SBE Sidebander II Service Manual

Sidebander II

MODEL SBE-12CB

SERVICE MANUAL

SBE®

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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	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 negative ground. Either with P/N mod.
Microphone	Dynamic
Size	2¼"H (57mm), 7½"W (190mm), 9½"D (240)
Weight	7 lbs. (3 Kg)
PA Output	3 watts into an external 8Ω speaker
Current Drain	13.8 VDC Receive: (squelched) 0.3 amps (2 watts audio) 1.0 amps Transmit: (AM 0 mod) 1.2 amps (SSB, 25W PEP) 2.8 amps
Fuse	4 amp fast blow (Type 3AG)
Antenna Connector	UHF, SO-239

2.2 RECEIVER

Sensitivity	0.7μV for 10db S+N/N
Selectivity	AM: 6db @ 3.5 KHz, 60db @ 8 KHz SSB: 6db @ 2.1KHz, 50db @ 5.5 KHz
IF Frequency	7.8 MHz
AGC Response	Less than 10db for 10 - 100,000μV
Squelch Threshold	Less than 0.7μV
Audio Power Output	3 watts @ 10% distortion

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

2.3 TRANSMITTER

Power Output	AM, 4 watts SSB, 25 watts, PEP
Modulation	AM, 95-100%
Intermodulation Distortion	SSB: 3rd order -20db 5th order -25db
Carrier Suppression	-35db or better
Unwanted Sideband	-40db or better

SECTION 3
INSTALLATION

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-12CB 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° F 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 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 SINGLE SIDEBAND (SSB) THEORY

When two signals are mixed, new signals are produced with frequencies that are the sum and difference of the original signals. When a CARRIER is AM modulated with an AUDIO frequency, three distinct frequencies are present: CARRIER FREQUENCY, CARRIER + AUDIO FREQUENCY (Upper Sideband), and CARRIER - AUDIO FREQUENCY (Lower Sideband). Single sideband refers to a signal with only an upper or lower sideband and no carrier. Basically, the single sideband signal is produced in the transmitter by driving a BALANCED MODULATOR with an audio amplifier. The output of the BALANCED MODULATOR is a signal with both upper and lower sidebands but suppressed carrier. The undesired sideband is then removed from this signal by a sharp filter. Usually, the SSB signal is first produced at a frequency lower than transmit frequency and then added or subtracted from a higher frequency to produce transmit frequency.

The BALANCE MODULATOR in the SBE-12CB is driven by a 7.8025 MHz signal, and its output is fed through a filter which passes only the LSB. This LSB signal is then added to a signal around 19 MHz to produce a LSB transmit signal at channel frequency (about 27 MHz). (See Table 5-4.)

Subtracting a SSB signal from a higher frequency "inverts" the sidebands. USB is achieved in the SBE-12CB by inverting a LSB signal to make a USB signal. The 7.8025 signal is doubled to 15.605 MHz which is then added to the 19 MHz signal to produce a signal around 34 MHz. The 7.8 MHz LSB signal out of the BALANCED MODULATOR is then subtracted from the 34 MHz signal to produce a USB transmit signal at channel frequency (about 27 MHz).

Demodulation can be viewed as the mixing of carrier with sidebands to yield audio. It is necessary in SSB demodulation to reinsert the carrier at the receiver. The SBE-12CB receiver demodulates a SSB signal in somewhat the reverse order in which it would be synthesized in an SBE-12CB transmitter. An incoming LSB signal is mixed with 19 MHz to produce a 7.8 MHz LSB IF while a USB signal is mixed with 34 MHz which inverts the sidebands to produce the same 7.8 MHz LSB IF. By mixing this LSB IF with the 7.8025 signal, audio is demodulated.

SSB has several advantages over AM. In AM transmission, at least two-thirds of the power is expended to produce the carrier while all of the power in SSB goes to produce a single sideband — the only part of transmission conveying intelligence. Since only one sideband is produced, only half of the bandwidth is used. Also, since a steady carrier is reinserted at the receiver, flutter effects often caused by vehicle motion are reduced.

4.2 TRANSCEIVER — OVERVIEW

The SBE-12CB Sidebander II is a single-conversion, single sideband and AM citizens band transceiver.

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

The CB/PA switch S2 determines whether the unit operates as a CB transceiver or a PA amplifier.

The B+ BUS (BB) is energized by the power switch S1.

The push-to-talk switch energizes TX/RX relay RL-1 which in conjunction with the LSB, USB, AM selector switch S5 determines the mode of operation of the unit by energizing certain +9 VDC buses.

These buses are shown on the schematic diagram and are labeled:

ARB	AM RECEIVE BUS	TP9 *
ATB	AM TRANSMIT BUS	TP10
SRB	SSB RECEIVE BUS	TP11
STB	SSB TRANSMIT BUS	TP12
ASRB	AM/SSB RECEIVE BUS	TP13
ASTB	AM/SSB TRANSMIT BUS	TP14

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

4.3 RECEIVER

GENERAL

In AM receive mode the RF signal is fed from the antenna to the 1st RF AMP Q1. The amplified signal is then fed to Q2 – the 1st RX MIXER – where it is mixed with an injected signal about 7.8 MHz **below** the receive channel frequency. The crystal filter FL-1 selects the 7.8 MHz converted signal which is then fed to Q5 – the 1st IF AMP. The output of Q5 feeds the 2nd IF AMP Q6 which feeds the 3rd IF AMP Q7 which then feeds the AGC DETECTOR D14-D17, the S-METER DETECTOR D18 and D19 and the AUDIO DETECTOR D20 and D21. The detected audio is fed through the NOISE LIMITER UNIT NL-1 and VOLUME CONTROL VR11 to AUDIO AMP Q27 which feeds AUDIO AMP Q24 which then feeds AUDIO DRIVER Q25 and Q26. The AUDIO DRIVER drives the speaker.

In LSB (Lower Sideband) mode, the RF signal arrives at the 2nd IF AMP Q6 in the same manner as in AM mode. The output of Q6, however, in LSB is fed to the PRODUCT DETECTOR Q10 and Q11 where it is detected by the 7.8 MHz injected signal and then fed through the VOLUME CONTROL VR11 to AUDIO AMP Q27. Q27 feeds the AUDIO AMP Q24 which feeds AUDIO DRIVER Q25 and Q26 which then drives the speaker.

The receiver signals involved in USB (Upper Sideband) mode are similar to LSB except that the signal injected at Q2 – the 1st RX MIXER – is about 7.8 MHz **above** the receive channel frequency.

THE AUDIO DETECTOR

The AUDIO DETECTOR demodulates the AM received signal by rectifying the IF signal. When the signal on the top of the primary of T5 swings negative, D21 conducts current on to C145. As the signal swings positive, C145 discharges through D20. The voltage on C148 thus tends to follow the peak-to-peak voltage of the received signal and is thus the demodulated audio signal.

PRODUCT DETECTOR

The PRODUCT DETECTOR demodulates the SSB received signal by mixing the IF signal with the 7.8 MHz signal and selecting the audio frequency. The IF signal is fed from T6 to Q10 and Q11 bases while the 7.8 MHz signal is capacitively coupled to their emitters. C152 filters the audio frequencies from the mix and thus the output across the collector resistor R141 is the demodulated signal.

AUTOMATIC GAIN CONTROL

The AGC circuit reduces the gain of the receiver in response to a strong signal by lowering the bias on the RF and IF amplifier. The IF signal is fed to D14 and D15 by C132 and to D16 and D17 by C131. Both sets of diodes rectify the signal. The voltage produced by D14 and D15 responds fast to a strong signal and is referred to as the "attack," while the voltage produced by D16 and D17 decays slowly and is referred to as "release." Since in SSB the signal is present only during modulation, it is necessary for good performance that the attack be fast, but the release be longer than the time between syllables. This is accomplished in the SBE-12CB by S5-5 which switches C128 into the circuit during SSB operation. Q4, operating as a source follower, reduces the impedance of the rectified voltage and feeds it to the base of the 1st RF AMP Q1 and through R123 to the base of the 1st IF AMP Q5.

SQUELCH

The squelch circuit shuts the audio off when the received signal is less than the threshold level as determined by the SQUELCH CONTROL – VR9. Raising the wiper on VR9 tends to forward bias the base of Q8 which turns it on. Q8 turns Q9 on which in turn raises the emitter voltage of R45 and disables Q27 – the 1st AUDIO AMP. As the received signal becomes stronger, however, the AGC voltage lowers the bias on Q8 which turns it and Q9 off and permits Q27 to output audio. Thus raising the wiper on VR9 increases the threshold level a signal must overcome to "break squelch" – turn Q8 and Q9 off and permit Q27 to amplify audio.

Since RF GAIN CONTROL VR10 affects signal level, squelch threshold will be changed by VR10 adjustments.

SUPER NOISE BLANKER (OPTION)

The SNB (SBE-1NB) blanks the IF signal when pulse noise appears in the CB band. The input to amp IC-1 is peaked at 24.5 MHz, but nulled at CB frequencies. 24.5 MHz is a clear frequency where wide band pulse noise can be sampled. To prevent strong adjacent channel signals from activating the SNB, it is fed IF which is taken before the filter FL-1. If this signal reaches about 4MV, the blanker is disabled.

4.4 TRANSMITTER

GENERAL

In AM transmit mode, the ATB bus applies voltage at the bottom of R159 biasing the BALANCE MODULATOR and causing it to feed 7.8 MHz through the FILTER FL-1 to Q5. The output of Q5 then feeds the 2nd TX MIXER Q20. The 7.8 MHz signal is mixed at Q20 with the 19 MHz output of Q5. The sum of these frequencies is selected by T13 and T14, and is the channel frequency which is amplified by TX RF AMP Q21, by TX DRIVER Q22, and by TX FINAL Q23. Modulation is accomplished by feeding the microphone output to the MIC AMP Q28 which feeds Q29. The output of Q29 then feeds Q24 – the audio driver – which drives push-pull audio amp Q25 and Q26. The output of Q25 and Q26 then drives the primary of T16. Since the top of T16 is connected to B+, modulated B+ appears at the bottom, and is fed to the collectors of Q22 – the TX DRIVER, and Q23 – the TX FINAL.

In SSB mode, the microphone output is amplified by Q28, Q29, Q30, and then fed to the balanced modulator. The output of the balanced modulator is fed through ceramic filter FL-1 to Q5 and then through the T3 primary to the TX MIXER Q20. In LSB the 7.8 MHz signal is mixed with 19 MHz from Q15 and the sum of the frequencies is selected by T13 and T14 and is the channel frequency which is amplified. In USB the 7.8 MHz signal is mixed with 34 MHz from Q17 and the difference of the frequencies is selected.

D32 and D33 are connected as a voltage doubler in SSB mode and apply about 24 volts to the TX FINAL Q23 and DRIVER Q24.

OVERMODULATION LIMITER

In AM mode, the OML regulates the gain of the audio amplifier to accommodate a wide range of voice levels without overmodulating the carrier. The audio signal is capacitively coupled off the modulated B+ through VR7 – the OM adjust. It is then rectified by D34, filtered by C413, R411 and C414, and then fed through R501 to the base of Q28 – the MIC AMP. As the sound level into the MIC increases, the voltage at the base of Q28 will thus lower and decrease the amplification of the sound output.

AUTOMATIC LOUDNESS CONTROL

In SSB mode, the ALC regulates the TX RF gain to accommodate a wide range of voice levels. TX RF output is sampled by C103 and C106. It is then rectified by D3 and D4, filtered by C108, and then fed through D12 to the gate of source follower Q4. The output of Q4 is then fed through R123 to the base of RF AMP Q5. As the sound level into the MIC increases, the voltage at the base of Q5 will thus lower and decrease the RF gain.

FREQUENCY MIXING SCHEME

Three oscillators are used to synthesize the frequencies used in the SBE-12CB. Q18, referred to as the 7.8 MHz oscillator, is controlled by a single 7.8025 crystal X1. Channel Selector switch S4 selects one of four crystals (X2 – X5) to set the frequency of the 7 MHz oscillator Q12, and one of six crystals (X6 – X11) to set the 11 MHz oscillator Q13. (See Table 5-4.) The 19 MHz signal, used for AM and LSB conversion, is synthesized by mixing the output of the 7 MHz oscillator Q12 together with the output of the 11 MHz oscillator Q13 at Q14 and selecting the sum of the frequencies from the output of Q14 by filter T9. The 19 MHz signal is then amplified by Q15. The 34 MHz signal, used for USB conversion, is synthesized by mixing the 19 MHz signal together with the 15 MHz signal at Q16 and selecting the sum. The 15 MHz signal is synthesized by selecting the 2nd harmonic of the 7.8 MHz signal by filter T11 and L4. Variable capacitors (CV1 – CV11) permit the fine tuning of the resonant frequencies of the crystals. C247 shifts oscillator Q12 up about 2 KHz during AM RX when D22 is not forward biased. This frequency shift is necessary to permit filter FL-1 to pass both AM sidebands. Matching the re-inserted RX carrier in SSB is accomplished by applying a voltage from the wiper of CLARIFIER VR8 across varactor D23 which then varies the 11 MHz (oscillator Q13) frequency.

OSCILLATORS

Crystal controlled oscillators Q12, Q13, and Q18 are common collector, colpitts circuits. Outputs are taken from the emitters; collectors are at AC ground. Fine tuning of these oscillators is accomplished by variable capacitors in series with the crystals. The clarifier – potentiometer VR8 – varies the voltage on varactor D23 which permits fine tuning of oscillator Q13.

FIG. 4-1 TRANSCEIVER BLOCK DIAGRAM