SECTION 3.
TUNING

3.1 TOOLS AND TEST EQUIPMENT

The following items should be available for proper servicing and testing:

Table 3-1. Tools and Equipment

ITEM	DESCRIPTION
1	Set of alignment/tuning tools
2	AC voltmeter
3	Analog multimeter
4	Spectrum analyzer (optional)
5	Oscilloscope
6	Communications service monitor, or if not available, RF power meter, AF generator, FM signal generator and frequency counter

NOTE:

Use extreme care in turning trimmers and cores. These devices are delicate and subject to damage if mistreated. Always use the proper tools.

The following table gives the procedure to access these devices:

Table 3-2. Procedure To Access Devices

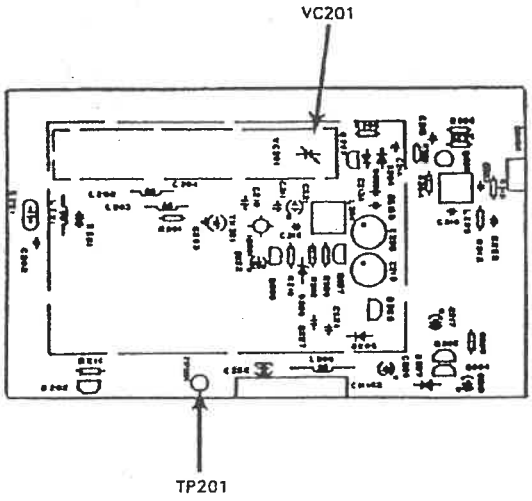
UNIT	STEP	PROCEDURE
RX UNIT	1	Remove four cap bolts and two bolt spacers from bottom cover.
	2	Remove bottom cover from chassis.
	3	Remove ten screws from RX unit cover.
	4	Remove RX unit cover from RX unit chassis.
	5	Pry off VCO unit cover from RX VCO PCB.
TX UNIT	1	Remove eight screws from TX unit cover.
	2	Remove TX unit cover from TX unit chassis.
PA UNIT	1	Remove four screws from chassis.
	2	Remove PA unit from main chassis, do not disconnect.
	3	Remove seven screws from PA cover.
	4	Remove PA cover from PA unit.
	5	To reassemble reverse the steps above.

3.2 RECEIVER ADJUSTMENT

(See Figure 3-1)

Table 3-3. Receiver Adjustment

TYPE	STEP	PROCEDURE
VCO/PLL	1	Install a properly programmed EPROM (see Section 2).
	2	Connect a DC voltmeter to TP201.
	3	Adjust L202(VHF) or VC201(UHF) for a reading of 3V.
	4	For multifrequency radios, make sure that the voltage is between 1V and 5V on each channel. Unlock indicator LED D106 will glow if the VCO is out of lock.
	5	Connect frequency counter to CN6P. Frequency should be 750 kHz.
	6	If necessary, adjust TCXO trimmer so that the frequency is exactly 750 kHz.
RF ALIGNMENT	1	Connect RF signal to receiver antenna port.
	2	For multifrequency radios, select a channel near center of range.
	3	Open the squelch and connect AC voltmeter to CN10S-13.
	4	Adjust BPF1 and BPF2 for best quieting sensitivity while maintaining RF at a low level (less than 20 dB quieting).
IF ALIGNMENT	1	Adjust L105 and T101 for best quieting.
	2	Adjust T102 and T103 for best SINAD with 1kHz modulation, 70% deviation.
AF ADJUSTMENT	1	Adjust FVR102 for -6 dBM level between CN102-8 and ground with 1kHZ modulation, 70% deviation.
	2	Using 1kHZ, 20% deviation signal as a reference, switch the modulation frequency to 3 kHZ.
	3	Adjust FVR101 for a level of –9.5 dB. This sets the de-emphasis to –6 dB/octave.
	4	Check speaker audio output at CN102-9. Audio PA is capable of 2W. Actual level may vary depending on control configuration.



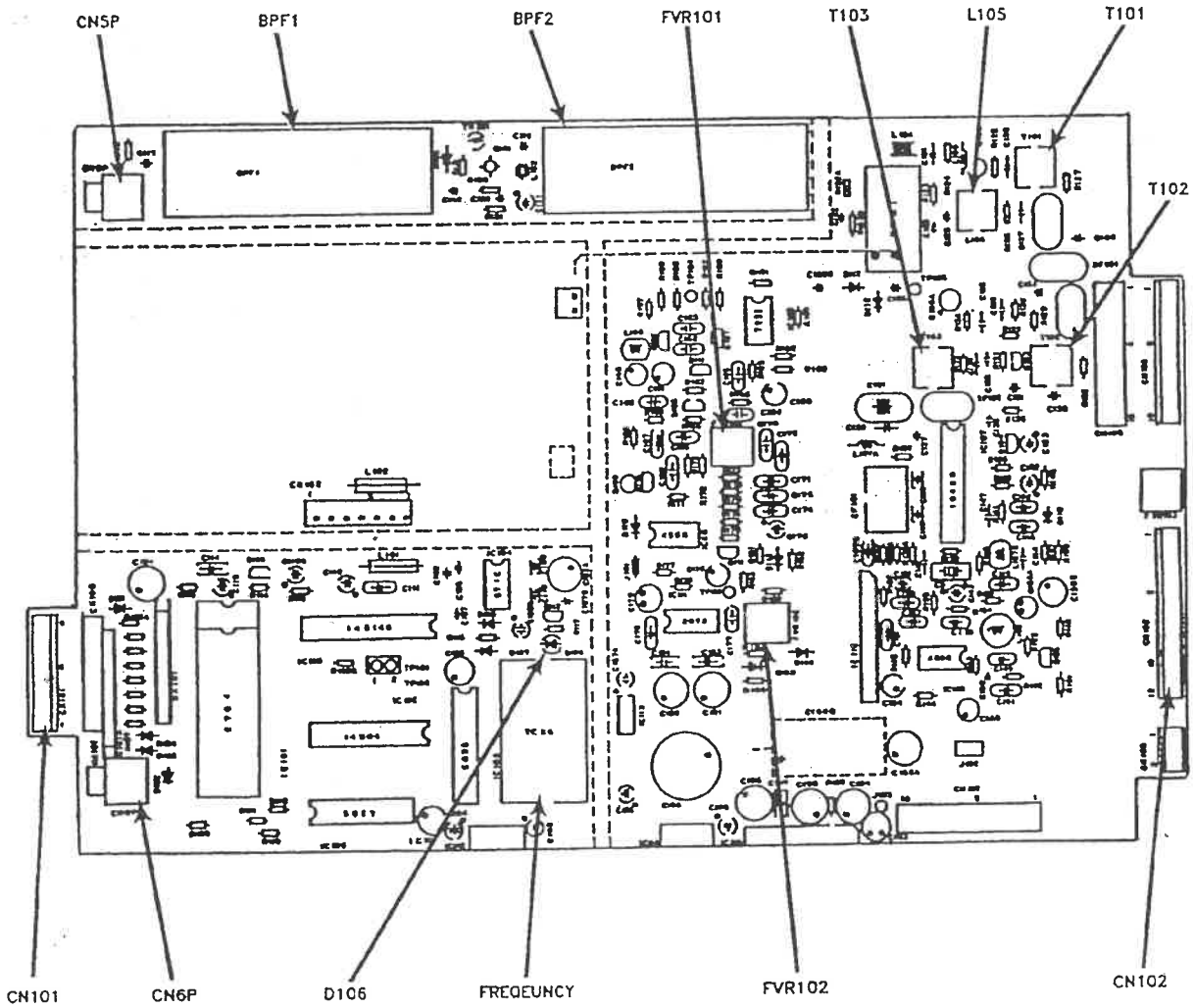


Figure 3-1. Receiver Adjustment

3.3 TRANSMITTER ADJUSTMENT

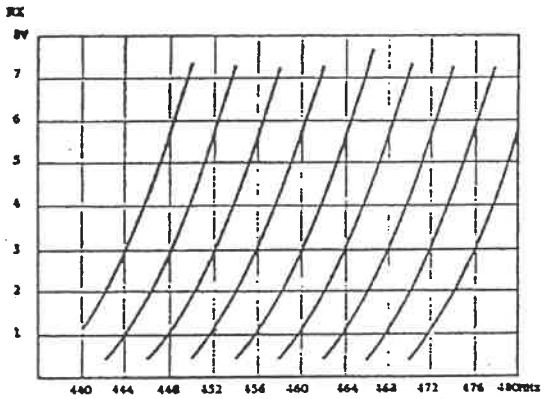
(See Figure 3-3)

Table 3-4. Transmitter Adjustment

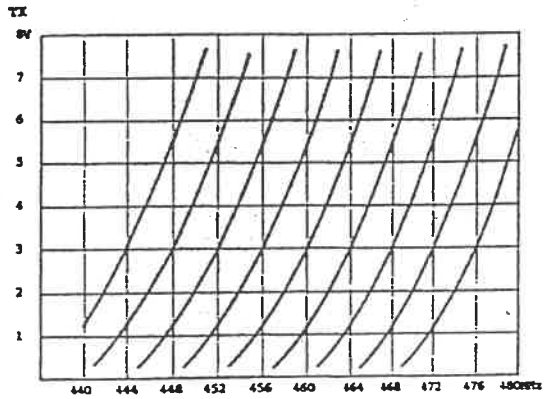
TYPE	STEP	PROCEDURE
VCO/PLL	1	Install a properly programmed EPROM (see Section 2).
NOTE: The transmitter PLL uses a 750 kHz reference provided from the receiver at CN6P. If testing the transmitter module alone, supply an external reference to this point.		
	2	Key transmitter by grounding CN10S-15.
	3	Connect a DC voltmeter to TP401.
	4	Adjust L402A(VHF) or VC401 (UHF) for a reading of 3V.
	5	For multifrequency radios, make certain that range of voltage is between 1V and 5V.
	6	Unlock indicator LED. D311 will glow if VCO is out of lock.
TRANSMITTER DRIVE	1	Connect wattmeter to drive output CN7P.
	2	Key transmitter and adjust FVR301 for 200 mW drive.
TRANSMITTER MODULATION	1	Apply a 1 kHz, –34 dBm signal to CN10S-33 (high) and 34 (ground).
	2	Preset FVR302, 303, and 304 to approximately 60% of maximum setting.
	3	Key transmitter and adjust FVR303 for 70% deviation.
	4	Then raise the input to –14 dBm and adjust FVR302 for rated system deviation.
	5	Repeat this procedure a few times since the adjustments interact.
	6	FVR304 may be used to adjust for slight variations in modulating signal sources.
TRANSMITTER MODULATOR FREQUENCY RESPONSE	1	NOTE: Do not tamper with this adjustment unless L310 or L311 have been replaced. L310 and L311 are part of a low pass filter which provides a sharp roll-off of frequencies above 3 kHz. The radio need not be turned on for this adjustment.
	2	Connect a 1 kHz, 2v signal to the high side of R339 and an AC voltmeter to the high side of R338.
	3	Adjust input for a suitable reference level.
	4	Switch to 3 kHz and adjust L310 for –3 dB on the meter.
	5	Move the input to the high side of R340A and again set a reference at 1 kHZ.
	6	Adjust L311 for –3 dB on the meter. When properly adjusted, response at 5 kHz will be approximately –20 dB.

3.4 RX/TX VOLTAGE WAVEFORMS

The radio will operate reliably within the VCO voltage range of 1V to 5V. Single channel radios should be adjusted for approximately 3V while multifrequency units should be set within the 1V to 5V range on the lowest and highest frequencies. Exceeding this range may result in unreliable operation. Refer to Figure 3-2 for VCO characteristic curves for RX and TX.

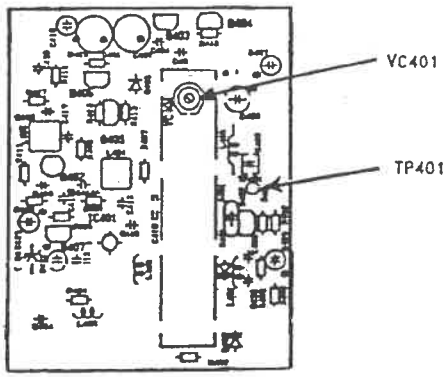


RX FREQ – VCO VOLTAGE



TX FREQ – VCO VOLTAGE

Figure 3-2. RX/TX Voltage Waveforms



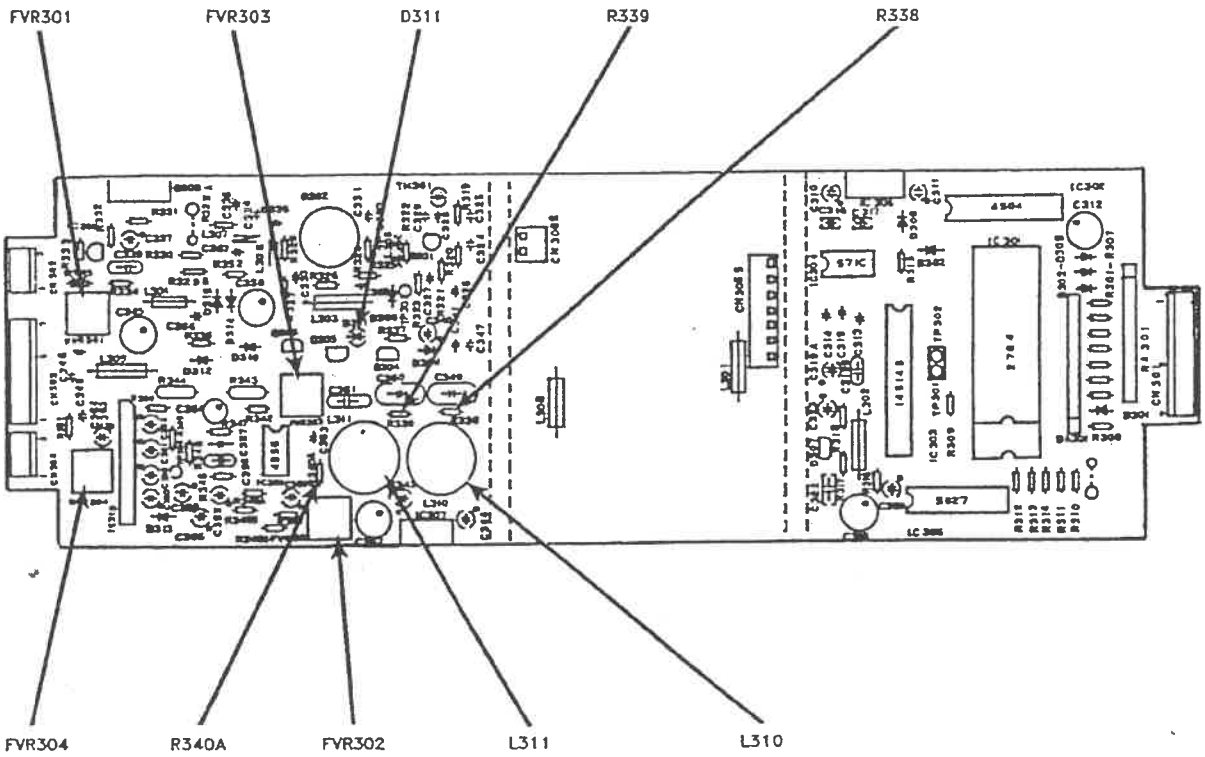


Figure 3-3. Transmitter Adjustment

3.5 PA UNIT ADJUSTMENT

(See Figure 3-4)

NOTE:

The PA contains a feedback control circuit which maintains power at the desired preset level. This circuit attempts to compensate for power level changes which occur during tuning. The following procedures will permit proper adjustment even though the power output will remain relatively constant during tuning.

Table 3-5. PA Unit Adjustment

TYPE	STEP	PROCEDURE
PA UNIT ADJUSTMENT	1	Connect wattmeter to transmitter output.
	2	For multifrequency units, select a channel near the center of the frequency range.
	3	Key transmitter. Set FVR601 for a power output of 10 to 15 watts.
	4	Q602 is located at the side of the PA module and is attached to the casting. The collector is the center pin. If necessary, solder in a short piece of wire for a test point. Connect DC voltmeter to Q602-C and adjust VC601 (VHF), VC601 and VC602 (UHF) for minimum reading.
	5	Adjust VC602 (VHF), VC603 AND VC604 (UHF) for minimum current from the power supply.
	6	Adjust FVR601 for desired power output. Do not adjust for more than 40 watts from the transmitter or 25 watts from the duplexer.

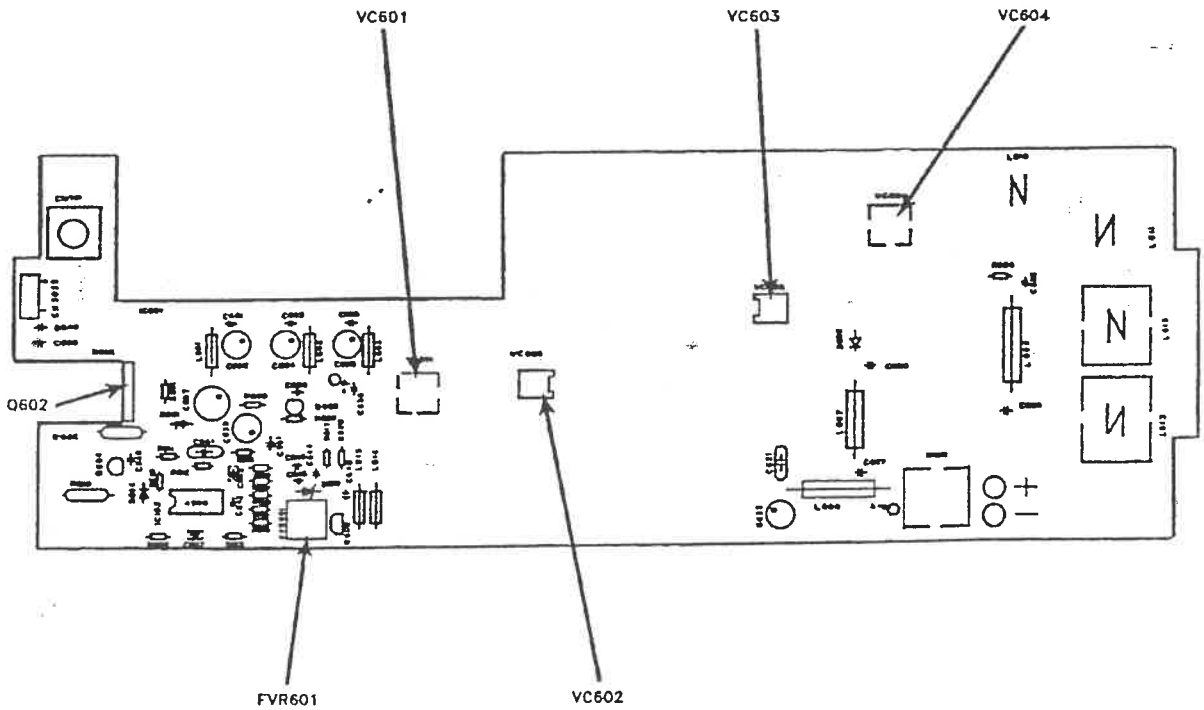


Figure 3-4. PA Unit Adjustment

3.6 HANDSET BASE UNIT

Use the following chart to determine the correct settings of the base unit DIP switch sections:

NOTE:

Disconnect power to the handset before changing any of the dip switch section positions from their factory default settings. Damage to some components in the base unit may occur if an unlisted combination of switch settings is maintained for an extended period of time.

Table 3-6. Base Unit DIP Switch Positions

SWITCH	PURPOSE	"OFF" FUNCTION	"ON" FUNCTION
1	Radio Channel Monitor Polarity	Reverse	Normal
2	Radio Channel Monitor Polarity	Normal	Reverse
3	On-Hook Transmit Logic	Trunking	Normal
4	On-Hook Transmit Logic	Trunking	Normal
5	On-Hook Transmit Logic	Normal	Trunking
6	Receiver Audio Source	(Open)	Black Wire
7	Receiver Audio Source	(Open)	Green Wire
8	On-Hook Transmit Logic	Normal	Trunking

NOTE:

Switches 1 & 2 must be set as a group to a given function, as must the group composed of switches 3, 4, 5 & 8. In most installations, switches 6 and 7 are placed in opposite positions.The "Normal" and "Trunking" designations used in the above table refer to typical system operating characteristics and may not necessarily apply to the system being used. Refer to Section 6 of this manual for a detailed description of these functions.

3.7 HANDSET MAIN PCB

NOTE:

In order to perform the following installation procedures, the Technician must first separate the two handset case halves. The easiest way to do this is as follows:

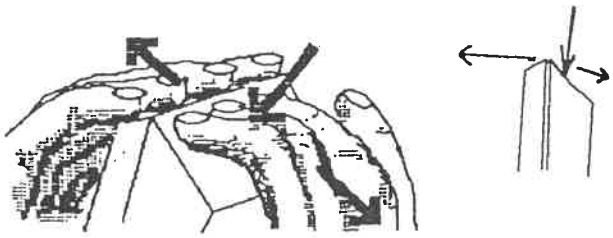


Figure 3-5. Opening the Handset Case

Use the following chart to determine the correct settings of the handset main PC board DIP switch sections:

Table 3-7. Handset Main PCB

STEP	PROCEDURE
1	Remove the two screws holding the case halves together. These screws are located under the switch label area in the inner half of the handset, near the speaker switch.
2	Remove the coiled cord from the bottom connector on the handset by pressing inward on the small clear plastic lever which is applied onto the cord connector.
3	Place the bottom of the handset on a soft, cushioned surface. Press downward on the top of the handset near the earpiece.
4	While placing downward pressure on the wide area at the top of the handset near the earpiece, pull the case halves apart. Be careful not to pull so far that the wires connecting the two case halves are stretched or broken.
5	Separate the joints at the bottom by carefully pulling the case halves apart in a manner similar to that used to separate the top joints.

Table 3-8. Handset DIP Switch Settings

SWITCH	PURPOSE	"OFF" FUNCTION	"ON" FUNCTION
1	DTMF High/Low Ratio (Twist)	+2 dB	+1 dB
2	Transmit Audio Output Range	High	Low
3	Transmit Audio Output Imp.	High (10K)	Low (10)
4	Receiver Audio Input Range	High	Low
5	Duplex Mic. Muting	Normal Muting	Dup. Muting
6	Normal Mic. Muting	Dup. Muting	Normal Muting
7	PTT Logic Select	Auto PTT Latch	Normal
8	PTT Logic Select	Normal	Auto PTT Latch
9	On- & Off-Hook ANI	Disable	Enable

NOTE:

As in the case of the base unit DIP switch settings, some of the above switches are set in groups (5 & 6, 7 & 8).Twist is the ratio between the levels of the DTMF column and row tones, expressed in dB. Because the higher frequency (column) tones are more readily attenuated in a telephone system than the lower frequency (row) tones, the twist is usually set to a positive value (+2 to +3 dB) in both telephones and interconnect equipment.

Since a large number of interconnects use DTMF audio directly from radios to dial the phone line, and since the net effects of pre-emphasis and de-emphasis cancel to a major extent in most radio systems, the twist selection switch should be set to the +2 dB position for normal operation.

3.8 HANDSET LEVEL SETTINGS

All level adjustment locations in the handset are located in the handset. There are no level adjustments in the base unit. (See Figure 3-6.)

Table 3-9. Level Adjustment

TYPE	STEP	PROCEDURE
DTMF LEVEL ADJ. (RV1)	1	This adjustment controls the level of the DTMF tones relative to the microphone audio level. For reliable DTMF signaling the total deviation (CTCSS plus each of the two single tones) should not exceed 2/3 of the maximum system deviation. As an example, for a maximum system deviation of 5 kHz, the total DTMF deviation should be adjusted for no more than 3.3 kHz.
	2	It is recommended that the transmitter CTCSS or DCS deviation be set to a level no higher than about 10 % of the maximum system deviation (500 Hz in a 5Hz system) in order to reduce the level of DTMF intermodulation distortion in the transmitter.
MICROPHONE SIDETONE LEVEL (RV2)	1	This adjustment controls the level of microphone sidetone in normal simplex operation. It is normally pre-set by the factory to the 12 o'clock position.
	2	For duplex operation or for radios with built-in sidetone, this control is adjusted to the fully counterclockwise (off) position.
MICROPHONE AUDIO LEVEL (RV3)	1	NOTE: Due to the high dynamic range of audio drive levels encountered between different radios, it may be possible to damage the microphone preamplifier circuitry of some radios by improper settings of the transmit audio output impedance and range switches. Follow the next steps closely if the required switch settings are unknown.

Table 3-9. Cont'd

MICROPHONE AUDIO LEVEL (RV3) Cont'd	2	In most cases, the microphone audio level is adjusted by first setting main PC board DIP switches S4-2 "on" and S4-3 "off".
	3	The Mic. Level Adj. potentiometer RV3 is adjusted for proper radio deviation with a normal speaking voice.
	4	If it is not possible to obtain a high enough deviation with these switch settings, repeat the above process with S4-2 in the "off" position.
	5	If the level is still not high enough, place S4-3 in the "on" position.
RECEIVE AUDIO LEVEL ADJ. (RV4 PLUS S4-4)	1	The receive audio level at the handset earpiece is adjusted to a comfortable level with potentiometer RV4 and main PC board DIP switch section S4-4.
	2	Remove the handset from the base and turn the audio speaker "on".
	3	Un-squelch the receiver, and adjust the radio volume control for a comfortable noise level from the speaker.
	4	With the earpiece held close to your ear, carefully adjust RV4 so that the level heard in the earpiece is equal to the level heard from the radio speaker with your other ear. It may be necessary to change the position of S4-4 in order to achieve the desired sound levels from the earpiece.

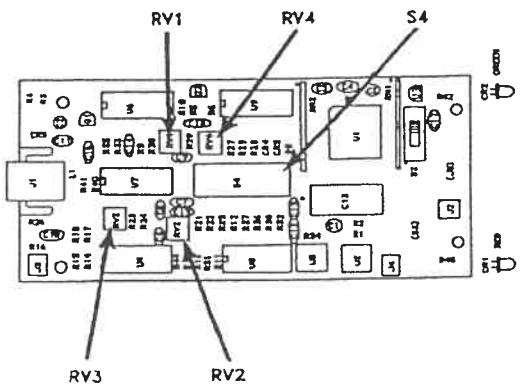
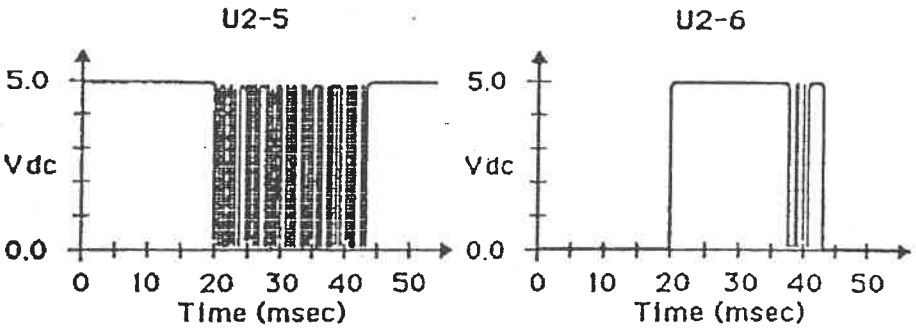


Figure 3-6. Handset Adjustment

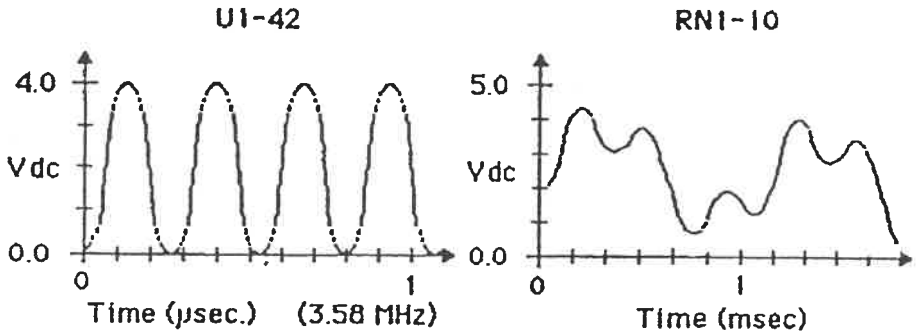
NOTE:

Improper adjustment of RV2, RV4, and S4-4 combined with high receiver volume settings may lead to a momentary loss of hearing and mild discomfort in the ear due to high sound levels from the earpiece in the handset. It is the responsibility of the technician installing the handset to determine the proper settings of these adjustments and to make sure that it is not possible to over-drive the handset audio amplifier with high volume control settings on the radio.

3.9 HANDSET VOLTAGE WAVEFORMS



Conditions: Waveforms shown above occur only during the first 100 msec. of a keypress during those operations which require EPROM memory access (ANI's and Autodialing locations only).



Conditions: Power on (Continuous)

Conditions: Manual DTMF operation with "5" key pressed

Figure 3-7. Handset Voltage Waveforms