SBE Cortez Service Manual

CORTEZ
MODEL SBE·21CB

SERVICE MANUAL

SBE®

TABLE OF CONTENTS

SECTION 2

SPECIFICATIONS

2.1 GENERAL

Compliance	F.C.C. Type Accepted (Part 95, Class D)
Channels	23
Frequency Range	(26.965 - 27.255) MHz
Frequency Control	Crystals, Synthesized
Frequency Tolerance	±0.003%
Operating Temperature Range	–30°C to +50°C
Humidity	95%
Input Voltage	(11.7 - 15.9) VDC positive or negative ground
Microphone	Dynamic
Size	Height: 2-1/8" (54mm) Width: 5-7/8" (150mm) Depth: 8-3/4" (223mm)
Weight	4 lbs., 1.82 Kg.
Power Consumption	13.8 VDC Receive (squelched) 400ma Receive (2 watts audio) 1.0A Transmit (3 watts out) 1.7A
Fuse	2A fast blow (Type 3AG or A.G.C.)

2.2 RECEIVER

Sensitivity	0.7μV for 10db S+N/N
Selectivity	6db @ 60 KHz, 50db @ 10 KHz
IF Frequency	10 MHz, 455 KHz
AGC Response	Less than 10db for 10-100,000μV
Squelch Threshold	Less than 1μV More than 200μV
Audio Power Output	2 watts

External Speaker	(Not Supplied) 4 or 8Ω. Disables internal speaker when connected.
Squelch Range	200μV (Minimum)

2.3 TRANSMITTER

Power Output	4 watts
Modulation	95-100%
Modulator Response	300-2500 Hz
Output Impedance	50Ω, unbalanced
Emission	6A3

SECTION 3
INSTALLATION

3.1 GENERAL

The first step in installation of the mobile transceiver is selection of antenna and transceiver mounting positions.

The selection of an antenna and its mounting position is the most critical factor in determining the end performance of an installation. Generally, the most satisfactory installation position for most vehicles is the center of the passenger compartment roof. As a second choice, the trunk can be a satisfactory antenna mounting point, especially on those cars where the trunk is large and flat. Due to increased susceptibility to ignition noise, mounting the antenna in the hood area is discouraged. Follow antenna manufacturer's recommendations carefully during installation.

The SBE-21CB is supplied with a universal mounting bracket and microphone holder. The transceiver may be mounted in any position and on any rigid surface, such as underneath an automobile dashboard, truck roof or vertically on a boat bulkhead.

The transceiver should be mounted with accessibility and operation convenience in mind.

CAUTION: Avoid mounting the transceiver in the direct air stream of the vehicle's heater. Temperatures in this area can exceed 150° and can result in serious damage to the unit.

It is recommended that the mounting bracket be installed on the transceiver and mounting clearances checked, with the unit held in the desired mounting position. It is especially important to leave sufficient space behind the unit for antenna and accessory cable connections.

When the most desirable mounting installation point has been decided upon, a pencil or other marking device should be used to outline the mounting bracket on the mounting surface. The transceiver should then be removed from the mounting bracket and the bracket held against the dash or other mounting surface, in the position marked, so that mounting holes may be marked and drilled.

CAUTION: Be sure to check behind the dash or other mounting surface to insure against damage of wiring and other devices before drilling any holes.

Install the microphone holder on the radio or other mounting surface as desired.

Install any accessories at this time, including external speaker, public address speaker, etc.

This unit is designed for either 12 volt positive or negative ground systems. In either system, the positive battery terminal always connects to the red supply wire, and the negative battery terminal always connects to the black supply wire. If the transceiver's power lead must be lengthened, use No. 14 or larger wire.

CAUTION: When using this radio in a positive ground system, it is important that none of the accessories are electrically connected to the vehicle's chassis (external speakers, P.A. speakers, etc.). Positive ground installations must utilize an additional 2 ampere fuse in the negative (black) supply lead to avoid possible damage to the transceiver. NOTE: The transceiver power lead may be connected to the accessory section of the ignition switch if desired. However, due to the possible presence of high-level noise from the ignition and accessories, this connection may not be desirable. In cases where excessive noise is present on the accessory line, a direct connection to the battery is recommended.

3.2 ANTENNA TUNING

The final step in installation is to trim the antenna for minimum S.W.R. The recommended method of antenna tuning is to use an in-line wattmeter or S.W.R. bridge to adjust the antenna for minimum reflected power on channel 11. A properly tuned antenna system will present a suitable load to the transceiver and will insure that maximum power is transfered from the radio to the antenna. If the antenna system in use presents a poor load, as indicated by a high S.W.R. reading, transmitter range will be substantially reduced and damage to the transmitter final amplifier transistor may occur. Poor S.W.R. can usually be corrected by altering the antenna's electrical length in accordance with the manufacturer's instruction. Extremely high S.W.R. readings may be indicative of a defective transmission line, antenna, or connections.

To determine whether the antenna should be lengthened or shortened, test the S.W.R. on channels 1 and 23. If the S.W.R. is the highest on channel 23, the antenna is too long and if highest on channel 1, the antenna is too short. When the antenna system has been tuned correctly, channel 11 should have the lowest S.W.R. and channels 1 and 23 will be slightly higher.

3.3 FINAL CHECK

Test drive the vehicle and make an operational check-out of the transceiver to insure proper operation of it and all the accessories installed. At this time, note any degradation of performance due to vehicle noise and take appropriate action to correct any deficiencies as outlined in the following section.

3.4 NOISE SUPPRESSION

The first step in assuring minimum ignition noise is to insure that the engine ignition system is in a good state of tune, and all factory original noise suppression devices are installed and operational. This includes an inspection of distributor points and condenser. Check to see that the spark plugs are clean and properly adjusted. The condition of the ignition wiring should be checked (radio resistor type ignition wire is standard on most late model vehicles and should be installed on vehicles not so equipped). The distributor cap should be checked for traces of carbon tracking or signs of arcing. Resistor type spark plugs are helpful in further reducing ignition noise and are standard as original equipment on many late model vehicles.

Alternator noise may be minimized by the installation of an alternator line filter, available from radio parts distributors.

Installation of bonding straps in the engine compartment will further reduce ignition noise. Short lengths of metal strap or heavy shield braid between the engine and frame, engine and fire wall, alternator and frame, exhaust pipe and frame, or hood to frame, will in many cases, greatly reduce ignition noise. Extremely high ignition noise levels or noise levels that become worse after a period of time are usually indicative of deterioration of the vehicle's electrical system. In some cases, interference may be caused by dash instruments including gasoline gauges, heater blowers and fans, etc. This interference may often be reduced by the installation of bypass capacitors from the terminals of the interfering instruments to ground. .01 microfarad capacitors of the ceramic disc variety rated at 500 working volts DC are recommended for this purpose.

For further information on the suppression of ignition noise in the automotive and marine environment, the Champion Spark Plug Company publication "Giving Two Way Radio Its Voice" is highly recommended. This publication is available from the automotive technical service department Champion Spark Plug Company, Post Office Box 910, Toledo, Ohio 43661. This publication is also available, at no charge, from the SBE Technical Services Department, upon request.

SECTION 4

CIRCUIT DESCRIPTION

4.1 INTRODUCTION

The SBE-21CB is an AM transceiver with a dual-conversion receiver using intermediate frequencies of 10 MHz and 455 KHz.

Refer to the block and schematic diagrams while following the circuit description.

TRANSMIT MODE is initiated by pressing the push-to-talk switch which energizes relay RL-1 which:

DISABLES:

RX RF AMP Q1,
1st RX MIXER Q2,
1st IF AMP Q3,
2nd IF AMP Q4,
RX OSCILLATOR Q9,
1st RX AUDIO Q15, by grounding the 9V RX BUS,
SPEAKER SP-1,

ENABLES:

TX OSCILLATOR Q10,
TX BUFFER Q12, by applying B+,
RX PROTECTION DIODE D1, by grounding the cathode.

When the push-to-talk switch is released the transceiver is in RECEIVE MODE and the above states are reversed.

PA MODE is initiated by placing the PA/CB switch in PA which:

disables the TX RF, by removing Q10, Q11 and Q12 B+,
disables the CB SPEAKER,
enables the PA speaker jack.

4.2 RECEIVER

In receive mode, an RF signal is fed from the antenna to the RF AMP Q1. The amplified RF signal is then fed to Q2 – the 1st mixer – where it is mixed with an injection signal from the MASTER OSCILLATOR Q8 about 10 MHz below the receive channel frequency. The resultant 10 MHz 1st IF is selected by T2 and fed to D4 – the 2nd mixer – where it is mixed with an injection signal from the RX OSCILLATOR Q9 455 KHz below the 10 MHz 1st IF. The ceramic filter FL-1 selects the 455 KHz signal and feeds it to the 1st IF AMP Q3 which then feeds it to the 2nd IF AMP Q4. The output of Q4 is fed through C28 to the AGC detection diodes D9 and D10, from T6 to the S METER detection diode D5, and through C26 to the audio detection diodes D6 and D7. After passing through the AUTOMATIC NOISE LIMITER, the detected audio signal is applied to the wiper of potentiometer VR3 – the volume control. The audio signal developed across VR3 is then fed to audio amplifier stage Q15 which then feeds Q16. The output of Q16 is transformer coupled to push-pull speaker driver amplifier Q17 and Q18.

AUTOMATIC GAIN CONTROL CIRCUIT

The AGC (Automatic Gain Control) on the SBE-21CB reduces the gain of the receiver in response to a strong signal by lowering the bias on the RF and IF amplifiers. The AGC voltage is developed at the R22, R23 junction and filtered by C34 and C35. With a weak receiver input signal – less than 1μV – diodes D9 and D10 are forward biased by current through R22 and R23. About 1.5 volts of AGC appear at the C34, R23 junction. As the input signal increases, the signal at the top of C28 increases. When the signal at the top of C28 swings negative, current flows through D9 on to C28. As the signal swings positive, C28 discharges through D10. The increase in current through R22 decreases the AGC voltage. The AGC voltage is then fed through R3 to the base of Q1, and through R11 to the base of Q3.

THE AUDIO DETECTOR

The AUDIO DETECTOR on the SBE-21CB demodulates the received signal. The output of the 2nd IF AMP is fed from the top of the primary T6 through C26 to the detector diodes D6 and D7. When the signal at the top of T5 swings negative, D7 conducts current on to C26. As the signal swings positive, C26 discharges through D6 and charges C30. The voltage on C30 thus tends to follow the peak-to-peak voltage of the received signal and is thus the demodulated audio signal which is then fed through the AUTOMATIC NOISE LIMITING circuit, through C32 to the wiper of VR3 – the volume control, and from the top of VR3 through C33 to Q15 – the first stage of audio.

AUTOMATIC NOISE LIMITER CIRCUIT

The ANL circuit prevents impulse noise, such as ignition noise, from being amplified. The audio output voltage from the detector diodes D6 and D7 is reduced about 1/2 by voltage divider R17 and R18 and then fed to the cathode of D8 – the ANL diode. The audio output from the detector diodes is also fed through R19 to C31 where it is filtered and then fed through R20 to the anode of D8. Since the audio signal is positive, the signal at the anode of D8 is normally more positive than the cathode and the diode is forward biased providing a low impedance path for the audio to the first audio stage, Q15. When a noise pulse appears in the output of the detector, the time constant of R19 and C31 prevents the anode of D8 from responding as fast as the cathode. The cathode of D8 is thus driven more positive than the anode causing D8 to become backed biased. D8 then becomes a high impedance that blocks the noise.

SQUELCH CIRCUIT

The squelch circuit shuts the audio off when the received signal is less than the threshold level as determined by the squelch control VR1. The 2nd IF signal is AC coupled from the secondary of T6 through C27 to the cathode of D11. A DC bias is applied to the signal from the wiper on the SQUELCH CONTROL VR1. An IF signal produces a negative voltage at the base of Q5 which tends to turn it off. When Q5 is turned off, Q6 is turned on turning Q7 off. With Q7 off, the 1st AUDIO AMP Q15 is properly biased to amplify audio. Moving the wiper on VR1 so as to make the DC component more positive, turns Q5 and Q7 on. Q7 then back biases Q15 and shuts the audio off. Thus moving the wiper on VR1 more positive increases the threshold level a signal must overcome to "break squelch" – turn Q7 off and permit Q15 to pass audio.

S METER CIRCUIT

In receive mode, meter M1 functions as an S METER, and indicates relative strength of the received signal. The IF signal from the secondary of T6 is rectified by D5, filtered by C29, and then fed to meter M1 through VR5 – the S METER ADJ.

4.3 TRANSMITTER

In transmit mode, the output of the MASTER OSCILLATOR Q8 and the TX OSCILLATOR Q10 are mixed in the TX MIXER D16. The output of D16 is then fed through BAND PASS FILTER T7 and T8 (26.965 – 27.255 MHz) to the TX BUFFER Q11. The output of the BUFFER feeds the TX AMP Q12 which in turn feeds the TX DRIVER Q13. The TX DRIVER then feeds the TX FINAL Q14. The output of the TX FINAL is then fed through a low pass filter, L8, C71, L9, C72, and a second harmonic trap CV1 and L10, to the antenna. Modulation is accomplished by driving the collector of the TX DRIVER and TX FINAL by modulated B+ derived from the lower secondary of T12 – the AUDIO OUTPUT transformer.

FREQUENCY MIXING SCHEME

Channel Selector switch S2 selects one of six crystals (X5 – X10) to set the MASTER OSCILLATOR Q8 frequency about 10 MHz below the selected channel frequency. (See Table 5-3.) The output of Q8 is fed to the 1st MIXER Q2 to produce the 1st IF. S2 also selects one of four crystals (X1 – X4) for the RX OSCILLATOR Q9. The output of Q9 is fed to the 2nd MIXER D4 to produce the 455 KHz 2nd IF. One of four crystals (X11 – X14) is also selected by S2 for the TX OSCILLATOR Q10. The outputs of the TX and MASTER OSCILLATORS are mixed in TX MIXER diode D16. The sum of the frequencies from these oscillators is selected to produce the transmitter frequency.

OVERMODULATION LIMITER

The OML regulates the gain of the audio amplifier so as to accommodate a wide range of voice levels without overmodulating the carrier. The audio signal is fed from the secondary of the audio output TRANSFORMER T12 through the OML adjustment VR4 to D14 where it is rectified; it is then filtered by R68, C79 and C78 and then fed to the emitter of Q15 – the 1st AUDIO AMP. As the sound level into the MIC increases, the voltage at the emitter of Q15 will rise and thus lower the amplification of the sound input.

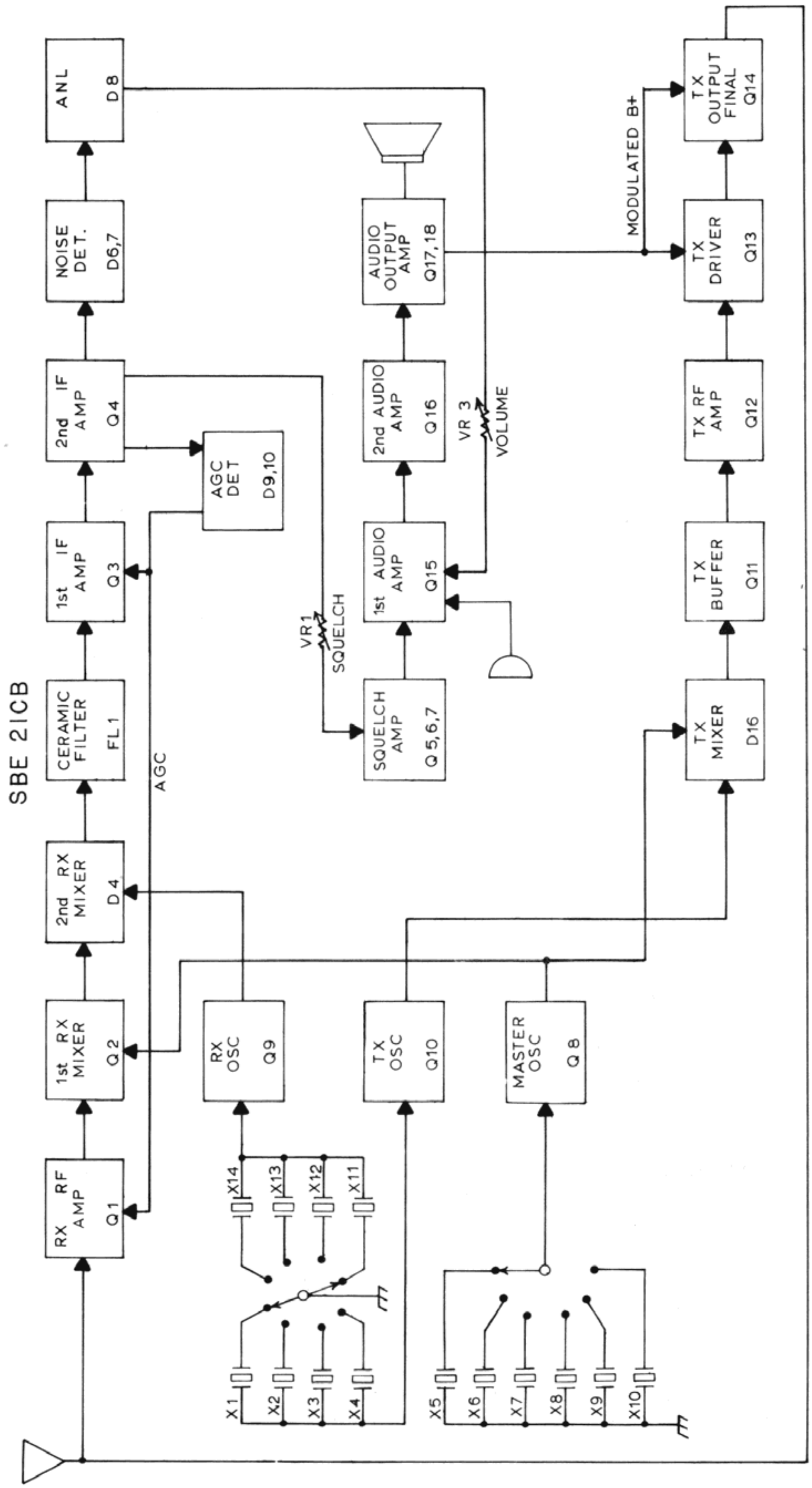
OSCILLATORS

Crystal oscillators Q8, Q9 and Q10 are common collector, colpitts circuits. Outputs are taken from the emitters. The collectors of Q8, Q9 and Q10 are at AC ground.

RF OUTPUT METER

In transmit mode, meter M1 functions as a transmitter power output indicator. A small sample of the transmitter's RF output signal is fed by C75 to network R71, D18 and C74 where it is rectified, filtered and then fed through VR6 – the RFO ADJ – to meter M1.

FIG. 4-1 SBE-21CB TRANSCEIVER BLOCK DIAGRAM



SECTION 5

SERVICING

5.1 INTRODUCTION

Read this section carefully before attempting any repair of the SBE-21CB. 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 Figure 5-1, PERFORMANCE VERIFICATION PROCEDURE. Figures 5-4, 5-5, 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 5-2 lists RECOMMENDED TEST INSTRUMENTS. Tables 5-10, 5-6 show the proper TRANSMITTER ALIGNMENT PROCEDURE and RECEIVER ALIGNMENT PROCEDURE respectively. Figure 5-8, 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-21CB during normal operation into a dummy load. CHECK POINT numbers next to the waveform pictures correspond to numbers in boxes on both the schematic diagram and component layout drawing. Figure 5-11 shows RF amplification through a properly aligned transmitter. Figure 5-12 shows 50%, 100% and overmodulation respectively. Notice that the waveform at the ANODE of D16 – the TX MIXER – contains several frequency components. Also notice that the waveform at the collector of Q14 – the TX FINAL – is unsymmetrical (Figure 5-11e). This is proper since the TX FINAL operates class C for greater efficiency. Figure 5-11f 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 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 5-9 together with CHECK POINT numbers which correspond to numbers in boxes on both the schematic diagram and component layout drawing. This table specifies 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 5-7. This table should be consulted before any adjustments are made on the squelch circuit since squelch is a function of AGC.

5.3 TROUBLESHOOTING

Troubleshooting the SBE-21CB 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 description and block diagram. 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 receiver functions properly but there is no carrier when the transmitter is keyed. Since the receiver audio works, it can be assumed that all of the audio amplifier is good. The MASTER OSCILLATOR can be assumed working since it is used by both the transmitter and receiver. After checking the TX/RX relay RL-1 and transmitter B+, the transmitter is then divided into:

BEFORE TX AMP – TX AMP and AFTER.

Figure 5-11, TRANSMIT ALIGNMENT WAVEFORMS, shows typical waveforms taken at various points in an SBE-21CB transmitter during normal operation. Place an oscilloscope probe on the collector of Q11. If a signal is present and doesn't differ significantly from the waveform picture then the problem exists after Q15. Keep dividing until the trouble is found.

This technique is sometimes 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.

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-21CB. Some VOM's place the – side of the Ω meter out the red test jack. Observe that D19 protects the unit from a reversed supply.

A fuse may blow only when the 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 EXT SP J2.

The second harmonic trap (L10 and CV1) 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 5-3 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, S2, by swapping crystals.

FIG. 5-1 PERFORMANCE VERIFICATION PROCEDURE

TRANSMITTER

INITIAL SET-UP

Connect the SBE-21CB to a 13.8 VDC supply. Connect a wattmeter, dummy load and oscilloscope to the antenna jack.

STEP 1

Key the transmitter and observe that the wattmeter indicates an output of at least 3 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 5-3.)

RECEIVER

INITIAL SET-UP

Connect SBE-21CB to 13.8 VDC supply. Connect RF signal generator to the antenna jack and set to 27.085 MHz 30% - 1 KHz modulation. Set the unit to channel 11. Turn the volume control full clockwise and the squelch control full counterclocksiwe. Connect 8Ω load to external speaker jack, EXT SP, and connect AC VTVM to 8Ω load. (See Figure 5-5.)

STEP 1

Adjust signal generator for 0.7μV output. Verify that at least 2 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 100μV. S-METER should read about 9.