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SBE Formula D Service Manual

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SBE®

FORMULA D

(MODEL SBE-26CB)

SERVICE MANUAL

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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	Single Crystal, Digitally Synthesized
Frequency Tolerance	±.003%
Operating Temperature Range	-20°C to +50°C
Humidity	95%
Input Voltage	11.7 V DC to 15.9 V DC, Positive or Negative Ground
Microphone	Dynamic 500 ohm Nominal Impedence
Size	2.5"H (60mm), 6¾"W (170mm), 9-3/8"D (240mm)
Weight	6 pounds (2.73 kg)
P.A. Output	3.5 watts into an external 8 ohm speaker. The front panel microphone P.A. gain control allows the operator to control the P.A. speaker volume when the CB/PA switch is in the P.A. position. When the CB/PA switch is in the P.A. position, the P.A. speaker also monitors the receiver.
Power Consumption	Receive (squelched) 0.5 A Receive (3.5 watts audio) 1.3 A Transmit (95% modulation) 1.7 A
Fuse	2 ampere fast blow (Type 3AG or A.G.C.)

2.2 RECEIVER

Sensitivity	0.5 microvolt for 10db S+N/N Ratio
Selectivity	50db @ ±10 KHz, 60db @ ±20 KHz, 65db @ ±30 KHz
I.F. Frequencies	10.695 MHz, 455 KHz
Receiver Delta Tune	±750 Hz, Nominal
A.G.C. Response	Less than 10db for 10 to 500,000 microvolts

Squelch Threshold	Less than 0.5 microvolts
Audio Power Output	Greater than 3.5 watts @ 10% T.H.D.
Built-in Speaker	8 ohms 3½'' Round
External Speaker	(Not Supplied) 4 or 8 ohms. Disables internal speaker when connected.
Spurious Rejection	
Image	-40db
I.F.	-70db
Others	-50db
Squelch Range	200 microvolts (Minimum)

2.3 TRANSMITTER

Power Output	4 watts maximum, 3 watts minimum
Modulation	90% minimum
Modulator Response	300 Hz to 2500 Hz, +3 -10db
Output Impedence	50 ohms, Unbalanced
Output Indicator	Front Panel Meter
Emission	6A3

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 Formula D 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 manufactures 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

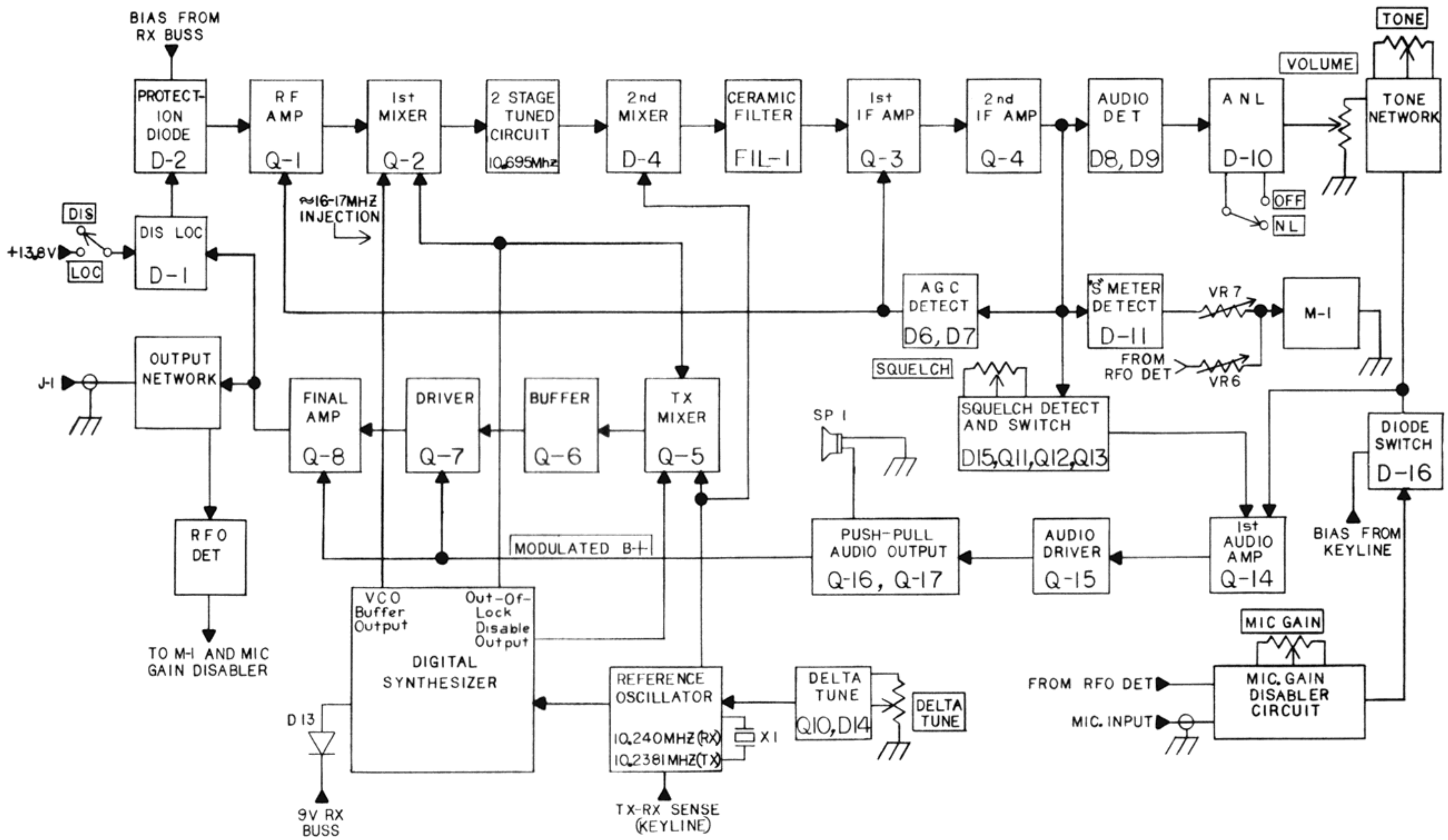
The first step in assuring minimum ignition noise is to insure that the engine ignition system is in a good state of tune, and all factory original noise suppression devices are installed and operational. This includes an inspection of distributor points and condenser, check to see that the spark plugs 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.

FIG. 4-1 TRANSCEIVER BLOCK DIAGRAM



SECTION 4

CIRCUIT DESCRIPTION

4.1 RECEIVER

GENERAL

The receiver circuitry of the SBE-26CB is of the dual conversion type. The initial R.F. amplification is performed by Q1, a common base amplifier operating at the receive channel frequency. The signal is then converted by means of a dual gate MOSFET mixer (Q2) to 10.7 MHz. The injection signal to this mixer is the approximately 17 MHz output signal from the digitally controlled synthesizer. After conversion to 10.7 MHz, the signal is filtered in a two stage filter consisting of T2-1 and T2-2. The filtered 10.7 MHz signal is then coupled from the output of T2-2 to D4, a 1N60 diode used as the second mixer. The crystal reference oscillator, Q9, which operates at 10.24 MHz, provides the injection signal for this mixer. The output frequency of the mixer is at 455 KHz. The output of the mixer is coupled to T3, which provides some filtering at 455 KHz, and also serves as an impedence matching device for the input of FIL-1, the 455 KHz ceramic filter, which provides the bulk of the bandpass filtering in the I.F. strip. The filtered 455 KHz signal from the output of FIL-1 is applied to the first I.F. amplifier, Q3. After amplification the signal is again filtered by T4 and T5 and applied to the base of the second I.F. amplifier, Q4. The output of Q4 is coupled to the various R.F. detector circuits via T6, the I.F. output transformer. The primary of T6 is coupled to the audio detector (D8 and D9), via C129. After passing through the automatic noise limiter, which will be discussed separately, the detected audio signal is then coupled to VR1, the volume control, and passes through the tone control circuit to the base of Q14, the first audio amplifier. R.F. output to the A.G.C., "S" meter and squelch detectors is provided by the secondary winding of T6. The operation of the squelch detector is discussed later in this section.

A.G.C. CIRCUIT

The A.G.C. detector of the Formula D consists of a full wave rectifier, the output of which is negative going. In other words, an increase in signal level at the secondary of T6 will tend to result in a higher negative voltage at the output (anode) of D6. This negative voltage is used to control the bias and therefore the gain of two stages. These are the R.F. amplifier (Q1) and the first I.F. amplifier (Q3). A range of expected voltages at various points in the A.G.C. system for various levels of input voltages is included in graph form to help in trouble-shooting.

"S" METER CIRCUIT

The "S" meter detector circuit consists of a half-wave rectifier (D11) and an "S" meter adjust Potentiometer. The positive going DC voltage from the detector circuit varies linearly with the R.F. voltage at T6.

SQUELCH CIRCUIT

The squelch circuit of the Formula D consists of a half wave peak detector which is biased with a D.C. voltage dependent upon the setting of the squelch and tight squelch controls. Rectified output of this detector is negative going and is used to control one input of a differential amplifier consisting of Q11 and Q12. The positive D.C. bias voltage on the cathode of D15 serves to "buck" the detected voltage appearing on D15's anode as the result of rectification of the input signal. The combined circuit consisting of D15 and its bias circuits could be called a variable threshold detector, in that the R.F. input level required to result in a negative output from the detector can be varied by changing the D.C. bias on the cathode. Thus, if the squelch control is set toward the end of its resistance range which results in the maximum D.C. voltage of the cathode of D15, the delay in turn on of D15 is maximized, resulting in minimum squelch sensitivity, this is the fully clockwise position on the squelch control. Turning the squelch control counter-clockwise reduces the bias voltage, increasing squelch sensitivity. The output of the squelch detector goes to one input of a differential amplifier. DC biasing of this differential amplifier results in the following conditions: Q11 is normally turned on by base current from the base pull up resistor, (R303). This conduction of Q11 results in the emitter of Q11 being pulled up to just below the collector voltage of the transistor. Since the emitters of Q11 and Q12 are tied directly together, the emitter of Q12 is pulled up also. Since the emitter of Q12 is at a higher DC voltage than the base of the transistor, Q12 is turned off. The base voltage of Q12 is set by the voltage divider consisting of R304 and R305 at approximately one volt. Since Q12 is reverse biased, its collector voltage will rise to approximately eight volts. This turns on the output emitter follower of the squelch circuit (Q13). The conduction of Q13 causes its emitter voltage to rise to 3.2 volts which results in a reverse bias condition of Q14. The above conditions describe the squelched condition of the radio. Conversely, when a signal of sufficient amplitude is present in the cathode of D15 to result in a detected output voltage which overcomes the back bias inserted at the cathode by the squelch controls, the base of Q11 is pulled down sufficiently to turn off the transistor. When the emitter voltage of Q11 goes to a low enough value to allow Q12 to begin conducting, its collector voltage is pulled down turning off Q13 and allowing Q13's emitter to go to a low voltage which enables the audio amplifier by eliminating the pull up voltage on its emitter. Most problems in the squelch circuit should be easy to fix by comparing voltages found in the circuit with those specified in the schematic for the two conditions possible (squelched or unsquelched.)

AUTOMATIC NOISE LIMITER CIRCUIT

The automatic noise limiter in the Formula D is of the series noise gate type. This type of noise limiter circuit consists of a diode whose DC bias is controlled by the output voltage of the audio detector. In order to properly understand its operation you should remember that impedences are quite high in this circuit.

The normal action of the direct coupled output of the audio detector is to provide a positive DC voltage which increases as the level of carrier signal increases. Any modulation is detected as AC riding on the DC voltage.

A voltage divider circuit consisting of R120, R121, R122 and R123 is used to forward bias D10, the noise limiter diode, whenever sufficient positive voltage is present at the output of the audio detector. Because the anode end of the D10 diode is totally isolated from DC ground any voltage that appears at the output of the audio detector will also appear at the anode of D10. Although the cathode voltage will also tend to rise, the voltage rise will be approximately half that encountered at the anode. Since C132 (.22 microfarad electrolytic capacitor) is present at the junction of R122 and R123, audio voltages are shunted to ground and only DC voltage can appear at this point. Therefore, unless D10 is forward biased by sufficient positive voltage from the detector, the loss through the A.N.L. circuit will be very high and very little audio output will appear. However, as soon as the diode is sufficiently forward biased, it will conduct the audio signal through to the wiper of the volume control. It is normal for a very considerable loss to be found across the A.N.L. circuit, even when it is conducting. Please consult the schematic diagram for audio and DC levels to be expected in this circuit. (Please note that this is an extremely high impedence circuit and instruments used to assess its performance should have a load impedence of 10 meg-ohms or greater.) Generally, the easiest method of trouble-shooting this circuit is through static tests of the components (ohmmeter).

4.2 TRANSMITTER

The transmit section of the SBE-26CB is a four stage circuit consisting of a mixer, buffer, driver and final amplifier.

The transmit mixer is Q5, a dual-gate MOSFET. This stage mixes together the outputs of the reference oscillator (10.2381 MHz) and the synthesizer (approximately 17 MHz). The output is taken from the drain of the transmit mixer to a two stage filter consisting of L3 and L4, which are tuned to the output frequency (approximately 27 MHz). Further amplification is provided by Q6, which serves as a buffer amplifier. The output of Q6 is coupled through T7 to Q7, the driver transistor. After further amplification by the driver, the R.F. signal is coupled to Q8, the final amplifier. After the last stage of amplification by Q8, the signal passes through an impedence matching circuit consisting of L8, L9, C419 and C420. The output is further filtered by L10 and CV1, which is a 54 MHz second harmonic trap.

The modulation source for the transmitter is the same amplifier chain used in the receive mode (Q14, Q15, Q16 and Q17). The B+ supply is modulated by the secondary of T9 and this modulated B+ voltage passes through D19 to the collectors of the driver and final amplifier transistors. The modulation limiting circuit consists of VR9, D17 and C213. The operation of the modulation limiter is to detect the audio levels on the modulated B+ line and provide a positive going DC voltage to reduce the forward bias of Q14. The positive DC voltage reduces its gain and limits the maximum modulation excursion.

MIC GAIN CONTROL MODIFICATION

Compliance with the Federal Communications Commission Type Acceptance requirements for this unit requires that no external "front panel" modulation adjust be provided. This stipulation was added since the initial design of the radio was completed. Therefore, a modification was added to comply with these F.C.C. requirements.

This modification is located on the left front of the chassis apron, immediately adjacent to, and behind the microphone jack. The circuit is basically a diode switching system, the purpose of which is to disable VR2 (microphone gain) during the transmit mode, and allow it to function normally in the P.A. mode.

The switching circuit itself consists of 2 diodes, D901 and D902, and their respective control transistors, Q901 and Q902. In the transmit mode, D901 is turned on and D902 is turned off. Conversely, in the P.A. mode, D901 is turned off and D902 is turned on. This is accomplished as follows. The R.F. output detector, D12, is coupled via a 4.7K ohm resistor, R901, to the base of Q901, the first control transistor. In the transmit mode, detected R.F. output will cause a positive voltage of sufficient level to appear on the base of Q901 turning it on. This results in a low value of voltage appearing on the cathode of D901 and the anode of D902 respectively, through resistors R904 and R905. At the same time the collector of Q901 is pulling down the base voltage on Q902, thus turning it off. This results in a high voltage appearing on the collector of Q902, which results in forward bias on D901 and reverse bias on D902. Therefore, D901 is turned on and D902 is turned off. In this condition the audio voltage from the microphone is conducted directly through D901 to the base of Q14, via the transmit-receive switching diode, D16, which is discussed in the transmit-receive switching circuit explanation.

Conversely, in the P.A. mode, the output of the R.F.O. detector, of course, will be zero. This means that there is no forward bias for Q901, therefore, its collector voltage will be high. This forward biases Q902, turning it on. At the same time, D901 is reverse biased, turning it off. This condition is the opposite of that encountered in the transmit mode. D902 is now conducting and as its input is through C904 to the wiper of the microphone gain control, this control is active on P.A.