MAINTENANCE MANUAL
RADIO DATA INTERFACE
WITH
DATA APPLICATION KIT
344A3191

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SECTION I

TMX-8210 / TMX-8310 RADIO INTERFACE

DESCRIPTION

This section describes the interface of a TMX-8210 or TMX-8310 radio with a data communication device (DCD), such as a radio modem. These radios are designed to operate in a GE-MARC trunked system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, the radio will not support voice communications.

Radio software replacement is required to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections from the radio to the 15-pin connector are shown in Figure 2.

CONNECTORS AND SIGNALS

CH Select 0	1 <
PTT	2 <
PTT	3 <
TX Audio	4 <
RX Audio	5 <
CH Select 1	6 <
Clear/Monitor	7 <
A-	8 <
TX Audio Low	9 <
Switched A +	10 <
RFCTS	11 <
VOL/SQ HI	12 <
Audio Mute	13 <
	14 <
A-	15 <

15-Pin Female Connector

Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

1. Channel Select 0 (To the radio)

This is a binary bit used for channel selection. See section on Control Head / Radio Protocol.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is 180 ohms, and the typical signal level is 85 mV_{P-P}.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 8 ohms with a signal level of up to 8 V_{P-P}.

6. Channel Select 1 (To the radio)

   This is a binary bit used for channel selection. See section on Control Head / Radio Protocol.
   $-0.5\ V < V_{IL} < 0.75\ V$,
   $2.1\ V < V_{IH} < 5.25\ V$,
   $I_{IL} = -800\ uA$ when $V_{IL} = 0.45\ V$.
   Will not source more than 80 uA in the high state.

7. Clear/Monitor (To the radio)

   This signal is active low. A low will end the call in trunked mode, or it will allow monitoring in direct mode.
   $-0.5\ V < V_{IL} < 0.75\ V$,
   $2.1\ V < V_{IH} < 5.25\ V$,
   $I_{IL} = -800\ uA$ when $V_{IL} = 0.45\ V$.
   Will not source more than 80 uA in the high state.

8. A- (From the radio)

   GND connection.

9. TX Audio Low (From the radio)

   This is the audio signal ground. To avoid ground loops it is not directly connected to A-.

10. Switched A + (From the radio)

    This ranges from 11 to 16 volts, with 1 Amp maximum.

11. RFCTS (RF Clear To Send) (From the radio)

    This signal is active low. Less than 0.5 volts indicates the radio is on-channel and ready for data communications. Since it is an open collector output, the DCD must provide a 10K pull up resistor to 5 volts. This output can sink 150 mA_{DC} and is rated at 40 V.

12. VOL/SQ HI (From the radio)

    The DCD can receive data on this line. This signal is broadband demodulated audio direct from the discriminator without any audio processing or de-emphasis. It is dc coupled and is typically a 0.4 V_{P-P} signal. Its impedance is typically 250 ohms and should not be loaded by less than 4K ohms.

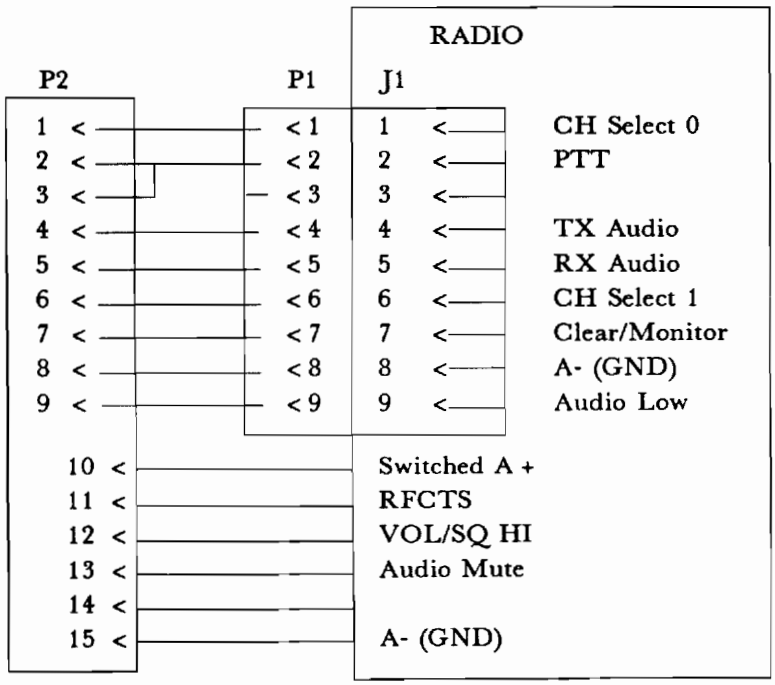


Figure 2 - Data Cable for TMX-8210 and TMX-8310 Radios

13. Audio Mute (To the radio)

This line provides the DCD with the means to mute received audio. The DCD pulls this line low to mute audio. This is an output from the microprocessor that the DCD must override. This output can source/sink 4 LS TTL inputs.
V_{OHmin} = 2.4 V when I_{OH} = -60 uA,
V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA.

15. A- (From the radio)

GND connection.

8310 Control Head / Radio Protocol

Channel Select 0 and Channel Select 1 will normally be at +5 volts and must be pulled low. A pull down resistor will not be needed. A logic 1 is equal to +5 V (see Table).

Channel	CH SELECT 1	CH SELECT 0
1	1	0
2	1	1
3	0	0
4	0	1

PTT equal to 0 volts will initiate a call or cause voice transmission.

Clear/Monitor equal to 0 volts will end the call if in trunked mode, or it will allow monitoring if in direct mode.

RADIO COMMUNICATIONS PROTOCOL

Voice Call

P1 of the data cable will plug into the jack that the control head normally occupied; therefore, voice communications will not be possible when the data cable is connected to the radio. This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD.

Originating

The current Area is determined by the switch on the speaker. The switch is set to the proper Area, then PTT is pressed. The radio will unmute audio, after which the operator will hear the alert tones. The call will end if the Monitor button is pushed in trunked mode or the repeater drops the radio because of inactivity for six seconds.

Receiving

The radio will monitor the repeaters until it finds an ID or tone set that matches one of the ID's in its current Area. The radio will unmute audio, after which the operator will hear the call alert tones. The XMIT Indicator will be ON whenever PTT is pressed. The same conditions that end an originated call will end a received call.

DCD Call

The channel is selected by setting the CH SELECT lines to the proper binary values listed in the Control Head/Radio Protocol. These lines must be pulled low.

The DCD will pull PTT low for at least 150 milliseconds to initiate a data call. If RFCTS does not go low within 6 seconds, the repeater access failed. The DCD should wait 20 seconds before trying to access the repeater again. RETRIES SHOULD BE LIMITED TO PREVENT A RADIO FROM TYING UP THE SYSTEM.

After the radio successfully accesses the repeater (RFCTS is 0 volts), the DCD can begin its data transmission using 1200 baud FSK. After the repeater is acquired, the DCD must pull PTT low at least 50 ms before sending any data because of the radio transmitter's audio attack time. PTT is held low during the data transmission.

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time.

Recommendations

After installing the data option per the installation instructions, set up the TMX-8210 or TMX-8310 radio for voice operation according to the Maintenance Manual for the radio. Disconnect P1 of the data cable

and connect the control head to the radio. Test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. See RFCTS STATES below. Be sure the DCD includes a pull up resistor to 5 volts for RFCTS.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	1	0	0

(where 1 = +5 volts, 0 = < 0.5 volts)

RFCTS will go low as soon as the radio acquires a repeater and is ready for communications. After acquiring the channel it is necessary to key the radio at least once every 6 seconds to maintain the RF link. It is recommended that PTT be held low for at least 150 ms. RFCTS will remain low as long as the RF link is maintained.

DATA APPLICATION KIT 344A3191

Description

The 344A3191G1 Data Application Kit is used with TMX-8210 and TMX-8310 radios to enhance data communications. The kit consists of a program software EPROM, a data interface cable and spike suppression diode and resistor.

Installation

The program EPROM, data interface cable and the spike suppression components must be installed in the associated TMX radio.

Program EPROM

The program EPROM must be installed on the logic board of the radio. Refer to the SERVICE SECTION in the associated radio Maintenance Manual for detailed disassembly instructions to gain access to the logic board. This usually requires removal of the radio bottom and top covers. When this has been done, the audio board must be carefully removed to expose the logic board.

Please note that the EPROM is a CMOS device and electrostatic precautions should be observed. Remove the existing EPROM on the logic board and replace with the EPROM provided in the Data Application Kit.

NOTE

If a masked microprocessor is present on the logic board (no EPROM used), HL1 and HL2 must be connected with a jumper wire. This will cause the masked microprocessor to read from external memory rather than internal memory.

Data Interface Cable

The 19B235192P4 Data Interface Cable provides connections between the TMX radio and the associated DCD. The cable assembly consists of two cables terminated in a 15-pin connector P2. P2 interfaces the DCD. Cable 1 is terminated in a 9-pin connector P1. P1 is to be connected to the radio microphone or handset connector J701. Un-terminated cable 2 is to be inserted through the auxiliary cable port on the front of the radio and connected to J702 on the RF Board and J703 on the audio board.

Before making connections to J702, remove the wire on P705-2 to prevent accidental damage to Q702 on the Logic Board.

Spike Suppression

To provide spike protection, a 100-ohm resistor and a 5-Volt Zener diode are supplied in the kit. Connect (solder) one end of the resistor to the BLACK (P2-13) wire of Cable 2. Connect the other end of the resistor to J703-13 on the audio board. Connect Zener diode cathode to J703-13 and the anode to GND (A-).

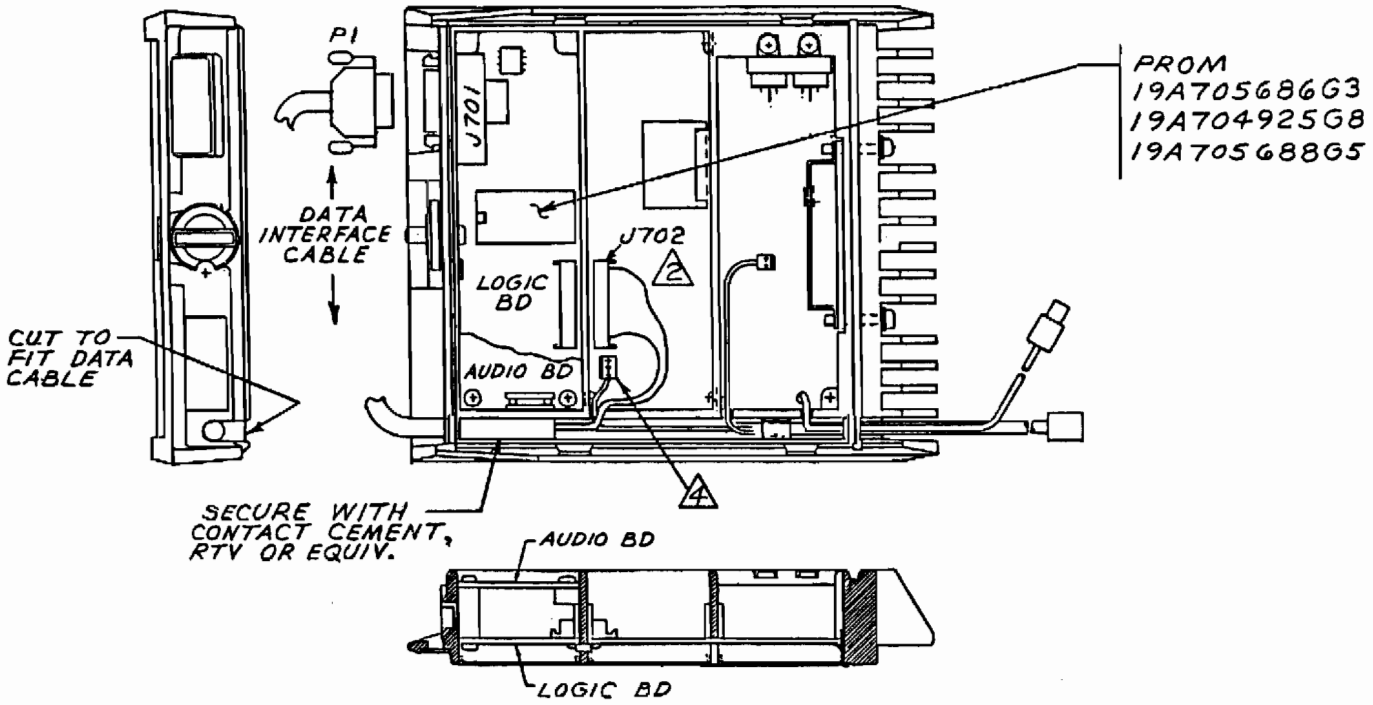
The remaining wires in Cable 2 are to be connected to J702 as shown in Installation Diagram 19C851988.

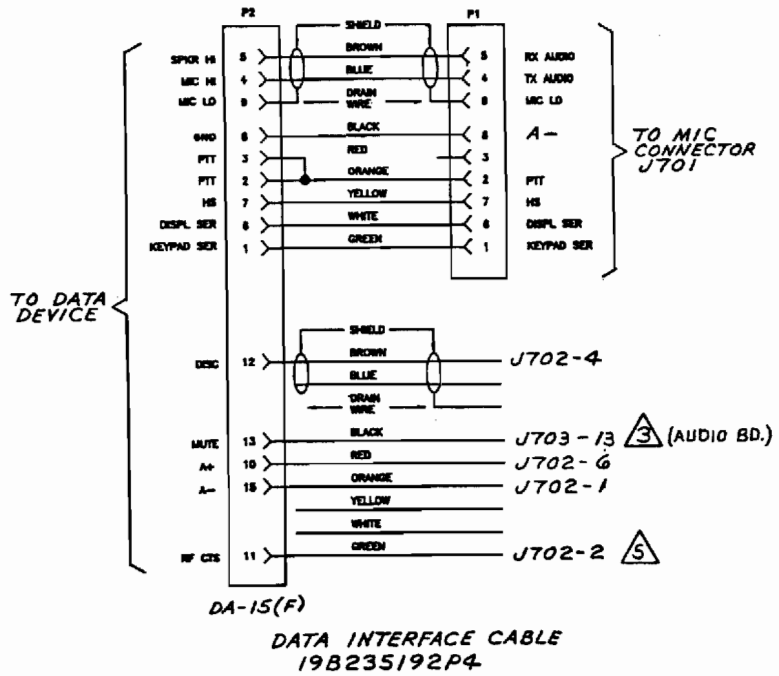
After the installation has been completed and checked, the radio may be re-assembled.

DATA APPLICATION KIT
344A3191G1
(TMX-8210/TMX-8310)
ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
	19B235192P4	Data Interface Cable.
	19A705686G3	Programmable Memory; used in TMX-8210 and TMX-8310.
	19A700025P5	Silicon, zener: 5.1 V, 400 mW max; sim to BZX55-C5V1.
	H212CRP110C	Deposited Carbon: 100 ohms ±5%, 1/4 w.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES





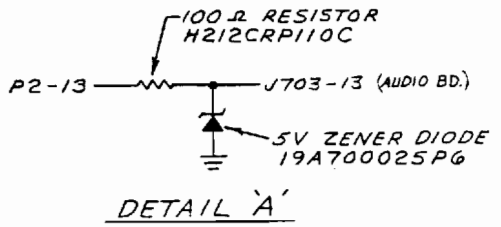
1. THESE INSTRUCTIONS COVER THE INSTALLATION OF THE DATA APPLICATION KIT TO THE TMC RADIOS (8218.8318, 8518 AND 8712) AND THE MCS RADIO.

NOTE:

1. HARDWARE USED IN THE FOLLOWING INSTRUCTIONS IS ON KIT FL344A3191.

INSTRUCTIONS:

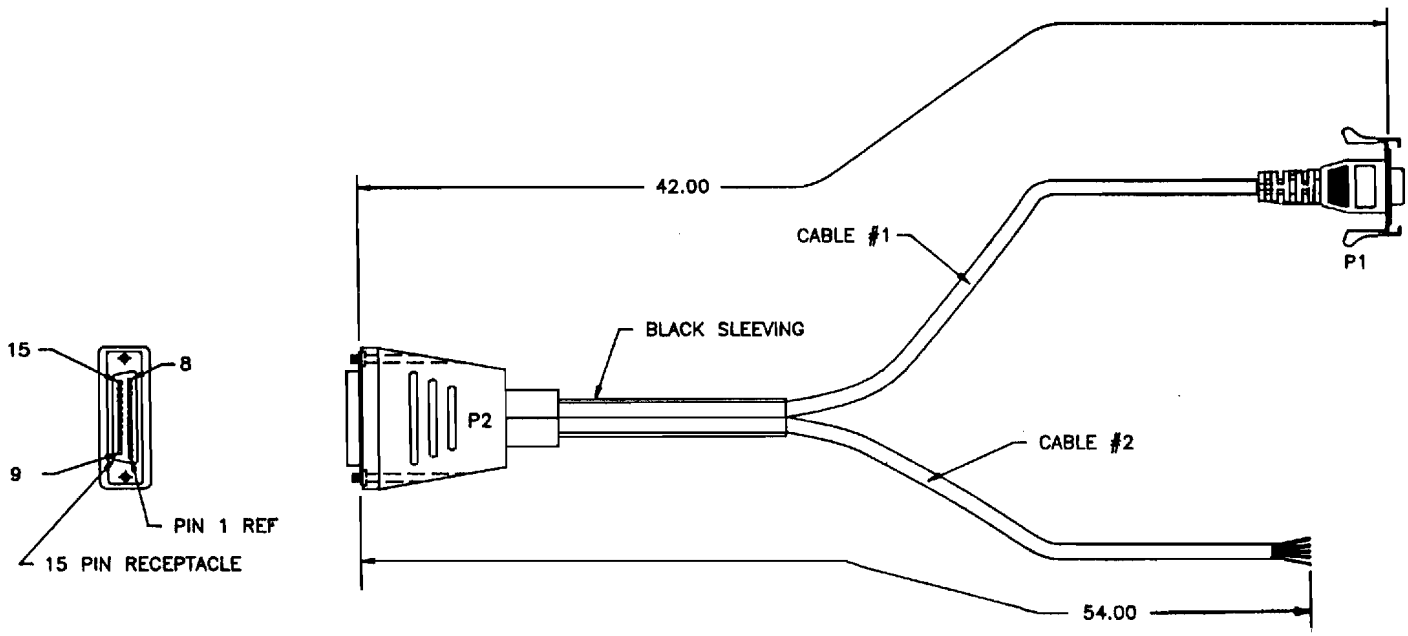
1. INSTALL FROM ON LOGIC BOARD (DOES NOT APPLY TO MCS).
2. SOLDER LOOSE WIRE ENDS OF DATA INTERFACE CABLE DIRECTLY TO J702 AND J703 PER DIAGRAM.
3. FOR SPIKE PROTECTION CONNECT A 100 OHM RESISTOR AND A 5V ZENER DIODE TO END OF BLACK WIRE BEFORE SOLDERING TO J703-13 PER DETAIL 'A'.
4. REMOVE WIRE ON P785-2 TO PREVENT ACCIDENTAL DAMAGE TO Q702 ON LOGIC BOARD.
5. FOR THE MCS RADIO ONLY, CONNECT GREEN WIRE TO J703-2 USING SPIKE PROTECTION SIMILAR TO NOTE 3.



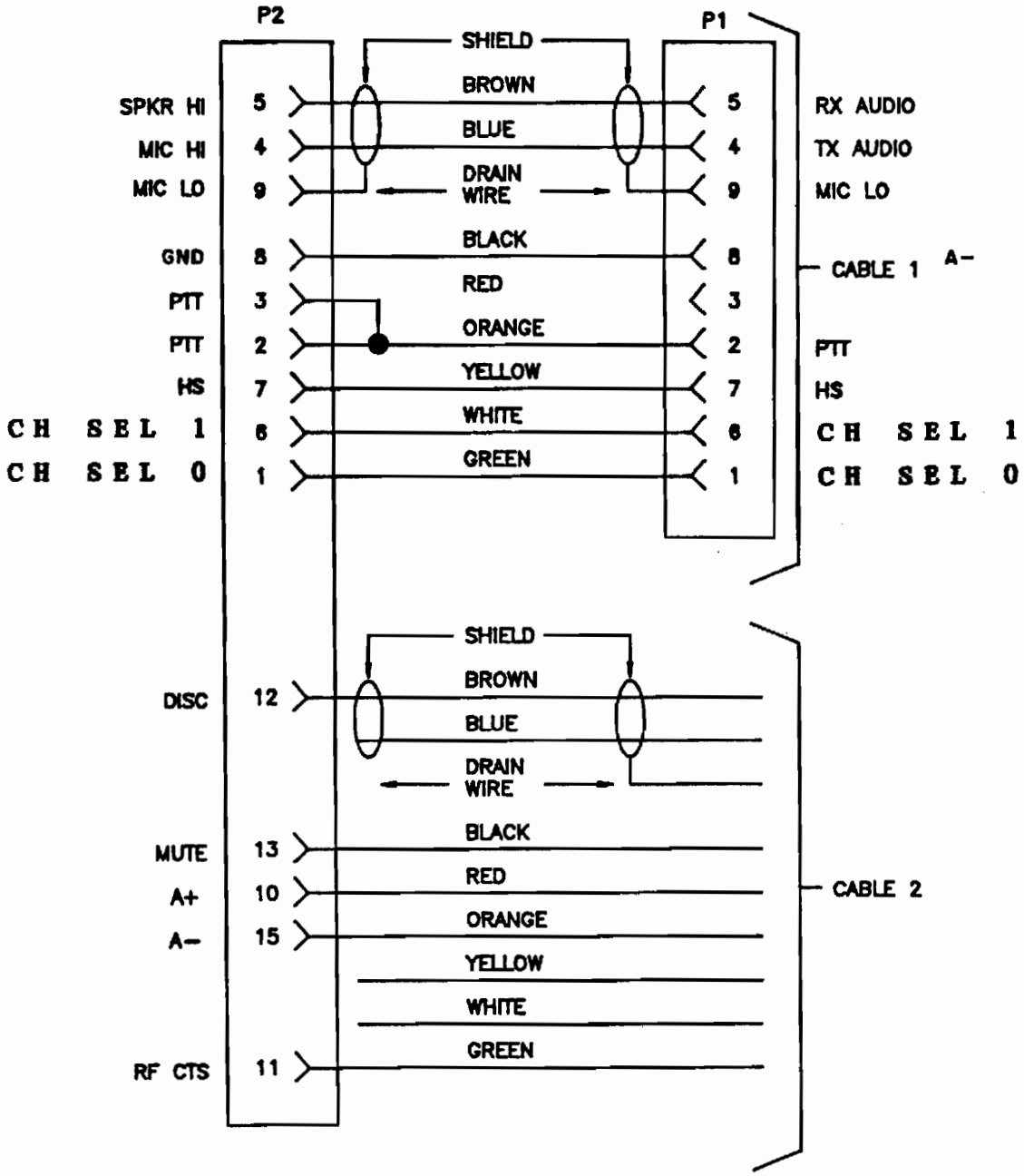
DETAIL 'A'

INSTALLATION INSTRUCTIONS

(19C851988, Rev. 1)



DATA INTERFACE CABLE
19B235192P4



DATA INTERFACE CABLE
19B235192P4

(19B235192, Sh. 10, Rev. 4)

SECTION II

TMX-8510 / TMX-8712 RADIO INTERFACE

DESCRIPTION

This section describes the interface of a TMX-8510 radio or a TMX-8712 radio with a data communication device (DCD), such as a radio modem. These radios are designed to operate in a GE-MARC trunked system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, the radio will not support voice communications.

Radio software replacement is required to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections from the radio to the 15-pin connector are shown in Figure 2.

CONNECTORS AND SIGNALS

Keypad Serial	1 <
PTT	2 <
PTT	3 <
TX Audio	4 <
RX Audio	5 <
Display Serial	6 <
Hookswitch	7 <
A-	8 <
TX Audio Low	9 <
Switched A +	10 <
RFCTS	11 <
VOL/SQ HI	12 <
Audio Mute	13 <
	14 <
A-	15 <

15-Pin
Female
Connector

Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

1. Keypad Serial (To the radio)

A 300 baud serial line.

$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is 180 ohms, and the typical signal level is 85 mV_{P-P}.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 8 ohms with a signal level of up to 8 V_{P-P}. Its level is controlled by the volume setting.

6. Display Serial (From the radio)

   A 300 baud serial line.

   This output can source/sink 4 LS TTL inputs.
   V_{OHmin} = 2.4 V when I_{OH} = -60 uA,
   V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA.

7. Hookswitch (To the radio)

   This signal is active low. A low indicates Off Hook.
   -0.5 V < V_{IL} < 0.75 V,
   2.1 V < V_{IH} < 5.25 V,
   I_{IL} = -800 uA when V_{IL} = 0.45 V.
   Will not source more than 80 uA in the high state.

8. A- (From the radio)

   GND connection.

9. TX Audio Low (From the radio)

   This is the audio signal ground. To avoid ground loops it is not directly connected to A-.

10. Switched A + (From the radio)

    This ranges from 11 to 16 volts, with 1 Amp maximum.

11. RFCTS (RF Clear To Send) (From the radio)

    This signal is active low. Less than 0.5 volts indicates the radio is on-channel and ready for data communications . Since it is an open collector output, the DCD must provide a 10K pull up resistor to 5 volts. This output can sink 150 mA_{DC} and is rated at 40 V.

12. VOL/SQ HI (From the radio)

    The DCD can receive data on this line. This signal is broadband demodulated audio direct from the discriminator without any audio processing or de-emphasis. It is dc coupled and is typically a 0.4 V_{P-P} signal. Its impedance is typically 250 ohms and should not be loaded by less than 4K ohms.

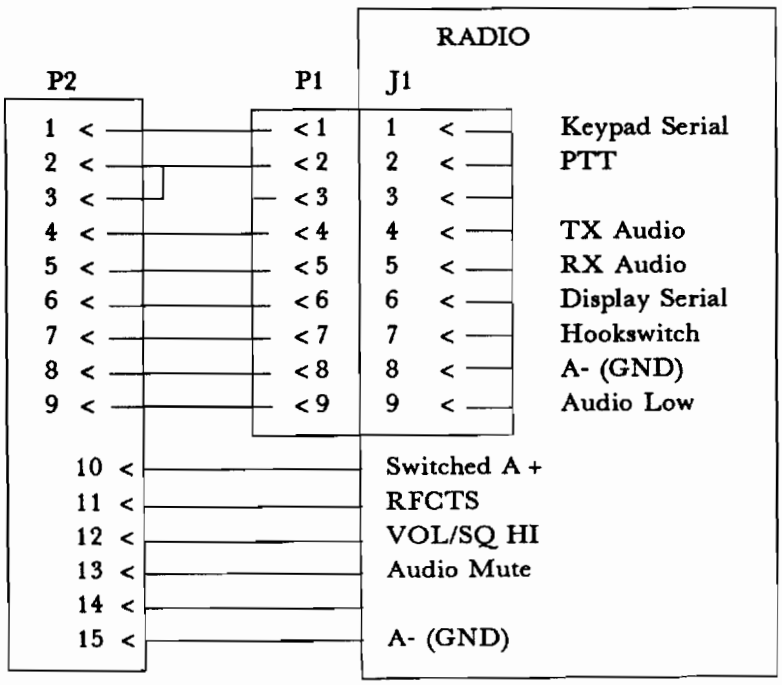


Figure 2 - Data Cable for TMX-8510 and TMX-8712 Radios

13. Audio Mute (To the radio)

This line provides the DCD with the means to mute received audio. The DCD pulls this line low to mute audio. This is an output from the microprocessor that the DCD must override. This output can source/sink 4 LS TTL inputs.
V_{OHmin} = 2.4 V when I_{OH} = -60 uA,
V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA.

15. A-(from the radio)

GND Connection.

RADIO COMMUNICATIONS PROTOCOL

Voice Call

P1 of the data cable will plug into the jack that the handset normally occupied; therefore, voice communications will not be possible when the data cable is connected to the radio. This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD.

Originating

A default Area and Group is stored in the radio and displayed on the handset. These can be changed by entering new values (see Operator's Manual). A call to the current Area and Group will be initiated if the handset is taken off-hook, PTT is depressed, or the Send key is depressed. The radio will unmute after which the operator will hear the alert tones. The call will end if the End Key is depressed, the handset is hung up, or the repeater drops the radio due to inactivity for six seconds. For all cases, the repeater will disconnect on a six second no activity time out. After this event, subsequent communication requires a new originating sequence.

Receiving

The radio will monitor the repeaters until it finds an ID number or tone set that matches one of the ID numbers in its current area. The radio will unmute after which the operator will hear the call alert tones. The Area and Group of the call will be displayed on the handset. The ROAM Indicator will be turned on, signifying that the radio is ready to send or receive a message. The IN USE Indicator will be on whenever the radio is transmitting. The same conditions that end an originated call will end a received call.

DCD Call

The DCD will pull PTT low for at least 150 milliseconds to initiate a data call. If RFCTS does not go low within 6 seconds, the repeater access failed. The DCD should wait 20 seconds before trying to access the repeater again. RETRIES SHOULD BE LIMITED TO PREVENT A RADIO FROM TYING UP THE SYSTEM.

After the radio successfully accesses the repeater (RFCTS is 0 volts), the DCD can begin its data transmission using 1200 baud FSK. After the repeater is acquired, the DCD must pull PTT low at least 50 ms before sending any data because of the radio transmitter's audio attack time. PTT is held low during the data transmission.

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes it transmission. This is due to the other radio's receiver recovery time. This only applies to the 8510 and the 8712 when operating half duplex. The 8712 in full duplex does not require this delay.

Recommendations

After installing the data option per the installation instructions, set up the TMX-8510 or TMX-8712 radio for voice operation according to the Maintenance Manual for the radio. Disconnect P1 of the data cable and connect the hand set to the radio. Test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. See RFCTS STATES below. Be sure the DCD includes a pull up resistor to 5 volts for RFCTS.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	1	0	0

(where 1 = +5 volts, 0 = < 0 .5 volts)

It is recommended that PTT be held low for at least 150 ms when initiating a call. RFCTS will be low after the radio acquires a channel and its audio transmit and receive is enabled. After acquiring the channel it is necessary to key the radio at least once every 6 seconds to maintain the RF link. RFCTS will remain low as long as the RF link is maintained.

DATA APPLICATION KIT 344A3191G2, G3

Description

The 344A3191G2 and G3 Data Application Kits are used with the TMX-8510 and TMX-8712 radios to enhance data communications. Each kit consists of a program software EPROM, a data interface cable and spike suppression diode and resistor.

Installation

The program EPROM, data interface cable and the spike suppression components must be installed in the associated TMX radio.

Program EPROM

The program EPROM must be installed on the logic board of the radio. Refer to the SERVICE SECTION in the associated radio Maintenance Manual for detailed disassembly instructions to gain access to the logic board. This usually requires removal of the radio bottom and top covers. When this has been done, the audio board must be carefully removed to expose the logic board.

Please note that the EPROM is a CMOS device and electrostatic precautions should be observed. Remove the existing EPROM on the logic board and replace with the EPROM provided in the Data Application Kit.

NOTE

If a masked microprocessor is present on the logic board (no EPROM used), HL1 and HL2 must be connected with a jumper wire. This will cause the masked microprocessor to read from external memory rather than internal memory.

Data Interface Cable

The 19B235192P4 Data Interface Cable provides connections between the TMX radio and the associated DCD. The cable assembly consists of two cables terminated in a 15-pin connector P2. P2 interfaces the DCD. Cable 1 is terminated in a 9-pin connector P1. P1 is to be connected to the radio microphone or handset connector J701. Un-terminated cable 2 is to be inserted through the auxiliary cable port on the front of the radio and connected to J702 on the RF Board and J703 on the audio board.

Before making connections to J702, remove the wire on P705-2 to prevent accidental damage to Q702 on the Logic Board.

Spike Suppression

To provide spike protection, a 100-ohm resistor and a 5-Volt Zener diode are supplied in the kit. Connect (solder) one end of the resistor to the BLACK (P2-13) wire of Cable 2. Connect the other end of the resistor to J703-13 on the audio board. Connect Zener diode cathode to J703-13 and the anode to GND (A-).

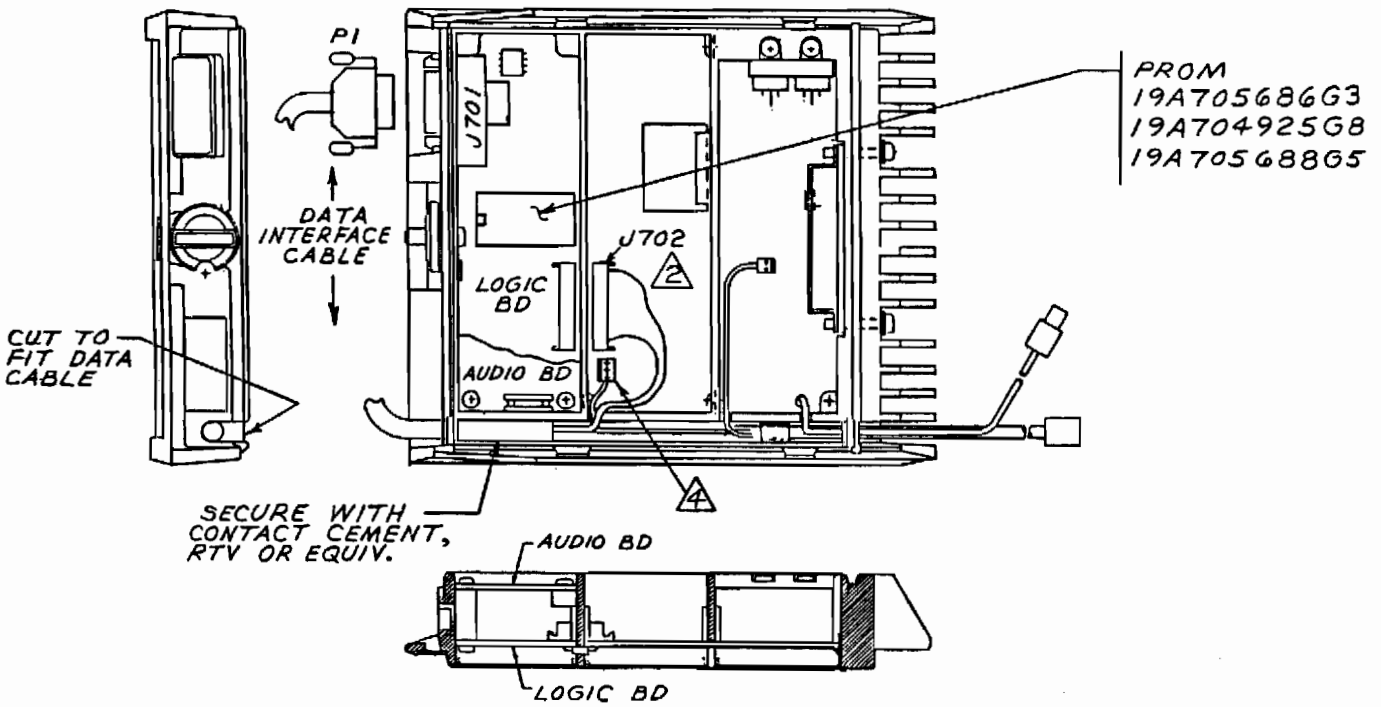
The remaining wires in Cable 2 are to be connected to J702 as shown in Installation Diagram 19C851988.

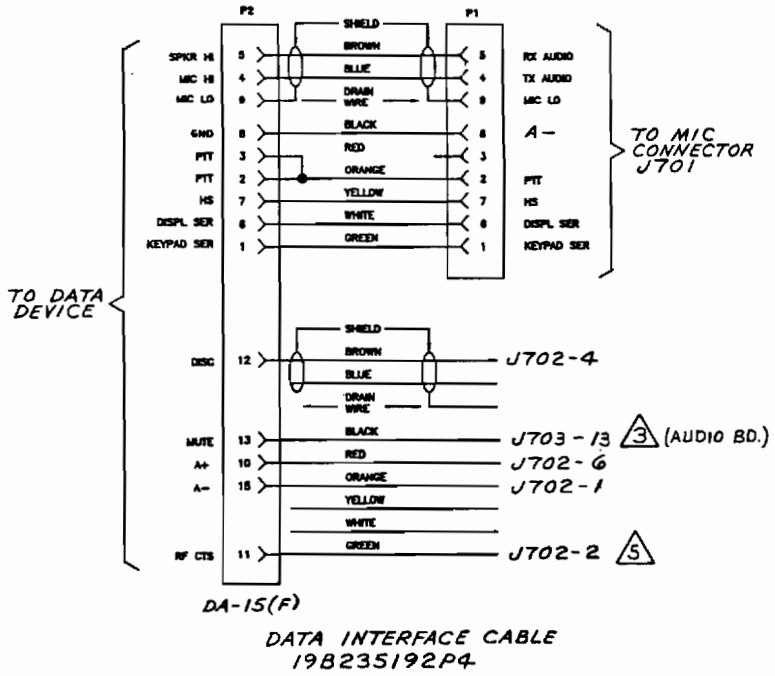
After the installation has been completed and checked, the radio may be re-assembled.

DATA APPLICATION KIT
344A3191G2 (TMX-8510)
344A3191G3 (TMX-S712)
ISSUE 2

SYMBOL	GE PART NO.	DESCRIPTION
	19B235192P4	Data Interface Cable.
	19A704925G8	Programmable Memory; used in TMX-8510 only.
	19A705688G5	Programmable Memory; used in TMX-8712 only.
	19A700025P5	Silicon, zener: 5.1 V, 400 mW max; sim to BZX55-C5V1.
	H212CRP110C	Deposited Carbon: 100 ohms ±5%, 1/4 w.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES





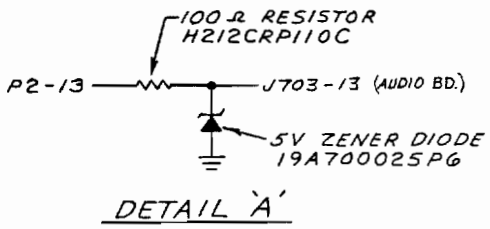
(1) THESE INSTRUCTIONS COVER THE INSTALLATION OF THE DATA APPLICATION KIT TO THE TMX RADIOS (8218.8318, 8518 AND 8712) AND THE MCS RADIO.

NOTE:

1. HARDWARE USED IN THE FOLLOWING INSTRUCTIONS IS ON KIT PL344A3191.

INSTRUCTIONS:

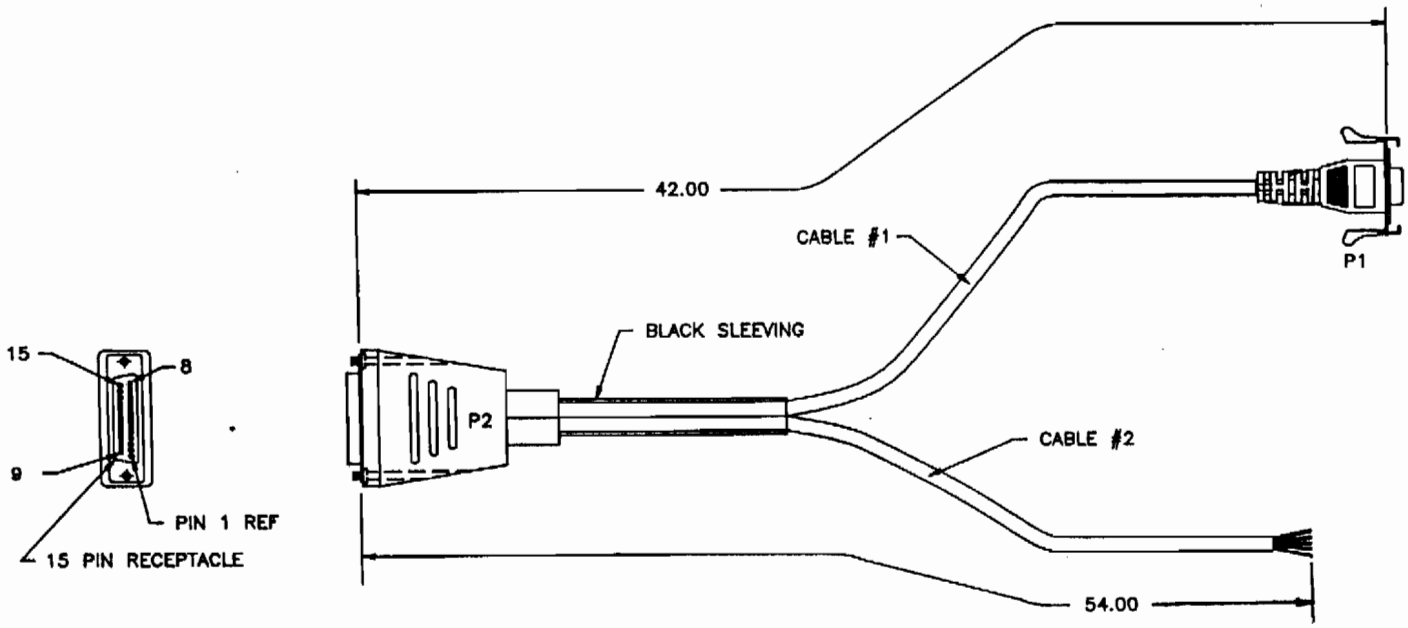
1. INSTALL PROM ON LOGIC BOARD (DOES NOT APPLY TO MCS).
2. SOLDER LOOSE WIRE ENDS OF DATA INTERFACE CABLE DIRECTLY TO J702 AND J703 PER DIAGRAM.
3. FOR SPIKE PROTECTION CONNECT A 100 OHM RESISTOR AND A 5V ZENER DIODE TO END OF BLACK WIRE BEFORE SOLDERING TO J703-13 PER DETAIL 'A'.
4. REMOVE WIRE ON P705-2 TO PREVENT ACCIDENTAL DAMAGE TO Q702 ON LOGIC BOARD.
5. FOR THE MCS RADIO ONLY, CONNECT GREEN WIRE TO J703-2 USING SPIKE PROTECTION SIMILAR TO NOTE 3.



DETAIL 'A'

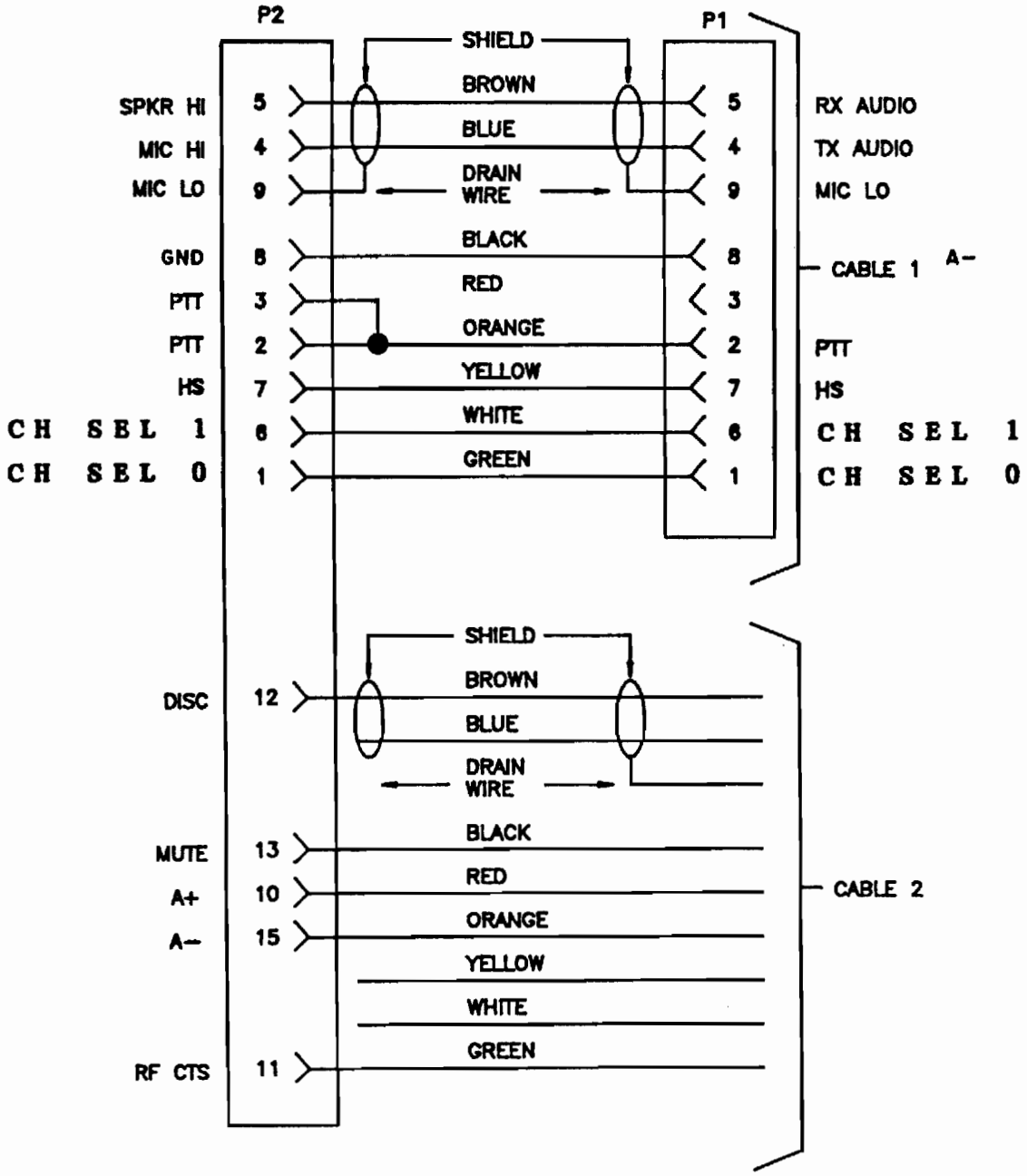
INSTALLATION INSTRUCTIONS

(19C851988, Rev. 1)



DATA INTERFACE CABLE
19B235192P4

(19B235192, Sh. 9, Rev. 4)



DATA INTERFACE CABLE
19B235192P4

(19B235192, Sh. 10, Rev. 4)

SECTION III

CONNECTORS AND SIGNALS

TMX-8415 / TMX-8615 / TMX-8630 RADIO INTERFACE

DESCRIPTION

This document describes the interface of a TMX-8415, TMX-8615 or TMX-8630 radio with a data communication device (DCD), such as a radio modem. These radios are designed to operate in a GE-MARC trunked system. The interface hardware and data communications protocol are described. When the data interface is added and a DCD is connected, voice communication is not supported.

Radio software replacement is required to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector interface is shown in Figure 1 (as seen from a DCD). The connections for the cable from the radio to the 15-pin connector are shown in Figure 2.

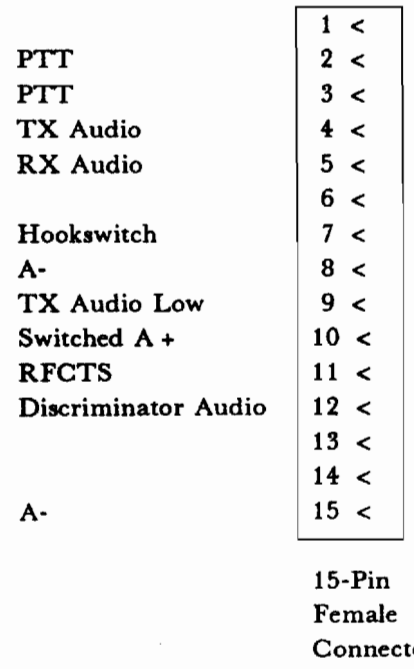


Figure 1 - Pin Layout for 15-Pin Connector

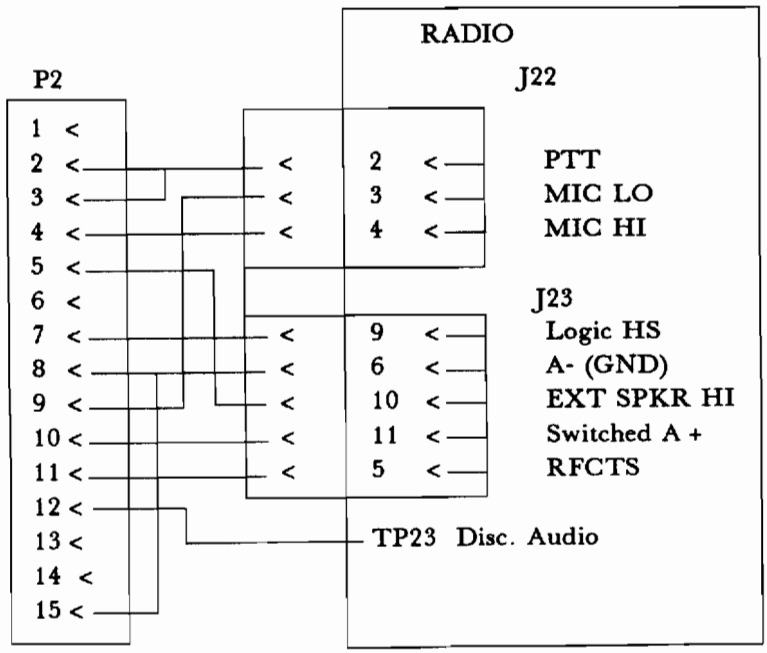


Figure 2 - Data cable for the TMX-8415/8615/8630 Radios

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltge Low

I_{IL} Input Current Low

I_{IN} Input Current High or Low

For I_{IL} and I_{IN} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -500$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is less than 470 ohms, and the typical signal level is 70 mV_{P-P}.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 4 ohms with a signal level of up to 9.8 V_{P-P}. Its level is controlled by the volume setting.

7. Hookswitch (To the radio)

This signal is active low. A low indicates Off Hook.
$-1.5\ V < V_{IL} < 0.9\ V$,
$3.15\ V < V_{IH} < 6.25\ V$,
$I_{INmax} = \pm 1$ uA.

8. A- (From the radio)

GND connection.

9. TX Audio Low (From the radio)

This is the audio signal ground. To avoid ground loops it is not directly connected to A-.

10. Switched A + (From the radio)

This ranges from 11 to 16 volts, with 1 Amp maximum.

11. RFCTS (RF Clear To Send) (From the radio)

This signal is active low. Less than 0.5 volts indicates the radio is on-channel and ready for data communications. Since it is an open collector output, the DCD must provide a 10K pull up resistor to 5 volts. This output can sink 250 mA_{DC} and is rated at 100 V.

12. Discriminator Audio (From the radio)

The DCD can receive data on this line. This signal is broadband demodulated audio direct from the discriminator without any audio processing or de-emphasis. It is dc coupled and is typically a 0.9 V_{P-P} signal. Its impedance is typically 2K ohms.

15. A- (from the radio)

GND Connection.

Microphone/Radio Communications Protocol

PTT equal to 0 volts will initiate a call or cause voice transmission.

Hookswitch transition from 1 (5V) to 0 (GND) will initiate a call.

RADIO COMMUNICATIONS PROTOCOL

Voice Call

This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD. When the data interface is added and a DCD is connected, voice communication is not supported.

Originating

The current Area/Group is determined by the push button switch on the radio. The Area/Group is selected, then the PTT is pressed. The radio will unmute audio, after which the operator will hear the alert tones. The call will end if the repeater drops the radio due to inactivity for six seconds.

Receiving

The radio will monitor the repeaters until it finds an ID or tone set that matches one of the ID's in its current Area. The radio will unmute audio, after which the operator will hear the call alert tones. The READY light will be ON when a repeater has been accessed. The XMIT Indicator will be ON whenever PTT is pressed. The same conditions that end an originated call will end a received call.

DCD Call

The DCD will pull PTT low for at least 150 milliseconds to initiate a data call. If RFCTS does not go low within 6 seconds, the repeater access failed. The DCD should wait 20 seconds before trying to access the repeater again. RETRIES SHOULD BE LIMITED TO PREVENT A RADIO FROM TYING UP THE SYSTEM.

After the radio successfully accesses the repeater (RFCTS is 0 volts), the DCD can begin its data transmission using 1200 baud FSK. After the repeater is acquired, the DCD must pull PTT low at least 50 ms before sending any data because of the radio transmitter's audio attack time. PTT is held low during the data transmission.

When the DCD is receiving data, it must not put data on the air until 100 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time.

Recommendations

After installing the data option per the installation instructions, set up the TMX-8415, TMX-8615 or TMX-8630 radio for voice operation according to the Maintenance Manual for the radio. Connect the microphone to the radio and test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. See RFCTS STATES below. Be sure the DCD includes a pull up resistor to 5 volts for RFCTS.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	1	0	0

(where 1 = +5 volts, 0 = < 0.5 volts)

When initiating a call, it is recommended that PTT be held low for at least 150 ms. RFCTS will be low after the radio acquires a channel and its audio transmit and receive is enabled. After acquiring the channel it is necessary to key the radio at least once every 6 seconds to maintain the RF link. RFCTS will remain low as long as the RF link is maintained.

DATA APPLICATION KIT 344A3191G4

Description

The 344A3191G4 Data Application Kit is used with the TMX-8415, TMX-8615 or TMX-8630 radios to enhance data communications. The kit consists of a program software EPROM, a data interface cable and a tie strap.

Installation

The program EPROM and the data interface cable must be installed in the radio.

Program EPROM

The program EPROM must be installed on the logic board of the radio. This requires removal of the radio top cover. Refer to the SERVICE SECTION of the radio Maintenance Manual for detailed disassembly instructions.

Please note that the EPROM is a CMOS device and electrostatic precautions should be observed. Remove the existing EPROM on the logic board and replace with the EPROM provided in the Data Application Kit.

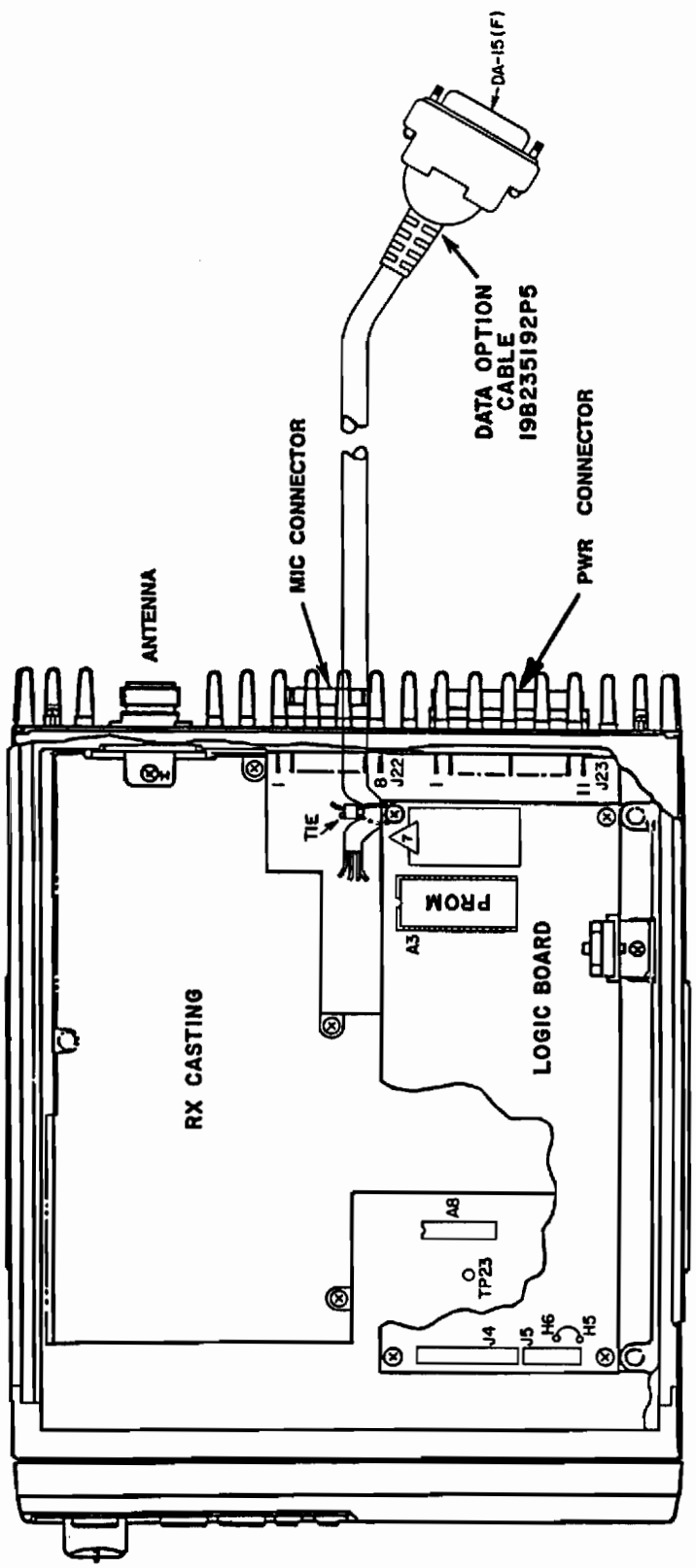
Data Interface Cable

The 19B235192P5 Data Interface Cable provides connections between the TMX-8415/8615/8630 radio and an associated data device. The cable assembly is a single cable terminated in a 15-pin connector P2, which is connected to the data device. The other end of the cable is blunt cut for installation into the radio per Installation Instructions 19C851950, Note 1.

DATA APPLICATION KIT
344A3191G4
(TMX-8415/TMX-8615/TMX-8630)
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
		DATA OPTION KIT 19A149972G1
	19B235192P5	Data Interface Cable.
	19A704732G12	Programmable Memory; used in TMX-8415, TMX-8615 and TMX-8630.
	19A706152P5	Tie Strap.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES



FUNCTION	WIRE COLOR	CONNECTION
A-	BLACK	J23-6
A+	GREEN	J23-11
RFCTS	ORANGE	J23-5
PTT	BLUE	J22-2
MIC HI	RED	J22-4
DISC	VIOLET	TP23
MIC LO	BROWN	J22-3
SPKR HI	WHITE	J23-10
A-	WHT/RED	J23-6
HS	YELLOW	J23-9

* JUMPER ON LOGIC BOARD

RFCTS	ANY	H5 - H6

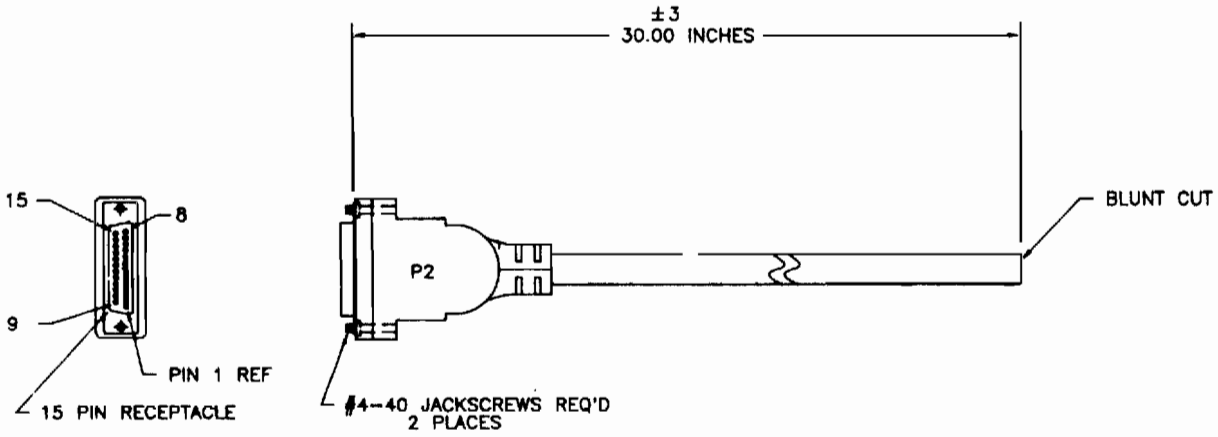
* REQUIRED ELSE ALARM SW MUST BE PRESSED FOR RFCTS.

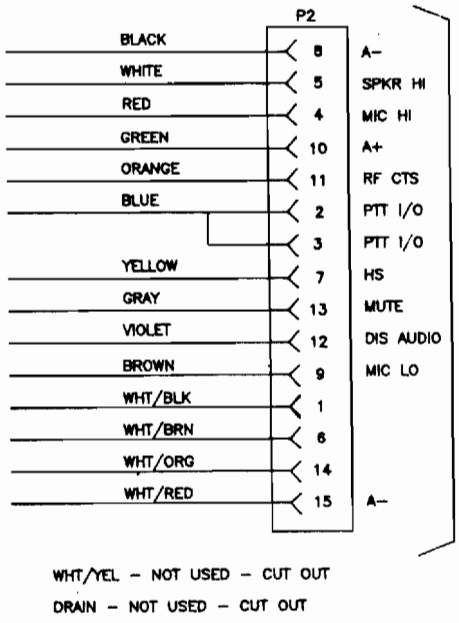
(1) NOTES:

1. REMOVE TOP COVER (2 SCREWS).
2. REMOVE DUST (FOAM) FILTER.
3. LOOSEN LOGIC BOARD (4 SCREWS).
4. INSTALL DATA CABLE AS SHOWN.
5. CONNECT WIRES PER CHART.
6. REASSEMBLE IN REV. ORDER 3,2,1.
7. SECURE CABLE, 19B235192P5 WITH STRAP, 19A706482P6 TO POST ON LOGIC BOARD.
8. REPLACE PROM, A3 IF SUPPLIED AS PART OF KIT 19A149972G1.

INSTALLATION INSTRUCTIONS

(19C851950, Sh. 1, Rev. 3)





WHT/YEL – NOT USED – CUT OUT

DRAIN – NOT USED – CUT OUT

DATA INTERFACE CABLE
19B235192P5

(19B235192, Sh. 11, Rev. 4)

SECTION IV

TMX-8825 RADIO INTERFACE

DESCRIPTION

This section describes the interface of a TMX 8825 radio with a data communication device (DCD), such as a radio modem. This radio is designed to operate in a GE-MARC trunked system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, voice communication is not supported.

Radio hardware modification is required to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections for the 15-pin cable are shown in Figure 2.

CONNECTORS AND SIGNALS

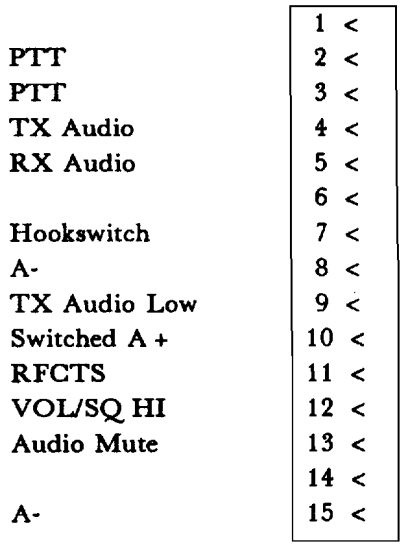


Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.85\ V$,
$1.95\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -50$ uA when $V_{IL} = 0.45$ V.
Will not source more than 60 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is less than 570 ohms, and the typical signal level is 120 mV_{P-P}.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 4 ohms with a signal level of up to 9.8 V_{P-P}. Its level is controlled by the volume setting.

7. Hookswitch (To the radio)

This signal is active low. A low indicates Off Hook.
$-0.5\ V < V_{IL} < 0.85\ V$,
$1.95\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -50$ uA when $V_{IL} = 0.45$ V.
Will not source more than 60 uA in the high state.

8. A- (From the radio)

GND connection.

9. TX Audio Low (From the radio)

This is the audio signal ground. To avoid ground loops it is not directly connected to A-.

10. Switched A + (From the radio)

This ranges from 11 to 16 volts, with 1 Amp maximum.

11. RFCTS (RF Clear To Send) (From the radio)

This signal is active low.
V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA,
V_{OHmin} = 2.4 V when I_{OH} = -80 uA.

12. VOL/SQ HI (From the radio)

The DCD can receive data on this line. This signal is broadband demodulated audio direct from the discriminator without any audio processing or de-emphasis. It is dc coupled and is typically a 0.4 V_{P-P} signal. Its impedance is typically 250 ohms and should not be loaded by less than 4K ohms.

13. Audio Mute (To the radio)

This line provides the DCD with the means to mute received audio. The DCD pulls this line low to mute audio. This is an output from the microprocessor that the DCD must override.
V_{OHmin} = 2.4 V when I_{OH} = -80 uA,
V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA.

15. A- (From the radio)

GND connection.

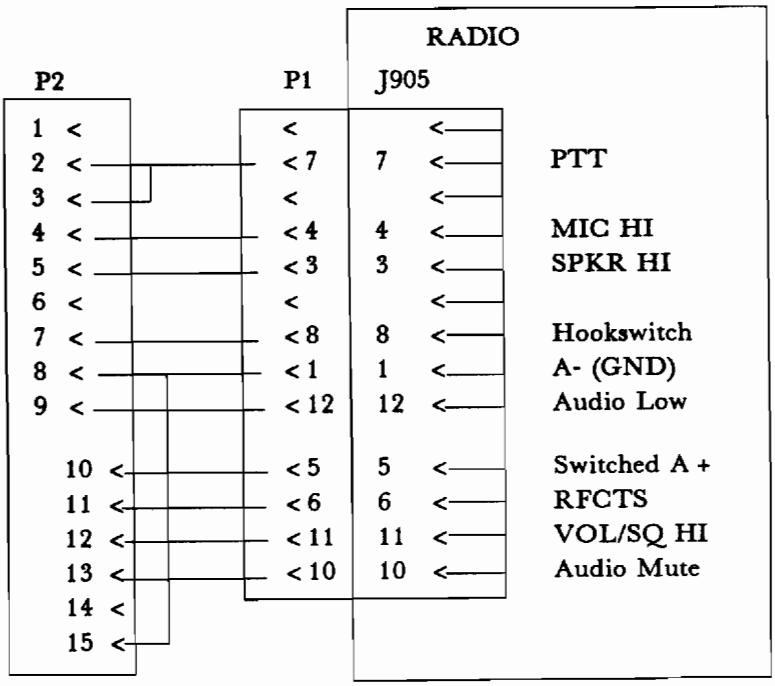


Figure 2 - Data Cable for TMX-8825 Radio

RADIO COMMUNICATIONS PROTOCOL

Voice Call

This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD. When the data interface is added and a DCD is connected, voice communication is not supported.

Originating

The current Area/Group is determined manually by the operator with Up/Down buttons on the front cap. The proper Area/Group is selected, then PTT is pressed. The radio will unmute audio, after which the operator will hear the call alert tones. The call will end if the CLEAR/MONITOR button is pushed or the repeater drops the radio due to inactivity for six seconds.

Receiving

The radio will monitor the repeaters until it finds an ID or tone set that matches one of the ID's in its current Area. The radio will unmute audio, after which the operator will hear the call alert tones. The same conditions that end an originated call will end a received call.

DCD Call

The DCD will pull PTT low for at least 150 milliseconds to initiate a data call. If RFCTS does not go low within 6 seconds, the repeater access failed. The DCD should wait 20 seconds before trying to access the repeater again. RETRIES SHOULD BE LIMITED TO PREVENT A RADIO FROM TYING UP THE SYSTEM.

After the radio successfully accesses the repeater (RFCTS is 0 volts), the DCD can begin its data transmission using 1200 baud FSK. After the repeater is acquired, the DCD must pull PTT low at least 50 ms before sending any data because of the radio transmitter's audio attack time. PTT is held low during the data transmission.

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time.

Recommendations

After installing the data option per the installation instructions, set up the TMX-8825 radio for voice operation according to the Maintenance Manual for the radio. Connect the microphone to the radio and test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. See RFCTS STATES below.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	1	0	0

(where 1 = +5 volts, 0 = < 0.5 volts)

When initiating a call, it is recommended that PTT be held low for at least 150 ms. RFCTS will be low after the radio acquires a channel and its audio transmit and receive is enabled. After acquiring the channel it is necessary to key the radio at least once every 6 seconds to maintain the RF link. RFCTS will remain low as long as the RF link is maintained.

DATA APPLICATION KIT 344A3191G5

Description

The 344A3191G5 Data Application Kit is used with the TMX-8825 radio to enhance data communications. The kit consists of a data interface cable and a wire.

Installation

The data interface cable must be installed in the TMX-8825 radio.

Radio System Board Modification for Data Interface Cable

To modify System Board 19D901891G1 for installation of data interface cable 19C851585P10:

For System Boards prior to Revision C follow the included Installation Instructions 19A149984P1

For System Boards subsequent to Revision C follow the included Installation Instructions 19A149984P3.

Data Interface Cable

The 19C851585P10 Data Interface Cable provides connections between the TMX-8825 radio and an associated DCD. The cable assembly is a single cable terminated in a 15-pin connector P2, which is connected to the data device. The 12-pin connector P1 of the cable is connected to the radio at J905 on the System Board. For access to the System Board, remove the bottom cover of the radio. Connect P1 of the cable to J905 on the radio System Board, remove the rubber plug from slot in the housing, and slip the strain relief collar of the Data Interface Cable into the slot. Replace the bottom cover.

DATA APPLICATION KIT
344A3191G5 (TMX-8825)
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
	19C851585P10	Data Interface Cable.
	19A115870P5	Stranded Wire.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

(1) TMX-8825 DATA OPTION
SYSTEM BOARD 19D901891G1 PRIOR TO REV. C

COMPONENT SIDE

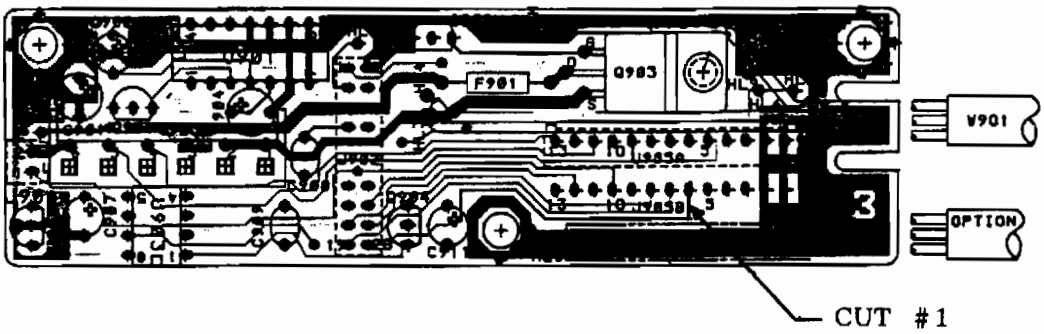


FIGURE 1

SOLDER SIDE

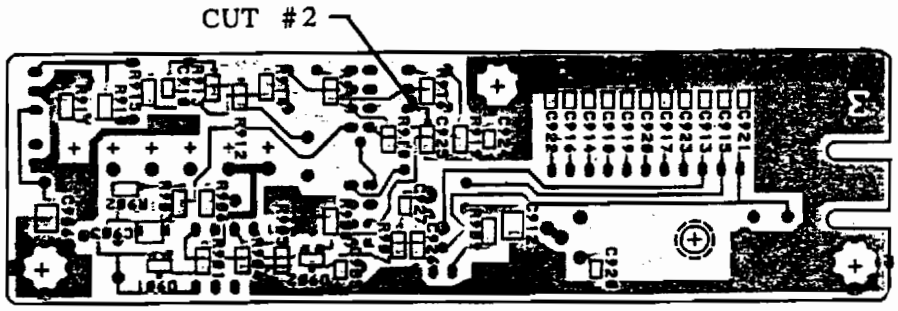


FIGURE 2

INSTALLATION INSTRUCTIONS
19A149984P1

(19A149984, Sh. 1, Rev. 1)

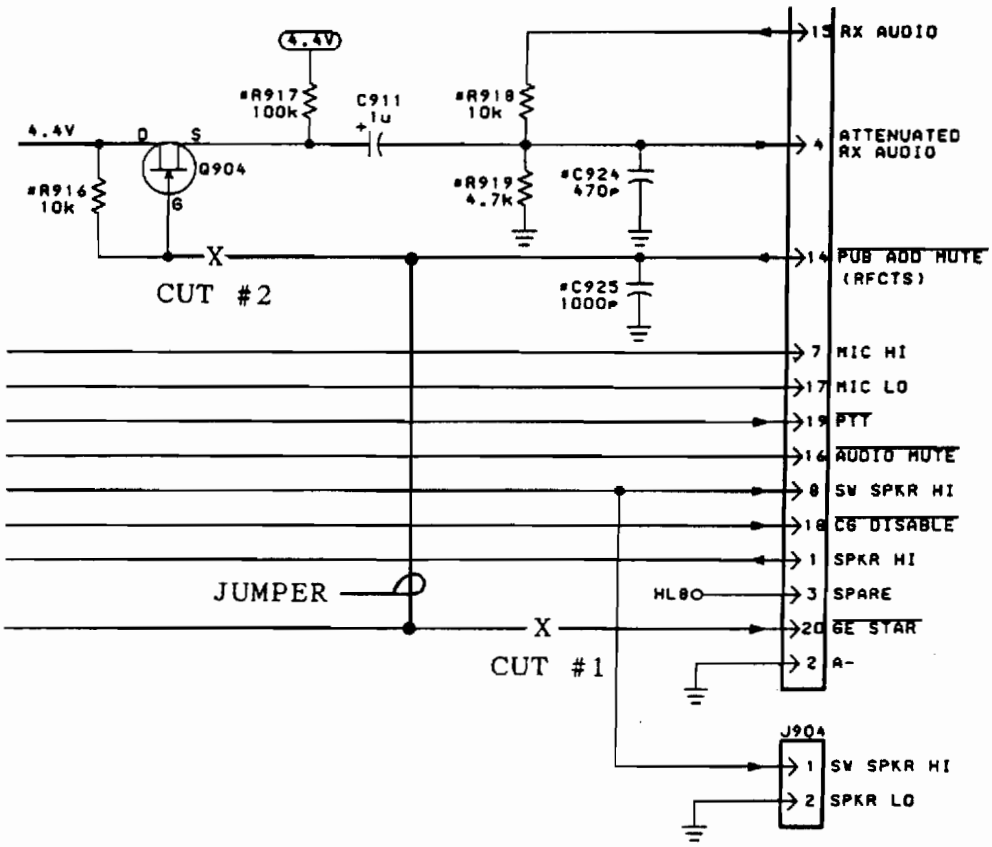
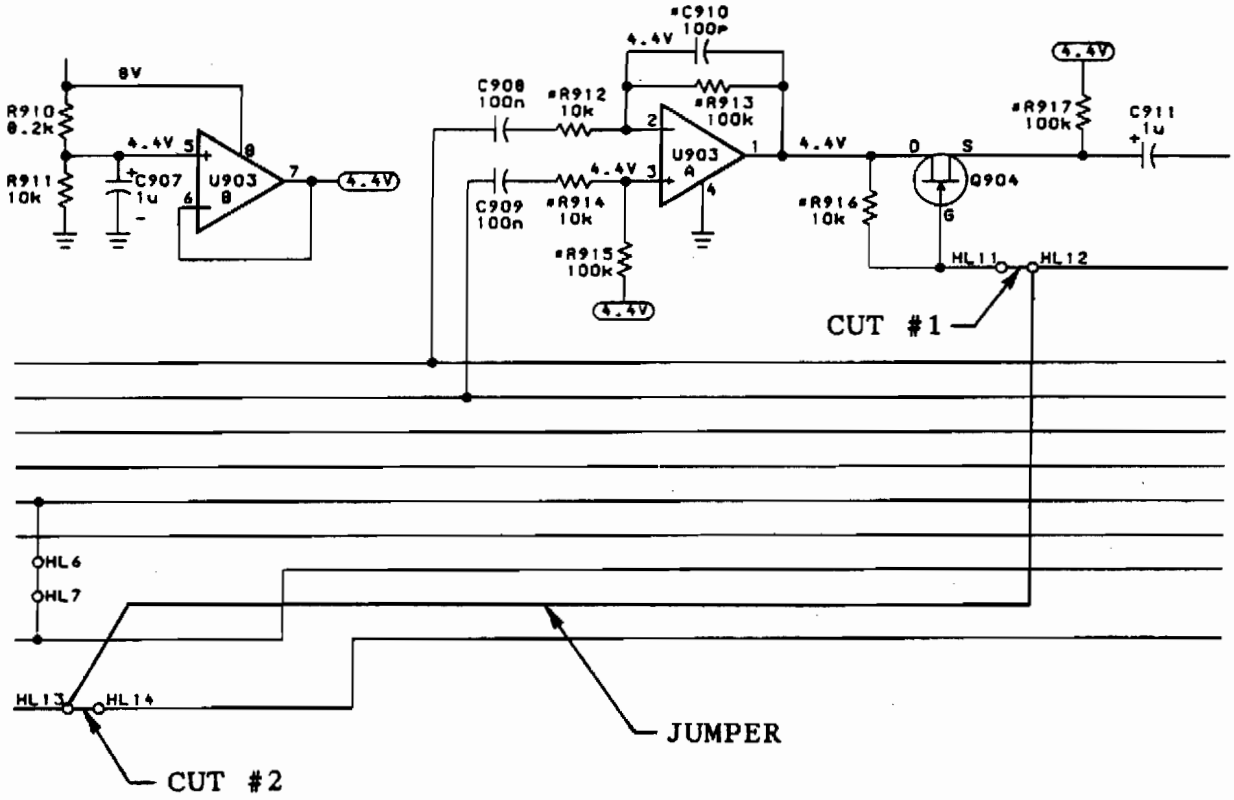


FIGURE 3

WHEN THIS MODIFICATION INSTRUCTION IS SPECIFIED, INSTALL DATA CABLE 19C815158P10 AND MODIFY SYSTEM BOARD 19D901891G1 OF THE TMX-8825 RADIO:

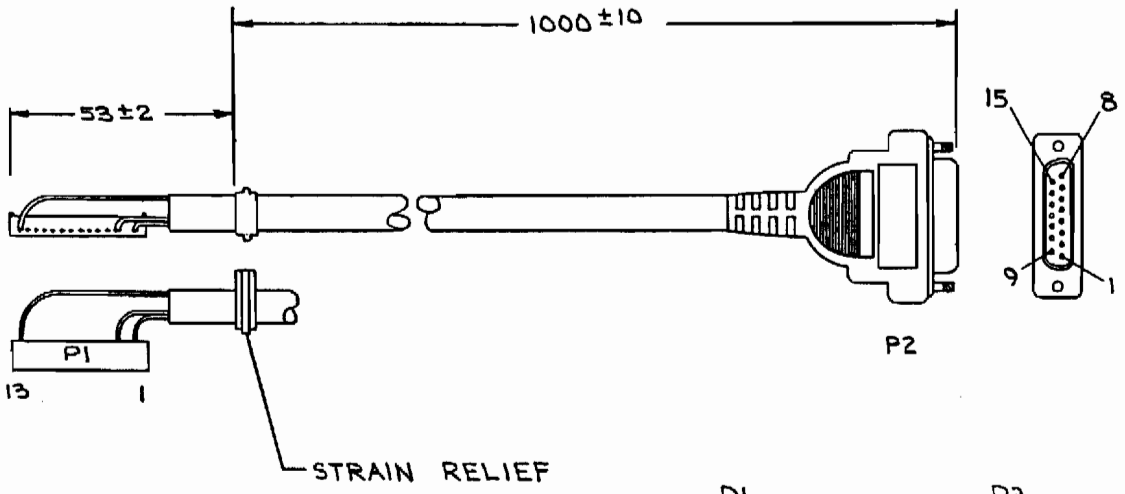
MODIFICATION TO SYSTEM BOARD 19D901891G1 (PRIOR TO REV. C):

1. CUT PATTERN NEAR J905B-6 ON COMPONENT SIDE OF BOARD (SEE FIGURE 1).
2. CUT PATTERN BETWEEN R916 AND C925 ON SOLDER SIDE (SEE FIGURE 2).
3. INSTALL JUMPER BETWEEN J905B-6 AND C925 (SEE FIGURE 3).
4. INSTALL DATA CABLE 19C851585P10 ON J905A.

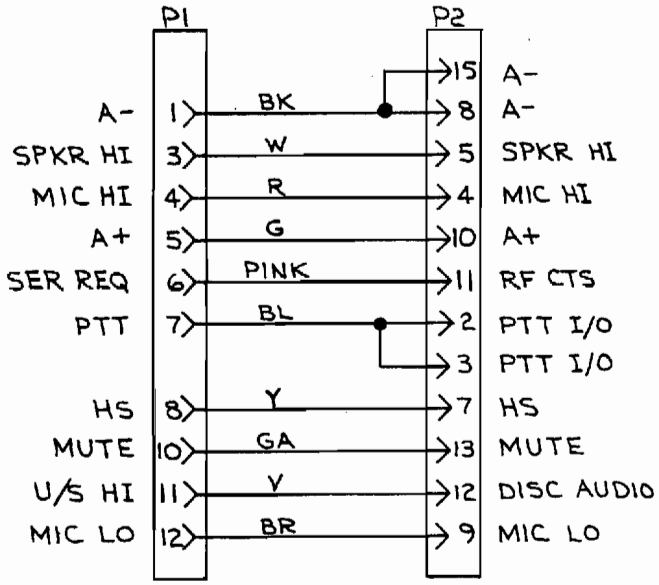


MODEL NO.	REV. LETTER
19D90189161	C

INSTALLATION INSTRUCTIONS
19A149984P3



WIRE CONNECTION CHART		
FROM	COLOR	TO
P1-1	BLACK	P2-8
P1-3	WHITE	P2-5
P1-4	RED	P2-4
P1-5	GREEN	P2-10
P1-6	PINK	P2-11
P1-7	BLUE	P2-2,3
P1-8	YELLOW	P2-7
P1-10	GRAY	P2-13
P1-11	VIOLET	P2-12
P1-12	BROWN	P2-9
P2-8	—	P2-15



DATA INTERFACE CABLE
19C851585P10

(19C851585, Sh. 9, Rev. 18)

SECTION V

MCS RADIO INTERFACE

DESCRIPTION

This section describes the interface of an MCS radio with a data communication device (DCD), such as a radio modem. This radio is designed to operate in a conventional system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, the radio will not support voice communications.

The CAS signal from the radio is used to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections from the radio to the 15-pin connector are shown in Figure 2.

CONNECTORS AND SIGNALS

CH Select 0	1 <
PTT	2 <
PTT	3 <
TX Audio	4 <
RX Audio	5 <
CH Select 1	6 <
Monitor	7 <
A-	8 <
TX Audio Low	9 <
Switched A +	10 <
RFCTS	11 <
VOL/SQ HI	12 <
Audio Mute	13 <
	14 <
A-	15 <

15-Pin
Female
Connector

Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

1. Channel Select 0 (CH SELECT 0) (To the radio)

   This is a binary bit used for channel selection. See section on Control Head / Radio Protocol.
   $-0.5\ V < V_{IL} < 0.75\ V$,
   $2.1\ V < V_{IH} < 5.25\ V$,
   $I_{IL} = -800\ uA$ when $V_{IL} = 0.45\ V$.
   Will not source more than 80 uA in the high state.

2,3. PTT (To the radio)

   The DCD will key the radio with this line. This signal is active low.
   $-0.5\ V < V_{IL} < 0.75\ V$,
   $2.1\ V < V_{IH} < 5.25\ V$,
   $I_{IL} = -800\ uA$ when $V_{IL} = 0.45\ V$.
   Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

   The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is 570 ohms (may be 180 ohms in some radios), and the typical signal level is 85 mV_{P-P}.

5. RX Audio (From the radio)

   The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 8 ohms with a signal level of up to 8 V_{P-P}.

13. Audio Mute (To the radio)

This line provides the DCD with the means to mute received audio. The DCD pulls this line low to mute audio. This is an output from the microprocessor that the DCD must override. This output can source/sink 4 LS TTL inputs.
V_{OHmin} = 2.4 V when I_{OH} = -60 uA,
V_{OLmax} = 0.45 V when I_{OL} = 1.6 mA.

15. A- (From the radio)

GND connection.

Control Head / Radio Protocol

Channel Select 0 and Channel Select 1 will normally be at +5 volts and must be pulled low. A pull down resistor will not be needed. The +5 volts is a logic 1 (see Table).

Channel	CH SELECT 1	CH SELECT 0
1	0	0
2	0	1
3	1	0
4	1	1

PTT equal to 0 volts will initiate a call or cause voice transmission.

Monitor equal to 0 volts will allow monitoring the current channel activity.

RADIO COMMUNICATIONS PROTOCOL

Voice Call

P1 of the data cable will plug into the jack that the control head normally occupied; therefore, voice communications will not be possible when the data cable is connected to the radio. This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD.

Originating

The current channel is determined by the switch on the speaker. The switch is set to the proper channel, then PTT is pressed. The call will end if the repeater drops the radio because of inactivity. A repeater may not be involved. Communications can be radio to radio.

Receiving

The radio will monitor the channel until it sees carrier or CG (depends on programming of radio). The radio will unmute audio, after which the operator will hear the caller's voice. The XMIT Indicator will be ON whenever PTT is pressed. The same conditions that end an originated call will end a received call.

DCD Call

The channel is selected by setting the CH Select lines to the proper binary values listed in the Control Head / Radio Protocol. These lines must be pulled low. RFCTS must be at 0 volts before initiating a call. The DCD must pull PTT low to initiate a call. If CG is used, a decode time of up to 250 milliseconds at 210 HZ and 500 milliseconds at 67 HZ will result at the receiving radio. IF DCG is used, a decode time of up to 450 milliseconds will result at the receiving radio. These decode times must be allowed to finish before data can be transmitted.

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time. Also decode times at the other radio must be considered.

Squelch Tail Elimination (STE) can be programmed in the radios. This will eliminate the squelch tail that modems often mistake for data. STE will add 200 milliseconds to the time for the transmitter to unkey after the release of PTT.

Recommendations

After installing the data option per the installation instructions, set up the MCS radio for voice operation according to the Maintenance Manual for the radio. Disconnect P1 of the data cable and connect the radio control head to the radio. Test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. See RFCTS STATES below. RFCTS will be low in the IDLE state only when the channel is not busy.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	0	0	1

(where 1 = +5 volts, 0 = < 0.5 volts)

If the modem detects extraneous data at the end of each reception, it may be due to the radio squelch tail. Use CG and STE to eliminate this.

DATA APPLICATION KIT 344A3191G6

Description

The 344A3191G6 Data Application Kit is used with the MCS radio to enhance data communications. The kit consists of a data interface cable, and two spike suppression circuits (diode and resistor).

Installation

The data interface cable and the spike suppression circuits must be installed in the MCS radio.

Data Interface Cable

The 19B235192P4 Data Interface Cable provides connections between the MCS radio and an associated data device (DCD). The cable assembly consists of two cables terminated in a 15-pin connector P2, which is connected to the DCD. Cable 1 is terminated in a 9-pin connector P1, which is connected to the radio microphone connector J701. Cable 2 is to be inserted through the auxiliary cable port on the front of the radio and connected to J702 on the RF Board and to J703 on the Audio Board.

Before making connections to J702, remove the wire on P705-2 to prevent accidental damage to Q702 on the Logic Board.

Spike Suppression

For spike suppression, two 100 ohm resistors and two 5 volt Zener diodes are supplied in the kit. Connect (solder) one end of the resistor to the BLACK wire (P2-13) and the other end to J703-13, and connect the Zener diode cathode to J703-13 and the anode to GND. Also connect one end of the second resistor to the GREEN wire (P2-11) and the other end to J703-2, with the second Zener diode cathode connected to J703-2 and the anode to GND.

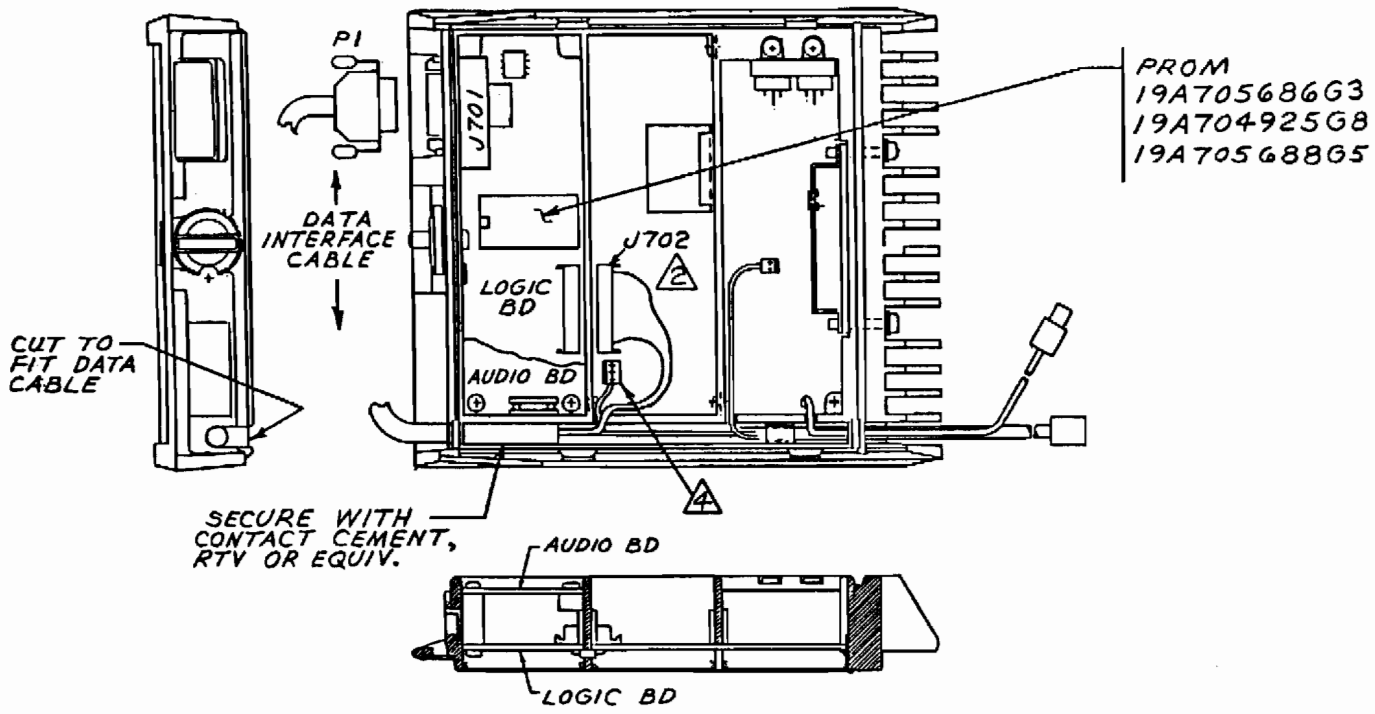
The remaining wires in cable 2 are to be connected to J702 and J703 as shown in Installation Diagram 19C851988.

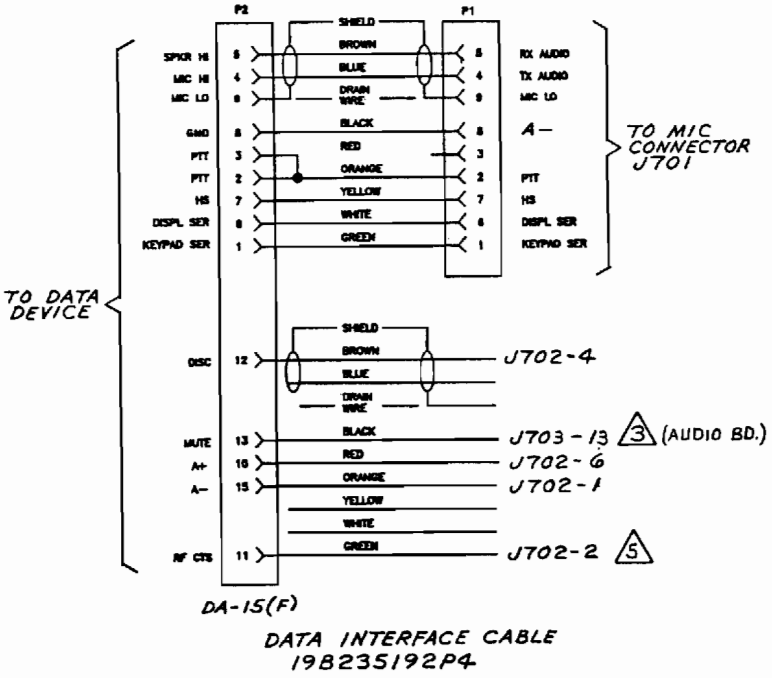
After the installation has been completed and checked, the radio may be re-assembled.

DATA APPLICATION KIT
344A3191G6 (MCS)
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
	19B235192P4	Data Interface Cable.
	19A700025P5	Silicon, zener: 5.1 V, 400 mW max; sim to BZX55-C5V1. (Qty 2).
	H212CRP110C	Deposited Carbon: 100 ohms ±5%, 1/4 w. (Qty 2).

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES





(1) THESE INSTRUCTIONS COVER THE INSTALLATION OF THE DATA APPLICATION KIT TO THE TMX RADIOS (8218.8318, 8518 AND 8712) AND THE MCS RADIO.

NOTE:

1. HARDWARE USED IN THE FOLLOWING INSTRUCTIONS IS ON KIT FL344A3191.

INSTRUCTIONS:

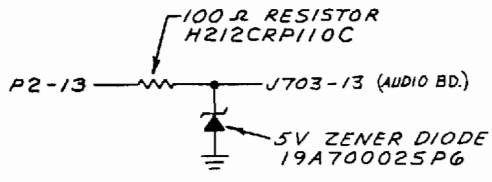
1. INSTALL PROM ON LOGIC BOARD (DOES NOT APPLY TO MCS).

(2) SOLDER LOOSE WIRE ENDS OF DATA INTERFACE CABLE DIRECTLY TO J702 AND J703 PER DIAGRAM.

(3) FOR SPIKE PROTECTION CONNECT A 100 OHM RESISTOR AND A 5V ZENER DIODE TO END OF BLACK WIRE BEFORE SOLDERING TO J703-13 PER DETAIL 'A'.

(4) REMOVE WIRE ON P705-2 TO PREVENT ACCIDENTAL DAMAGE TO Q702 ON LOGIC BOARD.

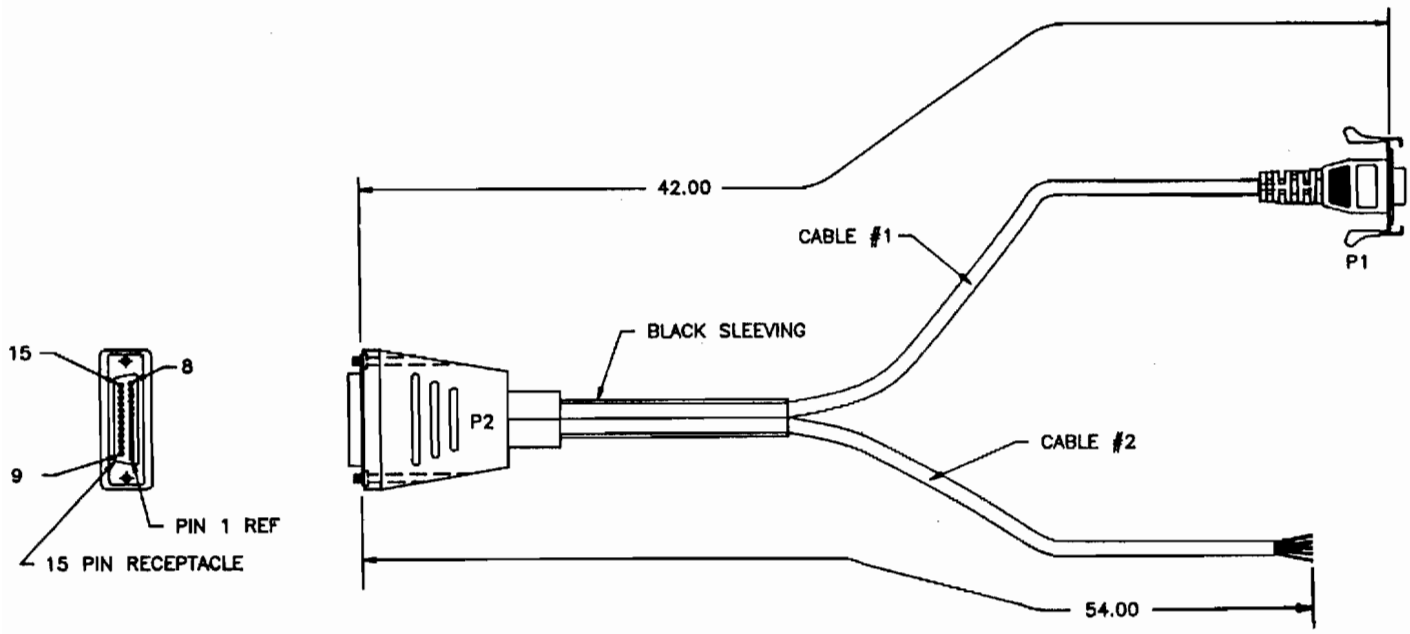
(5) FOR THE MCS RADIO ONLY, CONNECT GREEN WIRE TO J703-2 USING SPIKE PROTECTION SIMILAR TO NOTE 3.



DETAIL 'A'

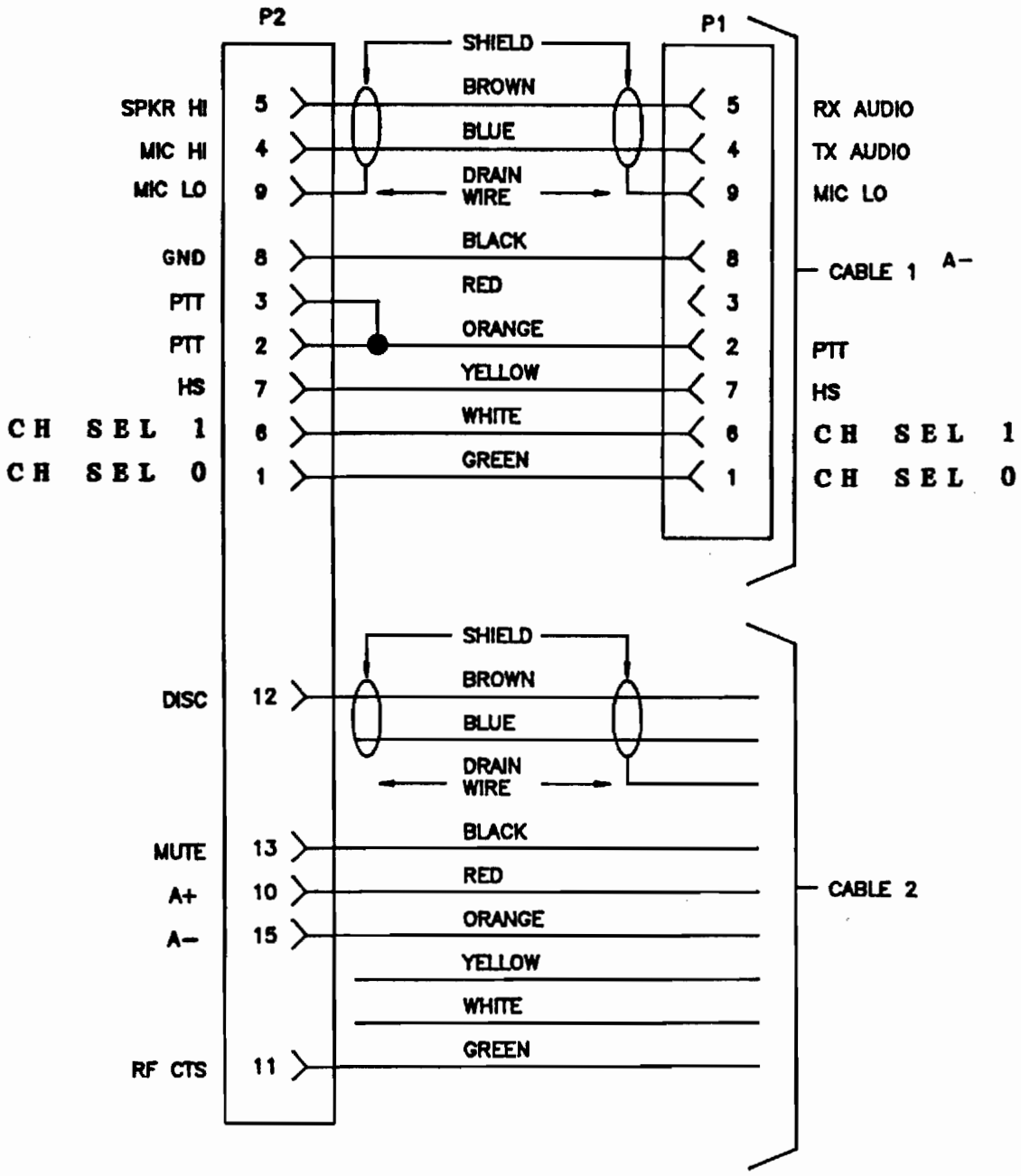
INSTALLATION INSTRUCTIONS

(19C851988, Rev. 1)



DATA INTERFACE CABLE
19B235192P4

(19B235192, Sh. 9, Rev. 4)



DATA INTERFACE CABLE
19B235192P4

(19B235192, Sh.10, Rev. 4)

SECTION VI

MVS RADIO INTERFACE

DESCRIPTION

This section describes the interface of an MVS radio with a data communication device (DCD), such as a radio modem. This radio is designed to operate in a conventional system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, voice communication is not supported.

The CAS signal from the radio is used to generate a "RF Clear to Send" (RFCTS) output. An added cable and connector are also required.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections for the 15-pin cable are shown in Figure 2.

CONNECTORS AND SIGNALS

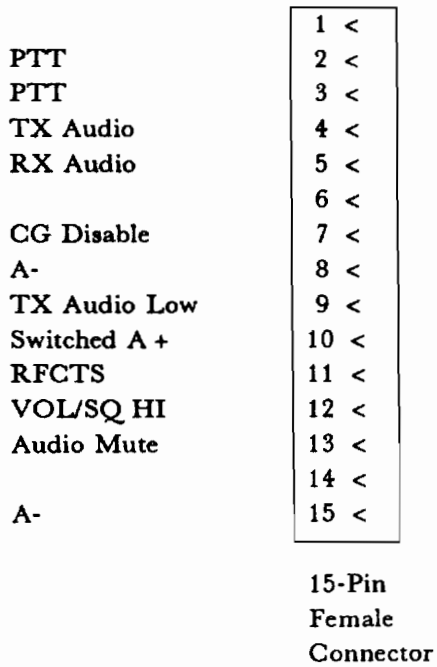


Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is 570 ohms (may be 180 ohms in some radios), and the typical signal level is 85 mV_{P-P}.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 8 ohms with a signal level of up to 8 V_{P-P}. Its level is controlled by the volume setting.

7. CG Disable (To the radio)

This signal is active low. A low will allow monitoring of the current channel for activity.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

RADIO COMMUNICATIONS PROTOCOL

Voice Call

This voice call description is provided only for the verification of the radio operation prior to the connection of the DCD. When the data interface is added and a DCD is connected, voice communication is not supported.

Originating

The current channel is determined by the push button on the front cap. The radio is set to the proper channel, then PTT is pressed. The call will end if the repeater drops the radio because of inactivity. A repeater may not be involved. Communications can be radio to radio.

Receiving

The radio will monitor the channel until it sees carrier or CG (depends on programming of radio). The radio will unmute audio, after which the operator will hear the caller's voice. The TX Indicator will be ON whenever PTT is pressed. The BSY indicator will be on when the channel is in use. The same conditions that end an originated call will end a received call.

DCD Call

RFCTS must be at 0 volts before initiating a call. The DCD must pull PTT low to initiate a call. If CG is used, a decode time of up to 250 milliseconds at 210 Hz and 500 milliseconds at 67 Hz will result at the receiving radio. IF DCG is used, a decode time of up to 450 milliseconds will result at the receiving radio. These decode times must be allowed to finish before data can be transmitted.

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time. Also decode times at the other radio must be considered.

Squelch Tail Elimination (STE) can be programmed in the radios. This will eliminate the squelch tail that modems often mistake for data. STE will add 200 milliseconds to the time for the transmitter to unkey after the release of PTT.

Recommendations

After installing the data option per the installation instructions, set up the MVS radio for voice operation according to the Maintenance Manual for the radio. Connect the microphone to the radio and test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. (See RFCTS STATES below). RFCTS will be low in the IDLE state only when the channel is not busy.

RFCTS STATES

	RADIO STATE		
	IDLE	TX	RX
RFCTS	0	0	1

(where 1 = +5 volts, 0 = < 0.5 volts)

If the modem detects extraneous data at the end of each reception, it may be due to the radio squelch tail. Use CG and STE to eliminate this.

DATA APPLICATION KIT 344A3191G7

Description

The 344A3191G7 Data Application Kit is used with the MVS radio to enhance data communications. The kit consists of a data interface cable, a spike suppression circuit (diode and resistor) and a wire.

Installation

Radio System Board Modification for Data Interface Cable

To modify System Board 19D901891G1 for installation of data interface cable 19C851585P10; for System Boards prior to Revision C, follow the Installation Instructions 19A149984P2, included.

Modification of System Boards subsequent to Revision C are to be made in accordance with Installation Instructions 19A149984P4, included.

Data Interface Cable

The 19C851585P10 Data Interface Cable provides connections between the MVS radio and an associated DCD. The cable assembly is a single cable terminated in a 15-pin connector P2, which is connected to the DCD. The 12-pin connector P1 of the cable is connected to the radio at J905 on the System Board. For access to the System Board, remove the bottom cover of the radio. Connect P1 of the cable to J905 on the radio System Board, remove the rubber plug from slot in the housing, and slip the strain relief collar of the Data Interface Cable into the slot. Replace the bottom cover.

PARTS LIST

DATA APPLICATION KIT
344A3191G7 (MVS)
ISSUE 1

SYMBOL	GE PART NO.	DESCRIPTION
	19C851585P10	Data Interface Cable.
	19A700025P5	Silicon, zener: 5.1 V, 400 mW max; sim to BZX55-C5V1.
	H212CRP110C	Deposited Carbon: 100 ohms ±5%, 1/4 w.
	19A115870P5	Stranded Wire.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES

(4) MVS DATA OPTION
SYSTEM BOARD 19D901891G1 REV. C

COMPONENT SIDE

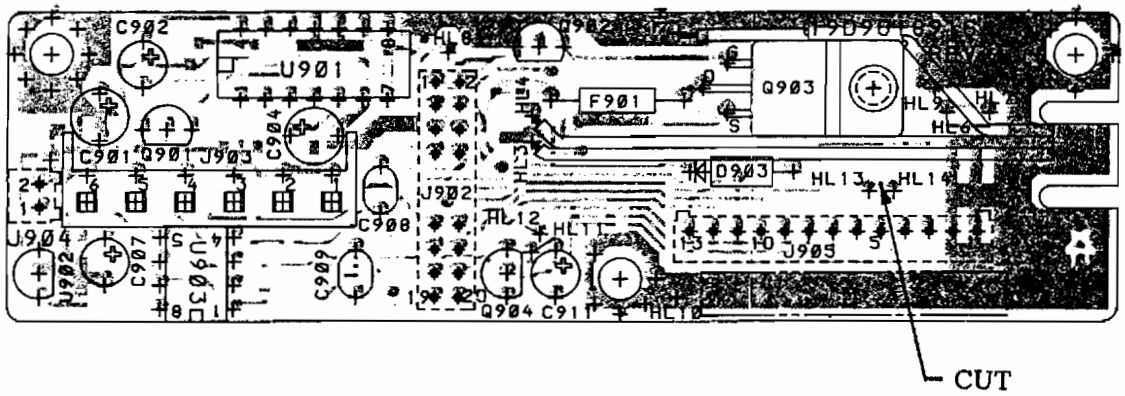


FIGURE 8

LOGIC BOARD 19D901690G5

SOLDER SIDE

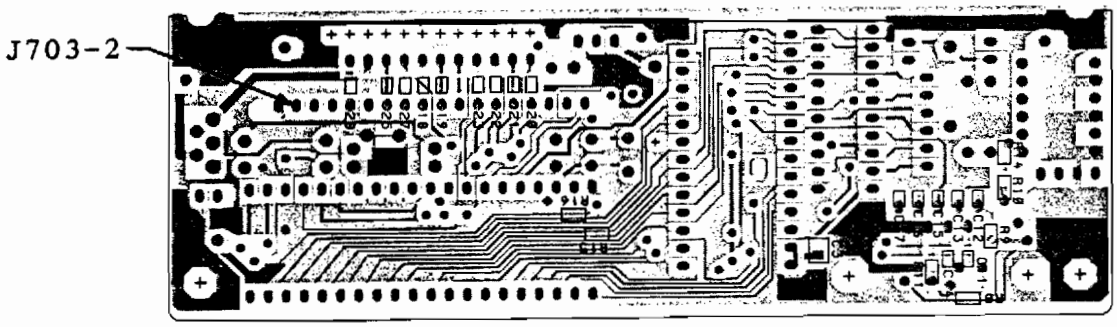


FIGURE 9

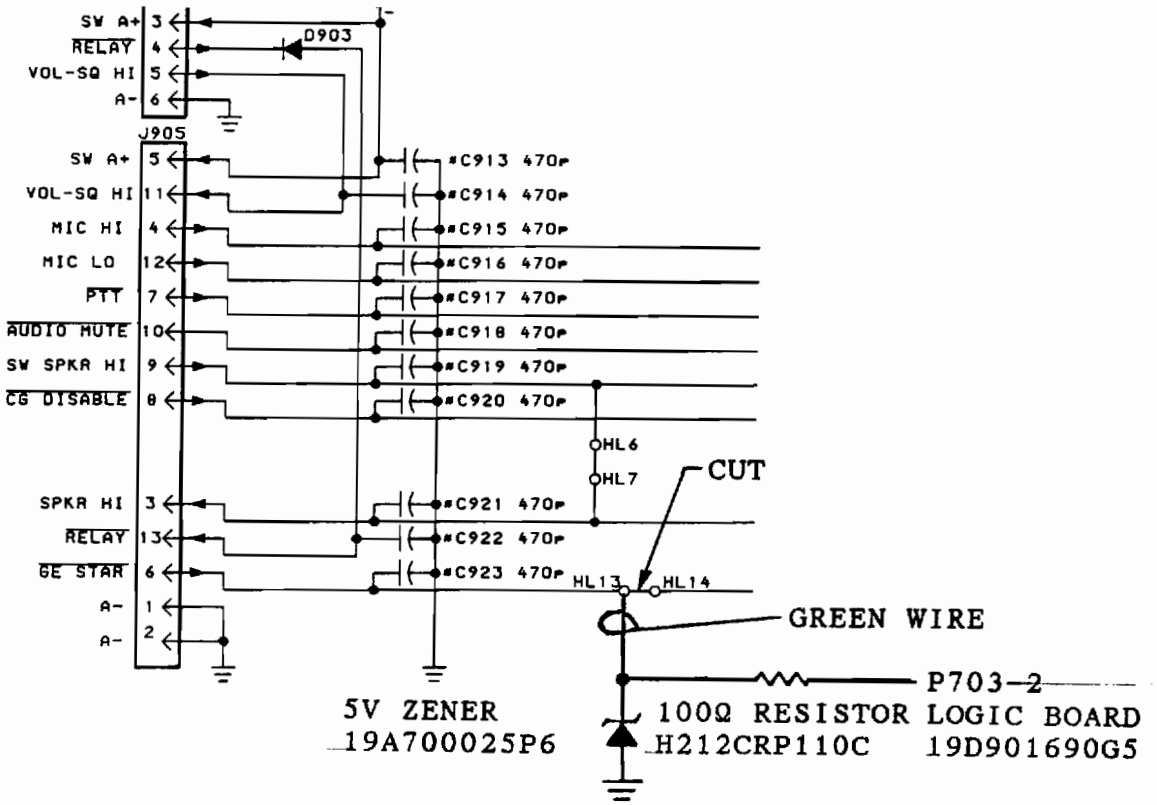


FIGURE 10

WHEN THIS MODIFICATION INSTRUCTION IS SPECIFIED, INSTALL DATA CABLE 19C851585P10 AND MODIFY SYSTEM BOARD 19D901891G1 OF THE MVS RADIO.

MODIFICATION TO SYSTEM BOARD 19D901891G1 REV. C.

1. CUT PATTERN BETWEEN HL13 AND HL14 ON THE COMPONENT SIDE OF THE BOARD (FIGURE 8).

2. INSTALL 5V ZENER AND 100Ω RESISTOR TO SOLDER SIDE OF THE LOGIC BOARD (FIGURE 9 & 10).

3. CONNECT GREEN WIRE FROM ZENER DIODE TO HL13 (FIGURE 10).

4. INSTALL CABLE 19C851585P10 TO J905.

INSTALLATION INSTRUCTIONS
19A149984P4

(19A149984, Sh. 7, Rev. 0)

(2) MVS DATA OPTION
SYSTEM BOARD 19D901891G1 PRIOR TO REV. C

COMPONENT SIDE

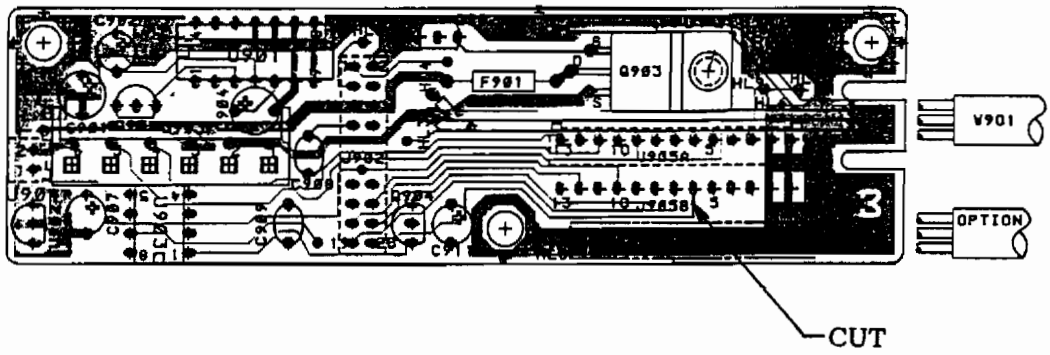


FIGURE 4

LOGIC BOARD 19D901690G5

SOLDER SIDE

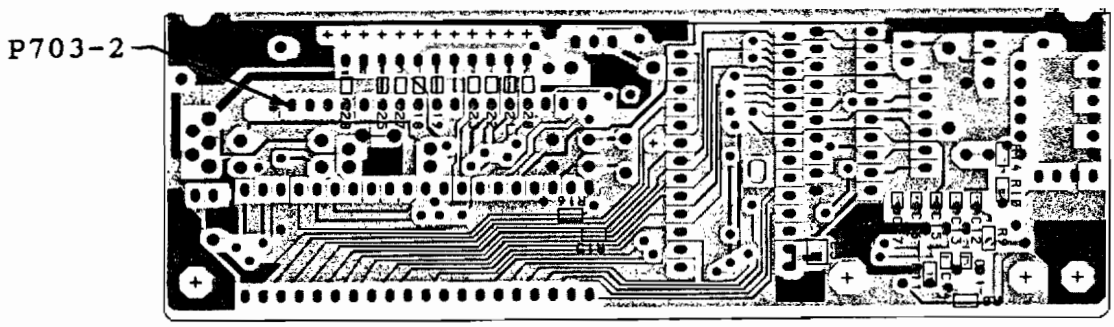


FIGURE 5

INSTALLATION INSTRUCTIONS
19A149984P2
(19A149984, Sh. 3, Rev. 0)

SYSTEM BOARD 19D901891G1

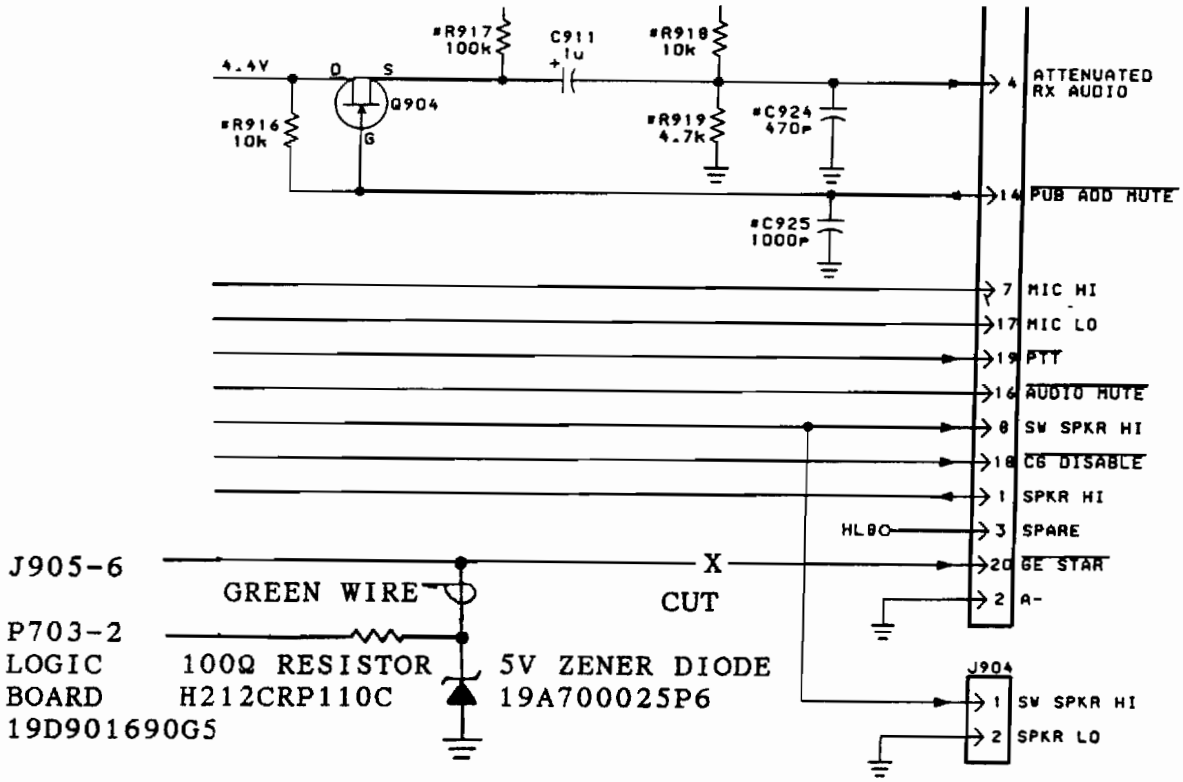


FIGURE 6

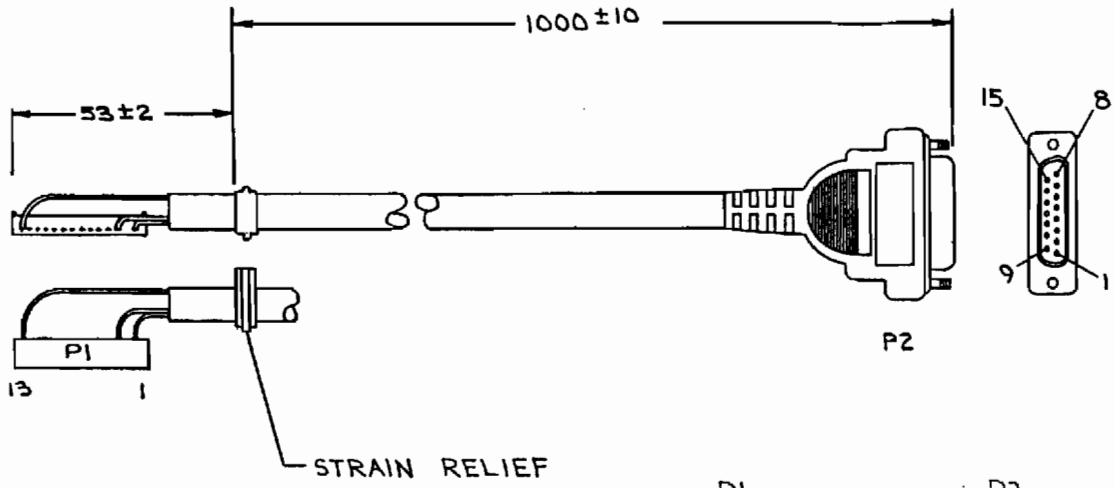
WHEN THIS MODIFICATION INSTRUCTION IS SPECIFIED, INSTALL DATA CABLE 19C851585P10 AND MODIFY SYSTEM BOARD 19D901891G1 OF THE MVS RADIO.

MODIFICATION TO SYSTEM BOARD 19D901891G1 (PRIOR TO REV. C):

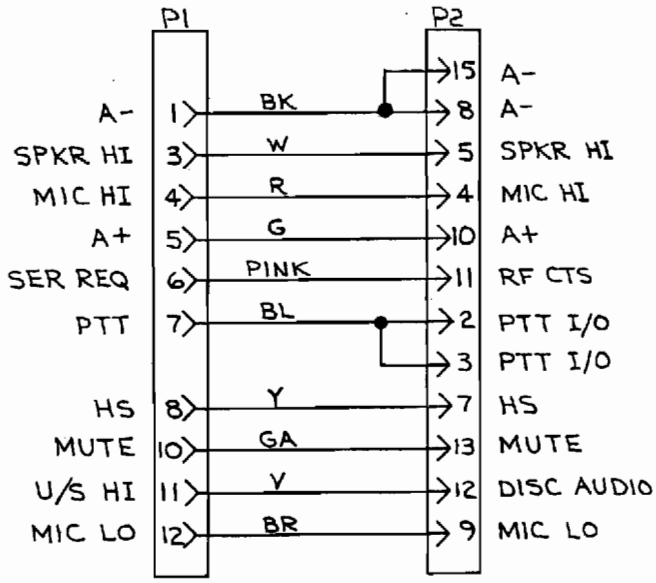
1. CUT PATTERN NEAR J905B-6 ON COMPONENT SIDE OF BOARD (SEE FIGURE 4).
2. ADD SPIKE PROTECTION CIRCUIT TO SOLDER SIDE OF LOGIC BOARD 19D901960 (SEE FIGURE 5 & 6).
3. CONNECT GREEN WIRE FROM PROTECTION CIRCUIT TO J905-6 ON SYSTEM BOARD (SEE FIGURE 5 & 6).
4. INSTALL DATA CABLE 19C851585P10 TO J905A.

INSTALLATION INSTRUCTIONS
19A149984P2

(19A149984, Sh. 4, Rev. 0)



WIRE CONNECTION CHART		
FROM	COLOR	TO
P1-1	BLACK	P2-8
P1-3	WHITE	P2-5
P1-4	RED	P2-4
P1-5	GREEN	P2-10
P1-6	PINK	P2-11
P1-7	BLUE	P2-2,3
P1-8	YELLOW	P2-7
P1-10	GRAY	P2-13
P1-11	VIOLET	P2-12
P1-12	BROWN	P2-9
P2-8	—	P2-15



DATA INTERFACE CABLE
19C851585P10

(19C851585, Sh. 9, Rev. 18)

APPENDIX

BARNETT RADIO MODEM

DESCRIPTION

This appendix describes the interface of TMX, MCS and MVS radios, which have data kits installed, to a Barnett Radio Modem.

The Barnett radio modem may be ordered as a vendor option. The conventional radio modem is option V4000. The trunked radio modem is option V4001.

SPECIFICATIONS

GENERAL

Transmission Rate	1200 Baud (Bell 202 signalling).
Power Requirement	Operates from 12 to 30 Vdc. Current consumption is typically 175 mA.
Temperature Range	-30°C to +50°C.
Physical Size	Approx. 10"x5"x1", inside a metal enclosure.
Radio and Wireline Connector	Compression screw terminals located inside the enclosure.
Data Connector	RS232-C compatable, connections available through a DB-25S socket located on the back of the enclosure.
Indicators	Power ON, TXD, RXD, CD, TRS, CTS, BUSY, TEST.
Receive Audio	Singled ended, AC coupled, -30 dBm to 0 dBm.
Transmit Audio	Single ended, AC coupled, -20 dBm to 0 dBm.
Squelch Detection	Single ended, 1M ohm inpedance, DC coupled, detection range 0 to 10 volts, polarity is DIP switch selectable. Inhibits data transmission when the squelch detector senses receiver activity on the radio channel.
PTT	Closure to ground for active, 1A @ 50 volts max.
4 Wire Receive Audio	Balanced, 600 ohm impedance, -30 dBm to 0 dBm (operates full duplex).
4 Wire Transmit Audio	Balanced, 600 ohm impedance, -20 dBm to 0 dBm, (operates full duplex).

TMX-8210/8310/8510/8712/8415/8615/8630 RADIOS

The Barnett B1474T radio modem with the Ericsson GE data cable option is recommended for these radios. The radio should be tuned for voice operation per the radio Maintenance Manual. Follow the modem operation instructions supplied by Barnett.

If the modem is ordered without a cable, a male DB-15 connector must be added to the modem. It is also necessary to add a 100K pull-up resistor between V+ and SQL in the modem and a 4.7K ohm resistor in series with the TX RAD line in the modem cable.

TMX-8825 RADIO

The Barnett B1474T radio modem with the Ericsson GE data cable option is recommended for this radio. First, the radio should be tuned for voice operation per the radio Maintenance Manual. Then turn the MIC GAIN pot on the radio audio board down, so that the adjustment range of the modem output level will allow adjustment for 2 KHz FM transmit deviation by the modem test tone (3 KHz total deviation with busy tone included).

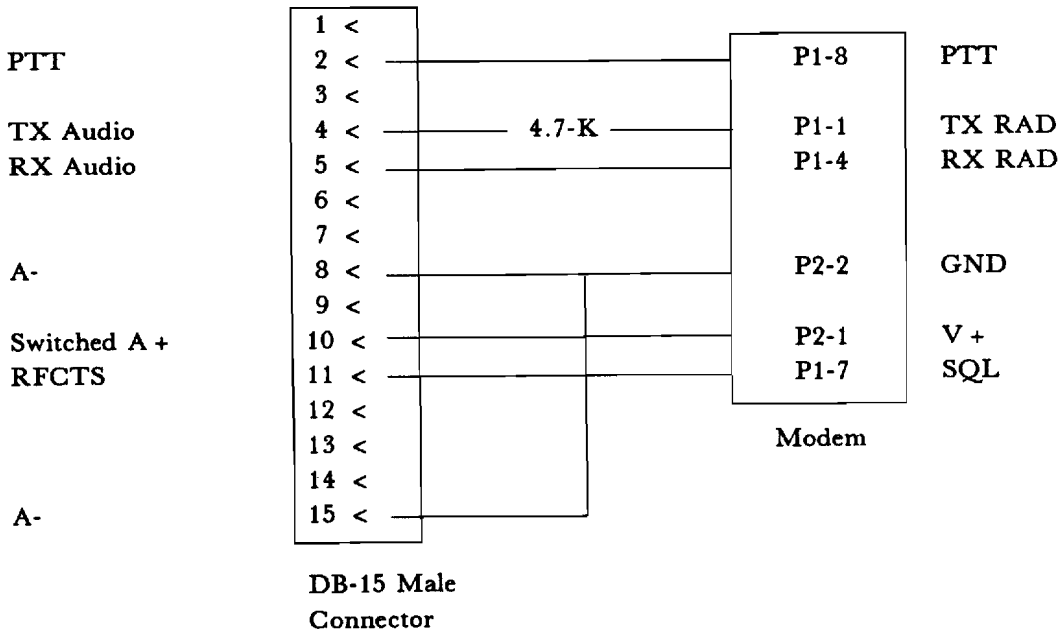
If the modem is ordered without a cable, a male DB-15 connector must be added to the modem. It is also necessary to add a 4.7K ohm resistor in series with the TX RAD line in the modem cable and turn the MIC GAIN on the radio audio board down, so that the adjustment range of the modem output level will allow adjustment for 2 KHz FM transmit deviation by the modem test tone (3 KHz total deviation with busy tone included). Follow the modem installation and operation instructions supplied by Barnett.

Recommended Trunked Modem Settings

These settings are a good starting point; they are not optimum for all situations. The radio programing and operating environment will determine the best settings.

TRANSMITTER WARM UP DELAY	20 ms 0 ms (8712 full duplex only)
PTT DROP DELAY	0 ms
SQUELCH POLARITY	+ voltage when channel is busy
TRANSMIT LEVEL	Adjust for 2 KHz of FM transmit deviation by the modem test tone, 3 KHz total deviation with busy tone included (higher levels will result in poor performance)
RECEIVE LEVEL ATTENUATION	0 dB (10 dB if noise causes CD and data falsing)
MODEM CONFIGURATION	Half duplex, with amplitude equalization

Barnett Trunked Modem Cable



MCS/MVS RADIOS

The Barnett B1474 radio modem with the Ericsson GE data cable option is recommended for these radios. The radio should be tuned for voice operation per the radio Maintenance Manual. Follow the modem operation instructions supplied by Barnett.

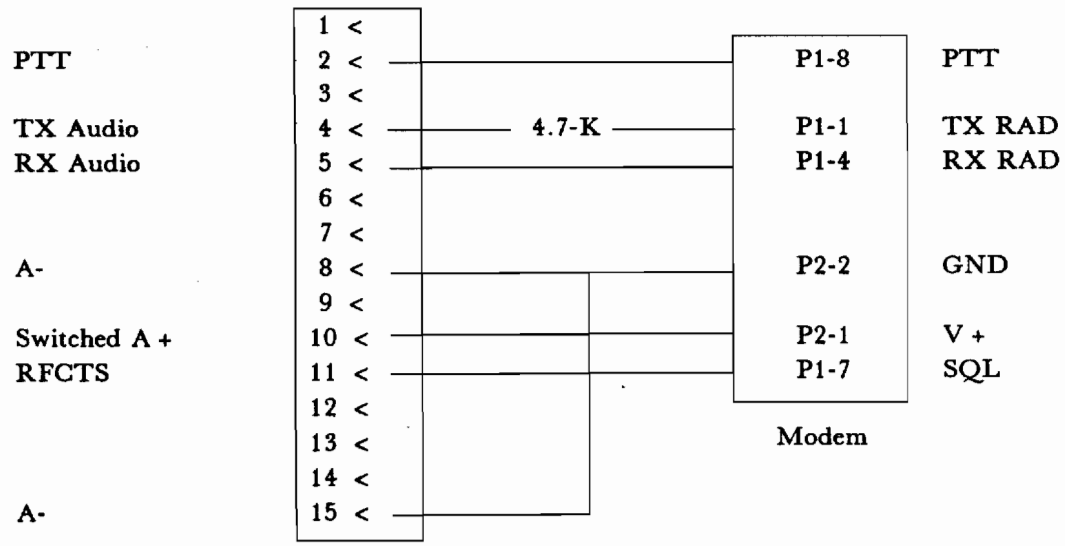
If the modem is ordered without a cable, a male DB-15 connector must be added to the modem. It is also necessary to add a 4.7K ohm resistor in series with the TX RAD line in the modem cable. The radio should be tuned for voice operation per the radio Maintenance Manual. Follow the modem installation and operation instructions supplied by Barnett.

Recommended Conventional Modem Settings

These settings are a good starting point; they are not optimum for all situations. The radio programing and operating environment will determine the best settings.

RTS/CTS DELAY	500 ms (experiment to find minimum setting)
PTT DROP DELAY	0 ms
SQUELCH POLARITY	+ voltage when channel is busy
TRANSMIT LEVEL	Adjust for 3 KHz of FM transmit deviation by the modem test tone, 3.75 KHz total deviation if CG is included
RECEIVE LEVEL ATTENUATION	0 dB (10 dB if noise causes CD and data falsing)
MODEM CONFIGURATION	Half duplex, with amplitude equalization

Barnett Conventional Modem Cable



DB-15 Male Connector

ERICSSON

Ericsson GE Mobile Communications Inc.
Mountain View Road • Lynchburg, Virginia 24502

Printed in U.S.A.

This addendum provides a correction to the drawings in Figure 6 and 10 found on pages VI-6 and VI-8 respectively. This addendum also adds Section VII. Section VII provides information for the MDS Conventional and GE-MARC radio Data Application Kit 344A3191G8. The information provided in the Appendix for the MVS radio will also apply to the MDS radio. The new drawings (below) and Section VII (starting on the following page) will be incorporated at the next printing of LBI-38596.

Figure 6 on page VI-6

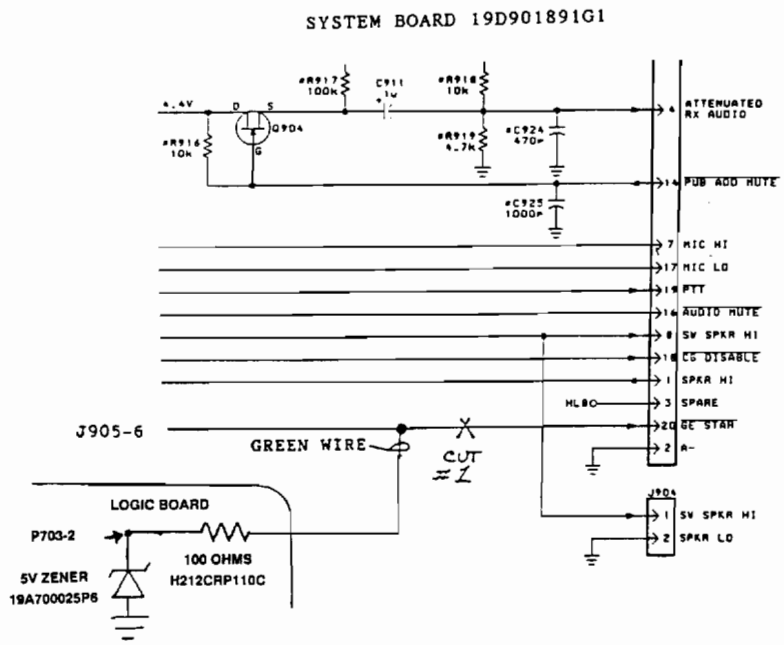
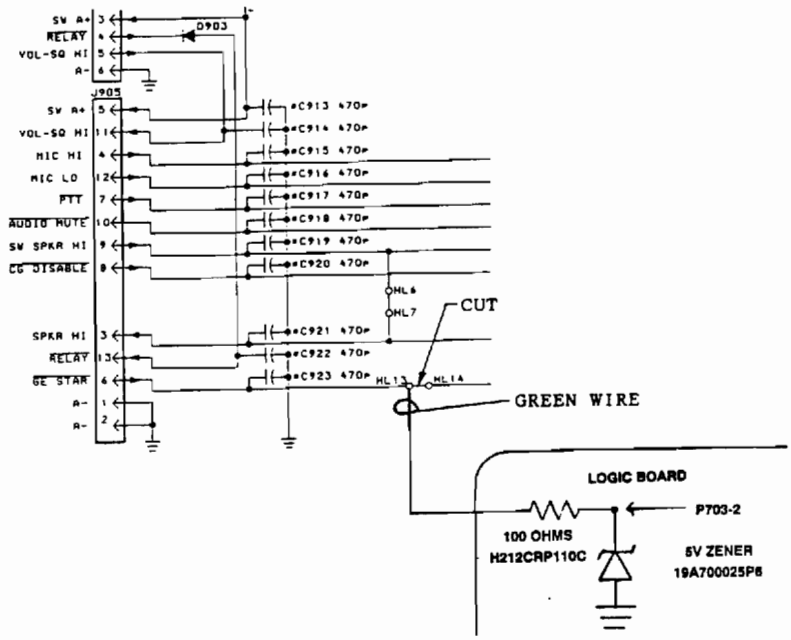


Figure 10 on page VI-8



SECTION VII

MDS CONVENTIONAL AND GE-MARC RADIO INTERFACE

DESCRIPTION

This section describes the interface of an MDS radio with a data communication device (DCD), such as a radio modem. This radio is designed to operate in a conventional system. The interface hardware and the data communications protocol are described. When the data interface is added and a DCD is connected, voice communication is not supported.

The CAS signal from the radio is used to generate an "RF Clear to Send" (RFCTS) output. An added cable and connector are also required to connect the radio to the external DCD.

The standard pin out for the female 15-pin data connector is shown in Figure 1 (as seen from a DCD). The connections for the 15-pin cable are shown in Figure 2.

CONNECTORS AND SIGNALS

	1 <
PTT	2 <
PTT	3 <
TX Audio	4 <
RX Audio	5 <
	6 <
CG Disable/Hookswitch	7 <
A-	8 <
TX Audio Low	9 <
Switched A +	10 <
RFCTS	11 <
VOL/SQ HI	12 <
Audio Mute	13 <
	14 <
A-	15 <

15-Pin Female Connector

Figure 1 - Pin Layout for 15-Pin Connector

P2 Data Communications Connector

LOGIC STATES

V_{IH} Input Voltage High

V_{IL} Input Voltage Low

I_{IL} Input Current Low

V_{OH} Output Voltage High

V_{OL} Output Voltage Low

I_{OH} Output Current High

I_{OL} Output Current Low

For I_{IL}, I_{OH} and I_{OL} the current flow is conventional (positive to negative). These currents are considered positive if they flow into the data connector.

2,3. PTT (To the radio)

The DCD will key the radio with this line. This signal is active low.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

4. TX Audio (To the radio)

The DCD will transmit data on this line. This signal will be pre-emphasized. Input impedance is 570 ohms, and the typical signal level is 85 mV RMS.

5. RX Audio (From the radio)

The DCD can receive data on this line. This signal will be de-emphasized. This output can drive an impedance of 8 ohms with a signal level of up to 8 V_{P-P}. Its level is controlled by the volume setting.

7. CG Disable (Conventional Radio)

This signal is active low. A low will allow monitoring of the current channel for activity.
$-0.5\ V < V_{IL} < 0.75\ V$,
$2.1\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -800$ uA when $V_{IL} = 0.45$ V.
Will not source more than 80 uA in the high state.

Hookswitch (To the radio) (GE-MARC)

This signal is active low. A low indicates Off Hook.
$-0.5\ V < V_{IL} < 0.85\ V$,
$1.95\ V < V_{IH} < 5.25\ V$,
$I_{IL} = -50$ uA when $V_{IL} = 0.45$ V.
Will not source more than 60 uA in the high state.

8. A- (From the radio)

GND connection.

9. TX Audio Low (From the radio)

This is the audio signal ground. To avoid ground loops it is not directly connected to A-.

10. Switched A + (From the radio)

This ranges from 11 to 16 volts, with 0.5 Amp maximum.

11. RFCTS (RF Clear To Send) (From the radio)

This signal is active low. Less than 0.5 volts indicates the radio is on-channel and ready for data communications. This output can sink 20 mA and can source 150 uA.

12. VOL/SQ HI (From the radio)

The DCD can receive data on this line. This signal is broadband demodulated audio direct from the discriminator without any audio processing or de-emphasis. It is dc coupled and is typically a 0.4 V_{P-P} signal. Its impedance is typically 250 ohms and should not be loaded by less than 4K ohms.

13. Audio Mute (To the radio)

This line provides the DCD with the means to mute received audio. The DCD pulls this line low to mute audio. This is an output from the microprocessor that the DCD must override. This output can source/sink 4 LS TTL inputs.
$V_{OHmin} = 2.4$ V when $I_{OH} = -60$ uA,
$V_{OLmax} = 0.45$ V when $I_{OL} = 1.6$ mA.

15. A- (From the radio)

GND connection.

RADIO COMMUNICATIONS PROTOCOL

Recommendations

After installing the data option per the installation instructions, set up the MDS radio for voice operation according to the Operator's Manual for the radio. Connect the microphone to the radio and test the radios in the normal conversation mode. Verify that there is audio in both directions at each radio before proceeding.

Key the radio manually and verify that RFCTS is functioning. (See RFCTS STATES below). RFCTS will be low in the IDLE state only when the channel is not busy.

RFCTS STATES

	RADIO STATE		
	IDLE	**TX**	**RX**
RFCTS	0	0	1

(where 1 = + 5 volts, 0 = < 0.5 volts)

For conventional operation, if the modem detects extraneous data at the end of each reception, it may be due to the radio squelch tail. Use CG and STE to eliminate this.

When initiating a call with GE-MARC systems, it is recommended that PTT be held low for at least 150 ms. RFCTS will be low after the radio acquires a channel and its audio transmit and receive is enaabled. After acquiring the channel it is necessary to key the radio at least once every 6 seconds to maintain the RF link. RFCTS will remain low as long as the RF link is maintained.

DCD Call

When the DCD is receiving data, it must not put data on the air until 150 ms after the other DCD finishes its transmission. This is due to the other radio's receiver recovery time. Also decode times at the other radio must be considered.

Conventional Systems

RFCTS must be at 0 volts before initiating a call. The DCD must pull PTT low to initiate a call. If CG is used, a decode time of up to 250 milliseconds at 210 Hz and 500 milliseconds at 67 Hz will result at the

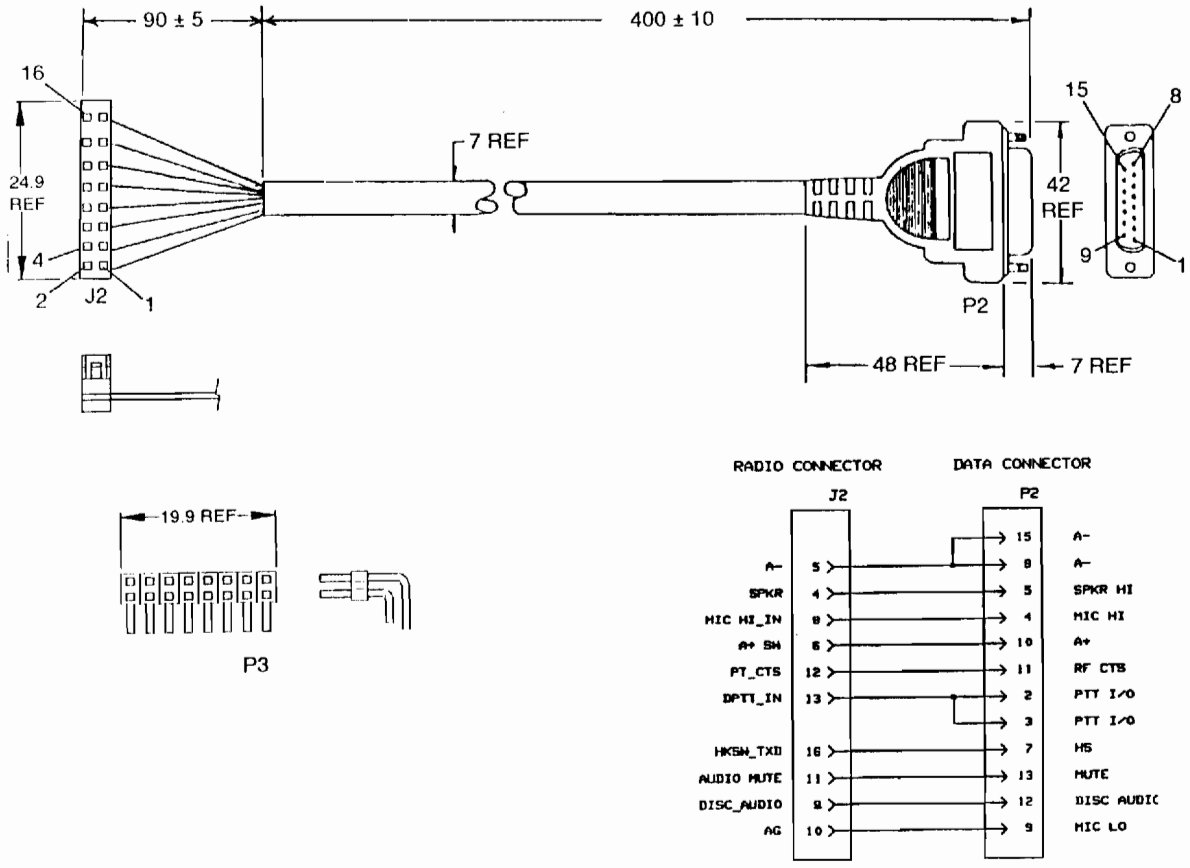


Figure 2 - Data Cable for the MDS Radio

receiving radio. IF DCG is used, a decode time of up to 450 milliseconds will result at the receiving radio. These decode times must be allowed to finish before data can be transmitted.

Squelch Tail Elimination (STE) can be programmed in the radios. This will eliminate the squelch tail that modems often mistake for data. STE will add 200 milliseconds to the time for the transmitter to unkey after the release of PTT.

GE-MARC Systems

The DCD will pull PTT low for at least 150 milliseconds to initiate a data call. If RFCTS does not go low within 6 seconds, the repeater access failed. The DCD should wait 20 seconds before trying to access the repeater again. RETRIES SHOULD BE LIMITED TO PREVENT A RADIO FROM TYING UP THE SYSTEM.

After the radio successfully accesses the repeater (RFCTS is 0 volts), the DCD can begin its data transmission using 1200 baud FSK. After the repeater is acquired, the DCD must pull PTT low at least 50 ms before sending any data because of the radio transmitter's audio attack time. PTT is held low during the data transmission.

DATA APPLICATION KIT 344A3191G8

Description

The 344A3191G8 Data Application Kit is used with the MDS radio to enhance data communications. The kit consists of a data interface cable, a right angle pin header and a strain relief hardware kit.

Installation

1. Remove the blank cover over the data cable entry opening on the bottom side of the radio front cap.
2. Remove the top and bottom radio covers. (Loosen two screws at back of each cover.)
3. Remove the front cap assembly from the radio casting. (Four screws.)
4. Remove the brass spring finger assembly of the bottom front main casting.
5. Plug the data connector onto the 16-pin right angle pin header P3 suplied in the kit.
6. On the bottom side of the main pwb assembly (solder side), insert the pin header into the array of holes (J2), just behind the front cap data cable entry opening. (Refer to the Radio Maintenance Manual.) The right angle header should be facing away from the front of the radio. Carefully solder the header connector to the printed wire board.
7. Unplug the data cable and route the cable assembly through the front cap data cable entry opening. Flatten the unjacketed portion of the cable where it passes over the front casting wall.

CAUTION

If the cable is plugged in backward, A + will be connected to ground and the 2 amp ignition lead fuse will be blown when power is applied to the radio.

8. Install the strain relief assembly to the data cable and assemble to the front cap with hardware provided. It may be necessary to wrap the cable with tape under the strain relief to assure a tight fit.
9. Connect the cable connector to the right angle header with pin one (red wire) facing up away from the pwb.
10. Replace the brass spring finger assembly and front cap assembly to the radio.
11. Replace radio covers.

This addendum corrects an error on page V-1 under P2 Data Communications Connector, item 5 "RX Audio (From the Radio)". The last line should read "with a signal level of up to 2.8 V p-p.