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**SBE Capri II Service Manual**

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*Capri II*

MODEL SBE-23CB



# SERVICE MANUAL

**SBE**®

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SUBJECT	NUMBER

## **SECTION 1 GENERAL**

### **1.1 CUSTOMER SERVICE**

The SBE Technical Services Department functions as a source of information on the application, installation and use of SBE products. In addition, the Technical Services Department provides technical consultation on service problems and availability of local and factory repair facilities.

In any communications to the Technical Services Department, please include a complete description of your problems or needs, including model and serial numbers of the unit or units in question, accessories being used, any modifications or attachments in use, or any non-standard installation details.

For assistance on any of the above matters, please contact SBE, Incorporated, Technical Services Department, 220 Airport Boulevard, Watsonville, California 95076. Phone: 408/722-4177.

### **1.2 PARTS ORDERS**

SBE original replacement parts are available from the Factory Parts Department at 1045 Main Street, Watsonville, California 95076.

When ordering parts, please supply the following information:

Model number of the unit.  
Serial number of the unit.  
Part number.  
Description of the part.

### **1.3 FACTORY RETURNS**

Repair services are available locally through SBE Certified Service Stations across the country. A list of these Service Stations is available upon request from the Technical Services Department. Do not return any merchandise to the Factory without authorization from the Factory.

**SECTION 2**  
**SPECIFICATIONS**

**2.1 GENERAL**

Compliance	F.C.C. Type Accepted (Part 95, Class D)
Channels	5
Frequency Range	(26.965 - 27.255) MHz
Frequency Control	Crystal, Controlled
Frequency Tolerance	±0.003%
Operating Temperature Range	-30° C to +50° C
Humidity	95%
Input Voltage	(11.7 - 15.9) VDC negative ground
Microphone	Dynamic
Size	Height: 1.5" (39mm) Width: 6.5" (166mm) Depth: 7.5" (191mm)
Weight	3.5 lbs., 1.6 Kg.
Power Consumption	13.8 VDC Receive (squelched) 0.25A Receive 1.0A Transmit (100% modulation) 1.4A
Fuse	2A fast blow (Type 3AG or A.G.C.)

**2.2 RECEIVER**

Sensitivity	0.7 $\mu$ V for 10db S+N/N
Selectivity	-6db @ ±6 KHz, -40db @ 20 KHz, -60db @ 40 KHz
IF Frequency	455 KHz
AGC Response	Less than 10db for 10-100,000 $\mu$ V
Squelch Threshold	Less than 1 $\mu$ V
Audio Power Output	2 watts with less than 10% distortion

External Speaker	(Not Supplied) 4 or 8 $\Omega$ . Disables internal speaker when connected.
Squelch Range	200 $\mu$ V (Minimum)

### 2.3 TRANSMITTER

Power Output	4 watts
Modulation	95-100%
Modulator Response	300-2500 Hz
Output Impedance	50 $\Omega$ , 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-23CB** 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.

### **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 transferred 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 noise suppression and 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-23CB is an AM transceiver with a single-conversion receiver using an intermediate frequency of 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:

- disables the RF AMP Q1, the RF MIXER Q2, the IF AMP Q3, and the first stages of audio Q10 and Q11,

- disables the CB SPEAKER by opening its ground return,

- forward biases D7 – the transmitter switching diode,

- enables the MIC AMP by grounding the return.

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

#### 4.2 RECEIVER

In the receive mode, the RF signal is fed from the antenna to the RF AMP (Q1). The amplified RF signal is then fed to Q2 – the mixer – where it is mixed with an injection signal 455 KHz below the receive channel frequency. The filter formed by T1, T2, T3 and T4 selects the 455 KHz converted signal to be fed to the 1st and 2nd IF amplifiers Q3 and Q4. The amplified IF signal is then detected by D4 and D5. After passing through the automatic noise limiter, the detected audio signal is applied across potentiometer VR3 – the volume control. The audio signal developed on the VR3 wiper is then fed to audio amplifier stage Q11. The output of Q11 is transformer coupled to push-pull speaker driver amplifier Q13 and Q14.

#### **AUTOMATIC GAIN CONTROL CIRCUIT**

The AGC (Automatic Gain Control) on the SBE-23CB reduces the gain of the RF and IF amplifiers in response to a strong signal by lowering their bias voltage. The rectified output of D2 and D3 is filtered by R15 and C19 to produce the AGC voltage which is then fed to the base of Q3. AMPLIFIED AGC is then taken from the top of R7 and C11 and fed to the bases of Q1, Q2 by R3.

#### **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 D4 and D5 is reduced by the voltage divider R16 and R18 and fed to the cathode of D6 – the ANL diode. The audio output from the detector diodes is also fed through R17 to C25 where it is filtered and then through R19 to the anode of D6. Since the audio signal is positive, the signal at the anode of D6 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, Q11. When a noise pulse appears in the output of the detector, the time constant of R17 and C25 prevents the anode of D6 from respond-

ing as fast as the cathode. The cathode of D6 is thus driven more positive than the anode causing D6 to become backed biased. D6 then becomes a high impedance that blocks the noise.

## **SQUELCH CIRCUIT**

The squelch circuit turns the audio off when the received signal is less than the threshold level as determined by the squelch control – VR4. If Q10 is off, R45, R46 and R49 form a voltage divider network that provides the proper forward bias to the base of Q11 permitting it to amplify the audio signal. Raising the wiper on VR4 tends to forward bias the base of Q10 which turns Q10 on. When Q10 is on, the bias is removed from the base of Q11 thus preventing amplification of the audio signal. As the received signal becomes stronger, the AMPLIFIED AGC voltage lowers the bias on the base of Q10. Lowering the base voltage on Q10 turns it off permitting Q11 to amplify audio. Thus raising the wiper on VR2 increases the threshold level a signal must overcome to turn Q10 off and permit Q11 to amplify audio.

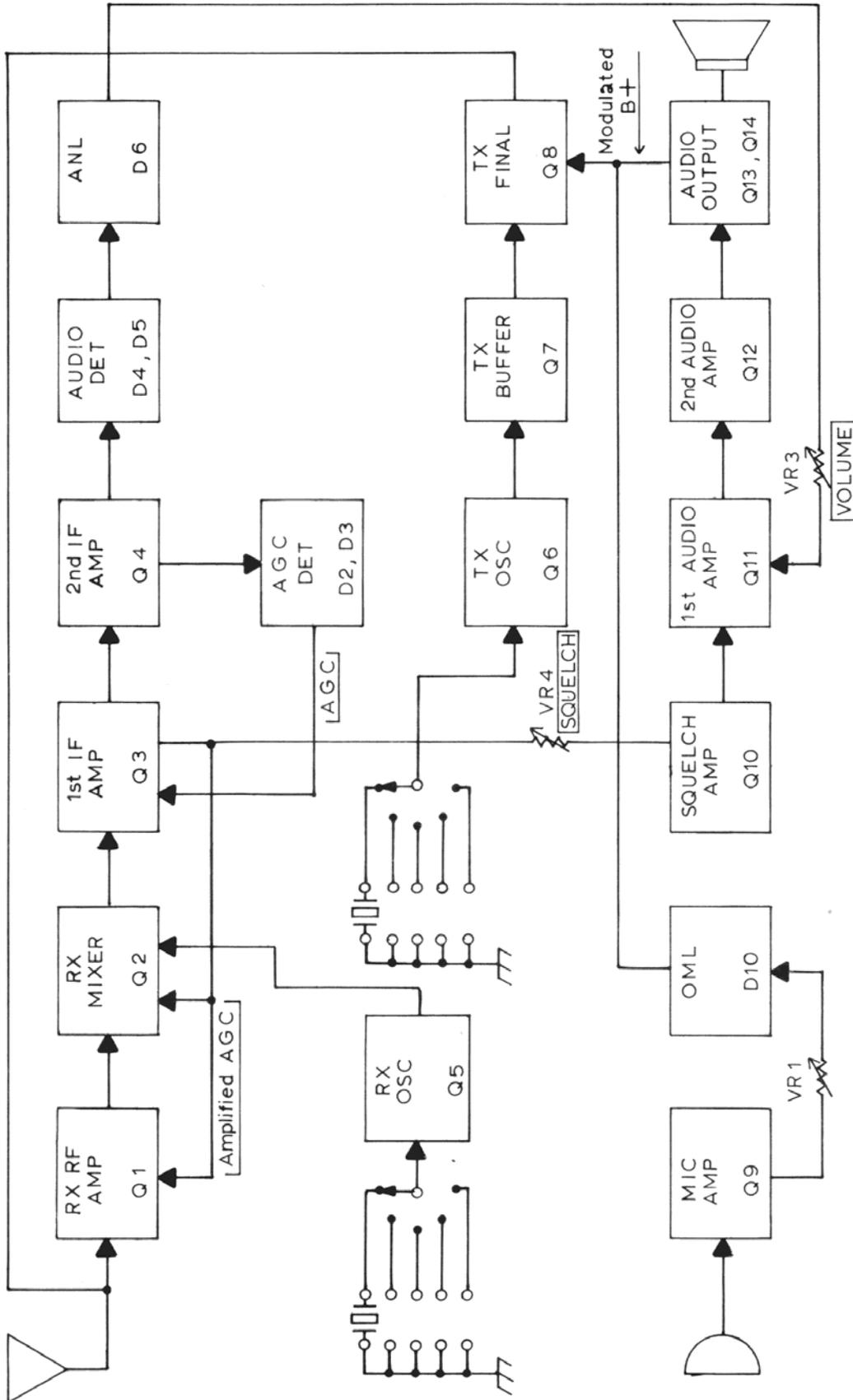
## **4.3 TRANSMITTER**

In transmit mode, the output of oscillator Q6 is fed through L4 to the TX BUFFER Q7. The output of the BUFFER is then fed through band pass filter L6 to the TX FINAL. The output of the TX FINAL is then fed through a low pass filter L8, C40 and L10, and a second harmonic trap, C41 and L9, to the antenna. Modulation is accomplished by driving the collector of the TX BUFFER Q7 and the collector of the TX FINAL Q8 from the top of the secondary of T8 – the AUDIO OUTPUT transformer.

## **OVERMODULATION CONTROL CIRCUIT**

The OML regulates the gain of the audio amplifier so as to accommodate a wide range of voice levels. The audio signal is fed from T8, the secondary of the audio output amplifier, through C60 to D10 where it is rectified; it is then filtered by R51 and C48 and fed through VR1 – the OML adjust – to the emitter of Q9 – the MIC AMP. As the sound level into the MIC increases, the Q9 emitter voltage will rise thus lowering the base-emitter bias which reduces the MIC AMP gain.

FIG. 4-1 SBE-23CB TRANSCEIVER BLOCK DIAGRAM



## SECTION 5

### SERVICING

#### 5.1 INTRODUCTION

Read this section carefully before attempting any repair of the SBE-23CB. 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 5-2, PERFORMANCE VERIFICATION PROCEDURE. Figures 5-3, 5-4, 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. Figures 5-9, 5-5 show the proper TRANSMITTER ALIGNMENT PROCEDURE and RECEIVER ALIGNMENT PROCEDURE respectively. Figure 5-7, 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-23CB 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 5-11 shows RF amplification through a properly aligned transmitter. Figure 5-10 shows 50%, 100% and overmodulation respectively. Notice that the waveform at the collector of Q8 – the TX FINAL – is unsymmetrical (Figure 5-11c). 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 voltmeter having 10M input impedance. Voltage measurements on high impedance RF points should be taken through a choke. While any choke about 100 $\mu$ H is suitable, SBE part number 8000-00011-0018 (150 $\mu$ H) 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 5-8 together with TEST 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 8 $\Omega$  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 5-6. 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-23CB 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 except the MIC AMP Q9 – the condition of which is yet unknown. After checking the 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-23CB transmitter during normal operation. Place an oscilloscope probe on the collector of Q7. If a signal is present and doesn't differ significantly from the waveform picture then the problem exists after Q7. 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 ohm meter at the power terminals in place of the supply. Make certain that the + side of the ohm meter is connected to the red power wire of the SBE-23CB. Some VOM's place the – side of the ohm meter out the red test jack. Observe that D9 protects the unit from a reversed supply. The push-to-talk switch can be used to start isolating the short.

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 (L9 and C41) 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. Check channel selector switch S2 by swapping crystals.