

# INSTRUCTION MANUAL FL-7000



**YAESU MUSEN CO., LTD.**

C.P.O. BOX 1500

## TABLE OF CONTENTS

<b>1.0</b>	<b>SPECIFICATIONS . . . . .</b>	<b>2</b>
1.1	General	2
1.2	Linear Amplifier Section	2
1.3	Automatic Antenna Tuner Section	2
<b>2.0</b>	<b>INDICATORS, SWITCHES &amp; JACKS . . . . .</b>	<b>3</b>
2.1	Front Panel	3
2.2	Rear Panel Connectors	5
<b>3.0</b>	<b>INSTALLATION . . . . .</b>	<b>6</b>
3.1	Unpacking and Inspection	6
3.2	Installation Procedure	6
3.3	Power Connections	6
3.4	Antenna Requirements	7
3.5	Interconnections	7
<b>4.0</b>	<b>OPERATION . . . . .</b>	<b>10</b>
4.1	Preliminary Checks	10
4.2	Initial Preparations	10
4.3	Drive Power Check	10
4.4	Antenna Matching Procedure	11
4.5	Linear Amplifier Operation	11
4.6	Manual Tweeking and Retuning	12
4.7	Band Changing	12
4.6	WARN and PROTECT Indications	13
4.8	Operating Precautions	13
<b>5.0</b>	<b>ALIGNMENT . . . . .</b>	<b>14</b>
5.1	Test Equipment Required	14
5.2	Preliminary Alignment Information	15
5.3	Alignment Procedures	15

*John Smith*  
1958

# YAESU FL-7000

## HF SOLID STATE, AUTOMATIC TUNING

### QSK LINEAR AMPLIFIER



The FL-7000 is a microprocessor-controlled, all solid state linear amplifier with built-in power supply and automatic antenna tuner, providing up to 1.2 kilowatts RF input power on the 160- through 10-meter hf amateur radio bands, including the WARC bands\*. Super-fast T/R turnaround timing allows the FL-7000 to be used for QSK CW, hf packet radio and even AMTOR with an exciter so designed. Requiring only 70 watts of excitation for full output, four transistors with 300W collector dissipation each are combined in a fully protected push-pull parallel wideband "no-tune" amplifier circuit, powered by a heavy duty regulated 47V, 25A DC power supply and cooled by a bottom-mounted fan through Yaesu's own "DVC" (Direct Vertical Cooling) heatsinking system (patent pending). A high-power, low-loss automatic internal antenna tuner automatically rematches the antenna whenever SWR exceeds 2:1.

Band changes are also completely automatic when the FL-7000 is used with Yaesu transceivers equipped with digital band data output, such as the FT-757GX, FT-767GX and FT-980. When changing bands, previously stored antenna selection and tuner setting are recalled from lithium-backed memories automatically: transmission and retuning are not required. When rematching to a new load, the power amplifier section automatically turns off until the antenna has been matched.

Six different parameters in the amplifier, power supply and tuner are simultaneously monitored by the protective circuitry to avoid distortion of the rf output as well as to protect the components: collector current, driving power from exciter, temperature of amplifier and regulator heatsinks, VSWR at output, push-pull circuit balance and ALC voltage fed back to exciter. Dual 2-speed cooling fans are controlled with independent thermal sensors, for the amplifier and power supply. Two large, clearly lit meters are provided for constant monitoring of amplifier current, and selectable monitoring of relative power output, supply voltage, automatic VSWR or ALC. Eight LEDs on the front panel inform the operator of tuner and protection system status, including fan activity and high/low speed. Additional LEDs indicate the selected band and antenna. Up to four different antennas can be connected and automatically selected by the FL-7000's microprocessor for different bands when the optional FAS-1-4R remote antenna relay unit is used.

---

Without costly vacuum tubes there is no need for a dangerous high-voltage supply in the FL-7000, eliminating the problems of tube and high voltage component failures. However, should your FL-7000 ever need realignment, it has been designed with every alignment point easily accessible by simply removing the top cover.

To assure optimum performance and safety, please read this manual carefully before connecting the FL-7000 to the power source and your transceiver.

## 1.0 SPECIFICATIONS

### 1.1 General

Frequency coverage (MHz):

1.8 - 2, 3.5 - 4, 7 - 7.5, 10 - 10.5,  
14 - 14.5, 18 - 18.5, 21 - 21.5, and  
24.5 - 25, 28 - 30 except USA version

Collector input power (final transistors):  
(SSB) 1200W PEP, (CW/FSK) 1200W DC

Continuous Full Power Transmission Period:  
(SSB) 100% for 30 min.,  
(Full Carrier) 100% for 1 min.

Case size (WHD):  
390 x 130 x 400mm

Weight:  
30 kg (66 lb)

Supply voltage:  
100/110/117/200/220/234 VAC  $\pm 10\%$

Power consumption:  
1900 VA maximum (@500W RF output)

### 1.2 Linear Amplifier Section

Excitation power:  
less than 100W for 1200W input

ALC voltage range:  
0 to -9V

Spurious radiation:  
less than -50dB

Third order intermodulation distortion:  
less than -25dB

Input/Output impedance:  
50 ohms, unbalanced

### 1.3 Automatic Antenna Tuner Section

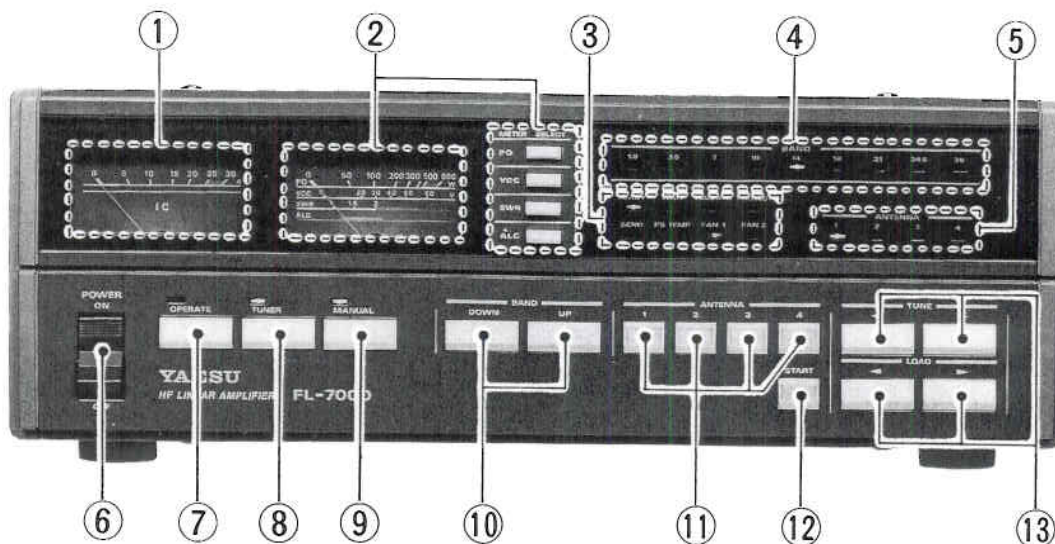
Impedance matching range:  
(1.8 - 2 MHz) 25 to 100 ohms, unbal.  
(other amateur bands) 16 to 150 ohms,  
unbalanced.

Maximum feedthrough power:  
600 watts

Insertion loss:  
less than 0.5dB when tuned to match

VSWR after matching:  
1:1 to 1.2:1

## 2.0 INDICATORS, SWITCHES & JACKS



### 2.1 FRONT PANEL

#### 2.1.1 IC Meter

This meter indicates total amplifier collector current, in Amperes.

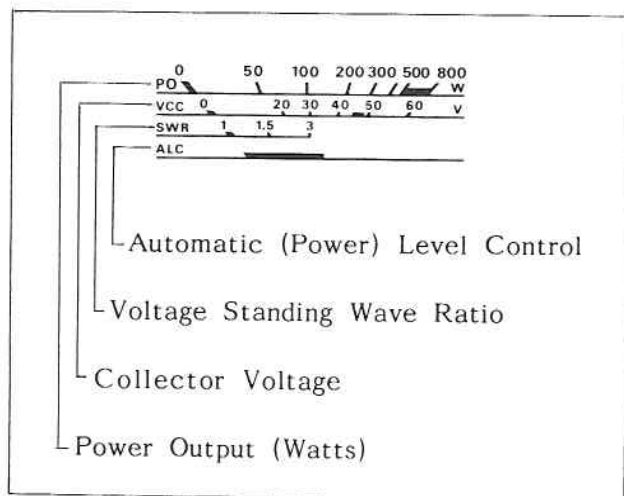
#### 2.1.2 Multimeter and Selector Switches

This meter indicates PO (Power Output), Vcc (DC collector voltage at final transistors), VSWR (Voltage Standing Wave Ratio) at the antenna jack, or ALC (Automatic Level Control) voltage fed back from the Amplifier to the exciter. The function to be displayed is selected by the corresponding pushbutton switches to the right of the meter.

#### 2.1.3 Function Status Indicators

These eight LEDs indicate the operational status of the amplifier, power supply and antenna tuner circuits, as follows:

LED	Color	Circuit	Lit Condition
READY	green	ATU	Antenna is tuned
WAIT	yellow	ATU	Tuner is busy
WARNING	red	ATU	SWR is too high
PROTECT	red	all	(see below)
SEND	red	Amp	Transmission
PS TEMP	yellow	PSU	PSU temp high
FAN1	green	PSU	PSU fan is on low
FAN2	green	Amp	Amp fan is on low



When one of the automatically monitored parameters exceeds safe limits the PROTECT indicator lights while the microprocessor takes defensive action, as described in the "Operation" section.

#### 2.1.4 BAND Indicators

One of these nine green LEDs will be lit to indicate the selected operating band of the amplifier.

#### 2.1.5 ANTENNA Indicators

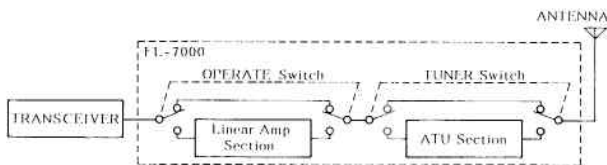
One of these four green LEDs will be lit to indicate the antenna selected via the optional FAS-1-4R Remote Antenna Selector, if used. Otherwise, these indicators and the corresponding switches may be ignored.

### 2.1.6 POWER ON/OFF Switch

This is the main power switch. When OFF, the exciter is connected directly to the antenna (No. 1 if the FAS-1-4R is in use). If this switch is turned off while the power supply and amplifier are hot, the PS TEMP, FAN1, FAN2 indicators and fans will remain on until the respective units have cooled sufficiently.

### 2.1.7 OPERATE Push Switch and LED

When this 2-position switch is in the depressed position, the amplifier will be functional and the green indicator will glow when the exciter is activated. When in the undepressed position, the amplifier is bypassed and the indicator will not light when the exciter is activated. See the diagram below. The function of this switch is overridden by the microprocessor if the PROTECT indicator is blinking.



### 2.1.8 TUNER Push Switch and LED

When this 2-position switch is in the depressed position the corresponding green indicator is lit and the antenna tuner is in the circuit between the amplifier and the antenna. When in the undepressed position, the antenna tuner is bypassed, and the amplifier connects directly to the antenna. See the diagram above.

### 2.1.9 MANUAL Push Switch and LED

When this 2-position switch is in the depressed position the corresponding green indicator is lit and the operating band of the FL-7000 can be selected manually via the BAND DOWN/UP buttons. When in the undepressed position the band is selected automatically by the transceiver (only FT-980, FT-757GX or FT-767GX) via the optional Band Control Cable.

### 2.1.10 BAND UP/DOWN Push Buttons

These buttons are required for band changing when using an exciter not equipped with the Yaesu Band Control Jack and optional Band Control Cable. When the MANUAL push switch is depressed, these buttons step the operating band of the FL-7000 up or down. The selected band is indicated by one of the nine green LEDs at the upper right of the front panel.

### 2.1.11 ANTENNA 1 - 4 Selector Buttons

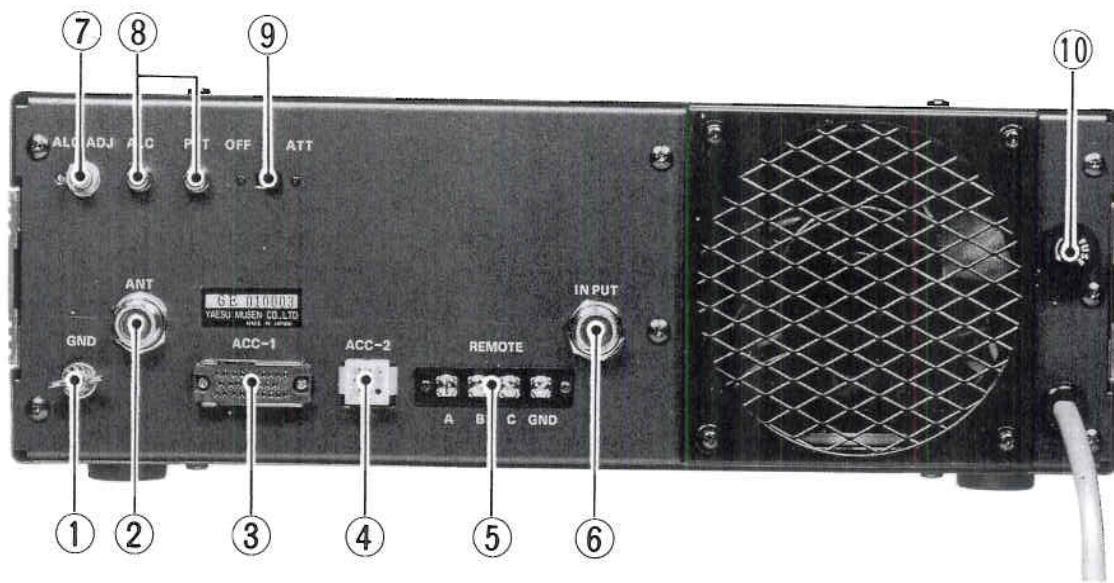
These four push buttons can be used to manually select one of up to four antennas when the optional FAS-1-4R Remote Antenna Selector is connected. The antenna selection is stored in memory, so once selected on a particular band, the same antenna will be reselected automatically when recalling that band. If the FAS-1-4R is not used, these buttons have no function.

### 2.1.12 START Push Button

This momentary contact button activates the auto-tune system manually. Normally, when the operating band is changed, the tuner will automatically adjust itself for the same antenna selection and matching impedance set the last time that band was used. Press the START button to retune if you are on a different part of the band, or if the SWR is still too high after automatic tuning. Manual restart with this button can be used to force re-matching the antenna at any time.

### 2.1.13 TUNE and LOAD Buttons

These two pairs of buttons allow manual adjustment of the matching network of the antenna tuner. The buttons under left-pointing arrows increase capacitance, and those under the right-pointing arrows decrease capacitance. In some cases it may be desirable to "tweak" the automatic tuner settings manually by poking these buttons while watching VSWR indication on the multimeter. These buttons are disabled when the automatic tuning system is active, and when the TUNER switch is off.



## 2.2 REAR PANEL CONNECTORS

### 2.2.1 GROUND Terminal Post

Connect this terminal to a good Earth ground using the shortest practical length of heavy braided cable. All other station equipment should be grounded to this terminal.

### 2.2.2 ANTENNA Jack

Connect this type 'M' (SO-239) jack to the antenna or input jack of the FAS-1-4R using large (RG-8/U or larger) 50-ohm impedance coaxial cable with the mating plug (type 'M', PL-259).

### 2.2.3 ACC-1 Accessory Jack

This 28-pin jack is provided for the optional control cable for the FT-980, to allow automatic band selection and T/R control from the FT-980, and transmitter sequencing of the FT-980 from the FL-7000.

### 2.2.4 ACC-2 Accessory Jack

This 8-pin molex jack provides for automatic control with the FT-757GX and FT-767GX transceivers, as described for the ACC-1 jack and FT-980, above.

### 2.2.5 REMOTE Terminal Strip

These terminals provide switched 13.5 VDC control signals for the FAS-1-4R.

### 2.2.6 INPUT Jack

This type 'M' (SO-239) jack should be connected through a short 50-ohm coaxial jumper to the ANT jack of the transceiver.

### 2.2.7 ALC ADJ Control and ALC Jack

This control allows adjustment of the ALC voltage level provided at the ALC phono jack, for control of the exciter. Maximum ALC range is 0 to -9 VDC.

### 2.2.8 PIT Jack

Shorting the contacts of this Jack activates the amplifier for transmission. This function must normally be provided by amplifier control contacts in the T/R relay in the exciter: closed to transmit. Open circuit voltage at this PIT jack is +12 VDC, and maximum closed circuit current required is 10 mA.

### 2.2.9 ATT/OFF Slide Switch

This switch attenuates excessive input from the exciter. It should be set to the ATT position if exciter output exceeds 100W PEP. Set it to the OFF position for the FT-757GX, FT-767GX or FT-980.

### 2.2.10 FUSE Holder

This holder must contain a 20A fuse if the amplifier is operated from 100 - 117 VAC, or a 15A fuse if operated from 200 - 234 VAC. Make certain that the fuse is correct for the AC voltage used.

### 3.0 INSTALLATION

#### 3.1 Unpacking and Inspection

Carefully remove the amplifier from its packing carton and examine the set for any signs of visible damage. Check the buttons and switches to ensure nothing has broken loose. If any damage is found, document it thoroughly and notify the shipping company at once. Save the packaging materials for possible use later.

#### 3.2 Installation Procedure

The amplifier must be located so that air can circulate freely around the top, bottom and rear of the cabinet. Do not place anything on top of or under the amplifier that might obstruct airflow.

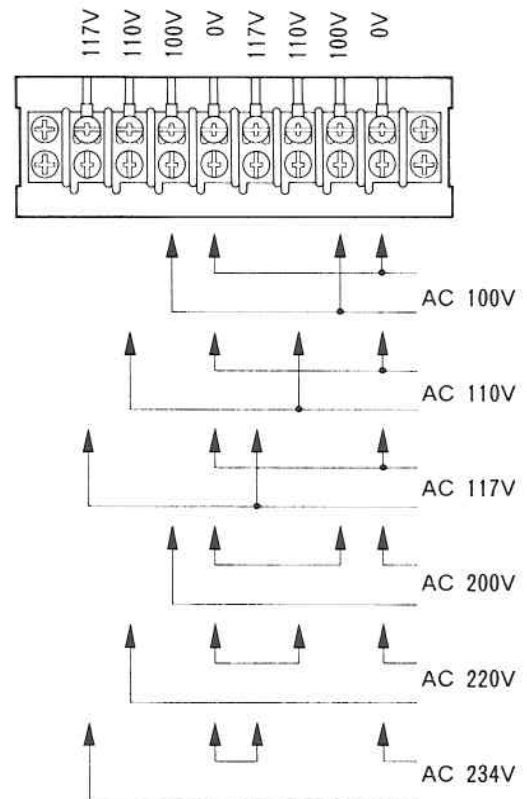
Refer to the interconnection diagrams for details of installations with the FT-757GX, FT-767GX or FT-980. Regardless of the model of transceiver used, make certain that the ALC jack on the amplifier is connected to the external ALC input of the transceiver, and that the transceiver is designed to respond to external ALC within the range of 0 to -9V. The PTT jack on the amplifier must also be connected to T/R relay contacts in the transceiver that are closed during transmission.

Use a short length of 50-ohm coaxial cable (RG-8A/U, RG-58A/U or equivalents) with type M (PL-259) connectors on both ends to connect the transceiver antenna jack to the INPUT jack on the amplifier. For the feedline from the ANT connection on the amplifier to the antenna or FAS-1-4R Remote Antenna Relay Unit, do not use small coaxial cable such as RG-58A/U, as it is not intended to handle the output power level of the FL-7000. Use the largest and best quality 50-ohm coaxial feedline available for this connection.

If the exciter (transceiver) being used with the FL-7000 produces more than 100W RF output, set the OFF - ATT switch to the ATT position. The FL-7000 requires only 70 watts drive to produce full output, and additional drive power will merely be wasted generating heat.

#### 3.3 Power Connections

The power supply in the FL-7000 is capable of operation from 100/110/117/200/220 or 234 VAC at 50 or 60 Hz. However, the primary of the power transformer must be wired to match the AC mains voltage you intend to use, as must the amplifier fuse. If you have a choice between two voltage ranges, use the higher voltage to minimize losses in the transformer. Make certain that the voltage specification marked on the rear panel of the amplifier matches the AC supply voltage you intend to use. If it does not, remove the top cover of the amplifier and reposition the transformer tap connections as indicated in the diagram on the left side of the chassis.



#### **WARNING**

SEVERE DAMAGE MAY RESULT IF IMPROPER AC SUPPLY VOLTAGE IS APPLIED TO THIS EQUIPMENT. OUR WARRANTY DOES NOT COVER DAMAGE CAUSED BY IMPROPER SUPPLY VOLTAGE OR USE OF AN IMPROPER FUSE.



If you change the power transformer connections from one range to the other, the fuse in the rear panel holder must be replaced. For 100/110/117 VAC use only a 20 Amp fuse. For 200/220/234 VAC use only a 15 amp fuse.

It is best to use a 200/220 or 234 VAC line exclusively for the amplifier, with its own 10 amp circuit breaker or fuse at the house fuse box. If only 100/110/117 VAC is available the line should have wiring of sufficient size for 20 amperes, and be fused for 20 amps at the fuse box, and that line used only for the amplifier. The FL-7000 should not be operated from a standard 100/110/117V house lighting circuit, as the wiring may not be large enough to carry the load.

### 3.4 Antenna Requirements

Any antenna used with the FL-7000 must be capable of dissipating at least 600 watts, and should be at or near resonance at the operating frequency, having a feedpoint impedance as close as possible to 50 ohms. In the FL-7000, the amplifier stage alone performs optimally with a load SWR of 1:1 at 50 ohms. With an SWR of 2:1, power output will be reduced by about 3 dB. The automatic antenna tuner in the FL-7000 expands the acceptable SWR range considerably, being able to reduce a 3:1 SWR to 1:1 above 3.5 MHz (or from 2:1 to 1:1 on 160m).

While the resulting operational SWR range of the FL-7000 is wide enough to add considerable operating flexibility, it is not unlimited. If the tuner stage is unable to bring the SWR below 1.2:1 (as presented to the amplifier stage), the protective circuitry will cause the amplifier stage to be bypassed, and the WARNING indicator will be lit, indicating that remedial antenna work is necessary. Although operation in this case will not damage the (bypassed) amplifier, it is not recommended. Antenna systems that are too far from resonance at the operating frequency to permit proper matching should be reworked, or used only on the frequencies where a 1.2:1 SWR can be obtained, and other antennas should be installed for other frequencies.

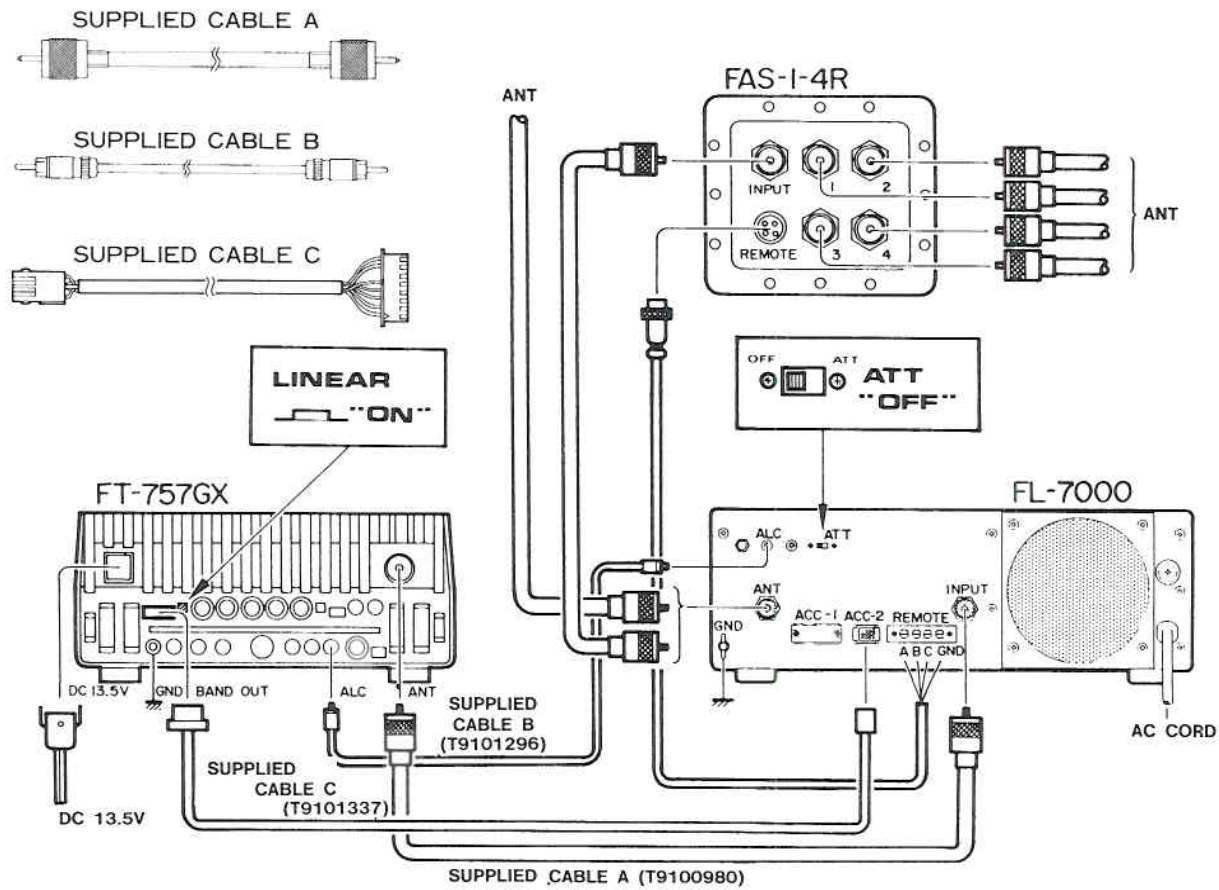
The FAS-1-4R Remote Antenna Switching Unit is designed to allow remote selection of up to four antennas, with a single feedline and control cable from the FL-7000 to the FAS-1-4R, which may be mounted remotely at the antenna feedpoint(s). After being manually set once, the correct antenna for each band is selected automatically whenever the operating band is changed in the FL-7000.

The FL-7000 and FAS-1-4R Remote Antenna Selector are designed for unbalanced (coaxial) feedlines. Use balun transformers for feeding antennas requiring balanced feed. Such baluns should provide 50 ohms at the unbalanced side, and then 50-ohm coaxial cable should be used to make connections to the equipment. If a portion of the feedline is open-wire type, the length of coax used between the feedline balun and the amplifier should be as short as possible to minimize loss.

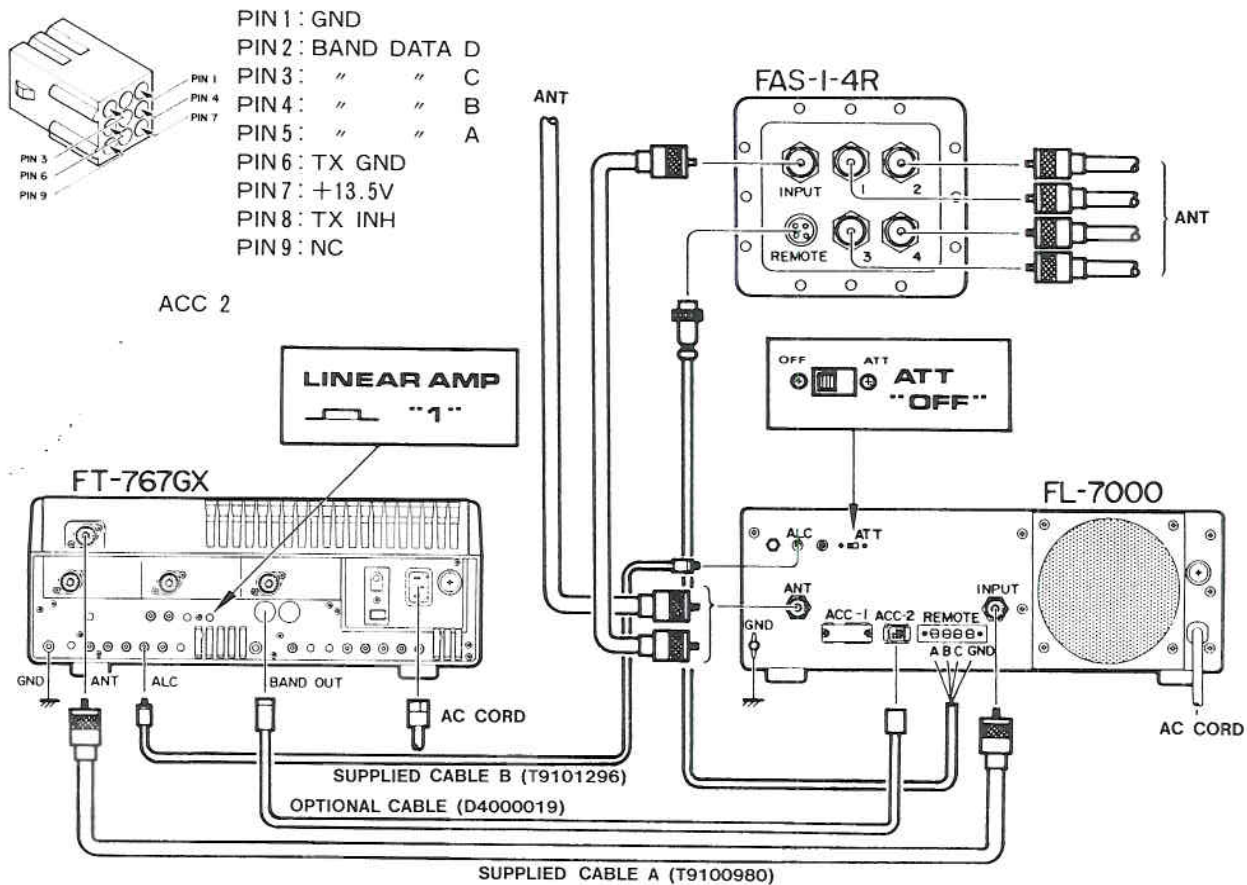
### 3.5 Interconnections

The diagrams on the following pages illustrate the interconnections between various HF transceivers and the FL-7000 and optional FAS-1-4R. Be certain to install the earth ground connection directly to the amplifier, with a short, independent grounding cable from the FL-7000 to the transceiver, in addition to the other connections shown.

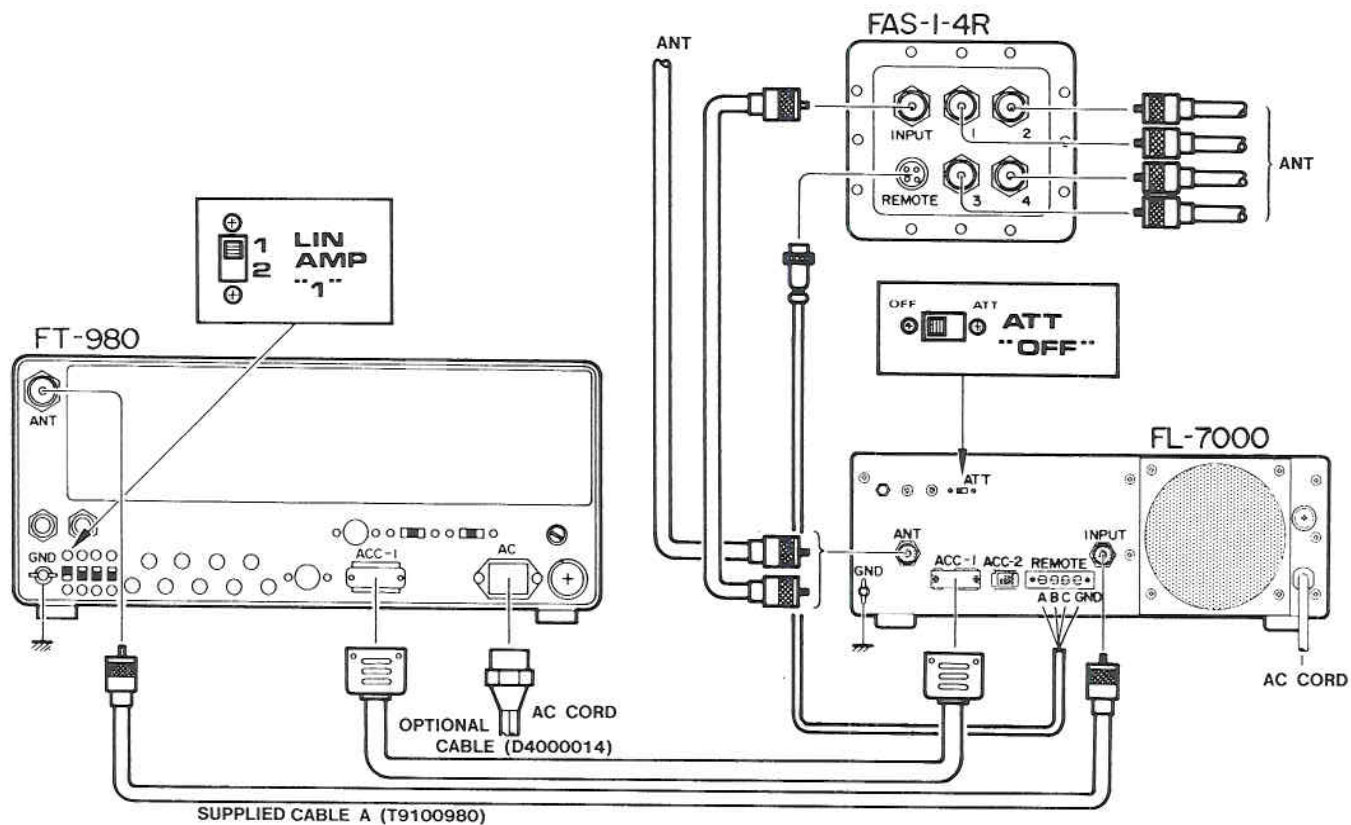
Note that the FT-757GX, FT-767GX and FT-980 transceivers have a linear amp switch on the rear panel (labelled LINEAR or LINEAR AMP) that must be specifically set when the FL-7000 is connected, to allow the amplifier to inhibit transmission during band changing. The diagrams for these models also show a special interconnecting cable, available as an option from your Yaesu dealer. This cable allows band switching in the transceiver to control the band selection in the FL-7000 automatically. Other transceivers, or these models without the optional cables, may be used with band selection of the FL-7000 using the front panel MANUAL buttons.



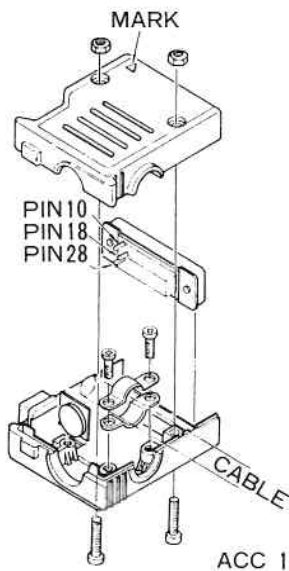
FL-7000 with FT-757GX & FAS-I-4R



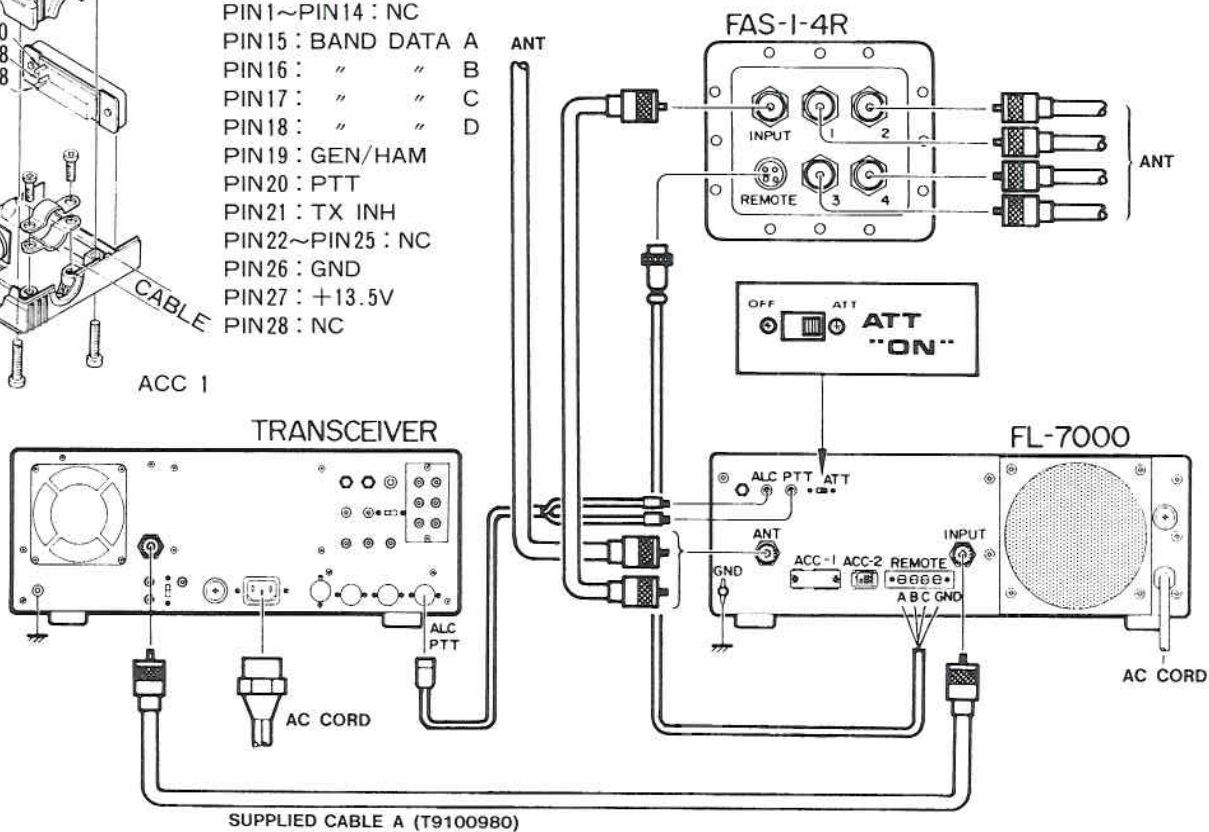
FL-7000 with FT-767GX & FAS-I-4R



FL-7000 with FT-980 & FAS-I-4R



- PIN 1~PIN 14 : NC
- PIN 15 : BAND DATA A
- PIN 16 : " " B
- PIN 17 : " " C
- PIN 18 : " " D
- PIN 19 : GEN/HAM
- PIN 20 : PTT
- PIN 21 : TX INH
- PIN 22~PIN 25 : NC
- PIN 26 : GND
- PIN 27 : +13.5V
- PIN 28 : NC



FL-7000 with Other Transceiver & FAS-I-4R

## 4.0 OPERATION

### 4.1 Preliminary Checks

Before switching on power, recheck all interconnections as described in the preceding section. Double check the ground and antenna connections, and the ALC connection cable. If using an FT-980, ensure that the LIN AMP switch on the rear panel is set to (upper) position 1. If using an FT-757GX or FT-767GX, ensure that the LIN or LINEAR switch is depressed (position 1).

If using one of the above transceivers with the optional Band Cable, band selection and antenna rematching occurs automatically whenever you change bands on the transceiver. In this case, if you are also using the FAS-1-4R with multiple antennas, the antenna last used on each band will also be reselected when that band is recalled on the transceiver. Do not press the MANUAL switch, however, as that would disable the automatic band and antenna selection functions.

If you are using one of the above transceiver without the optional Band Cable, or a different model transceiver press the MANUAL switch on the FL-7000. This switch should remain pressed at all times when the automatic band selection feature is not connected. Whenever changing bands, you must remember to press the BAND UP and DOWN keys to match the operating band of the FL-7000 with that of the transceiver.

**CAUTION:** Do not attempt to change bands while transmitting!

### 4.2 Initial Preparations

Initial setting of the antenna tuner (when the FL-7000 or antenna is new) requires that you transmit a steady carrier at full (exciter) power over the air for a few seconds (the FL-7000 power amplifier section is automatically bypassed during this process). We recommend that this be done in the CW mode. If you do not have a key or keyer paddles connected, just press the MOX switch on the transceiver to key the transmitter. If you normally have your

key or keyer paddles plugged into the transceiver you can close the key contacts to transmit (make sure the internal keyer in your transceiver is switched off, if you have one). If you are using an external electronic keyer you will need to short the output for tuning: do not try to tune up with a string of dits or dahs.

Always listen for at least 15 seconds to make certain that the frequency is clear before keying the transmitter. After initial tuning the FL-7000 will automatically store the tuner settings in memory and recall the stored settings when changing bands, without the need to transmit a carrier again.

### 4.3 Drive Power Check

If this is first-time operation, or whenever using a different exciter (transceiver) perform this step to check peak exciter driving power (the FL-7000 POWER switch should be OFF).

- (1) Set your transceiver to the band for which your antenna is designed. If using the FAS-1-4R, select the band that matches Antenna 1.
- (2) Set the transceiver DRIVE control for maximum output, CW mode.
- (3) Press the FL-7000 PO meter select switch, briefly key the transmitter, and note the exciter power indication on the PO scale of the FL-7000 multi-meter.
- (4) Return to receive, and if the exciter power was above 100 watts, turn the ATT switch on the rear panel on. Never move the ATT switch while transmitting.

NOTE: Drive power must be at least 50 watts for accurate SWR detection, and at least 70 to 80 watts for optimum tuner performance. When the FL-7000 power amplifier section is activated, ALC voltage is fed back from the amplifier to the transmitter, to reduce power output to this level.

Higher drive power to the amplifier will cause the protective circuitry to disable the amplifier (to avoid damage to the input circuits).

#### 4.4 Antenna Matching Procedure

- (1) Set all front panel switches on the FL-7000 to their undepressed (out) positions, except the Vcc meter select switch (and the MANUAL switch, if necessary, as described in section 4.1 above).
- (2) Set the transceiver to CW mode on a clear frequency near the frequency of interest, and preset the DRIVE control on the transceiver fully clockwise (maximum).
- (3) Turn the FL-7000 POWER switch on and confirm the Vcc indication on the meter is about 47V. The WAIT indicator should light while the antenna tuner tunes to the preset position (set at the factory with a 50-ohm dummy load). After a few seconds, the WAIT indicator should turn off and the READY indicator light.
- (4) If you have the MANUAL switch depressed, press the BAND UP and DOWN keys while observing the band indicators at the upper left of the front panel, to select the same band selected on the transceiver. (With the optional Band Cable, this step is automatic). The WAIT indicator will be lit while changing bands, and will turn off a few seconds after you have selected the proper band (and READY will light).
- (5) If you have the optional FAS-1-4R Antenna Selector connected, press the appropriate ANTENNA button (1 - 4) to select the proper antenna. If not using the FAS-1-4R, ignore this step.
- (6) Press the SWR meter select switch, and then briefly key the transmitter while watching the SWR scale of the multimeter, and note the indication. (SWR calculation is automatic, so no presetting is necessary).

- (7) If the SWR indication in step (6) was above 1.5:1 (but below 3:1), activate the ATU to retune, as follows;

- (a) Press the TUNER switch.
- (b) Turn the transmitter on.
- (c) Press the START button.

After a minute or so, the READY light will come on if the tuner is able to match the antenna. If not, WARN or PROTECT will come on. In any case, stop transmitting as soon as the WAIT light turns off (but not before). If WARN or PROTECT came on, see section 4.8 'WARN and PROTECT Indications'.

- (8) If the READY light is on after tuning, press the PO meter select switch, and press the OPERATE switch. The FL-7000 is now ready for operation, described in the next section. However, for first time operation (or when using a new transceiver), perform the next step first in the CW mode.
- (9) Locate the ALC ADJ potentiometer on the rear panel. This control is preset at the factory for the FT-757GX, so no further adjustment is needed for this model. However, if using another model transceiver, key the transmitter, and adjust this control for 500 watts on the PO meter.

#### 4.5 Linear Amplifier Operation

Although continuous full exciter power is required for accurate SWR measurement and antenna matching, this will cause overheating if transmitting for an extended period when the OPERATE switch is depressed (when the power amplifier section is on). So once the antenna has been matched the first time, back off the exciter DRIVE.

For SSB and CW operation, make sure to adjust the MIC gain and/or DRIVE controls on the transceiver for proper ALC indication on the transceiver ALC meter, as described in the transceiver manual.

Generally, for SSB, ALC meter indication should not deflect beyond a certain ALC limit on voice peaks; while for CW, the ALC indication should be just enough to cause slight meter deflection. Higher ALC levels are likely to produce distortion or key clicks, without additional power. The PO meter on the FL-7000 will indicate 500 watts at full power, as set by the ALC ADJ control.

After setting the DRIVE or MIC gain as indicated in the transceiver manual, press the ALC meter select switch on the FL-7000, and confirm that the indication is within the ALC zone on the multimeter.

For FM and FSK (RTTY, AMTOR or packet), adjust the DRIVE control on the transceiver so that the PO meter on the FL-7000 indicates 200 watts while transmitting. This is a safe level that will not cause overheating during continuous operation for extended periods.

For AM operation, adjust the DRIVE control on the transceiver so that the PO meter on the FL-7000 does not exceed 100 watts when transmitting a carrier. On voice peaks, the PO meter should fluctuate not more than about one width of the meter needle.

During transmissions (in any mode), the PS TEMP and FAN indicator LEDs on the FL-7000 will come on as the heatsink temperatures rise. This is normal. However, if you push the amplifier too hard, with long transmissions at full power, the PROTECT function will take over and disable the amplifier, in which case it will shut down and require toggling the POWER switch to reset the protection circuitry.

#### 4.6 Manual Tweaking and Retuning

During normal amplifier operation, the SWR detection circuitry senses the full output power of the amplifier, and indicates the resulting SWR on the multimeter when the SWR button is pressed. After automatic tuning, if you believe you can improve the match of the tuner further, use the TUNE and LOAD arrow keys to change the capacitor settings while watching the SWR meter closely. This can be done at full power with the amplifier section on (OPERATE

touches to the keys) while transmitting a steady carrier. If you allow the SWR indication to exceed 2:1, the microprocessor will automatically disable the TUNE and LOAD keys, shut off the amplifier section, and attempt to rematch automatically. If this happens, keep the carrier on until the tuner finishes (READY lights).

Similarly, if you tune to a different part of the same band, the ATU will sense the SWR when you transmit, and will automatically attempt to rematch the antenna if the SWR exceeds 2:1. When this happens, keep the transmitter keyed with a steady carrier (in SSB, you can whistle a steady note) until READY lights.

If you change frequency enough to cause a slight rise in SWR (less than 2:1), you can press the START key while transmitting a steady carrier to force automatic retuning, or you can use the TUNE and LOAD keys (gingerly), if you wish, to dip the SWR again.

Remember: always watch the SWR meter, key the transmitter and apply a steady carrier while rematching the antenna, manually or automatically. Bear in mind that the ATU requires 50 to 80 watts steady drive to tune properly, and that the power amplifier section of the FL-7000 is automatically bypassed by the ATU while it is tuning.

#### 4.7 Band Changing

When new, the FL-7000 must be set up as in section 4.4 for each band. If you are not using the Band Cable and one of the Yaesu transceivers noted at the beginning of this chapter, you must remember to change the band selected on the FL-7000 whenever the transceiver band is changed. When changing bands, the microprocessor will automatically recall the ATU settings last used on that band. Also, if the optional FAS-1-4R is connected with multiple antennas, the last antenna selected on a band will be recalled when returning to that band. If the FAS-1-4R is not being used, remember to reconnect the antenna last used on a band when it is recalled.

Press the SWR button to check SWR when you change bands, to make certain that the memorized settings of the ATU are correct for the antenna and frequency of operation. If the SWR is high, key the transmitter and press START to rematch.

#### 4.8 WARN and PROTECT Indications

If the antenna impedance is too far from 50 ohms, or if there is too much reactance in the antenna system (or if the drive power is too low when matching the antenna), the Antenna Tuning Unit (ATU) may be unable to find the minimum SWR point, and the WARN or blinking PROTECT indicator will come on after a few minutes, instead of the READY indicator. If this happens, press the PO button and check the PO scale of the multimeter to ensure that the transmitter is providing at least 70 watts output, and then return to receive.

The WARN lamp indicates that the SWR is too high. This can usually be confirmed in step (6) of the Antenna Tuning Procedure, section 4.4, where the SWR meter indication will be above 3:1. To remedy this situation the antenna or feedline will generally have to be repaired or replaced with one having an impedance closer to 50 ohms on the selected band. However, if the SWR indication is close to 3:1, it may be possible to obtain a better match by restarting the tuner: first recheck the antenna connections, and that the transmitter is set for at least 70 watts output. Then repeat step (7) of the Antenna Tuning procedure. If the WARN lamp is still on after tuning, rework or replace the antenna.

The blinking PROTECT lamp indicates the presence of any one or more of the following potentially dangerous conditions:

- (a) One or both of the power supply or amplifier heatsinks is overheated.
- (b) Drive level from the exciter (transceiver) has exceeded 80 watts, despite ALC fed back from the FL-7000 to control excitation.
- (c) ALC voltage is more negative than -9V.
- (d) More than 50 watts of power imbalance

When the microprocessor senses one of the above conditions, it bypasses exciter power around the power amplifier. The only way to reset from the protected state is to turn the FL-7000 POWER switch off and back on. If overheating caused the protector to trip, the PROTECT lamp will flash again, and the FL-7000 cannot be used until the heatsink(s) has cooled.

If overdrive or excessive ALC voltage caused the protector to trip, check the ALC connection to the transceiver, and that the exciter power level is not more than 100 watts (set the ATT switch on if it is).

Imbalance of the power amplifier is a more serious concern, generally requiring repair of the Power Combiner Unit or PA sections of the FL-7000. However, the protection afforded by this feature lessens the chance of damage finding its way to the power transistors.

#### 4.9 Operating Precautions

Summarized below are some precautions to adhere to in order to ensure long life and trouble-free operation with the FL-7000:

- (1) Do not transmit after changing bands until the READY indicator comes on.
- (2) Do not transmit when turning the POWER switch or the (rear panel) ATT switch on or off.
- (3) When changing bands, always make certain that the FL-7000 is set for the same band as the transceiver before transmitting, and that the proper antenna is connected. If using the FAS-I-4R, remember that Antenna 1 is automatically selected when the FL-7000 is switched off.
- (4) Reduce drive power or shorten transmissions if the PS TEMP or FAN indicators come on.

## 5.0 ALIGNMENT

Each FL-7000 is carefully aligned at the factory, so realignment should not be necessary unless a major component failure occurs. Under no circumstances should realignment be attempted without the proper test equipment, and unless operation of the FL-7000 is fully understood, the malfunction carefully analyzed, and the fault definitely determined to be caused by misalignment. Sudden difficulties are almost always due to component failure, rather than misalignment. However, thorough familiarity with the circuitry sometimes allows measurements quoted in the alignment procedure to provide useful clues for troubleshooting. To further facilitate troubleshooting, voltage and frequency "check" steps have been included within the alignment procedures.

**CAUTION:** Alignment by unauthorized persons may invalidate the warranty. Contact the selling dealer for instructions to obtain service under the warranty policy.

## 5.1 Test Equipment Required

HF Transceiver: FT-980, FT-757GX, FT-767GX or equivalent, providing 90 - 120 watts RF excitation in CW and SSB modes on 1.910 and 14.00 MHz.

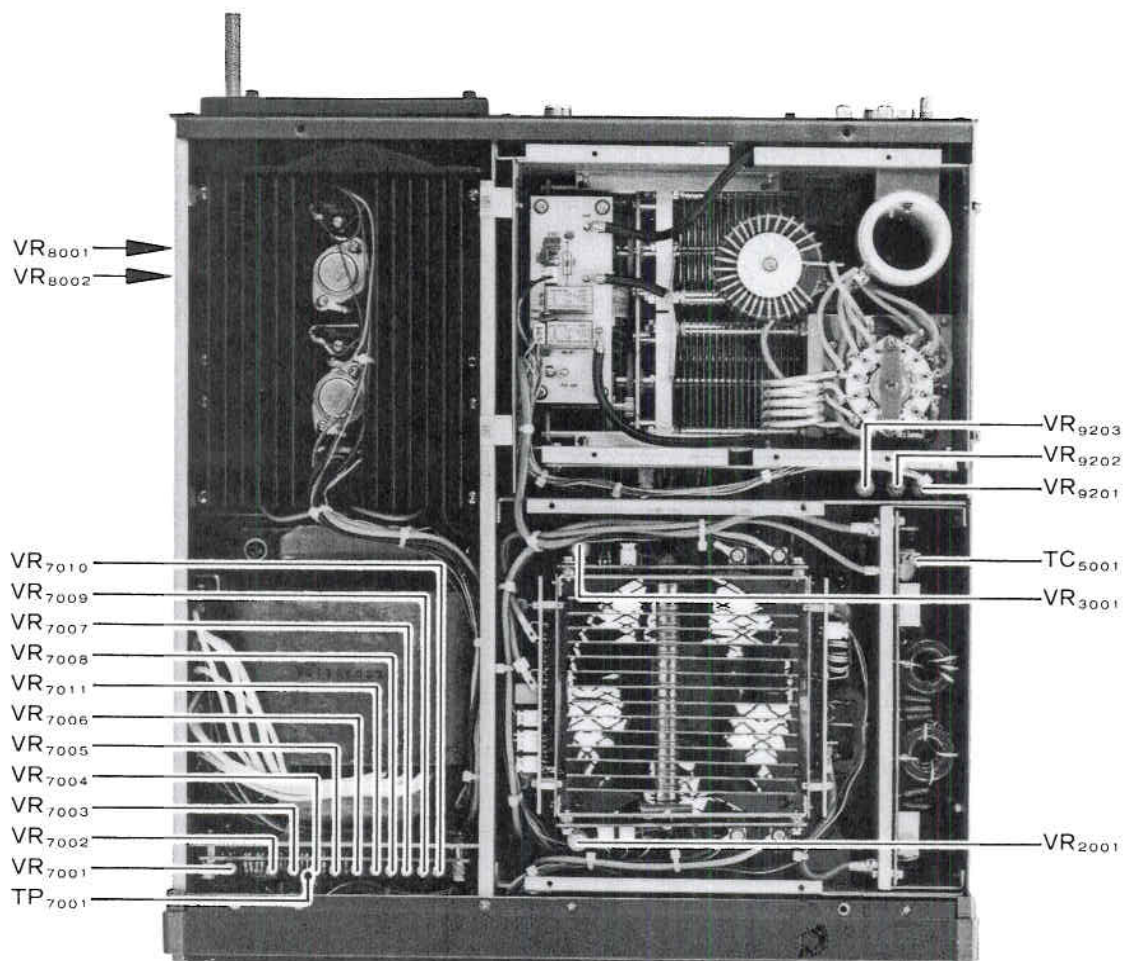
DC Voltmeter: with 50V DC scale.

DC Ammeter: with 1A scale.

Three 50-ohm, 1kW Non-reactive Dummy Loads and connectors for putting them together in parallel; or one each 50-, 25- and 16.5-ohm 1kW Dummy Loads.

In-Line RF Wattmeter to 1kW, 14 MHz.

9V DC Voltage Reference (9V battery)



FL-7000 ALIGNMENT POINTS



## 5.2 Preliminary Alignment Information

For those steps that require transmitter activation, set up the transceiver as described in section 3.5.

Connect the 1kW dummy load and in-line RF wattmeter to the antenna jack on the rear panel for all alignment steps.

For those steps that call for transmitter activation, key the transmitter only after all controls have been set and test equipment connected, and then return to receive immediately after taking the reading or making the called for adjustment.

Remember, although the DC supply voltage is not high enough to cause injury, the RF voltage developed by the power amplifier can still be lethal.

Before connecting the FL-7000 to AC power, remove the top cover and confirm that the power transformer primary taps are set correctly for the AC voltage to be supplied during alignment.

Refer to the photograph on page 14 for locations of the alignment points referred to in the alignment procedures. Adjustment points referred to are prefixed as follows:

- 'VR' = trimmer potentiometer
- 'TC' = trimmer capacitor
- 'TP' = terminal post (test point)

The word 'multimeter' in the alignment procedures refers to the multi-function (right-hand) meter on the FL-7000, while 'ammeter' refers to the (left-hand) Collector Current meter on the FL-7000. 'Test ammeter' refers to the external test equipment by that name. 'In-line' wattmeter refers to the external wattmeter connected between the FL-7000 antenna jack and the dummy load(s).

NOTE: some adjustments of automatic sensing thresholds may trigger their respective functions before alignment can be made. If this occurs, reset the trimmer and repeat the procedure. In those cases where the PROTECT thresholds are set, the POWER switch must be turned off and on.

## 5.3 Alignment Procedures

### 5.3.1 Vcc Setting & Meter Calibration

- (1) Connect the DC voltmeter (50V scale) to the Vcc terminal on the PS Unit, and adjust VR8002 for 47V.
- (2) Press the Vcc switch on the front panel, and adjust VR7010 on the Protector Unit for an indication of 47V on the front panel multimeter (corresponding to the 300W mark on the PO scale).

### 5.3.2 Overcurrent Protector

- (1) Mark the current position of the ALC ADJ potentiometer on the rear panel (so that it can be reset to this position after alignment), and then turn the potentiometer fully clockwise.
- (2) Press the OPERATE button and adjust VR7001 on the Protector Unit so that the ammeter (front panel meter at the left) is just at the threshold point where it begins to deflect (without transmitting).
- (3) Set the transceiver and amplifier to 14.000 MHz, CW mode, and adjust the excitation for 500W output from the linear. Adjust VR7011 on the Protector Unit for an indication of 20 Amps on the front panel ammeter.
- (4) Retune the equipment to 1.910 MHz, key the transmitter and adjust the ALC ADJ potentiometer for 27A on the ammeter.
- (5) With the setup of the previous step (4), key the transmitter and adjust VR8001 on the PS Unit very gradually so that the PROTECT indicator just starts to blink (the amplifier will shut down). Turn the POWER switch off and back on to reset.
- (6) Return the ALC ADJ potentiometer to the original (marked) position.

### 5.3.3 Idling Current

- (1) Temporarily disconnect the wire from the Vcc terminal on the PS Unit to the Vcc terminal on the PA-1 Unit, and connect the test ammeter (set for 1A f/s) in this line, '+' to the PS Unit and '-' to the PA-1 Unit.
- (2) Set the transceiver and FL-7000 to 14.000 MHz SSB mode, and set the MIC gain control on the transceiver fully counterclockwise (no drive). With the OPERATE button depressed, key the transmitter, wait sixty seconds, and then adjust VR2001 on the PA-1 Unit for 100 to 150 mA on the test ammeter.
- (3) Remove the test ammeter and replace the Vcc connection to the PA-1 Unit. Then repeat these steps with the PA-2 Unit, adjusting VR3001 on the PA-2 Unit.

### 5.3.4 CM Coupler Balance

- (1) With the transceiver and FL-7000 set to 14.000 MHz, CW mode, set the OPERATE and SWR switches to the depressed position, and the TUNER switch to the undepressed (off) position.
- (2) Key the transmitter, and with full output power, adjust TC5001 on the LPF Unit for minimum deflection on the multimeter (indicating SWR).

### 5.3.5 ALC Calibration and Setting

- (1) With the transceiver and FL-7000 set to 14.000 MHz, USB mode, set the OPERATE and ALC switches to the depressed position, and the TUNER switch to the undepressed (off) position.
- (2) Apply the +9V DC voltage reference to TP7001 on the Protector Unit.
- (3) With minimum excitation (MIC gain fully counterclockwise), adjust VR7008 on the Protector Unit so that the FL-7000 multimeter deflects exactly to the right edge of the ALC

- (4) Now adjust VR7005 on the Protector Unit very gradually so that the PROTECT indicator just starts to blink, and the amplifier shuts down.
- (5) Return to receive, remove the 9V reference, and turn the FL-7000 POWER switch off and back on to reset.
- (6) Switch the transceiver to CW mode, and set the transceiver drive control for full power. Key the transmitter and adjust VR7002 for 500W on the in-line wattmeter.
- (7) Install the second 50-ohm dummy load in parallel with the first, to provide a 25-ohm load. Key the transmitter and adjust VR7003 for 300W on the in-line wattmeter.

### 5.3.6 SWR Metering

- (1) With the transceiver and FL-7000 set to 14.000 MHz, CW mode, set the OPERATE and SWR switches to the depressed position, and the TUNER switch to the undepressed (off) position.
- (2) Connect the 16.5-ohm dummy load (or three 50-ohm loads in parallel) to the antenna jack with the in-line wattmeter.
- (3) Apply maximum CW excitation from the transmitter, and adjust VR7006 on the Protector Unit for minimum deflection on the FL-7000 multimeter (showing SWR).
- (4) Adjust VR7009 on the Protector Unit for an SWR indication of exactly '3' on the multimeter.

### 5.3.7 SWR Protection Calibration

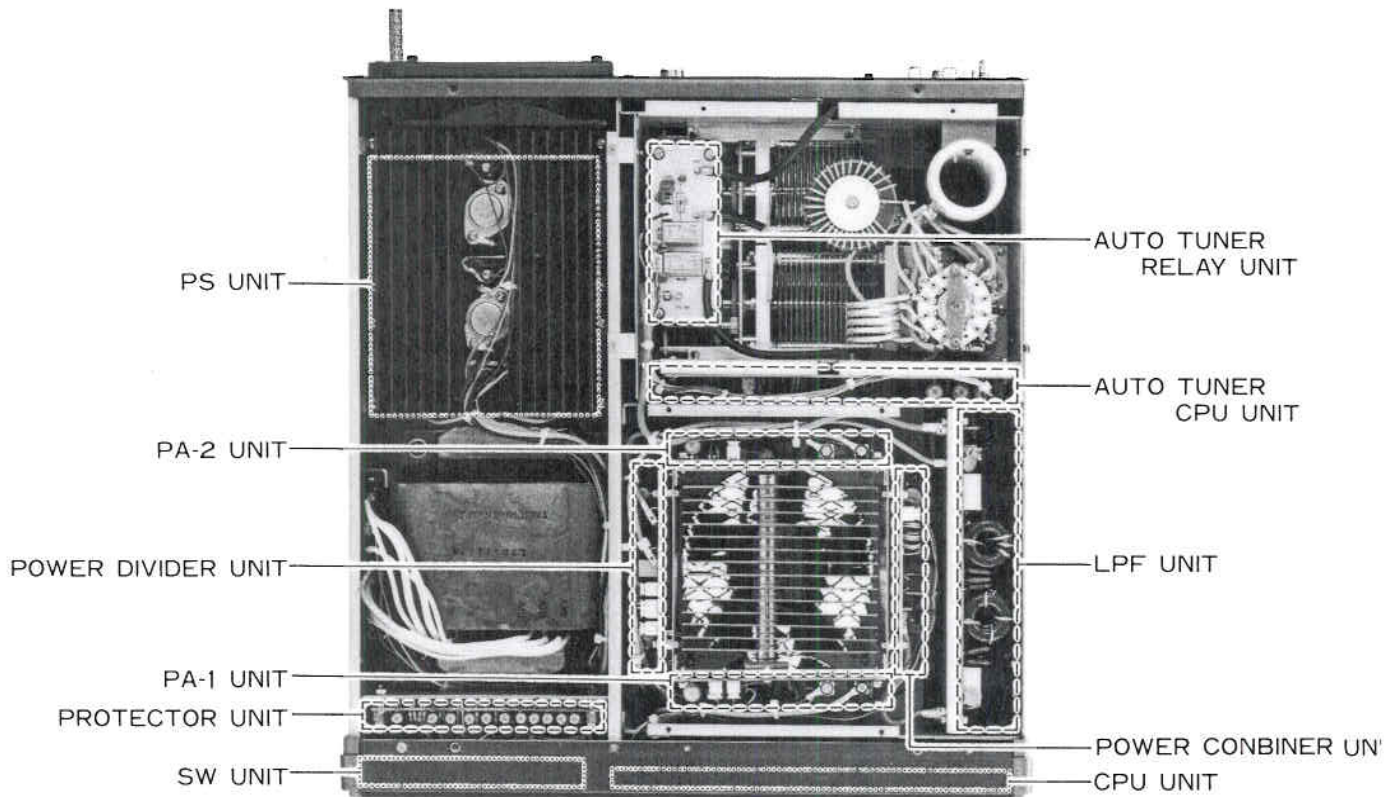
With the equipment set up and connected as in steps (1) and (2) of the previous procedure (5.3.6), apply maximum excitation and adjust VR7004 on the Protector Unit very gradually until the PROTECT indicator blinks and the amplifier shuts down. Turn the POWER switch off and on to reset.

### 5.3.8 PO Meter Calibration

- (1) With the transceiver and FL-7000 set to 14.000 MHz, CW mode, set the OPERATE and PO switches to the depressed position, and the TUNER switch to the undepressed (off) position.
- (2) Connect one 50-ohm dummy load with the in-line wattmeter to the antenna jack. Key the transmitter and adjust the exciter drive for 500W output on the in-line wattmeter.
- (3) Key the transmitter and adjust VR7007 on the Protector Unit for 500W indication on the PO scale of the FL-7000 multimeter.

### 5.3.9 ATU Sensitivity

- (1) With the transceiver and FL-7000 set to 14.000 MHz, CW mode, set the TUNER and SWR switches to the depressed position, and the OPERATE switch to the undepressed (off) position.
- (2) With the 50-ohm dummy load and in-line wattmeter connected to the antenna jack, apply maximum excitation and manually tune the FL-7000 LOAD and TUNE keys for 1:1 SWR on the multimeter.
- (3) Replace the 50-ohm dummy load with 25 ohms (two 50's in parallel). Then key the transmitter and adjust VR9203, if necessary, so the WAIT indicator comes on (the ATU starts automatic tuning).



FL-7000 UNIT LOCATIONS

