

Clegg

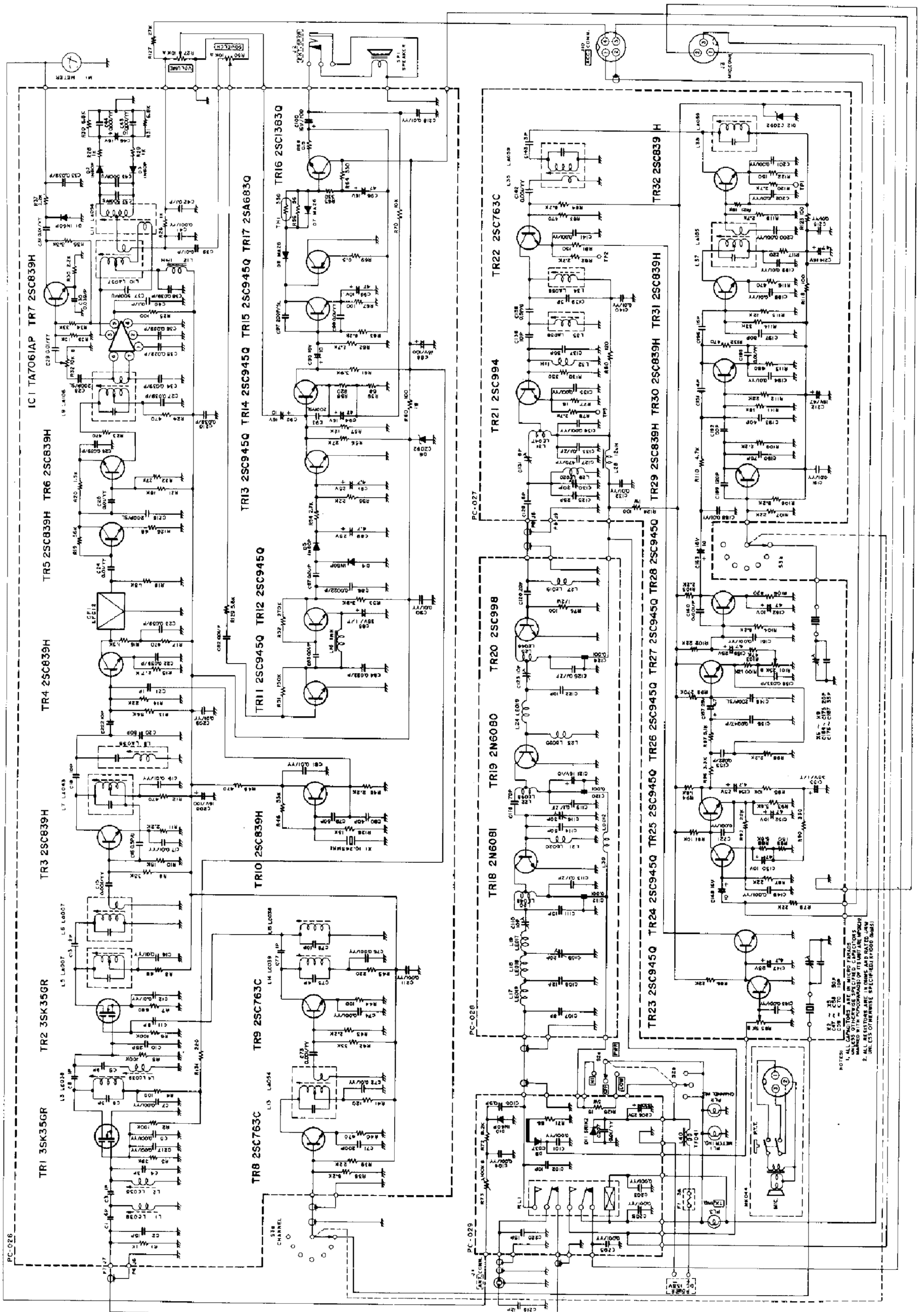
10 WATT 222 MHz FM TRANSCEIVER



FM-76

OWNER'S MANUAL

CIRCUIT DIAGRAM



NOTES:
 1. ALL CAPACITORS ARE IN MICRO FARADS UNLESS OTHERWISE SPECIFIED.
 2. ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
 3. UNLESS OTHERWISE SPECIFIED (RATED 50%)

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SECTION I SPECIFICATIONS

GENERAL:

Frequency coverage	220.00 to 225.00 MHz	
Number of Transistors	Transistors	30
	FET	2
	IC	1
	Diodes	12
Modulation Type	16F3	
Power Voltage	DC 13.8V \pm 15% negative ground	
Current Drain	Transmit:	
	HI (10W) average	3.1A
	LOW (1W) average	1.1A
	Receive: squelched	220mA
Antenna Input	50 ohms	
Size	2-1/4" (H) x 6-3/8" (W) x 8-7/8" (D)	
Weight	4-1/2 lbs.	

TRANSMITTER:

RF Power Output	HI	10W
	LOW	1W
Frequency Control	Crystal (18MHz) multiplied x 12	
Maximum Frequency Deviation	\pm 5 kHz	
Audio Input	10K ohms	
Modulation System	Variable reactance phase modulation	
Microphone	10K ohms-Dynamic microphone with push button switch	
Spurious Emission	-60 dB	

RECEIVER: Certified to comply with FCC part 15.

Reception Frequencies	12 channels for 223 MHz band	
	Built-in crystal units for 1 channel	
Reception System	Double Superheterodyne	
Intermediate Frequencies	1st IF:	10.7 MHz
	2nd IF:	455 kHz
Sensitivity	a. Better than 0.5 μ V 20dB quieting	
	b. S + N/N at 0.5 μ V input, 12 dB or more.	
Spurious Response	-60 dB	
Squelch Threshold	Less than 0.3 μ V	
Band width	kHz/-6 dB point	
	\pm 12kHz/-50 dB	
Audio output power	2.0W	
Audio output impedance	8 ohms	
Frequency control	Crystal (53 MHz) multiplied x 4	

ACCESSORIES:

The following accessories for the Clegg FM-76 are included.

1. Microphone (dynamic type)	8. External speaker plug	1
2. Microphone hanger	9. 4 prong plug or Tone Burst	
3. Spare fuse (3A)	Generator and Discriminator	
4. Mounting bracket	Meter	1
5. Mounting bracket studs	10. Crystals (installed) for	
6. Channel frequency ID card	223.50 MHz SIMPLEX	
7. Instruction Manual		

SECTION II DESCRIPTION

The Clegg FM-76 is an extremely rugged, completely solid state transceiver, Electrical design, mechanical construction and component selection assure reliable, high quality performance.

The compact, low profile packaging and convenient mobile mounting bracket facilitates convenient mounting in any vehicle. The clean, simple panel layout provides for ease of operation.

Although the FM-76 has been designed principally for mobile operation its attractive appearance and electrical performance suit it admirable for base station operation with an external power supply. The large S meter enhances beam orientation; the excellent front end selectivity provides good immunity from cross modulation.

The dual conversion receiver with its FET front end and high-Q helicalized cavity resonators produce sensitivity of 0.5 μ V or less. Signal gain of 90 dB or more is accomplished from the second mixer back by virtue of 3 stage of IF amplifier (1 transistor and 2 ICs). The need for additional front end RF amplification is thus eliminated. Zener regulated crystal-controlled first and second local oscillators produce unmatched stability. Audio reproduction is of an unusually high order of distortion free clarity.

The transmitter section will produce a nominal of 10 watts RF output. Again, a zener regulated crystal oscillator is employed for initial frequency stability. Twelve crystal controlled channels are provided for operating convenience and versatility. High-Q and shielded stages provided minimum interstage spurious reaction.

An encased low pass filter is placed at the output to further insure undesirable frequency products not being emitted. An Ingenious final PA transistor protection device (APC), is incorporated in the final output circuitry. A tiny VSWR bridge and four DC amplifiers constantly monitor the output for high VSWR, a shorted or absent antenna load or other difficulty that would cause irreparable final transistor damage. Should these difficulties occur, the APC instantaneously disables the driver and final PA without damage.

All circuitry is constructed in a series of module which are easily removable for servicing.

Each unit comes complete with built-in speaker, a high-quality dynamic microphone, mobile mounting bracket, microphone hanger, and operating manual.

SECTION III INSTALLATION

3.1 Unpacking:

Carefully remove your transceiver from the packing carton and examine it for signs of shipping damage. Should any shipping damage be apparent, notify the delivering carrier immediately, stating the full extent of the damage. It is recommended you keep the shipping carton. In the event storage, moving, or reshipment becomes necessary, they come in handy. Accessory hardware, cables, etc. are packed with the transceiver. Make sure you have not overlooked anything.

3.2 Location:

Where you place the transceiver in your automobile is not critical and should be governed by convenience and accessibility entirely. Since the unit is so compact, many mobile possibilities present themselves. In general, the mobile mounting bracket will provide you with some guide as to placement. Any place where it can be mounted with metal screws, bolts, or pop-rivets will work.

3.3 Power Requirements:

The transceiver is supplied ready to operate from any regulated 13.8V DC, 3.2 ampere negative ground source. An automobile, 12 volt, negative ground, system is usually more than adequate. Some note must be taken, however, to the condition of the vehicle's electrical system. Problems such as low battery, worn generator/alternator, poor voltage regulator, etc., will impair operation of your transceiver as well as the vehicle. High noise generation or low voltage delivery can be traced to these deficiencies. If an AC power supply is used with your transceiver, make certain it is adequately regulated for both voltage and current. Low voltage while under load will not produce satisfactory results from your transceiver. Receiver gain and transmitter output will be greatly impaired.

CAUTION: Excessive Voltage (above 16VDC) will damage to your transceiver. Be sure to check the source voltage before connecting the power cord.

Included with your transceiver is a DC power cable. The red wire positive (+), and the black wire is negative (-). If your mobile installation permits, it is best to connect these directly to the battery terminals. The arrangement eliminated random noise and transient spikes sometimes found springing from automotive accessory wiring. If such an arrangement is not possible, then any convenient B+ lead in the interior of the vehicle and the negative from can be utilized. Your transceiver provides an internal DC filter that will take out the large amount of transient difficulty anyway. Remember, the unit operates on a negative ground system only-it cannot be used in a positive ground automobile.

If an AC power supply is used with your transceiver, make certain it is adequately regulated for both voltage and current. Low voltage while under load will not produce satisfactory results from your transceiver. Receiver gain and transmitter output will be greatly impaired.

3.4 Antenna:

The most important single item that will influence the performance of any communications system is the antenna. For that reason, a good, high-quality, gain antenna of 50 ohms impedance is recommended.

When adjusting your antenna, whether mobile or fixed, by all means follow the manufacturer's instructions. There are some pitfalls to be aware of. For example: do not attempt to adjust an antenna for lowest VSWR when using a diode VSWR meter note engineered for VHF applications. Such readings will invariably have an error of 40% or more. Rather, use an in line watt meter similar to Bird Model 43 with VHF cartridge. Further, when adjusting a mobile antenna, do so with the motor running preferably above normal idling speed. This will insure proper voltage level to the transceiver.

Do not become alarmed if your transceiver fails to transmit at times during the antenna tune up procedure. Remember, your transceiver has a built-in Automatic Protection Circuit (APC) that will disable the transmitter if excessive VSWR, a short coaxial line or connector, or other antenna deficiency is present. A quick check on a good 50 ohm dummy load will show the transceiver to be working. The difficulty will lie with the antenna or its transmission line.

The RF coaxial connector on the rear chassis mates with a standard PL-259 connector.

3.5 Microphone:

A high quality dynamic microphone is supplied with your transceiver. Merely plug it into the proper receptacle on the front panel. Should you wish to use a different microphone, make certain it is of the high impedance type; at least 10K ohms or better. Particular care should be exercised in wiring also, as the internal electronic switching system is dependant upon it. See the schematic for the proper hook up. Under no circumstances use a "gain pre-amp" type microphone. The audio system in your transceiver is more than adequate and additional pre-amplification is unnecessary. To use this class of microphone is to invite distortion and possible damage to the transceiver.

3.6 Crystals:

Your transceiver has twelve channels, both transmit and receive, or a total of 24 crystal positions. The channel selector switch selects one transmit and one receive channel in each of its twelve positions.

Transmit and Receive crystals for most commonly used channels are available directly from Clegg inventory and may be ordered by mail or telephone. Crystals may, of course, be purchased from any of the reliable crystal sources advertising in the various ham periodicals. They should be ordered to the following specifications.

Crystal Data

1) Transmitter crystal

Holder type : HC-25/U
OSC. Mode : Fundamental
Pin to pin capacitance : 7pF Max. 4 pF Min.
Load capacitance : 30pF
Series resistance : 25 ohms Max.
Frequency tolerance : $\pm 0.001\%$ at 25°C
Crystal frequency : $\frac{\text{Desired operating frequency}}{12}$
Frequency Stability : $\pm 0.001\%$ (-20°C +50°C)

2) Receiver crystal

Holder type : HC-25/U
OSC. Mode : 3rd Overtone
Pin to pin capacitance : 7pF Max., 4pF Min.
Load capacitance : 20pF
Series resistance : 40 ohms Max.
Frequency tolerance : $\pm 0.001\%$ at 25°C
Crystal frequency : $\frac{\text{Desired operating frequency} - 10.7\text{MHz}}{4}$
Frequency stability : $\pm 0.001\%$ (-20°C +50°C)

Trimmers have been placed on the crystal board to assist you in adjusting new crystals on frequency. Consult the trimmer location chart (Fig. 1) for their positions.

The amount of frequency spread between any two receiving or any two transmitting frequencies should not exceed 2 MHz. Since the receiver and transmitter are independent of each other, you may have any practical amount of frequency separation you wish here. Only two or more widely spaced frequencies for the receiver alone or for the transmitter alone need be considered under the 2 MHz limitation.

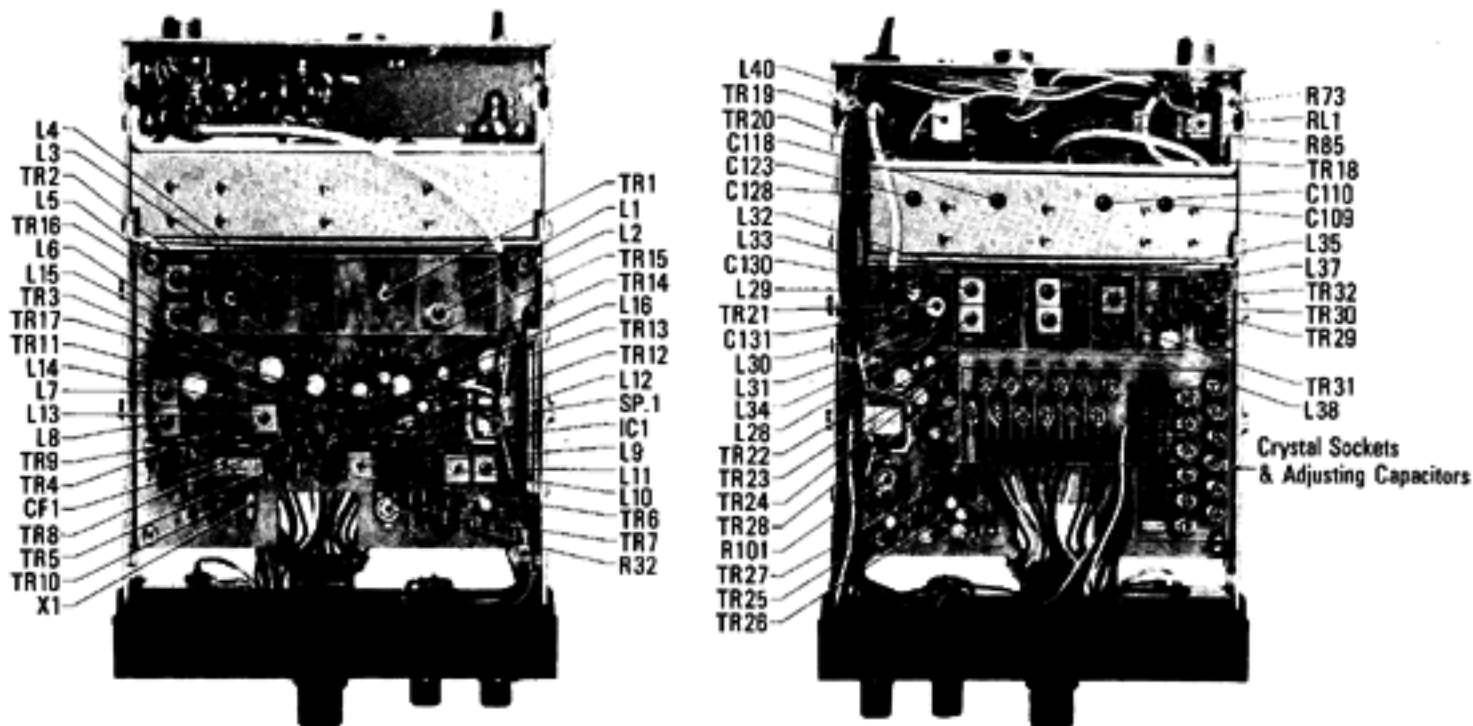


FIG. 1

3.7 External speaker jack and plug is supplies with your unit in the event another speaker is desirable. The external speaker impedance should be 8 ohms. The use of external speaker jack will disable the internal speaker. An 8 ohm headset can be utilized as well.

SECTION IV CONTROL FUNCTIONS

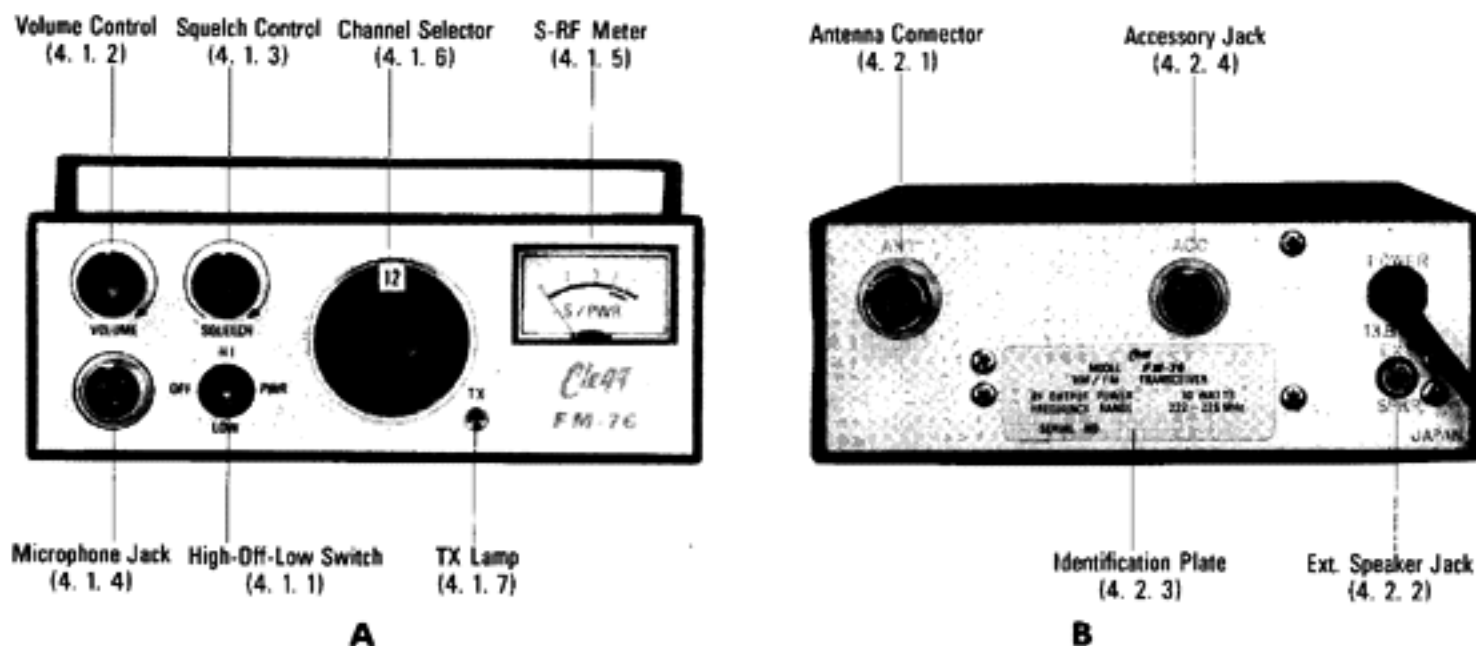


FIG. 2

4.1 Front control and jack (Fig. 2-A)

4.1.1 High-Off-Low Switch: opens or closes the 13.8 VDC source voltage to the transceiver. In "high" position, output power is 10 watts. In "low" position output power is 1 watt.

- 4.1.2 Volume Control: controls audio output level of the receiver.
- 4.1.3 Squelch Control: controls the squelch threshold point of the receiver.
- 4.1.4 Microphone Jack: accepts 3 prong mike plug supplied on microphone.
- 4.1.5 S-RF Meter: reads S signal strength in receive mode and relative RF output in transmit mode. The meter face is illuminated with a white lamp when the transceiver is switched on in in-receive condition.
- 4.1.6 Channel selector: selects one of twelve pairs of transmit receive crystals.
- 4.1.7 TX Lamp: Comes on when microphone PTT button is pressed and transmitter is on the air.

- 4.2 Rear Panel (Fig. 2-B)
 - 4.2.1 Antenna Connector: Accepts standards PL-259 coaxial connector. Note: Some transceivers may come with a metric threaded connector. If this is the case, a mating metric PL-259 is supplied also. Most PL-259 connectors will mate satisfactorily if care is taken to seat them properly. If you have difficulty, try a different make of PL-259.
 - 4.2.2 External Speaker Jack: This jack mates with the accessory Ext. speaker Plug supplied for external 8 ohm speaker or headset use. The use of this jack mutes the internal speaker.
 - 4.2.3 Identification Plant: States model, serial number, RF output power and frequency range, Note: It would be well to make a separate record of the serial number of your unit for insurance purposes.
 - 4.2.4 Accessory Jack: Accepts accessory 4 prong Plug supplied for tone-burst and discriminator meter.
It would have as connections:
 - 1. Tone audio input (10mV)
 - 2. 12 volt negative (ground)
 - 3. Transmit keyed 12 VDC positive
 - 4. Discriminator meter connection (See Section 7-2-d)

SECTION V OPERATION

- 5.1 Initial Preparations:
 - a. Connect the microphone to the microphone jack.
 - b. Connect the antenna to the antenna coax connector. Make sure the coax line is of the correct impedance (50 ohms) and is neither shorted nor open circuited.
 - c. Make sure the function switch is in the off position. The red lead should be connected to the positive side of the power source and the black lead to the negative side. In the even that these leads are improperly connected, the MARK 3 will not function. No damage will be incurred since protection is provided for this purpose.
 - d. Turn the volume and squelch controls to the maximum counter clockwise position.

- 5.2 Operation:
- a. When the function switch is set to either the "HI" or "LOW" position, the set is switched on, and the channel indicator window and meter will be illuminated.
 - b. Switch the channel selector to the desired channel.
- 5.3 Reception:
- a. Adjust the volume control to a comfortable listening level of noise, if no signal is present.
 - b. Carefully adjust the squelch control clockwise until the noise just disappears. This is the proper squelch threshold setting and must be done when no signal is received which opens the squelch. If the squelch is unstable due to the reception of weak or unstable stations, adjust the squelch control further until the proper threshold is obtained.
 - c. The S meter indicates the signal strength of the incoming stations and is calibrated in S units. An input signal of approximately $5\mu\text{v}$ will provide an S9 reading.
- 5.4 Transmitting:
- a. Push the PTT (push to talk) button on the microphone and the transceiver is set for transmitting. At the same time, the TX Lamp is illuminated and the meter provides an indication of relative power output of the transmitter. The pointer will be on or near the red mark on the meter scale when on high power and just a little over on low power.
 - b. Hold the microphone about three inches from your mouth and speak in a normal voice. Shouting does not increase your communication range, but a good antenna does. The microphone is of the dynamic type and provides good pickup for all levels of the voice.
 - c. To receive again, just release the PTT button. This will also switch off the red illumination of the Lamp.
- 5.5 Function Switch:
- a. You can select the proper output power according to the communication distance to be covered or conditions. When using the FM-76 as a driver or exciter for an amplifier, the function switch can be set to the low power position and the power output adjusted as described in the Power Supply section. This will provide the required amount of drive for the linear amplifier without wasting power in swamping resistors, etc. When the switch is set on "HI", the power output will be 10 watts; on "LOW" the output will be 1 watt.

SECTION VI THEORY OF OPERATION

- 6.1 **Receiver RF Amplifier and 1st Mixer:**
The input signal passed through the pre-selector circuit (C1, C2, C3, C4, L1 and L2) is amplified by TR1 (MOS-FET) and fed into 1st Mixer TR2 (MOS-FET) through Double-tuned Filter (L3 and L4).
- 6.2 **Receiver 1st Local Oscillator:**
3rd overtone crystal (53 MHz) is oscillated at 1st Local Oscillator (TR8) with several KHz adjustment by the trimmer capacitor built in series with crystal. The output of the 1st Local Oscillator is multiplied by four times at Multiplier (TR9), and then fed into the 1st Mixer (TR2), giving the 1st I.F. of 10.7 MHz.
- 6.3 **Receiver 1st IF amplifier, 2nd Mixer, 2nd Local Oscillator, 2nd IF Amplifier, Limiter, Discriminator and Meter Amplifier:**
The output from the 1st Mixer (10.7 MHz) is amplified by TR3 and fed to the 2nd Mixer (base of TR4). Also, the 2nd Local Frequency (10.245 MHz) is coupled into the 2nd Mixer through crystal control oscillator (emitter of TR10) to get the output of the 2nd Mixer (455 KHz). The 2nd IF signal is amplified and limited by TR5 and TR6, and then is detected by the Discriminator circuit consisted of L10, L11, D2 and D3. The Meter Amplifier (TR7) amplifies a part of output of the 2nd IF Amplifier (TR6) and detect it with D1 to feed into the Meter.
- 6.4 **Receiver Audio Amplifier and Squelch Amplifier:**
The audio signal from Discriminator circuit is adjusted by Volume Control (R27) and amplified by Audio Amplifier (TR14, TR15). This output signal is further amplified up to 2 watts by the Complementary Power Amplifier (TR16, TR17) and then fed into Speaker.
The noise signal (with the main element of 40 KHz) from Discriminator is controlled by Squelch Control (R50) and fed into the Noise Amplifier (TR11, TR12). The amplified noise signal is detected by D4 and D5 and coupled into DC Switching Amplifier (TR13).
When there is no RF signal, the noise signal from the Discriminator increases and the DC Switching Amplifier (TR13) is set on. In such case, Audio is cut-off since the collector of TR13 and the base of TR14 (Audio Amplifier) become zero level. While, when RF signal comes in, TR13 is set off and TR14 (Audio Amplifier) operates properly.
- 6.5 **Power Source Filter:**
The DC Filter (L40 and C206) protects the transceiver from the damages caused by surge and spike voltage, and also from the noises. D11 is also provided to protect the transceiver from the damage caused by miss connection of the power cord.
- 6.6 **Transmitter Crystal Oscillator and Phase Modulator:**
TR29 is a fundamental crystal oscillator of 18 MHz. The frequency adjustment in the range of several kHz, is made by the trimmer capacitors built in the series with crystals. The output of the Oscillator is coupled into the base of TR30 (Phase Modulator) and receive the Phase Modulation together with the Transmitter Audio Signal coming into the base of TR30.

- 6.7 **Transmitter Audio Amplifier:**
The audio signal from microphone is amplified by TR25 and then further amplified and limited by limiter transistor TR26.
The pre-emphasis circuit is formed as feedback type with C154, R95, C153, R90 and R89. The output signal from the AF Amplifier (TR26) is coupled into the Phase Modulator circuit (TR13) through the Integrator Circuit (TR28) and Active Audio Filter (TR27).
- 6.8 **Transmitter Multiplier:**
The output from the Phase Modulator (TR30) is multiplied twelve times to a final frequency of 220 MHz through TR31, TR32, TR22 and TR21. These transistors act as, in order, a frequency tripler, buffer amplifier, and frequency doublers.
- 6.9 **Transmitter Power Amplifier Block:**
The output signal from the multiplier is amplified to 10 watts by TR20, TR19 and TR18, and then coupled into the APC (Automatic Protection Circuit).
- 6.10 **APC (Automatic Protection Circuit) and Transmitter Power Monitor Circuit:**
A part of 10 watt output from the Power Amplifier Block is coupled by C105 and detected by D10 to be fed into the Meter to indicate as power monitor. The large portion of the RF output is fed into the Antenna Connector through VSWR Bridge and the Relay (RL1).
APC acts as protection to decrease the output of TR22, if the antenna is seriously mis-matched. A reflected power is detected by D9. When the antenna is mismatched, this circuit senses a high reflected power and provides a base drive to TR23. TR23 will conduct sufficient base drive to reduce the base drive of TR24. When TR24 begins to turn off, it reduces the Emitter current of TR22. As result, the power output of Power Amplifier Circuit (TR18) is reduced to a safe value. Thus, when the antenna is mismatched, APC protects from the damage.

SECTION VII MAINTENANCE

- 7.1 **Overall Alignment:**
The Clegg FM-76 has been factory aligned to produce full specified performance over the 222 to 224 MHz range on transmit and 223 to 225 MHz range on receive. Only when operation is required over a different portion of the 222 MHz band or after replacement of a major component should realignment of necessary.
If realignment is indicated it is recommended that the owner contact Clegg Division, Service Manager for detailed instructions.

7.2 Frequency Netting, Transmitter:

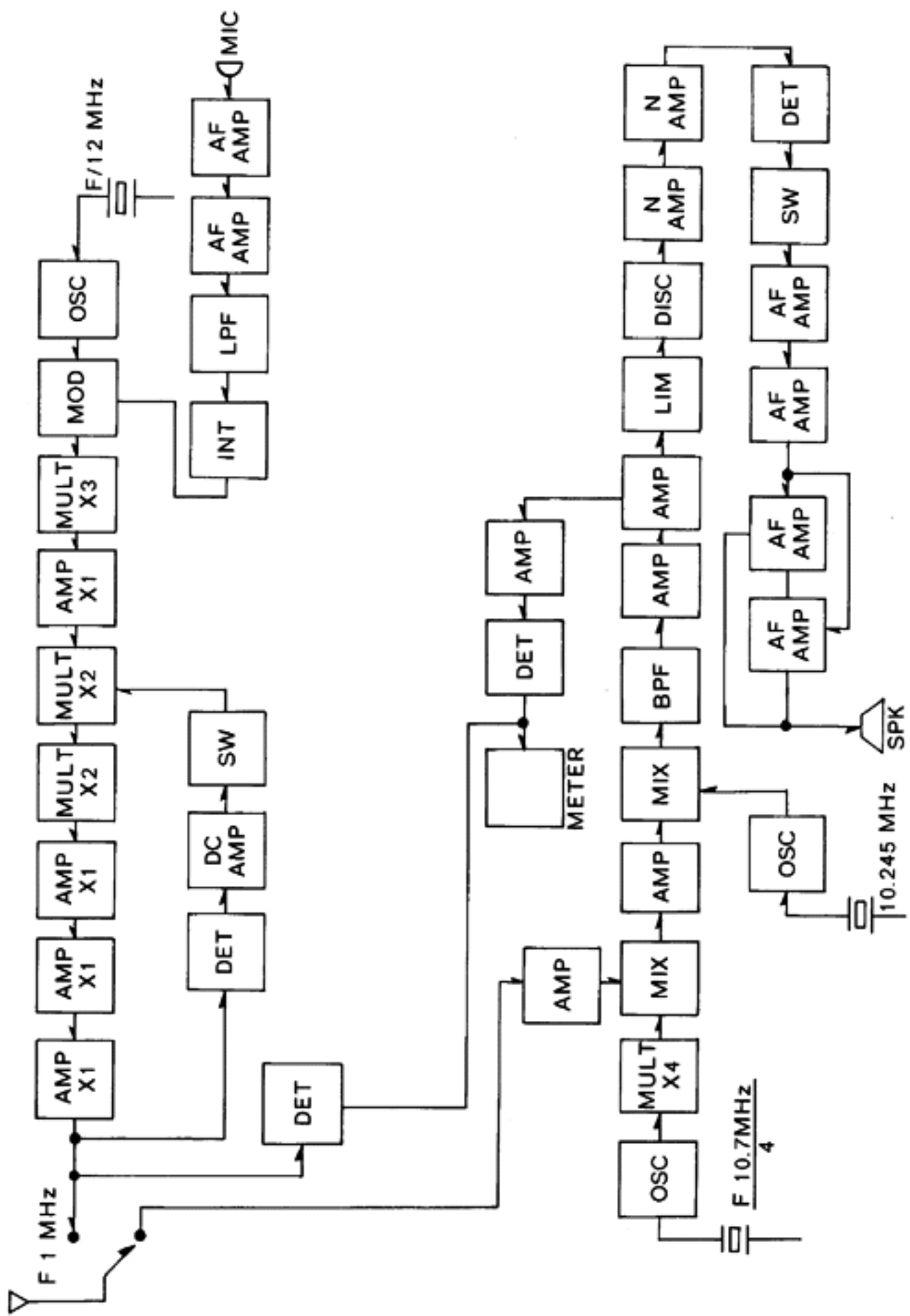
- a. Remove the eight self tapping screws on the both sides of the cabinet. Separate the Chassis from the cabinet.
- b. Connect a dummy load (50 ohms) or a wattmeter to coax connector.
- c. Connect the microphone to the microphone jack.
- d. To align the transmitter on a desired frequency, switch the channel control to the desired channel. Slowly adjust the trimmer capacitor for that channel until the desired frequency is achieved. Consult Fig. 1 for the location of the proper trimmer. These trimmers should be adjusted very slowly while the transmit frequency is observed on suitable measuring equipment. Another FM-76 equipped with a discriminator meter can serve well for this purpose. However, it must be adapted. This adaptation can be accomplished by installing a 50 microampere ϕ center meter. Install the meter to accessory plug (4 pin, and ground 2 pin). With the FM-76 meter installed, in the receive mode on the channel desired, adjust the trimmer capacitor for the null point on the meter.
- e. The multipliers, driver and power output stages should be aligned on LOW power first then set the function switch on HIGH power. Align these stages according to the alignment chart provided. (See Alignment Chart).

Be carefull not to transmit for more than 5 second during each alignment step. As damage could be caused to the transistors due to overload during this procedure.

7.3 Frequency Netting, Receiver:

- a. Remove the microphone form the transceiver to prevent accidental transmission during receiver alignment.
- b. Allow the test oscillator or generator to stabilize output frequency drift.
- c. Connect the test oscillator or generator to the antenna coax connector. Set the test oscillator or generator to the desired frequency. Set the squelch control to the maximum counter clockwise position.
- d. Align the receiver accrding to the chart provided. (See Alignment Chart).
- e. When setting the receiver to a desired frequency, a discriminator meter should be connected to Accessory Plug and the receiver trimmer capacitors adjusted to cause the S meter to read a maximum and the discriminator meter to read zero. Refer to Fig. 1 for the location of the proper trimmer corresponding to discriminator meter.

FM-76 BLOCK DIAGRAM



ALIGNMENT CHART**FM-76 VOLTAGE CHART**

NO.	NAME	GATE 1	GATE 2	SOURCE	DRAIN	REMARKS			
TR 1	3SK35	0	3.6	0	12.8				
2	3SK35	0	0	3.5	8.5				
NO.	NAME	# 1	# 2	# 3	# 4	# 5	# 6	# 7	REMARKS
IC 1	TA7061AP	1.9	1.9	8.6	0	7.8	1.9	1.9	
NO.	NAME	BASE	EMITTER	COLLECTOR	REMARKS				
TR 3	2SC839	2.4	2.0	8.3					
4	2SC839	2.1(2.1)	2.0(1.7)	7.3(7.5)	2nd Local osc. ON(OFF)				
5	2SC839	0.75	0.11	1.1					
6	2SC839	3.3	2.8	7.8					
7	2SC839	2.1	1.7	5.3					
8	2SC763	2.5(2.1)	1.6(1.5)	8.4(8.4)	() ; Vacant Channel				
9	2SC763	0.5(0.5)	0.45(0)	8.6(8.8)	() ; Vacant Channel				
10	2SC839	2.3(2.3)	3.2(1.8)	7.8(8.2)	2nd Local osc. ON (OFF)				
11	2SC945	0.6(0.6)	0	1.9(1.4)	Unsquelched (Squelched)				
12	2SC945	1.7(1.3)	1.9(1.4)	4.6(6.0)	Unsquelched (Squelched)				
13	2SC945	0(0.6)	0	2.4(0.02)	Unsquelched (Squelched)				
14	2SC945	2.4(0.02)	1.9(0)	4.9(13.5)	Unsquelched (Squelched)				
15	2SC945	1.6	0.95	6.3					
16	2SC1383	7.4	6.8	13.5					
17	2SA683	6.3	0	6.8					
18	2N6081	0	0	12.5(2.4)	Hi Power (Low Power)				
19	2N6080	0	0	12.5(2.4)	Hi Power (Low Power)				
20	2SC998	0	0	12.5(12.5)	Hi Power (Low Power)				
21	2SC994	0	1.1(0)	12.5(13.0)	() ; Vacant Channel				
22	2SC763	0.7(0.9)	1.6(0.4)	12.5(13.0)	() ; Vacant Channel				
23	2SC945	0(0.55)	0	0.6(0.6)	() ; Absent Antenna at HI				
24	2SC945	0.6(0.6)	0	0.02(1.6)	() ; Absent Antenna at HI				
25	2SC945	2.4	1.9	5.9					
26	2SC945	5.8	5.3	6.8					
27	2SC945	2.4	1.9	5.8					
28	2SC945	2.1	1.6	4.3					
29	2SC839	5.5(5.6)	5.4(5.0)	7.9(8.0)	() ; Vacant Channel				
30	2SC839	3.1(3.3)	2.6(2.5)	7.9(8.0)	() ; Vacant Channel				
31	2SC839	1.5(1.7)	2.0(1.2)	7.6(8.1)	() ; Vacant Channel				
32	2SC839	0.9(1.0)	1.0(0.4)	8.0(8.5)	() ; Vacant Channel				

Note: 1. They were measured by DC Volt Meter 33.3K Ω /V, \pm 3%.

2. Datas, From TR18 to TR32 were measured by DC Volt-Meter (Note 1) with 10K Ω Resistor-of it's probe.