MOBILE RADIO

MAINTENANCE MANUAL

406—512 MHz OSCILLATOR/MULTIPLIER BOARD 19D423266G1-G10

TABLE OF CONTENTS

DESCRIPTION

The MASTR® II oscillator-multiplier (Osc/Mult) can be equipped with up to eight Integrated Circuit Oscillator Modules (ICOMS). The ICOM crystal frequencies range from approximately 14.5 to 18.5 megahertz, and the crystal frequency is multiplied 27 times and then amplified to provide a low side in injection frequency to the mixer. Optional ICOMs are available for high side injection.

In receivers equipped with a Dual Front End (DFE), a second Osc/Mult board is used. A total of eight ICOMs can be used between the two Osc/Mult boards.

CIRCUIT ANALYSIS

ICOMs

Three different types of ICOMs are available for use in the Osc/Mult module. Each contains a crystal-controlled Colpitts oscillator, and two of the ICOMs contain compensator ICs. The different ICOMs are:

- 5C-ICOM - contains an oscillator and a 5 part-per-million (±0.0005%) compensator IC. Provides compensation for EC-ICOMs.
- EC-ICOM - contains an oscillator only. Requires external compensation from a 5C-ICOM.
- 2C ICOM - contains an oscillator and a 2 PPM (±0.0002%) compensator IC. Will not provide compensation for an EC-ICOM.

The ICOMs are enclosed in an RF shielded can with the type ICOM (5C-ICOM, EC-ICOM or 2C-ICOM) printed on the top of the can. Access to the oscillator trimmer is obtained through a hole on top of the can.

Frequency selection is accomplished by switching the ICOM keying lead (terminal 6) to A- by using the frequency selector switch on the control unit. In single frequency radios, a jumper from H9 to H10 in the control unit connects terminal 6 of the ICOM to A-.

In DFE applications, keying leads of the receiver and the DFE Osc/Mult ICOMs are operated in parallel. Therefore, ICOMs in the receiver can not be placed in the same position as those in the DFE.

In the receive mode, +10 Volts is applied to the external ICOM load resistor (R401) by the RX Osc control line, keeping the selected ICOM turned on. Keying the transmitter removes the 10 Volts at R401, turning the ICOM off.

CAUTION

All ICOMs are individually compensated at the factory and cannot be repaired in the field. Any attempt to repair or change an ICOM frequency will void the warranty.

In standard 5 PPM radios using EC-ICOMs, at least one 5C-ICOM must be used. The 5C-ICOM is normally used in the receiver F1 position, but can be used in any transmit or receive position. One 5C-ICOM can provide compensation for up to 15 EC-ICOMs in the transmitter and receiver. Should the 5C-ICOM compensator fail in the open mode, the EC-ICOMs will still maintain 2 PPM frequency stability from 0°C to 55°C (+32°F to 131°F) due to the regulated compensation voltage (+5 Volts) from the 10-Volt regulator IC. If desired, up to 16 5C-ICOMs may be used in the radio.

The 2C-ICOMs are self-compensated to 2 PPM and can not provide compensation for EC-ICOMs.

When a DFE is used with a wide spaced transmitter option, compensation voltage for the 5C-ICOMs is supplied from the EC-ICOM. Should the 5C-ICOM fail, the EC-ICOMs will still maintain 2 PPM frequency stability from 0°C to 55°C (32°F to 131°F) due to the regulated compensation voltage.

Oscillator Circuit

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

At both the coldest and the hottest temperatures, the frequency increases with increasing temperature. In the middle temperature range (approximately 0°C to +55°C), frequency decreases with increasing temperature. In the middle temperature range (approximately 0°C to +55°C), frequency decreases with increasing temperature.

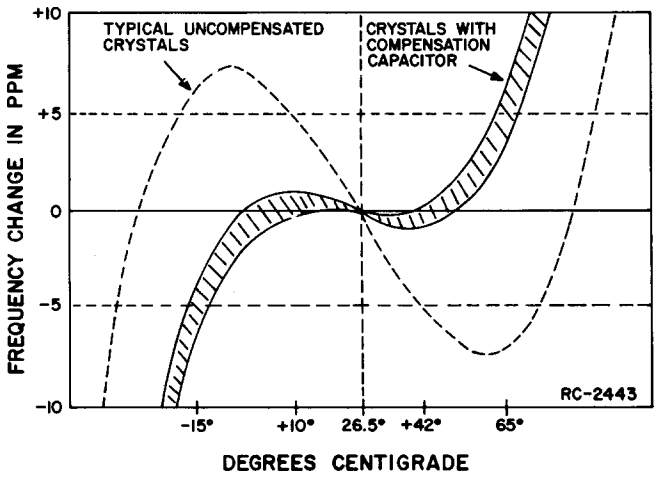


Figure 1 - Typical Crystal Characteristics

Since the rate of change is nearly linear over the mid-temperature range the output frequency change can be compensated by choosing a parallel compensation capacitor with a temperature coefficient approximately equal and opposite that of the crystal.

Figure 1 shows the typical performance of an uncompensated crystal as well as the typical performance of a crystal which has been matched with a properly chosen compensation capacitor.

At temperatures above and below the mid-range, additional compensation must be introduced. An externally generated compensation voltage is applied to a varactor (voltage-variable capacitor) which is parallel with the crystal.

A constant bias of 5 Volts (provided from Regulator IC U901 in parallel with the compensator) establishes the varactor capacity at a constant value over the entire mid-temperature range. With no additional compensation, all of the oscillators will provide 2 PPM frequency stability from 0°C to 55°C (+30°F to 131°F).

Compensator Circuits

Both the 5C-ICOMs and 2C-ICOMs are temperature compensated at both ends of the temperature range to provide instant frequency compensation. An equivalent ICOM circuit is shown in Figure 2.

The cold end compensation circuit does not operate at temperatures above 0°C. When the temperature drops below 0°C, the circuit is activated. As the temperature decreases, the equivalent resistance decreases and the compensation voltage increases.

The increase in compensation voltage decreases the capacity of the varactor in the oscillator, increasing the output frequency of the ICOM.

The hot end compensation circuit does not operate at temperatures below +55°C. When the temperature rises above +55°C, the circuit is activated. As the temperature increases, the equivalent resistance decreases and the compensation voltage decreases. The decrease in compensation voltage increases the capacity of the varactor, decreasing the output frequency of the ICOM.

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

MULTIPLIERS & AMPLIFIER

The output of the selected ICOM is coupled through a tuned circuit (L401 and C406) that is tuned to three times the crystal frequency. The output of the tuned circuit is applied to the base of Class C multiplier Q401. The collector tank circuit of the multiplier (L402, C411 and C412) is tuned to nine times the crystal frequency. The output of the multiplier stage is metered through a metering network consisting of C427 and L405, and applied to receiver metering jack J601 through P903-14.

Following the multiplier is a Class A Amplifier stage, Q402. The output of Q402 is metered through a metering network consisting of C419, C420, CR402 and R408 and applied to receiver metering jack J601 through P903-15. The amplified output of Q402 is applied to a tuned circuit (L403, C416 and C417) that is tuned to nine times the crystal frequency. The tuned circuit provides some selectivity in the oscillator-multiplier chain.

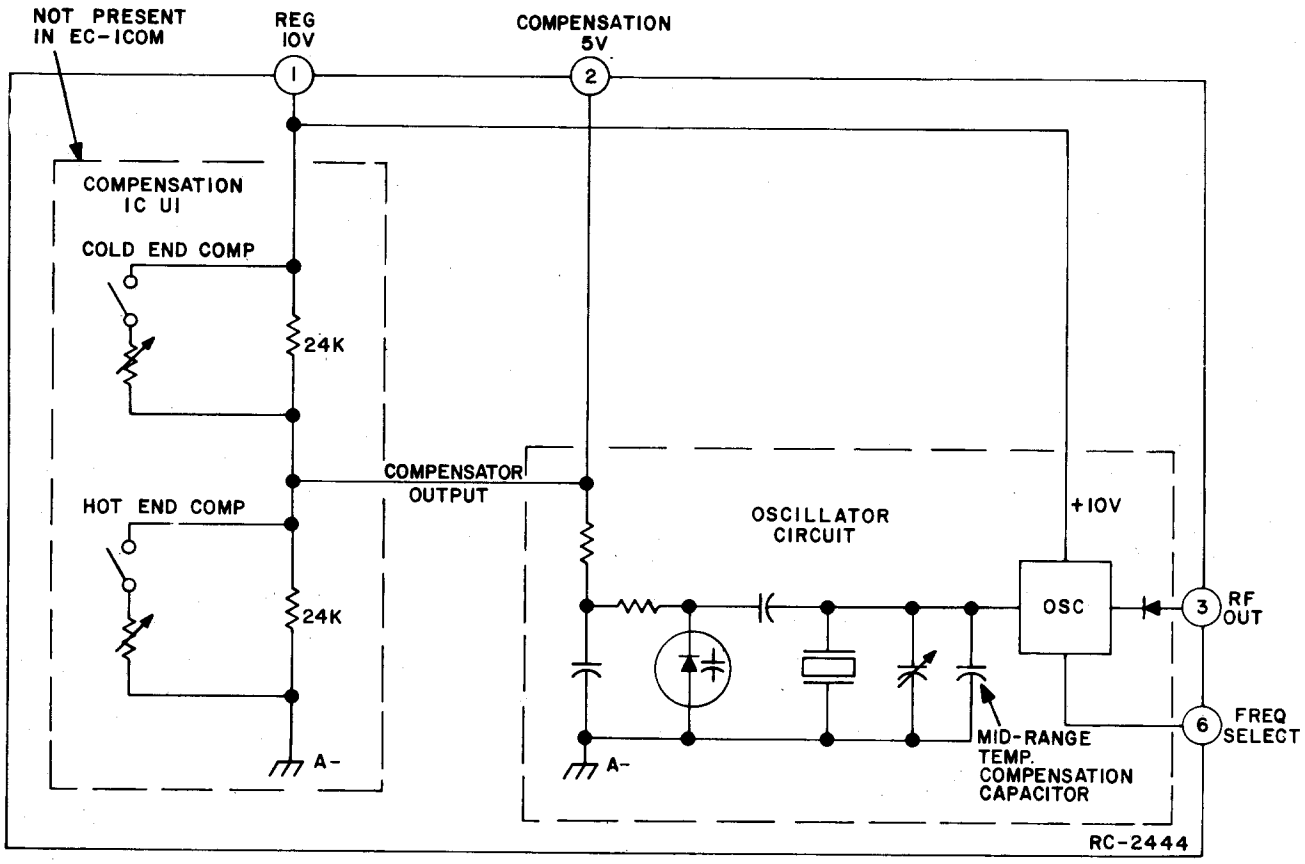


Figure 2 - Equivalent ICOM Circuit

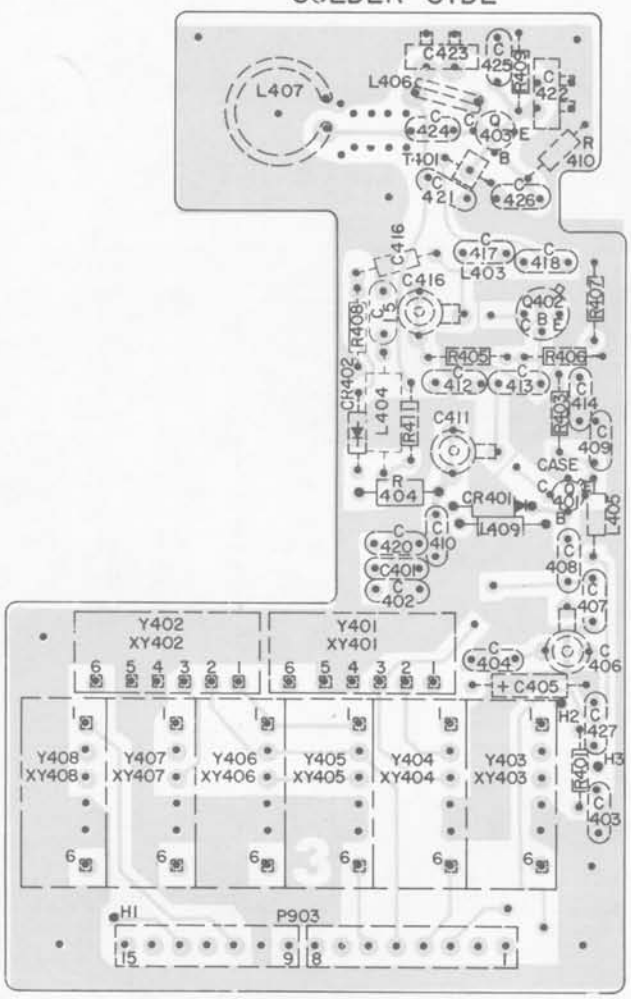
The amplifier output is applied to the base of Class C multiplier Q403 through a matching network (T401 and C426). The output of Q403 is inductively coupled to the first of three helical resonators on the RF Assembly through L407. The helicals are tuned to 27 times the crystal frequency.

Most of the selectivity for the oscillator-multiplier chain is provided by the three high-Q helicals. The output of the helicals is applied to the input of the mixer stage on the RF Amplifier assembly.

The multiplier output is metered at J605-7 through a metering network on the IF-Filter board. The metering network consists of L505, L506, C512, C513, C514, CR501 and R506.

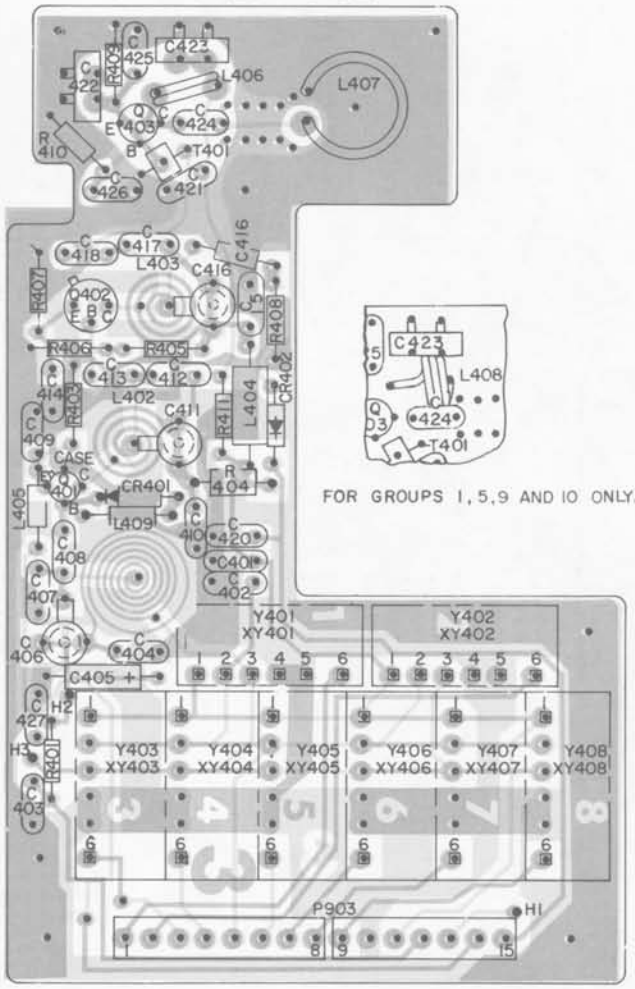
OSC/MULT BD

SOLDER SIDE



(19D423267, Sh. 2, Rev. 3)

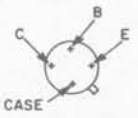
COMPONENT SIDE



(19D423267, Sh. 2, Rev. 3)
(19D423267, Sh. 3, Rev. 3)

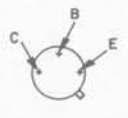
FOR GROUPS 1, 5, 9 AND 10 ONLY.

LEAD IDENTIFICATION FOR Q401



VIEW FROM CASE END

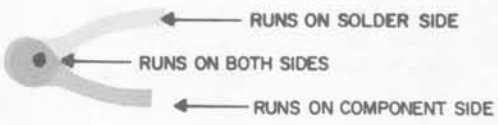
LEAD IDENTIFICATION FOR Q402, Q403



VIEW FROM CASE END

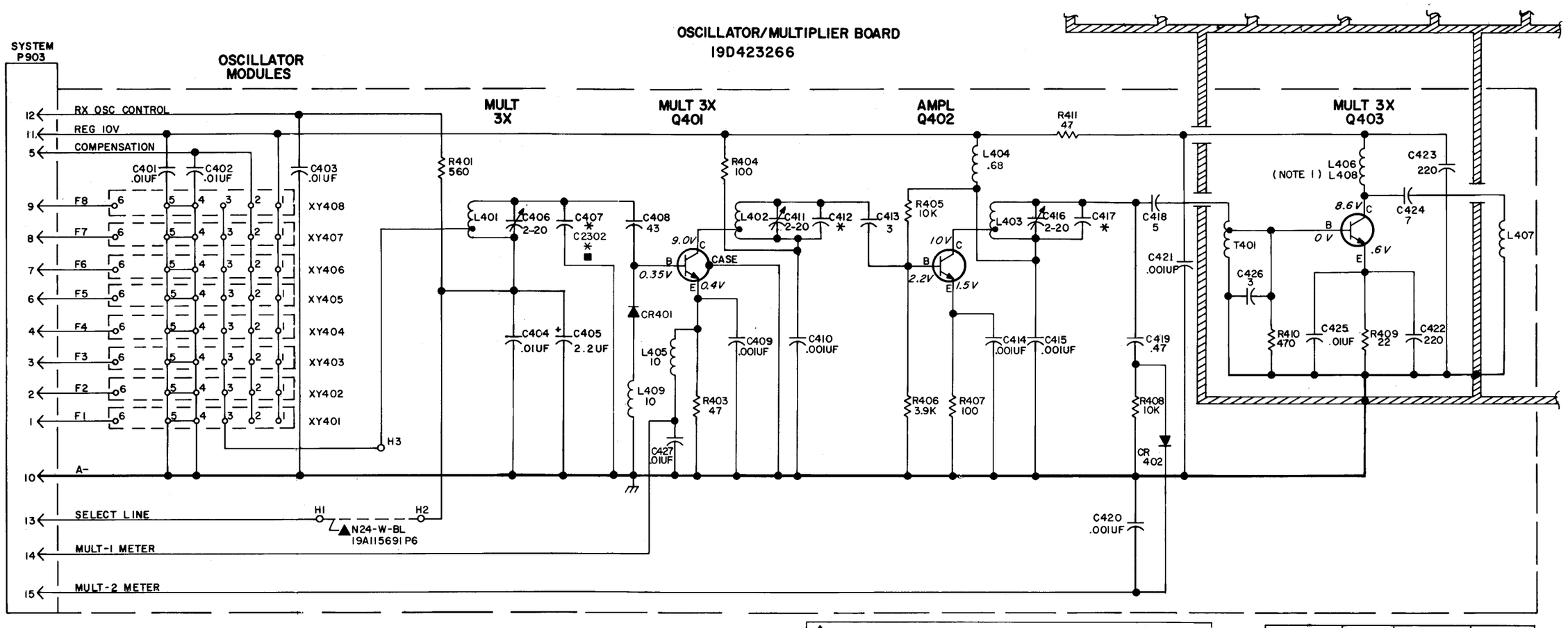
NOTE: LEAD ARRANGEMENT, AND NOT CASE SHAPE, IS DETERMINING FACTOR FOR LEAD IDENTIFICATION. TAB INDICATES EMITTER LEAD.

(19D423790, Rev. 4)



OUTLINE DIAGRAM

406—512 MHz OSCILLATOR/MULTIPLIER BOARD
19D423266G1-G8



NOTE: 1. L406 - G2, G3, G4, G6, G7, & G8
L408 - G1, G5, G9 & G10

✱ COMPONENT VALUE TABLE					
COMP DESIGN	LL	L	M	H	I M
RF FREQ (MHz)	406-420	450-470	470-494	494-512	420-450
C407	24	18	15	13	18
C412	12	6	5	4	8
C417	6	3	–	–	3
C2302	18	10	–	–	10

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.
CPD 310A

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.

▲ THESE COMPONENTS ARE USED TO ADAPT A STANDARD MASTR II RECEIVER TO OPERATION AS AND WITH A DUAL FRONT END. THESE COMPONENTS SHOULD BE IGNORED IN THE STANDARD RECEIVER. BOARDS IDENTIFIED BY A RED DOT HAVE BEEN MODIFIED FOR DFE OPERATION PER MOD KIT 19A129750G1 OR G2

RECEIVER CHANNEL	D.F.E. CHANNEL
SEE IF FILTER BD FOR OTHER DFE CHANGES	NO MODIFICATION REQUIRED ON THE IF FILTER BD
ON PL19D417072 (OSC/MULT BD) NO MODIFICATION REQUIRED	ON PL19D417072 (OSC/MULT BD) 1. N24-W-BL JUMPER ADDED BETWEEN H1 & H2 ON OSC/MULT BD.
THESE ITEMS ARE SUPPLIED IN MOD. KIT PL19A129750G1.	THESE ITEMS ARE SUPPLIED IN MOD. KIT PL19A129750G2.

■ THESE COMPONENTS USED TO ADAPT A STANDARD RECEIVER TO 9-12 FREQ. OPERATION.

OSC/MULT BD> 19D423266
1. C2302LL IS USED INSTEAD OF C407LL.
2. C2302L IS USED INSTEAD OF C407L.
3. C2302LM IS USED INSTEAD OF C407LM
THESE ITEMS ARE SUPPLIED IN KIT PL19A129737G2.
(19D DRAWING 19D417218)

	REV LETTER	FREQ RANGE (MHZ)	NO. OF FREQ
OSC/MULT BD			
19D423266G1	F	406-420	2
19D423266G2	E	450-470	2
19D423266G3	E	470-494	2
19D423266G4	D	494-512	2
19D423266G5	F	406-420	8
19D423266G6	E	450-470	8
19D423266G7	E	470-494	8
19D423266G8	D	494-512	8
19D423266G9	C	420-450	2
19D423266G10	C	420-450	8

(19D423463, Rev. 9)

SCHEMATIC DIAGRAM

406—512 MHz OSCILLATOR MULTIPLIER BOARD 19D423266G1-G8

PARTS LIST

LBI30030D

406-512 MHz OSCILLATOR/MULTIPLIER
19D423266G1-G10

SYMBOL	GE PART NO.	DESCRIPTION
		19D423266G1 2 FREQ 406-420 MHz (LL) 19D423266G2 2 FREQ 450-470 MHz (L) 19D423266G3 2 FREQ 470-494 MHz (M) 19D423266G4 2 FREQ 494-512 MHz (L) 19D423266G5 8 FREQ 406-420 MHz (LL) 19D423266G6 8 FREQ 450-470 MHz (L) 19D423266G7 8 FREQ 470-494 MHz (M) 19D423266G8 8 FREQ 494-512 MHz (H) 19D423266G9 2 FREQ 420-450 MHz (LM) 19D423266G10 8 FREQ 420-450 MHz (LM)
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C401	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C402 thru C404	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW.
C405	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C406	19B209351P2	Variable, ceramic: 2.5 to 20 pf, 200 VDCW, temp coef -250 +700 PPM/°C; sim to Matshushita ECV-1ZW20P32.
C407LL	19A116656P24J8	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -80 PPM.
C407L	19A116656P18J8	Ceramic disc: 18 pf ±5%, 500 VDCW, temp coef -80 PPM.
C407M	19A116656P15J8	Ceramic disc: 15 pf ±5%, 500 VDCW, temp coef -80 PPM.
C407H	19A116656P13J8	Ceramic disc: 13 pf ±5%, 500 VDCW, temp coef -80 PPM.
C408*	19A116656P43J0	Ceramic disc: 43 pf ±5%, 500 VDCW, temp coef 0 PPM.
		In G1 & G5 of REV C & earlier: In G2-G4, G6-G8 of REV B & earlier:
	19A116656P15J0	Ceramic disc: 15 pf ±5%, 500 VDCW, temp coef 0 PPM.
C409 and C410	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C411	19B209351P1	Variable, ceramic: 2 to 10 pf, 200 VDCW, temp coef -350 +500 PPM/°C; sim to Matshushita ECV-1ZW10P32.
C412LL*	19A116656P12J0	Ceramic disc: 12 pf ±5%, 500 VDCW, temp coef 0 PPM.
		In REV D & earlier:
	19A116656P10J0	Ceramic disc: 10 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C412L	19A116656P6G0	Ceramic disc: 6 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C412LM	19A116656P8J0	Ceramic disc: 8 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C412M	19A116656P5G0	Ceramic disc: 5 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C412H	19A116656P4G0	Ceramic disc: 4 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C413	19A116656P3K0	Ceramic disc: 3 pf ±1 pf, 500 VDCW, temp coef 0 PPM.
C414 and C415	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C416	19B209351P1	Variable, ceramic: 2 to 10 pf, 200 VDCW, temp coef -350 +500 PPM/°C; sim to Matshushita ECV-1ZW10P32.
C417LL*	19A116656P6G0	Ceramic disc: 6 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
		In REV D & earlier:
	19A116656P4G0	Ceramic disc: 4 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C417L	19A116656P3G0	Ceramic disc: 3 pf ±0.25 pf, 500 VDCW, temp coef 0 PPM.
C418	19A116656P5J0	Ceramic disc: 5 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C419	5491601P13	Phenolic: 0.47 pf ±10%, 500 VDCW.
C420 and C421	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C422 and C423	19A116679P220K	Mica: 220 pf ±10%, 250 VDCW.
C424*	19A116656P7K0	Ceramic disc: 7 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Added to G1 & G5 by REV E. Added to G2, G3, G4, G6, G7, G8 by REV D. Added to G9 & G10 by REV B.
C424LL*	19A116656P9K0	Ceramic disc: 9 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Added to G1 & G5 by REV E. Deleted in G1 & G5 by REV F.
C424L*	19A116656P9K0	Ceramic disc: 9 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Added to G2 & G6 by REV D. Deleted in G2 & G6 by REV E.
C424LM*	19A116656P9K0	Ceramic disc: 9 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Added to G9 & G10 by REV B. Deleted in G9 & G10 by REV C.
C424M*	19A116656P9K0	Ceramic disc: 9 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Added to G3 & G7 by REV D. Deleted in G3 & G7 by REV E.
C424H*	19A116656P7J0	Ceramic disc: 7 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM. Added to G4 & G8 by REV D.
C424*	19A116656P9K0	Ceramic disc: 9 pf ±1 pf, 500 VDCW, temp coef 0 PPM. Deleted by REV E in G1 & G5. Deleted by REV D in G2-G4, G6-G8. Deleted by REV B in G9, G10.
C425*	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW.
		In REV C & earlier:
	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C426	19A116656P3K0	Ceramic disc: 3 pf ±1 pf, 500 VDCW, temp coef 0 PPM.
C427	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW.
		- - - - - - - DIODES AND RECTIFIERS - - - - - -
CR401	19A115250P1	Silicon, fast recovery, 225 mA, 50 PIV.
CR402	19A116052P5	Silicon, capacitive.
		- - - - - - - - - - INDUCTORS - - - - - - - - -
L401 thru L403		(Part of printed board 19D423267P1).
L404	7488079P5	Choke, RF: 0.68 µh ±10%, 0.15 ohms DC res max; sim to Jeffers 4411-5K.
L405	19B209420P125	Coil, RF: 10.0 µh ±10%, 3.10 ohms DC res max; sim to Jeffers 4446-4K.
L406*	19A129711P1	Coil. Deleted in G1, G5 by REV A.
L407	19A129710P1	Coil.
L408*	19A129352P8	Coil. Added to G1, G5 by REV A.
L409*	19B209420P125	Coil, RF: 10.0 µh ±5%, 3.10 ohms DC res max; sim to Jeffers 4446-4K. Added to G1 & G5 by REV C. Added to G2-G4, & G6-G8 by REV B.
		- - - - - - - - - - PLUGS - - - - - - - - - -
P903		Includes:
	19B219594P1	Terminal strip: 7 pins.
	19B219594P2	Terminal strip: 8 pins.
		- - - - - - - - - - TRANSISTORS - - - - - - - - -
Q401*	19A134447P1	Silicon, NPN; sim to Type 2N5179.
		In G1, G5 of REV A & earlier; in G2-G4, G6-G8 earlier than REV A:
	19A115440P1	Silicon, NPN.
Q402	19A115329P2	Silicon, NPN.
Q403	19A116201P1	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R401	3R152P561K	Composition: 560 ohms ±10%, 1/4 w.
R403	3R152P470J	Composition: 47 ohms ±5%, 1/4 w.
R404	3R152P101K	Composition: 100 ohms ±10%, 1/4 w.
R405	3R152P103K	Composition: 10K ohms ±10%, 1/4 w.
R406	3R152P392J	Composition: 3.9K ohms ±5%, 1/4 w.
R407	3R152P101K	Composition: 100 ohms ±10%, 1/4 w.
R408	3R152P103K	Composition: 10K ohms ±10%, 1/4 w.
R409	3R152P220J	Composition: 22 ohms ±5%, 1/4 w.
R410	3R152P471K	Composition: 470 ohms ±10%, 1/4 w.
R411	3R152P470J	Composition: 47 ohms ±5%, 1/4 w.
		- - - - - - - - - TRANSFORMERS - - - - - - - - - -
T401	19A122920G1	Coil.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XY401 thru XY408	19A116779P1	Contact, electrical: sim to Molex 08-50-0404. (Quantity 6 for each socket).
		- - - - - - - - OSCILLATOR MODULES - - - - - - - -
		NOTE: When reordering specify ICOM Frequency. FOR STANDARD LOW SIDE INJECTION FREQUENCY ICOM Freq = Operating Freq - 11.2 / 27
Y401 thru Y408	19A129939G12	Compensated: ±5 PPM, 406-420 MHz, 450-512 MHz.
	19A129393G8	Externally Compensated: ±5 PPM, 406-420 MHz, 450-512 MHz.
	19A129393G4	Compensated: ±2 PPM, 406-420 MHz, 450-512 MHz.
		NOTE: FOR HIGH SIDE INJECTION FREQUENCY ICOM Freq = Operating Freq + 11.2 / 27
Y401 thru Y408	19A130283G6	Compensated: ±5 PPM. 406-420 MHz, 450-512 MHz.
	19A130283G4	Externally Compensated: ±5 PPM, 406-512 MHz.
	19A130283G2	Compensated: ±2 PPM, 406-512 MHz.
		DUPLEX HIGH SIDE INJECTION KIT 19A130045G5
		- - - - - - - - - - CAPACITORS - - - - - - - - -
C2315	19A116656P13J8	Ceramic disc: 13 pf ±5%, 500 VDCW, temp coef -80 PPM.
C2316	19A116656P5J0	Ceramic disc: 5 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C2317	19A116656P8J8	Ceramic disc: 8 pf ±0.5 pf, 500 VDCW, temp coef -80 PPM.
C2318	19A116656P10J8	Ceramic disc: 10 pf ±5%, 500 VDCW, temp coef -80 PPM.
C2319	19A116656P4J0	Ceramic disc: 4 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C2320	19A116656P5J8	Ceramic disc: 6 pf ±0.5 pf, 500 VDCW, temp coef -80 PPM.
C2321	19A116656P3J0	Ceramic disc: 3 pf ±0.5 pf, 500 VDC*, temp coef 0 PPM.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - -
	4031594P1	Insulator. (Located under C406, C411, C416).
	4036555P1	Insulator, washer: nylon. (Used with Q402).
	19A116707P3	Insulator: sim to Thermalloy 7717-46. (Used with Q403).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - 19D423266G1 & G5

To improve operation of oscillator/multiplier in 406-420 MHz band. Deleted coil L406 and added coil L408.

REV. B - 19D423266G1 & G5

REV. A - 19D423266G2-G4 & G6-G8

To provide uniform output over multi-frequency range. Changed Q401.

REV. B - 19D423266G2-4 & G6-8

REV. C - 19D423266G1 & G5

To increase output of OSC/MULT board with multiple ICOMs. Added L409.

REV. D - 19D423266G1 & G5

REV. C - 19D423266G2-4 & G6-8

To improve drive to first Multiplier. Changed C408.

REV. E - 19D423266G1, G5

REV. D - 19D423266G2, 3, 4, 6, 7, 8

REV. B - 19D423266G9, 10

To improve tuning. Changed C412, C417 and C425 in Groups 1 and 5. Changed C425 in Groups 2, 3, 6, 7, 9 and 10.

REV. A - 19D423266G9, G10

To allow operation in 420-450 MHz range. Deleted L406. Added L408.