MOBILE RADIO

LBI-31493B

MAINTENANCE MANUAL
FOR
GENERAL ELECTRIC
MPI® CHANNEL GUARD & TYPE 99 TONE
(WITH PROGRAMMABLE CODE PLUG)

GENERAL ELECTRIC

® Registered Trademark of GENERAL ELECTRIC COMPANY

SPECIFICATIONS

Tone Frequency Range Decode	288 Hz to 2046.9 Hz
Channel Guard Encode Frequency Range	67-255.75 Hz
Channel Guard Distortion	<5% from 67-255.75 Hz
Tone Input	200 millivolts RMS ±10 millivolts
Automatic Reset	Selectable, 1 to 63 seconds
Current Drain	
5.4 Volts	1.5 milliamps
7.5 Volts	12.0 milliamps

MAINTENANCE MANUAL
MPI TYPE 99 DECODE AND CHANNEL GUARD ENCODE

TABLE OF CONTENTS

DESCRIPTION

The MPI Type 99 Decode and Channel Guard Encode Option provides Individual, Group and Super Group Call decode as well as Channel Guard encode from one hybrid module and one nonvolatile RAM code plug. The option can decode Type 99 and Motorola formatted two-tone sequential signalling schemes. Other schemes may be accomodated. All necessary customer information is stored in one 256 bit nonvolatile RAM module (code plug).

The option consists of a Type 99 hybrid, a code plug and a Type 99 option kit. The Type 99 option kit includes a printed circuit board along with a top cover which contains the MONITOR/RESET switch S1.

Programming of the code plug is done in the field with the Universal Radio Programmer (TQ2310) and LBI-31551. The TQ2310 must be equipped with the Type 99 Module Adapter (TQ2341), and the Type 99 Module EPROM (TQ2345).

OPERATION

In Type 99 Tone Systems calls will not be heard from the receive circuit until the proper two tones are detected by the Type 99 decoder.

After detection of the first tone, the decoder switches to accept the second tone. The decoder recognizes the second correct tone before the tone is completed. The remaining portion of the second tone is applied to the receiver audio path to serve as an alert tone.

When the correct tones have been detected, the receiver audio path opens and remains open to receive messages until the decoder circuit is reset. The decoder can be reset manually by using the MONITOR/RESET switch S1. Alternately, the decoder can be automatically reset at the time specified by the customer selected reset time programmed into the code plug.

Channel Guard is selected by programming the desired frequency into the code plug and leaving in place the jumper present on the option board. Common Channel Guard frequencies are listed in Table 2.

A block diagram of the Type 99 Decode/Channel Guard Encode Option is shown in Figure 1.

CIRCUIT ANALYSIS

The main components of the Type 99 Decode and Channel Guard Encode Option, as shown in Figure 1, are the Type 99 module and the code plug. The Type 99 module contains a microcomputer (U2) and a digital tone detector (U3).

Turning the radio on resets the Type 99 module and loads all customer data, previously programmed into the code plug, into U2. The code plug is supplied with 5 volts for 50 milliseconds at power up

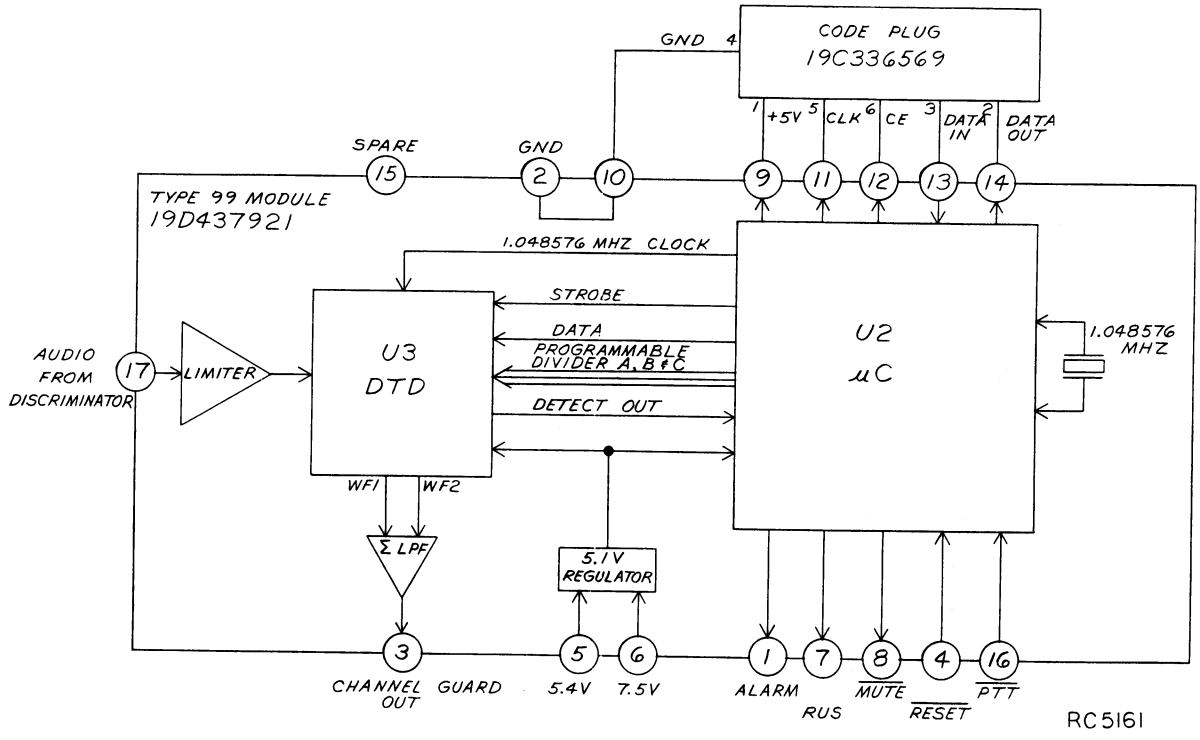


Figure 1 - Type 99 Module Block Diagram

(each time the radio is turned on). During this 50 ms period the code plug chip enable line is brought to logic high and the clock and data lines are active. The RUS line (T99 module pin 7) is set to a logic low, squelching the receiver audio at this time.

When a Type 99 tone is received, it is applied to pin 17 of the Type 99 module and then to the digital tone detector U3 through a limiter. When the correct first tone is detected, U3 signals a successful detect to U2 on the detect out line of U3. At this time U2 reprograms U3 to look for the correct second tone. If U3 detects the correct second tone, it notifies U2 via the detect out line again and the RUS line is brought to logic high.

When this happens, the RUS line of the Type 99 module, pin 7, goes high and unmutes the radio's audio allowing the remaining portion of the 2nd tone to be heard as an alert tone. Although the alert tone generated inside the Type 99 module (pin 1) is not used, it can be detected and seen on pin 1 for the duration of the second tone. After the alert tone ends, the mute line, which is not used in MPI, goes high also. The audio remains open to receive any message until the module is reset manually at pin 4 or internally at the automatic reset time programmed into the code plug.

The Channel Guard encode portion of the Type 99 module provides a continuous-tone encoder for operation on tone frequencies in the 67-255.75 Hz range. When the push-to-talk (PTT) switch is activated, pin 16 (PTT) is brought low and causes U2 to program U3 to output the Channel Guard encode frequency to pin 3. If Channel Guard encode is not desired, a jumper on the option board should be removed to prevent the tone frequency from being applied to the transmitter audio line.

CHANNEL GUARD TONES

Channel Guard tones should be carefully selected with due consideration being given to geographical location, terrain, neighboring tone systems, etc., in the interest of avoiding possible co-channel interference.

Channel Guard, when ordered with a multi-frequency unit, is applicable to all channels.

CHANNEL GUARD TONE FREQUENCIES
(See following notes before selecting CG Tone Frequencies)

67.0 Hz	85.4 Hz	107.2 Hz	136.5 Hz	173.8 Hz	218.1 Hz
69.3 (M)	88.5	110.9	141.3	179.9 (Note 1)	225.7
71.9 (M)	91.5	114.8	146.2	186.2	233.6
74.4	94.8	118.8 (Note 1)	151.4 (Note 1)	192.8	241.8
77.0	97.4	123.0	156.7	202.7 (M)	250.3
79.7	100.0 (Note 1)	127.3	162.2	203.5	
82.5	103.5	131.8	167.9	210.7	

NOTES:

1. Do not use 179.9 Hz or 118.8 Hz in areas served by 60 Hz power distribution systems (or 100.0 Hz or 151.4 Hz in areas supplied with 50 Hz power). Hum modulation or co-channel stations may "false" Channel Guard decoders.

2. Do not use adjacent Channel Guard tone frequencies in systems employing multiple Channel Guard tones. Avoid same-area-co-channel use of adjacent Channel Guard tones whenever possible. As stated in EIA Standard RS-220, there is a possibility of decoder falsing.

3. To minimize receiver turn-on time delay, especially in systems using Channel Guard repeaters or receiver voting, choose the highest usable Channel Guard tone frequency. Do not use tones below 100 Hz when it is necessary to meet the receiver response time requirements of EIA Standard RS-220.

Table 1 - Channel Guard Tone Frequencies

CODE PLUG PROGRAMMING

The code plug contains all customer tone and option information. Programming is accomplished by using the procedures described in the Type 99 Field Programmable Instructions LBI-31551.

DETERMINATION OF TONE FREQUENCIES

As previously mentioned, the Pager can receive and decode two-tone sequential signals coded in the GE Type 99 format or the Motorola format.

The structure and timing of General Electric and Motorola formats are given below.

General Electric

Tones		Timing	
AB	Individual	1st Tone:	1 sec ±200 msec
AD	Group	Pause:	200 msec ±50 msec
CD	Super Group	2nd Tone:	1 sec +3 sec, -0 sec

Motorola

AB	Individual	1st tone:	1 sec minimum
CB	Alternate Group	Pause:	---
		2nd Tone:	3 sec minimum
B	Group	1 tone only, 5-8 sec long	

GE FORMAT

INDIVIDUAL CALL

For example, assume the paging number to be 123. The first digit of the paging number is a 1. Look in Table 2, and read down the column labeled "100's Digit" to a 1. Read horizontally across to the column labeled "10's Digit". The tone group is B. The second digit of the paging number is a 2. The tone number is B2. Look in Table 3 and down the column labeled "Tone Designator" to find B2. Read horizontally across to the column labeled "Tone Frequency". The first tone frequency is 787.5 Hz.

To determine the second tone frequency look in Table 2 and as before, find the first digit of the paging number 1. Read horizontally across to the column labeled "1's Digit".

The second tone group is A. The third digit of the paging number is a 3 and the Tone Designator is A3. In Table 3 read down the column labeled "Tone Designator" and find A3. Read horizontally across the column labeled "Tone Frequency". The second tone frequency is 802.5 Hz.

For different paging numbers, locate the first digit in the "100's Digit" column and determine the tone frequencies as described in the example. For a complete description of tone applications see DATAFILE BULLETIN DF-5000-3A.

100's Digit	10's Digit	1's Digit
	For 1st Tone	For 2nd Tone
0	A	A
1	B	A
2	B	B
3	A	B
4	C	C
5	C	A
6	C	B
7	A	C
8	B	C
9	Not Used	

Table 2 - Tone Groups

TONE GROUP	TONE DESIGNATOR	TONE FREQUENCY
A	A0	682.5 Hz
	A1	592.5 Hz
	A2	757.5 Hz
	A3	802.5 Hz
	A4	847.5 Hz
	A5	892.5 Hz
	A6	937.5 Hz
	A7	547.5 Hz
	A8	727.5 Hz
	A9	637.5 Hz
B	B0	652.5 Hz
	B1	607.5 Hz
	B2	787.5 Hz
	B3	832.5 Hz
	B4	877.5 Hz
	B5	922.5 Hz
	B6	967.5 Hz
	B7	517.5 Hz
	B8	562.5 Hz
	B9	697.5 Hz
C	C0	667.5 Hz
	C1	712.5 Hz
	C2	772.5 Hz
	C3	817.5 Hz
	C4	862.5 Hz
	C5	907.5 Hz
	C6	952.5 Hz
	C7	532.5 Hz
	C8	577.5 Hz
	C9	622.5 Hz
Diagonal Tone		742.5 Hz

Table 3 - Tone Generator Frequencies

MOTOROLA FORMAT

INDIVIDUAL CALL

Tables 4 and 5 may be used to determine the tone frequencies.

The first digit of the code determines the tone groups used in the code (See Table 4). Then Table 5 is used to determine the actual tone frequencies.

For a code of 124, the tone groups used are shown in Table 4. (Tone A and Tone B are both located in Tone Group 1.) Tone A is tone number 2 in Tone Group 1, and Tone B is tone number 4. Refer to the following examples for additional information.

EXAMPLE 1 - Code 098:

The digit "0" in Table 4 (First Digit of Code) shows that Tone A is in Tone Group 4, and Tone B is in Tone Group 2 (See Table 5).

Tone number 9 in Tone Group 4 is 524.6 Hz.

Tone number 8 in Tone Group 2 is 879.0 Hz.

EXAMPLE 2 - Code 265:

The digit "2" in Table 4 shows that both Tone A and Tone B are both in Tone Group 2.

Tone number 6 is 788.5 Hz.

Tone number 5 is 746.8 Hz.

First Digit of Code	Group from Which Tone A is Selected	Group from Which Tone B is Selected
1	1	1
2	2	2
3	1	2
4	4	4
5	5	5
6	2	1
7	4	5
8	5	4
9	2	4
0	4	2
A	3	3

Table 4 - Motorola-Type Coder Numbers

GROUP CALL (Long B Tone Only Format)

In Group Call application, the Tone Group is determined by Table 6, while the frequency is determined by Table 5. Refer to the following examples.

NOTE

Group Call code numbers range from 00 to 99. However, there are several Group Calls with the same Tone B frequency. This limits the total number of Group Calls to 40.

EXAMPLE 1 - Group Call Code 07 (also code 27 and 37):

The digit "0" in Table 6 shows that Tone B is in Tone Group 2 along with 20 to 29 and 30 to 39. Tone number 7 in Tone Group 2 is 832.5 Hz (See Table 5).

EXAMPLE 2 - Group Call Code 98 (also code 48 and 88):

The digit "9" in Table 6 shows that Tone B is in Tone Group 4 along with 40 to 49 and 80 to 89. Tone number 8 in Tone Group 4 is 496.8 Hz.

Tone No.	Tone Group 1	Tone Group 2	Tone Group 3	Tone Group 4	Tone Group 5	Tone Group 6
1	349.0 Hz	600.9 Hz	288.5 Hz	339.6 Hz	584.8 Hz	1153.4 Hz
2	368.5 Hz	634.5 Hz	296.5 Hz	358.6 Hz	617.4 Hz	1185.2 Hz
3	389.0 Hz	669.9 Hz	304.7 Hz	378.6 Hz	651.9 Hz	1217.8 Hz
4	410.8 Hz	707.3 Hz	313.0 Hz	399.8 Hz	688.3 Hz	1251.4 Hz
5	433.7 Hz	746.8 Hz	953.7 Hz	422.1 Hz	726.8 Hz	1285.8 Hz
6	457.9 Hz	788.5 Hz	979.9 Hz	445.7 Hz	767.4 Hz	1321.2 Hz
7	483.5 Hz	832.5 Hz	1006.9 Hz	470.5 Hz	810.2 Hz	1357.6 Hz
8	510.5 Hz	879.0 Hz	1034.7 Hz	496.8 Hz	855.5 Hz	1395.0 Hz
9	539.0 Hz	928.1 Hz	1063.2 Hz	524.6 Hz	903.2 Hz	1433.4 Hz
0	330.5 Hz	569.1 Hz	1092.4 Hz	321.7 Hz	553.9 Hz	1122.5 Hz

Table 5 - Motorola Tone Frequencies and Groups

GROUP CALL CODE NUMBER	TONE GROUP (Tone B)
00 - 09	TG2
10 - 19	TG1
20 - 29	TG2
30 - 39	TG2
40 - 49	TG4
50 - 59	TG5
60 - 69	TG1
70 - 79	TG5
80 - 89	TG4
90 - 99	TG4

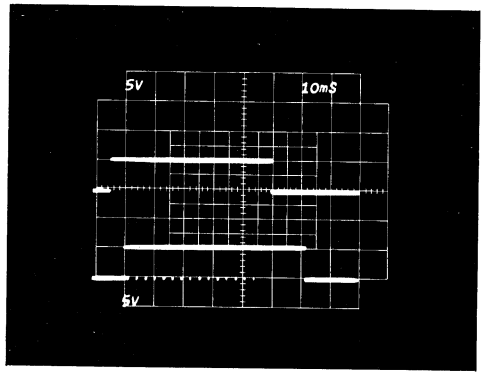
Table 6 - Group Call Tone Groups (TG)

TROUBLESHOOTING

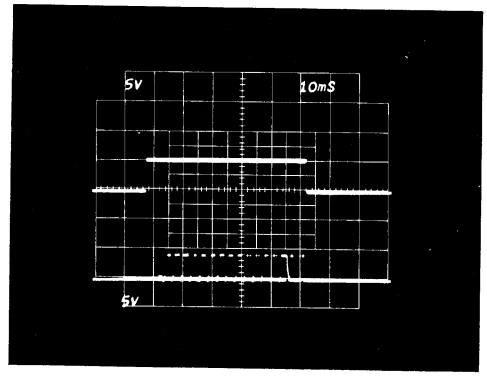
Troubleshooting of this option should determine whether the Type 99 module, code plug, option board or the radio is faulty. Using the procedures in Table 7 along with the associated wave shapes can isolate the defective component. If the MPI radio is suspected, refer to the appropriate MPI Maintenance Manual. If the Type 99 module is suspected, be sure to verify that the code plug is correctly programmed before proceeding to the troubleshoot procedure.

CODE PLUG PINS
(Trigger on Pin 1)

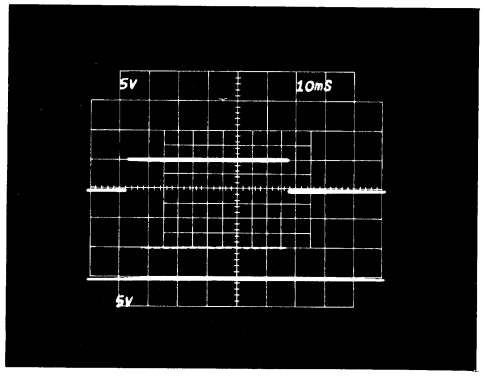
Pin 1
Pin 2



Pin 1
Pin 3



Pin 1
Pin 5



Pin 1
Pin 6

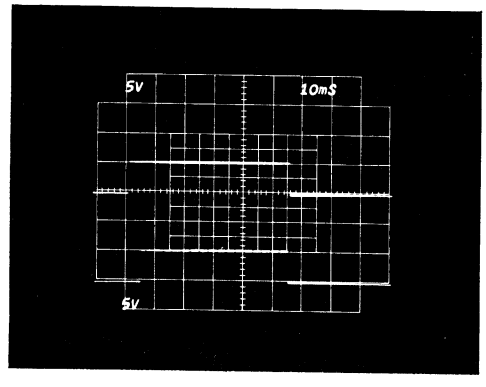
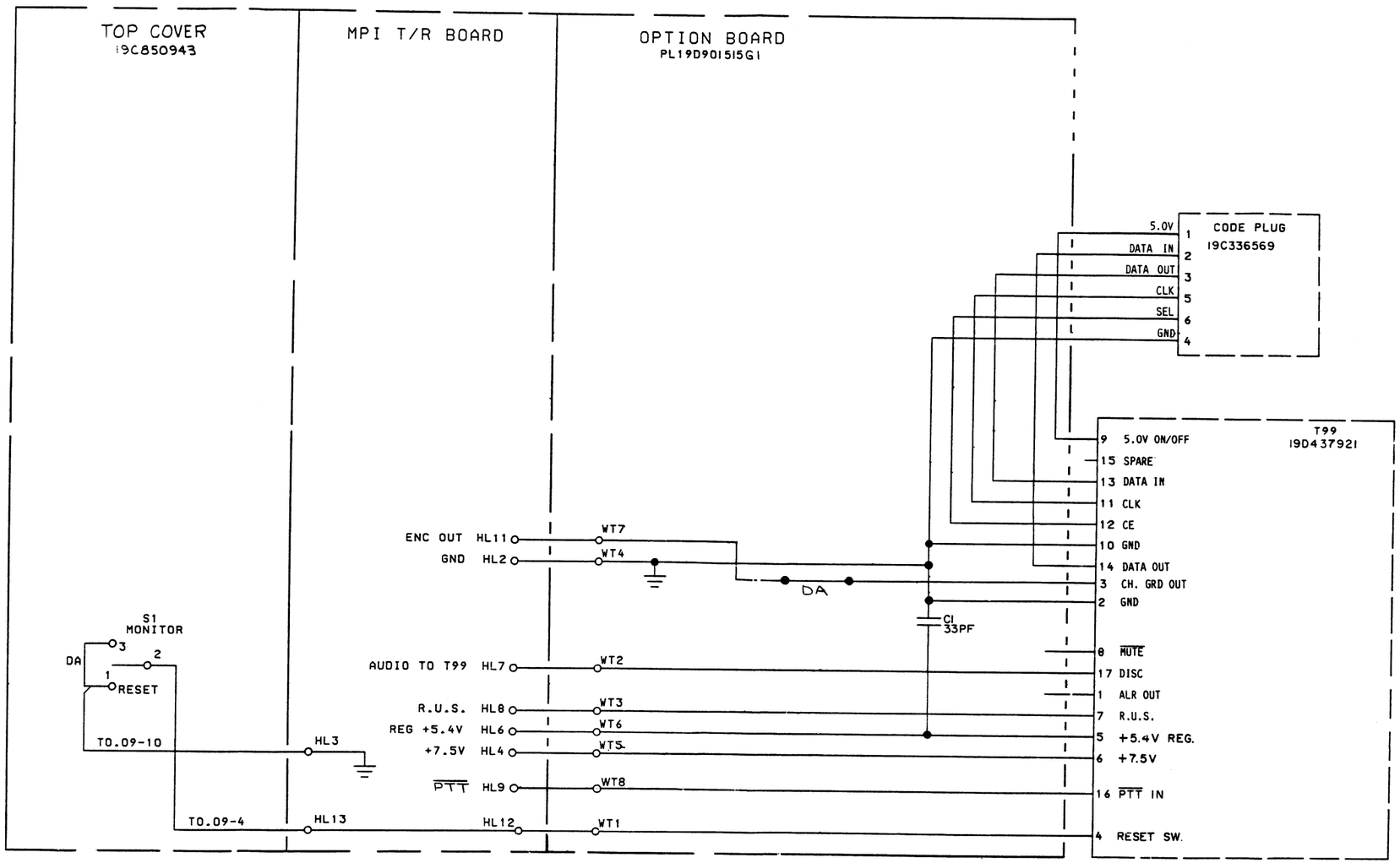


Table 7

TROUBLESHOOTING PROCEDURE

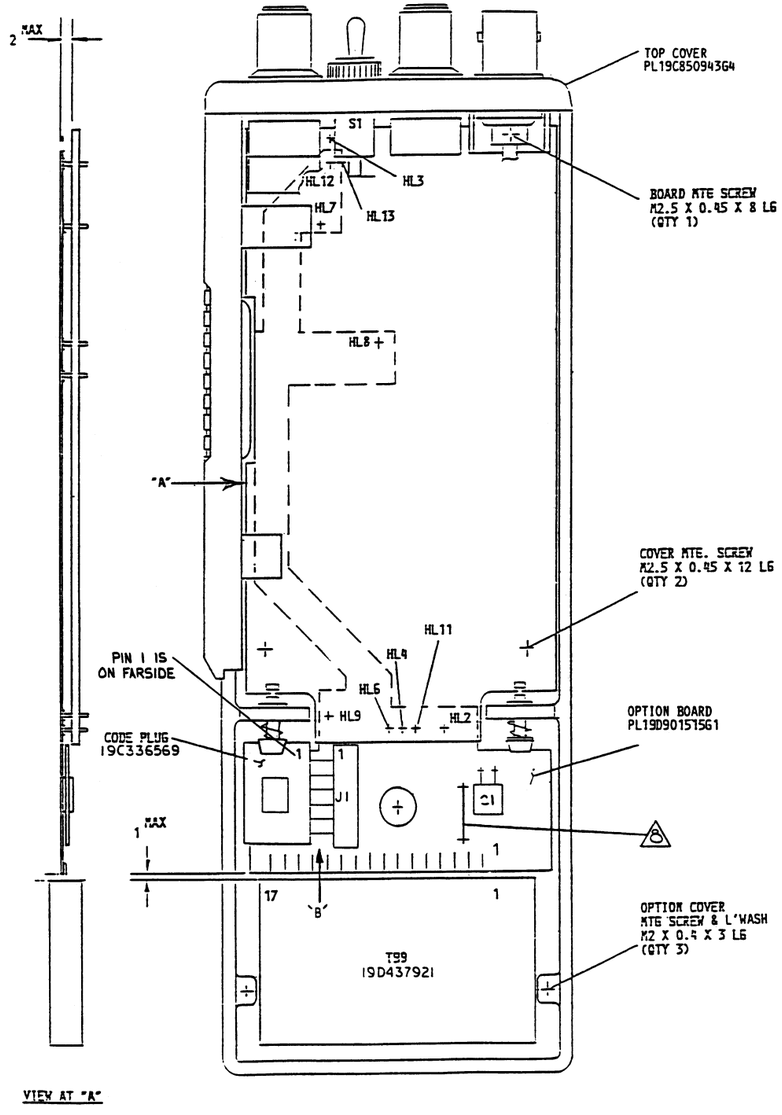
SYMPTOM	PROCEDURE
1) Won't decode or encode	Verify that correct voltages reach the Type 99 pins 2, 5, 6 & 10. If not then either the option board or the radio is faulty. Verify that 5 volts to the code plug is present for approximately 50 milliseconds, that pin 4 is at ground, and that there is activity on the other code plug lines. If no 5 volt pulse or ground is present or there is incorrect activity on code plug pins 2, 5, or 6, and the option board is correct, then the Type 99 module is faulty. If the activity on code plug pin 3 is incorrect but the option board is correct then the code plug is faulty. Visually examine the code plug for solder shorts or unsoldered leads and retest. If all of the above are correct and the code plug is correctly programmed, then the Type 99 module is faulty.
2) Won't decode; encodes correctly	Verify that the code plug is correctly programmed. Verify that the tones are reaching pin 17 of the module. If not, either the option board or the radio is faulty. If all above are functional then the Type 99 module is faulty.
3) Won't encode; decodes correctly	Verify that the code plug is correctly programmed. Be sure that the Channel Guard jumper is in place on the option board. Check to see that pin 16 is at logic low when the push-to-talk switch is pressed. If it isn't then either the option board or the radio is faulty. To eliminate any questions about whether an option board has failed, probe the board runs to where they contact the main radio circuitry. Check to see if the Channel Guard is present at pin 3 and at both sides of the jumper. If so then either the option board from the Channel Guard jumper to the radio or the radio itself is faulty. If Channel Guard isn't present at pin 3 then the Type 99 module is faulty.



MODEL NO.	REV. LETTER
PL19D901515G1	

WIRING DIAGRAM

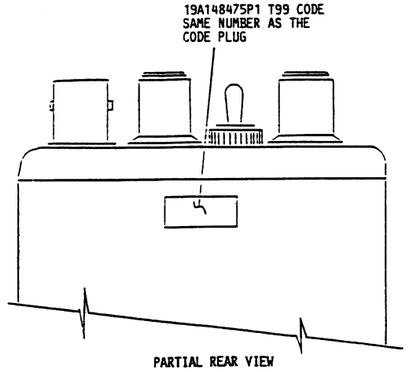
(19D901547, Sh. 1, Rev. 2)



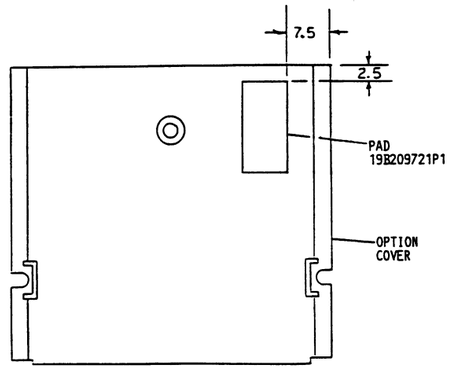
VIEW AT "A"

FRONT VIEW

WITH COVER REMOVED

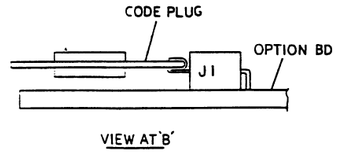


PARTIAL REAR VIEW



DETAIL "C"

VIEW FROM UNDERSIDE



VIEW AT 'B'

(3) THESE INSTRUCTIONS COVER THE INSTALLATION OF FACTORY KIT PL19A702805G5 AND FIELD KIT PL19A703776G4 APPLICATION OF TYPE 99 TO MPI PERSONAL RADIO.

1) REMOVE BATTERY PACK, OPTION COVER, FRONT COVER AND AUDIO BOARD. DEPENDING ON CASE STYLING AND FREQUENCY BAND YOU MAY HAVE TO EITHER UNSCREW OR UNSOLDER OUTPUT TRANSISTER HEAT SINK FROM RADIO CASE. REMOVE SCREW LOCATED AT THE MIDDLE OF THE ANTENNA SIDE OF THE TRANSMIT/RECEIVE BOARD IF ONE IS PRESENT. AFTER DISCONNECTING THE BATTERY POWER AND GROUND LINES REMOVE TOP COVER AND TRANSMIT/RECEIVE BOARD AS AN ASSEMBLY.

NOTE: USE CAUTION WHEN REMOVING OR INSTALLING THE OUTPUT TRANSISTOR HEATSINK ON MODELS THAT SCREW TO THE CASE BACK COVER. THE TRANSMIT/RECEIVE BOARD SHOULD BE SECURELY IN PLACE WHEN CONNECTING THIS HEATSINK. THE NUT ON THE TOP OF THE TRANSISTOR AND THE SCREW COMING THROUGH THE RADIO BACK COVER SHOULD BE TIGHTENED TOGETHER TO MINIMIZE STRESS ON THE TRANSISTOR STUD. DO NOT OVER TORQUE.

*2) REMOVE KNOBS & NUTS SECURING TOP COVER TO TRANSMIT/RECEIVE BOARD POTS AND REMOVE EXISTING TOP COVER.

3) MAKE THE FOLLOWING CONNECTIONS AND THEN ASSEMBLE TOP COVER PL19C850943G4.

FROM	TO	WIRE
S1-1	HL3	BK
S1-2	HL13	Y

BE CAREFUL THAT BOTTOM CONTACT ON RESET/MONITOR SWITCH, S1, DOES NOT CHAFE THE YELLOW WIRE AT THE POINT WHERE IT CONNECTS TO THE TRANSMIT/RECEIVE BOARD.

4) ALIGN PINS ON TRANSMIT/RECEIVE BORAD (OPTION BOARD IF 19D901515G1) WITH CORRESPONDING HOLES ON THE OPTION BOARD (TRANSMIT/RECEIVE BOARD IF 19D901515G1). SEAT FULLY AND SOLDER. MAX. ASSEMBLED HEIGHT TO BE 2MM BELOW THE TRANSMIT/RECEIVE BOARD.

*5) IF AN OLD OPTION BOARD IS ALREADY PRESENT IN RADIO THEN CAREFULLY REMOVE THIS BOARD (PINS INTACT IF 19D901515G1). CLEAN THE MOUNTING HOLES AND INSTALL AS DESCRIBED IN STEP 4.

6) REASSEMBLE TRANSMIT/RECEIVE BOARD WITH TOP COVER INTO REAR COVER.

7) SOLDER T99 MODULE TO OPTION BOARD AS SHOWN. IF INSTALLING IN ASSEMBLED RADIO, CENTER THE MODULE IN THE CAVITY. SOLDERING THE OUTSIDE PINS FIRST WILL HOLD THE MODULE IN PLACE WHILE THE OTHER PINS ARE SOLDERED.

⚠8 CUT CHANNEL GUARD JUMPER IF NO CHANNEL GUARD REQUESTED.

9) PROGRAM AND INSTALL CODE PLUG. THE 1 ON THE CODE PLUG P.W.B. SHOULD CORRESPOND TO THE 1 ON THE T99 OPTION P.W.B.

10) INSTALL OPTION COVER AND BATTERY PACK.

* APPLIES ONLY IN OPTION IS INSTALLED IN AN ASSEMBLED RADIO.

(19D900800, Sh. 3, Rev. 2)

PARTS LIST

TYPE 99 DECODER AND CG ENCODE OPTION KIT
19A702805G5 LOCAL AND LOCAL REMOTE

ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
		T99 OPTION BOARD 19D901515G1 (CONTACTS) 19D901515G2 (NO CONTACTS)
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C1	19A700219P47	Ceramic: 33 pF ±5%, 100 VDCW.
		- - - - - - - - - - - SOCKETS - - - - - - - - - - -
J1	19A704342P2	Socket.
		- - - - - - - - PRINTED WIRE BOARD - - - - - - - -
	19D901516P1	Flexible Printed Wire Board.
		- - - - - - - - - - - - PAD - - - - - - - - - - - -
	19A702471P6	Cushion/Insulator.
		- - - - - - - - - - - CONTACTS - - - - - - - - - -
WT1 thru WT8	19A702752P1	Contact. (Group 1 Only).
		TOP COVER 19C850943G4
		- - - - - - - - - - SWITCHES - - - - - - - - - -
S1	19C850845P19	Toggle: SPDT, contacts rated 1.5 amps @ 14 VDC; sim to C&K 7107MDG.
		- - - - - - - - - - TOP COVER - - - - - - - - - -
	19B800865G5	Top Cover.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19A702392P1	Nut, brass: No. 1/4-40. (Secures S1).
	19A702460P1	Contact, electrical. (Hung in wiring off S1).
	19D900667P1	Option Cover.
	19A702364P104	Machine screw, TORX Drive: M2 x 0.4 x 4mm long.
	19A700032P1	Lockwasher, internal tooth: M2.
	19B209721P1	Pressure tape. (Goes on underside of Option Cover).
		ASSOCIATED PARTS (NOT INCLUDED IN 19A702805G5)
	19C336569G1	Code Plug (Field Programmed).
	19D437921G2	T99 Module.
	19A148475P1	Call Code Nameplate (T99 Code).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES.