TEMPERATURE COMPENSATION INFORMATION FOR GE 5ppm CRYSTAL MODULE USED IN THE CUSTOM MVP AND EXECUTIVE II RADIOS.

There is a three digit number on the top of the crystal can. It indicates the direction of drift from +30 degrees C to -3.5 degrees C, and the extent of drift.

Code 132 = + 3.2 PPM
Code 005 = - 0.5 PPM

Codes will always be between +4.0 and -2 PPM
C2 is selected from chart

+4.0 to +3.5	43 pF @ -750 PPM/°C	19A116656P43J7
+3.4 to +2.8	43 pF @ -470 PPM/°C	19A116656P43J4
+2.7 to +2.1	43 pF @ -220 PPM/°C	19A116656P43J2
+2.0 to +1.8	43 pF Si MICA	7489162P18
+1.7 to +14	47 pF Si MICA	7489162P19
+1.3 to +1.0	51 pF Si MICA	7489162P20
+0.9 to +0.5	56 pF Si MICA	7489162P21
+0.4 to 0.0	62 pF Si MICA	7489162P22
-0.1 to -0.5	68 pF Si MICA	7489162P23
-0.6 to -1.0 *	75 pF Si MICA	7489162P24
-1.1 to -1.5 *	82 pF Si MICA	7489162P25
-1.6 to -2.0 *	91 pF Si MICA	7489162P26

* If value of C2 is 75 pF or greater, then C4 (4.7 pF) must be removed

The crystal is cut/ground/plated to be on frequency in a specific test fixture at 30° C. It is then measured again in the same fixture at -3.5° C. The difference is the drift error. If the crystal drifts 467 HZ high at -3.5° C, reference to 146.000 MHz at 30° C, then the drift is 3.2 PPM. (146 Hz drift @ 146 MHz = 1 PPM) The code on the crystal is 132 and the cap should be 43 pf with a negative 470 temp coefficient.

The C2 capacitor has to be in the circuit to oscillate, so I don't know what the "test" fixture used. However, I'm thinking that an NP0 capacitor could possibly be substituted to take the drift readings. Not sure of values, but several could be tried. If this were done using a "stock" GE crystal already installed in a module, one could reverse engineer (trial and error) until the correct value was discovered.

Audio Amplifier and Driver

The audio signal from the volume control arm is fed through the de-emphasis network (C933, C935, R931 and R932) to the audio amplifiers Q914 and Q915. Q915 provides push-pull drive for the PA through transformer T901. Output from the Class AB PA stage, Q916 and Q917, is coupled through transformer T1901 to the speaker. A tertiary winding of T1901 supplies feedback to Q915 through J906-1.

Audio Bias Adjust potentiometer R945 is used to set the PA bias current through J906 to 20 milliamperes.

SQUELCH CIRCUIT

Noise from Volume Hi is used to operate the squelch circuits. The setting of Squelch Adjust control R953 determines the squelch opening sensitivity. High-pass filter R981 and C946 reduce effects of audio signals on high settings of the Squelch Adjust R953. Diodes CR914 and CR915 and amplifier Q920 prevent audio squelching with large audio signals (squelch clipping).

To keep the receiver squelched with temperature changes, fixed squelch circuit Q918, RT902, and RT903 is used. This circuit compensates for gain changes by shunting less of the noise to ground with temperature changes. Below approximately 40°C, RT902 keeps Q918 on causing the impedance of RT903 to increase and shunt less noise to ground. Above 40°C, RT902 turns Q918 off, removing the shunting effect of RT903.

Q919 and Q920 provide noise gain. Q921 maintains a high load impedance for limiter/amplifier Q920.

C953, C954, and L901 form a second high pass filter to prevent audio signals from reaching the detector (CR916 and CR917) and squelching the receiver. Positive filtered DC from the detector is fed to the base of Q909 which turns on, causing the collector of Q909 to drop to near zero volts. This voltage drop turns Q913 off and in turn removes the forward bias from audio amplifiers Q914 and Q915, squelching the receiver.

A hysteresis action is provided by the positive DC feedback from the collector of Q909 through R970 to the emitter of Q920 and also from the collector of audio amplifier Q914 through Q940 to the base of Q909. When Q909 and Q914 turn on and off, they vary the gain of noise amplifier Q902 in such a way as to assist the hysteresis action and provide positive switching.

Squelch Monitor & CAS

In radios equipped with SAS board 19D423191G1, unsquelching the receiver applies ground to the output of the noise detector at the junction of R975 and R976. This turns off squelch switch Q909 and allows receiver mute switch Q913 to turn on. With Q913 turned on a positive voltage is applied to the base of audio amplifier transistors Q914 and Q915, turning both transistors on and passing audio through to the speaker.

In radios equipped with SAS board 19D423191G2, unsquelching the receiver applies ground to the base of Q910, turning the Q910 off. With Q910 off, Q909 and Q911 are both prevented from conducting. Q913 is now allowed to conduct, turning on Q914 and Q915 and passing the receiver audio through to the speaker.

In addition to turning the audio amplifiers on, the positive voltage at the collector of Q909, turns off the Carrier Activity Sensor (CAS) switch Q922 and Q923. This removes ground from J901B-7.

When the receiver is squelched, a positive voltage from the squelch circuit is applied to the base of Q909 turning it on. This applies a low to the base of CAS switch Q922, turning Q922 and Q923 on. When turned on, Q923 applies A- to the CAS line.

CARRIER CONTROL TIMER

In radios equipped with a Carrier Control Timer (CCT), interconnections to the SAS board are made through P908. The CCT determines the maximum length of each transmission. When the preset transmission time has elapsed, a squelch disable signal (A-) is applied to the base of squelch disable switch Q912. Q912 turns on and applies regulated 10 Volts to audio amplifiers Q914 and Q915, allowing an alerting tone to be heard in the speaker.

In addition, a transmitter disable signal (A-) is applied to the base of transmitter oscillator keying transistor Q906, turning Q906 and Q907 off. This removes the Tx OSC control voltage from the exciter and multi-frequency to remove the RF drive to the transmitter. In units equipped with Channel Guard, the Tx CG control voltage is also removed.

CHANNEL GUARD

In radios equipped with Channel Guard, interconnections to the SAS board are made through J907. The Channel Guard board contains a tone reject filter to prevent the tone from being heard in the speaker. The output of the tone reject filter is applied directly to the audio de-emphasis network (junction of R932, C936 and C935) in the base circuit of audio amplifier Q914.

CYRSTAL MODULE

Crystal modules determine the operating frequency of the transmitter and receiver. The plug-in module contains a crystal, a trimmer capacitor, and varicap for temperature compensation.

The quartz crystals used in the crystal module exhibit the traditional "S" curve characteristics of output frequency versus operating temperature.

In the mid-temperature range (-10°C to +50°C), the raw crystal characteristic is maintained. The compensation voltage which drives the crystal module varicap is approximately constant over this temperature range. Consequently, the crystal almost solely determines the temperature characteristic. The crystals whose temperature characteristic lie toward the high limit of +4PPM shown in Figure 1 are rotated slightly. All others have little or no rotation.

The cold end temperature characteristic is "lifted" by a temperature-dependent increasing voltage. The compensator which drives the crystal module varicap produces a voltage which increases linearly from -10°C to -30°C. This voltage decreases the varicap capacity, which in turn increases the module tuned circuit frequency to compensate for the decreasing frequency characteristic of the crystal.

The hot end crystal temperature characteristic in Figure 1 is shown to be increasing with temperature. The hot end (above 50°C) crystal characteristic is compensated for by a decreasing voltage from the compensator. This results in added capacity from the varicap. In turn, a decreasing module frequency results to counteract the increasing frequency response of the crystal.

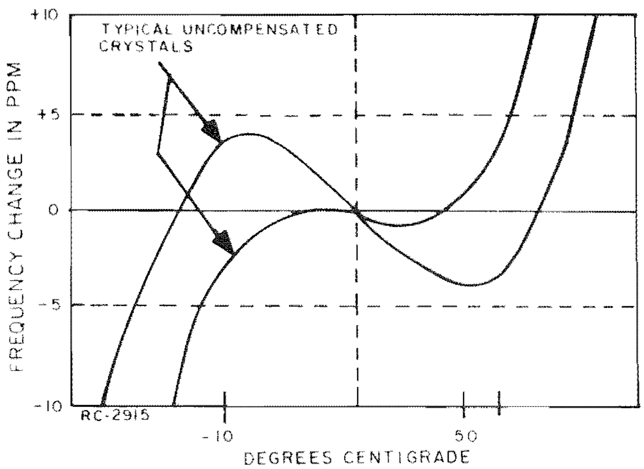


Figure 1 - Typical Crystal Characteristics

Service Note: Proper crystal module operation is dependent on the closely-controlled input voltages from the 10-Volt regulator. Should all of the crystal modules shift off frequency, check the 10-Volt regulator.

Compensation voltage from the exciter is applied to pin 4 of the crystal modules to maintain frequency stability within ±5 PPM over a temperature range of -30°C to +60°C.

The compensation voltage varies non-linearly with temperature to complement the temperature/frequency characteristics of the crystal. Listed below are typical minimum and maximum voltage readings to be expected at pin 4 of the crystal modules, as measured with a high impedance meter.

TEMPERATURE RANGE	OUTPUT VOLTAGE MINIMUM	MAXIMUM
-30°C	4.9 Volts	6.0 Volts
-10°C to +50°C	3.7 Volts	4.3 Volts
-75°C	3.3 Volts	3.8 Volts

Trimmer capacitor C3 is used to adjust the radio for the exact operating frequency. Refer to the applicable Alignment Procedure for details.

Operating voltage for the crystal module is supplied from the Tx OSC Control circuit on the SAS board or through the forward biased pin diode on the multi-frequency board to pin 1 of the selected crystal module.

MULTI-FREQUENCY BOARD

The multi-frequency board is provided in radios with more than one operating frequency. It contains the necessary circuitry to provide three additional transmit and three additional receive frequencies to the standard radio. The multi-frequency board plugs into J904 on the SAS board and utilizes crystal modules to determine the exact operating frequencies.

In multi-frequency radios, the DA jumper wire connected between H12 and H31 on the SAS board is removed. This removes the fixed ground from the F1 keying lead and allows frequency selection of F1-F4 by the frequency selector switch on the control unit.

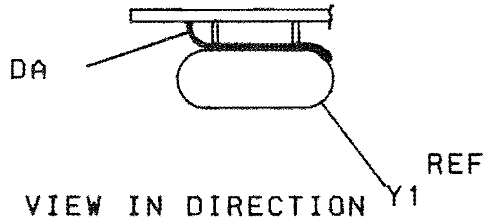
When frequencies other than F1 are selected, A- is removed from the F1 select lead. The F1 oscillator turns off due to a rising base voltage applied through pull-up resistor R983 on the SAS board.

OSCILLATOR CIRCUITS (F2-F4)

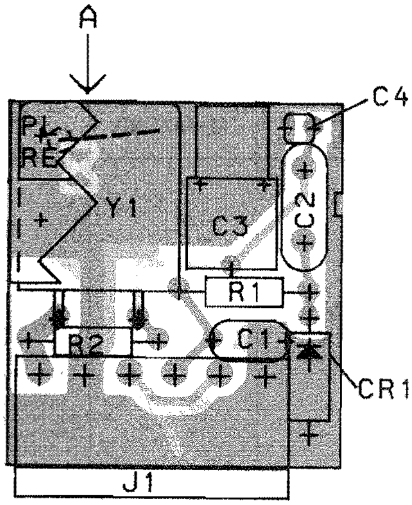
Separate oscillator circuits are used for transmit and receive frequencies.

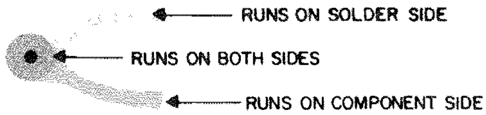
The transmit and receive oscillator circuits are identical, each using a single

OUTLINE DIAGRAM



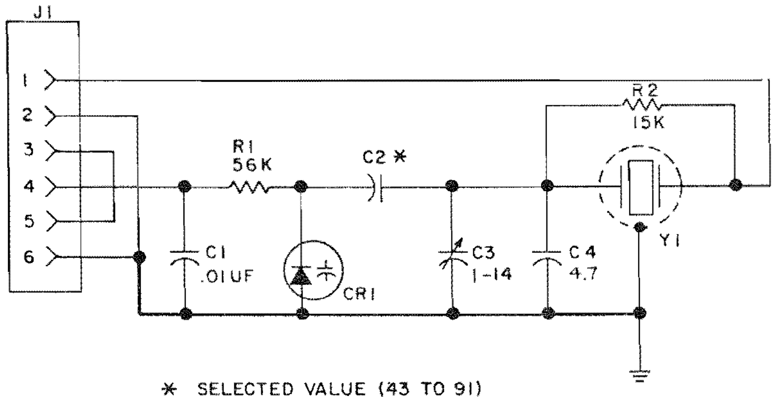
VIEW IN DIRECTION OF ARROW "A" (WITH SHIELD REMOVED)





(19B227337, Rev. 7)
(19B226851, Sh. 1, Rev. 8)
(19B226851, Sh. 2, Rev. 7)

SCHEMATIC DIAGRAM



* SELECTED VALUE (43 TO 91)

MODEL NO	REV LETTER
PL19B226962G1-27	

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG = 1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF= MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH= MILLIHENRYS OR H=HENRYS.

(19B226951, Rev. 5)

SCHEMATIC & OUTLINE DIAGRAM

CRYSTAL MODULE

PARTS LIST

LBI30069E

CRYSTAL MODULE (5 PPM)
19B226962G1-G29, 31-34, 36

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - CRYSTAL MODULES - - - - - - - -
		NOTE: When reordering, give GE Part Number and specify exact transmitter or receiver frequency needed.
Y2601 thru Y2606		19B226962G1 Tx 29.7-36 MHz 19B226962G2 Tx 36-42 MHz 19B226962G3 Tx 42-50 MHz 19B226962G31 Tx 66-78 MHz 19B226962G32 Tx 77-88 MHz 19B226962G4 Tx 138-155 MHz 19B226962G5 Tx 150.8-174 MHz 19B226962G6 Tx 406-420 MHz 19B226962G28 Tx 420-450 MHz 19B226962G7 Tx 450-470 MHz 19B226962G8 Tx 470-494 MHz 19B226962G9 Tx 494-512 MHz 19B226962G10 Rx 29.7-36 MHz 19B226962G11 Rx 36-42 MHz 19B226962G12 Rx 42-50 MHz 19B226962G33 Rx 66-78 MHz 19B226962G34 Rx 77-88 MHz 19B226962G13 Rx 138-155 MHz 19B226962G14 Rx 150.8-174 MHz 19B226962G15 Rx 406-420 MHz 19B226962G29 Rx 420-450 MHz 19B226962G16 Rx 450-470 MHz 19B226962G17 Rx 470-494 MHz 19B226962G18 Rx 494-512 MHz 19B226962G19 Rx 138-155 MHz HIGH SIDE INJECT 19B226962G20 Rx 150.8-174 MHz HIGH SIDE INJECT 19B226962G21 Rx 406-420 MHz HIGH SIDE INJECT 19B226962G36 Rx 420-450 MHz HIGH SIDE INJECT 19B226962G22 Rx 450-470 MHz HIGH SIDE INJECT 19B226962G23 Rx 470-494 MHz HIGH SIDE INJECT 19B226962G24 Rx 494-512 MHz HIGH SIDE INJECT 19B226962G25 Rx 29.7-36 MHz ALTERNATE IF 19B226962G26 Rx 36-42 MHz ALTERNATE IF 19B226962G27 Rx 42-50 MHz ALTERNATE IF
		- - - - - - - - - - - CAPACITORS - - - - - - - - -
C2		Capacitor, compensating. (Factory selected to match crystal characteristics).
C3	19A134633P1	Variable, glass: 2 to 14 pf, 500 VDCW; sim to Sprague-Goodman GSG185A.
		- - - - - - - - - - - CRYSTALS - - - - - - - - - - -
Y1		Crystal. (Not Field replaceable).
		COMPONENT BOARD 19B226849G1
		- - - - - - - - - - - CAPACITORS - - - - - - - - -
C1	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW.
C4		(Part of printed board 19B226850P1).
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR1	5495769P19	Silicon, variable capacitance, 34 pf nominal.
		- - - - - - - JACKS AND RECEPTACLES - - - - - - -
J1	19A116659P6	Connector, printed wiring: 6 contacts; sim to Molex 09-52-3061.
		- - - - - - - - - - - RESISTORS - - - - - - - - -
R1	3R152P563J	Composition: 56K ohms ±5%, 1/4 w.
R2	3R152P153J	Composition: 15K ohms ±5%, 1/4 w.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19B227397P1	Shield. (Y1).
	19A121175P39	Insulator, plate. (Used with C4).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES