MAINTENANCE MANUAL 25-50 MHz OSCILLATOR/MULTIPLIER BOARD

19D423078G1-G8

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DESCRIPTION

OSCILLATOR-MULTIPLIER

The MASTR® II oscillator-multiplier can be equipped with up to eight Integrated Circuit Oscillator Modules (ICOMs). The ICOM crystal frequencies range from approximately 11 to 20 megahertz, and the crystal frequency is multiplied three times and then amplified to provide a high side injection frequency to the mixer.

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 of the ICOMs 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 $(\pm 0.0005\%)$ 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 the top of the can.

Frequency selection is accomplished by switching the ICOM keying lead (terminal 6) to A- by means of 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 lead 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.



Printed in U.S.A.

LBI-4993

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 +10 Volt regulator IC provided with the wide spaced transmitter option.

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.

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 in 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 (+32°F to 131°F).



Figure 1 - Typical Crystal Characteristics

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 $+55^{\circ}$ C. When the temperature rises above $+55^{\circ}$ 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.

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

MULTIPLIER & MULTIPLIER

The output of the selected ICOM is applied to the base of common emitter amplifier stage Q401 through a base tank circuit consisting of L401/C402 and coupling capacitor C406. C402 is tuned to three times the crystal frequency. Q401 is metered through a metering network consisting of C407, C418,

R405, L405 and R411 and coupled through P903-14 to metering jack J601-3 on the IFAS board.

The output of Q401 is coupled to the base of amplifier Q402 through collector tank L402/C411 and coupling capacitor C410. C411 is tuned to three times the crystal frequency. Q402 is metered through a metering network consisting of C412, R409 and R410 and coupled through P903-15 to J601-4 on the IFAS board.



Figure 2 - Equivalent ICOM Circuit

The output of Q402 is coupled through three LC circuits (L404-C414 on the OSC/MULT board and L502-C506 and L503-C508 on the MIF board) to the mixer stage. The three LC circuits provide the selectivity for the oscillator-multiplier chain.

					L
		PARTS LIST		C408H	
				C409	
	25-	LBI4994F 50 MHz OSCILLATOR/MULTIPLIER		C410LL	
		19D423078G1 - G8		C410L	
				C410M	
SYMBOL	GE PART NO.	DESCRIPTION		C410H	
				C411	
		G1 25-30 MHz 2 FREQ (LL) G2 30-36 MHz 2 FREQ (L)		0410	
		G4 42-50 MHz 2 FRSQ (M) G5 25-30 MHz 8 FRSQ (LL)		and C413	
		G7 36-42 MHz 8 FREQ (L) G7 36-42 MHz 8 FREQ (M) G8 42-50 MHz 8 FREQ (H)		C414LL	
		CAPACITORS		C414L	
C401	T644ACP310K	Polyester: .010 uF ±10%, 50 VDCW.		C414M	
C402	19A700012P2	Variable, ceramic: 2.5 to 20 pF 200 VDCW, temp coef -250 -700 FPM; sim to Panasonic ECX12W20X32.		C414H*	
C403*	5496267P9	Tantalum: 3.3 uF ±20%, 15 VDCW; sim to Sprague Type 150D. Doleted by REV C.			
C403LL*	5496267F17	Tantalum: 1.0 uF $\pm 20\%,$ 35 VDCW; sim to Sprague Type 150D. Added by REV C.			
C403L*	5496267P30	Tantalum: 0.82 uF $\pm 20\%$, 35 VDCW; sim to Sprague Type 150D. Doleted by REV E.		C415 and	
	540626750	In REV B & earlier:		C416 C417	
0400W	548020798	Type 150D.		C418*	
and C403H	5490407P9	Tantalum: 3.3 uF +20%, 15 VDCW; sim to Sprague Type 150D.			
C404LL*	194701624020	Ceramic, disc: 33 pF ±5%, 500 VDCW, tomp coef 0 PPM ±30.		L401 and	
		In REV B & earlier:		L402 L404	
	5496219P53	Ceramic disc: 39 pF ±5%, 500 VDCW, temp coef 0 PPM.	:	L405*	
C404L*	19A701624P17	Ceramic, disc: 24 pF ±5%, 500 VDCW, temp coef 0 PPM ±30.			
	5496219P49	In REV B & earlier: Ceramic disc: 27 pF +5%, 500 VDCW term coef	:	P903	
C404M	19A701624P12	0 PPM. Ceramic, disc: 15 pP +5% 500 VDCW temp cost			
C404H	19470162496	O PPM ±30.			
C405	194701603219	0 PPM ±60. Ceremic: 1000 pF ±20% 1000 VDCW; cim to BMC		Q401	
C406LL	19470162408	Type JF Discap.		and Q402	
CADGI	104701624P6	coef 0 PPM ±30.		R401	
C406L	19470162426	Ceramic, filsc: 8 pF ±0.5 pF, 500 VDCW, temp coef 0 PPM ±60.	1	R402	
C406M	194701624P5	Ceramic, disc: 7 pF ±0.5 pF, 500 VDCW, temp coef 0 PPM ±60.		R403	
C406H	19470162493	Ceramic, disc: 5 pF ±0.5 pF, 500 VDCW, temp coef 0 PPM ±60.	1	R404 R405	
C407	19A701602P19	Ceramic: 1000 pF ±20%, 1000 VDCW; sim to RMC Type JF Discap.		R406	
C408LL*	19A701624P19	Ceramic, disc: 30 pF ±5%, 500 VDCW, temp coef 0 PPM ±30.	1	R407 R408	
	19A116656P33J0	In REV B & carlier: Ceramic disc: 33 pF +5%, 500 VDCW temp coef		and R409	
C408L*	194701624P15	О РРМ. Ceramic, disc: 20 pF ±5%, 500 VDCW temp coef	1	R410	
		0 PPM ±30.		n +i I. ™	
	19A116656P27J0	Cerumic disc: 27 pF ±5%, 500 VDCW, temp coef 0 PPM.	,	KY401	
C408M	19A701624P11	Ceramic, disc: 13 pF +5%, 500 VDCW, temp coef	1	thru KY408	
					1
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SYMBOL	GE PART NO.	DESCRIPTION
С408Н	19A701624P6	Ceramic, disc: 8 pF ±0.5 pF, 500 VDCW, temp coef 0 PPW +60.
C409	L9A701602P19	Ceramic: 1000 pF ±20%, 1000 VDCW; sim to HMC Type JF Discap.
C410LL	19A701624P8	Ceramic, disc: 10 pF ±0.5 pF, 500 VDCW, tcmp coef 0 PPM ±30.
C410L	19A701624P6	Ceramic, disc: 8 pF ±0.5 pF, 500 VDCW, temp coef 0 PPM ±60.
C410M	19A701624P5	Ceramic, disc: 7 pF ±0.5 pF, 500 VDCW, temp coef 0 PPM ±60.
С410н	19A701624P3	Ceramic, disc: 5 pF ± 0.5 pF, 500 VDCW, temp coef 0 PPM ± 60 .
C411	19470001202	Variable, ceramic: 2.5 to 20 pF 200 VDCW, temp coef -250 -700 PPM; sim to Panasonic SCX12W20X32.
C412 and C413	19A701602P19	Ceramic: 1000 pF ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C414LL	19A701624P119	Ceramic, disc: 30 pF ±5%, 500 VDCW, temp coef NS0 PPM ±30.
C414L	19A701624P118	Ceramic, disc: 27 pF $\pm 5\%$ -500 VDCW, temp coef N80 PPM ± 30 .
C414M	194701624P114	Coramic, disc: 18 pF $\pm 5\%$, 500 VDCW, temp coef N80 PPM ± 30 .
C414 ∏ *	19A701624P110	Ceramic, disc: 12 pF ±5%, 500 VDCW, temp coef N80 PPM ±30.
	19A116656P15K8	In may C & Gartier: Ceramic disc: 15 pF ±10%, 500 VDCW, temp coef -80 PPM
C415 and C416	19/101602519	Ceramic: 1000 pF $\pm 20\%$, 1000 VDCW; sim to RMC Type JF Discap.
C417	T644ACP310K	Polyester: .010 uF ±10%, 50 VDCW.
C418*	T644ACP310K	Polyester: .010 uF $\pm 10\%$, 50 VDCW. Added by REV A
		INDUCTORS
and L402		(Part of printed board 190433(62PI).
L404	19821941965	Coil.
L405*	19B209420P114	Coil, RF: 1.2 uH ±10%, .18 ohms DC res max; sim to Jeffers 4436-1K. Added by MEV A.
		PLUGS
P903	10021050401	Connector. Includes:
	1982195942	Contact, electrical: 8 pins.
0401	19411532801	Silicon NEW
and Q402		
R401	19A700106P57	Composition: 560 ohms ±5%, 1/4 w.
R402	19A700106P79	Composition: 4.7K ohms ±5%, 1/4 w.
R403	19A700106P67	Composition: $1.5K$ ohms $\pm 5\%$, $1/4 w$.
R404	19A700106P39	Composition: 100 ohms $\pm 5\%$, 1/4 w.
R405	19A700106P46	Composition: 200 ohms ±5%, 1/4 w.
R406	19A700106P79	Composition: 4.7K ohms ±5%, 1/4 w.
R407	19A700106P67	Composition: 1.5K ohms ±5%, 1/4 w.
R408 and R409	194700106P39	Composition: 100 ohms ±5%, 1/4 w.
R410	3R152P203J	Composition: 20K ohms ±5%, 1/4 w.
R411*	3R152P243J	Composition: 24K ohms ±5%, 1/4 w. Added by REV A
XY401 thru XY408	19A701785P1	Contact, electrical; sim to Molex 08-50-0404. (6 contacts with each socket).

SYMBOL	GE PART NÛ.	DESCRIPTION
		A8SOCIATED ASSEMBLIES
		OSCILLATORS
		NOTE: When reordering specify ICOM Prequency.
		ICOM Freq. (25-30, 36-42 MHz) = Oper Freq + 11.2
		ICOM Freq. (30-36, 42-50 MHz) = $\frac{0 \text{ per Freq} + 9.4}{3}$
Y401 thru	19A129393G1	Compensated: 2 FPM, 30-36, 42-50 MHz.
Y408	19A129393G2	Compensated: 2 PPM; 25-30, 36-42 MHz.
	19412939369	Compensated: 5 PPM; 30-36, 42-50 MHz.
	19A129393G10	Compensated: 5 PPM; 25-50, 36-42 MHz.
	19A129393G5	Externally Compensated: 5 PPM; 30-36, 42-50 Mhz
	19A129393G6	Externally Compensated: 5 PPM; 25-30, 36-42 MHz
		MISCELLANROUS
	4031594P1	Insulator. (Used with C402, C411).
		RECEIVER MODIFICATION KIT 19A12975061 (Used with DUAL FRONT END)
		CAPACITORS
C2301*	19A116656P8J0	Ceramic disc: 8 pF ± 0.5 pF, 500 VDCW; temp coef 0 PPM. Added by REV A. Deleted by REV B.
		DIODES AND RECTIFIERS
CR2301	19A116925P1	Silicon.
		RESISTORS
R2301	19A700106P95	Composition: 22K chms ±5%, 1/4 w.
R2302	19A700106P59	Composition: 680 ohms $\pm 5\%$, 1/4 w.
		CABLES
W2301	19B219999G2	Cable, RF: approx 1 foot long.
		DUAL FRONT END MOD KIT 19A129750C2
		CAPACITORS

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 <u>Oscillator/Multiplier Board 19D423078G1-G8</u> To reduce Pos. C moter reading below 1 Volt. Added R411.
- REV. B To reduce coupling between oscillator/multiplier board and IFAS board over the MULT-1 lead, Added L405 and C418.
- REV. C Oscillator/Multiplier Board 190423078G1, G5 To improve band end tuning. Changed C403.
- REV. C Oscillator'<u>Multiplier Board 19D42307862, G6</u> To improve tuning range. Changed C403L and C404L.
- REV. C Oscillator/Multiplier Board 19D42307864, G8 REV. D Oscillator/Multiplier Board 19D42307862, G6 To improve tuning range at high end of split. Changed C408L in groups 2 and 6 and C414H in groups 4 and 8.
- REV. E <u>Oscillator/Multiplier Board 19D42307862, G6</u> To improve MULT. 1 reading in 30-36 MHz range. Deleted C403L.

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OUTLINE DIAGRAM

SOLDER SIDE

COMPONENT SIDE



(19C327597, Rev. 3) (19B227815, Sh. 1, Rev. 0)



(19C327597, Rev. 3) (19B227815, Sh. 2, Rev. 0)

NOTE: PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION PREFIX WITH 400 SERIES. EXAMPLE:C1- C401, R1- R401....ETC.

LEAD IDENTIFICATION FOR Q1 & Q2



TOP VIEW

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

LBI-4993



25-50 MHz OSCILLATOR/MULTIPLIER

19D423078G1-G8



THESE COMPONENTS ARE USED TO ADAPT A STANDARD MASTER II RECEIVER TO OPERATION AS AND WITH A DUAL FRONT END. THESE COMPONENTS SHOULD BE IGNORED IN THE STANDARD RECEIVER. BOARDS DENTIFIED BY A RED DOT HAVE BEEN MODIFIED FOR DFE OPERATION PER MOD KIT 19A129750G1 OR G2.			
RECEIVER CHANNEL SEE MIXER/IF BD FOR OTHER DFE CHANGES ON PL19D417078 (OSC/MULT BD) NO MODIFICATION REQUIRED		D.F.E. CHANNEL	
		NO MODIFICATION REQUIRED ON THE MIXER/	
		ON PL19D417078 (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	

25-50 MHz OSCILLATOR/MULTIPLIER

19D423078G1-G8

(19D423468, Rev. 7)

4

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= MALLHENRYS OR H=HENRYS. CPD 3104

> 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.

VOLTAGE READINGS

VOLTAGE READINGS ARE TYPICAL READINGS MEASURED TO SYSTEM NEGATIVE (P903-10) WITH TEST SET MODEL 4EX3A11 OR A 20,000 OHM-PER-VOLT METER.

INDICATES A-

+ INDICATES VEHICLE GROUND

	REV LETTER	FREG RANGE (MHZ)	NO OF
OSC/MULT BD			
19042307861	С	25-30 (LL)	Ž
19042307862	ш	30-36 (L)	2
19D423078G3	9	36-42 (M)	2
190423078G4	0	42-5C (H)	2
19042307865	C	25-30 (LL)	6
19042307866	Ē	30-36 (L)	8
19D42307867	8	36-42 (M)	8
19D42307868	Ċ	42-50 (H)	6

	· COMPONENT VALUE TABLE			
COMP DESIG	٤ L	L	м	н
RF FREQ	25-30 MHZ	30-36 HHZ	36-42 MHZ	42-50 MHZ
IF FREQ	11.2 MHZ	9.4 MHZ	11,2 MHZ	9.4 MHZ
C 403	t	NONE	3.3	3,3
C404	33	24	15	9
C406	IQ	8	7	5
C408	30	20	13	6
C410	10	8	7	
C414	30	27	18	12

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