the received signal from the RF board and the difference frequency output is fed via a 35.4 MHz band-pass filter to the second mixer board.

34 MHz GENERATOR BOARD

10. This board generates a 34 MHz injection frequency signal for the second mixer; it also contains a 1.4 MHz carrier re-insertion generator, a 1.4 MHz beat frequency oscillator (BFO) and a 1 MHz divider.

11. The 5 MHz output from the internal frequency standard is applied to a divide-by-five stage and the resulting 1 MHz output is fed to an electronic switch; this electronic switch is controlled by the rear panel 1 MHz switch. In the INT position the 1 MHz signal is allowed to pass through the electronic switch and is also available at the rear panel 1 MHz IN/OUT socket. When the switch is set to EXT, the 1 MHz signal is replaced by an externally generated 1 MHz signal (from a second receiver or frequency standard) connected to the 1 MHz IN/OUT socket. The 1 MHz signal is used as a common reference frequency for the synthesizer and the 34 MHz generator; it is also used to generate the 1.4 MHz carrier re-insertion signal.

12. The 34 MHz generator consists of a 34 MHz oscillator; this feeds a divide-by-34 stage and the resulting 1 MHz output is phase-locked to the reference 1 MHz signal derived from the frequency standard. The 34 MHz output signal is fed to an electronic switch which is controlled by the 34 MHz IN/OUT switch. In the INT position the 34 MHz signal is allowed to pass through the electronic switch to a drive amplifier and is also available at the 34 MHz IN/OUT socket. When the switch is set to EXT, the 34 MHz signal is replaced by an externally generated 34 MHz signal (from a second receiver) connected to the 34 MHz IN/OUT socket.

13. The 1.4 MHz generator consists of a divide-by-five stage followed by a crystal filter. The 1 MHz input is divided down to 200 kHz and the filter selects the seventh harmonic to produce the required output at 1.4 MHz. The BFO is a 1.4 MHz voltage controlled LC oscillator, with a front panel variable voltage control, to provide a frequency variation of approximately plus and minus 3 kHz.

SECOND MIXER BOARD

14. The 35.4 MHz IF output from the first mixer is applied to the first IF amplifier; it is then fed via a 35.4 MHz band-pass filter to a balanced mixer where it is mixed with the filtered 34 MHz output from the 34 MHz generator board. The 1.4 MHz difference frequency output is then fed to the main IF/AF board via the selected 1.4 MHz filter on the IF Filter Board.

MAIN IF/AF BOARD

15. This board contains the 1.4 MHz second IF amplifier, the audio and AGC detectors and the audio amplifiers. An envelope detector is provided for AM reception and a product detector for all other reception modes. The output from the AGC detector is used to control the gain of both the first and second IF amplifier stages; it is also available at a terminal on the rear panel for connection to a second receiver for diversity reception. The audio pre-amplifier has a muting capability and its output is inhibited when an earth is connected to the MUTE terminal on the rear panel. The audio output from the pre-amplifier is fed to the line amplifier and also to the loudspeaker amplifier (the input switching to the loudspeaker amplifier is only necessary in ISB versions of the receiver). The loudspeaker amplifier feeds both the internal loudspeaker and an external loudspeaker connected to a pair of rear panel terminals; it also feeds the phone jack on the front panel via a suitable dropping resistor.

ISB IF/AF BOARD

16. This board, fitted to ISB versions of the receiver only, contains the lower sideband second IF amplifier, AGC and product detectors, and the audio amplifiers. It is similar to the main IF/AF board except that it does not contain an AM detector or a loudspeaker amplifier. The output from the AGC detector is used to control the gain of the first IF amplifier (AGC2) and the ISB channel IF Amplifier stage; it is also available at the ISB DIV AGC terminal on the rear panel for connection to a second receiver, for ISB diversity reception.

AUTOMATIC FREQUENCY CONTROL (AFC)

17. This is an optional facility to automatically lock the receiver frequency to that of the incoming carrier. The 1.4 MHz IF output signal from the second mixer is applied to the carrier filter and then to the AFC board. When the frequency of the received signal is identical to the receiver frequency, the AFC board provides an output of exactly 1 MHz. This is fed to the 34 MHz Generator board via an electronic switch (controlled by the AFC switch), where it is used in place of the 1 MHz signal derived from the frequency standard.

Any deviation in the frequency of the received signal results in a corresponding frequency deviation in the 1 MHz output signal from the AFC board. Since the 34 MHz second mixer injection signal is phase-locked to this 1 MHz signal, the receiver frequency is automatically adjusted by the correct amount.

FSK BOARD

18. The optional FSK board contains an FSK adaptor and a diversity switching circuit. The adaptor circuit follows the variation of the FSK signal within the pass-band of the selected IF filter. The output from the diversity switch feeds a solid state high speed relay which drives the associated teleprinter from either a 6-0-6V or an 80-0-80V telegraph supply, as selected by a rear panel switch. The 80-0-80V supply incorporates a current limiting lamp.

ADDITIONAL OPERATING NOTES

USE OF RF TUNE CONTROL

19. Under normal receiving conditions the receiver may be operated in the 'wide-band' condition i.e. without r.f. tuning. Strong signals (greater than 100 mV e.m.f.) may however, produce cross modulation or intermodulation to give the effect of interfering signals on the wanted channel.

Should interference occur, use of the RF TUNE control may remove it since the cross-modulation level is raised by the r.f. tuner from 300 mV to 3V for signals more than 12½% off tune.

CROSS TALK

20. During ISB operation with a.g.c. selected, a certain amount of independence (up to 20 dB) exists between the a.g.c. produced by the two i.f. boards to cater for differential fading of sideband signals. There is therefore a tendency in measurement for the a.g.c. to reduce the cross talk between the upper and lower sidebands. However, during operation, the wanted sideband signal produces an a.g.c. to suppress the unwanted sideband, and the true cross talk of 50 dB is realized. To achieve these true conditions during measurement, an equal signal is inserted into each sideband (see page Tech. Spec. (5)).

TUNING AN FSK SIGNAL

21. (1) Set the MODE switch to FSK TUNE.

(2) Set the receiver frequency approximately to the FSK signal it is desired to receive. Two alternating tones should be heard.

(3) Tune the receiver carefully, to decrease the pitch of both tones until one tone passes through zero beat and its pitch commences to increase.

(4) Now, adjust the receiver frequency so that both tones are as near as possible of the same pitch. The signal will then sound like a continuous tone with perhaps a warble and keying transients super-imposed.

NOTE: For narrow shifts of FSK signals, this effect will be difficult to reproduce but in that case tune the receiver as near to zero beat as possible.

(5) Set the MODE switch to FSK N (normal) or FSK R (reverse) to obtain correct copy on the teleprinter.

CHAPTER 5

DIVERSITY RECEPTION

INTRODUCTION

1. Two receivers may be interconnected for FSK diversity reception and, by using the Racal Audio Switching Unit MM532, for SSB/ISB diversity reception. This chapter contains the interconnection details and also a brief description of the audio switching unit. (For detailed technical information reference should be made to the RA.1778 Maintenance Manual).

SPACE DIVERSITY

2. For space diversity reception the two receivers are operated at the same frequency and are usually connected in the master-slave configuration, i.e. the synthesizer of the master receiver (receiver A) is used to control both receivers whilst the synthesizer of the slave receiver (receiver B) is disabled. This is achieved by connecting the LO, 34 MHz and 1 MHz sockets of receiver A to those of receiver B, setting the LO, 34 MHz and 1 MHz INT/EXT switches of receiver A to INT, and those of receiver B to EXT. (The 34 MHz connection is only required for receivers equipped with the AFC facility).

3. The out-of-lock lamp will illuminate to indicate slave operation, but receiver B must be set to display the same MHz digits as receiver A. The RF TUNE control on each receiver should then be tuned as instructed in Chapter 3, if this option is fitted.

4. The received signals from the two differently located or polarised antennas are ultimately compared with each other and the one with the better signal-to-noise ratio is selected. The comparison and selection circuitry for FSK diversity reception is contained on the FSK boards, whilst that for SSB/ISB diversity reception is contained in the audio switching module MM532.

FREQUENCY DIVERSITY

5. In a frequency diversity system two different frequencies are used, each carrying the same intelligence. Each receiver is operated independently (LO, 34 MHz and 1 MHz INT/EXT switches set to INT) and the received signal with the best signal-to-noise ratio is ultimately selected, as for space diversity described above.

FSK SPACE DIVERSITY RECEPTION

6. The interconnection diagram for FSK diversity reception is given in Fig. 6. With this arrangement, two teleprinters may be operated from receiver A provided each is fitted with a current limiting resistor (see Chapter 2, para. 18). Should three or four teleprinters be required, then by connecting the FSK OUT terminal of receiver A to the FSK IN terminal or receiver B, the additional teleprinter(s) may be operated from receiver B. (Again each must be fitted with a current limiting resistor).

7. Certain installations may require SSB or ISB diversity reception in addition to the FSK facility. The interconnection diagram for SSB diversity with the FSK facility is given in Fig. 7, whilst that for ISB diversity reception with the FSK facility is given in Fig. 8. The only difference between Fig. 6 and Figs. 7 and 8, as far as FSK diversity is concerned, is the DIV AGC connection; this is made by a relay in the audio switching module, via the DIV RL (diversity relay) terminal of receiver A, when the MODE switch of receiver A is set to any FSK position.

SSB SPACE DIVERSITY RECEPTION

8. The interconnection diagram for SSB diversity reception is given in Fig. 7. The audio switching module is mounted on the rear panel of receiver A with the orange and black flying leads connected to the +12V and E terminals respectively of TS2. The receivers are connected in the master/slave configuration as described in para. 2. The DIV RL and teleprinter connections are only required for FSK versions.

ISB SPACE DIVERSITY RECEPTION

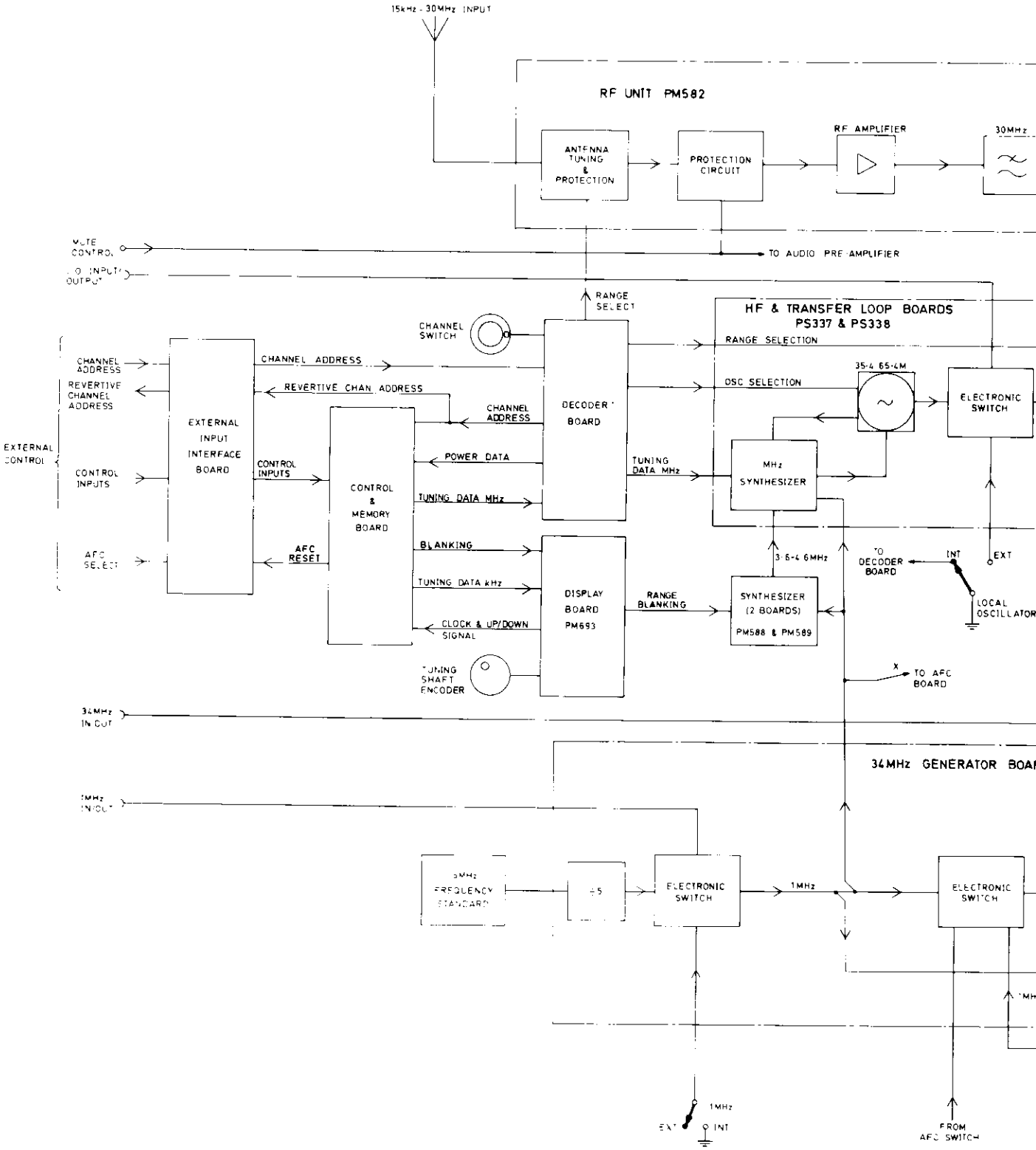
9. For ISB diversity reception, the audio switching module fitted to receiver A contains additional circuitry for the ISB (LSB) channel (see para. 10). As for SSB space diversity, the receivers are connected in the master/slave configuration, and the DIV RL and teleprinter connections are only required for FSK versions.

AUDIO SWITCHING UNIT MM532

10. Two versions of the audio switching unit are available; the MM532/1 contains a single audio diversity combiner board (PM533) for single channel (SSB) operation, whereas the MM532/2 contains a pair of boards for ISB operation. The layout diagram is given in Fig. 9.

AUDIO DIVERSITY COMBINER BOARD PM533

11. The audio diversity combiner circuit consists basically of an electronic switch which selects either channel A or channel B dependent on which channel has the highest level of AGC voltage. An audio signal zero-crossover detector circuit ensures that switching between channels occurs only at the zero-crossover point, to avoid the introduction of switching distortion and clicks.



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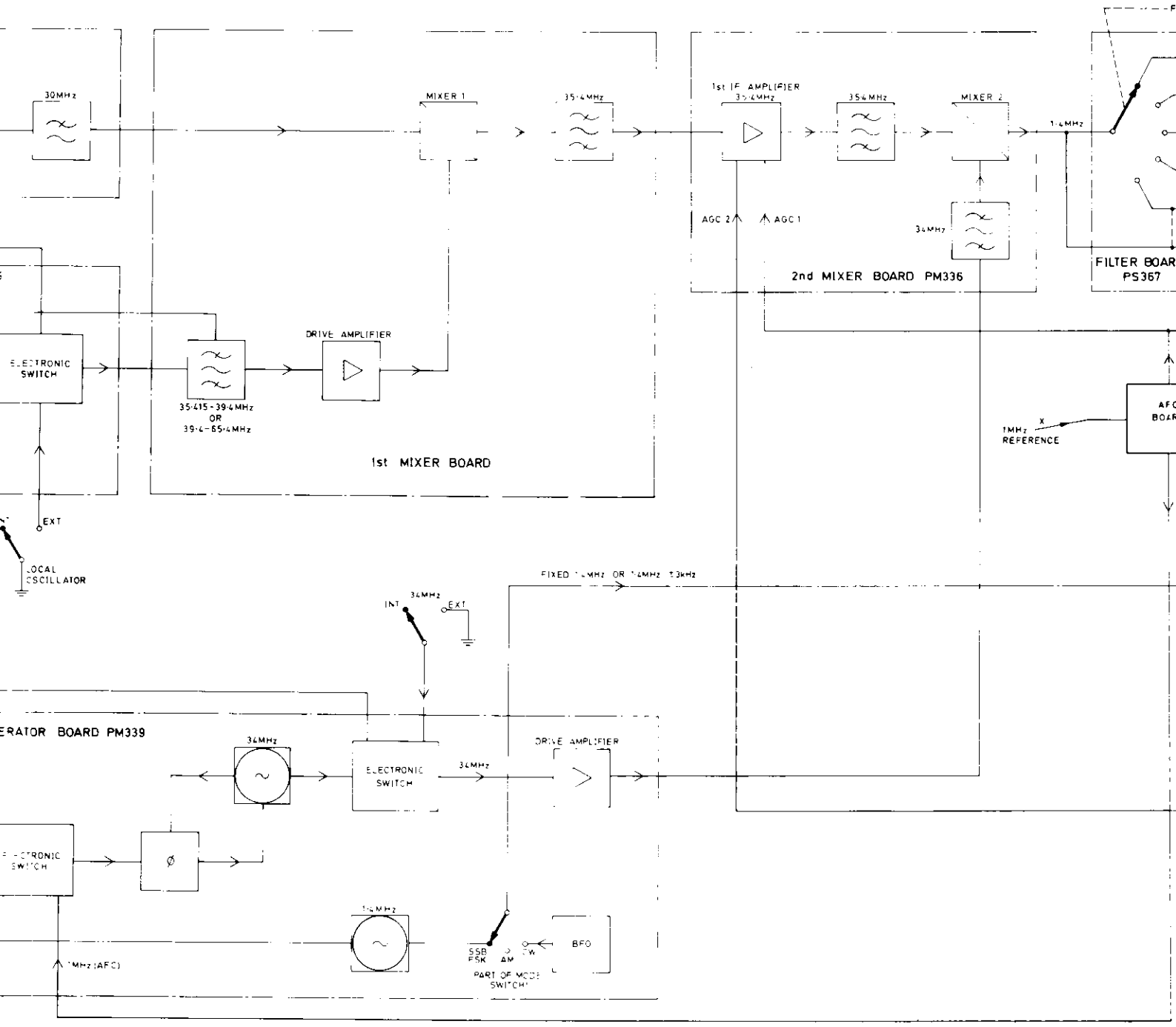
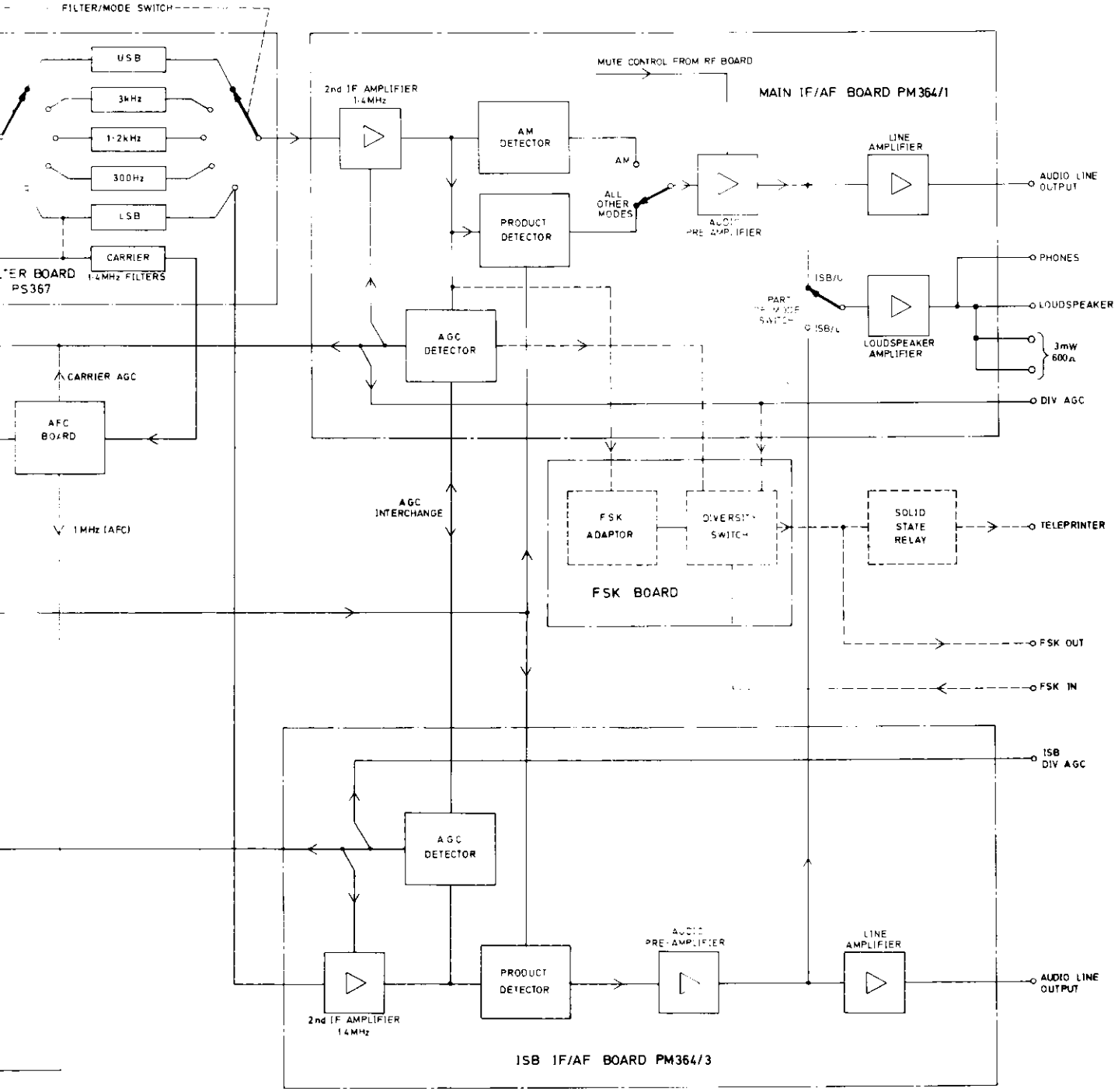


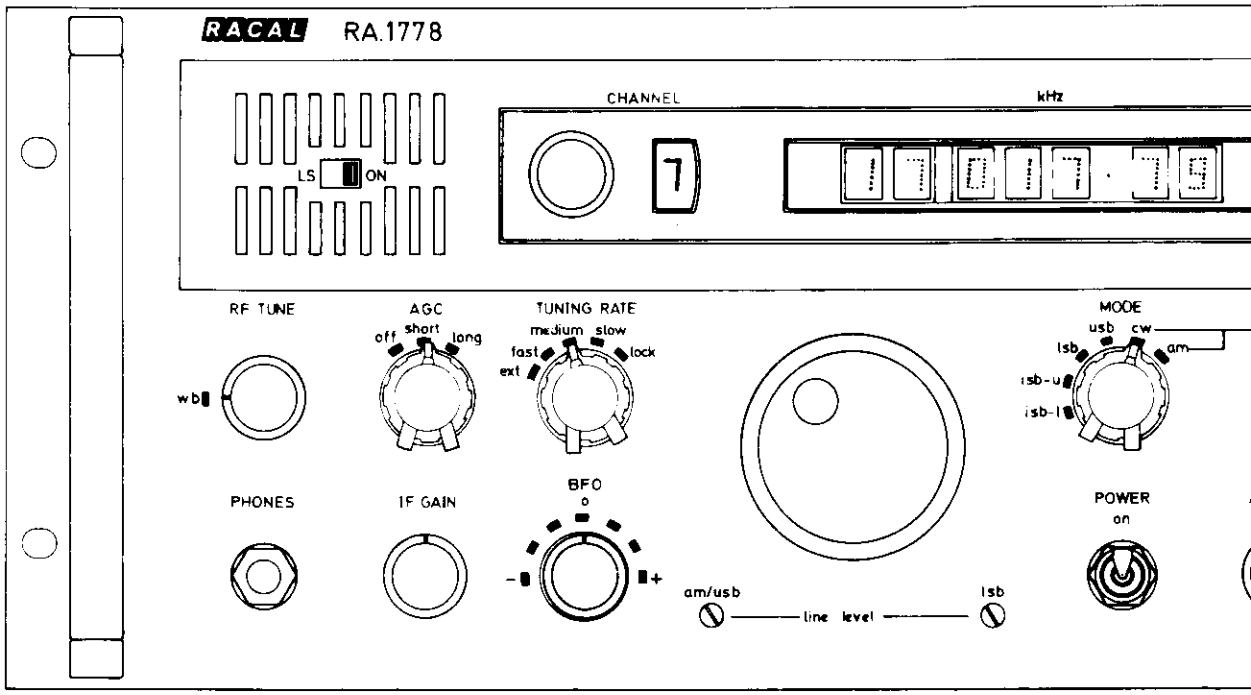
NOTE : OPTIONAL FACILITIES ARE SHOWN DOTTED

Block Diagram : RA.1778 HF Communications Receiv



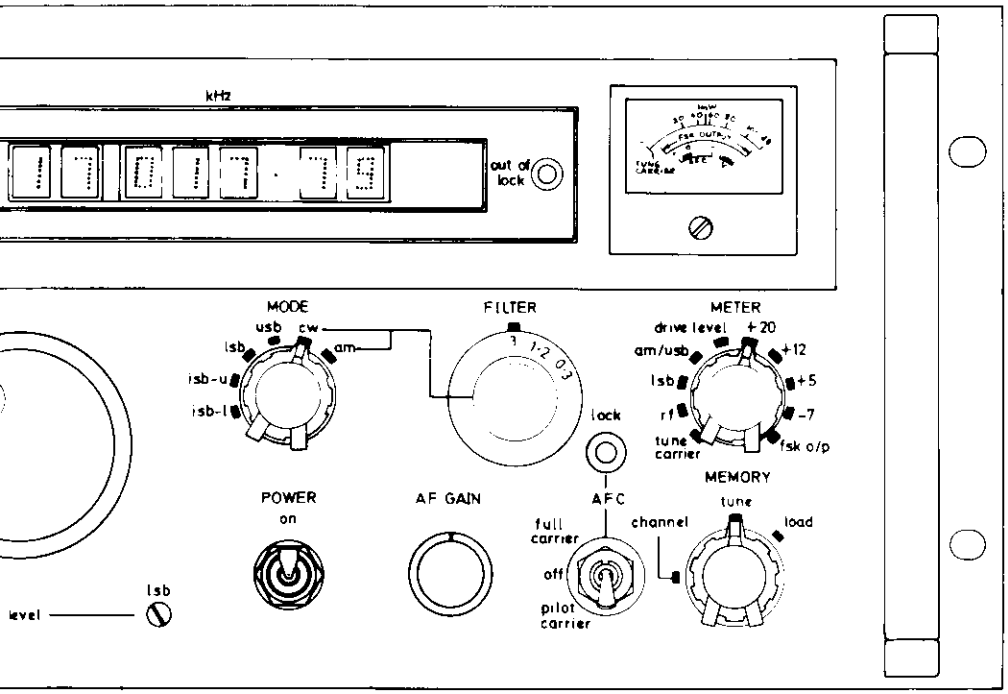
eceiver

Fig.1



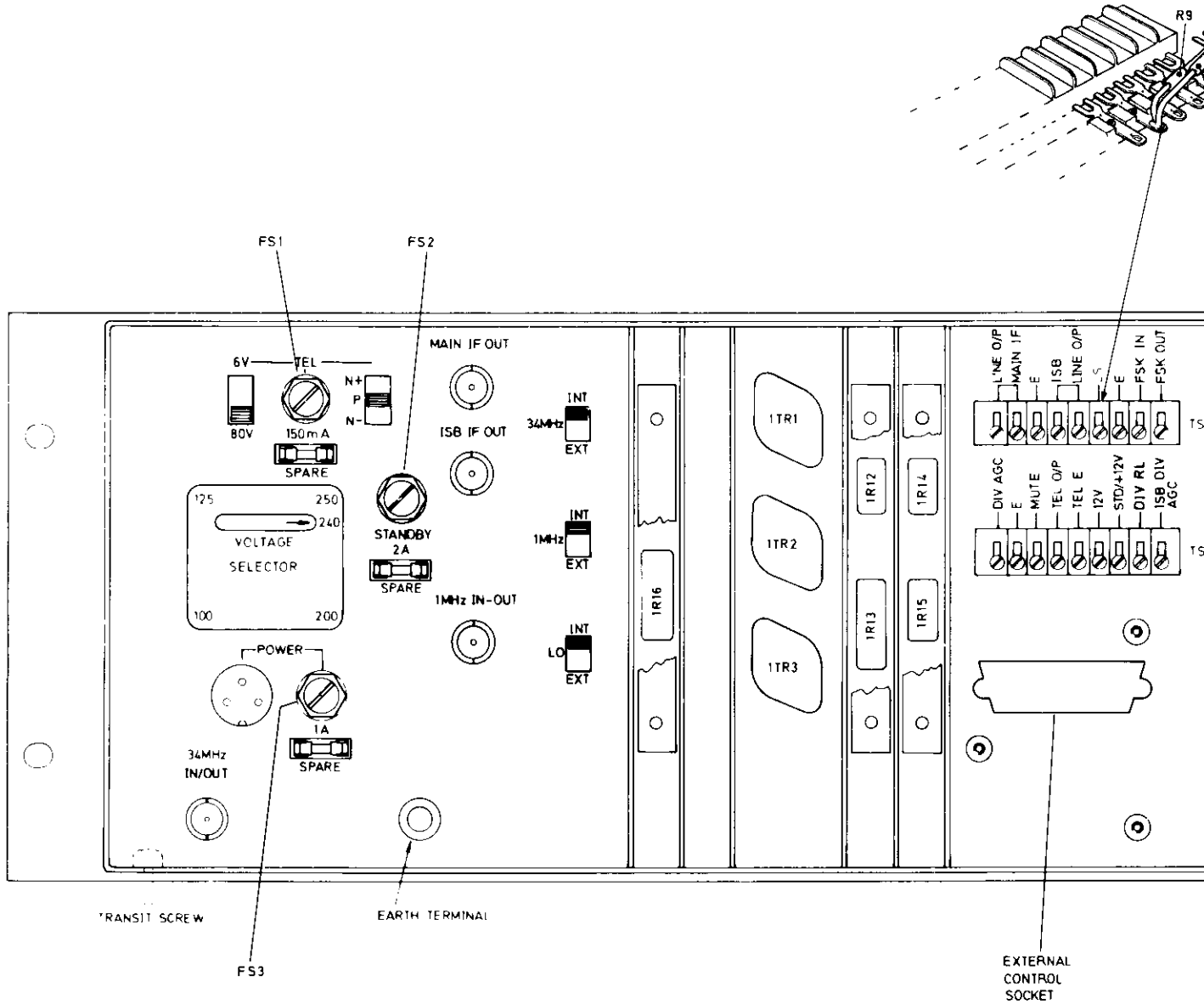
WOH 9318

Layout: Front Panel



: Front Panel

Fig. 2



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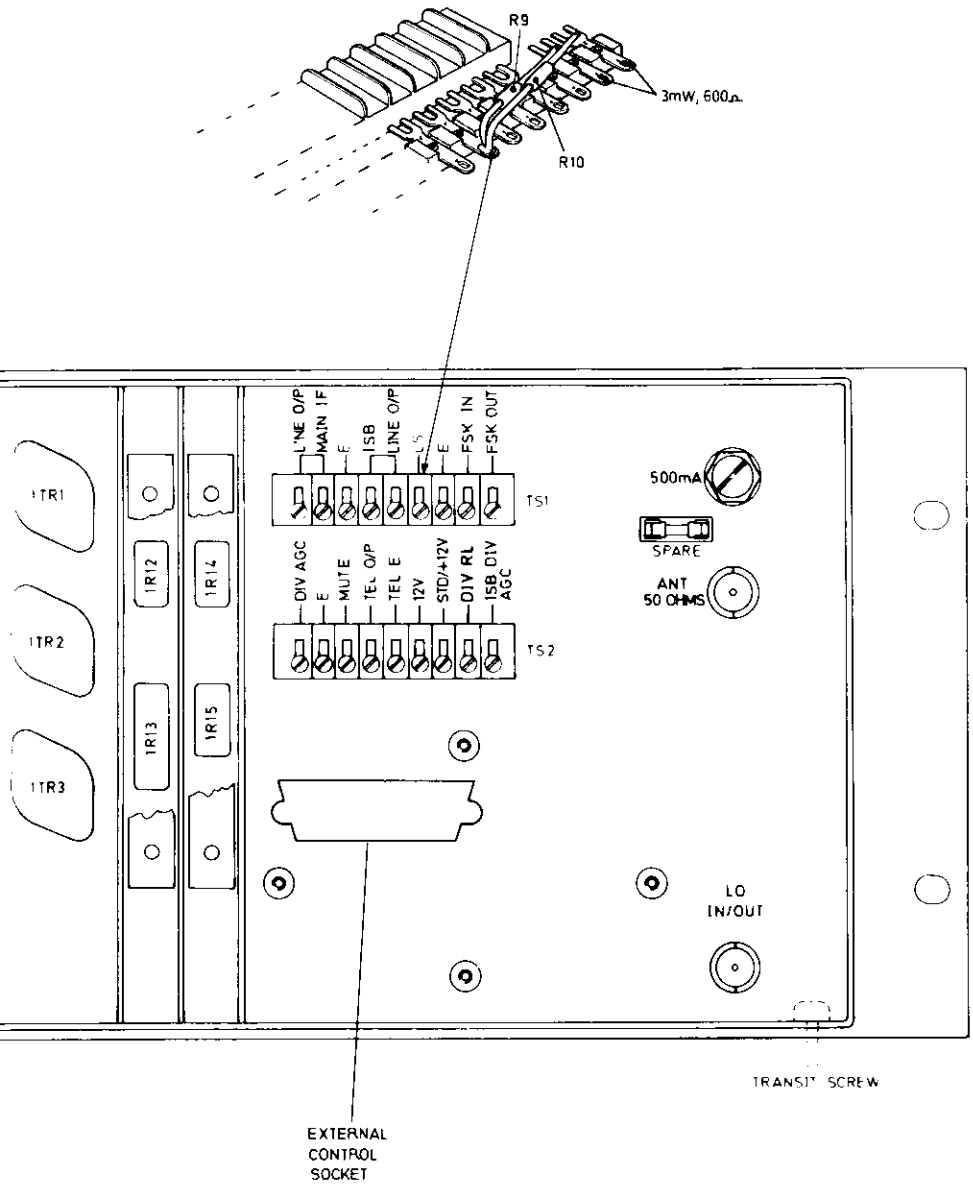
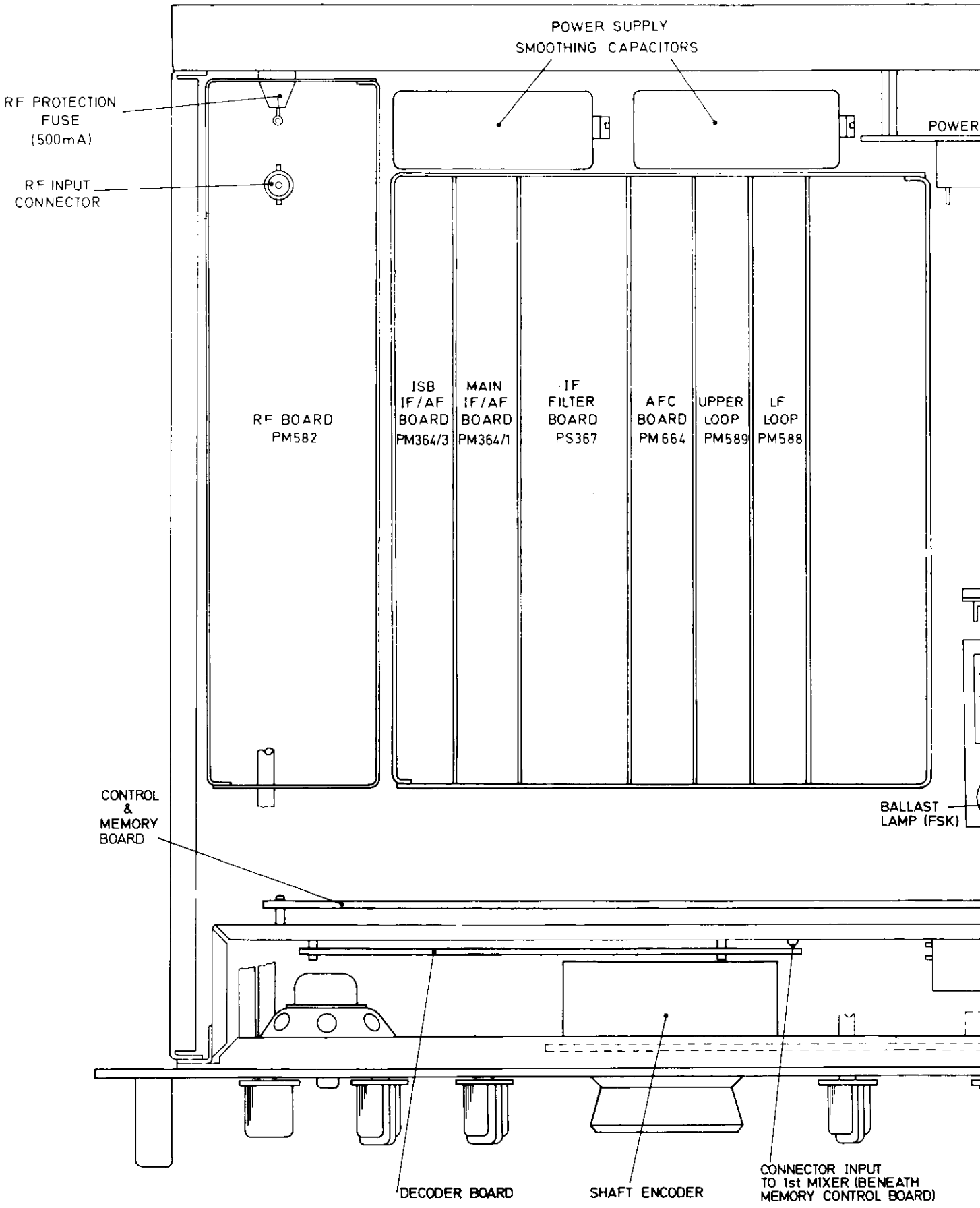
Layout: Rear Panel RA.1778



Panel RA.1778

Fig. 3



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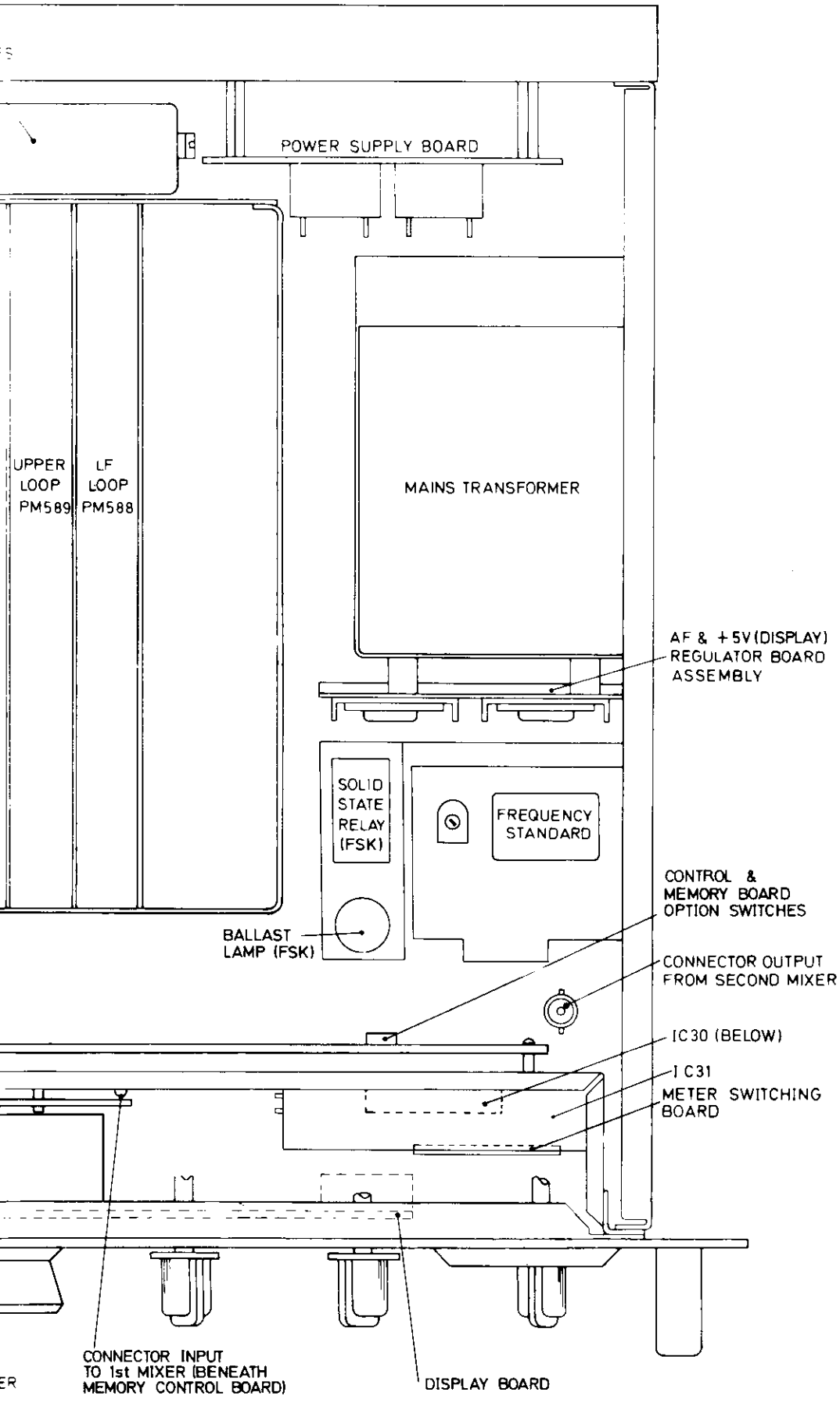
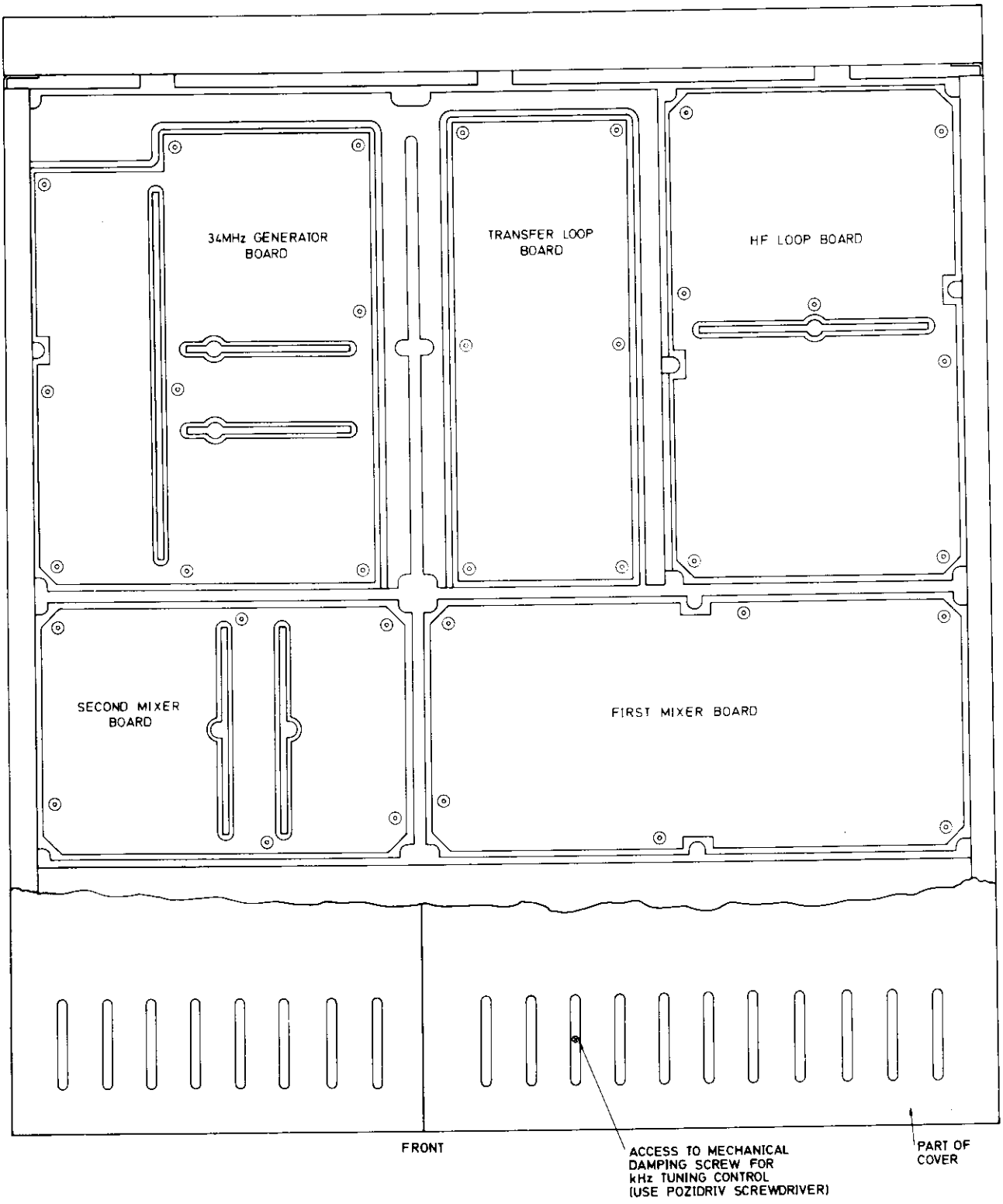
Chassis Layout : Top View RA.1778



Top View RA.1778

Fig. 4



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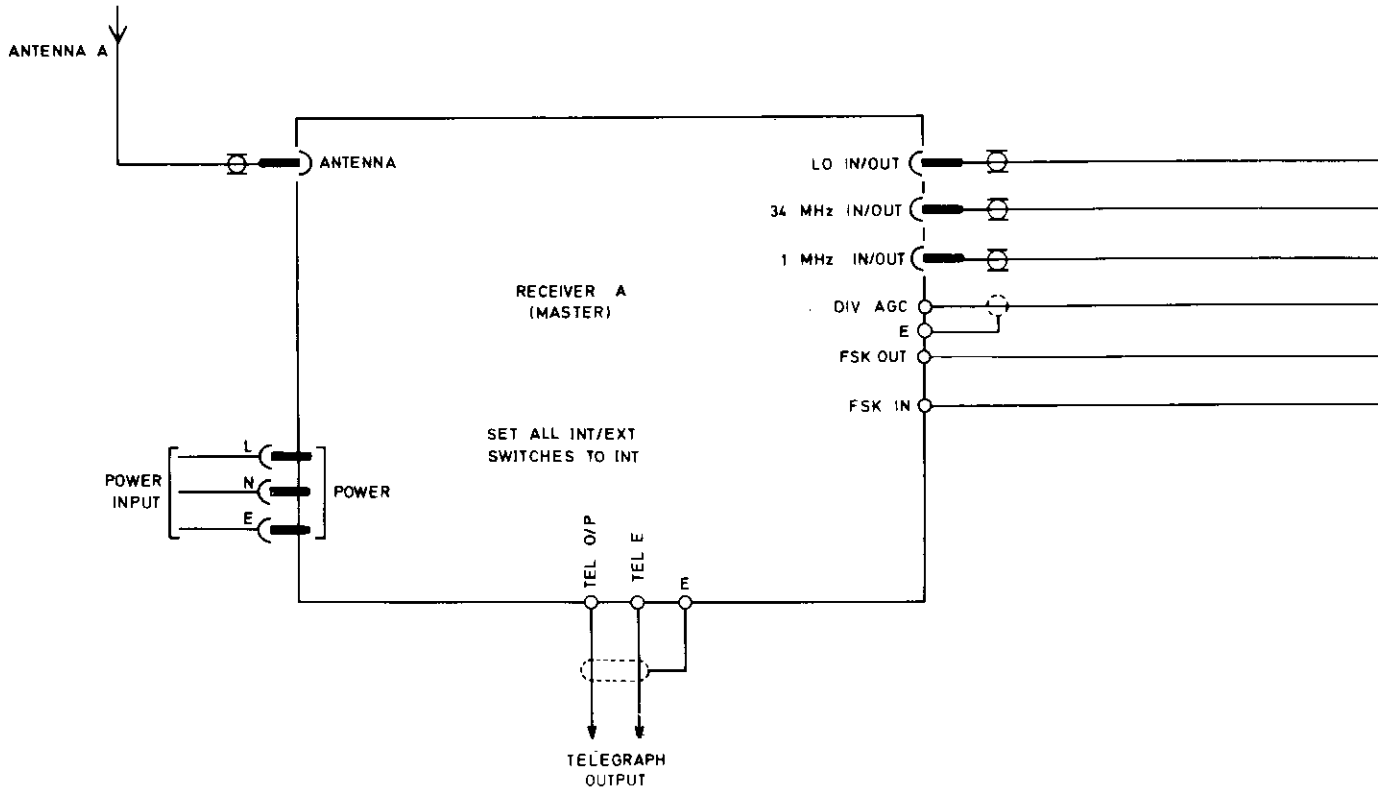
Chassis Layout : Underside View RA.1778

Fig. 5



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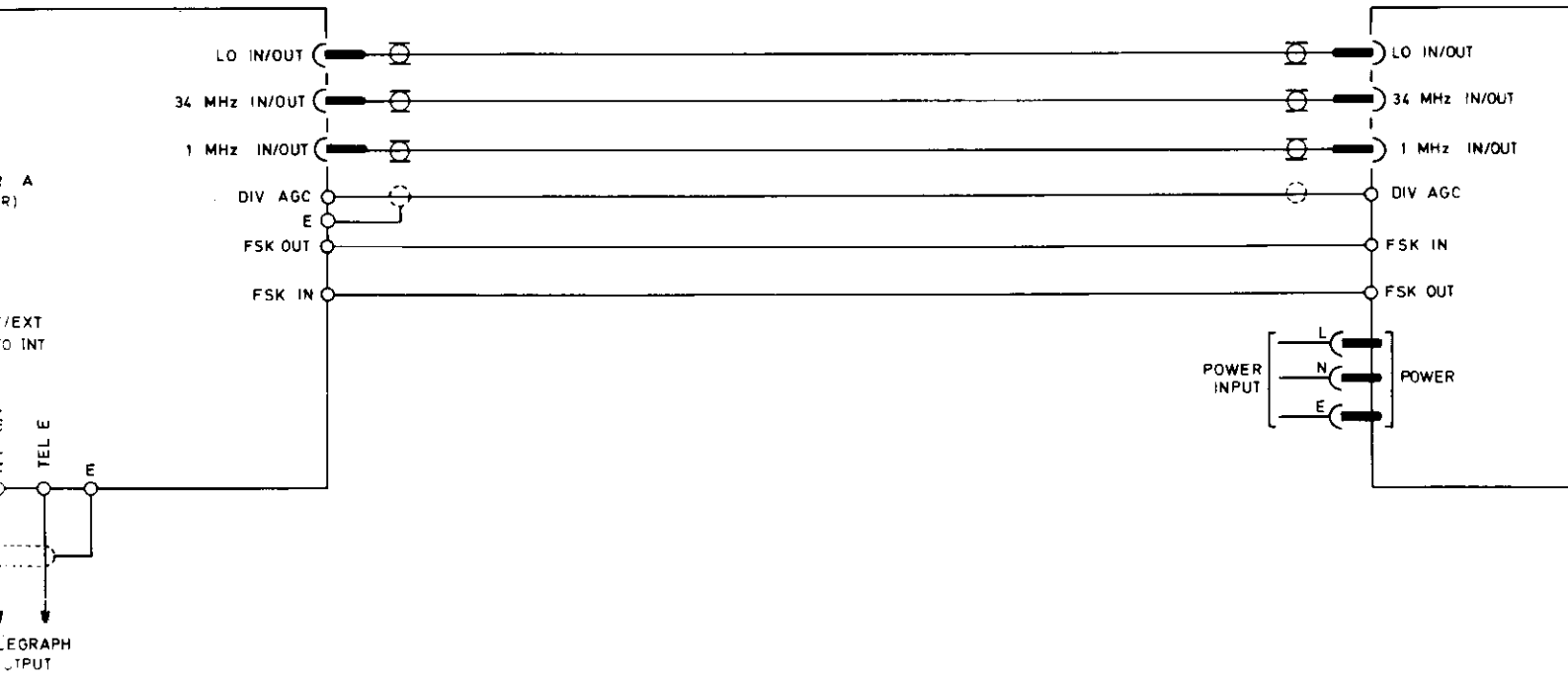
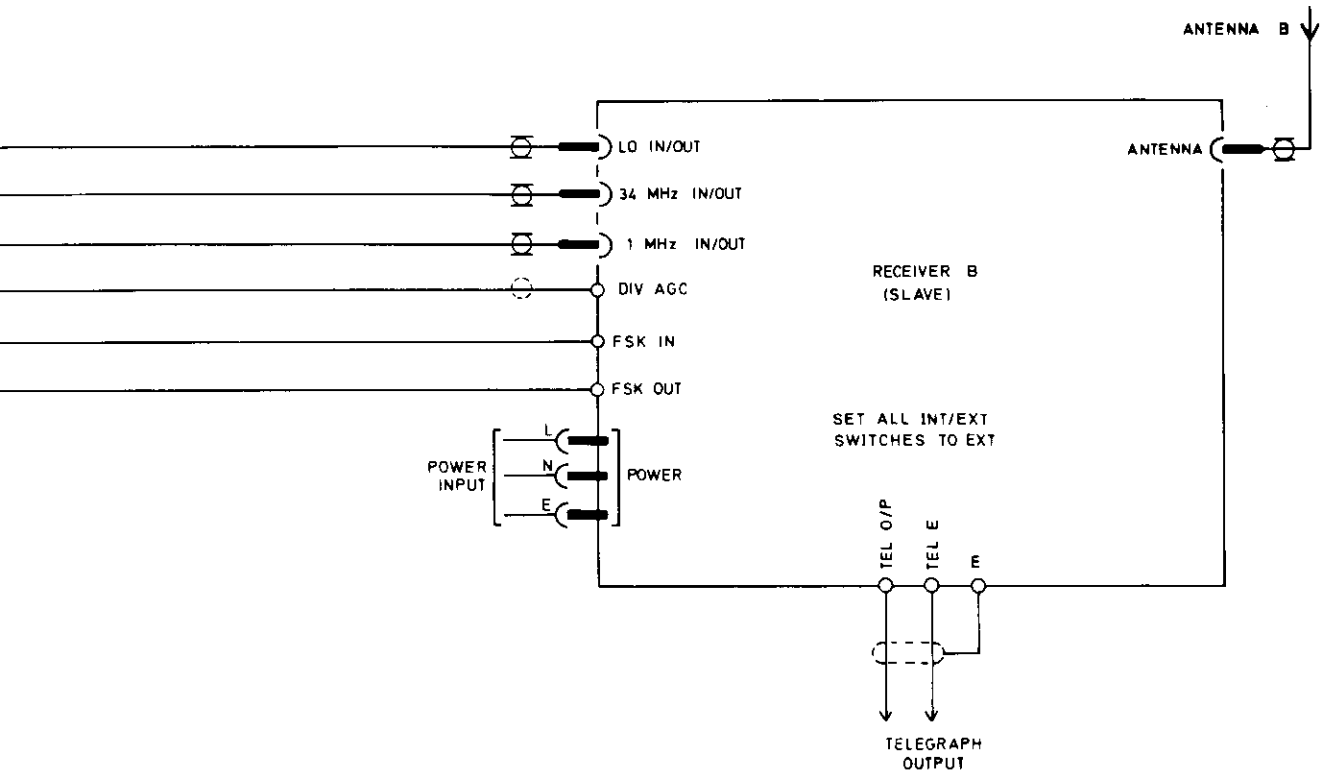
Interconnection Diagram: F

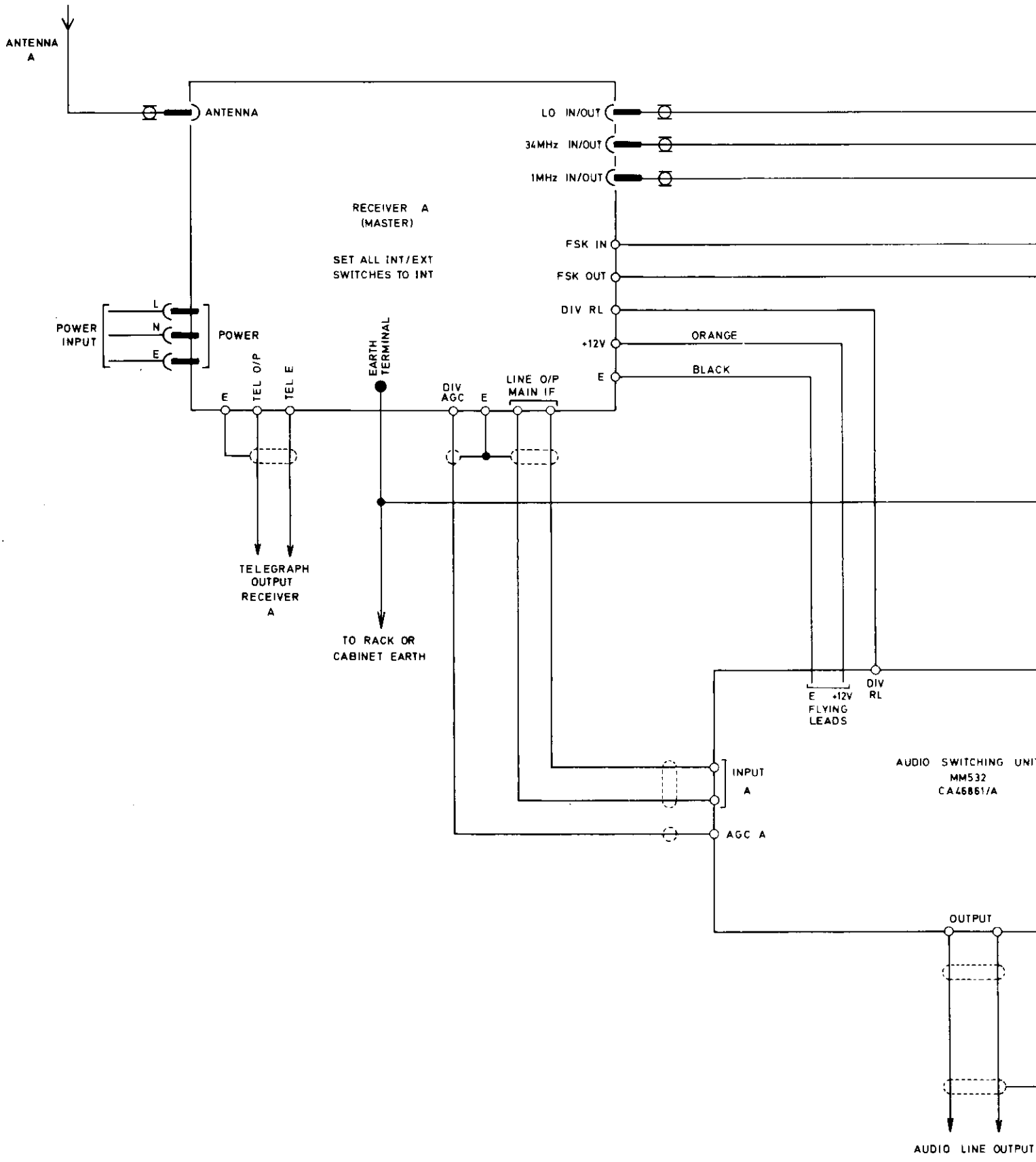


Interconnection Diagram: FSK Space Diversity Reception



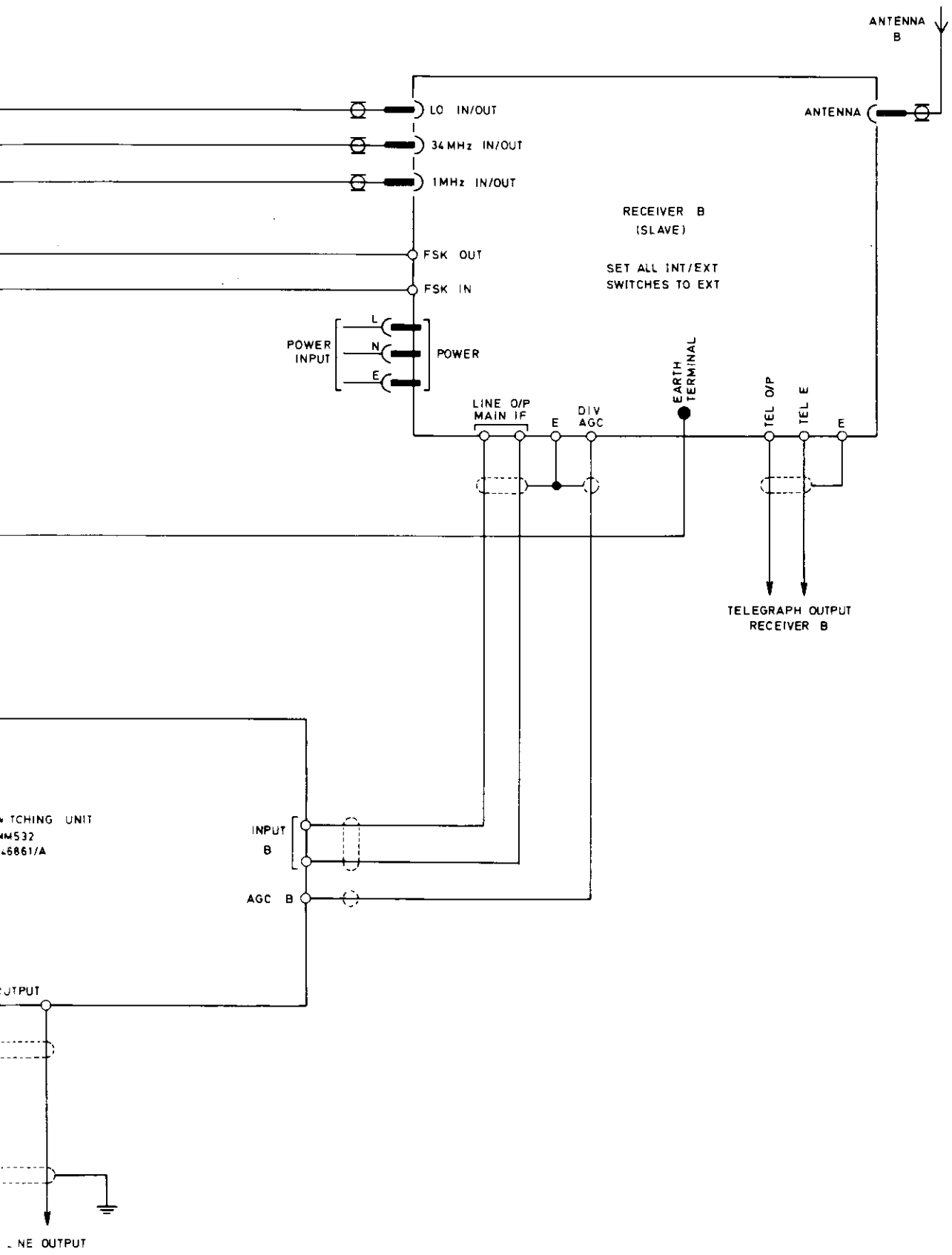
FSK Space Diversity Reception

Fig. 6



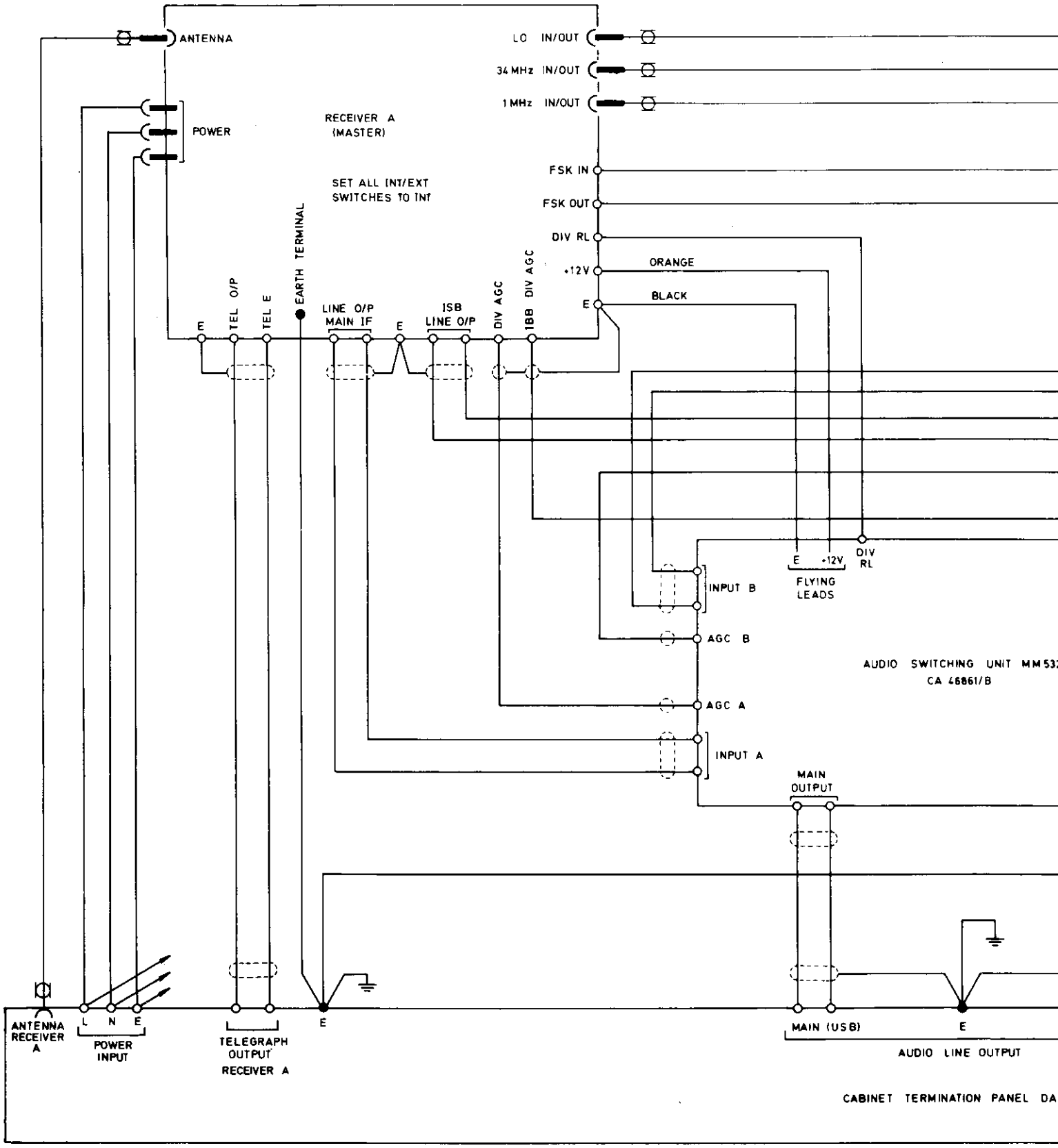
WOH 7048

Interconnection Diagram: SSB Space D



ace Diversity with FSK Facility

Fig. 7



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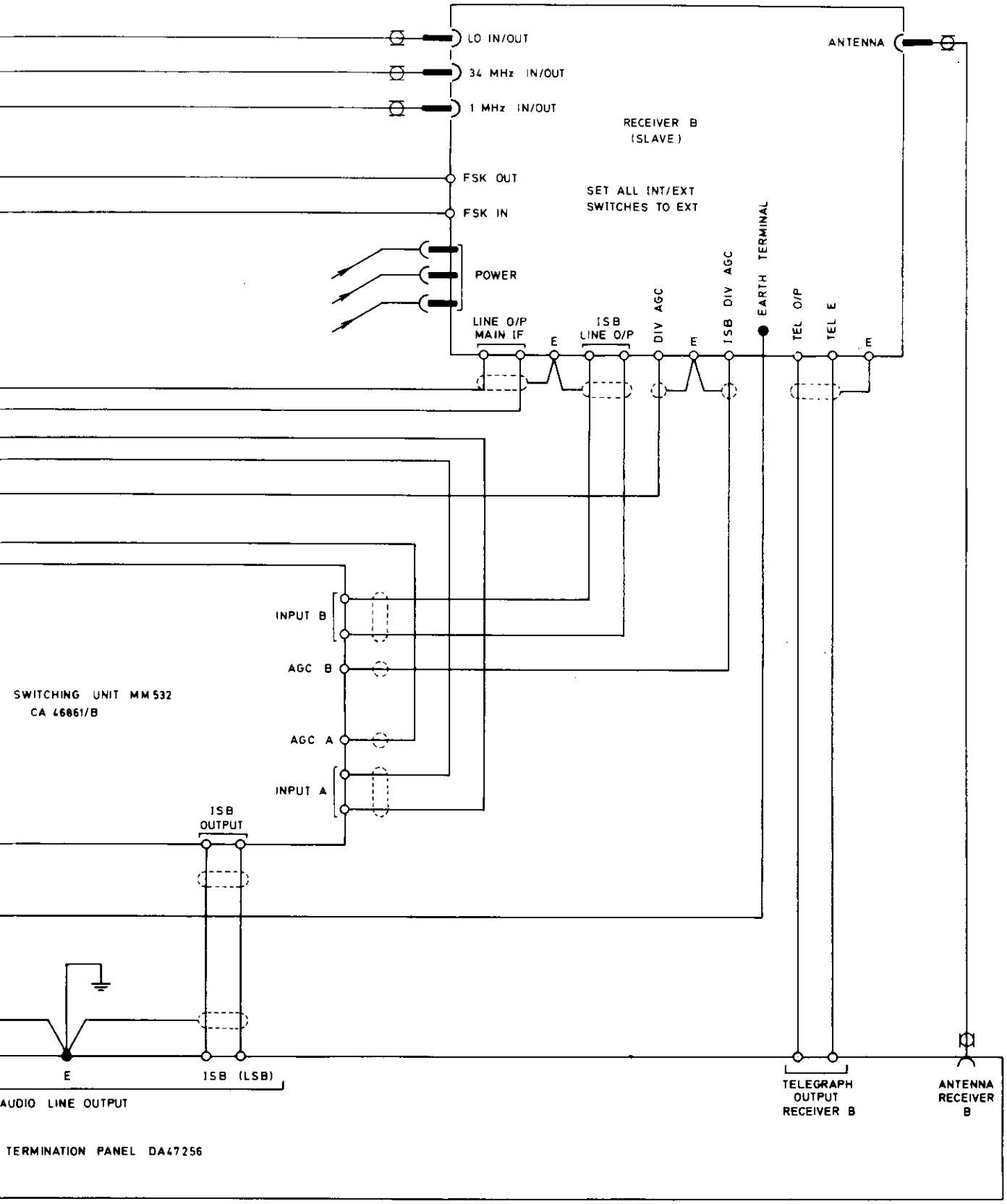
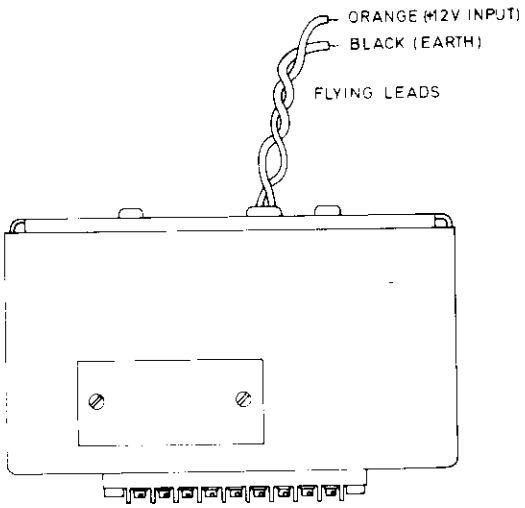
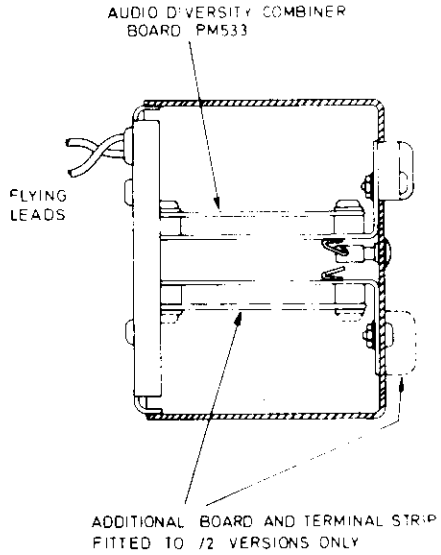
Typical Installation: ISB Space Diversity Rece

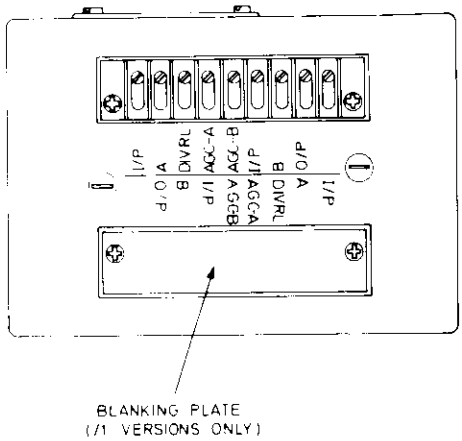


iversity Receiving Terminal with FSK Facility

Fig. 8







WOH7048 CA46861 B

Layout : Audio Switching Unit MM532 **Fig. 9**