MAINTENANCE MANUAL

CQP8000

VOLUME I

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MAINTENANCE MANUAL

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MODEL NOMENCLATURE

CQP8000

The diagram below is a schematic description of the radionomenclature explaining the meaning of the different numbers and characters contained in the radio specification.

LOCA- TION	TYPE OF UNIT	TX POWER W	FREQ. MHz	MODEL SERIES	SQUELCH	CHANNEL SPACING kHz	NO.OF CHAN- NELS	MODEL VAR'N	IS- SUE	
MD Ba- sing- stoke	H Hand held	3 2 W	3 VHF 136-174	SNU Std.	9 *Coded	1 20/25	2 2 Ch.	0 Uni- ver- sal	-	N Packaged **Model
		4 4/5 W	4 UHF 403-470 470-520			5 12.5	8 8 Ch.			
							16 16 Chan.			

* Select 5 tone signalling or PL or CS

** Packaged model, includes accessories such as battery, antenna etc.

NOTE:

20 kHz channel spacing is ordered by ordering a 25 kHz radio with the appropriate option.

MODEL CONFIGURATION

CQP8000 - VHF

The list covers models 2, 8 & 16 channels only in frequency bands: 136 - 151 MHz, 146 - 162 MHz, 157 - 174 MHz.

The individual frequencies of the radio do not appear from the model nomenclature. These frequencies are indicated on the test sheets delivered together with the radios.

If such test sheet is not present it should be noted that the frequencies are indicated on the board of the radio, too.

FACTORY I.D.	POWER LEVEL	CHAN. SPACING	NO. OF CHANS.
H33SNU9120BN	2 W	20/25 kHz	2 channels
H43SNU9120BN	5 W	20/25 kHz	2 channels
H33SNU9520BN	2 W	12.5 kHz	2 channels
H43SNU9520BN	5 W	12.5 kHz	2 channels
H33SNU9180BN	2 W	20/25 kHz	8 channels
H43SNU9180BN	5 W	20/25 kHz	8 channels
H33SNU9580BN	2 W	12.5 kHz	8 channels
H43SNU9580BN	5 W	12.5 kHz	8 channels
H33SNU9100BN	2 W	20/25 kHz	16 channels
H43SNU9100BN	5 W	20/25 kHz	16 channels
H33SNU9500BN	2 W	12.5 kHz	16 channels
H43SNU9500BN	5 W	12.5 kHz	16 channels

MODEL NOMENCLATURE

CQP8000

The diagram below is a schematic description of the radio nomenclature explaining the meaning of the different numbers and characters contained in the radio specification.

LOCA-TION	TYPE OF UNIT	TX POWER W	FREQ. MHz	MODEL SERIES	SQUELCH	CHANNEL SPACING kHz	NO. OF CHANS.	MODEL VAR'N	IS-SUE	
MD Basing-stoke	H Hand held	2 1 W	3 VHF 138-174	SNU Std.	9 *Coded	1 20/25	2 2 Ch.	0 Uni-ver'l	-	N Packaged **Model
		3 2 W	4 UHF 403-470			5 12.5	8 8 Ch.			
		4 4/5 W								

* Select 5 tone signalling or PL or CS

** Packaged model, includes accessories such as battery, antenna etc.

NOTE:

20 kHz channel spacing is ordered by ordering a 25 kHz radio with the appropriate option.

MODEL CONFIGURATION

CQP8000 - VHF

The list covers models 2 & 8 channels only in frequency bands: 138 - 150.8 MHz, 146 - 162 MHz, 157 - 174 MHz.

The individual frequencies of the radio do not appear from the model nomenclature. These frequencies are indicated on the test sheets delivered together with the radios.

If such test sheet is not present it should be noted that the frequencies are indicated on the board of the radio, too.

FACTORY I.D.	POWER LEVEL	CHAN. SPACING	NO. OF CHANS.
MDH23SNU9120A(N)	1 W	20/25 kHz	2 Channel
MDH33SNU9120A(N)	2 W	20/25 kHz	2 Channel
MDH43SNU9120A(N)	5 W	20/25 kHz	2 Channel
MDH23SNU9520A(N)	1 W	12.5 kHz	2 Channel
MDH33SNU9520A(N)	2 W	12.5 kHz	2 Channel
MDH43SNU9520A(N)	5 W	12.5 kHz	2 Channel
MDH23SNU9180A(N)	1 W	20/25 kHz	8 Channel
MDH33SNU9180A(N)	2 W	20/25 kHz	8 Channel
MDH43SNU9180A(N)	5 W	20/25 kHz	8 Channel
MDH23SNU9580A(N)	1 W	12.5 kHz	8 Channel
MDH33SNU9580A(N)	2 W	12.5 kHz	8 Channel
MDH43SNU9580A(N)	5 W	12.5 kHz	8 Channel

MODEL NOMENCLATURE

CQP8000

The diagram below is a schematic description of the radio nomenclature explaining the meaning of the different numbers and caracters contained in the radio specification.

LOCA-TION	TYPE OF UNIT	TX POWER W	FREQ. MHz	MODEL SERIES	SQUELCH	CHANNEL SPACING kHz	NO. OF CHANS.	MODEL VAR'N	IS-SUE	
MD Basing-stoke	H Hand held	2 1 W	3 VHF 138-174	SNU Std.	9 *Coded	1 20/25	2 2 Ch.	0 Uni-ver'l	-	N Packaged **Model
		3 2 W	4 UHF 403-470			5 12.5	8 8 Ch.			
		4 4/5 W								

* Select 5 tone signalling or PL or CS

** Packaged model, includes accessories such as battery, antenna etc.

NOTE:

20 kHz channel spacing is ordered by ordering a 25 kHz radio with the appropriate option.

MODEL CONFIGURATION

CQP8000 - VHF

The list covers models 2 & 8 channels only in frequency bands: 138 - 150.8 MHz, 146 - 162 MHz, 157 - 174 MHz.

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FACTORY I.D.	POWER LEVEL	CHAN. SPACING	NO. OF CHANS.
MDH23SNU9120A(N)	1 W	20/25 kHz	2 Channel
MDH33SNU9120A(N)	2 W	20/25 kHz	2 Channel
MDH43SNU9120A(N)	5 W	20/25 kHz	2 Channel
MDH23SNU9520A(N)	1 W	12.5 kHz	2 Channel
MDH33SNU9520A(N)	2 W	12.5 kHz	2 Channel
MDH43SNU9520A(N)	5 W	12.5 kHz	2 Channel
MDH23SNU9180A(N)	1 W	20/25 kHz	8 Channel
MDH33SNU9180A(N)	2 W	20/25 kHz	8 Channel
MDH43SNU9180A(N)	5 W	20/25 kHz	8 Channel
MDH23SNU9580A(N)	1 W	12.5 kHz	8 Channel
MDH33SNU9580A(N)	2 W	12.5 kHz	8 Channel
MDH43SNU9580A(N)	5 W	12.5 kHz	8 Channel

MODEL NOMENCLATURE
MODEL CONFIGURATION UHF

MODEL NOMENCLATURE

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LOCATION	TYPE OF UNIT	TX POWER W	FREQ. MHz	MODEL SERIES	SQUELCH	CHANNEL SPACING kHz	NO. OF CHANS.	MODEL VAR'N	ISSUE	
MD Basingstoke	H Hand held	2 1 W	3 VHF 138-174	SNU Std.	9 *Coded	1 20/25	2 2 Ch.	0 Univer'l	-	N Packaged **Model
		3 2 W	4 UHF 403-470			5 12.5	8 8 Ch.			
		4 4/5 W								

* Select 5 tone signalling or PL or CS

** Packaged model, includes accessories such as battery, antenna etc.

NOTE:

20 kHz channel spacing is ordered by ordering a 25 kHz radio with the appropriate option.

MODEL CONFIGURATION

CQP8000 - UHF

The list covers models 2 & 8 channels only in frequency bands: 403 - 433 MHz and 438 - 470 MHz.

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If such test sheet is not present it should be noted that the frequencies are indicated on the board of the radio, too.

FACTORY I.D.	POWER LEVEL	CHAN. SPACING	NO. OF CHANS.
MDH24SNU9120A(N)	1 W	20/25 kHz	2 Channel
MDH34SNU9120A(N)	2 W	20/25 kHz	2 Channel
MDH44SNU9120A(N)	4 W	20/25 kHz	2 Channel
MDH24SNU9520A(N)	1 W	12.5 kHz	2 Channel
MDH34SNU9520A(N)	2 W	12.5 kHz	2 Channel
MDH44SNU9520A(N)	4 W	12.5 kHz	2 Channel
MDH24SNU9180A(N)	1 W	20/25 kHz	8 Channel
MDH34SNU9180A(N)	2 W	20/25 kHz	8 Channel
MDH44SNU9180A(N)	4 W	20/25 kHz	8 Channel
MDH24SNU9580A(N)	1 W	12.5 kHz	8 Channel
MDH34SNU9580A(N)	2 W	12.5 kHz	8 Channel
MDH44SNU9580A(N)	4 W	12.5 kHz	8 Channel

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MD Basing-stoke	H Hand held	2 1 W	3 VHF 138-174	SNU Std.	9 *Coded	1 20/25	2 2 Ch.	0 Uni-ver'l	-	N Packaged **Model
		3 2 W	4 UHF 403-470			5 12.5	8 8 Ch.			
		4 4/5 W								

* Select 5 tone signalling or PL or CS

** Packaged model, includes accessories such as battery, antenna etc.

NOTE:

20 kHz channel spacing is ordered by ordering a 25 kHz radio with the appropriate option.

MODEL CONFIGURATION

CQP8000 - UHF

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MDH24SNU9120A(N)	1 W	20/25 kHz	2 Channel
MDH34SNU9120A(N)	2 W	20/25 kHz	2 Channel
MDH44SNU9120A(N)	4 W	20/25 kHz	2 Channel
MDH24SNU9520A(N)	1 W	12.5 kHz	2 Channel
MDH34SNU9520A(N)	2 W	12.5 kHz	2 Channel
MDH44SNU9520A(N)	4 W	12.5 kHz	2 Channel
MDH24SNU9180A(N)	1 W	20/25 kHz	8 Channel
MDH34SNU9180A(N)	2 W	20/25 kHz	8 Channel
MDH44SNU9180A(N)	4 W	20/25 kHz	8 Channel
MDH24SNU9580A(N)	1 W	12.5 kHz	8 Channel
MDH34SNU9580A(N)	2 W	12.5 kHz	8 Channel
MDH44SNU9580A(N)	4 W	12.5 kHz	8 Channel

CQP8000

GENERAL DESCRIPTION

The frequency-synthesized CQP8000 Radio is an advanced design, microprocessor-based transceiver that incorporates the latest technology available in two-way radio communications. All channel frequencies and squelch codes are stored in an electrically erasable programmable read only memory (EEPROM), with all transmit and receive operations controlled by a microcomputer.
The functions provided by the radio are identified by the model and option numbers. Model and option numbers will be shown on the radio's customer information sheet, which is shipped with each new radio.

PHYSICAL DESCRIPTION

All operating controls, except the push-to-talk (PTT) switch, the monitor buttons, and the keypad (models with DTMF or Multicall Options), are located on top of the radio. The PTT switch and monitor buttons are located on the left side of the radio (viewed from the front), and the keypad (if so equipped) is an integral part of the front cover.
The CQP8000 radio is small in size and weight, and constructed of a highly durable impact resistant, molded polycarbonate housing. O-rings and seals are utilized throughout the radio. All controls, including the PTT switch, the monitor buttons, and the keypad, are weather resistant. The microphone and speaker are covered with a special diaphragm to provide extra resistance against dirt, dust, and water intrusion. This proven rugged construction offers excellent protection against adverse environmental conditions.
The height of the radio varies with the size of the battery. All other dimensions are standard, except for those radios with a keypad option.

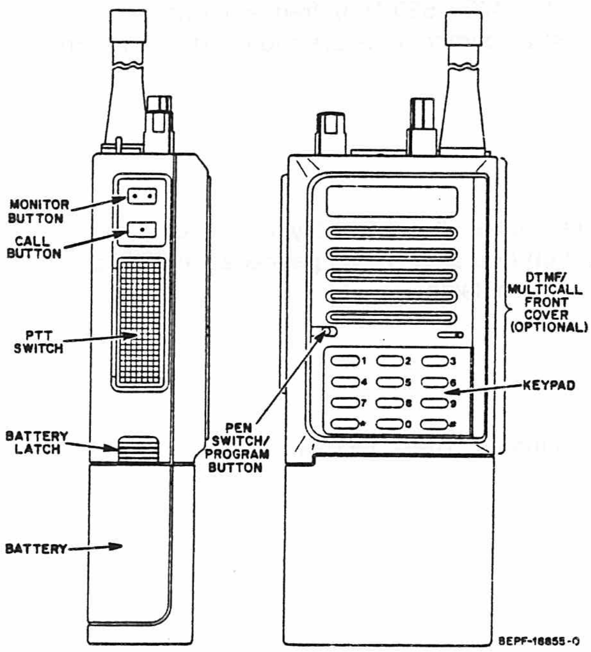

Figure 1. Typical CQP8000 *Portable Radio*

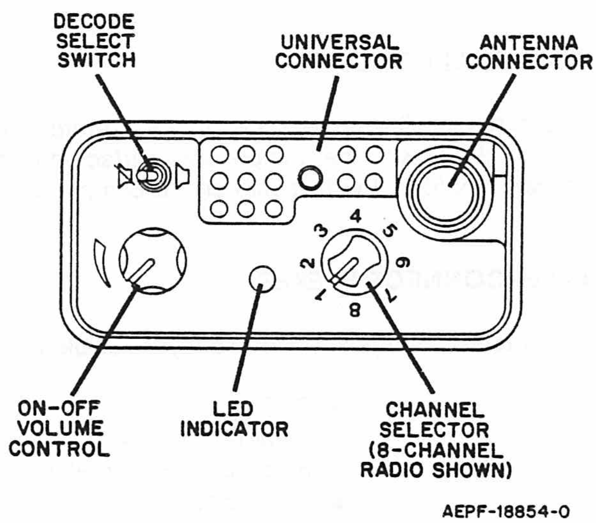

Figure 2. Top Panel Controls and Indicators

ELECTRICAL DESCRIPTION

Electrically, the radio can be divided into two basic sections: a transceiver board and a controller flexible circuit. The transceiver performs the transmit and receive functions, and the controller controls those functions.
The transceiver board includes an antenna switching circuit, a dual-conversion receiver, and a transmitter. The transmitter carrier and receiver first injection signals are generated by a common phase-locked loop (PLL) consisting of a voltage controlled oscillator (VCO) and a frequency synthesizer.
The controller flex assembly contains a microcomputer, an EEPROM which stores the channel frequencies and squelch codes, and an audio power amplifier IC that includes transmitter and receiver audio amplifiers. The controller flex also includes an audio filter IC which encodes and decodes (in conjunction with a microcomputer) PL and SELECT 5, adjusts and limits the audio level for correct transmitter deviation, and pre-emphasizes and de-emphasizes audio signals. Another circuit which is contained on the controller flex is a DC switch, which controls the radio's transmit and receive voltages.

PRINTED CIRCUIT BOARDS AND FLEXIBLE CIRCUITS

GENERAL

Functional circuits in the CQP8000 radio are contained on: (1) the Transceiver Board and (2) the Controller Flex.
Five flexible printed circuits eliminate all discrete wiring, except the switched B+ wire to the transceiver board. Radios with keypad options have functional circuits contained on a board in the front cover.

TRANSCEIVER BOARD

The transceiver board is a two-layer printed circuit board (radios in the 403 - 470 MHz frequency range) or a multi-layer printed circuit board (radios in the 470 - 520 MHz frequency range) containing the RF and I-F portions of the radio. Almost all components are mounted on the top side of this board.

CONTROLLER FLEX

The controller flex is packaged inside a protective flex carrier. It is a two-layer flexible printed circuit with the components surface-mounted on one side. When packaged in the flex carrier, it is folded in half with all the components on the outside.

INTERCONNECT FLEXES

The interconnect flexes are two-layer flexible printed circuits. These include:

- PTT/B + Flex
- Volume Pot Flex
- Frequency Switch Flex
- I-F Interconnect Flex
- Front Cover Flex

KEYPAD BOARD (OPTIONAL)

The keypad option board is a four-layer printed circuit board mounted in the radio's front cover. All components are surface mounted on one side of the board.

FEATURES

STANDARD FEATURES

The CQP8000 radio has an internal microphone and speaker, but can be operated with an optional external microphone and/or speaker. An external antenna connector and a top-mounted "universal connector" provide easy access for testing, and for attaching a wide variety of audio accessories. Radio models are available with up to 16 channels, tone "Privat-Line" (CTCSS), or SELECT 5 squelch operation.

Type of squelch is enabled on a per channel basis with one code pair available per radio. Two power output levels are offered: Medium power (2 watts) or high power (5 watts on VHF models or 4 watts on UHF models).
The battery pack slides on to the bottom of the radio and is held in place by a spring loaded catch. Batteries are available in two different sizes which correspond to the battery capacity: medium and high. The medium and high capacity batteries are available in standard and rapid charge rates. The different size batteries effect the operating time between charges as well as the overall height and weight of the radio.
A bicolor LED on the top of the radio serves as user feedback. The LED indicates when the radio is in transmit (continuous red), a low battery condition (flashing red), or channel busy (flashing green - coded squelch application only).

SPECIAL STANDARD FEATURES

RADIO CLONING

Each CQP8000 radio has a unique data-stored "personality" with frequencies, squelch code pairs, and other operating characteristics. Using a simple cloning cable, one radio's characteristics can be duplicated into another CQP8000 radio of the same bandsplit.

FIELD PROGRAMMING

The CQP8000 radio utilizes a reprogrammable EEPROM codeplug, which permits operating characteristics to be changed without opening the radio. Programming is accomplished via a programming cable interface to a PC.

SELECT 5 CODED SQUELCH AND TONE PRIVATE-LINE CODED SQUELCH

Coded squelch allows only those calls with a radio's particular code to be heard, and can be enabled on a per channel basis. So an CQP8000 radio can have carrier squelch on some channels, SELECT 5 squelch on others, and Tone PL squelch on even others. You can choose from any of the standard European SELECT 5 Signalling formats and 42 Tone Private-Line codes.

SPECIFICATIONS

CQP8000 - VHF

GENERAL

> **NOTE:**
>
> All batteries must be charged prior to use.
> Use of chemicals (Detergents, alcohol, aerosol spray, petroleum products) may be harmful and damage the radio housing. We recommend a mild dishwashing soap for cleaning the exterior of the product.
> O-ring seals must be properly lubricated and assembled to insure conformance to IP54 specifications for water intrusion.

Frequency Range:
136 - 174 MHz

Power Supply:
Nickel-Cadmium Battery

Battery Drain, at 10 VDC:

	H33	H43
Standby:	*43mA	*43mA
Receive:	*163mA	*163mA
Transmit:	**775mA	**1600mA

*Add 8 mA with Remote Antenna
**Add 25 mA with Remote Antenna

Dimensions (H x W x D):

Radio only:	99.00 x 66.80 x 35.30 mm
Radio with battery:	
With Medium-Capacity Battery:	161.30 x 66.80 x 35.30 mm
With High-Capacity Battery:	184.40 x 66.80 x 35.30 mm

Weight:

Radio only:	383 g
Radio with battery (Nickel-Cadmium):	
With Medium-Capacity Battery:	612 g
With High-Capacity Battery:	686 g

TRANSMITTER

RF Output, at 10 Vdc	**H33**	**H43**
Nickel-Cadmium battery:	2.0W	5.0W

Modulation (Type 16F3):
For 25 kHz channel spacing: ±5 kHz for 100% modulation at 1000 Hz (min. ±4.0 kHz.)
For 20 kHz channel spacing: ±4 kHz for 100% modulation at 1000 Hz (min. ±3.2 kHz.)
For 12.5 kHz channel spacing: ±2.5 kHz for 100% modulation at 1000 Hz (min. ±2.0 kHz.)
Including PL-modulation for PL-models.

PL Modulation:
25 kHz channel spacing: max. ±1 kHz min. ±500 Hz
20 kHz channel spacing: max. ± 800 Hz min. ±400 Hz
12.5 kHz channel spacing: max. ±500 Hz min. ±250 Hz

Audio distortion:
Meets CEPT requirements at rated audio.

Maximum Permissible Channel Separation:
6 MHz (No degradation)

Frequency Stability (-25°C to +55°C; +25°C ref.):
±.0005% (25/20 kHz Channel Spacing)
±.0002% (12.5 kHz Channel Spacing)

Spurious & Harmonic Frequencies:
Less than: 0.25 mW below 1 GHz
1.0 mW between 1 GHz - 4 GHz

FM Noise:
At least 40 dB below ±3.0 kHz deviation at 1000 Hz

RECEIVER

Audio Output:
At less than 5% distortion at 1 kHz into rated load

Second I-F Frequency:
450 kHz ±1.5 kHz measured at M1

Sensitivity:
Max. 0.40 mV (12 dB SINAD)
Max. 0.50 mV (20 dB SINAD Psophometrically weighted)

Noise Squelch Selectivity:
Programmable

Maximum Permissible Channel Separation
6 MHz (No degradation)

Frequency Stability (-25°C to +55°C; +25°C Ref.):
±.0005% (25/20 kHz Channel Spacing)
±.0002% (12.5 kHz Channel Spacing)

Useable Bandwidth:
±5 kHz (25 kHz Channel Spacing)
±4 kHz (20 kHz Channel Spacing)
±2.5 kHz (12.5 kHz Channel Spacing)

Spurious Frequency Rejection:
More than 70 dB below carrier

Image Rejection:
More than 70 dB below carrier

Selectivity:
More than 70 dB at ±20/25 kHz
More than 60 dB at ±12.5 kHz

Intermodulation:
More than 70 dB at adjacent channel

Channel Spacing:
25/20/12.5 kHz

SPECIFICATIONS

CQP8000 - UHF

GENERAL

> **NOTE:**
>
> All batteries must be charged prior to use.
> Use of chemicals (Detergents, alcohol, aerosol spray, petroleum products) may be harmful and damage the radio housing. We recommend a mild dishwashing soap for cleaning the exterior of the product.
> O-ring seals must be properly lubricated and assembled to insure conformance to IP54 specifications for water intrusion.

Frequency Range:
403 - 470 MHz
438 - 520 MHz

Power Supply:
Nickel-Cadmium Battery

Battery Drain, at 10 VDC:

	H34	H44
Standby:	*48 mA	*48 mA
Receive:	*166 mA	*166 mA
Transmit:	**875 mA	**1600 mA

*Add 8 mA with Remote Antenna
**Add 15 mA with Remote Antenna

Dimensions (H x W x D):

Radio only:	99.00 x 66.80 x 35.30 mm
Radio with battery:	
With Medium-Capacity Battery:	161.30 x 66.80 x 35.30 mm
With High-Capacity Battery:	184.40 x 66.80 x 35.30 mm

Weight:

Radio only:	383 g
Radio with battery (Nickel-Cadmium):	
With Medium-Capacity Battery:	612 g
With High-Capacity Battery:	686 g

TRANSMITTER

RF Output, at 10 Vdc	**H34**	**H44**
Nickel-Cadmium battery:	2.0 W	4.0 W

Modulation (Type 16F3):
For 25 kHz channel spacing: ±5 kHz for 100% modulation at 1000 Hz (min. ±4.0 kHz.)
For 20 kHz channel spacing: ±4 kHz for 100% modulation at 1000 Hz (min. ±3.2 kHz.)
For 12.5 kHz channel spacing: ±2.5 kHz for 100% modulation at 1000 Hz (min. ±2.0 kHz.)
Including PL-modulation for PL-models.

PL Modulation:
25 kHz channel spacing: max. ± 1 kHz min. ±500 Hz
20 kHz channel spacing: max. ±800 Hz min. ±400 Hz
12.5 kHz channel spacing: max. ±500 Hz min. ±250 Hz

Audio Distortion:
Meets CEPT requirements at rated audio

Maximum Permissible Channel Separation:
8 MHz (No degradation)

Frequency Stability (-25°C to +55°C; +25°C ref.):
±.0005% (25/20 kHz Channel Spacing)
±.0002% (12.5 kHz Channel Spacing)

Spurious & Harmonic Frequencies:

Less than:	0.25 mW below 1 GHz (403 - 470 MHz)
	1.0 mW between 1 GHz - 4 GHz (403 - 470 MHz)
or	2.5 mW between 1 GHz - 4 GHz (470 - 520 MHz)

FM Noise:
At least 40 dB below ±3.0 kHz deviation at 1000 Hz

Audio Response:
+1, -3 dB from 6 dB/octave pre-emphasis characteristic from 300 - 3000 Hz

RECEIVER

Audio Output:
Less than 5% distortion at 1 kHz into rated load

Second I-F Frequency:
450 kHz ±1.5 kHz measured at M1

Sensitivity
Max. 0.42 mV (12 dB SINAD)
Max. 0.50 mV (20 dB SINAD Psophometrically weighted)

Noise Squelch Selectivity
Programmable

Maximum Permissible Channel Separation
8 MHz (No degradation)

Frequency Stability (-25°C to +55°C; +25°C Ref.):
±.0005% (25/20 kHz Channel Spacing)
±.0002% (12.5 kHz Channel Spacing)

Useable Bandwidth:
±5 kHz (25 kHz Channel Spacing)
±4 kHz (20 kHz Channel Spacing)
±2.5 kHz (12.5 kHz Channel Spacing)

Spurious Frequency Rejection:
More than 70 dB below carrier

Image Rejection:
More than 70 dB below carrier

Selectivity
More than 70 dB at ±20/25 kHz
More than 60 dB at ±12.5 kHz

Intermodulation:
More than 70 dB at adjacent channel (403 - 470 MHz)
More than 65 dB at adjacent channel (470 - 520 MHz)

Channel Spacing:
25/20/12.5 kHz

SAFETY INFORMATION

DO NOT hold the radio with the antenna close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if the microphone is five to eight centimeters away from the lips and the radio is vertical.

DO NOT hold the transmit (PTT) switch on when not actually desiring to transmit.

DO NOT allow children to play with any radio equipment containing a transmitter.

DO NOT operate a transmitter near unshielded electrical blasting caps or in an explosive atmosphere unless it is a type especially qualified for such use.

CMOS PRECAUTIONS

This radio contains static-sensitive devices. Do not open the radio unless properly grounded. Take the following precautions when working on this unit.

The red printed circuit boards indicate static sensitive devices and contained on these boards, and should be handled with the following precautions.

1. Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic "snow" or plastic trays used for storage and transportation of other semiconductor devices.

2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the P/N 95D5042-00 Static Protection Table Mat (0.6 x 1.2 m) which includes ground cord and connector, plus wrist wrap with coil cord 95D5045-00.
   See also TEST INSTRUMENTS AND SOFTWARE).

3. Do not wear nylon clothing while handling CMOS devices.

4. Neither insert nor remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices and be certain there are no voltage transients present.

5. When straightening CMOS pins, provide ground straps for apparatus used.

6. When soldering, use a grounded soldering unit.

7. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

CAUTION

Do not depress the PTT or side switches while inserting the frame into the housing; damage to the switches could occur.
For reassembly, use only the tools that are recommended. Using unauthorised tools, or failing to adhere to torque specifications may cause irreparable damage.
Do not attempt to remove the antenna bushing from the control top; it is ultrasonically welded in place.
Do not desolder or resolder any connections between the volume potentiometer flex and the on/off-volume potentiometer with the switch in the off position. Make sure that the switch is in the on position before applying any heat; otherwise the internal parts of the switch will be damaged.

CLEANING

- Clean all external radio surfaces with a 0.5% solution of a mild dishwashing detergent in water (one teaspoon of detergent per 4 liters of water).
- Stronger cleaning agents may only be used to remove soldering flux from circuit boards after making repairs.
- Clean internal surfaces with water-activated optical wipes.

CAUTION

Never allow any alcohol- or solvent-based product to contact any plastic or rubber radio part.

SAFETY INFORMATION

DO NOT hold the radio with the antenna close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if the microphone is five to eight centimeters away from the lips and the radio is vertical.

DO NOT hold the transmit (PTT) switch on when not actually desiring to transmit.

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The red printed circuit boards indicate static sensitive devices and contained on these boards, and should be handled with the following precautions.

1. Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic "snow" or plastic trays used for storage and transportation of other semiconductor devices.

2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the P/N 0180386A82 Static Protection Kit which includes a wrist strap, 2 ground cords, a table mat, and a floor mat.

3. Wear a conductive wrist strap in series with a 1M resistor to ground. Replacement Wrist Straps that connect to the bench top covering - P/N RSX-4015B.

4. Do not wear nylon clothing while handling CMOS devices.

5. Neither insert nor remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices and be certain there are no voltage transients present.

6. When straightening CMOS pins, provide ground straps for apparatus used.

7. When soldering, use a grounded soldering unit.

8. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

CAUTION

Do not depress the PTT or side switches while inserting the frame into the housing; damage to the switches could occur.
For reassembly, use only the tools that are recommended. Using unauthorised tools, or failing to adhere to torque specifications may cause irreparable damage.
Do not attempt to remove the antenna bushing from the control top; it is ultrasonically welded in place.
Do not desolder or resolder any connections between the volume potentiometer flex and the on/off-volume potentiometer with the switch in the off position. Make sure that the switch is in the on position before applying any heat; otherwise the internal parts of the switch will be damaged.

CLEANING

- Clean all external radio surfaces with a 0.5% solution of a mild dishwashing detergent in water (one teaspoon of detergent per gallon of water).
- Stronger cleaning agents may only be used to remove soldering flux from circuit boards after making repairs.
- Clean internal surfaces with water-activated optical wipes.

CAUTION
Never allow any alcohol- or solvent-based product to contact any plastic or rubber radio part.

SAFETY INFORMATION

DO NOT hold the radio with the antenna close to, or touching, exposed parts of the body, especially the face or eyes, while transmitting. The radio will perform best if the microphone is five to eight centimeters away from the lips and the radio is vertical.

DO NOT hold the transmit (PTT) switch on when not actually desiring to transmit.

DO NOT allow children to play with any radio equipment containing a transmitter.

DO NOT operate a transmitter near unshielded electrical blasting caps or in an explosive atmosphere unless it is a type especially qualified for such use.

CMOS PRECAUTIONS

This radio contains static-sensitive devices. Do not open the radio unless properly grounded. Take the following precautions when working on this unit.

The red and green printed circuit boards indicate static sensitive devices and contained on these boards, and should be handled with the following precautions.

1. Store and transport all CMOS devices in conductive material so that all exposed leads are shorted together. Do not insert CMOS devices into conventional plastic "snow" or plastic trays used for storage and transportation of other semiconductor devices.

2. Ground the working surface of the service bench to protect the CMOS device. We recommend using the P/N 95D5042-00 Static Protection Table Mat (0.6 x 1.2 m) which includes ground cord and connector, plus wrist wrap with coil cord 95D5045-00.
   See also TEST INSTRUMENTS AND SOFTWARE).

3. Do not wear nylon clothing while handling CMOS devices.

4. Neither insert nor remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices and be certain there are no voltage transients present.

5. When straightening CMOS pins, provide ground straps for apparatus used.

6. When soldering, use a grounded soldering unit.

7. If at all possible, handle CMOS devices by the package and not by the leads. Prior to touching the unit, touch an electrical ground to remove any static charge that you may have accumulated. The package and substrate may be electrically common. If so, the reaction of a discharge to the case would cause the same damage as touching the leads.

CAUTION

Do not depress the PTT or side switches while inserting the frame into the housing; damage to the switches could occur.
For reassembly, use only the tools that are recommended. Using unauthorised tools, or failing to adhere to torque specifications may cause irreparable damage.
Do not attempt to remove the antenna bushing from the control top; it is ultrasonically welded in place.
Do not desolder or resolder any connections between the volume potentiometer flex and the on/off-volume potentiometer with the switch in the off position. Make sure that the switch is in the on position before applying any heat; otherwise the internal parts of the switch will be damaged.

CQP8000

MAINTENANCE

1. INTRODUCTION

This section of the manual describes the disassembly and reassembly procedures, recommended repair procedures, special precautions regarding maintenance, and recommended test equipment. Each of these topics provides information vital to the successful operation and maintenance of the radio.

2. PREVENTIVE MAINTENANCE

The radio does not require a scheduled preventive maintenance program; however, periodic visual inspection and cleaning is recommended.

a. Inspection

Check that the external surfaces of the radio are clean, and that all external controls and switches are functional. A detailed inspection of the interior electronic circuitry is not needed or desired.

b. Cleaning

The following procedures describe the recommended cleaning agents and the methods to be used when cleaning the external and internal surfaces of the radio. External surfaces include the front cover, housing assembly, and battery case. These surfaces should be cleaned whenever a periodic visual inspection reveals the presence of smudges, grease, and/or grime. Internal surfaces should be cleaned only when the radio is disassembled for servicing or repair.

The only recommended agent for cleaning the external radio surfaces is a 0.5% solution of a mild dishwashing detergent, in water. The only factory recommended liquid for cleaning printed circuit boards and their components is ISOPROPYL alcohol (70% by volume).

CAUTION

The effects of certain chemicals and their vapors can have harmful results on certain plastics. Aerosal sprays, tuner cleaners and other chemicals should be avoided.

(1) Cleaning External Surfaces

(a) Polycarbonate Surfaces

The detergent-water solution should be applied sparingly with a stiff, non-metallic, short-bristled brush to work all loose dirt away from the radio. A soft, absorbent, lintless cloth or tissue should be used to remove the solution and dry the radio. Make sure that no water remains entrapped near the connectors, cracks, or crevices.

(b) Silverized Surfaces

A non-metallic, soft-bristled brush should be used to apply the detergent-water solution to silverized surfaces, and a second non-metallic soft-bristled brush (free of detergent or rinsed in clean water) should be used to remove the detergent-water solution.

Upon completion of the cleaning process, a soft, absorbent, lintless cloth or tissue should be used (with a blotting action) to dry the frame and covers. The blotting action will prevent damage to the silverized conductive coating.

(2) Cleaning Internal Circuit Boards and Components

Isopropyl alcohol may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked materials located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the inside of the radio.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that controls or tunable components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process, since this could cause the liquid to puddle and collect in unwanted places.

Upon completion of the cleaning process, use a soft, absorbent, lintless cloth to dry the area. Do not brush or apply any isopropyl alcohol to the frame, front cover, or back cover.

NOTE

Always use a fresh supply of alcohol and a clean container to prevent contamination by dissolved material (from previous usage).

3. DISASSEMBLY

Disassembly of the radio involves removal of the major components listed below, one at a time, in the sequence described in the following paragraphs.

NOTE

1. Several special tools are required to completely disassemble the radio. Refer to the "Tools, Test and Programming Equipment" section. Also refer to the "Torque and Tool Specifications Chart.
2. Before proceeding, make sure that the radio is turned off.

a. Battery Removal

To remove the battery from the radio, proceed as follows:

Step 1. Hold the radio with the front of the radio facing up.

Step 2. Disengage the battery latch from the battery by pushing and holding the latch towards the top of the radio.

Step 3. With the battery latch disengaged, slide the battery from left to right to remove it from the baseplate on the bottom of the radio housing.

b. Gaining Access to Internal Components

CAUTION

The radio contains complementary metal-oxide semiconductor (CMOS) devices, which are highly susceptible to damage in handling due to static discharge. The entire printed circuit board should be treated as static sensitive. Damage can be latent, resulting in failures occurring weeks or months later.

DO NOT attempt to disassemble the radio without first referring to the "Safe Handling of CMOS Devices" paragraph in this section

Step 1. Remove the battery as described in paragraph **a.**

Step 2. Remove the two screws from the back of the radio.

Step 3. Remove the two screws on the bottom of the radio (baseplate corners).

Step 4. Lift the front cover from the radio housing, being careful not to pull against the speaker/-microphone flex.

Step 5. Disconnect the speaker/microphone connector from the controller flex by grasping the speaker flex strain relief (near the plug) and pulling the plug straight out and away from the circuit board.

Step 6. Loosen the two captive screws on the bottom of the radio. Do not completely remove the captive screws from the baseplate.

Step 7. With a thumb and forefinger, grasp the antenna at its base and pull lightly to remove the frame assembly from the radio housing. Do not press the PTT switch during removal.

Step 8. Remove the antenna by unscrewing it counterclockwise.

Step 9. Remove the screw that secures the front shield to the controller carrier.

Step 10. Remove the front shield by pulling it straight out and away from the radio.

Step 11. Remove the four screws that secure the main back shield to the frame.

Step 12. Remove the main back shield by pulling it straight out and away from the radio.

c. Removing the Controller Assembly

Step 1. Perform steps 1 through 10 of paragraph **b.**

Step 2. Remove the four screws (two on each side) that secure the controller carrier to the frame.

NOTE

Be careful to pull each connector straight out and away from the mating socket so as not to bend or break the connector pins.

Step 3. Disconnect the two bottom flex connectors by carefully sliding them away from the synthesizer.

Step 4. Lift the controller circuit (nearest the bottom of the radio) away from the radio just enough to gain access to the connector under the controller.

Step 5. Disconnect the connector under the controller.

Step 6. Disconnect the two connectors at the top of the controller.

Step 7. Lift the controller assembly totally away from the radio.

d. Gaining Access to the Controller Flexible Circuit

Step 1. Perform steps 1 through 7 of paragraph c.

Step 2. Remove the screws that secure the bottom shield to the top flex carrier.

Step 3. Along the top edge of the controller assembly (edge nearest speaker clearance indentation), gently pry the bottom shield away from the top flex carrier.

Step 4. Pull the bottom shield completely away from the top flex carrier and remove the controller flexible circuit.

e. Removing the Transceiver Board from the Frame

Step 1. Perform steps 1 through 7 of paragraph c.

Step 2. Remove the four screws that secure the main back shield, and remove the shield.

Step 3. Unsolder four contacts (two pins and one frame ground connection) located next to the screw (back, top-center of transceiver board), and the antenna ferrule located on the back, top-left corner of the transceiver board.

Step 4. Remove one screw (back, top-center of transceiver board) that secures the transceiver board to the frame.

Step 5. Unsolder and remove the red B+ wire (controller side of radio) from the On-Off / volume switch pot.

CAUTION

Always place the On-Off / Volume switch pot in the 'On' position before soldering to this switch, and return to the 'Off' position when finished soldering.

Step 6. Gently pull the transceiver circuit board straight out and away from the frame.

f. Removing the Control-Top Panel Components

Step 1. Perform steps 1 through 5 of paragraph e.

NOTE

All control-top panel components, except the antenna jack, are connected on two flexible circuits, which are connected together and should be removed as one unit.

Step 2. Remove the control knob(s) by pulling straight out and away from the control-top panel.

Step 3. Remove the teflon washer(s).

Step 4. The escutcheon is stuck to the top surface of the control-top panel with adhesive. Gently pry one corner of the escutcheon away from the control-top panel and then peel the escutcheon completely away. Notice that washer(s) are stuck on the back side of the escutcheon.

Step 5a. Remove the hex nut and washer from the volume potentiometer.

Step 5b. Remove the hex nut and washer from the frequency switch.

Step 6. Remove the spanner nut and washer from the PL switch.

Step 7. Pry the header (part of volume pot flex assembly) away from the universal connector pins.

Step 8. Unsolder the three legs of the LED and pull the flex away from the legs.

Step 9. Unsolder and remove the black wire (ground wire from header to frame) where it contacts the frame.

Step 10. The frequency switch flex connects to the PTT / B+ flex with five solder tabs located along the side of the frame near the monitor popple switches. Unsolder the five contact tabs, and with "solder- wick", remove the solder and separate the two flexes.

NOTE

A capacitor is placed across the last two tabs.

Step 11. Push the switch shaft(s) until clear of the mounting holes, and remove the flex circuits and control-top panel components away from the frame.

g. Removing the Control-Top Panel and LED

Step 1. Perform steps 1 through 8 of paragraph f.

Step 2. Unsolder the ground pin of the universal connector contacting the frame (near the antenna bushing).

Step 2a. Remove the screw and washer located near the antenna receptacle.

Step 2b. Gently pull the control-top panel away from the frame.

Step 2c. Push the LED and rubber boot out of the control-top panel, and pull the LED out of the rubber boot.

h. Removing the Battery Latch

Step 1. Perform steps 1 through 7 of paragraph **b.**

Step 2. Remove the ground contact screw that holds the negative battery contact. Be careful not to lose the lockwasher, contact, and rubber pad (under the contact).

Step 3. While holding the latch slide, carefully pull the baseplate assembly away from the housing.

Step 4. Carefully slide the latch out of the housing.

Step 5. Remove the exposed latch springs.

i. Removing the PTT / B+ Flex

Step 1. Perform steps 1 through 7 of paragraph **b.**

Step 2. Two corners of the PTT / B+ flex are soldered to the frame. Remove the solder, using "solder-wick".

Step 3. The PTT / B+ flex connects to the frequency switch flex with five solder tabs located along the top side of the frame near the PL switch. Unsolder the five contact tabs, and with "solder-wick", remove the solder and separate the two flexes.

> **NOTE**
>
> A capacitor is placed across the last two tabs.

Step 4. The PTT / B+ flex is stuck to the frame with adhesive. Carefully peel the PTT / B+ flex away from the frame.

4. REASSEMBLY

1. DO NOT attempt to reassemble the radio without first referring to the "Safe Handling of CMOS Devices" paragraph in this section of the manual.
2. DO NOT attempt to reassemble the radio without first referring to the approriate VHF or UHF service manual "TORQUE AND TOOL SPECIFICATIONS CHART".
3. Inspect all O-rings and replace if obvious damage exists.

a. Reinstalling the Battery Latch and Base Plate

Step 1. Insert the two springs into their proper holes, and replace the slide latch.

Step 2. Position the base plate and hold it firmly to compress the springs.

Step 3. Holding the base plate in place, install the negative battery contact, being sure that the rubber pad is in place in the cup of the contact.

Step 4. Reinstall the screw and lockwasher in the negative battery contact. Tighten the screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

b. Reinstalling the PTT / B+ Flex

Step 1. Position the PTT / B+ flex to the frame such that the five contact tabs line up with the corresponding tabs on the frequency switch flex. Note that a little oval hole in the corner of the flex (near the solder tabs) mates with a round dot on the frame.

Step 2. Press the flex to the frame. Note that two more places, holes in the flex correspond with dots on the frame.

Step 3. Resolder the five solder tabs connecting the PTT / B+ flex to the frequency switch flex.

> **NOTE**
>
> A capacitor is placed across the last two tabs.

Step 4. Resolder the two corners of the flex to the frame.

c. Reinstalling the LED and Control-Top Panel

Step 1. Insert the LED into the rubber boot such that the flat edge of the LED's base mates with the flat edge inside the boot.

Step 2. Insert the LED and boot into the control-top panel.

Step 3. Place the control-top panel on the frame.

Step 4. Reinstall the screw and washer located near the antenna receptacle, and tighten the screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 5. Resolder the ground pin of the universal connector to the frame.

d. Reinstalling the Control-Top Panel Components

Step 1. Insert the switch shafts into the proper holes.

Step 2. Resolder the three LED legs to the frequency switch flex.

Step 3. Press the volume pot header on to the corresponding pins of the universal connector.

Step 4. Resolder the black ground wire to the frame.

Step 5. Resolder the five solder tabs of the frequency switch flex to the corresponding tabs of the PTT / B+ flex.

Step 6. Reinstall the PL switch washer and spanner nut, and tighten per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 7. Reinstall the frequency switch and volume pot washers and hex nuts, and tighten each screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 8. Reinstall the escutcheon.

Step 9. Reinstall the teflon washers on the frequency switch and volume pot shafts.

Step 10. Reinstall the switch knobs.

e. Reinstalling the Transceiver Board

Step 1. With the frame's backside laying down, and viewing the transceiver board from the solder side with the assembly upright, slightly spread the sides of the frame and slide the transceiver into the frame.

Step 2. Turn the unit over and resolder the loose end of the red B+ wire to the On-Off/Volume switch pot.

CAUTION

Always place the On-Off / Volume switch pot in the 'On' position before soldering to this switch, and return to the 'Off' position when finished soldering.

Step 3. Reinstall one screw (back, top-center of transceiver board) that secures the transceiver board to the frame, and tighten securely.

Step 4. Resolder four contacts (two pins and one frame ground connection) located next to the screw (back, top-center of transceiver board), and the antenna ferrule contact (back top-left corner of board).

Step 5. Press the main back shield (edges over the frame) flush to the transceiver board.

Step 6. Reinstall the four screws that secure the main back shield to the frame, and tighten each screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

g. Reassembling the Controller Assembly

CAUTION

Make sure that the flex insulator is installed around the controller flex before placing the controller flex into the carrier.

Step 1. With the outside surface of the carrier laying down, and the controller flex folded over (shield-to-shield), align the holes in the flex with corresponding holes in the carrier, and place the flex into the carrier. Make sure that the P1 and P2 jack's grooves slide into the tabs of the carrier. Also, make sure that the J5 jack is seated properly in the carrier.

Step 2. Align the controller bottom shield to the controller flex and carrier. In the J5 jack area, slide the tab of the shield under the slot in the carrier, and press the bottom shield into place (sides of the bottom shield fit inside the sides of the carrier).

Step 3. Reinstall the screws that secure the bottom shield to the controller carrier, and tighten each screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

g. Reinstalling the Controller Assembly

NOTE

Be careful to push each connector straight into the mating socket so as not to bend or break the connector pins.

Step 1. Reconnect the two top flex connectors, firmly seating both plug / jack connections.

Step 2. Reconnect the connector under the controller, firmly seating the plug / jack connection.

Step 3. Press the controller into place (inside of frame sides).

Step 4. Reconnect the two bottom flex connectors, firmly seating both plug / jack connections.

Step 5. Reinstall the four screws (two on each side) that secure the controller carrier to the frame, and tighten each screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 6. Reinstall front shield (shield edges fit inside the frame).

Step 7. Reinstall the screw that secures the front shield to the controller carrier, and tighten the screw per the "TORQUE AND TOOL SPECIFICATIONS CHART".

h. Final Reassembly

Step 1. Insert the internal radio unit into its housing, and tighten the two screws on the baseplate per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 2. Reconnect the speaker / microphone connector, being careful to push the connector straight into the mating socket so as not to bend or break the connector pins.

Step 3. Reinstall the front cover.

Step 4. Reinstall the two screws on the bottom of the radio (baseplate corners), and tighten the screws per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 5. Reinstall the two screws that secure the front cover to the housing, and tighten each screws per the "TORQUE AND TOOL SPECIFICATIONS CHART".

Step 6. Reinstall the antenna.

Step 7. Reinstall the battery.

5. SAFE HANDLING OF CMOS DEVICES

Complementary metal-oxide semiconductor (CMOS) devices are used in the radio. While the attributes of CMOS are many, their characteristics make them susceptible to damage by electrostatic or high voltage charges. Damage can be latent, resulting in failures occurring weeks or months later. Therefore, special precautions must be taken to prevent device damage during disassembly, troubleshooting, and repair. The following handling precautions are mandatory for CMOS circuits, and are especially important in low humidity conditions.

a. All CMOS devices must be stored or transported in conductive material so that all exposed leads are shorted together. CMOS devices must not be inserted into conventional plastic "snow" or plastic trays of the type that are used for storage or transportation of other semiconductor devices.

b. All CMOS devices must be placed on a grounded bench surface and the technicians must ground themselves prior to handling the devices. This is done most effectively by having the technician wear a conductive wrist strap in series with a 1M ohm resistor to ground.

c. Do not wear nylon clothing while handling CMOS circuits.

d. Do not insert or remove CMOS devices with power applied. Check all power supplies to be used for testing CMOS devices, and be certain that there are no voltage transients present.

e. When straightening CMOS device leads, provide ground straps for the apparatus used.

f. When standing, use a grounded soldering iron.

g. All power must be turned off in a system before printed circuit boards containing CMOS devices are inserted, removed, or soldered.

6. REPAIR PROCEDURES AND TECHNIQUES

a. Parts Replacement and Substitution

Special care should be taken to be as certain as possible that a suspected component is actually the one at fault. This special care will eliminate unnecessary unsoldering and removal of parts, which could damage or weaken other components or the printed circuit board itself.

When damaged parts are replaced, identical parts should be used. If the identical replacement component is not locally available, check the parts list for the proper part number and order the component from your service center.

b. Rigid Circuit Boards

The radio uses bonded multi-layer printed circuit boards. Since the inner layers are not accessible, some special considerations are required when soldering and unsoldering components. The printed through holes may interconnect multiple layers of the printed circuit. Therefore, care should be exercised to avoid pulling the plated circuit out of the hole.

When soldering near the module socket pins, use care to avoid accidentally getting solder in the socket. Also, be careful not to form solder bridges between the module socket pins. Closely examine your work for shorts due to solder bridges. When removing modules with metal enclosures, be sure to desolder the enclosure ground tabs as well as the module pins.

c. Flexible Circuits

The flexible circuits are made from a different material than the rigid boards, and different techniques must be used when soldering. Excessive prolonged heat on the flexible circuit can damage the material. Avoid excessive heat and excessive bending.

To replace a component on a flexible circuit, grasp the edge of the flexible circuit with seizers near the part to be removed, and pull gently. Apply the tip of the soldering iron to the component connections while pulling with the seizers. Do not attempt to puddle out components. Prolonged application of heat may damage the flexible circuit.

7. TEST EQUIPMENT AND SERVICE AIDS

The following paragraphs describe the test equipment and service aids required for maintaining the radio.

Refer to Figure 1 for an illustration of trouble-shooting, test equipment, and programming set-up.

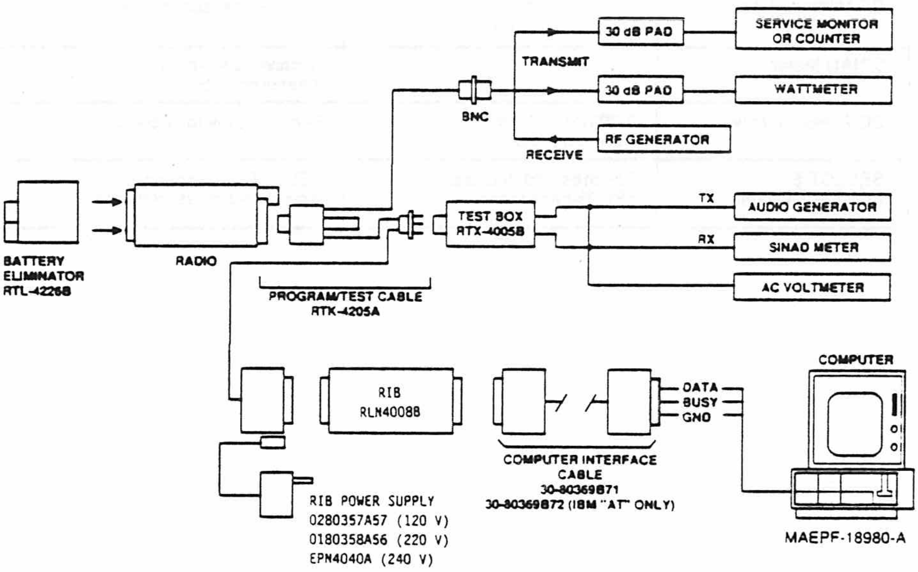


Figure 1. Troubleshooting, Test Equipment, and Programming Set-Up Detail

a. Recommended Test Equipment

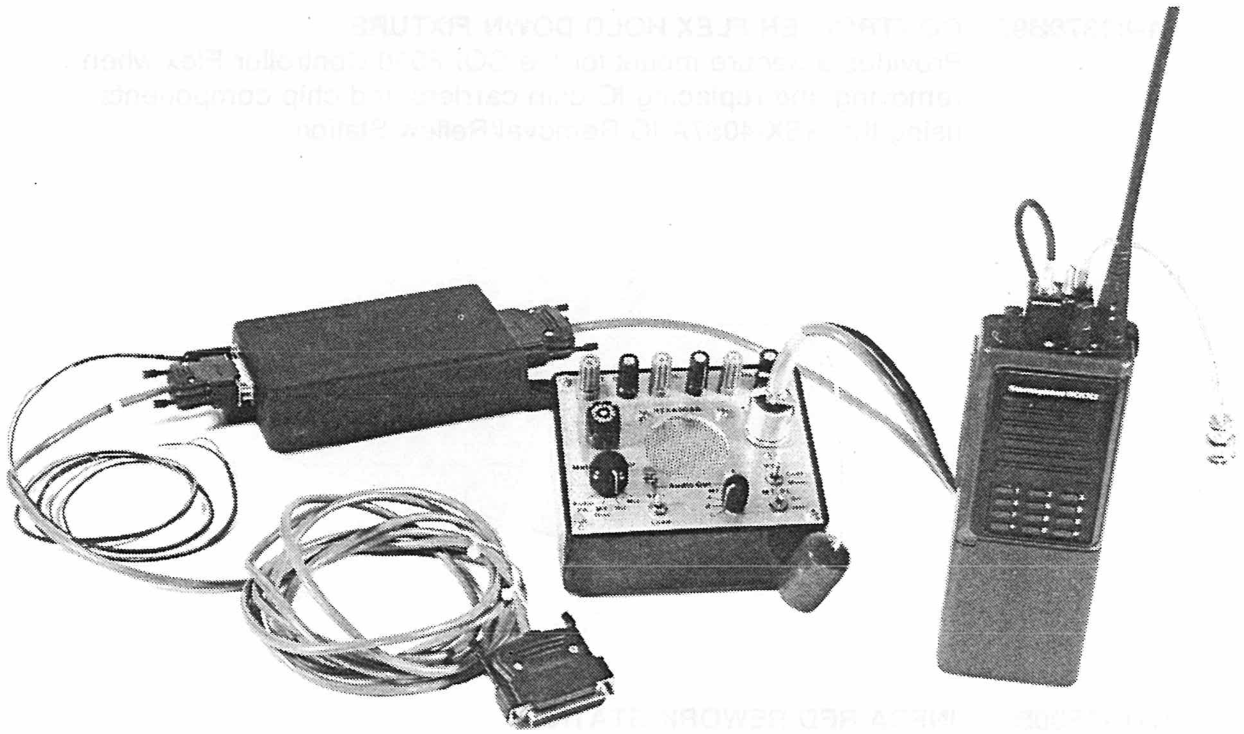
The list of equipment contained in Table 2 includes all the test equipmet required for servicing two-way portable radios.

Table 2. Test Equipment

DESCRIPTION	CHARACTERISTICS	APPLICATION
Digital Multimeter		Two meters recommended for ac/dc voltage and current measurements
Audio Oscillator	67 to 161.4Hz tones	Used with service monitor for injection of PL tones
AC Voltmeter Power Cable for Meter Test Leads for Meter	1mV to 300V, 10-Megohm input impedance	Audio voltage measurements
Dual-Trace Oscilloscope	20MHz bandwidth 5mV/cm - 20V/cm	Waveform measurements
Watt Meter Plug-in Element RF Dummy Load	50-ohm, ±5% accuracy 10 Watts, maximum 0-1000MHz, 300W	Transmitter power output measurements
RF Millivolt Meter	100mV to 3V rf 10kHz to 1.2GHz	RF level measurements
SINAD Meter		Receiver sensitivity measurements
DC Power Supply	0-20Vdc, 0-5 Amps current limited	Bench supply for 7.5Vdc
SELECT 5 Encoder/Decoder	Encodes and decodes 681-2800Hz tones	SELECT 5 Signalling testing and measurements

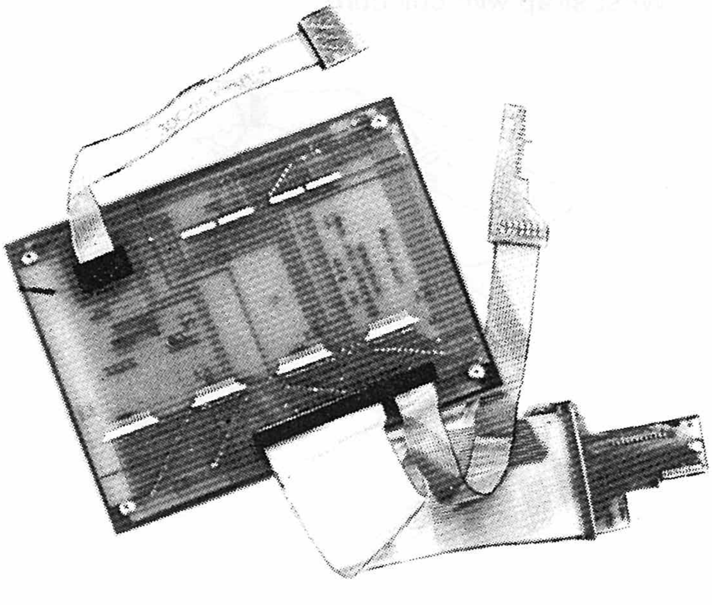
CQP8000 SERIES

TOOLS
TEST AND
PROGRAMMING
EQUIPMENT



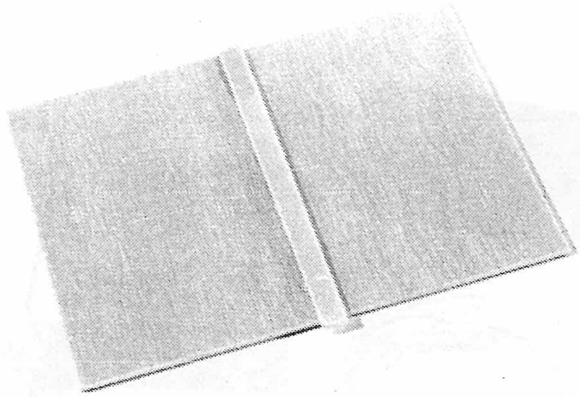
TOOLS

SDEN4004A **CONTROLLER FLEX EXTENDER FIXTURE**
Allows access to all electrical points on the CQP8000 Controller Flex and the interior of the RF board for troubleshooting purposes. The Controller Flex is removed from the flex carrier assembly and then externally mounted on the fixture's P.C. board. Electrical interconnect between the fixture and the radio RF board is provided through two ribbon cables.



Storno
SERVICE INSTRUMENTS
AND SOFTWARE

01-80370B92 **CONTROLLER FLEX HOLD DOWN FIXTURE**
Provides a secure mount for the CQP8000 Controller Flex when removing and replacing IC chip carriers and chip components using the RSX-4057A IC Removal/Reflow Station.

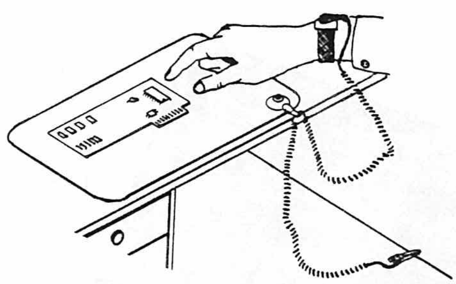


RTR-1500B **INFRA RED REWORK STATION**
Used for removal of surface mounted devices.

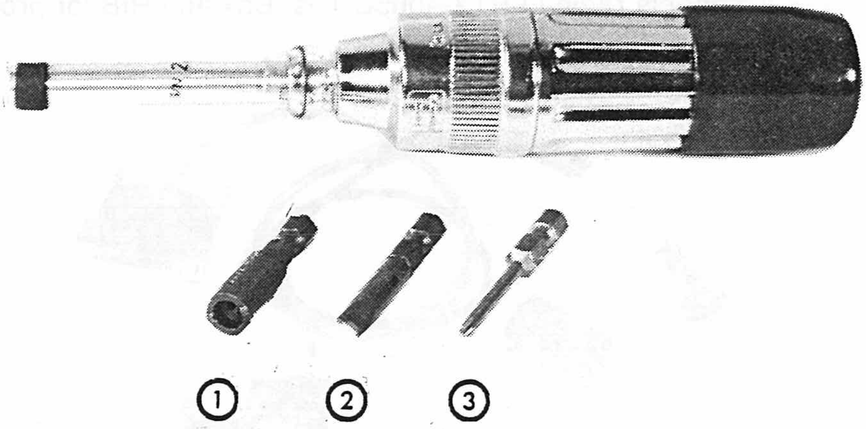
ANTI-STATIC PROTECTION MATERIAL
Used during all radio assembly and disassembly procedures.

95D5042-00 3-layer laminated table mat 0.6 x 1.2 m with grounding wire and connector.

95D5045-00 Wrist strap with coil cord.



RSX-4043A **TORQUE SCREWDRIVER**
Handle for bits:



- bits described below:

55-05717E01 **HEXSOCKET BIT** ①
Removes nuts on volume and rotary switch.

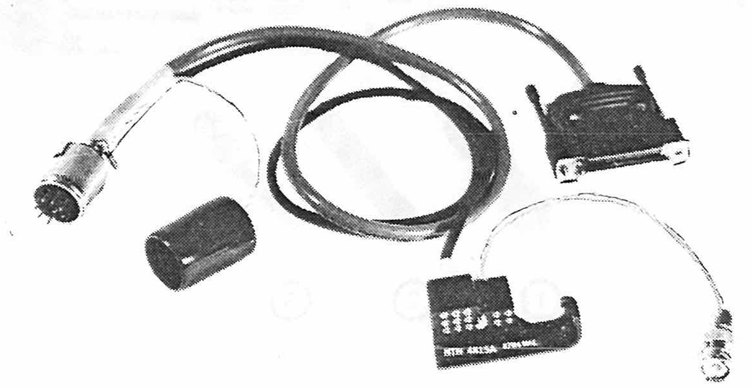
66-80370B95 **SPANNER BIT** ②
For use on toggle switch spanner nut.

66-80321B86 **PHILIPS BIT** ③
For removal of radio screws.

66-05106N01 **TUNING TOOL**
For use on tunable coils and potentiometers.

TEST EQUIPMENT

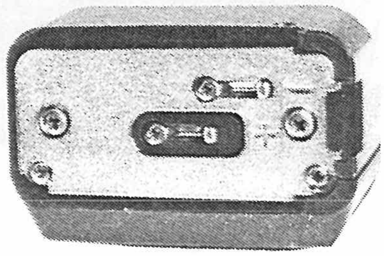
RTK-4205A **PROGRAMME TEST CABLE**
Connects radio to RTX-4005B Test Box and RIB for programming and testing of the CQP8000 radios.



RTL-4226B **BATTERY ELIMINATOR**
Replaces the battery pack during radio servicing of all CQP8000 radio models. The power supply input is overvoltage protected to 12 V DC maximum supply voltage. Reverse supply polarity protection and input fuse protection are also provided.

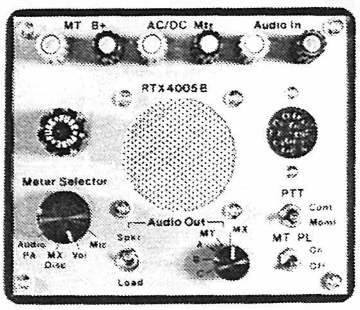
15-80384B40 **BATTERY ADAPTER**

Replaces the radio housing during servicing of all CQP8000 radio models. The Battery Adaptor is screw mounted to the base of the radio frame providing an easy slide on mount for a battery or the RTL-4226B Battery Eliminator. With the Battery Adaptor in place, electrical test points located on the back of the CQP8000 radio RF board are accessible.



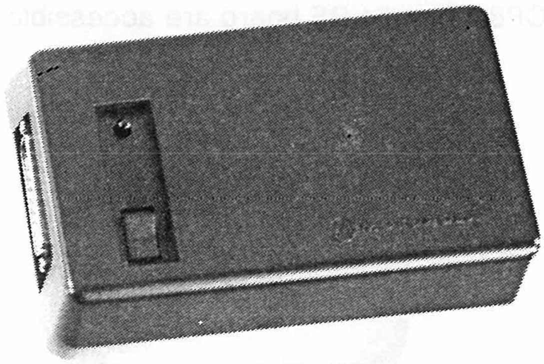
RTX-4005B **PORTABLE TEST SET**

Provides the capability for testing many transmitter and receiver functions. Transmitter modulation and keying can be simulated and receiver parameters can be tested without opening the radio. The Test Set is used in conjunction with the RTK-4205B Program/Test Cable.

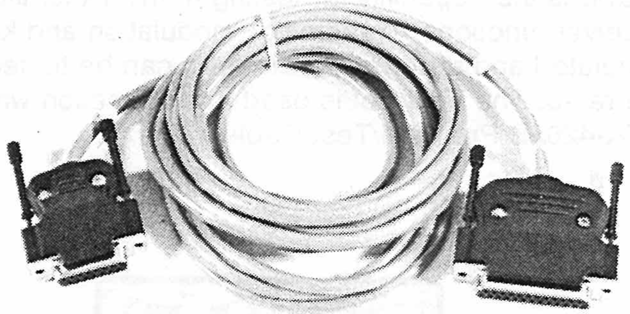


PROGRAMMING EQUIPMENT

01-80353A74 **RADIO INTERFACE BOX (RIB)**
Voltage level shifter to enable communications between the radio and the computer's RS232 Serial Communications Adaptor.



30-80369B71/ 30-80369B72 **COMPUTER INTERFACE CABLES**
Used to Connect the computer's Asynchronous Serial Communications adapter to the RIB (RLN4008B). Use B72 for the IBM PC AT. All other IBM models use B71.



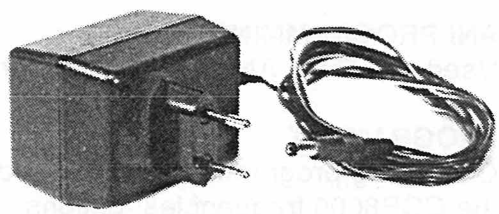
0280357A57 **POWER SUPPLY FOR RIB**
120 V US Plug.

0180358A56 **POWER SUPPLY FOR RIB**
220 V European Plug.

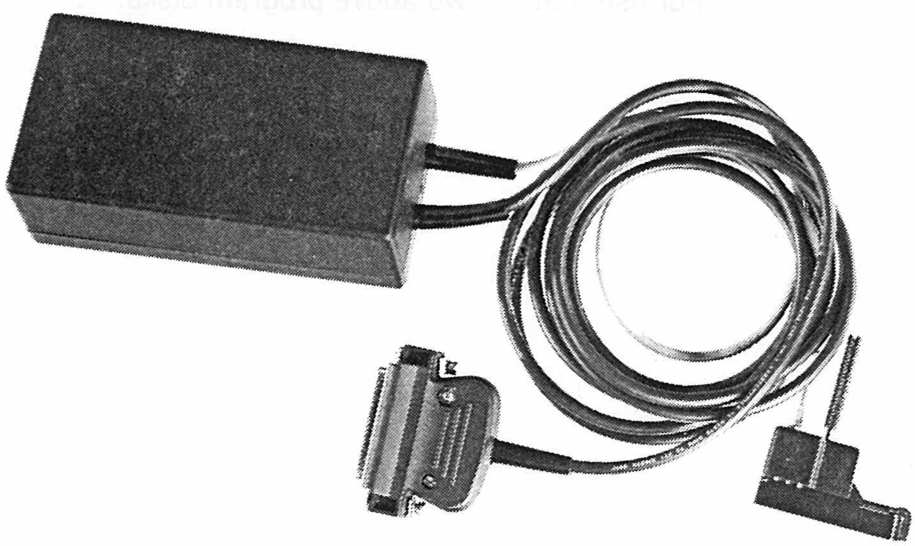
EPN-4040A **POWER SUPPLY FOR RIP**
240 V UK Plug.

SDPN4006A **POWER SUPPLY FOR RIB SDLN4010A**
220 V European Plug.

SDPN4005A **POWER SUPPLY FOR RIB SDLN4010A**
240 V UK Plug.



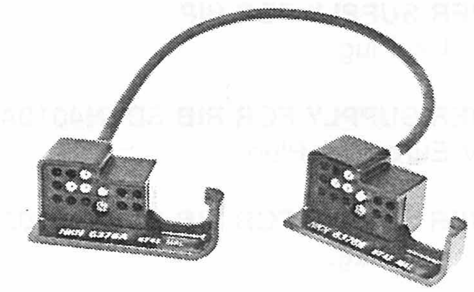
SDLN4010A **RADIO INTERFACE BOX (RIB)**
Voltage level shifter to enable communications between the radio and the computer's RS232 Serial Communications Adaptor.
For programming purposes only. Fixed interface cables.



Storno
SERVICE INSTRUMENTS
AND SOFTWARE

TOOLS
TEST AND
PROGRAMMING
EQUIPMENT

NKN-6376A — **CLONING CABLE**
Allows a CQP8000 radio to be duplicated from a Master radio by transferring programmed data from one radio to another. The Cloning Cable is non-polarized and has a thumb screw mounted connector at each end, allowing for easy connect/disconnect.



0180358A59 — **ANI PROGRAMMING TOOL**
Used on DTMF ANI options to program ANI codes.

EVN-4210A — **PROGRAM KIT**
Containing programmer manual and 5 1/4" program disk. For changing the CQP8000 frequencies, options, and electronically tunable parameters.

82-02000F04 — **5 1/4" PROGRAM DISK**
For changing frequencies, options and electronically tunable parameters (same as contained in program kit EVN-4210A).

8314.8801 — **PROGRAMMER MANUAL**
For use with the two above program disks.

TORQUE AND TOOL SPECIFICATIONS CHART

CQP8000

DESCRIPTION	SIZE	PART NUMBER	QTY.	RETIGHTEN WITH RSX-4043A TORQUE SCREWDRIVER AND BIT NO.	TORQUE IN N/METER INT'L.	CHAPT.10, VOL 2 DIA. M405.480 EXP.VIEW NUMBER
Control Top Antenna Bushing Spanner		0205765L02	1	6680370B90	1.36	22
Volume Pot Nut	0.75x8x1.6	0205629L01	1	5505717E01	0.57	17
Freq. Switch Nut	0.75x8x1.6	0205629L01	1	5505717E01	0.57	17
Toggle Switch Spanner		020516Q01	1	6680370B95	0.45	19
Control Top Screw	4-40x3/16"	0300136785	1	6680321B79	0.57	6
Housing Battery Contact Screws	2-56x5/32"	0300139982	2	6680321B86	0.34	45
Bottom Front Cover Screws	2-56x1/4"	0300140041	2	6680321B86	0.34	87
Baseplate to Frame Screws	4-40 (captive)	0305941K01	2	6680321B79	0.57	49
Front Cover Post Screws	4-40x5/16"	0305137Q01	2	6680321B79	0.57	52
Controller Front Shield Screw	2-56x7/16"	0300140484	1	6680321B86	0.23	35
Bottom Screw	2-56x5/16"	0300138620	1	6680321B86	0.34	67
Controller to Frame Screws	2-56x1/8"	0300140369	4	6680321B86	0.23	35
RF Board Back Shield Screws	2-56x5/16"	0300136772	4	6680321B86	0.34	65
RF Board Screw	2-56x1/8"	0300136772	1	6680321B86	0.34	not shown
PA Heatsink to PCB (VHF,2-W)	2-56x3/16"	0300136771	2	6680321B86	0.34	15
PA Heatsink to PCB (VHF,5-W)	2-56x3/16"	0300136771	1	6680321B86	0.34	15
PA to Heatsink (VHF,2-W)	2-56x5/32"	0300139685	1	6680321B86	0.34	101
PA to Heatsink Nut (VHF,5-W)	1/4		1		0.57	not shown
PA Heatsink to PCB (UHF)	2-56x3/16"	0300136771	2	6680321B86	0.34	15
Synthesizer Casting Screw	2-56x3/16"	0300136771	2	6680321B56	0.45	15
Front Cover Speaker/Mic Tab Screws	2-56x5/32"	0300139982	4	6680321B86	0.34	45

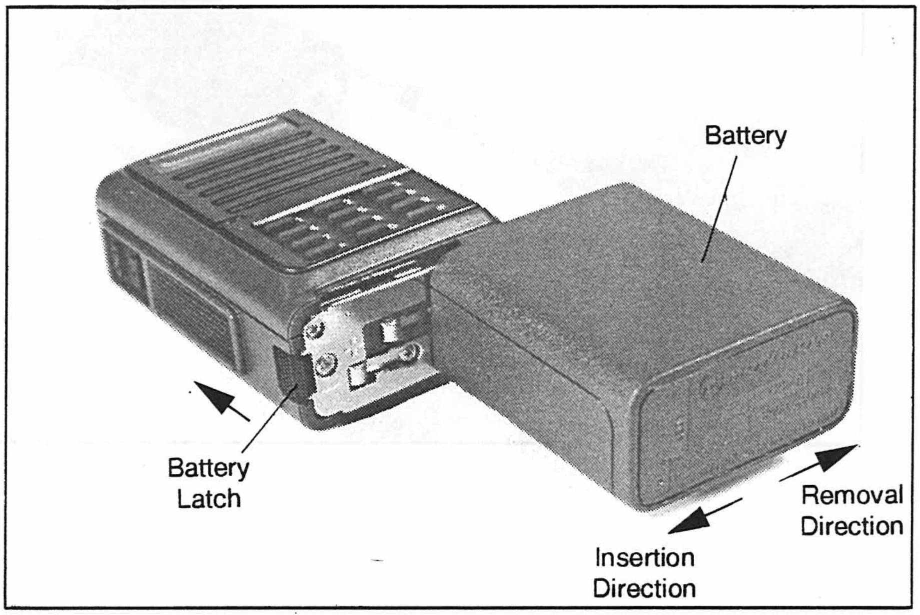
DISASSEMBLY PROCEDURE

CQP8000

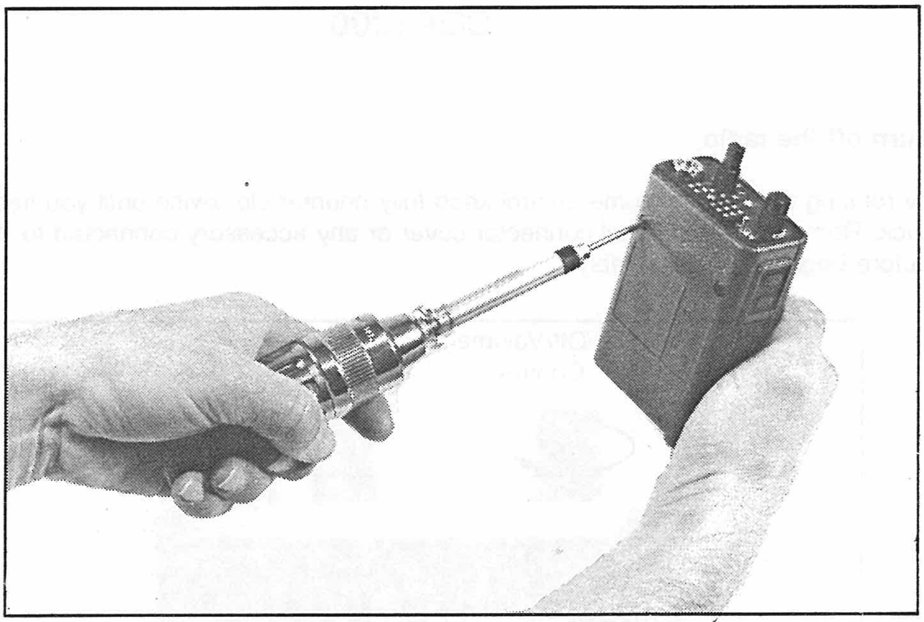
1. **Turn off the radio**

   by rotating the on/off-volume control knob fully counter clockwise until you hear a click. Remove the universal connector cover or any accessory connected to the radio before beginning disassembly.

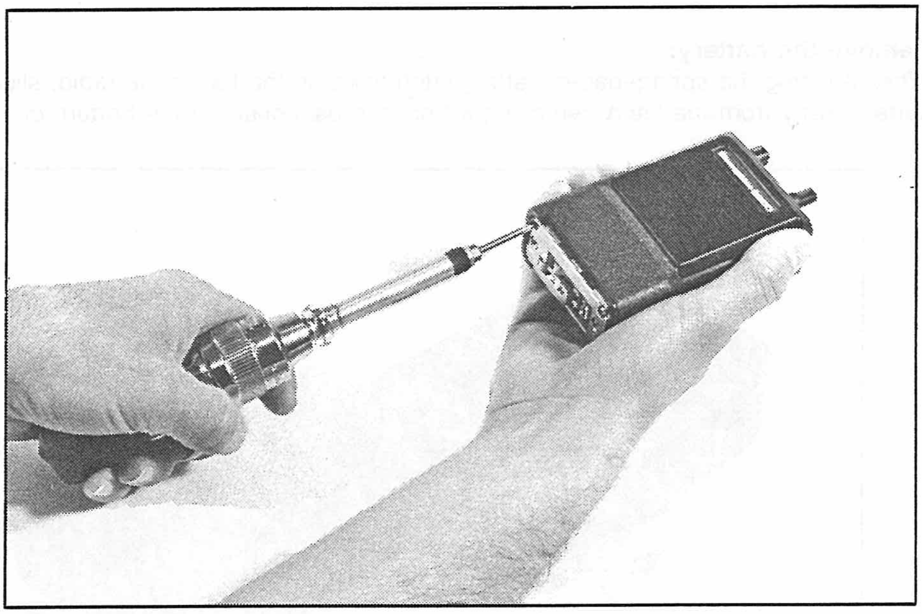
2. **Remove the battery:**
   While pushing the spring-loaded battery latch towards the top of the radio, slide the battery away from the latch, removing it from the baseplate on the bottom of the radio.



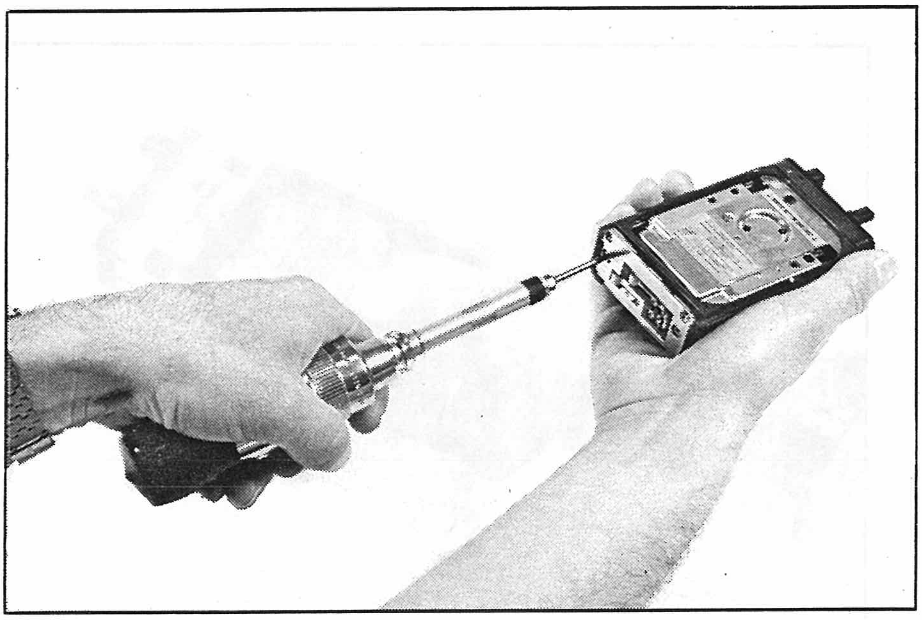
3. Remove the two screws from the back of the radio.



4. Remove the two screws on the bottom of the radio (baseplate corners).

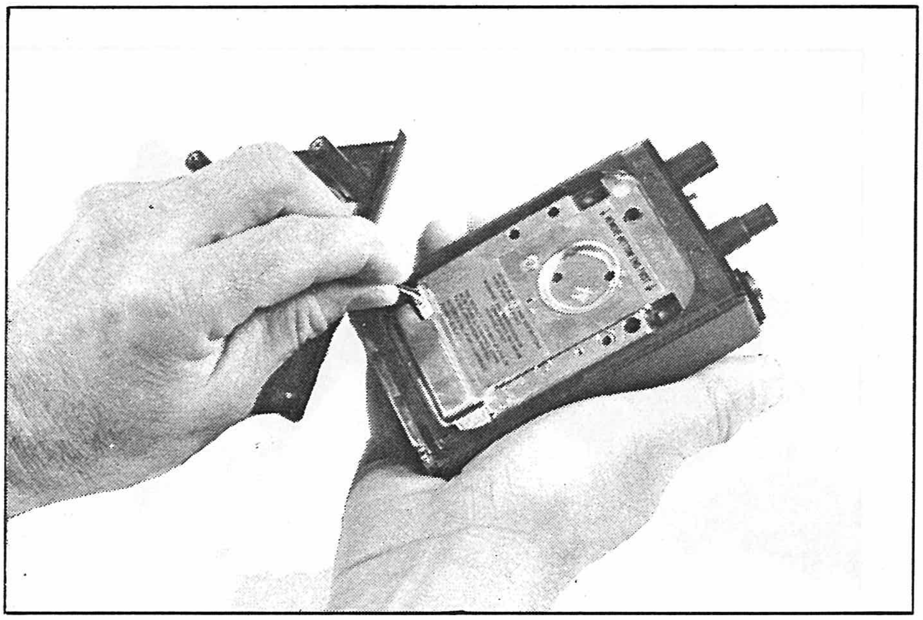


5. **Loosen the two captive screws on the bottom of the radio,**
   (middle of each end of baseplate).
   Do not completely remove the captive screws from the baseplate.

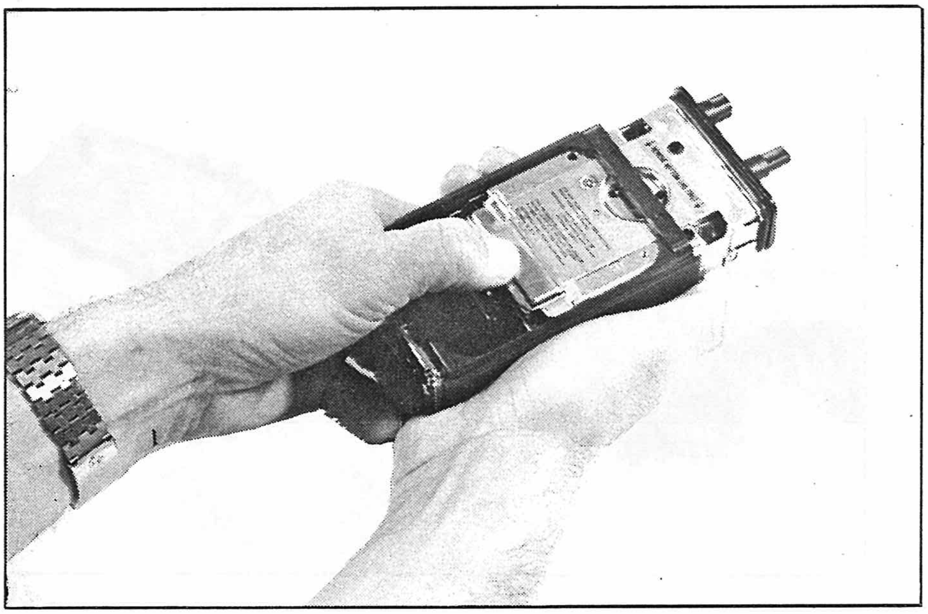


6. **Lift the front cover from the radio housing**
   being careful not to pull against the speaker/microphone wires.

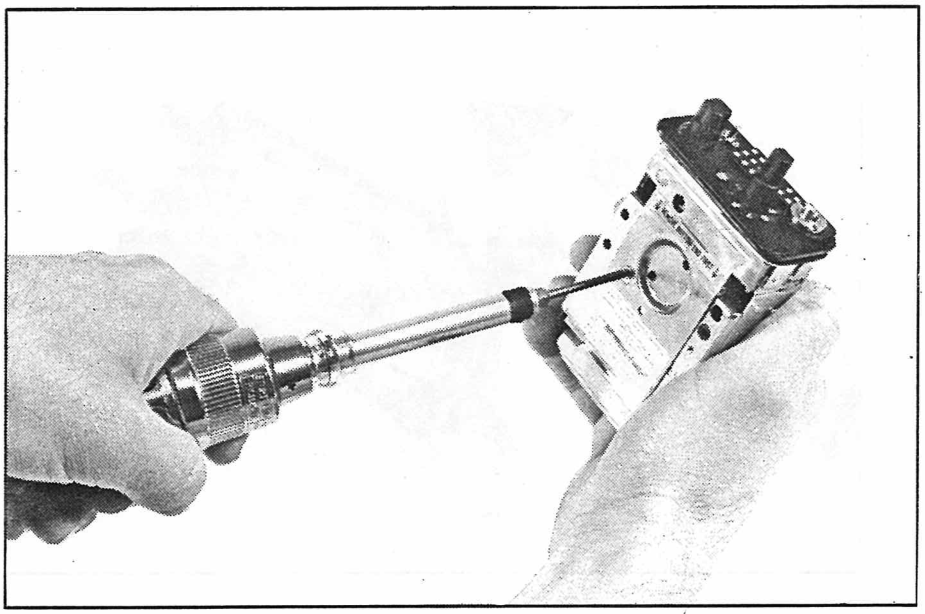
7. **Disconnect the speaker/microphone connector**
   from the controller flex by grasping the microphone flex (near the plug) and pulling the plug straight out and away from the circuit board.



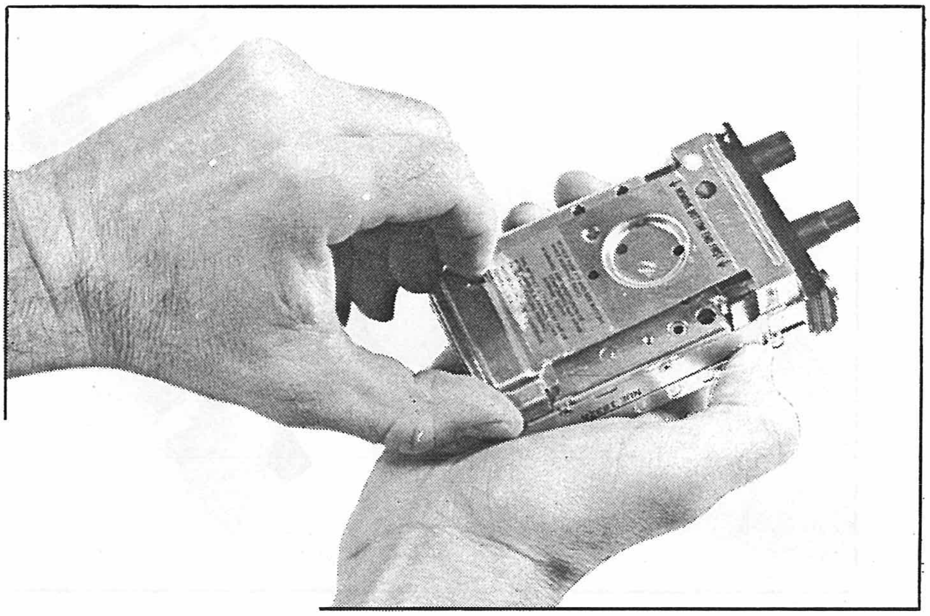
8. **Remove the frame assembly**
with a thumb and forefinger, grasp the antenna at its base and pull lightly to remove the frame assembly from the radio housing. Do not press the PTT switch during removal.



9. **Remove the screw that secures the front shield.**

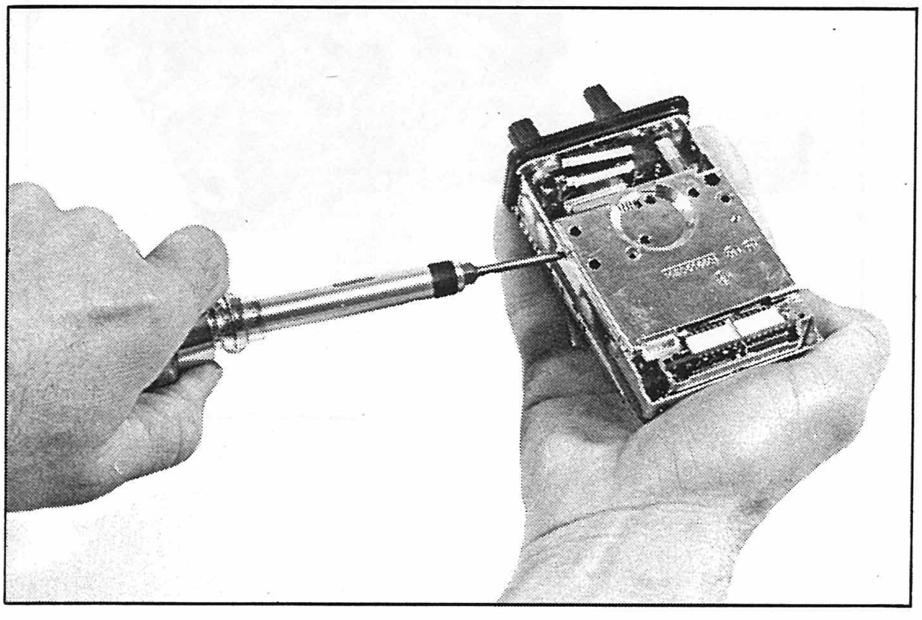


10. Remove the front shield
by pulling it straight out and away from the radio.

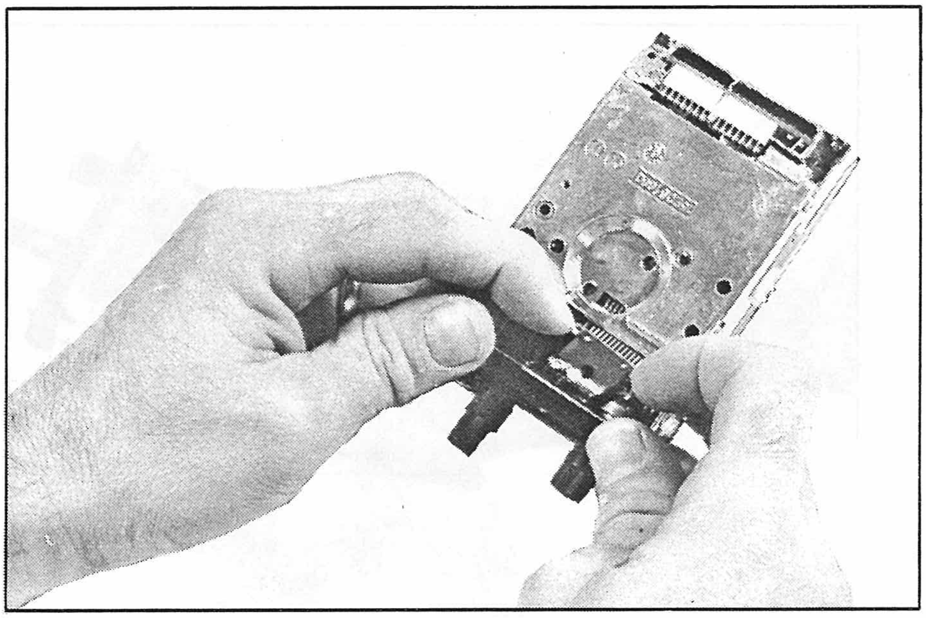


11. Remove the controller circuit as follows:
Remove the 4 screws (2 on each side) that secure the controller to the frame.

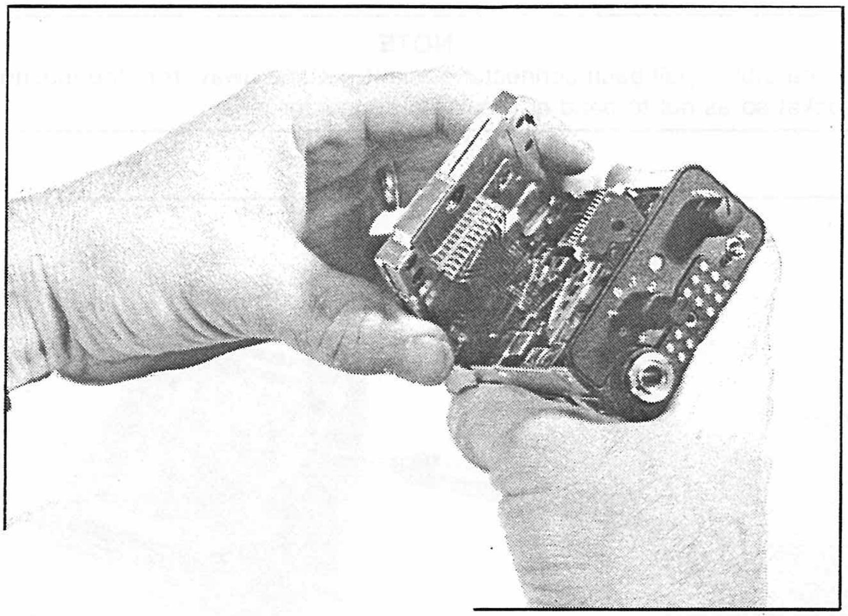
NOTE
Be careful to pull each connector straight out and away from the mating socket so as not to bend or break the connector pins.



- Disconnect the 2 bottom flex connectors by carefully sliding them away from the bottom of the radio.



- Lift the controller circuit (nearest the bottom of the radio) away from the radio just enough to gain access to the connector under the controller.

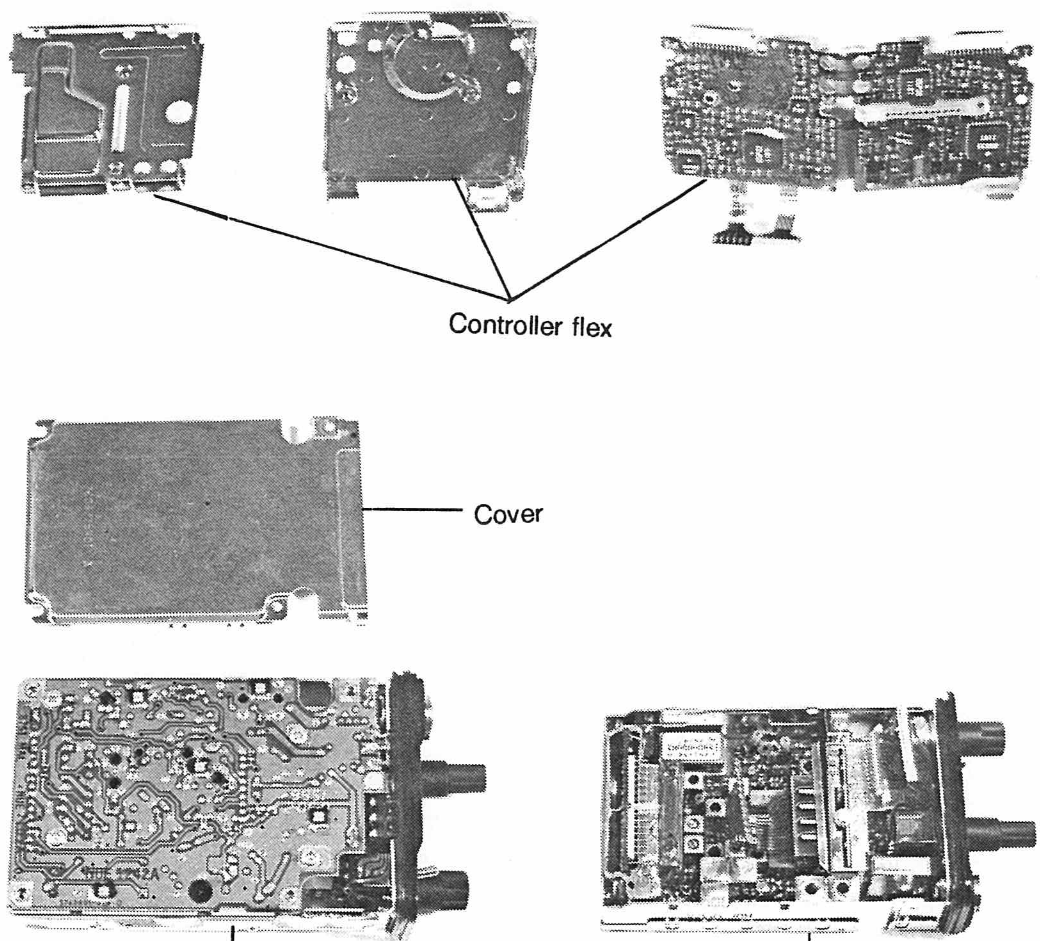


- Disconnect the connector under the controller.
- Disconnect the 2 connectors at the top of the controller.

CAUTION

REFER TO "CMOS" PRECAUTIONS, PART OF SAFETY INFORMATION SECTION

- Lift the controller totally away from the radio.



NOTE

Refer to the Exploded View Diagram if further disassembly is necessary.

12. **Assemble the radio in the reverse order of disassembly, making certain:**

- to avoid damage to the flex circuits, connectors, and connector pins when reinserting the controller.
- not to depress the PTT switch when sliding the circuit board back into the housing.

CAUTION

Inspect the frame O-ring and control head O-ring. Replace if obvious damage exists.

CHAPTER 8

RADIO FUNCTIONAL TESTS

a) Alignment VHF & UHF
b) Test & Programming Set-up
c) Troubleshooting
d) Cloning Procedure

RADIO FUNCTIONAL TESTS (@ 10 Vdc)

CQP8000

TRANSMITTER PERFORMANCE

TEST	SERVICE MONITOR	RADIO	TEST BOX	COMMENTS
REFERENCE FREQUENCY	Set to POWER MONITOR, FREQ.ERROR;frequency to radio transmit frequency; input to RF IN/OUT	Set to channel corresponding to frequency of test	PTT Continuous (during performance check)	Frequency error= ≤450 Hz (vhf) ≤750 Hz (uhf)
RF POWER OUT	Same as above, except set monitor to measure POWER	Set to channel corresponding to frequency and power level under test.	PTT Continuous (during performance check)	RF power output ≥ published specs for channel under test.*
VOICE MODULATION	Same as above, except set monitor to measure DEVIATION	Set to channel corresponding to frequency and power level under test.		Press radio's PTT switch and say "four" loudly into mic. Deviation should be ≥4.0 kHz and ≤5.0 kHz

RECEIVER PERFORMANCE

TEST	SERVICE MONITOR	RADIO	TEST BOX	COMMENTS
RATED AUDIO	Set to GENERATOR; frequency to radio receive frequency;1 mV RF output; 1 kHz modulation; 3 kHz deviation	Set to open squelch	Speaker selector on position "A";switch to load.	Verify that audio is present; adjust radio volume control to read 3.7 to 3.9 Vac on DVM.
12 dB SINAD	Same as above,except set monitor to measure SINAD	Set to open squelch	Set to speaker load	Reduce RF level to achieve 12 dB SINAD; RF level ≤published specs.

Note: Tests should be performed with Test Box RTX-4005 and associated Test Cable RTK4203.

* RF power levels can be different for each individual channel.

ALIGNMENT VHF
ALIGNMENT UHF

ALIGNMENT

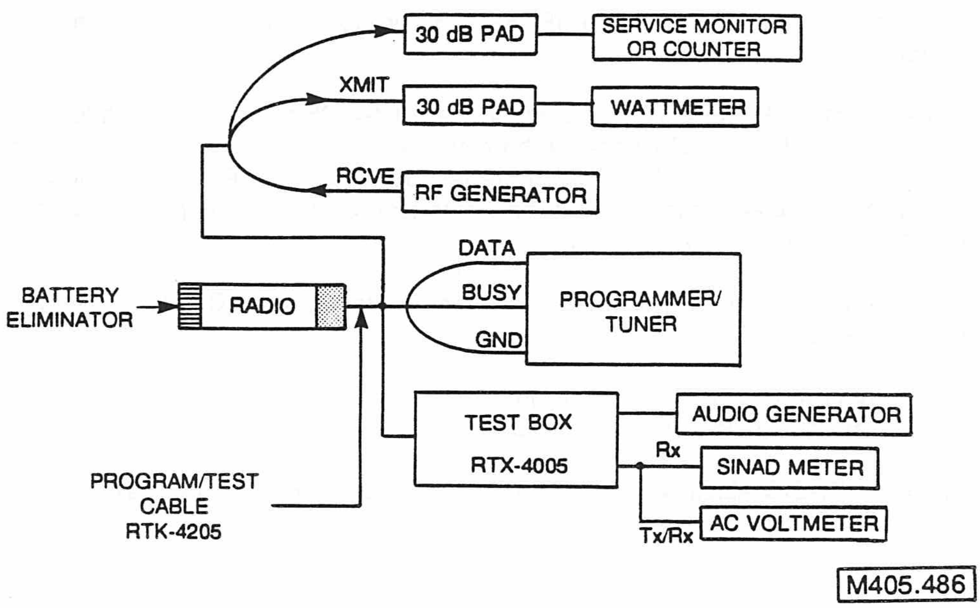
CQP8000 - VHF

THIS RADIO HAS BEEN FACTORY ALIGNED AND DOES NOT REQUIRE ANY ADJUSTMENTS.

Realignment may be required if components are replaced or have aged, or if any transmitter/receiver frequencies are changed. If it is necessary to realign the radio, perform the following procedures:

1. When using the RTX-4005 test box, place the MP PL switch in the OFF position.
2. Remove the battery and front cover as described in the "DISASSEMBLY PROCEDURE".
3. Refer to the Test Set-Up Detail and connect the test equipment and Programmer/Tuner to the radio as illustrated.
4. Connect a DC power supply to the battery eliminator and attach the battery eliminator to the radio.
5. Adjust the power supply for 10.0 VDC. Set current limit to 2.0 A.
6. Turn the radio off then on to reinitialise the radio.
7. Frequency Adjust (Synthesizer). Terminate the program/test cable (RTK-4205), RF lines (pins 10 and 12), through a 30 dB pad to a frequency counter or service monitor. Set the radio's frequency switch to any channel. Key the radio using the external PTT switch. Compare the frequency reading on the counter (or service monitor) to the customer frequency assigned to that channel. The frequency difference should be less than ±750 Hz. Adjust R129 if the frequency difference is more than ±750 Hz.
8. Perform either the "RECEIVER ALIGNMENT" procedure or "TRANSMITTER ALIGNMENT" procedure as required.

TEST SET-UP DETAIL



TRANSMITTER ALIGNMENT

PRELIMINARY ADJUSTMENTS:

1. Terminate the program/test cable (RTK-4205), RF lines (pins 10 and 12), to a power meter through a 30 dB pad.

2. Make all measurements at the Program Test Cable (pins 10 and 12), with radio keyed through the external PTT switch.

3. Program new customer frequencies (if necessary)

POWER OUTPUT ADJUSTMENTS:

STEP	ADJUST	FOR	USING	NOTE
1	Check power output on all channels. NOTE: You must dekey before changing channels for the synthesizer to change frequencies. Set the frequency switch to the channel with the lowest output power			
2	C120 P.A.Trimmer capacitor (on U102)	Maximum power output with least current drain	RF Wattmeter and Ammeter	Reading should be greater than rated RF power output, with current drain less than 800 mA (2-W-Models), or less than 1625 mA (5-W-Models.) **Note:** Two possible peaks, choose peak with least current drain. Adjust from component side.
3	Check remaining channels	Same power and current readings obtained in STEP 2	RF Wattmeter and Ammeter	
4	Repeat steps 1 through 3 if necessary.			

DEVIATION ADJUSTMENT

1. Terminate the program/test cable (RTK-4205) through a 30 dB pad to a service monitor (or deviation meter).

2. Place the METER SELECTOR switch on the RTX-4005 test box to the MIC position. Insert a 1 kHz tone at the AUDIO IN port of the test box. Use an AC voltmeter to monitor the voltage at the AC/DC METER port of the test box. Using the PTT switch on the RTX-4005 box to key the radio, adjust the level of the 1 kHz tone until 45 mV is present at the AC/METER port. Dekey the radio.

3. Connect the program/test cable to the Radio Interface Box (RIB). Use the Programmer/Tuner to read the radio.

4. If the radio requires a change in frequency or options, make the appropriate changes to the personality file and program the radio.

5. Enter the RADIO ALIGNMENT and SERVICE AIDS menu from the main menu. Select the TUNE CHANNEL option.

6. Set the frequency switch on the radio's control top for the channel to be adjusted.

7. Proceed to the VCO MODULATION LEVEL position of the TUNE CHANNEL screen.

8. Press and hold down the PTT switch on the RTX-4005 to continuously key the radio.

9. Press the ± keys to tune for a peak deviation as shown in the table below for the radio's appropriate channel spacing.

10. Release the PTT switch on the RTX-4005 to dekey the radio.

11. Proceed to the REF OSCILLATOR LEVEL position of the TUNE CHANNEL screen.

12. Disconnect the 1 kHz tone from the AUDIO IN port on the RTX-4005.

13. Press and hold down the PTT switch on the RTX-4005 to continuously key the radio.

14. Press the ± keys to tune for a peak deviation as shown in the table below for the radio's appropriate channel spacing.

15. Release the PTT switch on the RTX-4005 to dekey the radio.

16. Reconnect the 1 kHz tone to the AUDIO IN port of the RTX-4005.

17. Repeat steps 6-16 for all channels to be tuned.

18. Exit from the TUNE CHANNEL menu and program the radio.

19. With the 1 kHz tone applied, check the total transmit deviation to the range shown in the table below. Repeat the above procedure to retune any of the channels if necessary.

20. The programmer disables normal transmit (5-tone or PL encode) while on the REF OSCILLATOR LEVEL operation, and forces the radio to encode 30 Hz PL regardless of radio settings.

21. If any changes to the deviation levels were necessary, the radio must be reprogrammed.

CH SPACING	VCO MODULATION		REF MODULATION
	STEP 9	STEP 19	STEP 14
25 kHz	4.5-4.8 kHz	4-5 kHz	670-730 Hz
20 kHz	3.5-3.8 kHz	3.2-4 kHz	590-650 Hz
12.5 kHz	2.25-2.40 kHz	2-2.5 kHz	300-350 Hz

NOTE

While in the TUNE CHANNEL Screen, changes to the deviation settings are made in the radio's RAM. If the radio is dekeyed during the deviation adjustment, the radio's original information will be returned to RAM.
To place the programmer settings back into RAM, press either the ENTER, +, or - key.

DEVIATION ADJUSTMENT DTMF RADIOS

1. Follow the deviation procedure detailed above, but in step 14, adjust for the VCO MODULATION LEVEL as shown in the table below for the radio's appropriate channel spacing.

2. Press the number **1** key on the DTMF pad and continuously key the radio using the radio's PTT switch. Adjust R709 for the deviation defined in the table below for the radio's appropriate channel spacing.

CH.SPACING	STEP 1	STEP 2
25 kHz	4.7-4.9 kHz	3.0-3.2 kHz
20 kHz	3.7-3.9 kHz	2.4-2.6 kHz
12.5 kHz	2.35-2.45 kHz	1.5-1.7 kHz

NOTE

DTMF memory is volatile. If the battery is left off for more than 2 minutes the memory will be erased.

RECEIVER ALIGNMENT

PRELIMINARY ADJUSTMENTS:

1. The receiver is factory tuned to operate over the entire bandsplit and should not need retuning. Perform the "Receiver Check" to determine if "RECEIVER ALIGNMENT" (tuning any portion of the receiver) is necessary.

2. Connect the program/test cable (RTK-4205) to the Radio Interface Box (RIB). Use the Programmer/Tuner to read the radio.

3. When using the RTX-4005 test box, place the AUDIO OUT switch in the B position to set for proper speaker loading. Place the meter selector in the AUDIO PA position for receiver tests.

4. Connect the RF cable of the test cable to an RF generator or service monitor.

RECEIVER CHECK:

1. Use the Programmer/Tuner to program for new customer frequencies, if necessary.

2. Set the RF generator (or service monitor) for the appropriate frequency at a 1 mV level with a 1 kHz tone modulated at 3 kHz deviation.

3. Connect the AC/DC METER port of the RTX-4005 to an AC voltmeter. Adjust the volume potentiometer (R140) for an AC voltmeter reading of 4.47 Vrms.

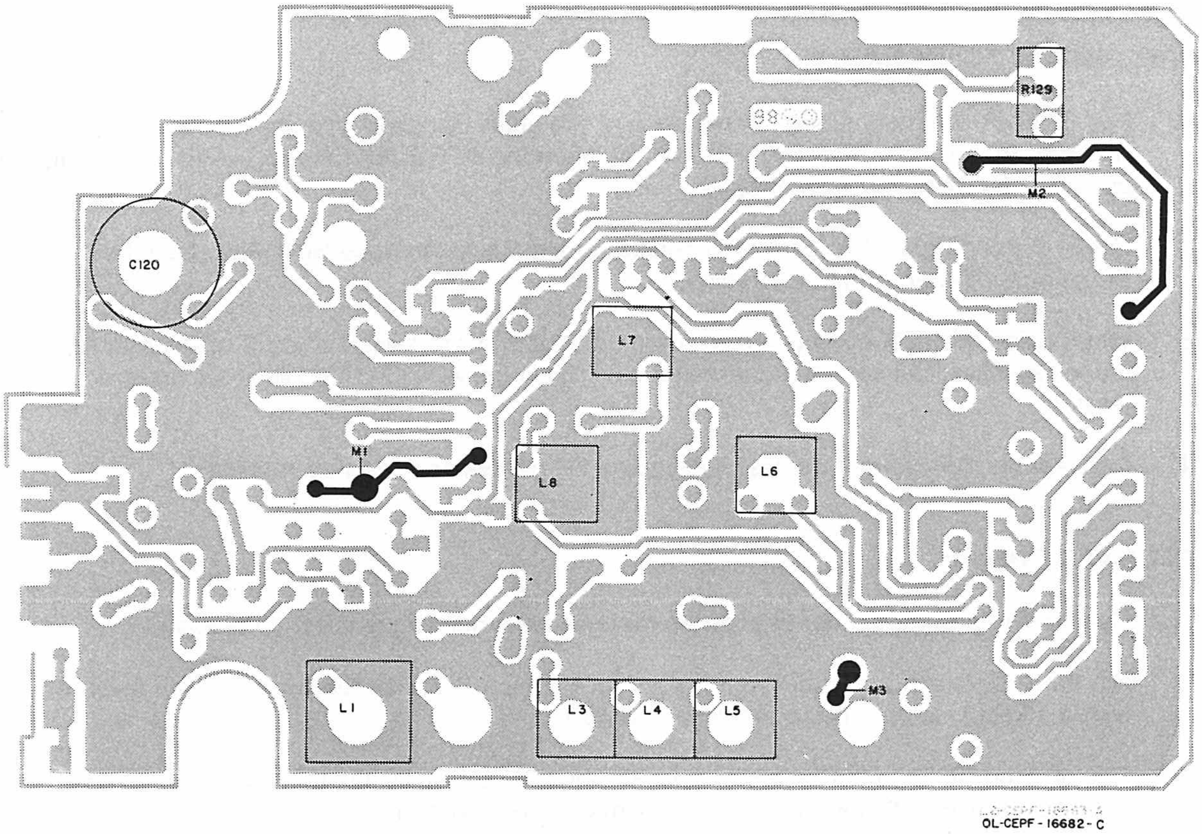
4. Connect a SINAD meter to the AC/DC METER port of the RTX-4005.

5. Reduce the RF level until 12 dB of SINAD is obtained; record the RF level reading. Depress the monitor button while taking this measurement to ensure that the radio is not squelched. Also temporarily disconnect the test cable from the RIB to ensure that computer noise does not affect the measurement.

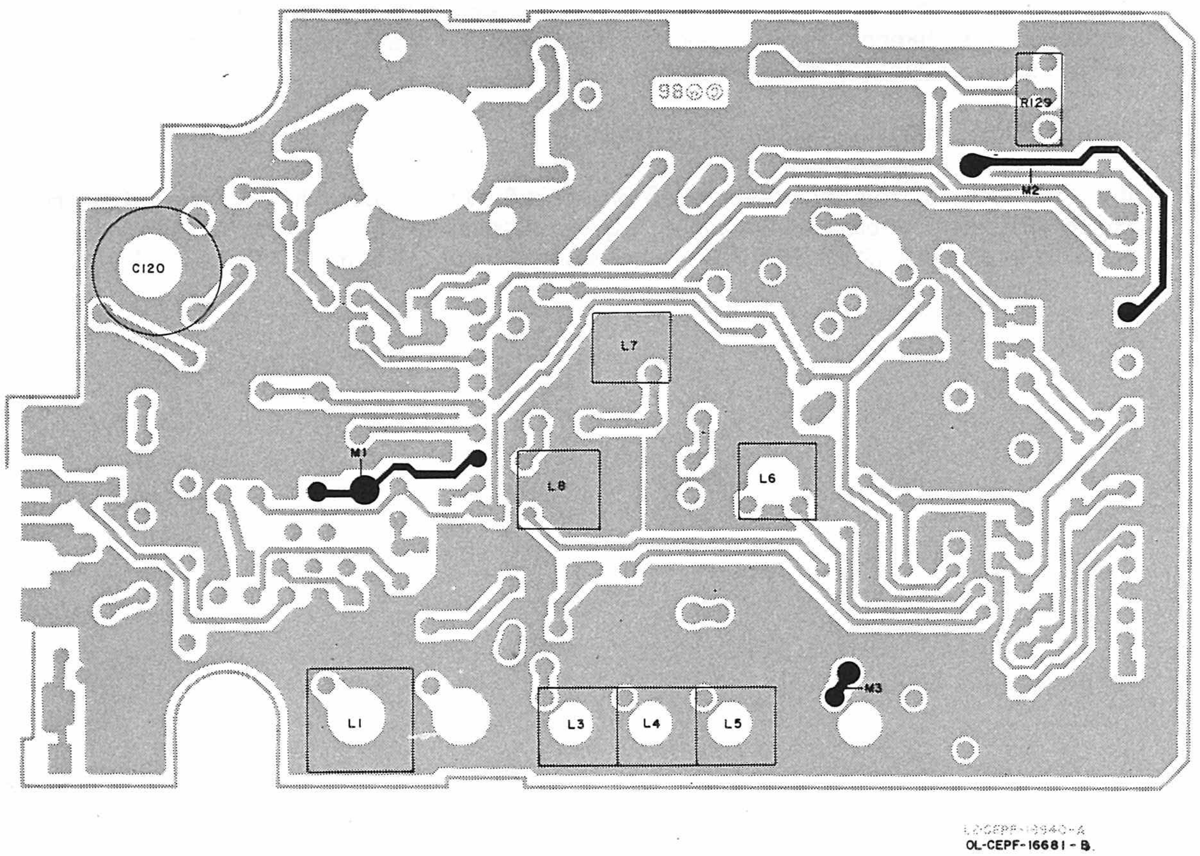
6. Perform SINAD measurement on all channels.

7. If the RF level required to produce 12 dB SINAD is 0.40 mVor less, DO NOT REALIGN THE RECEIVER; instead, proceed directly to "Squelch Sensitivity/Check Adjustment." If the RF required to produce 12 dB SINAD is greater than 0.25 mV, perform the "Receiver Alignment."

2 WATT RADIOS



5 WATT RADIOS



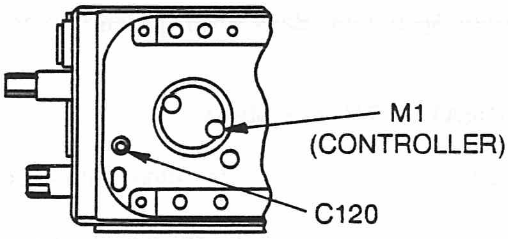
M405.492

RECEIVER ALIGNMENT BACK END:

DO NOT PERFORM RECEIVER ALIGNMENT UNTIL THE "RECEIVER CHECK" HAS BEEN PERFORMED.

> **NOTE**
>
> The receiver back end coils L6, L7, and L8, and the receiver front end coils L1, L3, L4 and L5 are factory tuned to cover the entire bandsplit and should not need retuning. Should the RF amp, mixer, crystal filters, i-f module, or accompanying parts need replacing, it may be necessary to perform the following tuning procedure:

M1 METERING POINT LOCATION (CONTROLLER)



BACK END

1. Remove the radio from its housing as described in the "DISASSEMBLY PROCEDURE," then remove the backplane shield (exploded view item #74).

2. Attach the battery adapter to the radio frame, then attach the battery eliminator to the battery adapter.

3. Selecting any one of the customer frequencies, adjust the RF generator or monitor for the appropriate frequency. Then, place the radio front side down so that the solder side (side 2) of the PC board is facing up.

4. Tune coils L6, L7, and L8 flush with the solder side of the PC board.

5. With an AC voltmeter, monitor M1 on the solder side of the PC board. Set the AC voltmeter to the -40 dB scale, and adjust the RF level so that the voltage can be monitored at M1. During the following procedure, adjust the RF level to keep the AC voltage at M1 within the -40 dB scale.

6. Peak coils L6, L7, and L8 (in that order) for maximum AC voltage at M1.

7. Perform the "Receiver Check" procedure, then repeat steps 4-6 of the "Back End" procedure, if necessary.

> **NOTE**
>
> Perform the following procedure only if the radio fails the receiver back end alignment have been performed. The radio should already be removed from the housing.

NARROW BANDWIDTH (6 MHz OR LESS)

8. Tune coils L1, L3, L4, and L5 flush with the solder side (size 2) of the PC board.

9. Set the radio to the highest customer receive frequency, then adjust the RF generator or service monitor for the appropriate frequency.

10. With an AC voltmeter, monitor M1 on the controller flex. Set the AC voltmeter to the -40 dB scale and adjust the RF level so that the AC voltage can be read at M1. During the following procedure, adjust the RF level to keep the AC voltage at M1 within the -40 dB scale.

11. Adjust L3, then L5 for the maximum AC voltage level at M1.

12. Set the radio to the lowest customer receive frequency, then adjust the RF generator or service monitor to the appropriate frequency and level.

13. Adjust L4, then L1 for the maximum AC voltage level at M1.

14. Perform the "Receiver Alignment (Back End)" procedure and then the "Receiver Check."

WIDE BANDWIDTH (GREATER THAN 6 MHz)

15. Tune coils L1, L3, L4, and L5 flush with the solder side (side 2) of the PC board.

16. Use the Programmer/Tuner to program the receiver frequency for 147.125 ±0.1 MHz for low split radios (136 - 151 MHz), or 158.125 ±0.1 MHz for mid split radios (146 - 162 MHz), or 170.125 ±0.1 MHz for high split radios (157 - 174 MHz). If interference is present, program for receive frequency as close to the desired frequency as possible.

17. Adjust L3, then L5 for the maximum AC voltage level at M1. Select the peak where the slugs of the coils are closest to the solder side of the PC board.

18. Use the Programmer/Tuner to program the receiver frequency for 161.975 ±0.1 MHz for mid split radios (146 - 162 MHz), or 173.975 ±0.1 MHz for high split radios (157 - 174 MHz).

19. Adjust L4 for the maximum AC voltage level at M1. Select the peak where the slug of the coil is closest to the solder side of the PC board.

20. Use the Programmer/Tuner to program the receiver frequency for 136.125 ±0.1 MHz for low split radios (136 - 151 MHz), or 146.125 ±0.1 MHz for mid split radios (146 - 162 Mhz), or 157.125 ±0.1 MHz for high split radios (157 - 174 MHz).

21. Adjust L1 for the maximum AC voltage level at M1. Select the second peak where the slug of the coil farthest from the solder side of the PC board.

22. Program the radio back to the original customer receiver frequencies.

23. Perform the "Receiver Alignment (Back End)" procedure and then the "Receiver Check."

SQUELCH SENSITIVITY CHECK/ADJUSTMENT

1. Use the Programmer/Tuner to read the radio, then proceed to the RADIO ALIGNMENT and SERVICE AIDS menu from the main menu. Next, select the TUNE RADIO operation.

2. Set the frequency switch for the channel determined to have the poorest sensitivity on the "Receiver Check." Place the decode select switch to the carrier squelch position.

3. Connect an AC voltmeter to the AC/DC METER port of the RTX-4005.

4. Set the RF generator or service monitor for the appropriate frequency and no modulation. Reduce the RF level to a minimum, then turn the RF off.

5. Depress the monitor button on the side of the radio and adjust the noise level for 2.2 Vrms. Make a note of the level on the dB scale. This will be the reference level for quieting measurements.

6. Proceed to the TONE SQUELCH position in the TUNE RADIO screen.

7. Turn the RF of the generator or service monitor on at the minimum possible level. Increase the RF level until squelch break occurs. Note the quieting level at squelch break. If squelch break occurs between 7 and 12 dB of quieting proceed directly to the carrier squelch check in step 10. If the quieting level is not within the 7 to 12 dB range, continue on with step 8.

8. Press the ± key to adjust the tone squelch setting to 0. Adjust the RF level for 8 dB of quieting.

9. Holding the RF level constant, press the + key to increment the tone squelch setting one step at a time until the radio squelches. This will be the tone squelch setting.

10. Proceed to the CARRIER SQUELCH position in the TUNE RADIO screen.

11. Adjust the tone squelch to the same value used for the carrier squelch setting.

12. Exit from the RADIO ALIGNMENT and SERVICE AIDS menu.

13. If the squelch settings required modification, program the radio.

ALIGNMENT

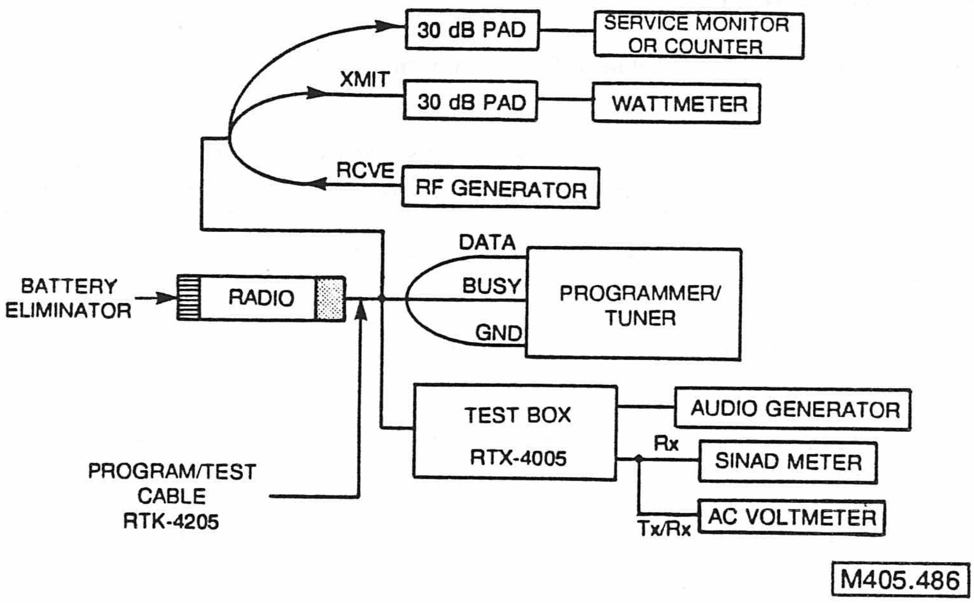
CQP8000 - UHF

THIS RADIO HAS BEEN FACTORY ALIGNED AND DOES NOT REQUIRE ANY ADJUSTMENTS.

Realignment may be required if components are replaced or have aged, or if any transmitter/receiver frequencies are changed. If it is necessary to realign the radio, perform the following procedures:

1. When using the RTX-4005 test box, place the MP PL switch in the OFF position.
2. Remove the battery and front cover as described in the "DISASSEMBLY PROCEDURE".
3. Refer to the Test Set-Up Detail and connect the test equipment and Programmer/Tuner to the radio as illustrated.
4. Connect a DC power supply to the battery eliminator and attach the battery eliminator to the radio.
5. Adjust the power supply for 10.0 VDC. Set current limit to 2.0 A.
6. Turn the radio off then on to reinitialise the radio.
7. Frequency Adjust (Synthesizer). Terminate the program/test cable (RTK-4205), RF lines (pins 10 and 12), through a 30 dB pad to a frequency counter or service monitor. Set the radio's frequency switch to any channel. Key the radio using the external PTT switch. Compare the frequency reading on the counter (or service monitor) to the customer frequency assigned to that channel. The frequency difference should be less than ±1250 Hz. Adjust R120 if the frequency difference is more than ±1250 Hz.
8. Perform either the "RECEIVER ALIGNMENT" procedure or "TRANSMITTER ALIGNMENT" procedure or both procedures as required.

TEST SET-UP DETAIL



TRANSMITTER ALIGNMENT

PRELIMINARY ADJUSTMENTS:

1. Terminate the program/test cable (RTK-4205), RF lines (pins 10 and 12), to a power meter through a 30 dB pad.

2. Make all measurements at the Program Test Cable (pins 10 and 12), with radio keyed through the external PTT switch.

3. Program new customer frequencies (if necessary)

POWER OUTPUT ADJUSTMENTS:

STEP	ADJUST	FOR	USING	NOTE
1	Check power output on all channels. NOTE: You must dekey before changing channels for the synthesizer to change frequencies. Set the frequency switch to the channel with the lowest output power			
2	C120 P.A.Trimmer capacitor (on U102)	Maximum power output with least current drain	RF Wattmeter and Ammeter	Reading should be greater than rated RF power output, with current drain less than 890 mA (2-W-Models), or less than 1615 mA (4-W-Models.) **Note:** Two possible peaks, choose peak with least current drain. Adjust from component side.
3	Check remaining channels	Same power and current readings obtained in STEP 2	RF Wattmeter and Ammeter	
4	Repeat steps 1 through 3 if necessary.			

DEVIATION ADJUSTMENT

1. Terminate the program/test cable (RTK-4205) through a 30 dB pad to a service monitor (or deviation meter).

2. Place the METER SELECTOR switch on the RTX-4005 test box to the MIC position. Insert a 1 kHz tone at the AUDIO IN port of the test box. Use an AC voltmeter to monitor the voltage at the AC/DC METER port of the test box. Using the PTT switch on the RTX-4005 box to key the radio, adjust the level of the 1 kHz tone until 45 mV is present at the AC/METER port. Dekey the radio.

3. Connect the program/test cable to the Radio Interface Box (RIB). Use the Programmer/Tuner to read the radio.

4. If the radio requires a change in frequency or options, make the appropriate changes to the personality file and program the radio.

5. Enter the RADIO ALIGNMENT and SERVICE AIDS menu from the main menu. Select the TUNE CHANNEL option.

6. Set the frequency switch on the radio's control top for the channel to be adjusted.

7. Proceed to the VCO MODULATION LEVEL position of the TUNE CHANNEL screen

8. Press and hold down the PTT switch on the RTX-4005 to continuously key the radio.

9. Press the ± keys to tune for a peak deviation as shown in the table below for the radio's appropriate channel spacing.

10. Release the PTT switch on the RTX-4005 to dekey the radio

11. Proceed to the REF OSCILLATOR LEVEL position of the TUNE CHANNEL screen.

12. Disconnect the 1 kHz tone from the AUDIO IN port on the RTX-4005

13. Press and hold down the PTT switch on the TRX-4005 to continuously key the radio.

14. Press the ± keys to tune for a peak deviation as shown in the table below for the radio's appropriate channel spacing.

15. Release the PTT switch on the RTX-4005 to dekey the radio.

16. Reconnect the 1 kHz tone to the AUDIO IN port of the RTX-4005.

17. Repeat steps 6-16 for all channels to be tuned.

18. Exit from the TUNE CHANNEL menu and program the radio.

19. With the 1 kHz tone applied, check the total transmit deviation to the range shown in the table below. Repeat the above procedure to retune any of the channels if necessary.

20. The programmer disables normal transmit (5-tone or PL encode) while on the REF OSCILLATOR LEVEL operation, and forces the radio to encode 30 Hz PL regardless of radio settings.

21. If any changes to the deviation levels were necessary, the radio must be reprogrammed.

CH SPACING	VCO MODULATION		REF MODULATION
	STEP 9	STEP 19	STEP 14
25 kHz 20 kHz 12.5 kHz	4.5-4.8 kHz 3.5-3.8 kHz 2.25-2.40 kHz	4-5 kHz 3.2-4 kHz 2-2.5 kHz	670-730 Hz 590-650 Hz 300-350 Hz

NOTE

While in the TUNE CHANNEL Screen, changes to the deviation settings are made in the radio's RAM. If the radio is dekeyed during the deviation adjustment, the radio's original information will be returned to RAM.
To place the programmer settings back into RAM, press either the ENTER, +, or - key.

DEVIATION ADJUSTMENT DTMF RADIOS

1. Follow the deviation procedure detailed above, but in step 14, adjust for the VCO MODULATION LEVEL as shown in the table below for the radio's appropriate channel spacing.

2. Press the number **1** key on the DTMF pad and continuously key the radio using the radio's PTT switch. Adjust R709 for the deviation defined in the table below for the radio's appropriate channel spacing.

CH.SPACING	STEP 1	STEP 2
25 kHz	4.7-4.9 kHz	3.0-3.2 kHz
20 kHz	3.7-3.9 kHz	2.4-2.6 kHz
12.5 kHz	2.35-2.45 kHz	1.5-1.7 kHz

NOTE

DTMF memory is volatile. If the battery is left off for more than 2 minutes the memory will be erased.

RECEIVER ALIGNMENT

PRELIMINARY ADJUSTMENTS:

1. Coils L9 through L13 are tuned at the factory for a 30 MHz bandwidth and should never need retuning. Coils L1 and L2 adjust an 8 MHz window anywhere across the 30 MHz bandwidth. Perform the "Receiver Check" to determine if "RECEIVER ALIGNMENT" (tuning any portion of the receiver) is necessary.

2. Connect the program/test cable (RTK-4205) to the Radio Interface Box (RIB). Use the Programmer/Tuner to read the radio.

3. When using the RTX-4005 test box, place the AUDIO OUT switch in the B position to set for proper speaker loading. Place the meter selector in the AUDIO PA position for receiver tests.

4. Connect the RF cable of the test cable to an RF generator or service monitor.

RECEIVER CHECK:

1. Use the Programmer/Tuner to program for new customer frequencies, if necessary.

2. Set the RF generator (or service monitor) for the appropriate frequency at a 1 mV level with a 1 kHz tone modulated at 3 kHz deviation.

3. Connect the AC/DC METER port of the RTX-4005 to an AC voltmeter. Adjust the volume potentiometer (R140) for an AC voltmeter reading of 4.47 Vrms.

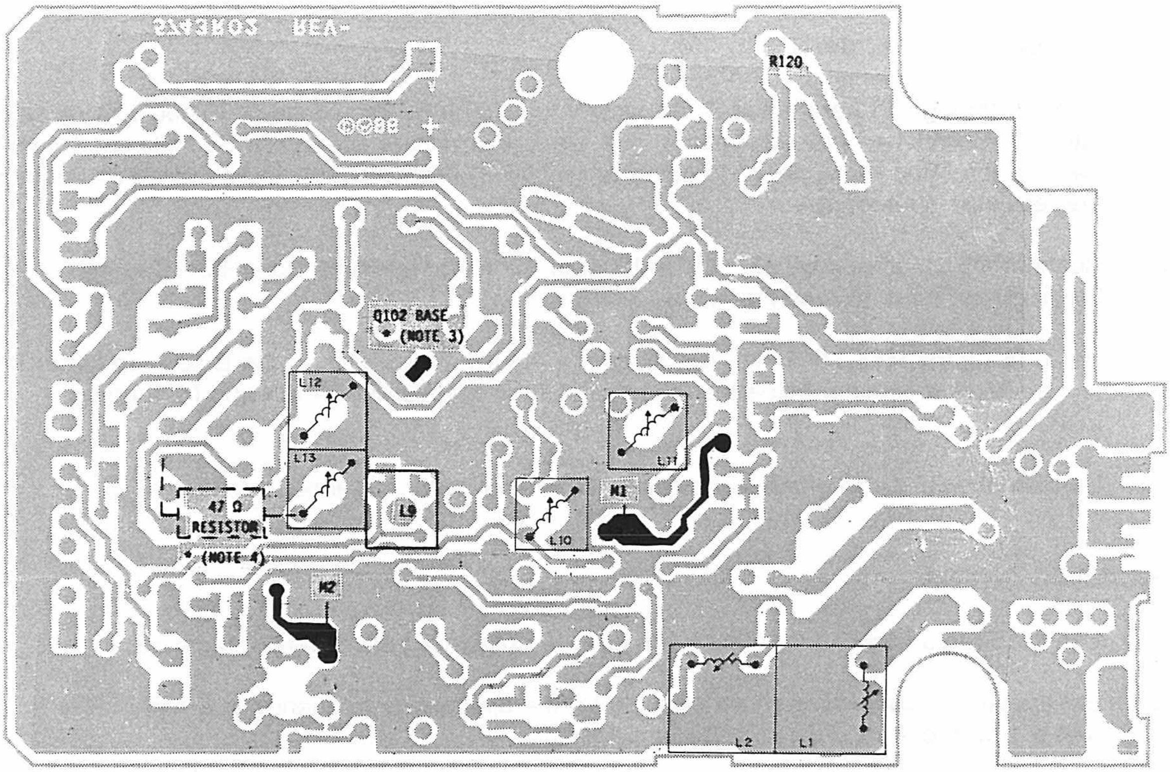
4. Connect a SINAD meter to the AC/DC METER port of the RTX-4005.

5. Reduce the RF level until 12 dB of SINAD is obtained; record the RF level reading. Depress the monitor button while taking this measurement to ensure that the radio is not squelched. Also temporarily disconnect the test cable from the RIB to ensure that computer noise does not affect the measurement.

6. Perform SINAD measurement on all channels.

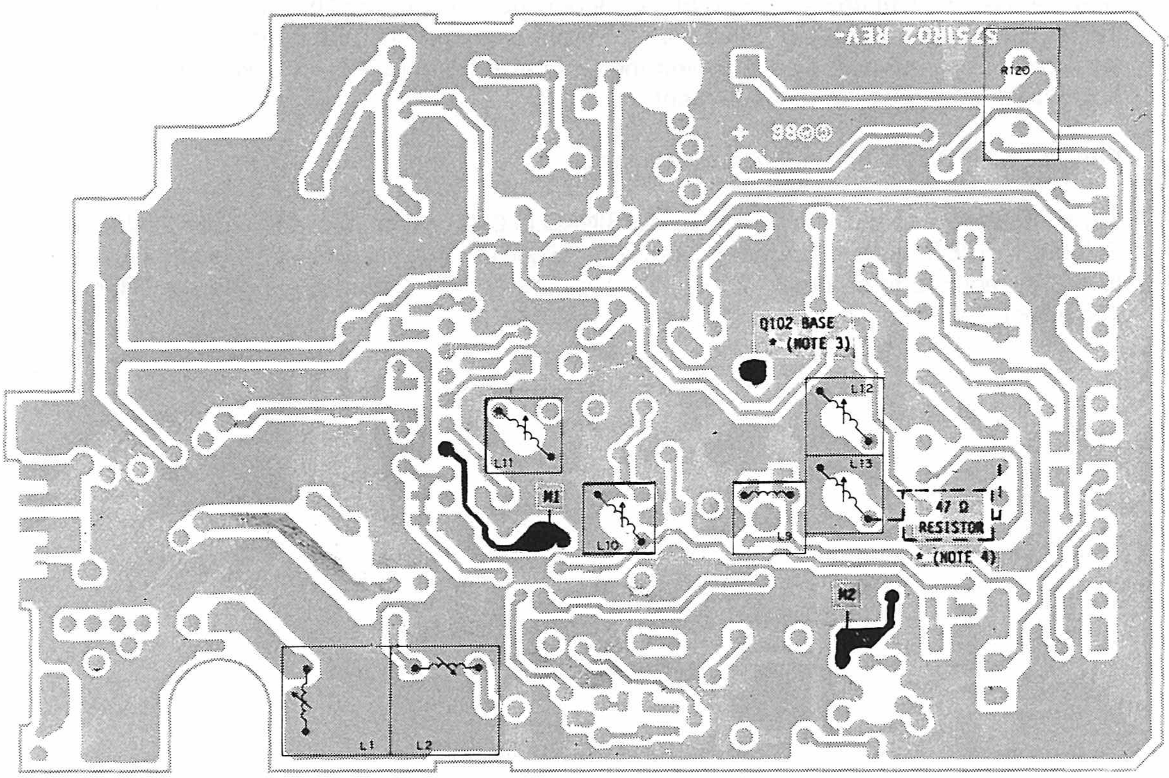
7. If the RF level required to produce 12 dB SINAD is 0.42 mV or less, DO NOT REALIGN THE RECEIVER; instead, proceed directly to "Squelch Sensitivity/Check Adjustment."
   If the RF required to produce 12 dB SINAD is greater than 0.42 mV, perform the "Receiver Alignment."

2-WATT RADIOS



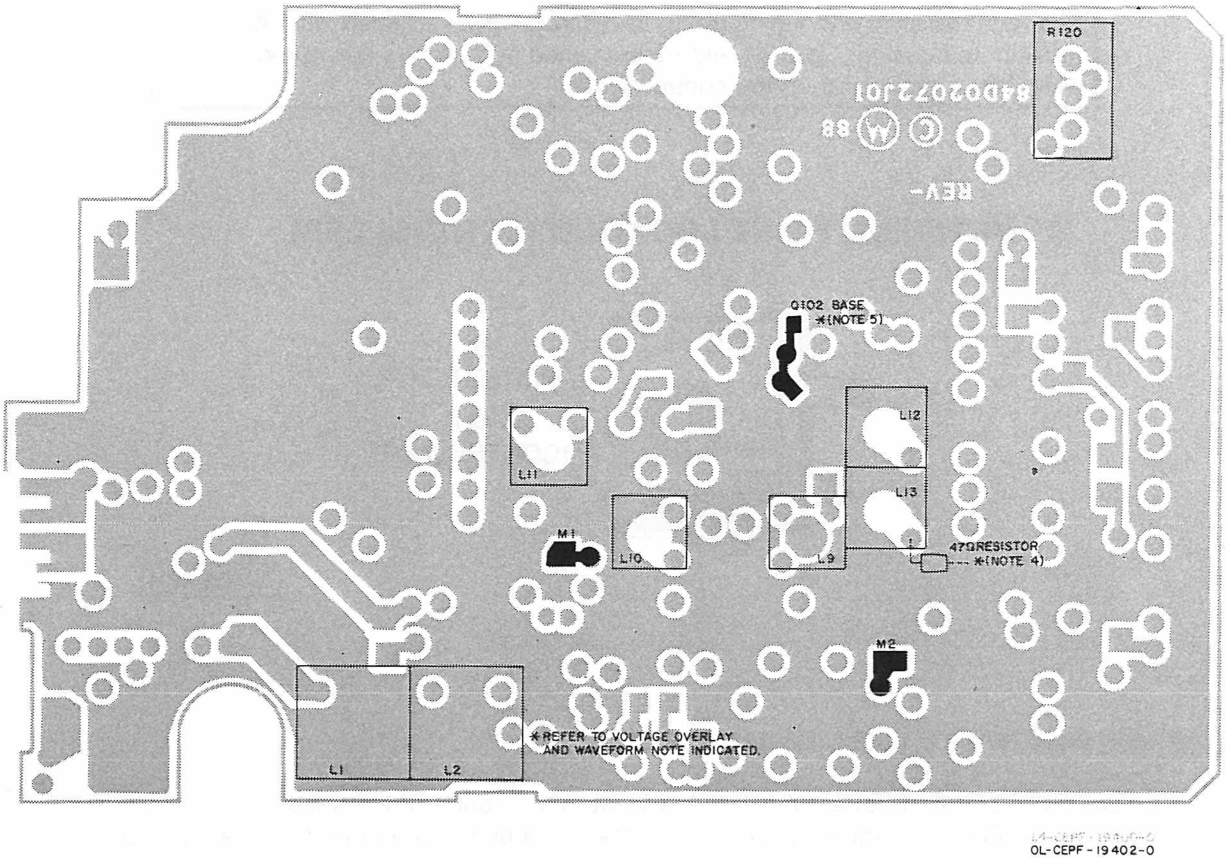
* REFER TO VOLTAGE OVERLAY
AND WAVEFORM NOTE INDICATED

4-WATT RADIOS (430 - 470 MHz)



* REFER TO VOLTAGE OVERLAY
AND WAVEFORM NOTE INDICATED

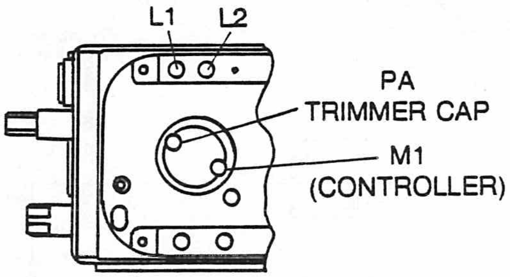
4-WATT RADIOS (470 - 520 MHz)



RECEIVER FRONT END:

> **NOTE**
>
> The receiver front end tuning procedure can be accomplished with the radio in its housing. Coils L1 and L2 are tuned through the flex carrier while M1 is monitored on the controller flex.

M1 METERING POINT LOCATION (CONTROLLER)



M405.488

NARROW BANDWIDTH (LESS THAN 5 MHz)

1. Select the customer frequency which is closest to the center of the specified customer frequencies. For two-frequency radio select the channel with the lowest frequency. Set the channel switch for the appropriate frequency.

2. Tune coils L1 and L2 to the top of the coil form. This will be the position where the slugs are nearest to the flex carrier.

3. With an AC voltmeter, monitor M1 on the controller flex. Set the AC voltmeter to the -40 dB scale. Set the service monitor to the appropriate frequency and adjust the RF level so that the AC voltage can be read at M1. During the following procedure, adjust the RF level to keep the AC voltage at M1 within the -40 dB scale.

4. Peak coil L1 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly.

5. Peak coil L2 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly.

6. Perform steps 2 through 7 of the "Receiver Check" procedure, then repeat the "Narrow Bandwidth" procedure, if necessary.

WIDE BANDWIDTH (5 - 8 MHz)

7. For wide bandwidth tuning, coils L1 and L2 must be peaked at a frequency that is located ±0.1 MHz from the center of the specified customer frequencies. If no such frequency is specified, it will be necessary to program a temporary tune frequency. (Make sure that the highest and lowest customer frequencies are not changed for a radio with more than 2 channels. If the radio has 2 channels, program the lowest frequency channel for the center frequency.) Program the radio for this frequency if necessary. Set the channel switch for this center frequency.

8. Tune coils L1 and L2 to the top of the coil form. This will be the position where the slugs are nearest to the flex carrier.

9. With an AC voltmeter, monitor M1 on the controller flex. Set the AC voltmeter to the -40 dB scale. Set the service monitor to the appropriate frequency and adjust the RF level so that the AC voltage can be read at M1. During the following procedure, adjust the RF level to keep the AC voltage at M1 within the -40 dB scale.

10. Peak coil L1 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly.

11. Peak coil L2 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly. For a 2 channel radio, reprogram the lowest frequency channel before going to step 12.

12. Set the channel switch to the lowest customer frequency. Repeak coil L2 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly.

13. Set the channel switch to the highest customer frequency. Repeak coil L1 for maximum AC voltage at M1. Select the peak where the coil's slug is closest to the flex carrier assembly.

14. Perform steps 2 through 7 of the "Receiver Check" procedure, then repeat the "Wide Bandwith" procedure, if necessary.

15. Program the radio back to the specified customer frequency, if necessary.

RECEIVER ALIGNMENT (BACK END/INJECTION FILTER):

NOTE

The receiver back end coils L9, L10, and L11, and the injection filter coils L12 and L13 are factory tuned for 30 MHz and should not need retuning. Should the mixer, crystal filter, i-f modules, or accompanying back end parts need replacing, it will be necessary to perform the back end procedure.

BACK END

16. Remove the radio from its housing as described in the "DISASSEMBLY PROCEDURE," then remove the backplane shield (exploded view item #74).

17. Attach the battery adapter to the radio frame, then attach the battery eliminator to the battery adapter.

18. Selecting any one of the customer frequencies, adjust the RF generator or monitor for the appropriate frequency. Then, place the radio front side down so that the solder side (side 2) of the PC board is facing up.

19. Tune coils L9, L10, and L11 flush with the solder side of the board.

20. With an AC voltmeter, monitor M1 on the solder side of the PC board. Set the AC voltmeter to the -40 dB scale, and adjust the RF level so that the voltage can be monitored at M1. During the following procedure, adjust the RF level to keep the AC voltage at M1 within the -40 dB scale.

21. Peak coils L9, L10, and L11 (in that order) for maximum AC voltage at M1.

22. Perform the "Receiver Check" procedure, then repeat steps 19-21 of the "Back End" procedure, if necessary.

INJECTION FILTER

> **NOTE**
>
> Perform the following procedure only if the radio fails the receiver check and both receiver front end and back end alignment have been performed. The radio should already be removed from the housing.

23. Tune coils L12 and L13 to be flush with the solder side of the PC board.

24. Monitor M2 with a DC voltmeter

25. Peak L12, then L13 for maximum DC voltage at M2

26. Perform the "Receiver Check" procedure, then repeat steps 23-25 of the "Back End" procedure, if necessary.

SQUELCH SENSITIVITY CHECK/ADJUSTMENT

1. Use the Programmer/Tuner to read the radio, then proceed to the RADIO ALIGNMENT and SERVICE AIDS menu from the main menu. Next, select the TUNE RADIO operation.

2. Set the frequency switch for the channel determined to have the poorest sensitivity on the "Receiver Check." Place the decode select switch to the carrier squelch position.

3. Connect an AC voltmeter to the AC/DC METER port of the RTX-4005.

4. Set the RF generator or service monitor for the appropriate frequency and no modulation. Reduce the RF level to a minimum, then turn the RF off.

5. Depress the monitor button on the side of the radio and adjust the noise level for 2.2 Vrms. Make a note of the level on the dB scale. This will be the reference level for quieting measurements.

6. Proceed to the TONE SQUELCH position in the TUNE RADIO screen.

7. Turn the RF of the generator or service monitor on at the minimum possible level. Increase the RF level until squelch break occurs. Note the quieting level at squelch break. If squelch break occurs between 7 and 16 dB of quieting proceed directly to the carrier squelch check in step 10. If the quieting level is not within the 7 to 12 dB range, continue on with step 8.

8. Press the ± key to adjust the tone squelch setting to 0. Adjust the RF level for 8 dB of quieting.

9. Holding the RF level constant, press the + key to increment the tone squelch setting one step at a time until the radio squelches. This will be the tone squelch setting.

10. Proceed to the CARRIER SQUELCH position in the TUNE RADIO screen.

11. Adjust the tone squelch setting to the same value used for carrier squelch setting.

12. Exit from the RADIO ALIGNMENT and SERVICE AIDS menu.

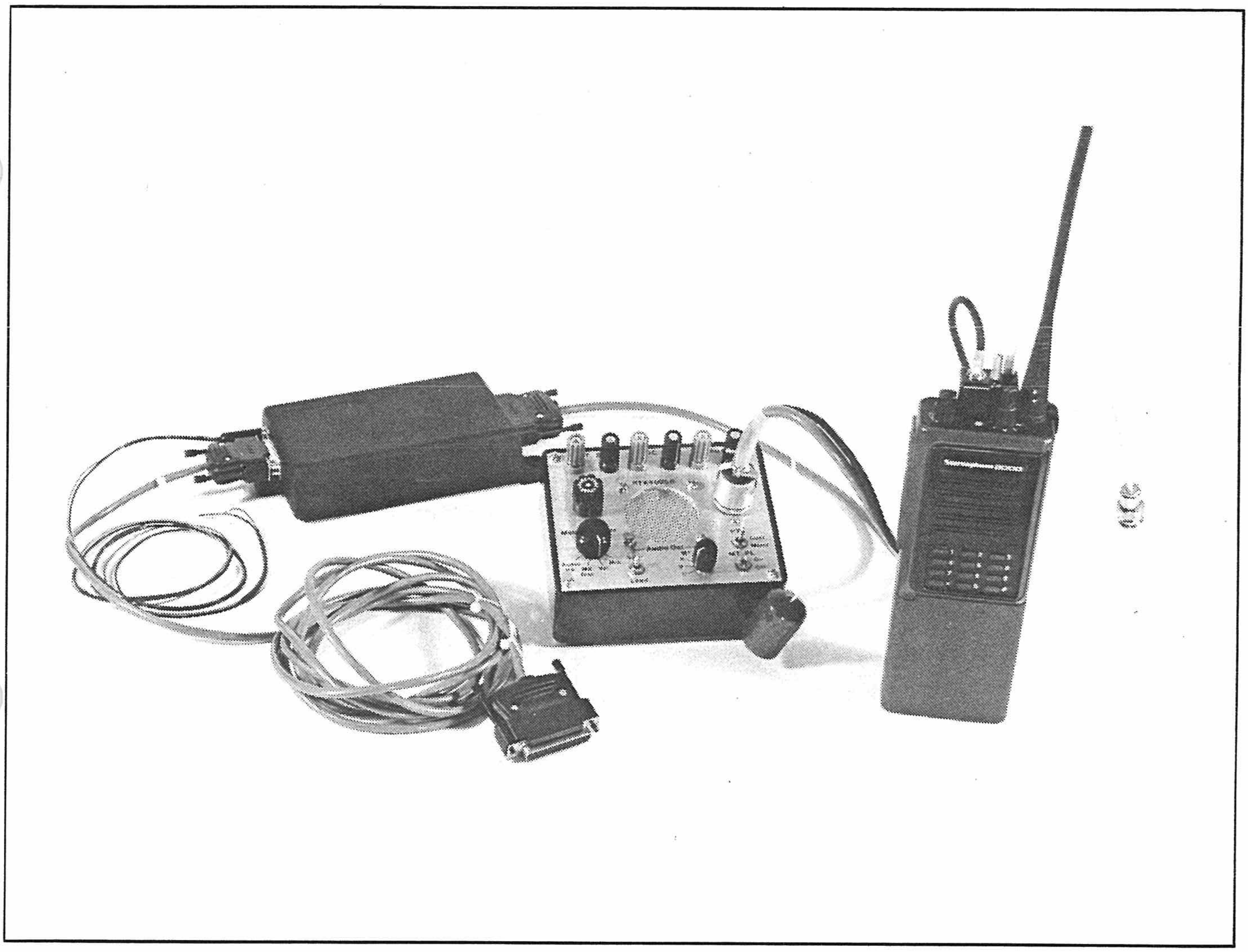
13. If the squelch settings required modification, program the radio.

TEST & PROGRAMMING SET-UP

Example

TEST & PROGRAMMING SET-UP

EXAMPLE



TROUBLESHOOTING

CQP8000

TROUBLESHOOTING

Servicing the CQP8000 Series radio requires the localization of the malfunctioning circuit before the defective component can be isolated and replaced. Since localizing and isolating a defective component constitutes the most time consuming part of troubleshooting, a thorough understanding of the circuits involved will aid the technician in performing efficient servicing. The technician must know how one function affects another; he must be familiar with the overall operation of the radio and the procedures necessary to place it back in operation in the shortest possible time.

The radio functional block diagrams, schematic diagrams, and troubleshooting charts provide valuable information for troubleshooting purposes. The functional diagrams provide signal flow information in a simplified format, while the schematic diagrams provide the detailed circuitry and the biasing voltages required for isolating malfunctioning components. By using the diagrams, troubleshooting charts, and deductive processes, the suspected circuit may be readily found.

To determine if analyzation of the radio is required, perform checks such as 20 dB SINAD psophometrically weighted 12 dB SINAD, noise and PL squelch sensitivity, for the receiver; and current drain for the transmitter. These should give the technician a general indication of where the problem is located.

NOTE
See Figure 16 - Troubleshooting, Test Equipment and Programming Set-Up Detail.

After the general problem area of the radio has been identified careful use of a dc voltmeter RF millivoltmeter and an oscilloscope should isolate the problem to an individual component.

TROUBLESHOOTING PROCEDURE

Each time that the radio is turned on, a microcomputer self-test occurs. A 1600 Hz alert tone is generated for approximately 500 milliseconds to indicate that the microcomputer is functioning properly. If the alert tone is not heard (and the alert tones have not been disabled via the Radio Service Software), there is a problem with the radio.

Following the microcomputer self-test, a synthesizer self-test occurs. A continuous 1600 Hz alert tone is generated if the synthesizer test is NOT successful. If this condition occurs (continuous alert tone) refer to the VCO/synthesizer troubleshooting chart.
When a radio performs unsatisfactorily, the following procedures should help localize the fault.

CHECK BATTERIES

The first step in localizing a trouble is to check the battery voltage under load. With the transmitter turned on (keyed), check the battery voltage. A convenient way to do this is to remove the front cover monitor the B + line with a voltmeter (with respect to ground). The measured load voltage should not be less than eight volts. Even though the transmitter may operate at a lower voltage, operation would marginal and for only a short period of time. Low-voltage transmit operation is indicated by the flashing LED on top of the radio. If the measured voltage is zero volts, check the battery and fuse. The recommended procedure is to replace, or recharge the battery if the voltage is below eight volts under load.

ALIGNMENT

Strict adherence to the published procedures is a prerequisite to accurate alignment and proper evaluation of the performance of the radio. The selection of test equipment is critical. The use of equipment other than that recommended should be cleared through your Motorola Area Representative to ensure that it is of equivalent quality.

The service technician must observe good servicing techniques. The use of interconnecting cables that are too long, poorly positioned (dressed), or improperly terminated will result in erratic meter readings. As a result, it will not be possible to tune the radio to the desired specifications.

Use the recommended test equipment setup and proper connections for alignment and adjustments. Refer to the detailed procedures supplied in the applicable service manual.

CHECK OVERALL TRANSMITTER OPERATION

If the battery voltage is sufficient, check the overall performance of the transmitter. A good overall check of the transmitter is the RF power output measurement. This check indicates the proper operation of the transmitter amplifier stages. A properly tuned and operating transmitter will produce the rated RF output into a 50-ohm load with a dc input of 10 volts (refer to "Transmitter Alignment Procedure," located in the service manual, for specific RF output). If the power is less than rated RF output, refer to the applicable transmitter troubleshooting chart.

CHECK OVERALL RECEIVER OPERATION

20 dB SINAD Psophometrically weighted

This procedure is a standard method for evaluating the performance of an FM receiver, since it provides a check of the RF, I-F, and audio stages. The method consists of finding the lowest modulated signal necessary to produce 50% of the radio's rated audio output with a 20 dB or better ratio of signal + noise + distortion/noise + distortion. This is termed "usable sensitivity."

To perform this measurement, connect the leads from a SINAD meter, which has a psophometric filtering network (CCIT filter), to the audio output of the test box. Set the service monitor or RF signal generator to output a 1-millivolt signal. Modulate the RF signal with a 1 kHz tone at 60% of the total system deviation. Introduce the signal to the radio at the exact channel frequency through the universal connector. Set the volume control for half the rated audio output (3.16 Vrms). Decrease the RF signal level until the SINAD meter reads 20 dB. The signal generator output (20 dB SINAD measurement) should be less than 0.50 uV on both UHF and VHF receivers. If the radio does not meet this specification, try to retune the receiver using the procedure indicated in the service manual. If this does not solve the problem, refer to the reciver troubleshooting chart.

12 dB SINAD

This procedure is a standard method for evaluating the performance of an FM receiver , since it provides a check of the RF, I-F, and audio stages. The method consists of finding the lowest modulated signal necessary to produce 50% of the radio's rated audio output with a 12 dB or better ratio of signal + noise + distortion/noise + distortion. This is termed "usable sensitivity."

To perform this measurement, connect the leads from a SINAD meter to the audio output of the test box. Set the service monitor or RF signal generator to output a 1-millivolt signal. Modulate the RF signal with a 1 kHz tone at 60% of the total system deviation. Introduce the signal to theradio at the exact channel frequency through the universal connector. Set the volume control for half rated audio output (3.16 Vrms). Decrease the RF signal level until the SINAD meter reads 12 dB. The signal generator output (12 dB SINAD measurement) should be less than 0.40 mV on VHF receivers or less than 0.42 mV on UHF receivers. If the radio does not meet this specification, try to retune the receiver using the procedure indicated in the service manuals. If this does not solve the problem, refer to the receiver troubleshooting chart.

VOLTAGE MEASUREMENT AND SIGNAL TRACING

To aid in troubleshooting, ac and dc voltage readings are provided (in red) on the transceiver schematic diagram in the service manual. When making these voltage checks, pay particular attention to any notes that may accompany the voltage reading of a particular stage.
If reciver sensitivity is high or if the RF power output is lower than normal for a fully tuned transceiver, the dc voltages on the printed circuit board should be checked. These voltages should be referenced to ground.

CAUTION

When checking a transistor or module, either in or out of the circuit, do not use an ohmmeter having more than 1.5 volts dc appearing across the test leads or an ohms scale of less than x 100.

It is recommended not to replace a transistor or module before a thorough check is made. Read the voltages around the suspected stage. If these voltages are not reasonably close to those specified, the associated components should be checked.
A low impedance meter should not be used for measurement. If all dc voltages are correct, the signal should be traced through the circuit to show any possibility of breaks in the signal path.

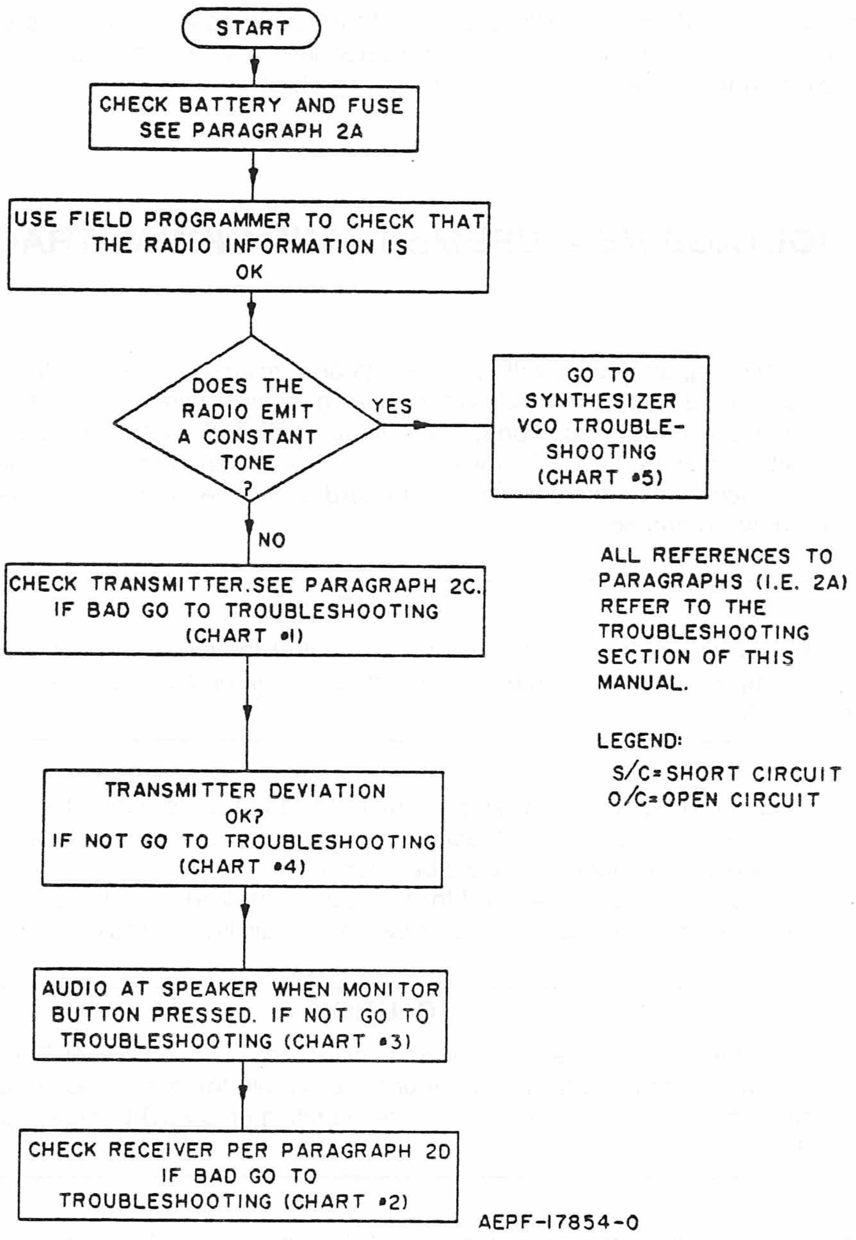
CAUTION

The microcomputer is a static sensitive device contained on the controller flex assembly. DO NOT attempt to troubleshoot or disassemble the micrcomputer/controller flex assembly without first referring to the "Safe Handling of CMOS Devices" paragraph in Chapter 3.

When troubleshooting the microcomputer controller flex circuits, it will be necessary to disconnect the flex from the radio main circuit board and reconnect it via a flex extender fixture. Also, many of the measurements referred to in the microcomputer troubleshooting charts that follow are short in duration. So, it will be necessary to use an oscilloscope set for 1 V/division and 5 ms/division.

TROUBLESHOOTING CHARTS

The troubleshooting charts on the following pages will help isolate troubles in the different sections of the radio. Start at the top of the appropriate chart and make the checks as indicated. Most usual malfunctions will respond to the systematic approach to troubleshooting. Also, a flowchart is provided to aid in choosing the proper troubleshooting chart.



TROUBLESHOOTING FLOW CHART

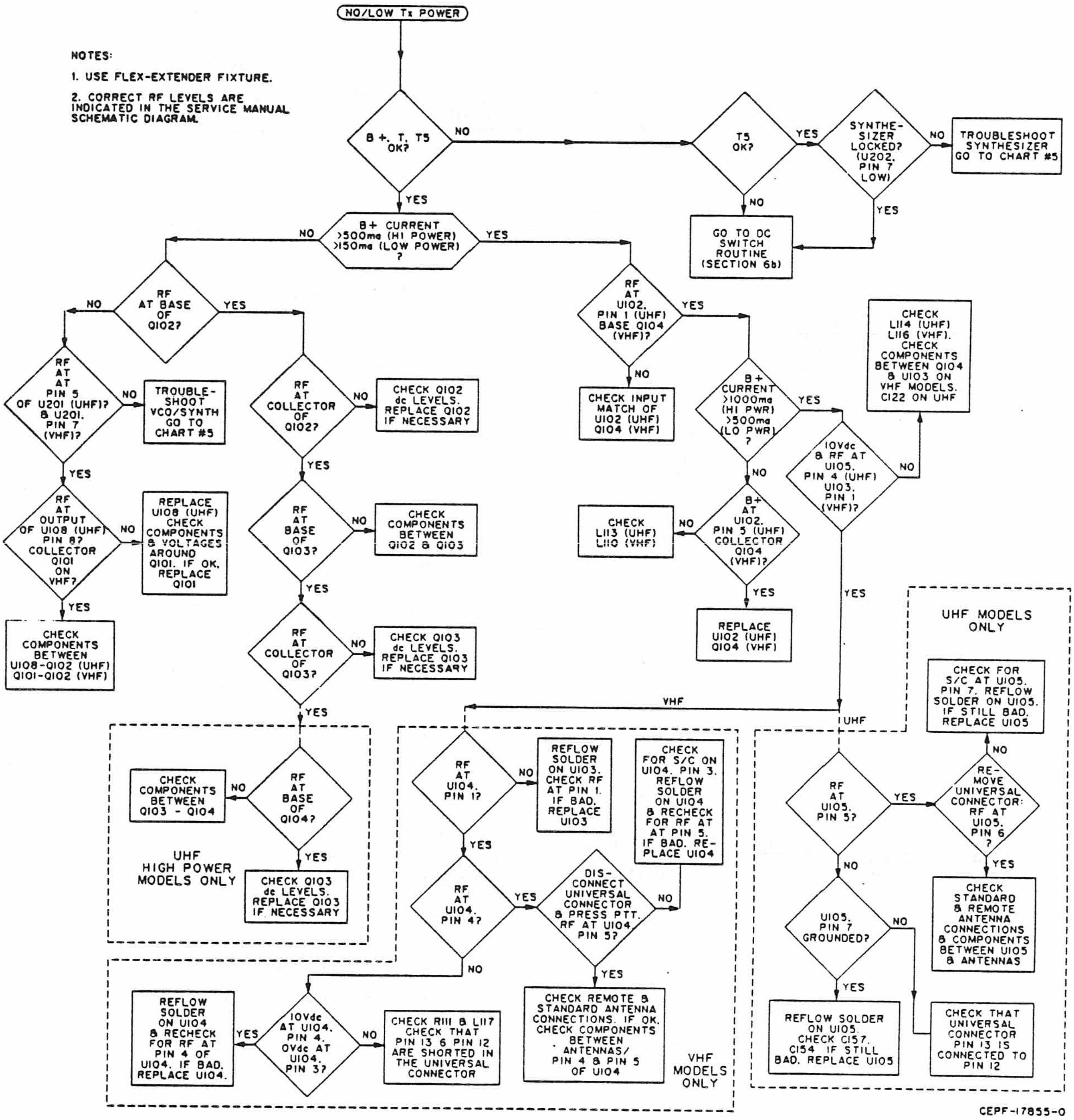


CHART #1: TRANSMITTER (RF)

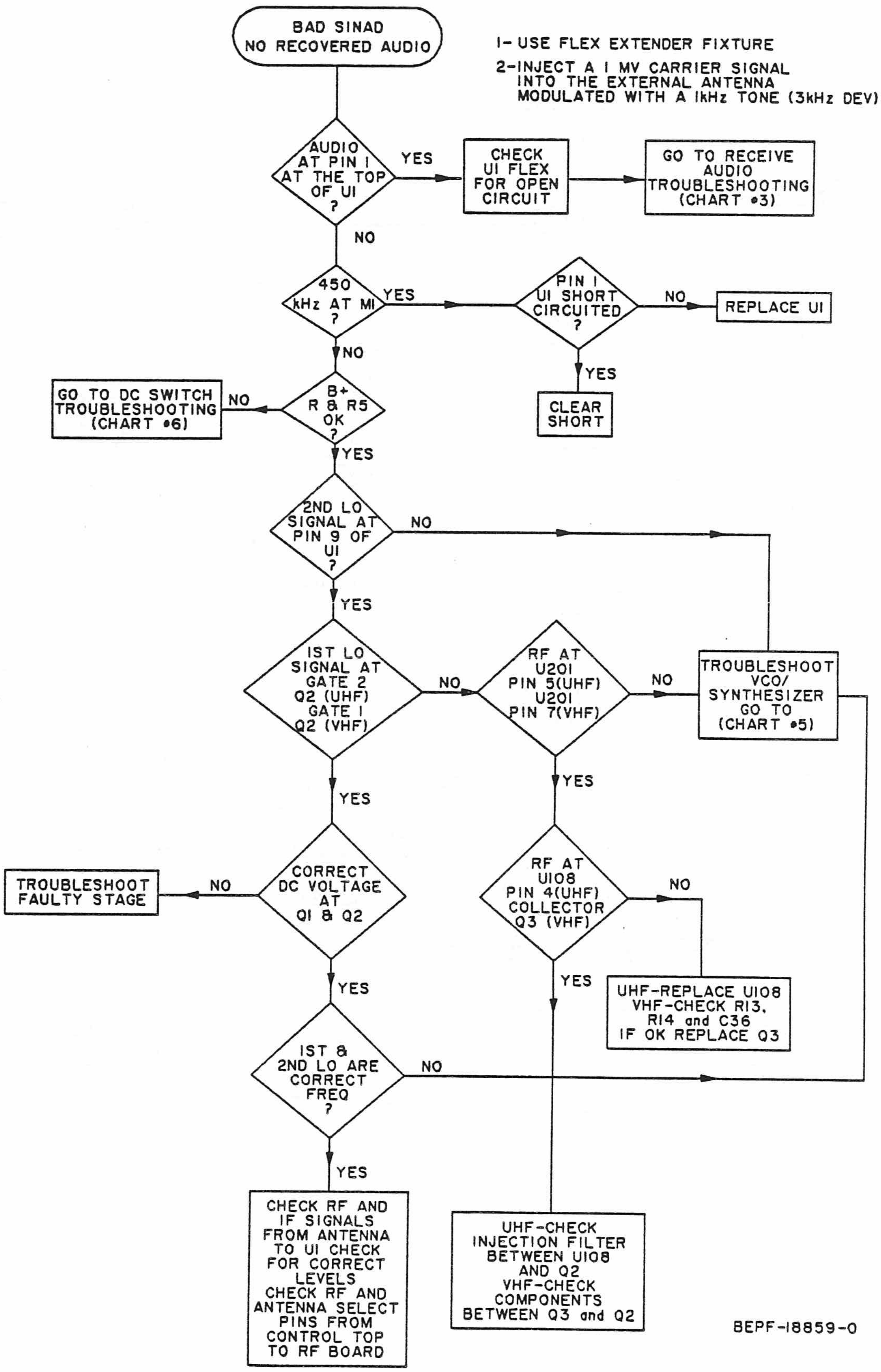


CHART #2: RECEIVER (RF)

SETUP

1. INJECT SIGNAL MODULATED WITH 1kHz TONE AT UNIVERSAL RF INPUT
2. USE FLEX EXTENDER FIXTURE SO FLEX COMPONENTS WILL BE ACCESIBLE
3. TO CHECK OUT THE EXTERNAL SPEAKER OUTPUT USE THE TEST BOX. IF NO PROBLEM IS EVIDENT DISCONNECT THE EXTERNAL SPEAKER AND USE THE RADIO'S SPEAKER

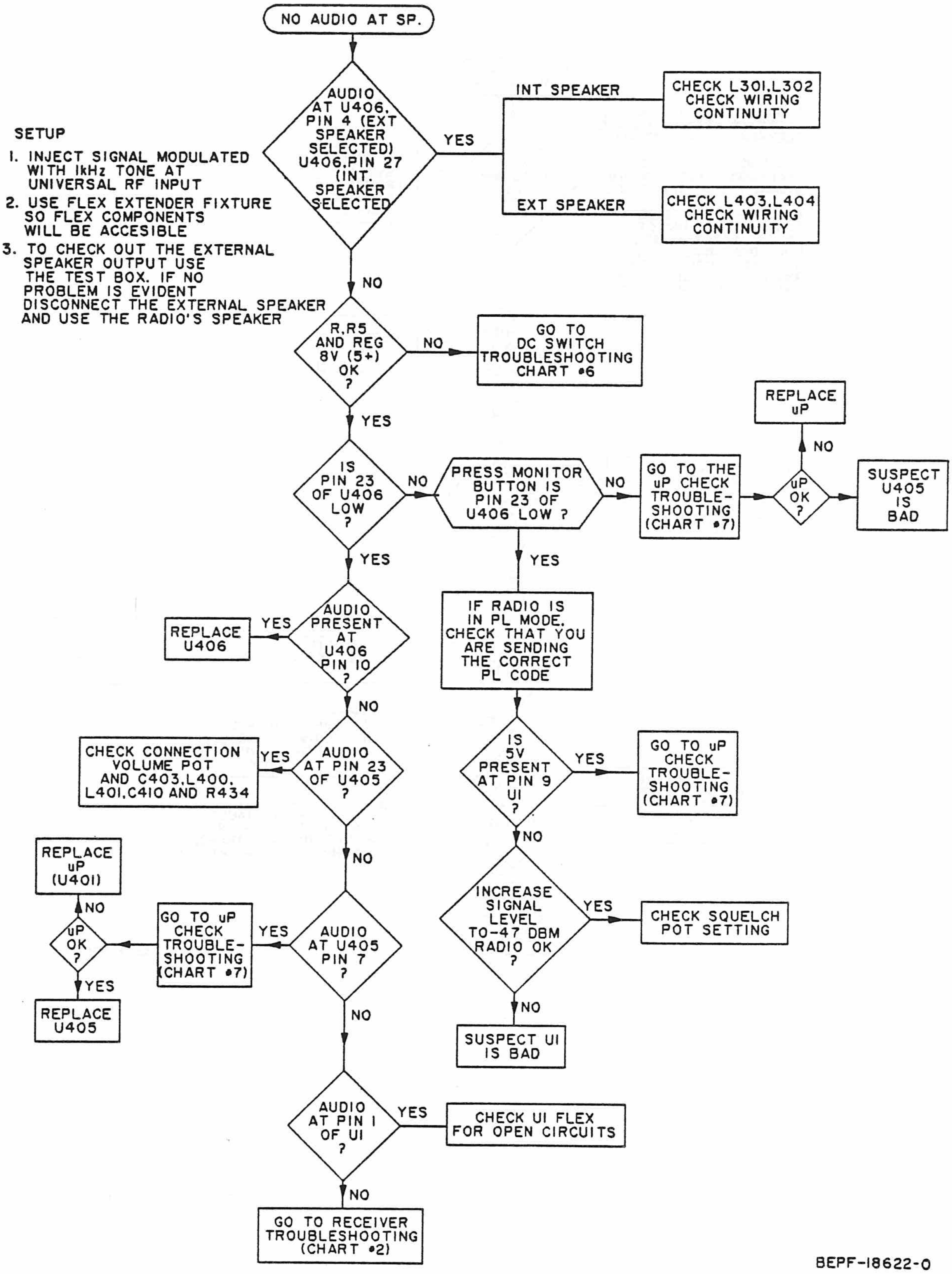


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CHART #3: RECEIVER (AUDIO)

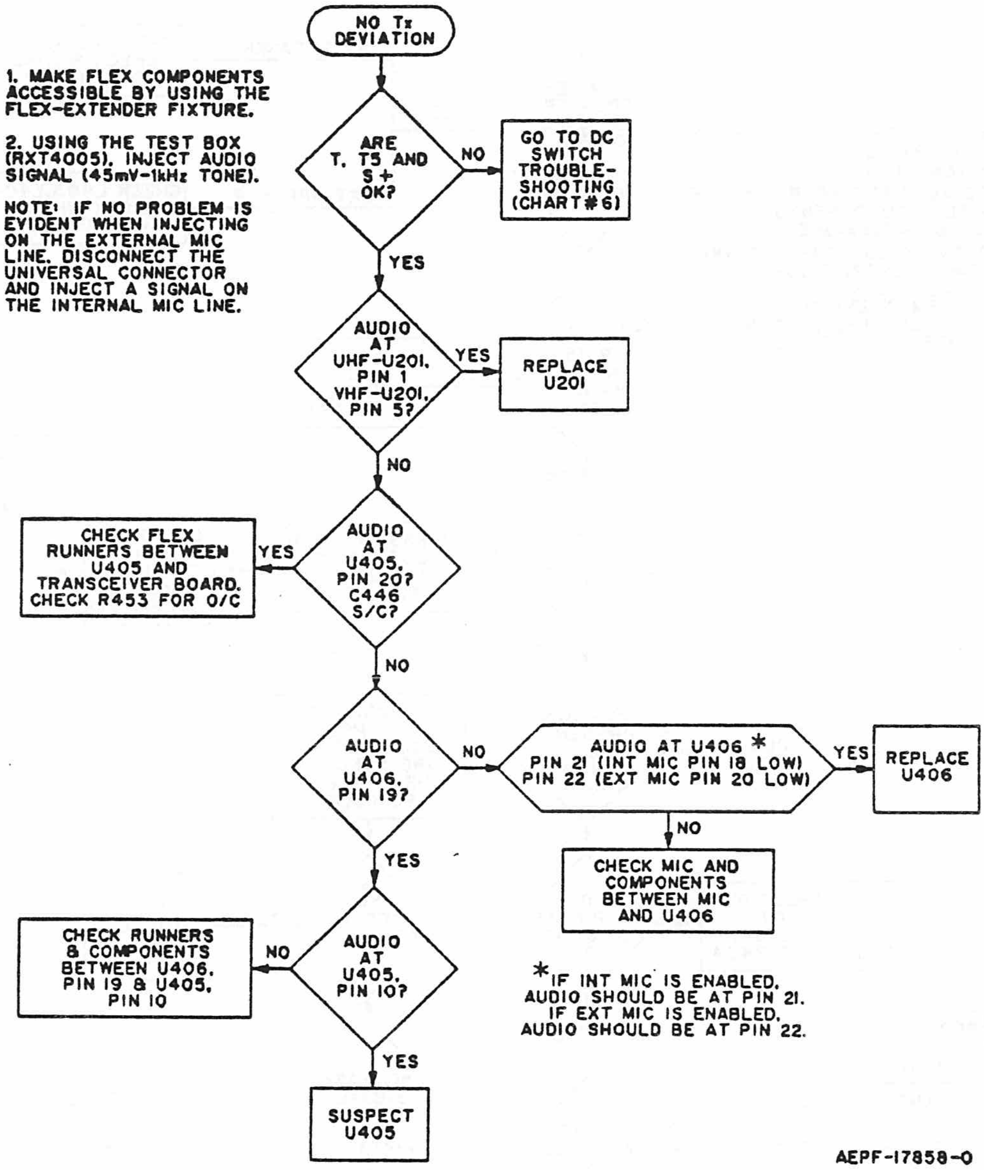


CHART #4: TRANSMIT (AUDIO)

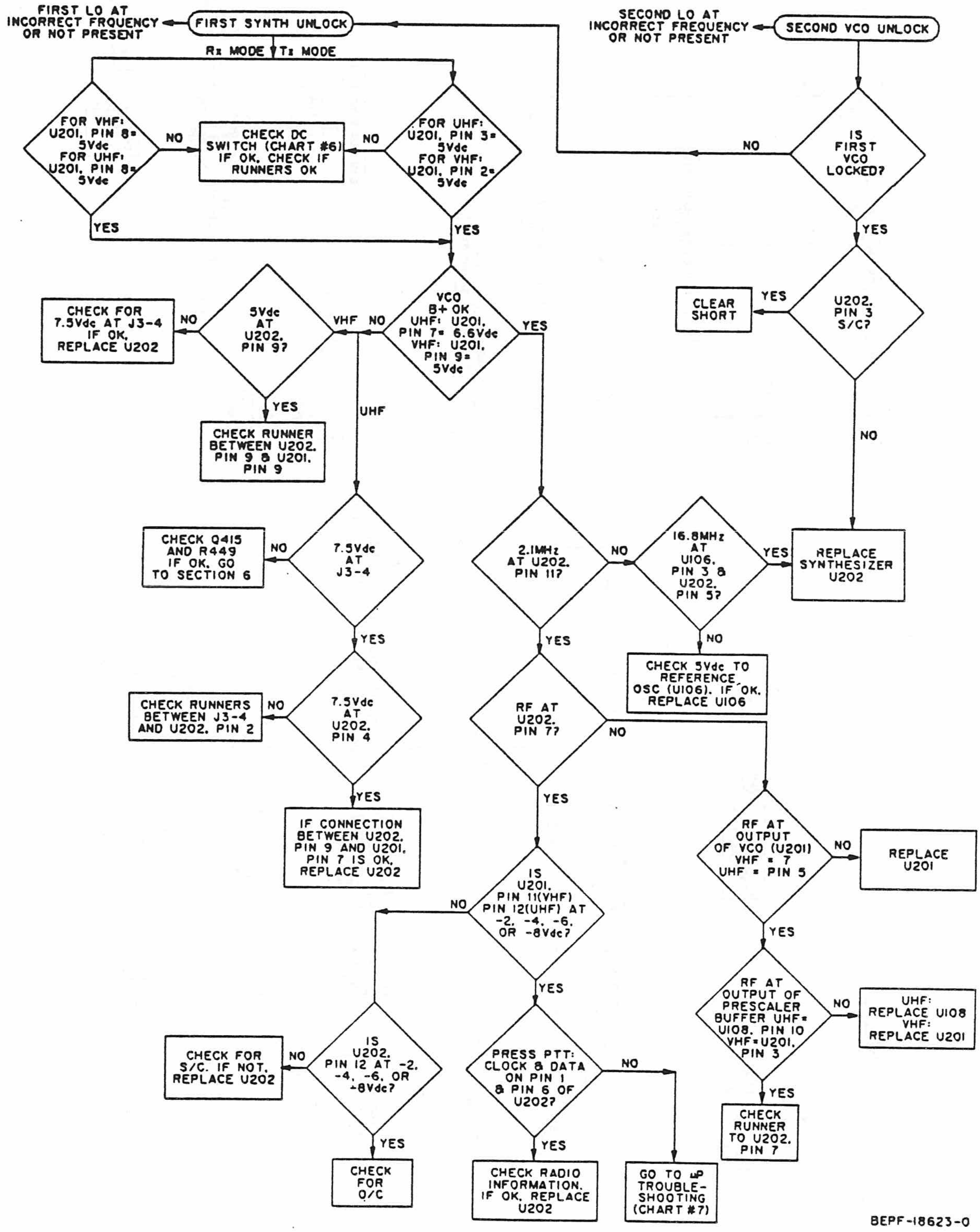


CHART #5: VCO/SYNTHESIZER

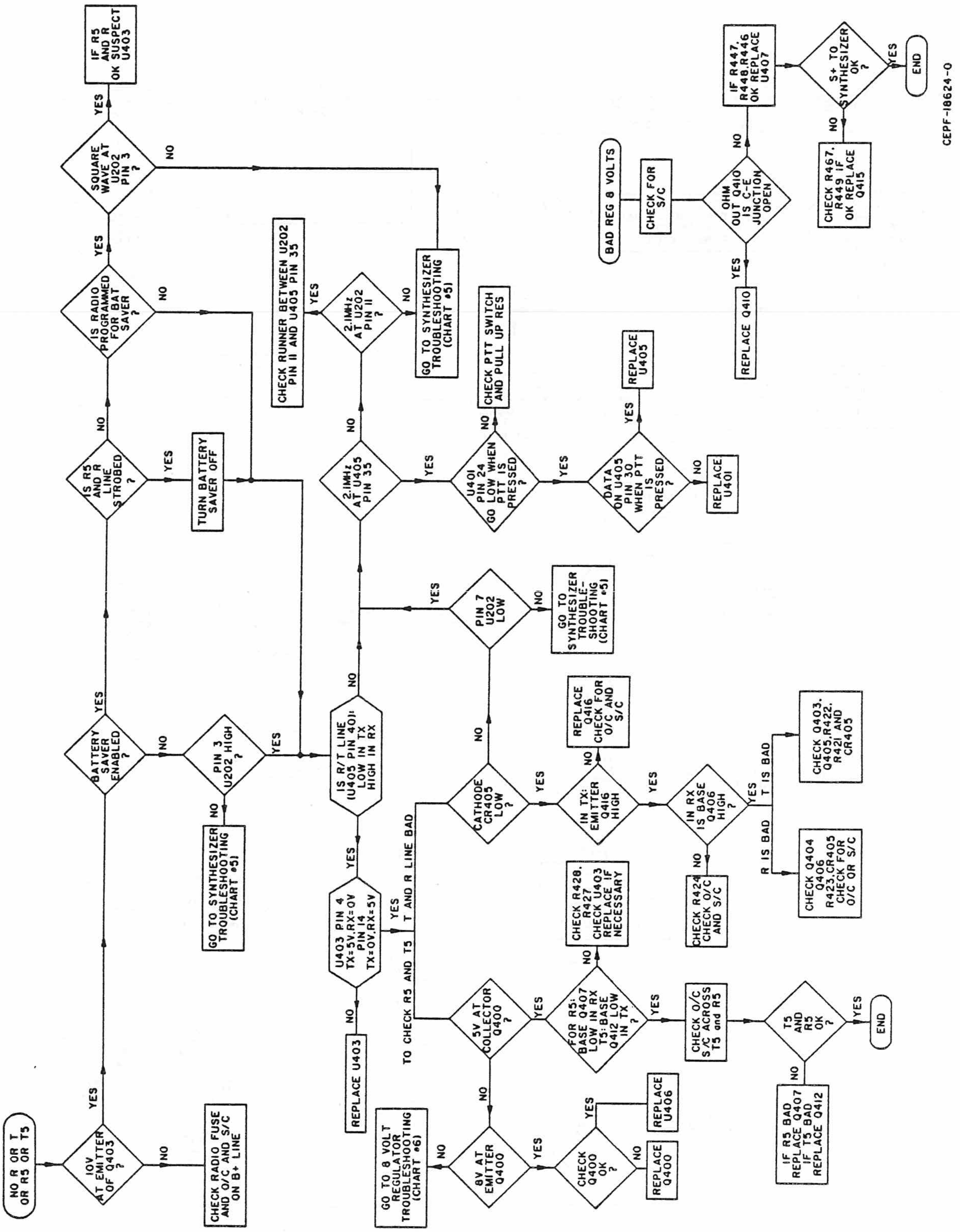


CHART #6: DC SWITCH

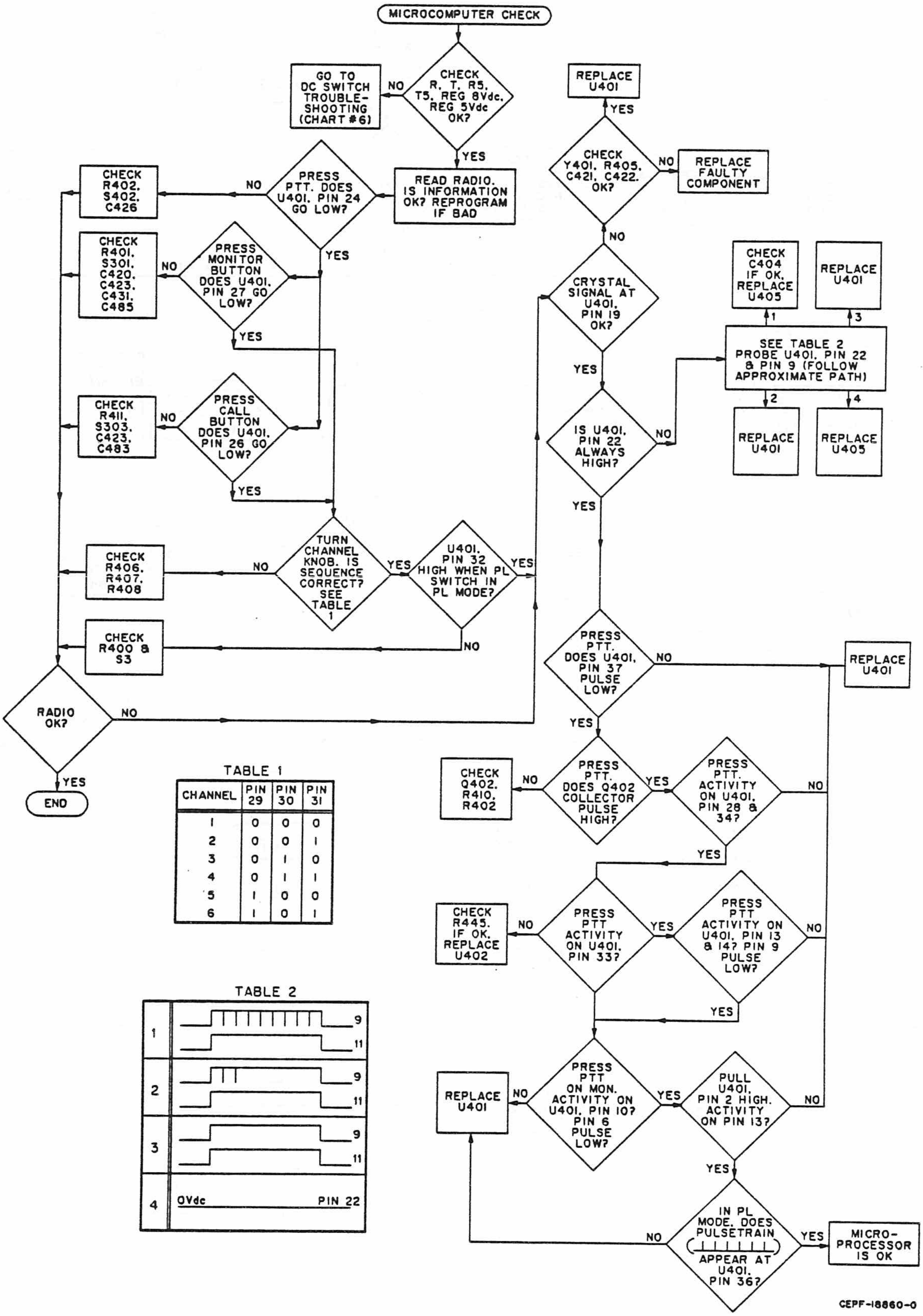


TABLE 1

CHANNEL	PIN 29	PIN 30	PIN 31
1	0	0	0
2	0	0	1
3	0	1	0
4	0	1	1
5	1	0	0
6	1	0	1

TABLE 2

CHART #7: MICROCOMPUTER

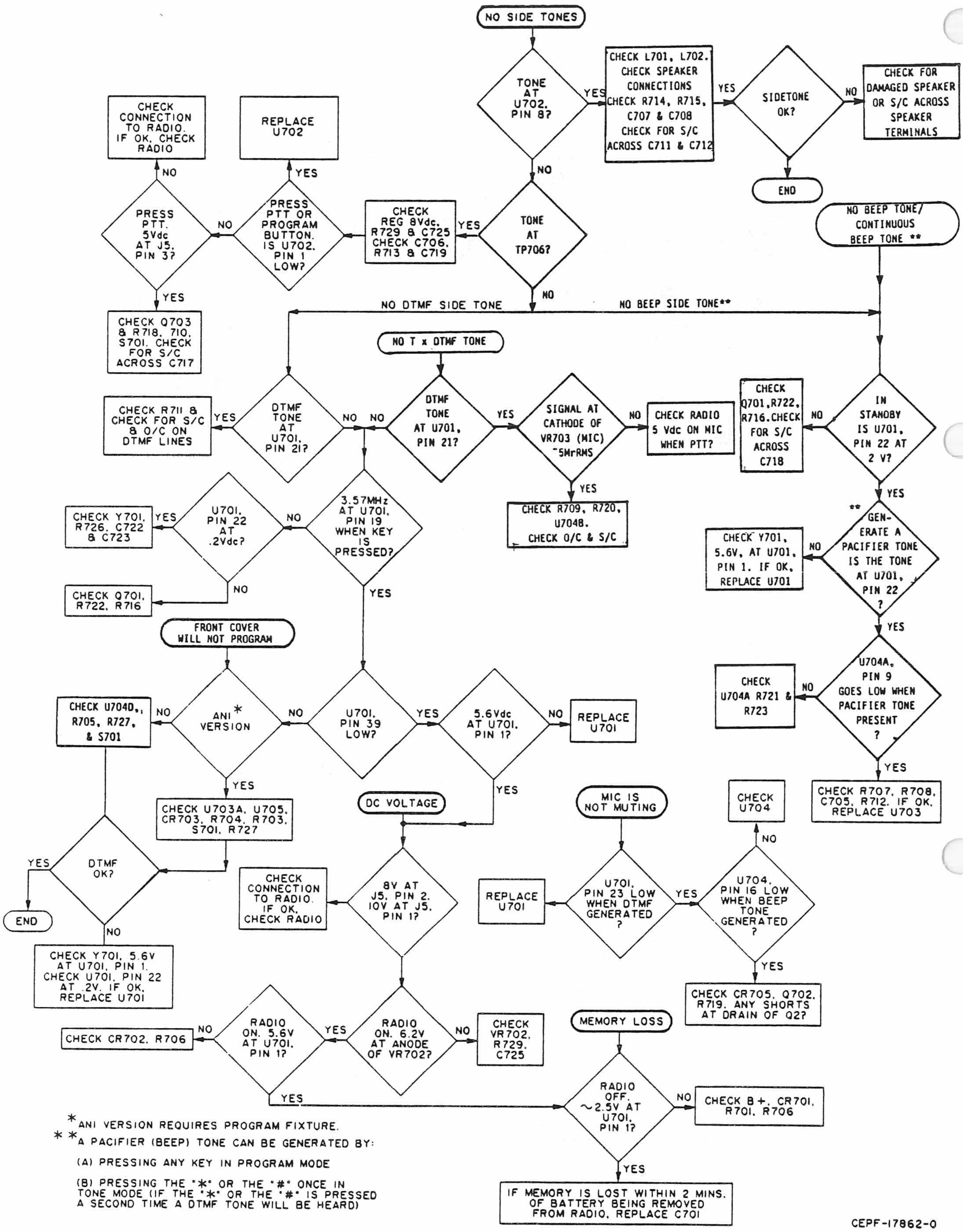

NO SIDE TONES
TONE AT U702, PIN 8?
CHECK L701, L702. CHECK SPEAKER CONNECTIONS CHECK R714, R715, C707 & C708 CHECK FOR S/C ACROSS C711 & C712
SIDETONE OK?
CHECK FOR DAMAGED SPEAKER OR S/C ACROSS SPEAKER TERMINALS
END
CHECK CONNECTION TO RADIO. IF OK, CHECK RADIO
REPLACE U702
PRESS PTT, 5Vdc AT J5, PIN 3?
PRESS PTT OR PROGRAM BUTTON. IS U702, PIN 1 LOW?
CHECK REG 8Vdc, R729 & C725 CHECK C706, R713 & C719
TONE AT TP706?
NO BEEP TONE/ CONTINUOUS BEEP TONE **
CHECK Q703 & R718, 710, S701. CHECK FOR S/C ACROSS C717
NO DTMF SIDE TONE
NO BEEP SIDE TONE**
NO T x DTMF TONE
CHECK R711 & CHECK FOR S/C & O/C ON DTMF LINES
DTMF TONE AT U701, PIN 21?
DTMF TONE AT U701, PIN 21?
SIGNAL AT CATHODE OF VR703 (MIC) ~5MrRMS
CHECK RADIO 5 Vdc ON MIC WHEN PTT?
CHECK Q701, R722, R716. CHECK FOR S/C ACROSS C718
IN STANDBY IS U701, PIN 22 AT 2 V?
CHECK Y701, R726, C722 & C723
U701, PIN 22 AT .2Vdc?
3.57MHz AT U701, PIN 19 WHEN KEY IS PRESSED?
CHECK R709, R720, U704B. CHECK O/C & S/C
CHECK Y701, 5.6V, AT U701, PIN 1. IF OK, REPLACE U701
** GEN-ERATE A PACIFIER TONE IS THE TONE AT U701, PIN 22 ?
CHECK Q701, R722, R716
FRONT COVER WILL NOT PROGRAM
CHECK U704A R721 & R723
U704A, PIN 9 GOES LOW WHEN PACIFIER TONE PRESENT ?
CHECK U704D, R705, R727, & S701
ANI* VERSION
U701, PIN 39 LOW?
5.6Vdc AT U701, PIN 1?
REPLACE U701
CHECK U703A, U705, CR703, R704, R703, S701, R727
DC VOLTAGE
MIC IS NOT MUTING
CHECK U704
CHECK R707, R708, C705, R712. IF OK, REPLACE U703
DTMF OK?
END
CHECK CONNECTION TO RADIO. IF OK, CHECK RADIO
8V AT J5, PIN 2, 10V AT J5, PIN 1?
REPLACE U701
U701, PIN 23 LOW WHEN DTMF GENERATED ?
U704, PIN 16 LOW WHEN BEEP TONE GENERATED ?
CHECK Y701, 5.6V AT U701, PIN 1. CHECK U701, PIN 22 AT .2V. IF OK, REPLACE U701
CHECK CR705, Q702, R719. ANY SHORTS AT DRAIN OF Q2?
MEMORY LOSS
CHECK CR702, R706
RADIO ON, 5.6V AT U701, PIN 1?
RADIO ON, 6.2V AT ANODE OF VR702?
CHECK VR702, R729, C725
RADIO OFF, ~2.5V AT U701, PIN 1?
CHECK B+, CR701, R701, R706
IF MEMORY IS LOST WITHIN 2 MINS. OF BATTERY BEING REMOVED FROM RADIO, REPLACE C701
YES
NO
*ANI VERSION REQUIRES PROGRAM FIXTURE.
**A PACIFIER (BEEP) TONE CAN BE GENERATED BY:
(A) PRESSING ANY KEY IN PROGRAM MODE
(B) PRESSING THE "*" OR THE "#" ONCE IN TONE MODE (IF THE "*" OR THE "#" IS PRESSED A SECOND TIME A DTMF TONE WILL BE HEARD)
CEPF-17862-0

CHART #8: DTMF

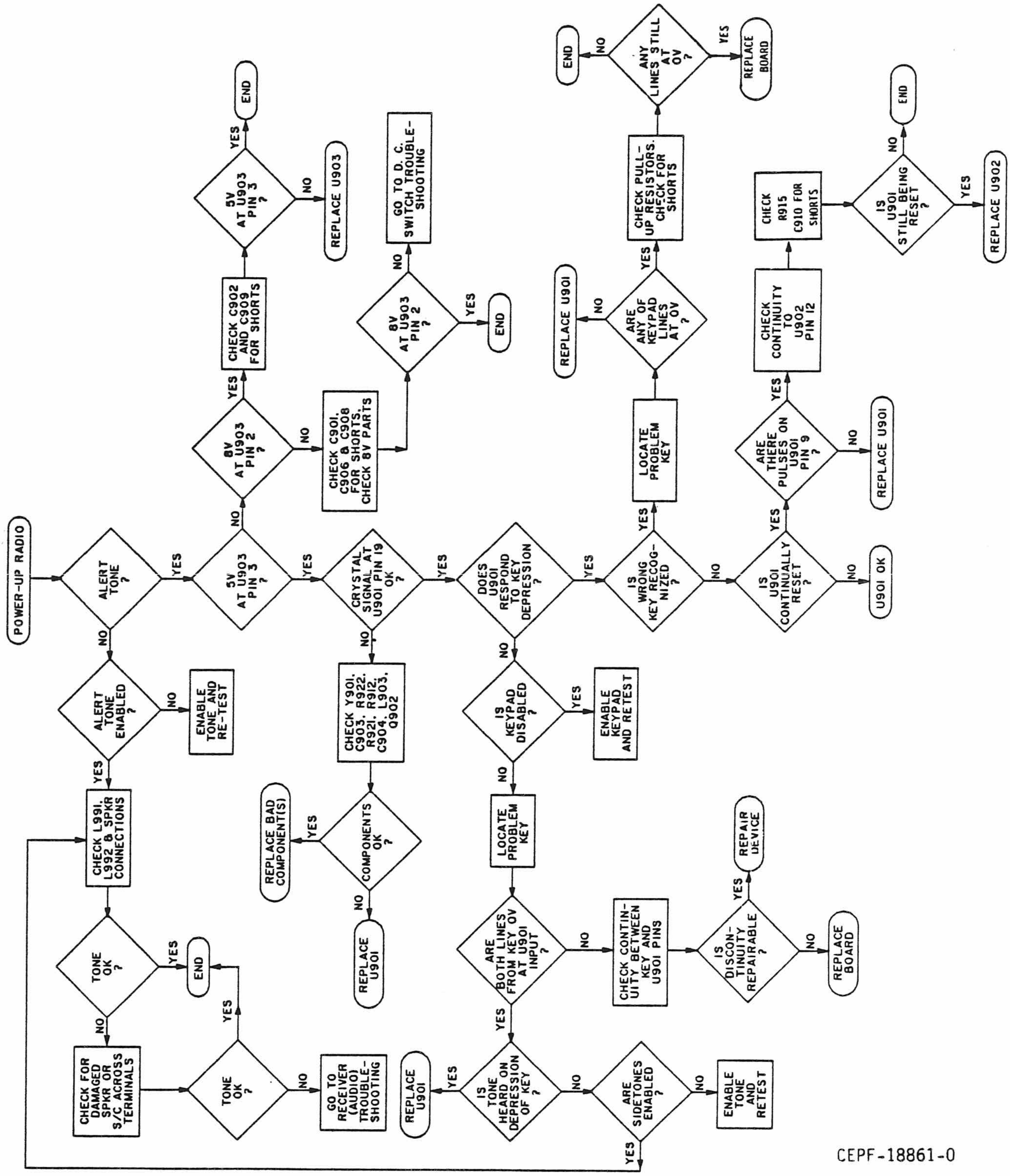


CHART #9: MULTICALL

CLONING PROCEDURE

CLONING PROCEDURES

CQP8000

2-CHANNEL & 8-CHANNEL RADIOS

(The contents of radio A is to be duplicated into radio B)

1. Connect the cloning cable (NKN6376) to the Universal Connector of both radio A and radio B.

2. Turn off radio A and turn on radio B.

3. Place the decode select switch on radio A to the carrier squelch position for full cloning, or to the coded squelch position for partial cloning. Full cloning will duplicate the entire content of radio A to radio B.

4. Simultaneously depress the PTT and either monitor button on radio A and hold.

5. Turn on radio A. The green LED on radio B will flash indicating cloning is in progress.

6. Cloning is complete once the green LED turns off and an alert tone is heard from radio B. Release both the PTT and monitor button on radio A.

16-CHANNEL RADIOS

(The contents of radio A is to be duplicated into radio B)

1. Connect the cloning cable (NKN6376) to the Universal Connector of both radio A and radio B.
2. Turn off radio A and position the channel selector switch to channel 1. Turn on radio B.

3. Place the decode select switch on radio A to the carrier squelch position for full cloning, or to the coded squelch position for partial cloning. Full cloning will duplicate the entire content of radio A to radio B.

4. Simultaneously depress the PTT and either monitor button on radio A and hold.

5. Turn on radio A. The green LED on radio B will flash indicating cloning is in progress.

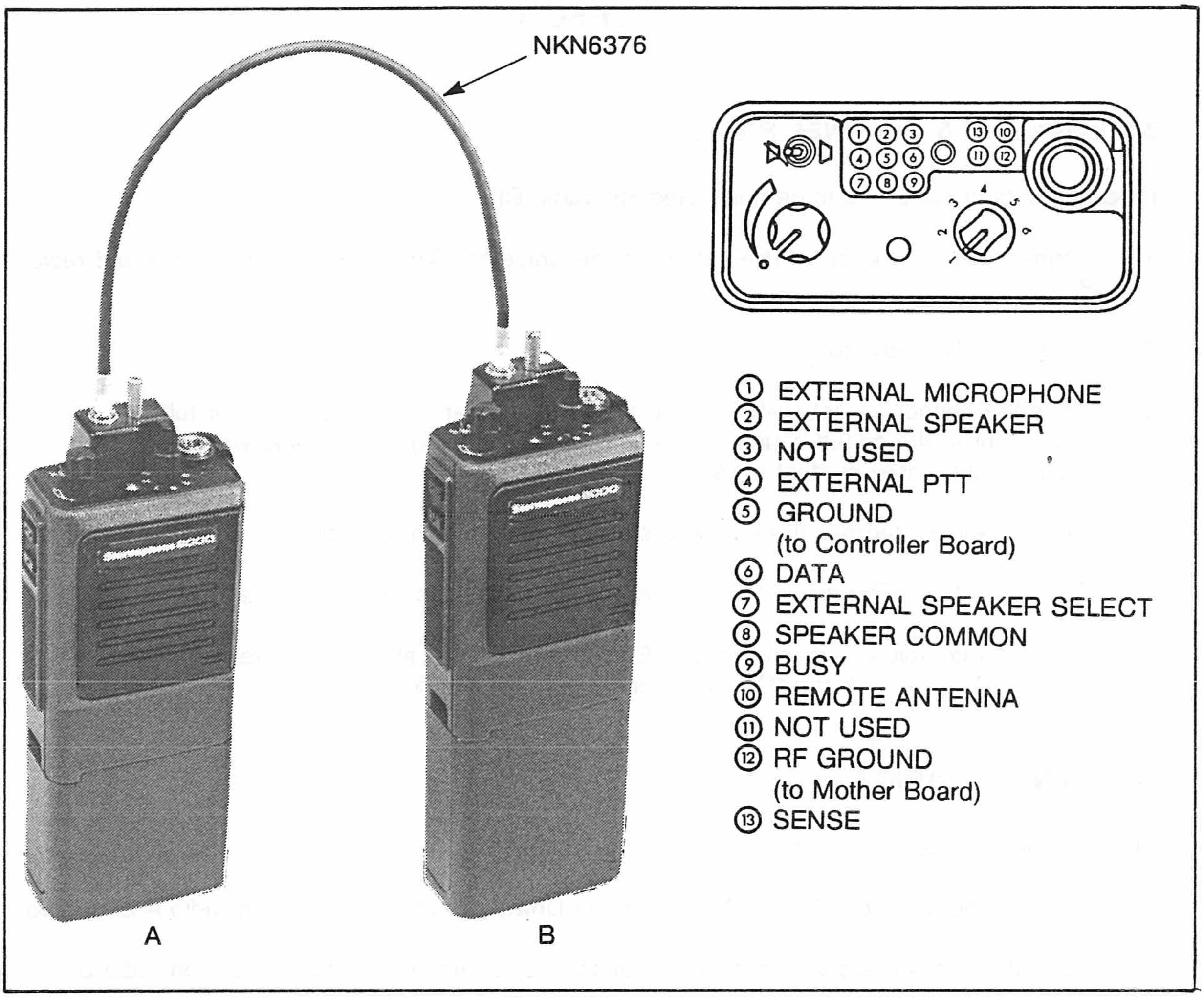
6. This step of cloning is complete once the green LED turns off and an alert tone is heard from radio B. Release both the PTT and monitor button on radio A.

7. Turn off radio A and position the channel selector to channel 16. Radio B should still be on.

8. Simultaneously depress the PTT and either monitor button on radio A and hold.

9. Turn on radio A. The green LED on radio B will flash indicating cloning is in progress.

10. The final step of cloning is complete once the green LED turns off and an alert tone is heard from radio B. Release both the PTT and monitor button on radio A.


NKN6376
A
B
① EXTERNAL MICROPHONE
② EXTERNAL SPEAKER
③ NOT USED
④ EXTERNAL PTT
⑤ GROUND
(to Controller Board)
⑥ DATA
⑦ EXTERNAL SPEAKER SELECT
⑧ SPEAKER COMMON
⑨ BUSY
⑩ REMOTE ANTENNA
⑪ NOT USED
⑫ RF GROUND
(to Mother Board)
⑬ SENSE

M405.487

CQP8000

THEORY OF OPERATION

1. INTRODUCTION

This section of the manual provides a functional description of the radio. First, overall basic functions are discussed in general terms with each circuit and its relationship to other parts of the radio described. Then, detailed circuit descriptions are given for each board, circuit, and module used in the radio.

2. BASIC FUNCTIONAL DESCRIPTION

a. DC Voltage Distribution *(See Figure 1.)*

Operating power for the radio is derived from a 10-volt battery. This 10 volts (BATT B+), via the PTT/B+Flex, the Frequency Switch Flex, and the Volume Pot Flex, is applied to the ON/OFF switch. When the radio is turned on, the voltage sources required to operate the various stages of the radio are distributed as shown in Figure 4. In the transmit mode (PTT actuated) a logic low on the R/T line enables the DC switch to provide the required 5 Vdc and 10 Vdc to the transmitter circuits.

b. Frequency Generation and Distribution Circuits *(See Figure 2)*

The frequency generation and distribution circuits in the radio are common to both transmitter and receiver. They consist of two phase-locked loops (PLLs). One PLL provides the carrier frequency for the transmitter and the injection signal for the receiver first mixer stage. The other PLL generates the second local oscillator (LO) signal. Audio is modulated on the carrier in two different places (two-spot modulation); the VCO's frequency response allows it to modulate audio above 60 Hz, the reference modulator modulates audio below 60 Hz.

The frequency generation circuits include a reference oscillator (U106), a synthesizer (U202), and a VCO (U201). The reference oscillator generates a 16.8 MHz reference signal for the synthesizer. An external adjustment is provided to set the frequency at the output of the reference oscillator.

The following is a functional description of the transmitter first injection PLL. Initially, the VCO becomes active and generates a signal, part of which is coupled back to the synthesizer as a feedback signal. The synthesizer divides this signal and compares it to a reference frequency. If the frequencies differ, the synthesizer generates a control (error) voltage which causes the VCO to change frequency. When the VCO reaches the correct frequency, the synthesizer generates a constant control voltage signal, locking the VCO on frequency. In the transmit mode, voice audio is applied to a varactor on the VCO. The capacitance of the varactor changes in proportion to the instantaneous audio voltage, which results in a shift in carrier frequency at an audio rate. Audio below 60 Hz is modulated onto the synthesizer reference signal, which in turn causes a similar shift in the carrier frequency.

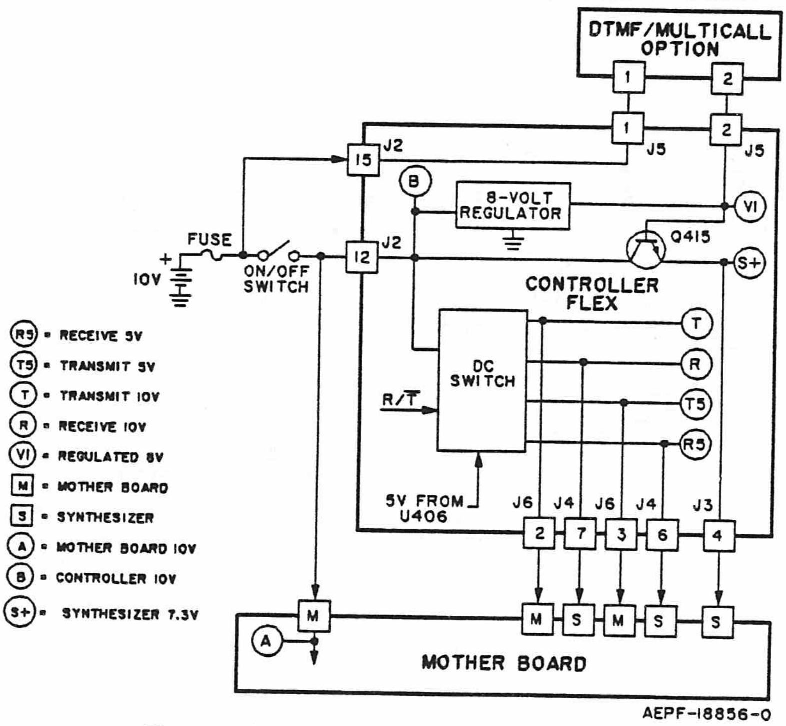


Figure 1. DC Voltage Distribution Block Diagram

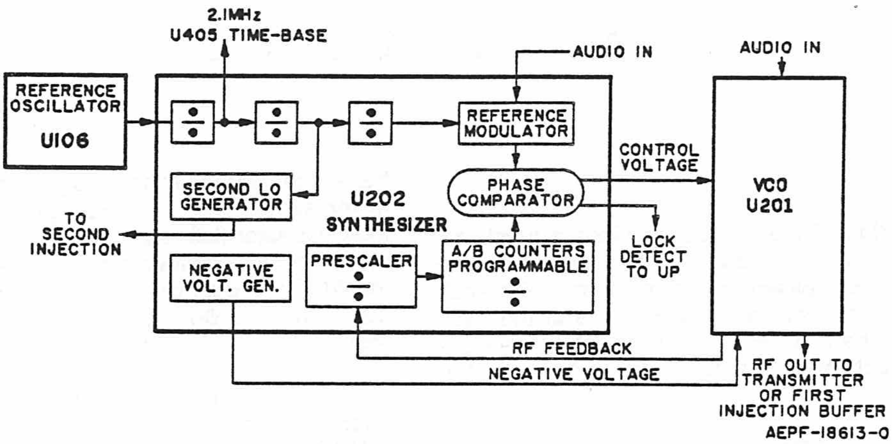


Figure 2. Frequency Generation Circuits

c. Basic Controller Functions

Module U401 is a single-chip microcomputer and is the heart of the controller. It works in conjunction with the code plug (U402), which stores radio information data. The controller's functions are as follows:

- Read the PTT and channel selector switches, and program the synthesizer for the desired operating frequency using the information stored in the code plug.
- Set the audio output levels for the VCO and synthesizer.
- Control the DC switch.
- Unsquelch the receiver's audio PA when a carrier is present, a correct PL tone or SELECT 5 sequence is decoded, or when an alert tone is generated or the monitor button is pressed.
- Monitor the internal and external PTT.
- Encode a PL tone or SELECT 5 sequence.
- Control the Receive/Transmit LED.
- Monitor battery voltage.
- Perform a self test during power-up.

d. Antenna Switch

The antenna switch consists of modules U103 and U104 on VHF models and U105 on UHF models. Through the use of pin diodes, the antenna switch directs incoming rf from either the standard or remote antenna to the receiver circuitry and outgoing rf from the transmitter to the remote or standard antenna.

e. Basic Receiver Operation *(See Figure 3)*

The radio uses double-conversion super-heterodyne receiver circuits to provide greater image-signal suppression and improved adjacent channel selectivity. The receiver consists of three main sections:

- radio frequency (rf) circuits
- intermediate frequency (i-f) circuits
- audio frequency (af) circuits

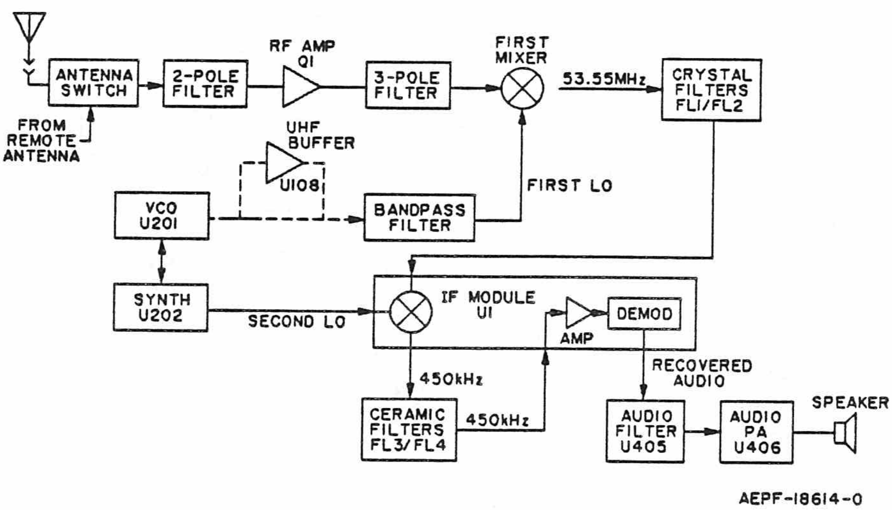


Figure 3. Receiver Block Diagram

(1) RF Signal Path

The rf signal is received by the antenna and coupled to a two-pole bandpass filter through the antenna switch. The output of the two-pole filter is amplified by an rf amplifier (Q1). The output of the amplifier is then coupled through a three-pole bandpass filter, and applied to the rf input of the first mixer stage (Q2). An injection signal (FIRST LO) is applied to the second input of the mixer, resulting in an output difference frequency of 53.55 MHz, which is the first i-f frequency.

(2) I-F Signal Path

The first i-f signal is passed through highly selective crystal filters (FL1 and FL2) to circuit module U1, where it is mixed with a second oscillator injection signal (SECOND LO) to produce the second i-f frequency of 450 kHz. The low conversion signal is then filtered via highly selective ceramic filters (FL3 and FL4), amplified, and demodulated. The resultant signal (RECOVERED AUDIO) is sent to the audio filter (U405) on the controller flex. Module U1 also contains a squelch detect circuit.

(3) Audio Signal Path

Recovered audio from U1 is received by the audio filter IC (U405). The audio filter performs basically two functions in the receive mode. It filters, de-emphasizes, and attenuates the voice audio, and routes the signal to the volume control. Secondly, if the radio is receiving a coded signal, U405 low-pass filters the audio and seperates the subaudible PL tones. The tones are filtered, sampled and then sent to the microcomputer for decoding.

After passing through the volume control, the audio is sent to audio PA IC (U406). Integrated circuit U406 amplifies the audio and drives the speaker. The audio amplifier consists of three separate amplifiers; an internal speaker amplifier, an external speaker amplifier, and a common amplifier. If the internal speaker is selected it is differentially driven by the internal and common amplifiers. If the external speaker is selected it is driven by the external and common amplifiers.

Squelch circuitry resides in the i-f module (U1). Discriminator noise from U1 is sent to U405, where the noise is passed through a programmable attenuator (squelch control) and sent back to U1. The squelch circuits in U1 detect demodulator signal-to-noise ratio and produce a dc logic output (5 volts when carrier is present). This output is read by the microcomputer, which in turn programs the audio filter (U405) to enable the audio power amplifiers on U406.

f. Basic Transmitter Operation *(See Figure 4)*

The transmitter (excluding the frequency generation and distribution circuits described in earlier paragraphs) comprises two main circuits:

- Audio circuitry
- RF power amplifiers

(1) Audio Signal Path

When the PTT switch is pressed, audio from the microphone is fed to the input of the mic amplifier in U406. The amplified audio is then sent to an audio filter IC (U405). Integrated circuit U405 pre-emphasizes, limits, and low-pass filters the audio. IC U405 also generates squelch codes, which are summed with the voice audio. The audio is then passed through programmable attenuators and sent to the reference modulator and VCO to be modulated.

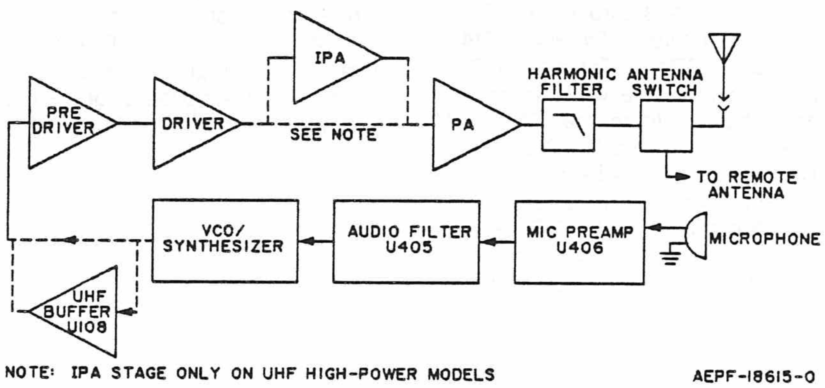


Figure 4. Transmitter Block Diagram

(2) UHF Medium Power Modulated RF Signal Path

The modulated rf carrier from the VCO / synthesizer is applied through a transmit buffer stage to three consecutive stages of amplification: pre-driver, driver, and rf power amplifier. Low power UHF radios output 2 Watts of rf power.

(3) UHF High Power Modulated RF Signal Path

High power UHF radios output 4 Watts of rf power. This is accomplished through four consecutive stages of amplification: pre-driver, driver, intermediate power amplifier (IPA), and final rf power amplifier.

(4) VHF Modulated RF Signal Path

VHF radios are available in low and high power models. In both models, the modulated rf carrier is applied directly from the VCO / synthesizer to three consecutive stages of amplification: pre-driver, driver, and final rf power amplifier. The difference in power output between low and high power radios is achieved using different final rf power transistors.

3. DETAILED CIRCUIT DESCRIPTION

The circuit descriptions contained in the following paragraphs are supplemented with simplified schematic diagrams to help the service technician understand the signal processing in various parts of the radio. They are not intended for troubleshooting or servicing. Refer to the complete schematic diagram in the service manual when repairing a radio. **When signal tracing on the schematic diagram, pay particular attention to the circles and squares around the module's pin numbers. Circles denote connections to the controller flex; squares denote connections to the main circuit board.**

a. DC Switch

The dc switch controls voltages being applied to the receiver and transmitter circuits. These voltages are R (10V) and R5 (5V) for receive, and T (10V) and T5 (5V) for transmit. The DC switch consists of module U403, transistors Q403 thru Q407, Q412, Q413, Q416, resistors R421 thru R424, R427, R428, and diodes CR403 through CR407. Transistors Q403 and Q405 drive the T voltage line while transistors Q404 and Q406 drive the R voltage line. R5 and T5 voltages are provided via transistors Q407 and Q412 respectively. The DC switch receives its supplies from fused 10V, B, and the five-volt regulator (Q400 collector). Module U403 responds to the R/T line from U405 pin 40, which is controlled by the micro-computer. In transmit the R/T line is low (0 volts) and in receive the R/T line is high (5 volts).

The microcomputer monitors the LOCK DETECT line from the synthesizer (U202 pin 7). When the LOCK DETECT line is low, indicating a frequency lock condition, the microcomputer signals U405, via the microprocessor interface, to switch the output at U405 pin 39 low. This low is applied to diode CR405, which supplies a ground path for the emitters of transistors Q405 and Q406. These emitters must have this ground path so that the R/T line can forward bias Q405 or Q406, activating the T or the R line, respectively.

In transmit (synthesizer locked), the R/T line is at 0 volts. The R/T low is fed to the input of an inverter on U403. The output of the inverter turns on transistors Q416, Q405, and Q403 to activate the T voltage line (Q403 collector). The R/T low is also fed to the base of transistor Q412, which turns on Q412 and activates the T5 voltage line (Q412 collector).

In receive (synthesizer locked, Battery Saver - off, U202 pin 3 high), the R/T line is at 5 volts. The R/T high is fed to the input of U403 where it is NANDed with the high on the BATTERY SAVER line (U403 pins 8 and 7 respectively). The resulting low at the NAND gate output forward biases transistor Q407, which activates the R5 voltage line (Q407 collector). Also, the low output from the NAND gate is inverted and the high output at U403 pin 14 turns on Q406 and Q404 to activate the R voltage line (Q404 collector). When the R voltage line is activated, Q413 is forward biased, which supplies drive voltage for the green LED (CR301A).

If the battery saver option is programmed into the radio, the microcomputer programs the synthesizer to strobe the R and R5 lines via the BATTERY SAVER line. The battery saver signal is a square wave which is NANDed with the 5 volts on the R/T line. The strobing of the receive voltages reduces current drain when the radio is in the stand-by condition.

Another part of the dc switch circuit is an 8-volt regulator. The 8-volt regulator consists of module U407, transistor Q410, and resistors R447, R448, and R446. Module U407 is a five-volt regulator which is offset to 8 volts by R447 and R448. Transistor Q410 is a pass transistor which increases the regulators current sourcing ability. The 8 volts is applied to the audio PA (U406 pin 9) and also applied to the base of Q415, which supplies approximately 6.6V S+ to the synthesizer at U202 pin 4.

b. Frequency Generation and Distribution
(See Figures 5 and 6)

(1) The VCO (VHF Radios - Figure 5)

The VCO (U201), in conjunction with the synthesizer (U202) and the reference oscillator (U106), generates rf in both modes of operation (receive and transmit). The VCO RF OUT signal is produced at U201 pin 7. A sample of the rf signal is routed from U201 pin 3 as a buffered feedback to a prescaler circuit in the synthesizer (U202). After frequency comparison in the synthesizer, a resultant control voltage from U202 pin 14 is received at U201 pin 12. This voltage is between 0 and 5 volts when the PLL is locked on frequency. At the same time, a negative voltage from the synthesizer is applied to U201 pin 11. This negative voltage is either -2, -4, -6, or -8 volts. The negative voltage and control voltage are applied at opposing ends of a varactor diode, which tunes the VCO to the correct frequency.

Five volts at U201 pin 8 places the VCO in the receive mode. During the receive condition, the VCO produces the first LO injection signal at U201 pin 7. The signal is routed to the first mixer (Q2), via a transistor buffer stage (Q3).

During the transmit condition, PTT depressed, the five volts at U201 pin 8 is removed and five volts is applied to U201 pin 2. This places the VCO in the transmit mode. During the transmit condition, the VCO generates the carrier signal, and routes it from U201 pin 7 to the pre-driver (Q102), via a transistor buffer stage (Q101). Also in the transmit mode, the audio signal to be modulated onto the carrier is received by a varactor in the VCO module at U201 pin 5.

(2) The VCO (UHF Radios - Figure 6)

The VCO (U201), in conjunction with the synthesizer (U202) and the reference oscillator (U106), generates rf in both modes of operation (receive and transmit). The VCO rf output, produced at U201 pin 5, is routed to the VCO buffer (U108). A sample of the rf signal is routed from U108 pin 10 (PRE-SCALER RF OUT) as a buffered feedback to a prescaler circuit in the synthesizer (U202). After frequency comparison in the synthesizer, a resultant control voltage from U202 pin 14 is received at U201 pin 13. This voltage is between 0 and 5 volts when the PLL is locked on frequency. At the same time, a negative voltage from the synthesizer is applied to U201 pin 12. This negative voltage is either -2, -4, -6, or -8 volts. The negative voltage and control voltage are applied at opposing ends of a varactor diode, which tunes the VCO to the correct frequency.

In the receive mode, five volts (R5) is applied to U201 pin 8 and U108 pin 3, which places the VCO in the receive mode and enables a receive injection buffer in U108. The rf signal (first LO injection) at U201 pin 5 is received at U108 pin 6 (VCO IN). The buffer stage in U108 routes this signal (RF INJECTION OUT), via U108 pin 4, to the first mixer (Q2).

During the transmit condition (PTT depressed), the five volts at U201 pin 8 and U108 pin 3 is removed. Five volts is applied to U201 pin 3 and U108 pin 9, which places the VCO in the transmit mode and enables a transmit buffer in U108. During the transmit condition, the VCO generates the carrier signal, and routes it from U201 pin 5 to U108 pin 6 (VCO IN). The buffer stage in U108 routes this signal (Tx RF OUT), via U108 pin 8, coil L101, capacitor C105 , and coil L116, to the pre-driver Q102. Also in the transmit mode, the audio signal to be modulated onto the carrier is received by a varactor in the VCO module at U201 pin 1.

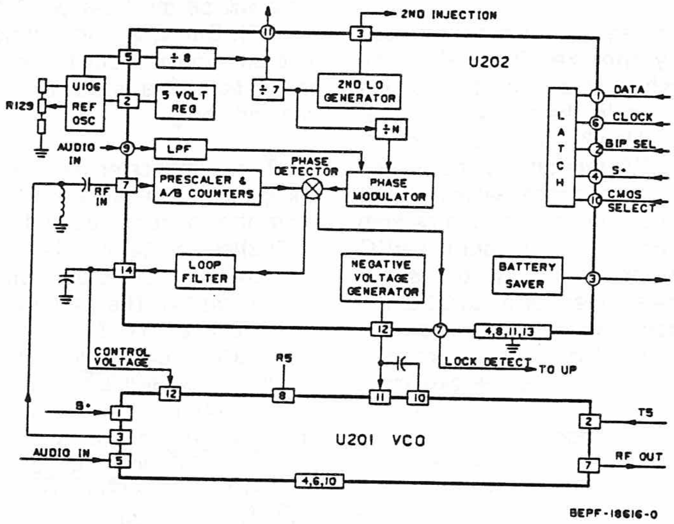


Figure 5. VCO / Synthesizer Block Diagram, VHF

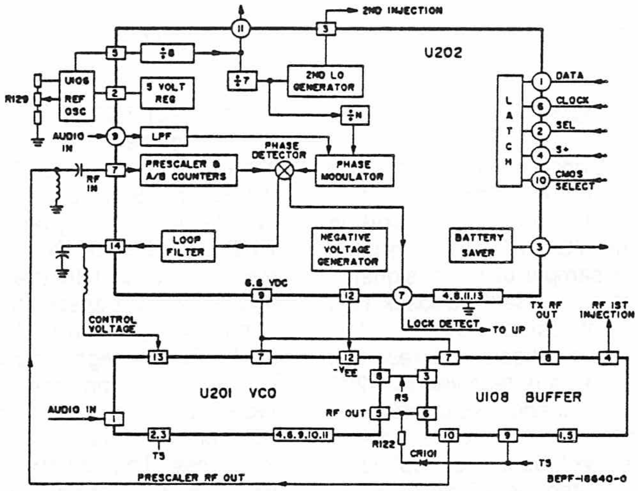


Figure 6. VCO / Synthesizer Block Diagram, UHF

(3) The Synthesizer

The microcomputer (U401) reads the code plug (U402) and sends set-up signals, which are received by the synthesizer (U202) latch circuit. These set-up signals determine the correct negative voltage and the A/B counter divide ratios needed to generate the proper rf frequencies. The reference frequency for the synthesizer / VCO phase-locked loop is provided by a 16.8 MHz crystal oscillator (U106), which is fine-tuned by resistor R129. The 16.8 MHz crystal oscillator frequency is divided, first to 2.1 MHz and then to 300 KHz. The 300 KHz signal is used for two different applications in the synthesizer.

First, the 300KHz reference frequency is applied to an internal phase-locked loop circuit (within the synthesizer), which generates the receiver's second LO injection signal. The second LO injection frequency of 53.1 MHz (for low-side injection) or 54.0 MHz (for high-side injection) is routed from U202 pin 3 to the second mixer stage in I-F module U1.

Secondly, the 300 KHz frequency is further divided to produce a VCO / synthesizer PLL reference frequency of 5.0 KHz, which is applied to a phase modulator. In the transmit mode, the phase modulator modulates audio below 60 Hz (PL tones, U202 pin 9) onto this reference signal. The reference signal is then fed, as one of two inputs, to a phase detector. The second input signal to the phase detector comes from the VCO (U201 pin 3, VHF radios) or from the VCO buffer (U108 pin 10 UHF radios). This second signal (RF IN) is received by the synthesizer at U202 pin 7, divided by a prescaler circuit, divided again by an A/B counter circuit, and then applied to the phase detector. The phase detector circuit compares the two input signals. If the frequencies are not the same, a CONTROL VOLTAGE (error voltage) is generated and sent to the VCO, ultimately pulling the PLL on frequency. When the two frequencies are the same, the phase detector outputs a low on the lock detect line. This lock detect low is routed to the microcomputer, which in turn sets up radio transmit and receive voltages. Refer to the "DC SWITCH" section for a more detailed explanation.

c. Controller *(See Figure 7)*

Module U401 is a single chip, 8-bit microcomputer which performs control and processing functions. It works in conjunction with the code plug which stores the radio personality in its non-volatile memory. The microcomputer controls three data buses; the code plug bus, the synthesizer module/audio filter IC bus, and the radio programming bus.

The code plug data bus is bi-directional, meaning that data can be sent to or received from the code plug. When the microcomputer wants to access the code plug it will pull $\overline{\text{CODE PLUG POWER}}$ (U401, pin 39) low, turning on the supply to the code plug through Q402. The microcomputer will then transmit the address of the data to the code plug on the data bus by toggling CODE PLUG CLOCK (U401, pin 34). The data will be available on CODE PLUG DATA (U401, pin 35). During a read instruction, data is input to the microcomputer from the code plug. During a write instruction, data is output from the microcomputer to the code plug.

The synthesizer module/audio filter IC programming bus is uni-directional, meaning that data is sent from the microcomputer to the synthesizer module (U202)/audio filter IC (U405). The bus is synchronous and the flow of data is controlled by SPI CLOCK (U401, pin 14). The data appears on SPI DATA (U401, pins 10 and 11). The synthesizer module has two separate programming latch circuits which are controlled by $\overline{\text{BIPOLAR SEL}}$ (U401, pin 8) and $\overline{\text{CMOS SEL}}$ (U401, pin 7). When programming the synthesizer module, the microcomputer first pulls $\overline{\text{BIPOLAR SEL}}$ low and sends data using SPI CLOCK and SPI DATA. $\overline{\text{BIPOLAR SEL}}$ is then pulled high and $\overline{\text{CMOS SEL}}$ is pulled low. The microcomputer again sends data using SPI CLOCK and SPI DATA.

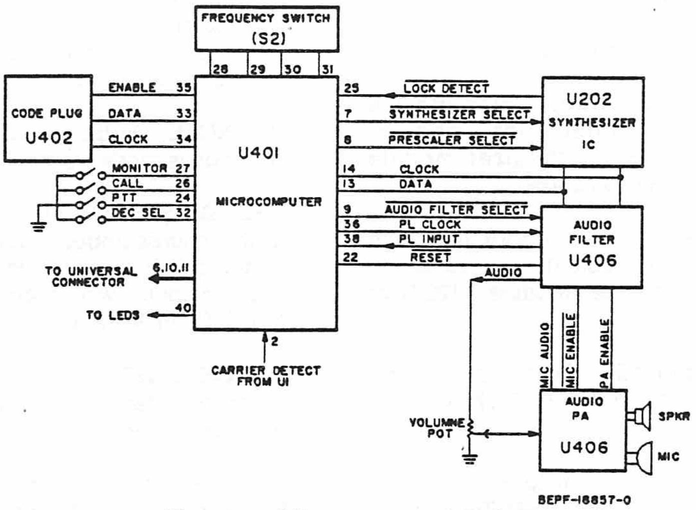


Figure 7. Microcomputer Interface

When the data transfer is complete, CMOS SEL is pulled high. The synthesizer module is now programmed for the new operating frequency. To program the audio filter IC, AF SELECT (U401, pin 9) is pulled low. The data is transfered using SPI CLOCK and SPI DATA. When the data transfer is complete AF SELECT goes high.

The radio programming bus is bi-directional, meaning that data can be sent to or received from the microcomputer. The bus is asynchronous and data is sent or received on SCI DATA (U401, pins 10 and 11). The flow of data is controlled by BUSY (U401, pin 6). A low on the BUSY line indicates that a message exists on the DATA line.

(1) Microcomputer (U401) functions

- Read the PTT and channel selector status, and program the synthesizer module (U202) for the desired operating frequency using the data stored in the code plug.
- Program the audio filter IC (U405) to set the audio output levels to the speaker and VCO module (U201) and synthesizer module (U202).
- Control the dc switch circuits which supply B+ and other voltages to the receiver and transmitter at various times. It does this by signalling the audio filter IC (U405) to set the R/T line (U405, pin 40) and the dc switch enable line at U405, pin 39.
- Program the audio filter IC (U405) to unsquelch the radio when a carrier is detected, when a squelch code is detected, when an alert tone is to be generated, or when the monitor button is pressed.
- Control the flashing of the LED by turning transistor Q401 on and off.

(2) Microcomputer (U401) input/output pin functions

- **Vss** (pin 1) - Ground for the microcomputer.
- **CARRIER DETECT** (pin 2) - This input to the microcomputer goes high when a carrier is present. It is used to determine if the radio should be un squelched.
- **SELECT 5 ENCODE** (pins 3, 4) - These output lines from the microcomputer encode single tone or SELECT 5 sequences in the form of a tri-state digital waveform.
- **SELECT 5 DECODE** (pin 5) - This input to the microcomputer is a filtered and limited signal from the demodulator used by the microcomputer to decode a SELECT 5 sequence.
- **BUSY** (pin 6) - This line is bi-directional and is used to indicate the presence of data on the programming bus.
- **CMOS SEL** (pin 7) - This output from the microcomputer is used when programming the synthesizer module (U202).
- **BIPOLAR SEL** (pin 8) - This output from the microcomputer is used when programming the synthesizer module (U202).
- **AF SELECT** (pin 9) - This output from the microcomputer is used when programming the audio filter IC (U405) It is also used to reset a watchdog timer in the audio filter IC (U405), ensuring that the microcomputer is operating properly. When the microcomputer is operating properly this line will be pulsed at a periodic rate.

- **SCI DATA** (pins 10,11) - These lines are the asynchronous, bi-directional lines used for communicating with the microcomputer.
- **SPI DATA** (pins 12,13) - These lines are the synchronous uni-directional lines used for communicating with the synthesizer module (U202) and the audio filter IC (U405).
- **SPI CLOCK** (pin 14) - This output from the microcomputer is the clock line used when programming the synthesizer module (U202) or audio filter IC (U405).
- **SLAVE SELECT** (pin 15) - This input to the microcomputer enables the SPI CLOCK and SPI DATA lines.
- **ADAPT** (pin 16) - This output from the microcomputer will go high whenever the channel changes and when going from transmit to receive mode. It will cause the squelch circuitry to go into a fast mode of operation.
- **$\overline{\text{LOW BATTERY}}$** (pin 17) - This input to the microcomputer goes low when the radio battery voltage drops below approximately 8.5 volts. The microcomputer responds by flashing the red LED when in the transmit mode.
- **Pin 18** is not used.
- **OSC1, OSC2** (pins 19,20) - These two lines are connected to the 3.6864 MHz crystal that provides the reference clock frequency for the microcomputer.
- **Vcc** (pin 21) - 5-volt dc power for the microcomputer.
- **$\overline{\text{RESET}}$** (pin 22) - A low on this line will reset the microcomputer. The microcomputer is reset by the watch dog timer on the audio filter IC (U404).
- **$\overline{\text{IRQ}}$** (pin 23) - This pin is not used and is pulled to 5 volts through a resistor.
- **$\overline{\text{PTT}}$** (pin 24) - This input to the microcomputer goes low when the PTT switch is pressed, and signals the microcomputer to enable the transmitter circuitry.
- **$\overline{\text{LOCK DETECT}}$** (pin 25) - This input to the microcomputer goes low when the synthesizer is locked on frequency.
- **CALL** (pin 26) - This input to the microcomputer goes low when the call button is depressed. The microcomputer will respond by encoding a call sequence if enabled for the channel.
- **MONITOR** (pin 27) - This input to the microcomputer goes low when the monitor button is pressed. The microcomputer will respond by turning on the audio.
- **CHANNEL SELECT** (pins 28,29,30,31) - Channel selection is made via the freq sw (S3).
- **DECODE SELECT SWITCH** (pin 32) - This input to the microcomputer goes low when the mode select switch is in the coded squelch mode. The microcomputer will respond by turning on the PL CLOCK (pin 36) when carrier is detected.
- **CLOCK SHIFT** (pin 33) - This output from the microcomputer is 0 volts to shift the microcomputer oscillator frequency and 5 volts to keep the oscillator frequency unshifted. The oscillator frequency is shifted depending on the receive frequency of each channel.
- **CODE PLUG CLOCK** (pin 34) - This output from the microcomputer is used to clock data in and out of the code plug.
- **CODE PLUG DATA** (pin 35) - This input/output from the microcomputer receives data from or sends data to the code plug(s).
- **PL CLOCK** (pin 36) - This output from the microcomputer is the reference clock used when encoding/decoding PL.
- **$\overline{\text{CODE PLUG POWER}}$** (pin 37) - This output from the microcomputer is used to power-up the code plug(s).
- **PL DECODE** (pin 38) - This input to the microcomputer receives filtered and limited squelch code signal from the audio filter IC (U405).
- **Pin 39** is not used.
- **LED CONTROL** (pin 40) - This output from the microcomputer turns on the LEDs through Q401.

d. Antenna Switch and Filters

(1) VHF Radios

The antenna switching circuitry consists of two modules, U103 and U104. Module U103 is the receiver / transmitter signal select switch. Module U104 is the remote / standard antenna select switch. Applying 10V through L116 to U103 pin 1 puts U103 in transmit mode, and creates a low impedance path between pin 1 and pin 2. Removing 10 volts from L116 causes U103 to revert back to receive mode and a low impedance path exists between pin 2 and pin 4.

Grounding pin 3 of U104 selects the remote antenna while an open circuit at pin 3 selects the standard antenna. Ten volts is present at the anode of CR101 during the transmit mode to increase the bias and reduce insertion loss. Coils L115, L119, L120 and capacitors C123, C145, C148, C149, C151, and C152 provide additional filtering and matching to the antennas.

(2) UHF Radios

In transmit, 10 volts T is supplied to the antenna switch (U105 pin 4), via L114. When T is removed the antenna switch reverts back to receive mode. Grounding the REMOTE ANTENNA SELECT line (pin 7) selects the remote antenna while an open circuit will select the standard antenna. In transmit, with the remote antenna selected, a low impedance path exists between pin 4 and pin 5. When the standard antenna is selected a low impedance path exists between pin 4 and pin 6. In receive, with the remote antenna selected, a low impedance path exists between pin 5 and pin 1. When the standard antenna is selected a low impedance path exists between pin 6 and pin 1. Coils L115 and L122 and capacitors C143 and C154 match the output of U108 to the standard antenna. Capacitors C151 and C185 match the remote port of U108 to the universal connector. When the remote antenna is selected, current flows via R128 and L119 to turn on the remote port. Also, when transmitting with a remote antenna, additional current is provided to the antenna switch via CR103 and R123.

e. Receiver Selectivity and RF Amplifier

The received signal at the antenna is routed through the antenna switch and antenna matching networks, and applied to the receiver rf front end for filtering and amplification.

(1) VHF Radios

There are 5 poles of filtering for rf front end selectivity. Coils L1, L2, and capacitors C1 thru C5 form a two-pole tuned butterworth filter with a bandwidth of greater than 16 MHz. Capacitor C8 thru C14 together with coils L3, L4, and L5 form a 3-pole Chebychev filter with a bandwidth of 16 MHz. The rf amplifier (Q1) is a low noise rf transistor, configured in the common-base mode for good intermodulation performance. Transistor Q1 is biased when the R5 voltage is applied to the resistor divider of R1 and R2. Capacitor C21 provides a good rf ground to the base of Q1. The weak rf signal from the two-pole filter is fed to the emitter of Q1, and the amplified signal is available at the collector.

(2) UHF Radios

Tunable preselectors L1 and L2 form a two-pole tunable butterworth filter with a bandwidth of greater than 8 MHz. Capacitors C1, C2, C3, resistor R1, and coil L3 match the output of the preselector's to the input of the rf amp (Q1). Capacitors C41 and C49 improve the preselector's performance. Transistor Q1 is configured in the common-emitter mode. The amplified rf signal is available at the collector and is matched to the 3-pole fixed tuned preselector (L5, L6, and L7) by L4, C6, and C7. Capacitors C35, C36, and C37 improve preselector performance. In some bandsplits C7, C35, C36, C37, and C41 are replaced by 0-ohm resistors. The 3-pole filter has a bandwidth of greater than 30 MHz. Capacitor C8 and coils L8 and L16 match the output of the 3-pole filter to the input of the mixer (Q2).

f. Receiver First Mixer, Crystal Filter, and Injection Buffer

(1) VHF Radios

Transistor Q2, a dual-gate MOSFET, is used as the first mixer stage. The rf signal from the three-pole filter is fed to the source of Q2. The first injection signal from the VCO, via buffer transistor Q3, is introduced at gate 1. The output of Q2 is taken from the drain. The difference signal of 53.55 MHz is the desired i-f output.

The first or high i-f is fed to filter FL1 / FL2 , which is a four-pole quartz crystal filter resonant at 53.55 MHz. The filter provides about 28 dB of adjacent channel protection. Components C20, C19, L12, C37, C24, L7, L8 C25, C26, and C27 provide matching for the crystal filters. The i-f signal is then passed to the i-f module (U1) for further signal processing.

Transistor Q3 is in cascade with an open-collector transistor located within the VCO module (U201). Biasing of Q3 (common base) occurs when the R5 voltage is applied to the voltage divider of R13 and R14. Capacitor C36 insures a good rf ground at the base. Transistor Q3, together with coils L9, L10 and capacitors C30, C32, and C35, provide buffering and rejection of unwanted harmonics on the injection string.

(2) UHF Radios

Transistor Q2, a dual-gate MOSFET, is used as the first mixer stage. The rf signal from the three-pole filter is fed to gate 1 of Q2. The first injection signal is developed by the VCO (U201) and sent to an injection buffer contained on the VCO buffer module, U108. The buffered signal is routed through a bandpass filter network consisting of C21, C22, L12, L13, C25, C31 and C30, and applied to gate 2 of the mixer. The output of Q2 is taken from the drain. The difference signal of 53.55 MHz is the desired i-f output.

The first or high i-f is fed to filter FL1 / FL2 , which is a four-pole quartz crystal filter resonant at 53.55 MHz. The filter provides about 28 dB of adjacent channel protection. Components L9, L10, L11, L14, C14, C15, C43, C29, C16, and C18 match the output of the mixer to the input of the i-f module, U1.

g. Receiver Second I-F and Signal Processing *(See Figure 8)*

Module U1 contains the second mixer, i-f amplifier, PLL demodulator, noise amplifiers and filters, and squelch circuitry. The first i-f signal (53.55 MHz) is received at U1 pin 7. The second LO injection signal from the synthesizer (U202 pin 3) is received by the mixer at U1 pin 9. The desired output frequency from the mixer is 450 KHz. Therefore, the oscillator injection frequency must be 450 KHz above or below the first i-f of 53.55 MHz. The second oscillator frequency is 54 MHz (high-side injection) or 53.1 MHz (low-side injection). The resulting 450 KHz second i-f signal is filtered by the ceramic filter FL3 and FL4 to reject unwanted mixing products. The second i-f signal is then amplified and can be monitored at M1 (U1 pin 4 or 12). The signal is then demodulated and the resultant audio can be monitored at U1 pin 1. The audio is then passed to the audio filter IC (U405).

The squelch controller circuit contained in module U1 is a noise detection circuit. The noise output from the squelch controller at U1 pin 5 is routed to U405 to be attenuated by a programmable squelch attenuator and is then fed back to pin U1 pin 7 to the carrier detect circuitry. When the noise level exceeds the threshold level set by the squelch pot on U405, U1 pin 9 (CARRIER DETECT line) goes low, indicating the absence of a carrier signal. The microcomputer reads this CARRIER DETECT low and programs the audio filter (U405) to turn off the power amplifiers on U406 by pulling the PA EN line (U405 pin 3) low. If the noise is less than the threshold level set by the attenuator on U405, U1 pin 9 (CARRIER DETECT line) goes high, indicating the presence of a carrier signal. The microcomputer reads this CARRIER DETECT high and programs the audio filter (U405) to turn on the power amplifiers (U406) by outputting a high PA EN signal (U405 pin 3).

h. Receiver Audio Circuitry *(See Figure 9)*

The recovered audio from U1 is routed to the audio filter IC (U405 pins 7 and 8). The audio is low-pass filtered to separate squelch codes and high pass filtered to separate voice. Squelch codes are filtered, sampled, and sent to the microcomputer (U401 pin 38). If the radio is in the PL squelch mode, the microcomputer turns on its decoding circuitry. When the squelch codes are decoded, the microcomputer sends program signals to a microprocessor interface circuit in the audio filter module (U405). The audio filter IC, via the PA EN line, turns on the audio PA IC (U406).

In radios with SELECT 5 decode, the SELECT 5 code sequence is processed by module U801 and sent to the microcomputer (U401, pin 5). Once the proper code sequence is decoded by the microcomputer, program signals are sent from the microcomputer to the microprocessor interface circuit in the audio filter IC (U405) for recognition of either an individual call or a group call. The audio filter IC, via the PA EN line, turns on the audio PA IC (U406). The audio filter IC also outputs the specific call alert tone for individual call or group call, and keys the LED to flash at the proper rate for individual call or group call.

After high-pass filtering, voice audio is de-emphasized, filtered, sent through a programmable attenuator (volume control), and then passed from the audio filter to the volume pot (U405 pin 23 to R140). Audio is routed from the volume pot to the audio PA IC (U406 pin 10) and applied to three audio power amplifiers: internal PA, external PA and common PA. The common PA is active for both internal and external speaker applications. Without an external speaker connected, a high input at on the EXTERNAL

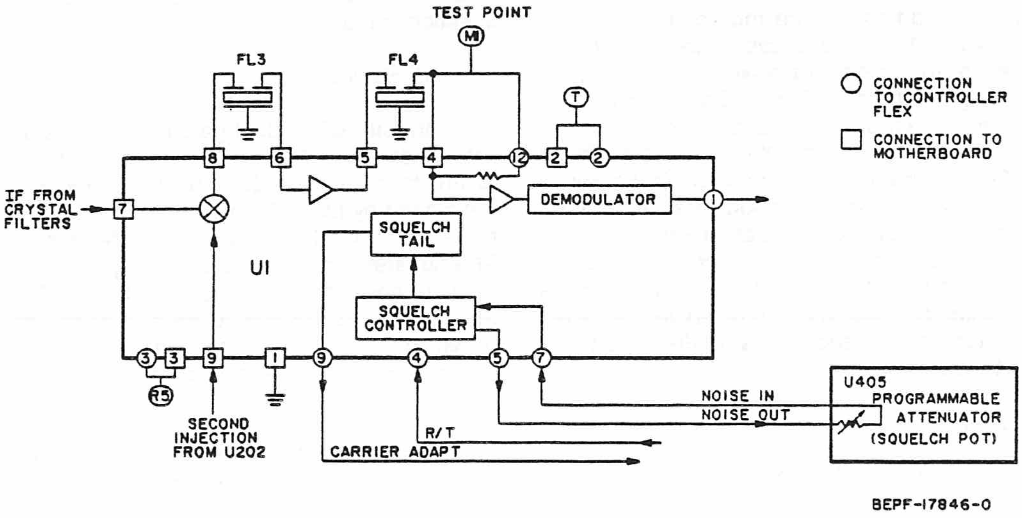


Figure 8. U1, I-F Module

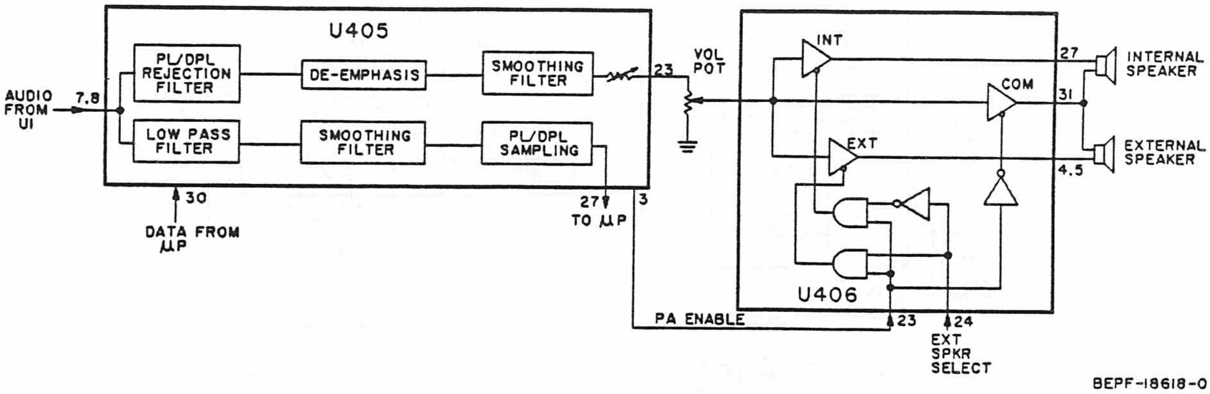


Figure 9. Receiver Audio Circuitry

SPEAKER SELECT line (U406 pin 24) biases the internal PA, and audio from the internal and common power amplifiers is 180 degrees out of phase, which drives the internal speaker (LS1) differentially. Audio from the common power amplifier and external power amplifier is in phase.

If an external speaker is attached to the radio's universal connector, the EXTERNAL SPEAKER SELECT line (U406 pin 24) is pulled low. This low biases the external PA and shifts the audio output of the common amplifier 180 degrees. This phase shift does two things. First, it puts the audio output from the common amplifier 180 degrees out of phase with the audio output from the external amplifier, and the external speaker is driven differentially. Secondly, audio from the common power amplifier and internal power amplifier is in phase, which results in no audio drive for the internal speaker.

i. Transmitter Audio Circuitry *(See Figure 10)*

Audio from the microphone is routed to the audio power amplifier (U406), which contains two microphone amplifiers (internal and external). Pressing the PTT switch (internal or external) pulls U401 pin 24 low. The microcomputer reacts by programming the microprocessor interface on U405 to output a low on the R/T line (U405 pin 39). This low is inverted by U403 and applied to U406 pin 18, which enables the microphone circuits. If the internal PTT switch is pressed, a high is present at U406 pin 20, enabling the internal amplifier. If the external PTT switch is pressed, U406 pin 20 is pulled low, and the external microphone amplifier is enabled. Module U406 amplifies and high pass filters the audio. The audio signal is then routed from U406 pin 19 to the audio filter (U405 pin 10), where it is pre-emphasized, limited, and sent through a splatter filter. In PL applications, the audio is summed with the squelch code, which is generated in U405. The audio is then attenuated by two programmable attenuators and the resultant audio signal is routed from U405 pin 20 to the VCO modulation port (U202 pin 8), and from U405 pin 19 to the reference modulator input at U202 pin 9.

The SELECT 5 encoded sequence consists of one to five tones, defined by the various signalling formats. The encoded sequence is initiated from either the call button or the PTT switch. Depressing the call button results in only the encoded sequence being transmitted with or without voice. If transmitted with voice, the encoded sequence can be tied to pressing the PTT switch (before voice) or releasing the PTT switch (after voice).

The microcomputer encodes a digital waveform and sends the encoded signal, via U401 pins 3 and 4, to shaping and filtering circuits in U801 and the audio filter IC (U405). The signal is attenuated by a programmable attenuator in U405 and the resultant output signal at U405 pin 19 is routed through the synthesizer (U202, pin 8 to pin 1) and applied to the VCO modulation port (U201, pin 1).

j. Transmitter

(1) VHF Radios

Transmit rf is originated in the VCO / synthesizer modules as discussed in earlier paragraphs of this manual. The rf output of the VCO (U201 pin 7) is applied to the buffer stage (Q101 and associated circuitry). Transistor Q101 is base biased by the T5 voltage via R100, and collector biased by the A voltage line via R102. The rf signal is coupled to the predriver stage (Q102) through C100 and the matching network of C101, L102, and C102. The predriver (Q102), operated class AB, is biased from the T voltage line. Base bias for Q102 is supplied through resistors R105, R104, and R103. Collector bias for Q102 is provided through coil L103. The predriver (Q102) is matched to the driver (Q103) by coils L104, L105, and capacitors C140, C107, C108

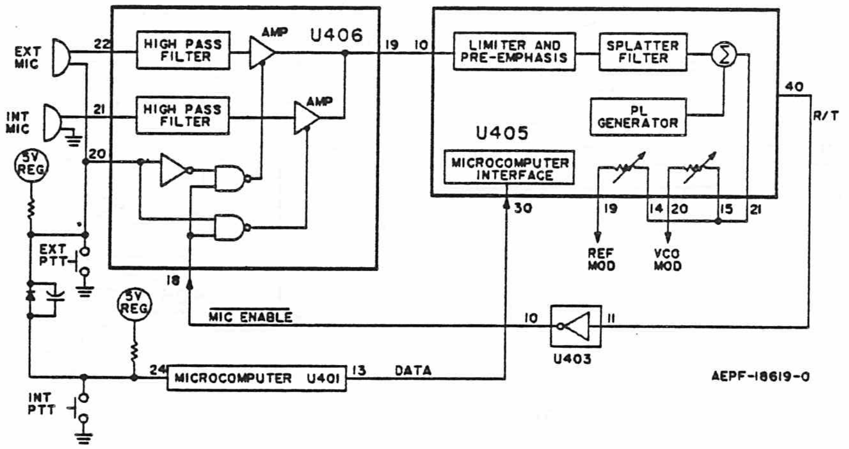


Figure 10. Transmitter Audio Circuitry

and C109. Transistor Q103 operates class C and is supplied from the A voltage line. Collector bias for Q103 is provided through L107. Coil L106 and resistor R108 establish a dc ground return for the base. RF from the collector of Q103 is coupled through C111 and matched to the final PA (Q104) by capacitors C142, C112 and coil L108. Resistor R112 provides stage stability. Transistor Q104 operates class C and is supplied from the A voltage line. Collector bias for Q104 is provided through coil L110. Resistor R109 and coil L109 provide a dc ground return for the base. The PA (Q104) is matched to the antenna switch (U103) by capacitors C143, C117, C118 , C120, and coils L111 and L112. A five-element low-pass filter is used to reject unwanted harmonics of the carrier signal. This network consists of C119, C121, C122, L113, and L114. The trimmer cap (C120) is used for adjusting output power. The VHF transmitter is available in 2-watt and 5-watt versions. The main difference is the device used for the final PA (Q104).

(2) UHF Low-Power Radios

Transmit rf is originated in the VCO / synthesizer / VCO buffer stages as discussed in earlier paragraphs of this manual. RF output of the VCO buffer (U108 pin 8) is applied to the predriver stage (Q102). Impedance matching between the VCO buffer (U108) and the predriver (Q102) is accomplished by L101, C105, C102 and L116. Transistor Q102 operates in the class AB mode. Transistor Q106 and associated circuitry is use to supply operating voltage to the predriver. The T voltage line forward biases Q106 and supplies drive to the base of Q102 through resistors R107, R103, and R102. The collector of Q102 is biased via L104. Both the buffer and predriver have a 30 MHz bandwidth. The output of the predriver (Q102) is matched to the input of the driver (Q103) by L105, C110, C158 and L106. Capacitor C152 and resistor R121 provide stage stability. Both the driver and final PA (U102) operate in class C mode. The driver (Q103) is collector biased from the A voltage line through coil L108. A dc ground return for the base is provided by L107 and R113. Resistor R127 and capacitor C155 provide stage stability. RF output from the driver (Q103) is matched to the input of the PA module (U102) by C116, L112, and C117. The trimmer cap on U102 adjusts the power output. The nominal power output for the UHF low power radio is 2 watts.

(3) UHF High-Power Radios

The transmitter in high power radios is very similar to the transmitter in low power radios. The differences are:

- In the high power model Q106 is eliminated and the predriver is powered directly from the T voltage line.
- The high power model has an additional stage of amplification (the IPA stage). Impedance matching the output of the driver (Q103) to the input of the IPA (Q104) is accomplished by L118, C167, C111, L109, and C112. Transistor Q104 operates in the class C mode and is supplied by the A voltage line. Collector bias is provided through L111, and a dc ground return for the base is provided through L110 and R115. The nominal output power of the UHF transmitter is 4 watts.

k. Dual-Tone Multiple Frequency (DTMF) Circuits (Optional)

(1) Timed Tone Option

The DTMF circuit receives its power from unswitched battery B+ and an 8-volt regulator (U407) on the controller flex, via connector plug P701. When the radio is turned on, the regulated 8 volts supplied to the DTMF board is routed through a low-pass filter network (R729 and C725). The 8 volts is applied to audio amplifier U702 pin 6, and to the 5-volt regulator (U706). The regulated 5 volts is used throughout the

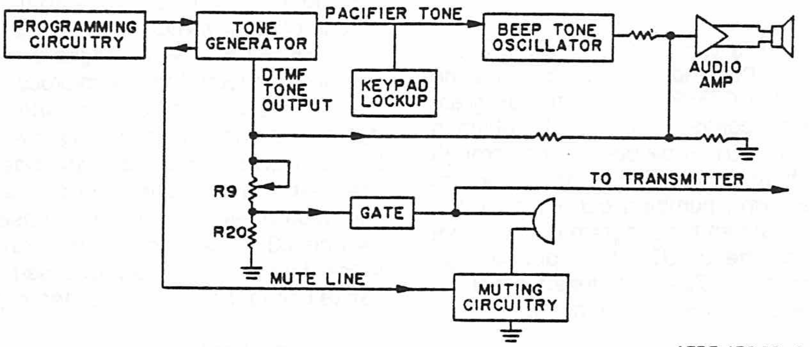


Figure 11. DTMF Option Diagram

circuit. Module U701, the heart of the DTMF circuit, receives its supply voltage (5V) through steering diode CR702. When the radio is turned off, the 5 volts is removed and U701 is supplied with memory retention voltage from the radio's unswitched B+ through resistor R701 and steering diode CR701. Resistor R706 and capacitor C701 act as a low-pass filter to keep noise off the IC's supply line. Capacitor C701 is also a memory retention cap. When the radio's battery is removed C701 will hold memory retention voltage for 2 minutes. **If the battery is not replaced within two minutes, memory will be lost.** All of the 47 pf caps are used for rf bypassing.

Transistor Q701, and resistors R722, R716 lock and unlock the keypad. When the radio is on, Q701 is saturated, U701 pin 22 is pulled low, and the keypad is unlocked. When the radio is turned off, Q701 is off, U701 pin 22 is pulled high through resistor R716, and the keypad is locked-up.

Integrated circuit U701 is a CMOS tone generator. Components Y701, R726, C722, and C723 form the oscillator circuit for the tone generator. When a key is pressed, U701 goes into the encode mode and outputs the appropriate tone on pin 21. Module U701 also sends a low (MUTE output) from pin 23 to NOR gate U703D pin 3. The tone (DTMF OUT) is routed through the deviation adjusting network of R720 and potentiometer R709, and applied to pin 6 of isolation switch U704B. If the control "C" input at U704B pin 4 is high, the switch closure is made and the DTMF tone output at U704B at pin 7 is applied to the radio's INT MIC IN line via connector plug P701 pin 3.

The purpose of the isolation gate (NOR gate U703D) is to prevent the transmission of beep tones. Therefore, the switch (U704B) will only close when a DTMF tone is to be transmitted, which is determined by a high output of NOR gate U703D at pin 4. This high output is achieved when both inputs are low. One input (pin 3) goes low everytime a DTMF tone is generated. The other input (pin 2) goes low whenever the radio is in transmit, via the saturation of transistor Q703.

The function of FET transistor Q702 is to mute the microphone during tone transmission. If the microphone was not muted, noise could get mixed with the DTMF tones and prevent successful decoding. Transistor Q702 is controlled by the MUTE output (U701 pin 23). When no tone is present, the mute line is pulled high by resistor R728, transistor Q702 is on, and the microphone has a low impedance path to ground. When a DTMF tone is generated the mute line goes low, Q702 is turned off, and the microphone is no longer grounded. Therefore, the microphone is muted. It is also necessary to mute the microphone when beep tones are generated. When a beep tone is present, switch U704C closes and transistor Q702 turns off. The time that Q702 stays off is controlled by the RC network of C724 and R719.

The combination of U703B, U703C, U704A, R707, R708, C705,C703, and R723 is the beep-tone oscillator circuit. When a "*" or a "#" command key is pressed, or when any key is pressed during the program mode, module U701 generates a pacifier tone. This tone, which lasts for approximately 30 milliseconds, is applied to beep tone gate U704A, which responds with a low output at pin 9. The low at U704A pin 9 is applied to the beep-tone oscillator (U703B pin 10), which responds by generating a 2000 Hz beep tone. The beep tone continues until U703B pin 10 goes high, which is determined by the RC network of C703 and R723 (approximately 57 milliseconds).

DTMF and beep tones are routed to the sidetone / beep-tone amplifer U702. This IC amplifies the tones and sends them to the speaker. Amplifier U702 is enabled when pin 1 is pulled low through CR704A or CR704B, which occurs when module U701 is in the program mode or when the radio is in transmit.

Resistor R702 and capacitor C702 control the duration of the DTMF tones and the rate the tones are generated during automatic dialing. Tone duration is set at 150 ms.

Program switching is done by U704D, U703A, U705, R703, R704, R705, and CR703. Pressing the program button puts the DTMF circuit in the program mode by grounding the contol line of U704D, which in turn causes pin 39 of U701 to be pulled high through resistor R705. With module U701 in the program mode (U701 pin 39 high), numbers can be stored in the memory registers. When the program button is not pressed, the control line of U704D is pulled high through R727, the switch (U704D) is closed, pin 39 of U701 is grounded, and U701 is in tone mode.

R731 is removed in radios with the ANI version DTMF circuit to prevent programming DTMF functions. In order to put module U701 into the program mode (a high at U701 pin 39), both inputs (pins 6 and 8) of U703A must be low. This can be accomplished only by using the ANI programming fixture to push the program button.

(2) Continuous Tone Option

Integrated circuit U801 is a DTMF tone generator, which accepts inputs from the keypad. The option is supplied from the radio's 8-volt line. During tone generation, the IC outputs a high on its MUTE line (pin 8). This output mutes the microphone by saturating Q804 which turns off Q802, resulting in a high impedance path to ground for the microphone. The MUTE line also turns on Q801, which supplies a path to ground for the resistor divider network of R804 and R805.

The tone generator outputs a tone on pin 16 of U801. This tone level is reduced by R804 and R805, and is applied to the radio's MIC line to be transmitted. The tones are also divided by R806 and R807, and routed to the side-tone amplifier (U802). The amplified tones are then sent to the radio's speaker for user feedback.

The amplifier is enabled by the radio's MIC line. In the transmit mode, the MIC line is at 5 volts. This turns on Q803 and pulls pin 1 of U802 low, enabling the amplifier.

I. Multicall 100,000 (100k) Circuitry (Optional)

The multicall circuit receives its power from an 8-volt regulator (U407) on the controller flex, via connector plug P701. When the radio is turned on, the regulated 8 volts is received by the multicall board and applied to a 5-volt regulator (U903) at pin 2. The regulated 5-volt output from U903 is applied to the microcomputer (U901 pin 21), to the watchdog timer (U902, pin 16), to the keypad, and throughout the multicall circuitry.

The multicall circuit is operated via an enable/disable switch (S901) and a multicall keypad. The keypad contains digits 0 through 9, the * key, and the # key. All input lines from the keypad and the enable/disable switch to U901 (pins 23 through 31) are normally at 5 volts. Digits 0 through 9 and the * key are connected to the microcomputer via row and column inputs. Whenever one of these keys is depressed, the corresponding row and column inputs to the microcomputer are grounded. The # key and the enable/disable switch are tied to the microcomputer via seperate sense lines (U901 pins 24 and 23 respectively). And likewise, when one of these (key or switch) is depressed, the corresponding sense line to the microcomputer is grounded.

The multicall microcomputer (U901)handles:

- all interface on the keypad
- radio control communications to the radio's microcomputer (U401) on the controller flex
- multicall system control

Module U901 reads in the keypad buttons depressed, and depending on the radio's codeplug programming, configures the radio's operation accordingly. Interface between the multicall's microcomputer (U901) and the radio's microcomputer (U401) is accomplished via control codes sent and received on a communications bus, which consists of DATA (U901 pin 10) and BUSY (U901 pin 7). Information is sent and received on the DATA line, while the BUSY line monitors the bus for use.

Timing for the multicall microcomputer is controlled by clock crystal Y901 and associated circuitry. The clock frequency is automatically shifted as a direct result of the receiver frequency. The voltage level on pin 33 of U901 controls the shifting network. If no frequency shift is required (as sensed by the microcomputer), 5 volts is applied to the base of transistor Q902, which turns on the transistor and shorts across coil L903. If a frequency shift is required, the microcomputer removes the 5 volts on pin 33, Q902 turns off, and L903 is placed in series with the crystal (Y901). The added inductance shifts the resonant frequency of the oscillator circuit, resulting a lower clock frequency.

To monitor the microcomputer's (U901) operation and to reset the microcomputer should the device fail, "get lost", or fall asleep during it's operation, a watchdog timer (U902) is incorporated in the multicall circuitry. The watchdog timer generates a 12.5 kHz pulse rate interrupt (wake up) signal (U902 pin 1 to U901 pin 18) to wake up the microcomputer if it is in the sleep mode. The microcomputer sends a return signal to reset the watchdog timer (U901 pin 9 to U902 pin 12). If the microcomputer should fail to send a reset signal to the watchdog timer, the watchdog timer sends a second interrupt signal to U901 pin 18.

If the microcomputer again fails to send a reset signal to the watchdog timer, the watchdog timer sends a pulse to Q901. Transistor Q901 inverts the pulse and and applies it to U901 pin 22, which resets the microcomputer.

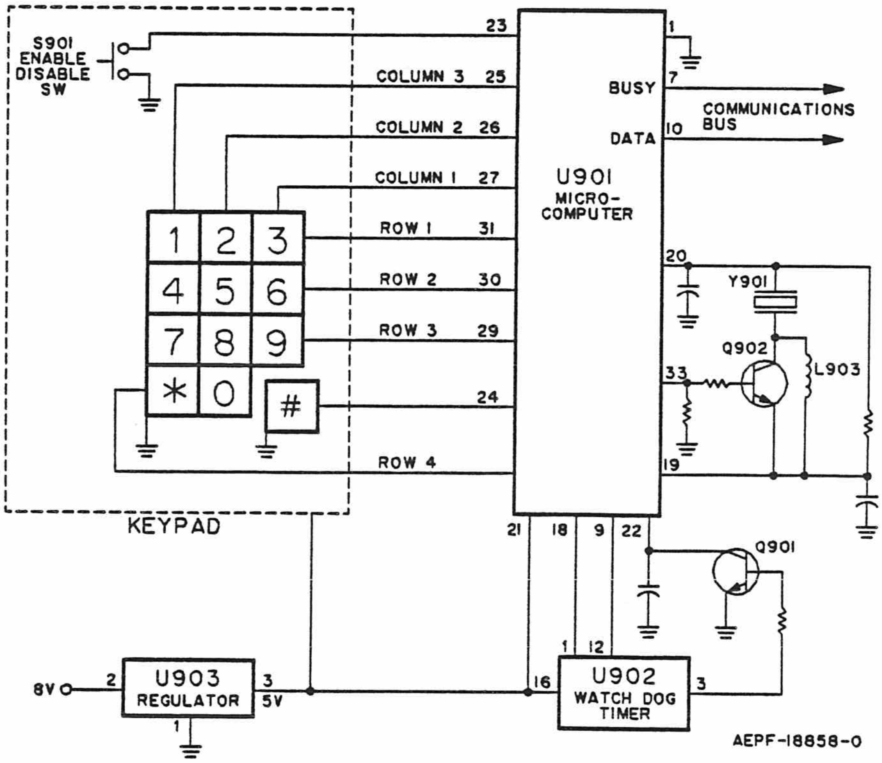


Figure 12. Simplified Multicall Circuitry

GRAPHICAL SYMBOLS USED IN CIRCUIT DIAGRAMS

Resistors(R)

- Resistor
- Resistor with fixed tap
- Variable resistor
- Resistor with movable tap (Potentiometer).
- VDR — Varistor (voltage-dependent resistor)
- NTC — Temperature-dependent resistor with negative temperature coefficient
- Light-emitting diode (photosensitive resistor)
- PTC — Temperature dependent resistor with positive temperature-coefficient.
- Resistor with preset adjustment

Capacitors(C)

- Capacitor
- Variable capacitor
- Trimmer capacitor
- Feedthrough capacitor
- Electrolytic capacitor polarized
- Polarized capacitor general
- Electrolytic capacitor non-polarized

Coils(L)

- RF coil, air core
- Coupled RF coils, air core
- RF coil with adjustable core
- Coil with tap.
- Helical-coil.

Transformers(T)

- Transformer with iron core
- Transformer with adjustable RF cores

Diodes(D)

- Diode
- Bridge rectifier
- Series-connected stabilizer diodes within one case
- Light-emitting diode
- Zener diode (unidirectional)
- Zener diode (bidirectional)
- Tunnel diode
- Backward diode
- Varactor diode
- Controlled rectifier, PNPN (N-thyristor)
- Controlled rectifier, NPNP (P-thyristor)
- Zener diode-programable.

Transistors(Q)

- Transistor, PNP
- Transistor, NPN
- Light-sensitive transistor PNP
- Unipolar transistor with N-type base

Junction Field Effect Transistors (JFET)

- DRAIN, GATE, SOURCE — N-channel JFET
- P-channel JFET
- DRAIN, GATE2 (SUBSTR.), GATE, SOURCE — N-channel dual gate JFET
- P-channel dual gate JFET

Insulated Gate Field Effect Transistors (IGFET or MOS)

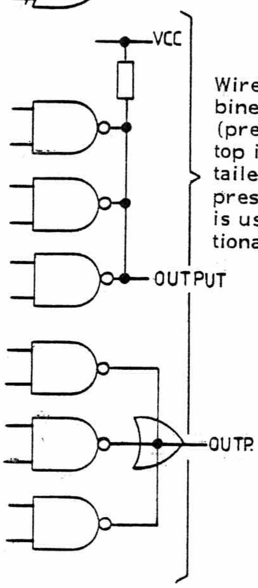
- DRAIN, GATE, SUBSTR., SOURCE — N-channel IGFET (MOS)
- P-channel IGFET (MOS)
- DRAIN, GATE1, GATE2, SOURCE — N-channel dual gate IGFET (MOS)
- P-channel dual gate IGFET (MOS)

Integrated Circuits (U)

Several integrated circuits contained within one case are designated by one common number followed by an identifying letter (a, b, c, etc.). Thus, circuits U1A, U1B and U1C are contained within one case.

Gates

- AND gate.
- OR gate.
- NAND gate.
- NOR gate.
- Exclusive OR gate.



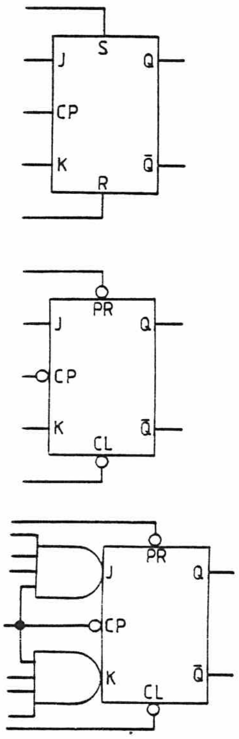
Wired OR (combined OR outputs) (presentation at top is used in detailed diagrams; presentation below is used in functional diagrams)

GRAPHICAL SYMBOLS USED IN CIRCUIT DIAGRAMS

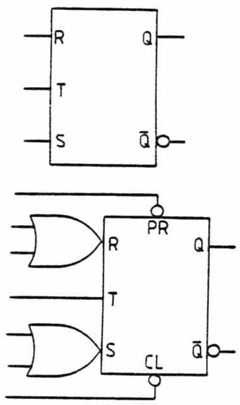
Flip-flops

Abbreviations used:

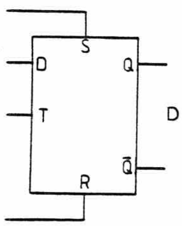
- S = Set
- R = Reset
- CP = Clock pulse
- PR = Preset
- CL = Clear
- T = Toggle



J-K Flip-Flops



R-S Flip-Flops



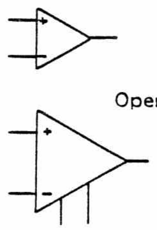
D Flip-Flop

Inverters

Inverter

Three-state driver

Operational Amplifiers



Operational amplifiers.

Relays(K)

Single-coil relay

Dual-coil relay

P Polarized relay

SO Slow-acting relay

SR Slow-release relay

Relay with change-over contacts

Contacts

Open contact (make)

Closed contact (break)

Change-over contact

Change-over contact centre off

Make-before-break

Switches and Keys(S)

On/Off switch

Locking keys or switches: push on, push off

Non-Locking self-releasing keys or switches

Make-before-break

Locking mutually releasing keys or switches (In row of push-buttons etc.)

Rotary switch.

ON/OFF switch electrically controlled. (Not a relay)

Lamps(V)

Indicator Lamp.

Neon Lamp

Fuses and Cut-outs(F)

Fuse

Circuit breaker

Batteries(B)

Battery one cell

Battery multi cell

Feedthrough Filters(Z)

Feedthrough filter

Ferrite Beads(FB)

Ferrite bead

Crystals(Y)

Crystal

Cables and Wires(W)

Usual conductor.

Three conductors

8 Eight conductors.

7 Shift from multiple-line to single-line presentation.

Screened cable.

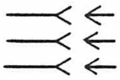
Coaxial cable.

GRAPHICAL SYMBOLS USED IN CIRCUIT DIAGRAMS

Connectors(J and P)

 Female (socket) connector.

 Male (plug) connector

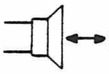
 Multi-wire connector.

 Coaxial plug.

 Coaxial socket.

Loudspeakers(LS)

 Loudspeaker.

 Loudspeaker-Microphone.

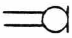
Telephones(TEL)

 Telephone.

 Single headphone.
(Earphone).

 Double headphone.

Microphones(M)

 Microphone.

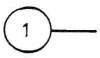
Meters etc.

 Indicating instrument.

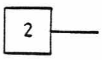
 Balancing instrument.
(Galvanometer).

 Basic letters
see DESIGN STANDARD
10.02.3.1 section 12.

Test Points



DC test point.



AC test point.

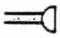
Replaceable Connections(W)

 Cross-field connection.
(jumper).

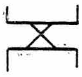
 Strap.

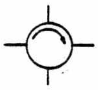
Miscellaneous

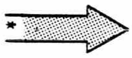
 Antenna

 Buzzer.

 Horn.

 Directional Coupler.

 Circulator.



Multiconductor bus
(used in logic diagrams)
* = Identifying bus label
e.g. DATA, ADDRESS....

 Chassis or frame connection

 Grouping of leads.

 Crossing of wires.

 Junction of connected wires

COLOUR CODE/
CODE DES COULEURS/
FARBKODE

0	BK/BLK	BLACK	NOIR	SCHWARZ
1	BN/BRN	BROWN	MARRON	BRAUN
2	RD/RED	RED	ROUGE	ROT
3	OR/ORG	ORANGE	ORANGE	ORANGE
4	YW/YEL	YELLOW	JAUNE	GELB
5	GN/GRN	GREEN	VERT	GRÜN
6	BL/BLU	BLUE	BLEU	BLAU
7	VT/VIO	VIOLET	VIOLET	VIOLET
8	GY/GRY	GREY	GRIS	GRAU
9	WH/WHT	WHITE	BLANC	WEIß