SECTION 5

SERVICING

5.1 INTRODUCTION

Read this section carefully before attempting any repair of the SBE-12CB. Refer to the circuit description, block and schematic diagrams. The transistor case diagrams are shown on the schematic diagram. Refer to these diagrams before checking transistors. Component layout and location prints are provided to aid troubleshooting and alignment. **Use only recommended replacement parts.** Refer to the parts list in the back of this book. **Never replace blown fuses with higher rated ones or fast acting with slow blow.** To check operation of the unit, refer to Table 5-2, PERFORMANCE VERIFICATION PROCEDURE. Figures 5-5, -6, TRANSMITTER TEST CONNECTION and RECEIVER TEST CONNECTION respectively, show the proper manner to connect the unit to test instruments for performance verification or alignment. Table 5-1 lists RECOMMENDED TEST INSTRUMENTS. Tables 5-11, -7 show the proper TRANSMITTER ALIGNMENT PROCEDURE and RECEIVER ALIGNMENT PROCEDURE respectively. Figure 5-9, ALIGNMENT LAYOUT, is placed next to the alignment procedures to show alignment adjustments at a glance.

5.2 TEST SIGNALS

OSCILLOSCOPE WAVEFORMS are shown which were taken from various points in the SBE-12CB during normal operation into a dummy load. TEST POINT numbers next to the waveform pictures correspond to numbers in boxes on both the schematic diagram and component layout drawing. Figure 5-12 shows RF amplification through a properly aligned transmitter. Figure 5-13 shows 50%, 100% and overmodulation respectively. Notice that the waveforms at the TX MIXER – gate 1, gate 2 and drain of Q20 – contain several frequency components. Also notice that the waveform at the TX FINAL is unsymmetrical (Figure 5-12-f). This is proper since the TX FINAL operates class C for greater efficiency. Figure 5-12-g shows how the output should look at the dummy load.

VOLTAGE MEASUREMENTS are shown on the schematic diagram for normal operation. All voltages were measured with an AC VTVM having 10MΩ input impedance. Voltage measurements on high impedance RF points should be taken through a choke. While any choke of about 100μH is suitable, SBE part number 8000-00011-0018 (150μH) may be ordered from the factory. Mini-test clips are very useful for making voltage measurements in hard to reach places.

RECEIVER INJECTION VOLTAGES are given in Table 5-10 together with TEST POINT numbers which correspond to numbers in boxes on both the schematic diagram and component layout drawing. These tables specify the voltage level, carrier frequency and particular points in the receiver string at which a 30% – 1 KHz modulated signal injected through a .01 MFD capacitor should produce 2 VAC of audio across the speaker or 8Ω load plugged into the speaker jack, EXT SP. While the value of this capacitor is not critical, capacitive coupling of the signal generator to the circuit is necessary to prevent grounding out the transistor biases.

Before setting up to measure RECEIVER INJECTION VOLTAGES, small hand-held "all-purpose signal generators" can be used to provide a quick check of the receiver string. Basically, these devices generate pulses rich in harmonics from AF to RF to test whether a stage is working.

AGC VOLTAGES versus RF INPUT LEVEL are shown in Table 5-8. This table should be consulted before any adjustments are made on the squelch circuit since squelch is a function of AGC. Also, notice that AGC is a function of RF gain.

TRANSMITTER and RECEIVER ALIGNMENT PROCEDUREs are given in Tables 5-11 and 5-7, respectively. The TRANSMITTER ALIGNMENT PROCEDURE should be done first since it also aligns the frequency synthesizer.

The Troubleshooting Chart (Table 5-3) lists transceiver troubles and possible causes. This list is not meant to exhaust all possibilities, nor are they necessarily the most probable cause; they are the ones that stand out in repair people's minds because they are not obvious. Also, check the back pocket of this manual for later Service Bulletins.

5.3 TROUBLESHOOTING

Troubleshooting the SBE-12CB transceiver is not essentially different than troubleshooting any other electronic device. Be a detective; suspect everything and everyone. Carefully inspect the unit for evidence of overheated components, cold solder joints, or tampering. Understand thoroughly the circuit descriptions and block diagrams. Check the various +9 VDC buses. Follow the signal flow shown on the block and schematic diagrams. Test the transceiver in all modes. Try to start big and isolate the problem. Devise tests that will divide the transceiver in two and isolate the trouble to a particular half. Continue to divide into two parts until the trouble is located. For example, it is determined that a problem exists in a particular transceiver. The unit is divided into:

TRANSMITTER – RECEIVER.

Suppose that the transmitter puts out properly modulated carrier in AM, LSB and USB mode, but the receiver will not respond to a properly modulated RF signal at the selected channel frequency fed into the antenna jack. Since the transmitter AM modulates, it can be assumed that those stages of the audio amplifier used for both receive and AM modulation (Q24, Q25 and Q26) are good. Vary the RF signal level fed to the antenna and observe the S METER. If the S METER responds, we may conclude that the receive signal reaches Q7. Since the unit does not receive either AM or SSB and it is unlikely that problems could have occurred in both the PRODUCT DET and the AM AUDIO DET circuits, therefore, suspect Q27 or the squelch circuit. Divide this and continue until the trouble is found.

This technique is variously called, "partitioning," "boxing-in-the-trouble," "divide and conquer," or "binary search"; it is mandatory for complex electronic systems, but can save time and energy on almost any electronic device. Never fear to question an earlier assumption. For example, if an SBE-12CB looses SSB TX but not AM TX, logical analysis might indicate a faulty Q30 stage. Actually, it is more likely that either the Q28 or Q29 stages are faulty. This is because the Q28, Q29, Q30 amplifier string needs less gain for AM than SSB modulation. Often such problems are listed in the TROUBLE-SHOOTING CHART. (See Table 5-3.)

A blown fuse should only be replaced by one of the proper rating and type. If the fuse blows again, replace it, but place an Ω meter at the power terminals in place of the supply. Make certain that the + side of the Ω meter is connected to the red power wire of the SBE-12CB. Some VOM's place the - side of the Ω meter out the red test jack. Observe that diode D48 protects the units from a reversed supply.

A fuse may blow only when a unit is connected in a vehicle because the vehicle has a positive ground and there is a short from the PCB ground to the chassis, or a grounded speaker was plugged into the external speaker jack.

The second harmonic trap is adjusted at the Factory; field adjustment should not be attempted without proper equipment. Failure of particular channels to work or be on frequency probably indicates a defective crystal. Refer to Table (5-4) SYNTHESIZER MIXING SCHEME. Notice that the same Transmit and Receive crystals are used every fourth channel while each Master crystal is used on four adjacent channels. Check channel selector switch by swapping crystals.

TABLE 5-1 RECOMMENDED TEST INSTRUMENTS

TEST INSTRUMENT	REQUIRED SPECIFICATIONS	USE	RECOMMENDED INSTRUMENT TYPE
R.F. Signal Generator	Output frequency: 26.965 to 27.255 MHz. Output level calibrated from .1 microvolts to 500,000 microvolts. Internal modulation capability of 30% minimum at 1 KHz. (Calibrated)	Receiver service and alignment.	Hewlett-Packard Model 606A or B. Wavetek Model 3000.
Oscilloscope	Vertical bandwidth of 25 MHz or greater at 3db point. Triggered sweep capability.	Transmitter and receiver test and alignment.	Tektronics Model T932. Tektronics Model 465. Hewlett-Packard Model 180. Phillips Model PM3260E.
Frequency Counter	Frequency range DC to 30 MHz. Sensitivity: 10mv R.M.S. at 30 MHz. Overall timebase accuracy ±.002%, 6 digit resolution.	Transmitter frequency check and synthesizer troubleshooting.	Heath-Schlumburger Model SM128A
Wattmeter	25 watts full scale into 50 ohm load ±5% accuracy.	Measure power output and S.W.R.	Bird Model 43 with type 25A element. (May be terminated with antenna load
AC VTVM	-40 to +20db range.	Measure audio output.	Heath Model IM-21.
Audio Oscillator	400 Hz to 4000 Hz output: Adjustable level, 0-1 volt output impedence 600 ohm.	Audio and modulator tests.	Hewlett-Packard Model 204C. Heath Model SG18A.
DC Power Supply	13.8 volt DC ±10% at 4 amperes.	Primary supply voltage for servicing.	Heath Model SP2720 (SBE Model SBE-4AC may be used if available.)

TABLE 5-2 PERFORMANCE VERIFICATION PROCEDURE

TRANSMITTER

INITIAL SET-UP
Connect the SBE-12CB to a 13.8 VDC supply. Connect a wattmeter, dummy load and oscilloscope to the antenna jack.
STEP 1 Key the transmitter in AM and observe that the wattmeter indicates an output of at least 3.5 watts and that the RFO meter indicates about the same.
STEP 2 Whistle into microphone with transmitter keyed. Check for 90-100% modulation.
STEP 3 Connect counter to dummy load and check transmit frequencies on channels 1, 2, 3, 4, 8, 12, 16, and 20. (See Table 5-4.)
STEP 4 Key the transmitter in LSB without modulation. Check for less than 0.1 P-P carrier on scope.
STEP 5 Whistle into microphone with transmitter keyed. Check for at least 12 watts output.
STEP 6 Repeat steps 4 and 5 in USB.

RECEIVER

INITIAL SET-UP
Connect SBE-12CB to 13.8 VDC supply. Connect RF signal generator to the antenna jack and set to 27.085. Set the unit to channel 11. Turn the volume control full clockwise, the squelch control full counterclockwise, and center CLARIFIER. Connect 8Ω load to external speaker jack, EXT SP, and connect AC voltmeter to 8Ω load. (See Figure 5-6.)
STEP 1 Set the mode selector in AM. Adjust signal generator for 0.7μV output with 30% - 1 KHz modulation. Verify that at least 4 VAC appear across the 8Ω load.
STEP 2 Increase signal generator output to 200μV. Rotate squelch knob full clockwise. Receiver should squelch.
STEP 3 Adjust signal generator for 200μV. S-METER should read about 9.

STEP 4
Remove connection from external speaker jack if used. Adjust signal generator for 0.7μV output with no modulation. Set the mode selector to LSB. Rotate CLARIFIER back and forth. Tone should be heard at one end of the CLARIFIER.
STEP 5
Repeat step 4 in USB.

TABLE 5-3 TROUBLESHOOTING CHART

TROUBLE	REMEDY	
	CHECK	**REPLACE**
No TX, weak RX		Q23, D29
No TX, RF out of Q23	L9, L11, and L12	
No TX, no Q20 output	D39	
No SSB TX but AM TX O.K.	Q28, Q29, Q30	
No RX or very weak RX	Q1 for E-B short	Q1 and Q6
Weak noisy RX		Q2
No or bad AM RX	7.803 MHz OSC FREQ	
No RX AUDIO, S-MTR shows RX	SQ CKT, C133, Q8 & Q9	

TABLE 5-4 SYNTHESIZER MIXING SCHEME

7.8 MHz OSC XTAL FREQ X1 = 7.8025

CH	FREQ	11 MHz OSC XTAL FREQ	7 MHz OSC XTAL FREQ (AM RX ADD 2 KHz)
1	26.965		X5 = 7.4625
2	26.975	X6 = 11.700	X4 = 7.4725
3	26.985		X3 = 7.4825
4	27.005		X2 = 7.5025
5	27.015		X5
6	27.025	X7 = 11.750	X4
7	27.035		X3
8	27.055		X2
9	27.065		X5
10	27.075	X8 = 11.800	X4
11	27.085		X3
12	27.105		X2
13	27.115		X5
14	27.125	X9 = 11.850	X4
15	27.135		X3
16	27.155		X2
17	27.165		X5
18	27.175	X10 = 11.900	X4
19	27.185		X3
20	27.205		X2
21	27.215		X5
22	27.225	X11 = 11.950	X4
23	27.255		X2

15 MHz signal is produced by doubling the 7.8 MHz signal
15.605 = 2 X (7.8025)

19 MHz signal is produced by mixing 7 MHz with 11 MHz
* 19.2025 = 7.5025 + 11.700 SSB TX, RX & AM TX
* 19.2045 = 7.5045 + 11.700 AM RX

34 MHz signal is produced by mixing 19 MHz with 15 MHz
* 34.8075 = 19.2025 + 15.605

* 27.005 MHz = 19.2025 + 7.8025 LSB
* 27.005 MHz = 34.8075 - 7.8025 USB

*EXAMPLE CHANNEL 4

FIG. 5-5 TRANSMITTER TEST CONNECTION

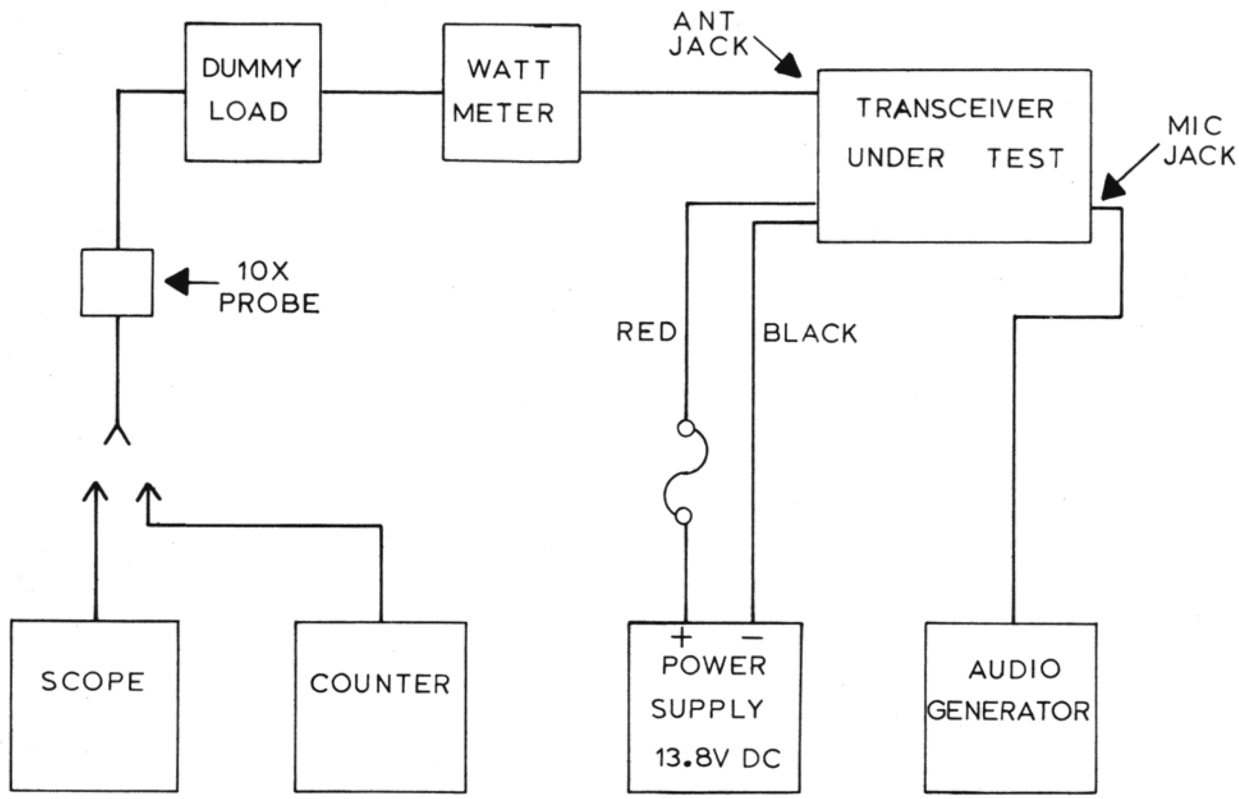

FIG. 5-6 RECEIVER TEST CONNECTION

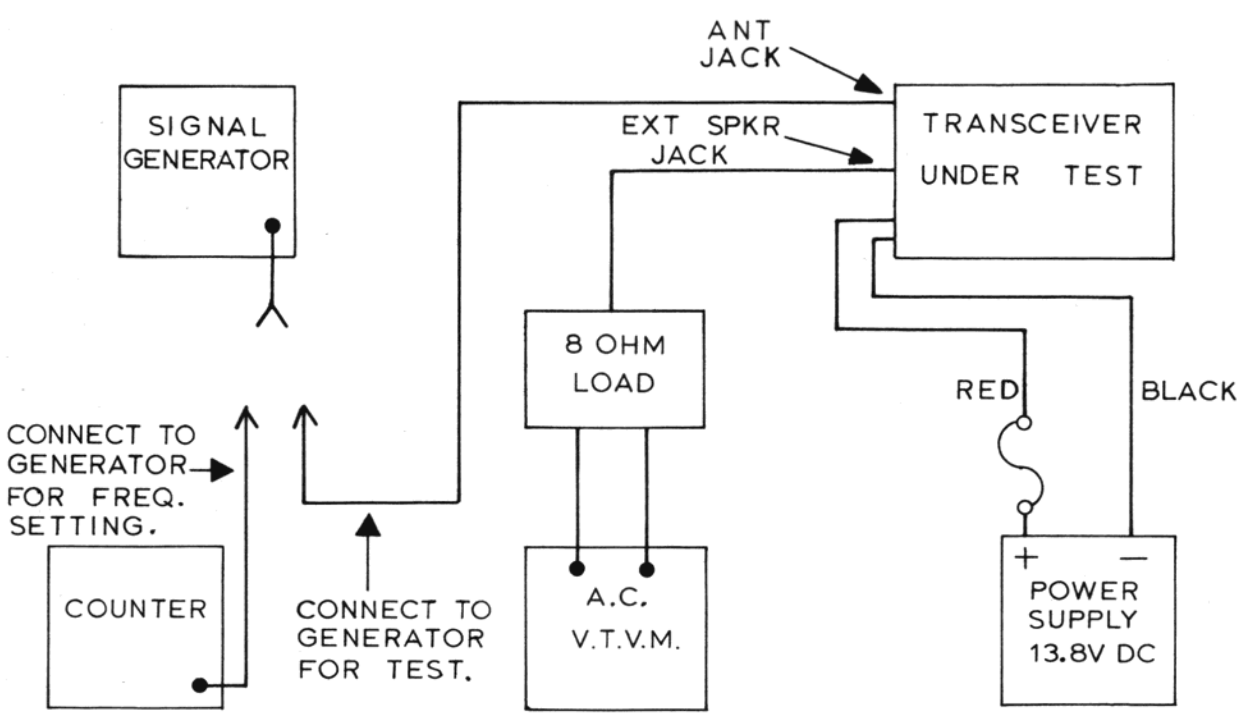

FIG. 5-7 RECEIVER ALIGNMENT PROCEDURE

INITIAL SET-UP

Connect the transceiver to a 13.8 VDC supply. Set channel selector to channel 11, PA/CB switch to CB. Turn squelch control full counterclockwise, and the volume control full clockwise. (See Figure 5-6.)

STEP 1

Connect a voltmeter to TP3. Set mode switch to AM. Without a connection to the antenna jack, adjust AGC potentiometer VR4 for 1.0 VDC.

STEP 2

Set an RF signal generator to 30% - 1 KHz modulation @ 27.085 MHz. Connect this generator to the antenna jack, and adjust to a level just sufficient to produce a slight indication on the S METER. Connect an AC voltmeter across the speaker or 8Ω load plugged into the EXT SP J3. Adjust T1, L1, T2, T4, and T5 for maximum indication on voltmeter. Repeat adjustment until 0.7μV RF signal produces about 2 VAC.

STEP 3

Set output level of RF signal generator to 200μV. Adjust VR3 for an S-9 indication.

STEP 4

Set RF signal generator level to 300μV. Turn squelch control full clockwise. Adjust VR9 until squelch just breaks.

STEP 5

Set RF signal generator to 27.085, without modulation and 0.7μV level. Adjust clarifier and T6 for maximum voltmeter indication.

TABLE 5-8 AGC VOLTAGES versus RF INPUT LEVEL

INPUT LEVEL (1)	AGC VOLTAGES (2)
ANT JACK J1	+1.0
1μV	+0.96
10μV	+0.51
100μV	+0.18
1000μV	+0.08
10,000μV	+0.05

(1) Channel Frequency at Antenna Jack.

(2) Measured with 10MΩ input at TP3.

FIG. 5-9 ALIGNMENT LAYOUT

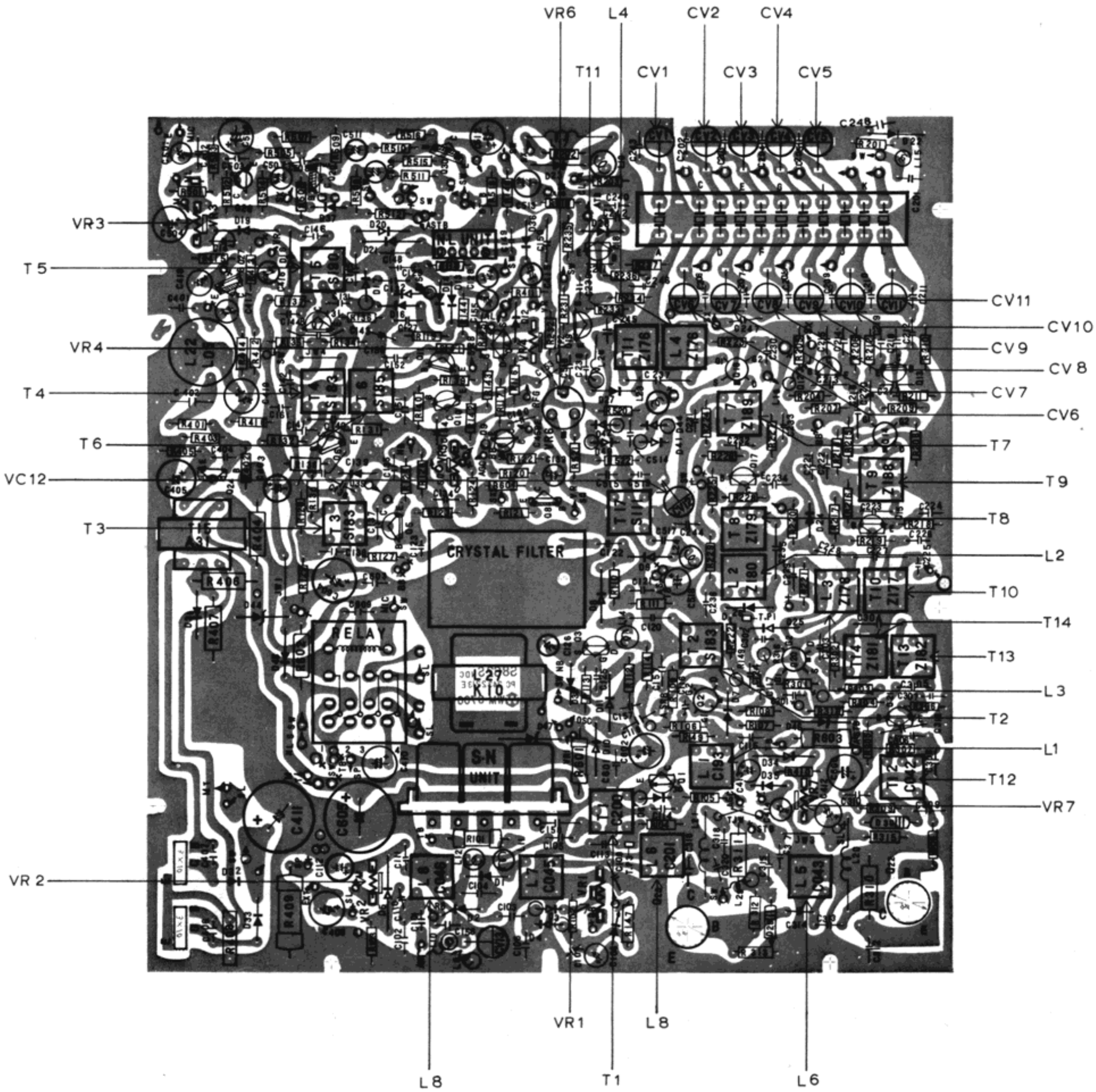

TABLE 5-10 RECEIVER INJECTION VOLTAGES

All injection voltages are at 30% – 1 KHz modulation at the specified frequency fed through a .01 MFD capacitor, and should produce at least 2 VAC audio output measured across the speaker or across an 8Ω load connected at EXT SP J3. Typical audio output voltages are given.

INJECTION POINT	INJECTION LEVEL	FREQUENCY	AUDIO OUTPUT
ANT JACK J1	1μV	Channel Freq.	8.5V
Emitter of Q1 – TP4*	3μV	Channel Freq.	3.5V
Gate 1 of Q2 – TP5	10μV	7.8 MHz	2.9V
Base of Q5 – TP6	10μV	7.8 MHz	6.0V
Base of Q6 – TP7	30μV	7.8 MHz	3.6V
Base of Q7 – TP8	300μV	7.8 MHz	3.5V

* TP numbers correspond to numbers in boxes on schematic diagram and component location drawing.

FIG. 5-11 TRANSMITTER ALIGNMENT PROCEDURE

INITIAL SET-UP

Connect the transceiver to a 13.8 VDC supply. Connect an audio oscillator and AC voltmeter to the MIC input, a wattmeter and dummy load to the antenna jack, an oscilloscope to the dummy load, set the CB/PA switch to CB, center CLARIFIER, and set the channel selector to channel 17. (See Figure 5-5.)

STEP 1

Connect frequency counter to TP-2. Adjust CV1 for 7.8023 MHz.

STEP 2

Connect frequency counter to emitter of Q13. Set the channel selector and adjust:

channel 1, CV6 for 11.700 MHz
channel 5, CV7 for 11.750 MHz
channel 9, CV8 for 11.800 MHz
channel 13, CV9 for 11.850 MHz
channel 17, CV10 for 11.900 MHz
channel 21, CV11 for 11.950 MHz

STEP 3

Connect counter to dummy load. Key transmitter in AM. Set the channel selector and adjust:

channel 1, CV2 for 26.965 MHz
channel 2, CV3 for 26.975 MHz
channel 3, CV4 for 26.985 MHz
channel 4, CV5 for 27.005 MHz

STEP 4

Set the audio oscillator to 1 KHz, key the transmitter in LSB. Adjust ALC control VR1 to end that gives maximum power output.

STEP 5

Set to channel 17. Key transmitter in USB. Set the audio level to indicate about 6 watts on wattmeter. Adjust T11, L4, T9, T10, T7, T8, L2, T3, T14, and T13 for maximum power output.

STEP 6

Key transmitter in LSB. Adjust L3 for maximum power output.

STEP 7

Increase audio oscillator level until maximum indication on wattmeter is reached. Adjust T12, L5, L6, and L8 for maximum power output.

STEP 8

While switching between channels 1 and 23, adjust T14 for least change in power output.

(cont.)