



**MOTOROLA**

# VRM 500™ Vehicular Radio Modem



## Owner's & Installation Manual

68P02943C70-O



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**TABLE OF CONTENTS**

**GENERAL DESCRIPTION ..... 68P02943C71**

1. OVERVIEW ..... 1

2. HARDWARE DESCRIPTION ..... 2

    2.1 FRONT-PANEL LEDs ..... 2

    2.2 REAR PANEL CONNECTORS ..... 3

        2.2.1 DTE to VRM 500 ..... 3

        2.2.2 Auxiliary to Modem ..... 3

        2.2.3 Radio to Modem ..... 3

3. POWER SUPPLY ..... 3

4. RECHARGEABLE LITHIUM BACKUP BATTERY ..... 3

5. USING THIS MANUAL ..... 3

**LITHIUM BATTERY SAFETY PRECAUTIONS..... 68P02938C97**

1. GENERAL ..... 1

2. DISPOSAL REQUIREMENTS ..... 1

3. EMERGENCY PROCEDURES ..... 1

**INSTALLATION ..... 68P02943C72**

1. UNPACKING ..... 1

2. INSTALLATION ..... 1

    2.1 INSTALLATION PLANNING ..... 1

    2.2 VEHICLES EQUIPPED WITH AIR BAGS ..... 1

    2.3 RECOMMENDED TOOLS FOR INSTALLATION ..... 1

    2.4 SINGLE-BRACKET INSTALLATION ..... 1

    2.5 ELECTRICAL CONNECTIONS ..... 1

3.	POWERING THE VRM 500 ON .....	2
4.	POWERING THE VRM 500 OFF .....	2

**FUNCTIONAL DESCRIPTION ..... 68P02943C73**

1.	GENERAL .....	1
2.	FUNCTIONAL DESCRIPTION .....	1
2.1	BOARD INTERFACE .....	1
2.1.1	RS-232 DTE Signals and Connections .....	4
2.1.2	RS-232 Auxiliary Signals and Connections .....	4
2.1.3	CMOS Signals and Connections .....	4
2.1.4	Radio and Power Connections .....	4
2.2	RS-232 INTERFACE .....	4
2.3	DSP56156 .....	5
2.4	DATA TRANSMIT PATH .....	5
2.5	DATA RECEIVE PATH .....	5
2.6	POWER SUB-SYSTEM .....	5
2.7	LITHIUM BACKUP .....	5

**MAINTENANCE & TROUBLESHOOTING..... 68P02943C68**

1.	GENERAL .....	1
2.	CHECKING AND CLEANING THE VRM 500 .....	1
3.	TROUBLESHOOTING .....	1
3.1	GENERAL .....	1
3.2	TEST AND SERVICE EQUIPMENT .....	1
3.3	TESTING THE VRM 500 .....	1
4.	REPLACING THE LITHIUM BATTERY .....	2
5.	DISASSEMBLY/REASSEMBLY .....	2
5.1	HANDLING CMOS PARTS .....	2
5.2	DISASSEMBLY/REASSEMBLY .....	2

**LIST OF FIGURES**

**GENERAL DESCRIPTION**

Figure 1.	Typical Configuration .....	1
Figure 2.	Front Panel LEDs .....	2
Figure 3.	Rear Panel Connectors .....	3

**INSTALLATION**

Figure 1. Mounting Bracket Mechanical Drawing ..... 3  
 Figure 2. Installing the VRM 500 Inside its Bracket ..... 3  
 Figure 3. Cable Connections ..... 4  
 Figure 4. VRM 500 to DTE Cables ..... 5  
 Figure 5. VRM 500 to Spectra Radio Cables ..... 6  
 Figure 6. VRM 500 to MaxTrac Radio Cable ..... 7

**FUNCTIONAL DESCRIPTION**

Figure 1. Functional Block Diagram ..... 2  
 Figure 2. Component Location ..... 3

**MAINTENANCE & TROUBLESHOOTING**

Figure 1. Exploded View & Mechanical Parts List ..... 3

**LIST OF TABLES**

**GENERAL DESCRIPTION**

Table 1. Power LED (Red) ..... 2  
 Table 2. LED 1 (Amber) ..... 2  
 Table 3. LED 2 (Green) ..... 2  
 Table 4. LED 3 (Amber) ..... 2  
 Table 5. LED 4 (Green) ..... 2

**FUNCTIONAL DESCRIPTION**

Table 1. DTE Connector J4 ..... 4  
 Table 2. Direction of DTE Interface Signal Lines ..... 4  
 Table 3. RS-232 Auxiliary Connector J5 ..... 4  
 Table 4. DTE CMOS Level Connector J3 ..... 4  
 Table 5. Radio and Power Connector J2 ..... 4

**MAINTENANCE & TROUBLESHOOTING**

Table 1. Recommended Test and Service Equipment ..... 1

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 DataTAC, Spectra, and VRM 500 are trademarks of Motorola Inc.

## PERFORMANCE SPECIFICATIONS

### PHYSICAL

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Size (W x H x D)	5" x 1.1" x 4.7" (127 x 27 x 119 mm)
Weight	1.1 lbs (0.5 kg)
Front panel indicators	5 power and status LEDs. Fault condition indicated by blinking LEDs (1 to 4)
Rear panel connectors	CMOS: 8-pin Hirose QM10-8R, signal polarity is active low (default) programmable DTE port: RS-232, DB-9 receptacle (female) AUX: DB-9 plug (male)—includes power lines straight from external power to RADIO connector RADIO: 13-pin Hirose RP13A—includes power lines

### ENVIRONMENTAL

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Operating temperature	-30° to + 60°C
Storage temperature	-40° to + 85°C
Humidity	95% RH @ 50°C (operational)
Vibration	2 times EIA RS-152/RS-204 and MIL-STD-810D, Method 514.3, Procedure I
Shock	2 times EIA RS-152/RS-204 and MIL-STD-810D, Method 516.3, Procedure I

### ELECTRICAL

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Power supply voltage	13.8±20% V DC from radio or vehicle
Input current drain	Standard: 180 mA. Maximum: 300 mA
RAM backup	10 days minimum retention; rechargeable lithium battery
CPU	Motorola microcontroller, 68HC11A1CFN3@2.4576 MHz
DSP	Motorola DSP56156 @ 2.5 to 40 MHz for data modulation and demodulation
CPU SRAM	128 kbytes
CPU Flash EEPROM	256 kbytes (application program)
DSP SRAM	32k by 16-bit words

## REGULATORY STANDARDS

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FCC	Meets FCC Part 15, Subpart J, Class B emissions for computing devices. Meets applicable FCC Part 90 requirements when operated with specified mobile radios.
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## FIXED-END EQUIPMENT REQUIREMENTS

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Motorola DataTAC infrastructure	Motorola Data System Station DSS II or equivalent Motorola Radio Network Controller RNC6000 or equivalent
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## DIAGNOSTICS

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Diagnostics	Power On Self-Test (POST) Manufacturing diagnostics to assist with component level repair (available only to Motorola service depots). All diagnostic routines may be accessed over the DTE serial interface port
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## DATA TERMINAL EQUIPMENT (DTE) INTERFACE PORT

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Signal levels	RS-232-C ( $\pm 12$ V) or CMOS (0-5 V)
Signals	DCD, RXD, TXD, DTR, DSR, RTS, CTS, RI, and GND (RI and DCD not included in CMOS connector)
Data rate	1200, 2400 (default), 4800, or 9600 bps programmable
Synchronization	Asynchronous
Flow control	No control, XON-XOFF (escape sequence), or RTS-CTS (default) programmable
Data format	8-bit, no parity, one-stop bit
Data Presentation	Transparent (Hayes <sup>®</sup> AT commands), Buffered Handshake or Native mode
Maximum message size	See radio data system characteristics
Message buffers	16-kbyte store and forward, bidirectional, with buffer full notification

## AUX INTERFACE (requires special application firmware)

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Signals	RXD, TXD, DTR, DSR, RTS, CTS, GND, -BAT and +BAT (13.8 $\pm$ 20% V DC pass-through)
Other specifications	See DTE Interface port above

## RADIO DATA SYSTEM CHARACTERISTICS

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Channel bandwidth	12.5 or 25 kHz
Air protocols	Motorola MDC or RD-LAP
Data rate	MDC: 4800 bps; RD-LAP: 9.6/19.2 kbps
Maximum message size (system dependent)	MDC-4800: 2 kbytes; RD-LAP: 2 kbytes Longer messages may be supported by application

## FCC COMPLIANCE

**NOTE:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## MODEL COMPLEMENTS

### F2054 VRM 500

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FHN5707	Housing Kit
FLN6781	Logic Board
FRN5755	Mounting Bracket
68P02943C70	Owner's and Installation Manual

**NOTE:**

Model F2054 does not include internal protocol software and cables. These *must* be ordered separately when ordering the model.

## OPTIONS

### *Protocol Options*

**NOTE:**

Order one per model. The protocol is an internal, factory-installed software.

**J560 Add MDC-4800 (NCP) Protocol**

**J819 Add RD-LAP 9.6 Protocol**

**J829 Add RD-LAP 19.2 Protocol**

**J942 Add MDC-4800 Protocol**

**J944 Add MMP Protocol**

### *Radio Cables*

**J372 Add VRM 500 to MaxTrac Radio Cable**

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FKN4173	VRM 500 to MaxTrac Radio Cable
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**J466 Add VRM 500 to Spectra Radio Cable (Data-Only)**

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FKN4392	VRM 500 to Spectra Radio Cable (Data-Only)
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**J467 Add VRM 500 to Spectra Radio Cable (Voice & Data)**

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FKN4365	VRM 500 to Spectra Radio Cable (Voice & Data)
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**DTE Cables****J272 Add VRM 500 to DTE Cable, 20 feet, DB9 F-M Connector & Bracket**


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 FKN4174 VRM 500 to DTE Cable, 20 feet, DB9 F-M Connector & Bracket
**J969 Add VRM 500 to DTE Cable, 10 feet, DB9 M-M Connector**


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 FKN4368 VRM 500 to DTE Cable, 10 feet, DB9 M-M Connector
**J967 Add VRM 500 to DTE Cable, 20 feet, DB9 M-M Connector**


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 FKN4376 VRM 500 to DTE Cable, 20 feet, DB9 M-M Connector
**J970 Add VRM 500 to DTE Cable, 10 feet, DB9 F-M Connector**


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 FKN4369 VRM 500 to DTE Cable, 10 feet, DB9 F-M Connector
**J968 Add VRM 500 to DTE Cable, 20 feet, DB9 F-M Connector**


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 FKN4367 VRM 500 to DTE Cable, 20 feet, DB9 F-M Connector
**ACCESSORIES****Bracket**

FRN5755 Mounting Bracket for VRM 500

**Radio Cables****NOTE:**

Order one cable per model.

 FKN4173 VRM 500 to MaxTrac Radio  
 FKN4392 VRM 500 to Spectra Radio, Data Only  
 FKN4365 VRM 500 to Spectra Radio, Voice & Data  
 FKN4416 VRM 500 to Spectra Radio, Voice & Data, with Modulation Resistor
**DTE Cables****NOTE:**

It is highly recommended to order one of the Motorola cables.

 FKN4174 VRM 500 to DTE, 20 feet, DB9 F-M Connector & Bracket  
 FKN4368 VRM 500 to DTE, 10 feet, DB9 M-M Connector  
 FKN4376 VRM 500 to DTE, 20 feet, DB9 M-M Connector  
 FKN4369 VRM 500 to DTE, 10 feet, DB9 F-M Connector  
 FKN4367 VRM 500 to DTE, 20 feet, DB9 F-M Connector

*Performance Specifications & Model Complements*

***Manuals***

68P02931C65 Service Manual (Motorola specialized depots only)  
68P02931C70 Programming Guide (for programmers and system managers)  
68P02937C40 Diagnostics Software User's Guide (engineering release for Motorola specialized depots only)

***Programming***

RVN4133 Radio Service Software (RSS)  
68P02938C95 RSS User's Guide

**1. OVERVIEW**

The VRM 500 (Vehicular Radio Modem) is designed to interface Data Terminal Equipment (DTE) with Motorola mobile radios for access to Motorola DataTAC mobile data networks.

The DTE can be either a laptop computer, a terminal supporting industry-standard Hayes® AT commands, or a peripheral requiring a specific application firmware.

The radio data network infrastructure is comprised of a host computer, base interface equipment and base stations (see Figure 1).

The Radio Network Controller (RNC) performs message routing between the DTE and the host computer. The RNC serves to translate host transmitted messages into

proprietary signaling format, and convert received messages in the signaling format to the appropriate host protocol.

The DSP technology enables the VRM 500 to support the following RF protocols: MDC-4800, MMP-30/31, RD-LAP 9.6/19.2 kbps.

The VRM 500 incorporates the following key features:

- Receive and store incoming messages ability even while disconnected from DTE.
- A rechargeable, internal lithium back-up battery to preserve the modem's random-access memory (RAM) for up to ten days when the main power is removed.
- Visible status indicators (LEDs).
- Capability to operate with both parallel and serial interface schemes.

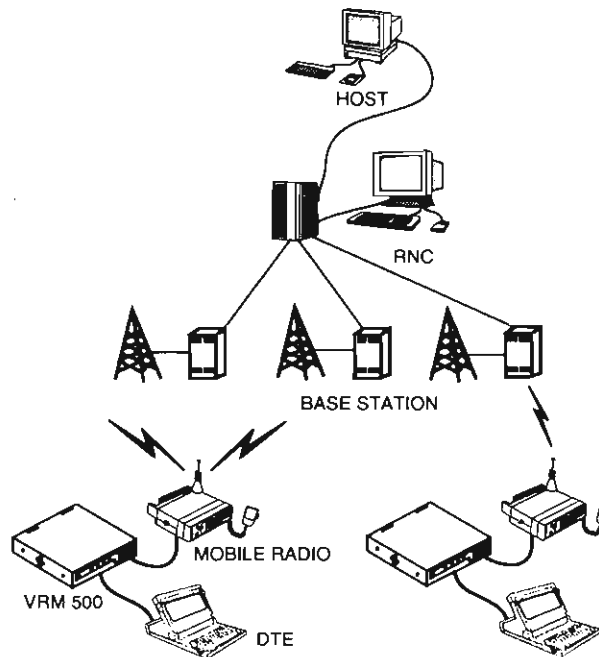


Figure 1. Typical Configuration

## 2. HARDWARE DESCRIPTION

### 2.1 FRONT-PANEL LEDs

The modem's front panel includes five LEDs (see Figure 2):

- Power LED (PWR)
- Status LED no.1, indicating the modem status on the data channel
- Status LED no.2, indicating the modem's operating mode
- Status LED no.3, indicating the status of the inbound messages
- Status LED no.4, indicating the status of the outbound message(s)

All LEDs blink to indicate a fault condition. The LED functions are described in Tables 1 to 5.

Table 1. Power LED (Red)

STATUS	FUNCTION
ON	The modem is powered on.
OFF	The modem is powered off.

Table 2. LED 1 (Amber)

STATUS	FUNCTION
ON	The modem is attached to the data channel.
BLINKING	The modem requests a data channel.
OFF	The modem is not on the data channel.

Table 3. LED 2 (Green)

STATUS	FUNCTION
ON	The modem is on-line.
OFF	The modem is off-line (in local command).

Table 4. LED 3 (Amber)

STATUS	FUNCTION
ON	The modem has one or more inbound messages to be transmitted to the host.
OFF	The modem has no inbound messages to be transmitted to the host.

Table 5. LED 4 (Green)

STATUS	FUNCTION
ON	The modem has one or more outbound messages queued for transmission to the DTE.
OFF	The modem has no outbound messages to be transmitted to the DTE.

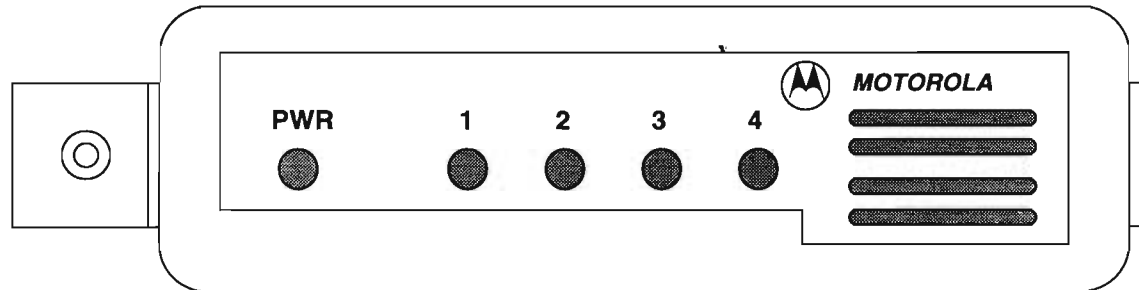


Figure 2. Front Panel LEDs

## 2.2 REAR PANEL CONNECTORS

The rear panel has all the connectors required for DTE and radio connection (see Figure 3).

### 2.2.1 DTE to VRM 500

The modem can interface any DTE via one serial port that has the following parameters:

- Baud rate set at 2400 bps (default)
- 8-bit data
- No parity
- One-stop bit

The baud rate can be modified to operate at 1200, 2400, 4800, or 9600 bps.

The modem provides two connectors for this type of interface: a 9-pin D-type female connector for RS-232 levels, and a 8-pin Hirose QM10-8R connector for CMOS levels.

#### NOTE

The user can connect only one connector at a time.

### 2.2.2 Auxiliary to Modem

This RS-232 port is used for connecting external devices such as a GPS (Global Positioning System) receiver, a bar code reader, etc.

All signals from this port are RS-232 levels. The port also provides a power line for accessing devices requiring a power supply.

### 2.2.3 Radio to Modem

The modem is capable of operating Motorola radios such as MaxTrac (parallel interface) and Spectra (serial interface).

For the Spectra radio, the modem uses the SB9600 interface hardware.

## 3. POWER SUPPLY

Power for the modem is supplied directly from the radio. The voltage level is 13.8 V $\pm$ 20%.

## 4. RECHARGEABLE LITHIUM BACKUP BATTERY

The battery can back up the RAM for 10 days in case of power failure and is fully charged in less than 50 hours.

## 5. USING THIS MANUAL

In addition to this section, this manual contains the following information:

- The *Lithium Battery Safety Precautions* section lists safety and replacement instructions for the lithium battery.
- The *Installation* section lists the recommended procedure for installing the VRM 500.
- The *Functional Description* section provides a technical description of the electronic circuits.
- The *Maintenance & Troubleshooting* section includes the information necessary to maintain the VRM 500's specified performances.

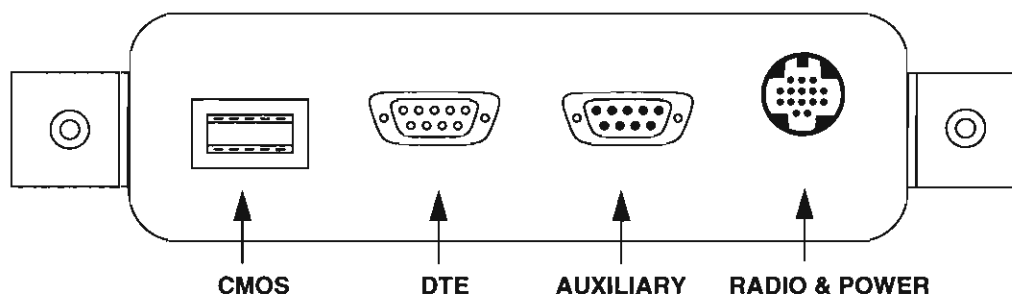


Figure 3. Rear Panel Connectors



# LITHIUM BATTERY SAFETY PRECAUTIONS

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## 1. GENERAL

This equipment contains a rechargeable lithium battery. This battery is safe under all environmental conditions for which they were designed. The reactive chemicals are sealed and pose no hazard unless the battery is mishandled.

Nevertheless, exercise the following precautions when handling a lithium battery:

- **DO NOT** expose the battery to water.
- **DO NOT** short a battery cell—excessive heat can cause burns.
- **DO NOT** disassemble the battery—it does not contain any replaceable parts.
- **DO NOT** connect the battery backward or to another power source.
- **DO NOT** crush or puncture the battery.
- **DO NOT** incinerate the battery or expose it to heat or fire.

## 2. DISPOSAL REQUIREMENTS

Federal and local regulations specify the space disposal of a lithium battery. Check and comply with all regulations before disposing of a battery.

## 3. EMERGENCY PROCEDURES

If a lithium battery ruptures, burns or explodes, follow these procedures:

- Treat any affected skin or body area as an acid burn.
- Flush skin area for 15 minutes.
- Contact a physician.
- Ventilate the working area; do not breathe the battery vapors.
- Use lithex to control fire and sodium bicarbonate powder to neutralize acid
- **DO NOT USE WATER OR WATER SOLUTIONS TO EXTINGUISH FIRE.**

Use appropriate equipment as needed for clean-up and disposal of materials:

- Acid-type gas mask
- Respirator
- Face shield
- Acid-resistant gloves
- Acid-resistant boots
- Acid-resistant apron



## 1. UNPACKING

Thoroughly inspect the equipment as soon as possible after delivery. If any part of the equipment has been damaged in transit, report the extent of damage to the transportation company immediately.

## 2. INSTALLATION

### 2.1 INSTALLATION PLANNING

Install the unit independently from the radio inside a single bracket.

The installation should not interfere with the operation of the vehicle or its accessories nor disturb passenger seating or leg space.

If the surface at the proposed mounting location is uneven, use washers as shims to obtain an even mounting plane.

Follow the installation procedure described in the following paragraphs.

### 2.2 VEHICLES EQUIPPED WITH AIR BAGS

When planning the installation of communication equipment in a vehicle with one or more air bags, proceed as follows:



#### **CAUTION**

**Vehicles equipped with air bags. An air bag inflates with great force. Do NOT place objects, including communication equipment, in the area over the air bag or in the air bag deployment area. If the communication equipment is improperly installed and the air bag inflates, this could cause serious injury.**

- Installation of vehicle equipment should be performed by a professional installer/technician qualified in the requirements for such installations. An air bag's size, shape and deployment area can vary by vehicle make, model and front compartment configuration (e.g., bench seat vs. bucket seats).
- Contact the vehicle manufacturer's corporate headquarters, if necessary, for specific air bag information for the vehicle make, model and front compartment configuration involved in your communication equipment installation.

### 2.3 RECOMMENDED TOOLS FOR INSTALLATION

The following tools are recommended for proper installation of the modem and bracket:

- Portable drill
- Hammer
- Center punch
- Drill Bit
- Phillips screwdriver

### 2.4 SINGLE-BRACKET INSTALLATION

Use the bracket as a template to determine the mounting screw location. Figure 1 shows a mechanical drawing of the single bracket. Figure 2 shows how the modem is installed onto the bracket.

### 2.5 ELECTRICAL CONNECTIONS

The VRM 500 has four external connectors (see Figure 3):

- CMOS – 8-pin connector J3 for connecting to a CMOS level DTE
- DTE – DB-9 female connector J4 for connecting to a RS-232 level DTE
- AUXILIARY – DB-9 male connector J5 for connecting to RS-232 level DTE, sensors or GPS
- RADIO – 13-pin circle connector for serial/parallel radio interface and power connection

For cable connections see Figures 4 to 6 in this section.

*Step 1.* Connect the radio cable between the RADIO & POWER connector located on the VRM 500's rear panel and the appropriate connector of the radio.

*Step 2.* Connect data cable (or cables) to the CMOS or DTE connector and/or the AUXILIARY connector, depending on the application used.

See the Functional Description section for detailed connector pinouts.

### **3. POWERING THE VRM 500 ON**

When the radio is turned on, the VRM 500 turns on and automatically carries a self-test to ensure that it operates properly. If the self-test is completed successfully, the POWER LED remains lit and all other LEDs are off. If the self-test fails, all the LEDs blink simultaneously.

### **4. POWERING THE VRM 500 OFF**

The VRM 500 turns off when the radio is turned off.



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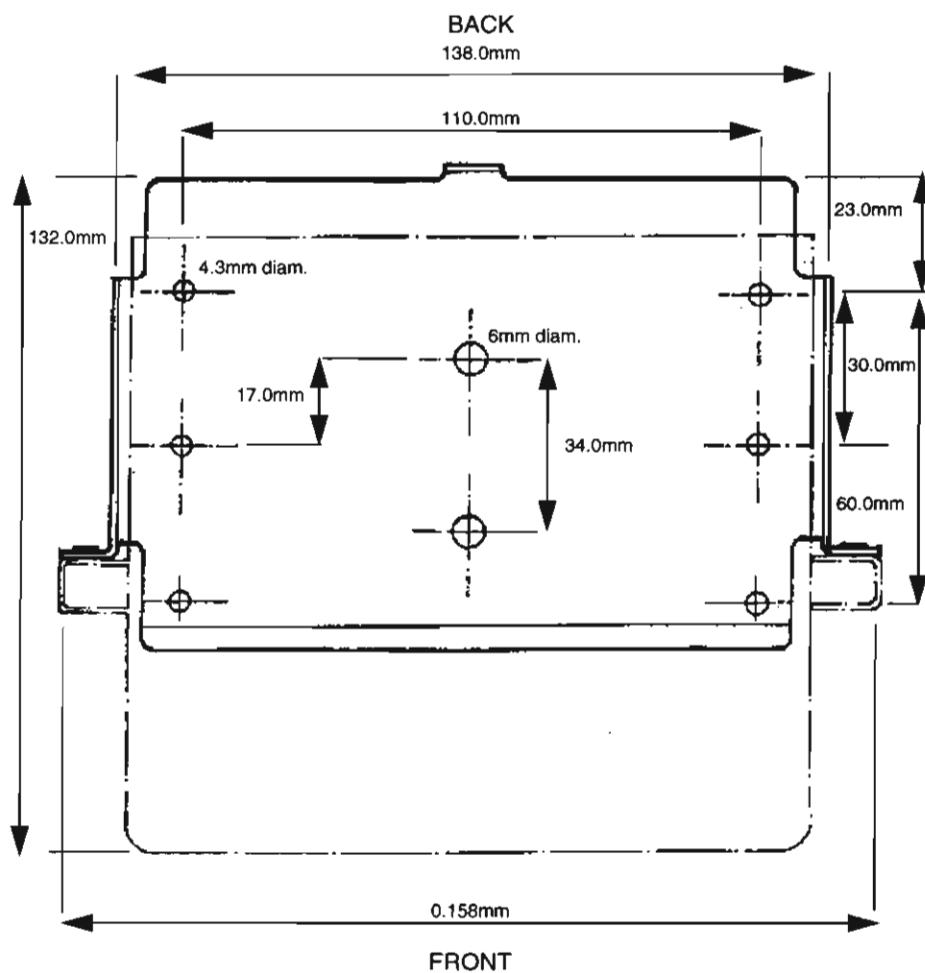


Figure 1. Mounting Bracket Mechanical Drawing

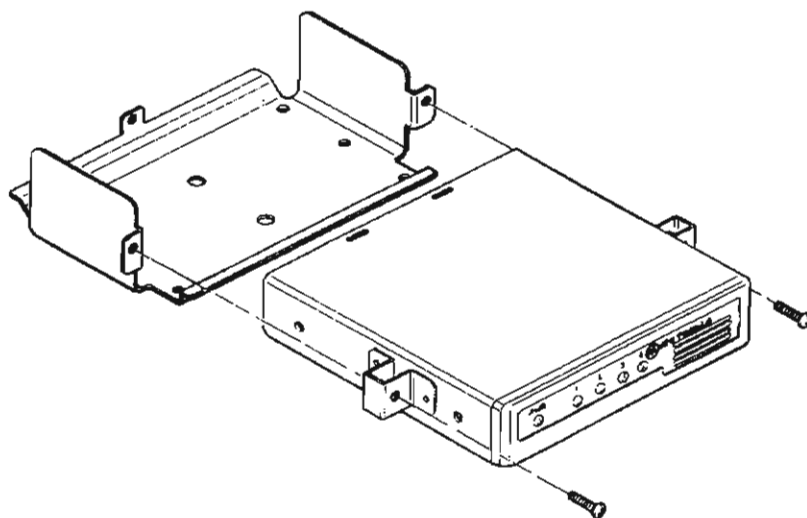
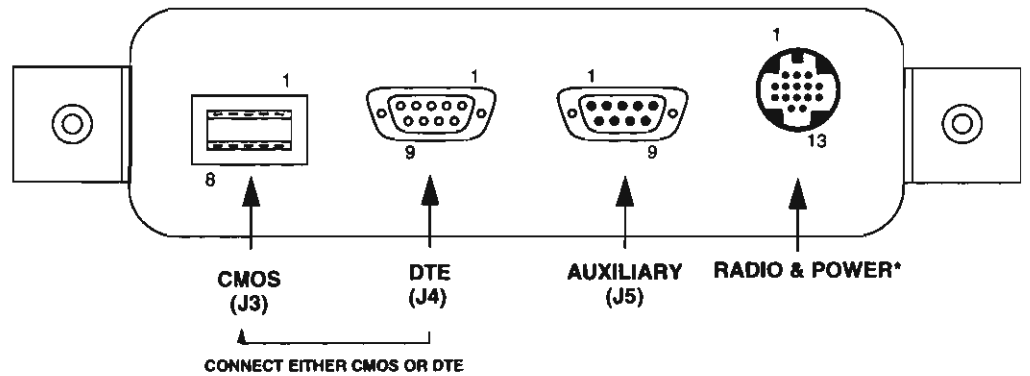


Figure 2. Installing the VRM 500 Inside its Bracket



CMOS CONNECTOR

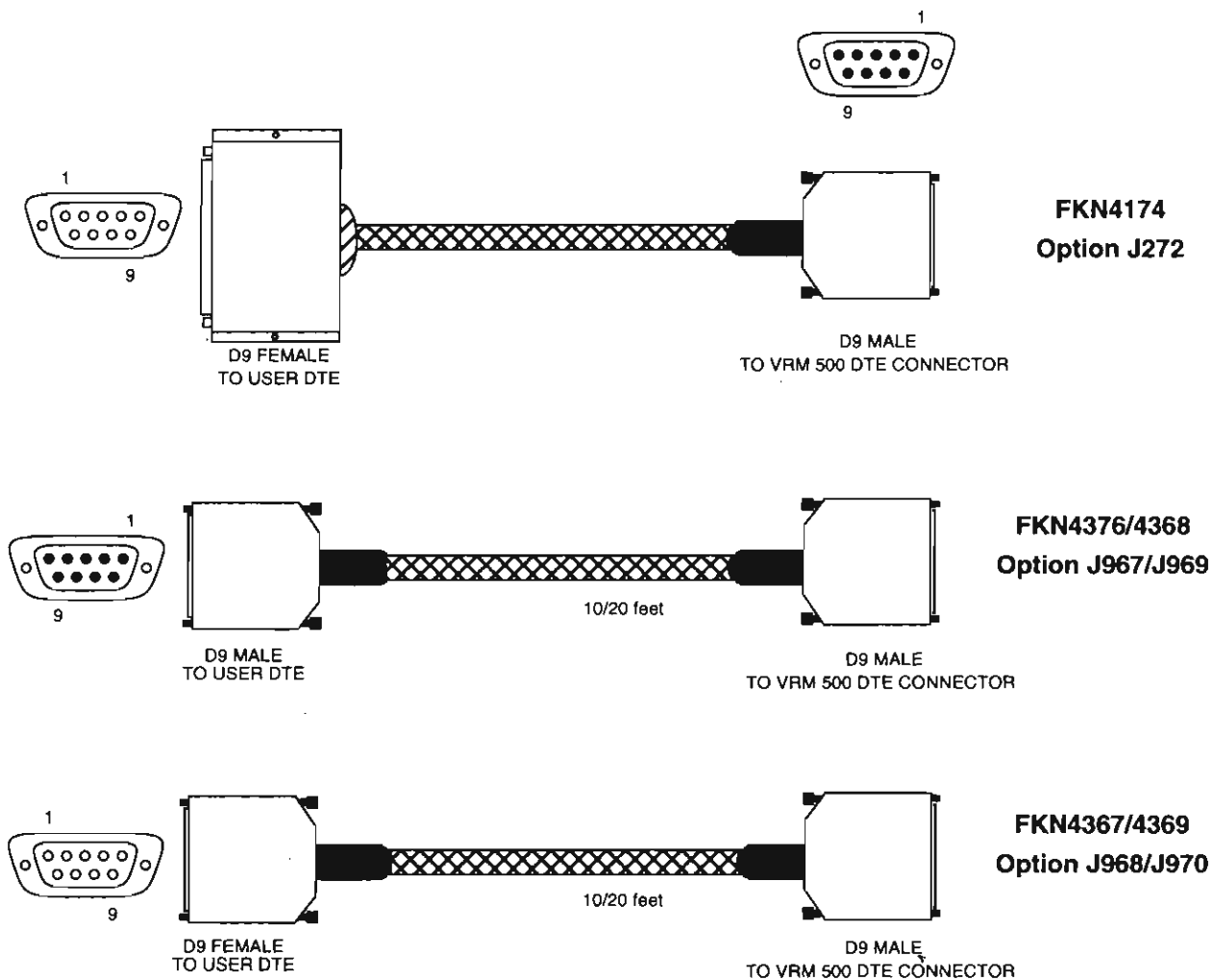
Pin	Signal
1	DTE RTS C
2	DTE CTS C
3	CMOS GROUND
4	DTE DTR C
5	DTE RXD C
6	DTE TXD C
7	DTE DSR C
8	CMOS GROUND

AUXILIARY CONNECTOR

Pin	Signal
1	N VBAT
2	AUX RXD
3	AUX TXD
4	AUX DTR
5	AUX GND
6	AUX DSR
7	AUX RTS
8	AUX CTS
9	P VBAT

\* For DTE connector description see Figure 4. For RADIO & POWER connector description, see Figures 5 and 6.

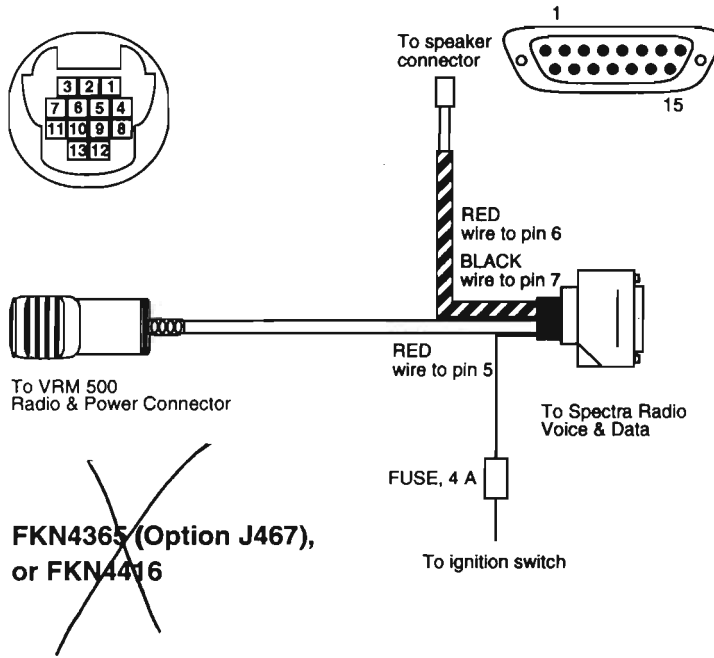
Figure 3. Cable Connections



Pin	Signal	Wire Color
1	DTE DCD	BLACK/RED
2	DTE RXD	RED
3	DTE TXD	GREEN
4	DTE DTR	BLACK
5	DTE GND	SHIELD
6	DTE DSR	BLUE
7	DTE RTS	BLACK/WHITE
8	DTE CTS	WHITE
9	DTE RI	ORANGE

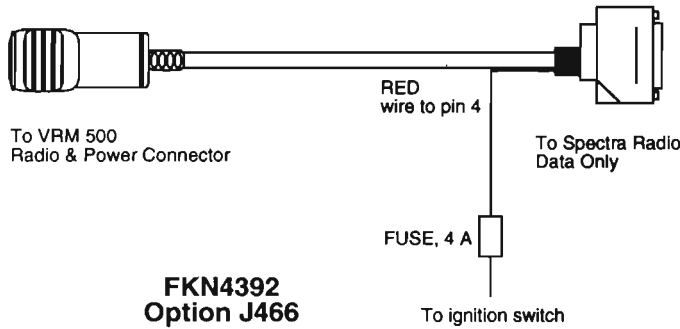
PIN TO PIN CONNECTION ON BOTH SIDES.  
PIN 5 CONNECTED TO SHIELD ON BOTH SIDES.

Figure 4. VRM 500 to DTE Cables



PIN CONNECTION		
VRM 500 Connector Pin No.	Spectra Connector Pin No.	Wire Color
1	15	BLACK
2	9	BROWN
3	14	RED
4	10	ORANGE
6	13	YELLOW
7	11	GREEN
8*	1*	BLUE
9	3	VIOLET
	2	BLACK, short
12	4	WHITE
	18# RED wire to pin No.5	
13	8	SHIELD + BLACK, Short

\*For FKN4416 there is a 5.6K resistor between VRM 500 pin 8 and Spectra pin 1. The resistor Motorola catalog number is 0611009C67.



PIN CONNECTION		
VRM 500 Connector Pin No.	Spectra Connector Pin No.	Wire Color
1	15	BLACK
2	9	BROWN
3	14	RED
4	10	ORANGE
6	13	YELLOW
7	11	GREEN
8	1	BLUE
9	3	VIOLET
	2	Short BLACK
12	4	WHITE + RED
13	8	SHIELD + BLACK, short

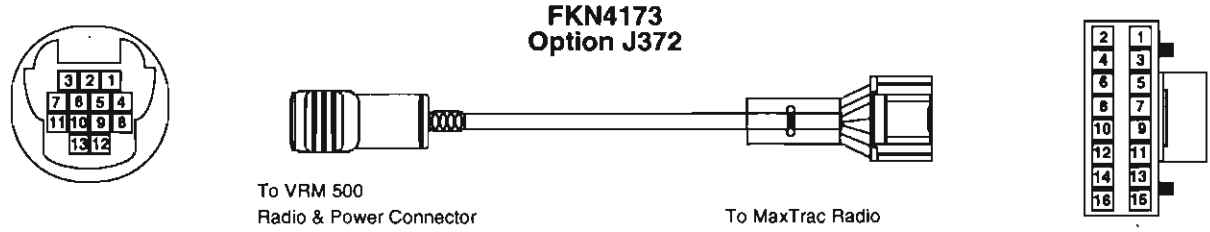
VRM 500 RADIO & POWER CONNECTOR

Pin	Signal
1	RESET
2	BUSY
3	BUS+
4	BUS-
5	DMR
6	DPTT
7	DISC
8	MOD
9	RSSI
10	DMW
11	DMG
12	POWER
13	P GND

DATA MODE REQUEST  
DATA PTT  
DISCRIMINATOR  
MODULATOR

DATA MESSAGE WAIT  
DATA MODE GRANT

Figure 5. VRM 500 to Spectra Radio Cables



VRM 500 RADIO & POWER CONNECTOR

Pin	Signal
1	RESET
2	BUSY
3	BUS+
4	BUS-
5	DMR
6	DPTT
7	DISC
8	MOD
9	RSSI
10	DMW
11	DMG
12	POWER
13	P GND

PIN CONNECTION

VRM 500 Connector Pin No.	MaxTrac Connector Pin No.	Wire Color
5	12	RED
6	6	BLACK
7	11	BLUE
8	5	BLACK
9	8	GREEN
11	14	BLACK
12	13	WHITE
13	7	SHIELD

Figure 6. VRM 500 to MaxTrac Radio Cable

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## 1. GENERAL

The VRM 500 board uses the following components:

- 68HC11A1 microcontroller running at 9.8304 MHz. This gives a bus clock of about 2.45 MHz. The CPU interprets commands and controls the data link protocol.
- MDD5001 ASIC, integrated system peripheral, providing memory management, bus multiplexing, reset control, and additional parallel I/O for the 68HC11.
- DSP56156 (Digital Signal Processor), responsible for controlling data transfer to and from the communication channels under the 68HC11 control.
- 68HC11 and DSP external memories (128 kB and 32 kB RAM).
- 256 kB Flash EEPROM.
- Rechargeable lithium battery, capable of backing up the 128 kB RAM for at least three days.
- Two UARTs (Universal Asynchronous Receiver Transmitter).
- Serial ADC (Analog to Digital Converter).
- Communication and power LEDs.

The board operates using a nominal  $13.8 \pm 20\%$  V DC from the radio and regulates it to 5.0 V DC logic supply ( $V_{CC}$ ).

The board is constructed on a six-layer printed circuit board (PCB).

## 2. FUNCTIONAL DESCRIPTION

See Figure 1 for the functional block diagram and Figure 2 for the board's component location.

### 2.1 BOARD INTERFACE

The board includes the following interfaces:

- DTE – terminated by a DB9 female connector
- Auxiliary communication – terminated by a DB-9 male connector
- DTE CMOS level – terminated by an 8-pin connector
- Serial/parallel radio – terminated by a 13-pin connector.

Power is supplied via the radio connector. Depending on the DTE installed, the interface conforms either to RS-232 or to TTL levels.

See paragraphs 2.1.1 to 2.1.4 for a description of the connector pin functions.

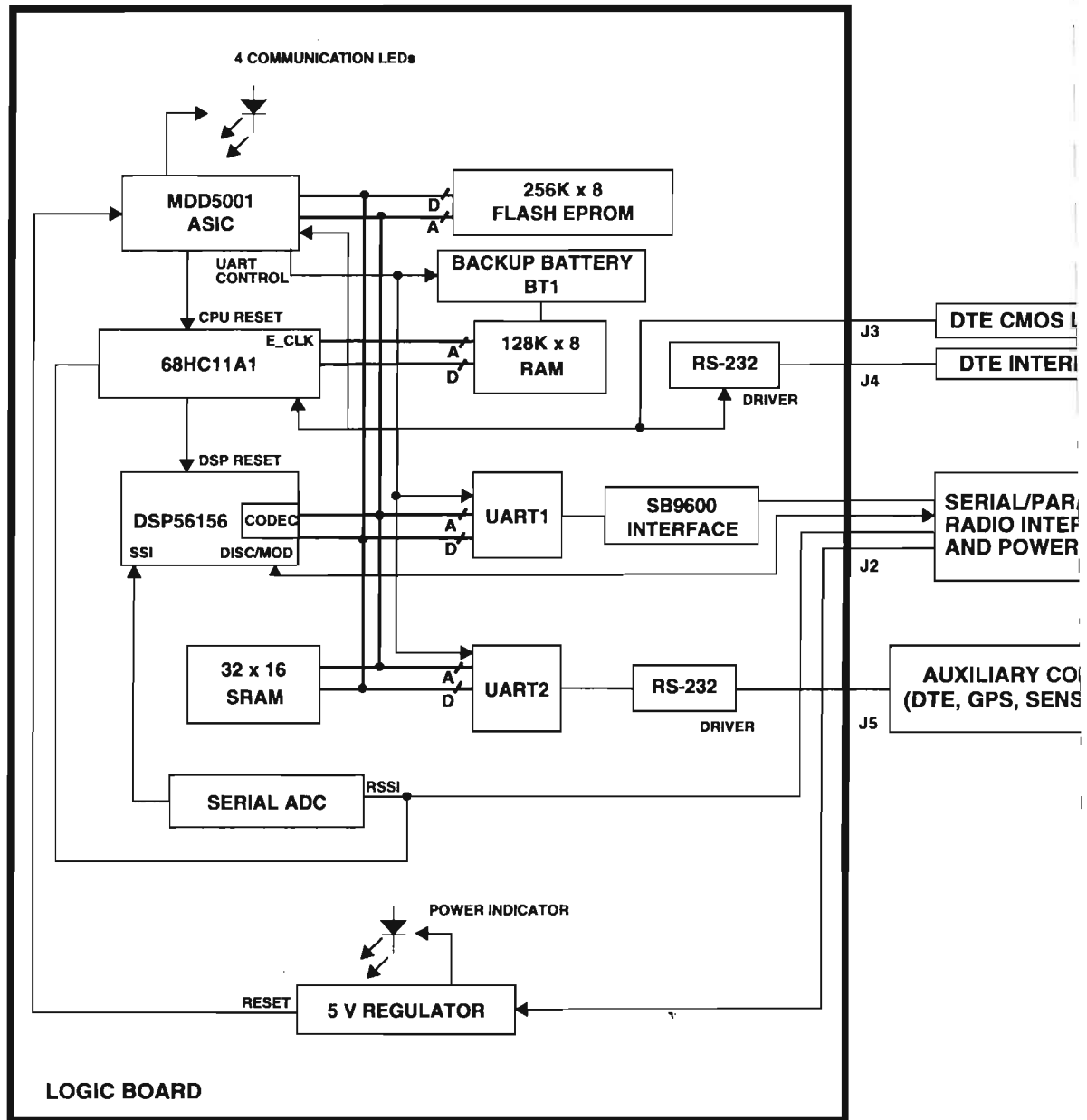


Figure 1. Functional Block Diagram

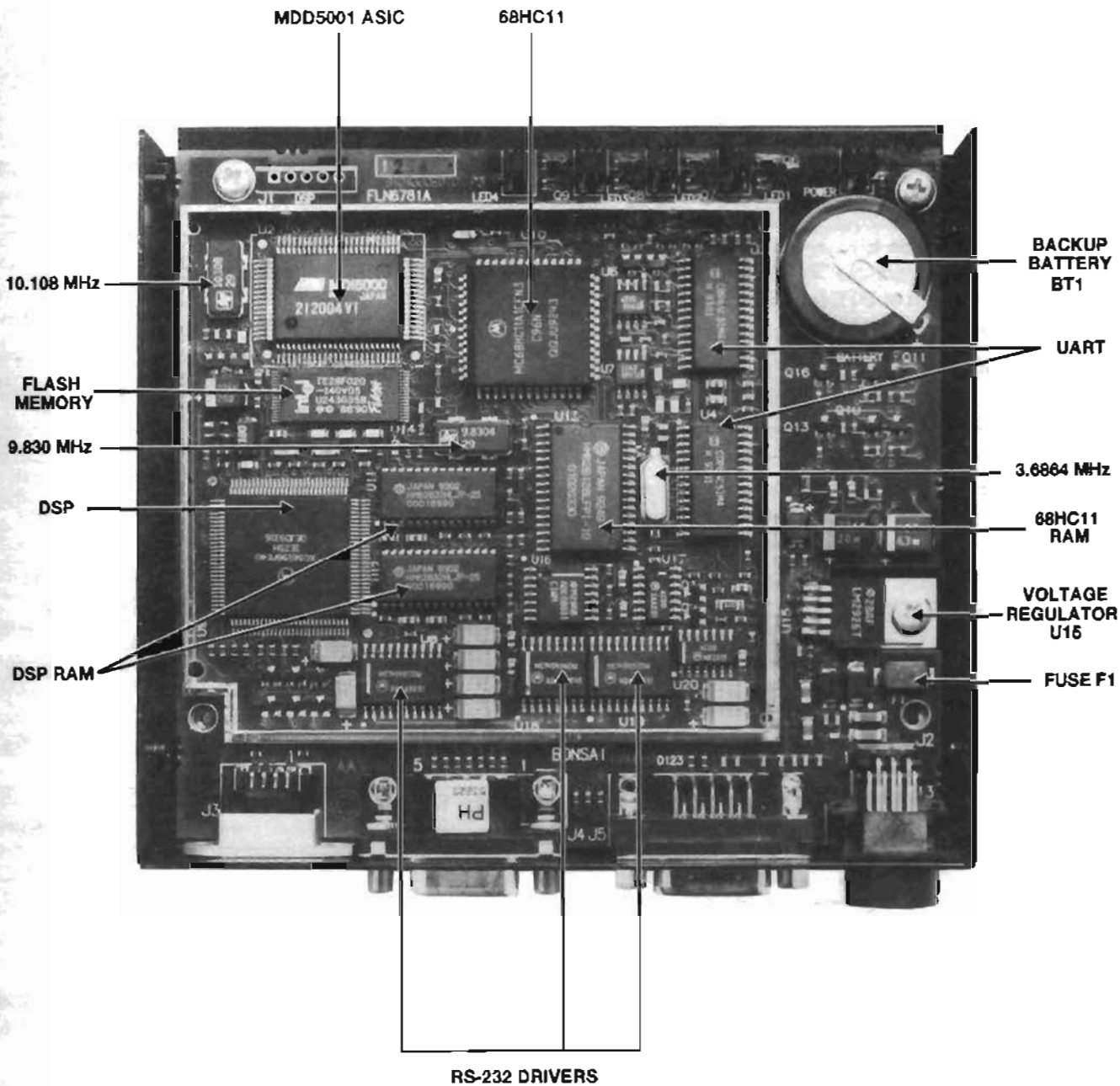


Figure 2. Component Location



Table 1. DTE Connector J4

Pin	Signal	Type	Function
1	DTE DCD	Output	Data Carrier Detect
2	DTE RXD	Output	Transmit Data
3	DTE TXD	Input	Receive Data
4	DTE DTR	Input	Data Terminal Ready
5	DTE GND	Ground	Signal Ground
6	DTE DSR	Output	Data Set Ready
7	DTE RTS	Input	Request-To-Send
8	DTE CTS	Output	Clear-To-Send
9	DTE RI	Output	Ring Indicator

Table 2. Direction of DTE Interface Signal Lines

Pin	Signal From DTE	Data		Control	
		From modem	To modem	From modem	To modem
1	DCD			X	
2	RXD	X			
3	TXD		X		
4	DTR				X
5	GND				
6	DSR			X	
7	RTS				X
8	CTS			X	
9	RI			X	

### 2.1.2 RS-232 Auxiliary Signals and Connections

Table 3. RS-232 Auxiliary Connector J5

Pin	Signal	Type	Function
1	N VBAT	Ground	Negative (battery)
2	AUX RXD	Output	Transmit Data
3	AUX TXD	Input	Receive Data
4	AUX DTR	Input	Data Terminal Ready
5	AUX GND	Ground	Signal Ground
6	AUX DSR	Output	Data Set Ready
7	AUX RTS	Input	Request-To-Send
8	AUX CTS	Output	Clear-To-Send
9	P VBAT	9-16 V	Positive (battery)

Table 4. DTE CMOS Level Connector J3

Pin	Signal	Type	Function
1	DTE RTS C	Input	Request-To-Send
2	DTE CTS C	Output	Clear-To-Send
3	CMOS GROUND	Ground	Signal Ground
4	DTE DTR C	Input	Data Terminal Ready
5	DTE RXD C	Output	Transmit Data
6	DTE TXD C	Input	Receive Data
7	DTE DSR C	Output	Data Set Ready
8	CMOS GROUND	Ground	Signal Ground

### 2.1.4 Radio and Power Connections

Table 5. Radio and Power Connector J2

Pin	Signal	Type	Function
1	RESET	Input/output	SB9600 reset
2	BUSY	Input/output	SB9600 busy
3	BUS+	Input/output	SB9600 data sig
4	BUS-	Input/output	SB9600 data sig
5	DMR	Output	Data Mode Requ
6	DPTT	Output	Data Push-To-T
7	DISC	Input	Discriminator
8	MOD	Output	Modulator
9	RSSI	Input	Receive Signal Str Indicator
10	DMW	Input	Data Message V
11	DMG	Input	Data Mode Gr
12	POWER	Power	External Powe (13.8±20% V)
13	P GND	Power Ground	External Grou

## 2.2 RS-232 INTERFACE

The RS-232 signals incoming from the DTE and a interface are associated with transmission and co into CMOS levels.

Conversion in both directions takes place in U8, U U19. U8 and U19 are single-supply (5 V) RS-232. U8 drives U18 and gives it the RS-232 voltage leve

### 2.3 DSP56156

The DSP section of the logic board is made up of the DSP56156-40 16-bit digital signal processor, discrete address decoding logic, and two 32 kB SRAMs. The DSP performs modulation/demodulation functions and associated filtering.

The synchronous serial interfaces (SSI) provide a full-duplex serial port for serial communication. Each SSI is made up of an independent transmitter and receiver sections and a common SSI clock generator. These interfaces are synchronous because all serial transfers are synchronized to a clock. In the VRM 500 SSI port No. 0 is used to interface to the radio; SSI port No. 1 is used for interface with the serial RSSI analog-to-digital converter.

The CODEC is a sigma-delta analog interface converter. It contains one A/D converter and one D/A converter. It also contains a reference voltage, bias current generator and master clock circuit.

Software inside the DSP uses the CODEC to develop a base-band data modulation signal for the radio.

Outputs from the CODEC (SPKP and SPKM) are differential signals. (Differential signals are the same, but are 180° out of phase.) These voltages are not referenced to ground, but are referenced to each other.

The CODEC output contains quantization noise due to the finite number of voltage levels that the switched cap low-pass filter is capable of outputting. This filter is internal to the CODEC.

For smoothing out this noise, a filter formed by a combination of resistors and capacitors provides a 3 dB corner frequency of about 80 kHz while maintaining a low-impedance output signal to the radio.

The radio's DISC (discriminator) output is connected to the MIC input of the DSP internal CODEC.

### 2.4 DATA TRANSMIT PATH

During transmission, the user data is used to generate an optimum modulating waveform for the radio. The DSP generates this waveform.

The microprocessor and MDD5001 control other radio control signals for data transmission.

### 2.5 DATA RECEIVE PATH

The receive signal is applied from the radio discriminator to the DSP for data decoding.

The RSSI signal from the radio is sampled at two separate locations on the board. The 68HC11A1 can sample RSSI using its internal ADC. RSSI is also made available to the DSP through a serial ADC communicating with the DSP.

The microprocessor and MDD5001 control other control signals for data receiving indication.

### 2.6 POWER SUB-SYSTEM

The modem includes a group of regulators that receives the DC input voltage and provides a regulated voltage for the internal circuits.

A fuse protects the input line by disconnecting it when the modem draws excessive current. A diode protects the modem against reverse polarity of the input voltage.

### 2.7 LITHIUM BACKUP

This is a rechargeable lithium battery for RAM backup. When the VRM 500 is powered off, power for memory backup is supplied from the 3 V DC lithium battery.

## 1. GENERAL

This section contains the following information:

- General maintenance information
- Quick troubleshooting procedures
- Disassembly and reassembly procedure including safety information

## 2. CHECKING AND CLEANING THE VRM 500

The surfaces should be cleaned only when the VRM 500 has been disassembled for repair and a visual inspection reveals the presence of smudges, grease, or grime. Refer to paragraph 6 for disassembly procedure.

Always use a fresh supply of isopropyl alcohol and a clean container to prevent contamination by dissolved material from previous usage.

Isopropyl alcohol may be applied with a stiff, non-metallic, short-bristled brush to dislodge embedded or caked material located in hard-to-reach areas. The brush stroke should direct the dislodged material out and away from the VRM 500.

Alcohol is a high-wetting liquid and can carry contamination into unwanted places if an excessive quantity is used. Make sure that components are not soaked with the liquid. Do not use high-pressure air to hasten the drying process. This could cause the liquid to collect in unwanted places. Use a soft, absorbent, lintless cloth to dry the area.

## 3. TROUBLESHOOTING

### 3.1 GENERAL

Abnormal VRM 500 operation may be due to any of the following:

- VRM 500 problem
- DTE problem
- Radio fault
- Cables and connection faults
- Improper configuration

### 3.2 TEST AND SERVICE EQUIPMENT

The following test equipment and service aids (or equivalents) are required to maintain the VRM 500.

Table 1. Recommended Test and Service Equipment

MODEL No.	TEST EQUIPMENT
Hewlett Packard 8903A/B or equivalent	Audio Analyzer
Hewlett Packard 6632A or Lambda LK340AFM or equivalent	Dual DC power supply. 0 to 20 V DC, 0 to 2 A
R1072A or Fluke 87 or equivalent	Digital Multimeter
Personal Computer	IBM PC/AT or compatible
Fluke 87 or equivalent	Current measuring tester (1 A maximum)
RVN4133	Radio Service Software
Unspecified, specialized depot only	Diagnostics Software

### 3.3 TESTING THE VRM 500

Test the VRM 500 in the following sequence.



**CAUTION**

**Make sure to save the customer configuration and/or the customer software when you download new software or configurations.**

- Use the RSS to read and store the current configuration and customer software.
- Load the standard configuration.
- Test the configuration.
- If the VRM 500 is still not functioning properly, contact the local Motorola Regional Support Center in your area. In North America dial (708) 576-5760 for the Motorola National Subscriber Depot (NSD). The depot address is 1318 North Plum Grove Road, Schaumburg IL 60173, U.S.A.

#### 4. REPLACING THE LITHIUM BATTERY



**WARNING**

**An authorized Motorola Service Center should perform the replacement of the lithium battery. The lithium battery is very sensitive to heat. Attempting to replace it without proper precautions may cause the battery to explode.**

#### 5. DISASSEMBLY/REASSEMBLY

##### 5.1 HANDLING CMOS PARTS

The VRM 500 contains CMOS parts and is, therefore, susceptible to damage from electro static discharge. Take the following precautions when handling the VRM 500 parts.

- Minimize handling of static-sensitive components and modules.
- Transport and store static-sensitive components or assemblies in their original containers on a metal rail. Label any package that contains static-sensitive components or assemblies.
- Discharge static electricity from the body by wearing a grounded antistatic wrist strap while handling these components. Servicing

static-sensitive components or assemblies should only be done at a static-free work station by qualified service technicians. Increasing the humidity in the work area minimizes static electricity problems.

- Do not allow anything that can generate or hold a static charge on the workstation surface.
- Keep the component leads shorted together whenever possible.
- Pick up components by their bodies. Never pick them up by their leads.
- Do not slide the components over any surface.
- Avoid handling components in areas with a floor or work surface covering that can generate a static charge.
- Use a soldering iron connected to earth ground.
- Use only approved, anti-static, vacuum-type desoldering tools for removing components.
- When removing printed circuit boards (PCBs), remove the screws in a diagonal pattern to reduce stress on the boards.

##### 5.2 DISASSEMBLY/REASSEMBLY

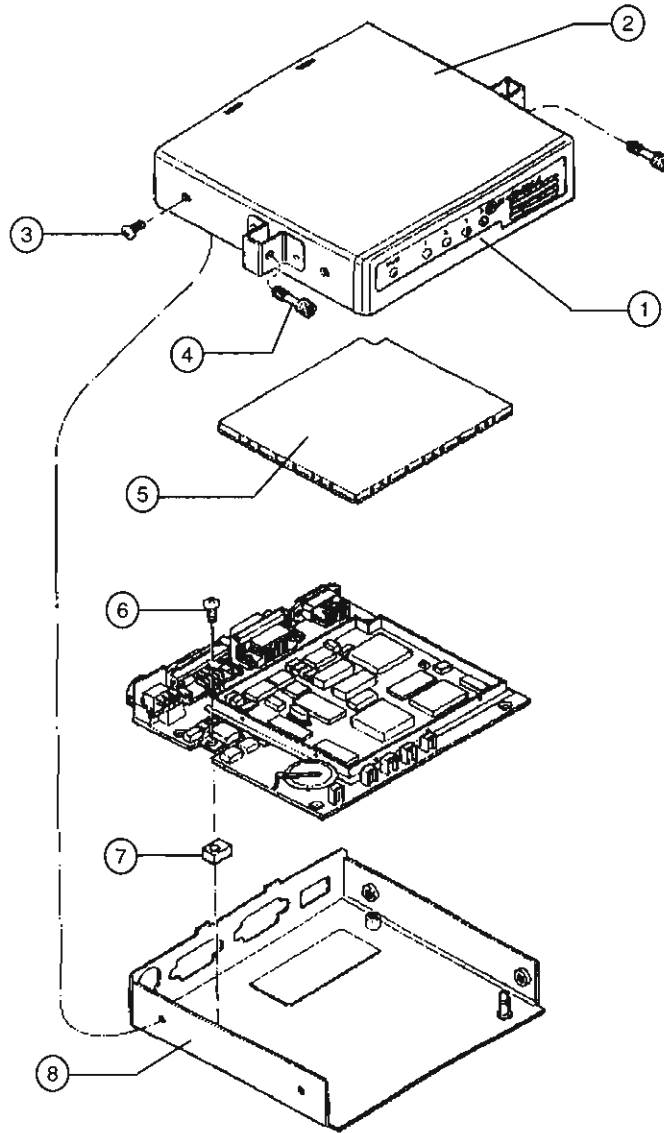
This paragraph describes how to disassemble and assemble the VRM 500 when replacing the parts. Follow these procedures to prevent any damage that could result if the unit or its parts are not properly handled.

- Step 1.* Disconnect all cables from the VRM 500.
- Step 2.* Unscrew the four Phillips screws holding the top and bottom covers together. Lift the top cover and front panel.
- Step 3.* Insert a flat-blade screwdriver under the shield. Remove the shield by separating at the corners. Be careful not to overbend the corners, or damage the components and the board.
- Step 4.* Remove the screw securing the voltage regulator.
- Step 5.* Insert a flat-blade screwdriver under the board and push upwards. The board is now released.

**NOTE**

Leave the thermal cube in its place on the chassis.

To reassemble the unit, perform the above steps in reverse order. Use a torque screwdriver to tighten the Phillips screws to 4 inch-pound.



ITEM	CATALOG NO.	DESCRIPTION	QTY PER UNIT
1	6404611E01	Window	1
2	1504887E01	Cover	1
3	0302443C23	Screw, machine 4-40x1/4"	4
4	0302035P01	Screw, M4x16"	2
5	1504814E01	RF Shield cover	1
6	0300129997	Screw, lock 4-40x5/16"	1
7	4308231S02	Thermal cube	1
8	2704609E01	Chassis	1

Figure 1. Exploded View & Mechanical Parts List