MARCUS™
Installation Guide

MARCUS™ Radio Module

Version 2.4

NOTICE

TRADEMARKS

Discrete Wireless
950 E. Paces Ferry Road, Suite 1435
Atlanta, Georgia 30326
Customer Support: (404) 365-2080
Fax: (404) 365-9293
E-mail: customersupport@discretewireless.net

Contents

This manual covers the following:

List of Figures

1.1 Introduction

This Operator's Manual is designed to provide instructions in the operation of Discrete Wireless, Inc. family of Advanced Generation wireless in-vehicle hardware MARCUS™ Radio Module and software (MARCUS™ application) and Internet based Hosting Services (DISCRETE Gateway™). This manual provides a detailed description of the MARCUS™ Radio Module with optional GPS board. This manual does not discuss the DISCRETE Gateway™ .

Wireless Network: The MARCUS™ Radio Module is optimized to be utilized on the Cingular Interactive Intelligent Wireless Data Network in the U.S. and other 900mhz Mobitex based Packet Data Networks.

In addition, this manual describes how to install and operate MARCUS™ Radio Module.

1.2 Overview

The purpose of the MARCUS™ application is to track vehicles using a standard Internet connection. The overall system consists of one or more mobile devices and the DISCRETE Gateway™. A tracking device can easily be attached to a vehicle. The MARCUS™ Radio Module receives commands from the DISCRETE Gateway™ to monitor vehicle location using a Global Positioning System (GPS) receiver. The MARCUS™ Radio Module can also monitor operational status and can collect data from an externally connected RS-232 device. All of this information is transferred to the DISCRETE Gateway™ through a wireless communication link. The DISCRETE Gateway™ is capable of controlling and monitoring multiple mobile devices. The position data received from the mobile devices is transferred to the DISCRETE Gateway™ where it is displayed on a Geographical Information System (GIS) utilizing mapping technology within the Internet-based on the MARCUS™ application.

1.3 MARCUS™ Radio Module *Hardware*

The mobile devices are small, can be easily and quickly attached to a vehicle, and will receive commands, provide GPS position data and status information to the DISCRETE Gateway™ via a wireless network

The GPS and wireless communication modules require antennas. In addition, the device is powered by an externally supplied power supply; vehicle power (10-15 volts). The devices are capable of surviving and functioning while exposed to environmental conditions (heat, humidity, dirt, rocks), minor power interruptions, vibration, and shock that are common during vehicular travel.

The mobile devices consist of a sealed ABS plastic housing containing the electronic components. This includes the radio modem, the GPS receiver, along with power modules and support components. Also included, are the separate power connection cable and GPS antenna with cables. A listing of all these components their size and specification is given in Appendix B. The box enclosure exterior measurements and weight for each MARCUS™ Radio Module is given below:

MARCUS™ Radio Module – 4" x 3" x 1.385," weight 8 ounces, is shown below.

The MARCUS™ Radio Module has an operating temperature range of -30 degrees to +60 degrees centigrade, and operates in an extended temperature range of –30 degrees to +75 degrees centigrade for a short period of time.

Internal mounting brackets are provided which secure the electronics inside the enclosure. The box is black, and no part of the box will be less than one-eighth of an inch (1/8) thick. Mounting channels have been designed along the perimeter of the box that allows for an easy attachment to the vehicle.

The MARCUS™ family of devices uses a common suite of connectors among the devices. The connector configuration is composed of dissimilar connectors to eliminate the chance of an operator incorrectly wiring the unit. Four connectors make up the connector configuration.

2. Equipment and Tools

The following is a general list of tools and supplies required for installation of the MARCUS Radio Module.

2.1 Recommended Equipment

Voltmeter
12 Volt circuit tester
Screwdrivers (standard, Phillips, torx, Hex)
Wire Strippers / Wire cutters
Coax stripper
Pliers
Razor knife
Portable Drill
Drill bits
¾ Hole Saw
Wire snake
Crimping tool
Upholster removal tool
Flash light
Socket set
9 Pin DB-9 Serial communication cable

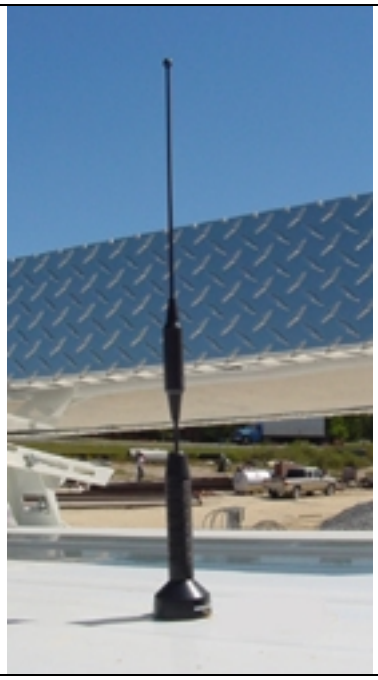
2.2 Recommended Supplies

Electrical tape
Double sided tape
Velcro
Silicon sealant
5 amp fuses
fuse taps
ground terminals
Tie-Wraps
Grommets
Crimp connectors
Butt end connectors
Screws
18-gauge wire

3. Antennas

3.1 General Antenna Guidelines

The general guidelines for proper antenna placement are the following:



3.2 GPS Antenna

As a general rule, the placement of the GPS antenna must have a clear view of a large portion of the sky in order to be able to receive GPS satellite data. It is recommended that the GPS antenna have a clear view of at least 40 % of the sky. Reception is shielded by metal, but the antenna can be under such non-metallic materials such as plastic, fiberboard, glass, etc.

The GPS antenna should be a + 3.3V active gain (+24dBm gain) antenna

3.3 RF Antenna

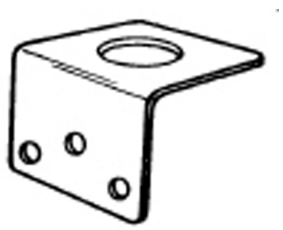
As a general rule, the placement of the Radio Frequency (RF) antenna is as high as possible. Windscreens, ladder racks, or other radio transmission antennas should not obstruct the antenna placement. The antenna should be mounted in a vertical position at all times. If there are other radio antennas on the vehicle, position the MARCUS RF transmission antenna at least 18 inches away. You should always refer to the antenna manufacturer's guidelines that will be included with the antenna packaging.

The RF antenna should be for the frequency range of 890 to 960 Mhz.

The following antennas must be used with the MARCUS Radio Module

3.4 Antenna and Hardware Types

MAXRAD MMB34 3/4 hole Mirror Mount Bracket Tessco Order Number 40425 Used to mount mobile antennas to side view mirrors on vehicles 3/4" hole mirror mount bracket. Chrome.	

MAXRAD TGB34 3/4 hole L bracket for trunk mounting Tessco Order number 79784 Bracket that can be mounted on the unexposed part of trunk lip. Trunk groove L bracket, mounting bracket only, 3/4" hole. Chrome.	

RF Industries RSA-3000-C SMA male connector for RG58 cable Tessco Order Number 37467 SMA connectors are good up to 18 GHz.	

MAXRAD
M-NC
3/4 Permanent hole mount w 17' cable no connector.
Tessco Order number 80834
Requires a SMA connector

MAXRAD permanent body mount for 3/4" hole. Includes 17 foot RG-58A/U cable. Order desired connector separately.
Motorola-style mounts install in a 3/4" hole. Feature a 1-1/8"-18 thread and nickel-plated brass nut.

MAXRAD
BMAX9155S
890-945 MHz spring base whip antenna 4 dB gain
Tessco Order Number 21495

Product Narrative: A complement to the popular line of BMAX base antennas for the 900 MHz band. Specially designed for SMR and Cellular systems in rural areas, this antenna provides high gain with a special single phasing coil design.

Gain (db): 4

Maximum Power (Watts): 150

Whip Length (inches): 13″

Mount Type: Hole or Mag mount

MAXRAD
WMLPV800
Vertical Low Profile 2 dB gain antenna 800-960 MHz
Tessco Order number 10096

Product Narrative: The MLPV800 series has superior pattern coverage for mobile and fixed applications using frequencies from 806 to 960. The design provides broadband performance with minimum loss and no tuning. Efficient radiator design with rugged solid brass construction. Ground plane is required.

Gain (db): 1

Maximum Power (Watts): 150

Whip Length (inches): 2.5″

Whip Material (color): White or Black

Mount Type: Hole or Mag mount

Antenna Specialists
APG874.3
"On-Glass" Antenna 3 dB with 15' cable
890-960 MHz
Tessco Order number 48531
Requires a SMA connector
Frequency (MHz)/ 890-960

Product Narrative On Glass IV low power antenna with enclosed coil whip. Features a small mounting foot for maximum efficiency especially between defroster wires, solid state coupling box and a mini UHF connector on the coupler

Gain (dB) 3

Maximum Power (Watts) 10

Whip Length (In.) 14", replacement whip

Mount Type On-Glass

Cable 15' RG58/U

Covert Antenna
MobileMark antenna

Covert Antenna

- Compact antenna measures only 1 5/8"W x 2 3/8"L x 5/8"H.
- GPS portion features 5 dBic gain with 27 dB active amplifier; the Cellular & Trunking portion typically features 1-2 dBi gain.
- The patented antenna design is an integral dipole antenna with separate cable for the 800 & 900 MHz portion.
- Double-sided adhesive tape is used for mounting the antenna in a variety of locations.

To the right is a picture of a dashboard with a covert antenna hidden underneath

Trial Installations: The temporary installation of both RF and GPS antenna's can be achieved through the use of magnetic mounts placed on the hood, roof, or truck of the vehicle. Wires can be temporarily run out of any window, or readily available space that will not squeeze the wires to a crimping point.

4. Radio Module Location

The MARCUS Radio Module placement is dependant on several factors.

- the type of vehicle
- the placement of the antennas
- the availability of a constant 12 volt power supply

In most vehicles, the MRM can be placed inside or underneath the dashboard. The vehicle's radio can be removed and the unit placed behind the radio. A kick plate can be removed, and the unit can be safely secured to a firewall or zip-tied onto a permanent fixture, or the MRM can be secured underneath the dashboard on either the driver or passenger side, in any location that will not interfere with the safety of vehicle operation.	

	Avoid placing the unit near moving parts, or next to any of the vehicle's pedals. Always consider the placement of the antennas and be sure the cables can reach the desired location of the mobile.

A convenient place to acquire a constant 12-volt power supply is near a fuse box. There are usually several constant powered wires coming out of the back of the fuse box that control accessories such as the vehicle's horn, power locks, or interior light group.	

A constant power source is essential in the retention of GPS data inside the MARCUS unit, and is REQUIRED. Be sure to verify that the power source you have chosen will work when the vehicle is not running, and the keys are removed. **Insert a 5-amp fuse in-line with the power lead. This will protect the unit against power surges and voiding the warranty.** These in-line fuses may be purchased at Radio Shack for about $1.59 each product # 270-123C or copy this web address into your browser to buy on-line:
http://www.radioshack.com/category.asp?catalog%5Fname=CTLG&category%5Fname=CTLG%5F010%5F015%5F007%5F000&Page=2
Modules can also be located in the trunk, or anywhere in the interior of the vehicle where a constant power source, and all antennae wires can be connected.
(Before final placement of module, please read and complete section 5, vehicle wiring)

Connect the radio, GPS, and power cables to the MRM. Wrap any extra cable neatly with tie-wraps or electrical tape.	

- Secure the MARCUS Radio Module

(Above is the MARCUS Radio Module just before final placement)

Fasten the MRM with screws using the pre-drilled holes on the fins of the unit, securely tie-wrap unit to a permanent structure. Safely tie wrap and store any extra cable around the unit.

Replace all paneling or molding that was removed in the running of any antennae wires or power cable.

5. Vehicle Wiring

5.1 To connect power-

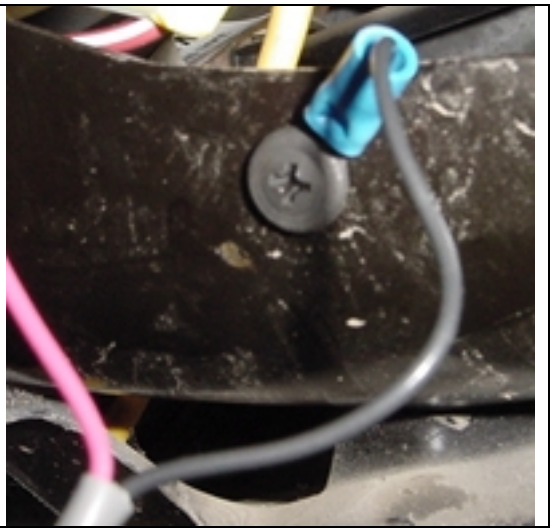
It is helpful to review the owner's manual of each vehicle to determine which wires are acceptable to use. Test probable wires with a 12-volt current circuit tester, and a voltmeter to determine if they have the proper voltage in both the engine running, and engine off states. It is recommended that a 14-18 gauge wire crimps be used to splice onto the proper wire.

- 5.2 To use wire crimp

Place red wire from MARCUS power cable into sleeve of crimp, along with constant power wire. Close crimp with pliers around both wires, leaving red power cable wire jumping off from the vehicle's power wire. Be sure to place a 5-amp inline fuse between the power source and the mobile unit.

- 5.3 Securing ground wire.

Strip enough slack in the MRM power cable to allow sufficient length as to attach the black wire to a solid metal surface somewhere on the vehicle. Add a grounding connector to the end of the black wire, and screw it securely onto a metal frame or plate. Temporarily connect the MRM to ensure it is on constant power before final placement.



5.4 Power Specifications

The power connector on the unit is a female Molex plug with 6 pins, of which two are used to power the MARCUS unit, and four pins are left available for sensor installations. This mates with the male Molex connector attached to the power cable. The power cable connector has a red + VDC lead and a black ground lead.

The power for each MARCUS™ Radio Module consumes approximately 1.2 amps while transmitting data over the Cingular Interactive MOBITEX network, and 140 milliamps when the unit is placed in a sleep state, after the vehicle has come to a stop.

There is an external connector for the power into the unit. The unit will operate with external vehicle power between +10 to +15 volts DC. The power supply board inside the box converts the externally supplied power to voltages needed by the system through DC-to-DC conversion components. The unit has been designed to use a minimum of electrical power thereby minimizing battery drain.

6. After Installation Testing

6.1 In the Field

The MARCUS Radio Module registers on the Discrete Wireless Gateway for the first time when its in both radio and GPS coverage. You can determine whether or not the unit is in

coverage easily by the presence of the 3 solid green or red lights on the face of the MARCUS Radio Module. GPS and RF coverage can also be determined when HyperTerminal is actively connected to the module (see also Troubleshooting).

6.2 On the Internet

It is recommended that after installation, the vehicle be driven around for 3 to 5 minutes. Through a computer connected to the Internet, using Internet Explorer 5.0 or higher, go to www.discretewireless.com and sign in using the end-users customer login and password.

. Note: **If you do not have Internet Explorer 5.0 with 128 bit encryption, the unsecured login website is as follows:** http:/www.discretewireless.com/dwrl/default.asp

After logging into the end-users account, view the recently installed unit under the Find Tab (see **MARCUS VEHICLE TRACKING APPLICATION USER'S GUIDE).** Check the recent history of the vehicle and verify the unit is operational.

7.1 Troubleshooting an Installation

Problem Description	Troubleshooting Steps
MRM will not power up	A) Check connection to power supply B) Check fuse C) Check with volt meter that there is 12-volts on the red power wire D) Make sure that unit is properly grounded snuggly to metal surface.
Vehicle will not appear on website	A) Check for 3 solid red or green lights B) Is there power to the mobile? C) Be sure to "view" the correct mobile on the Discrete Wireless, Inc. website. D) "Ping" vehicle twice to ensure it is in radio coverage. If the vehicle information has not updated within 3 minutes, vehicle may be out of coverage, or not responding. E) Check the "Account Information" tab on the Discrete Wireless, Inc. website to ensure the proper MAN# is entered for the vehicle, and that all information about the mobile is correct.
COV light is blinking	A) Check antenna and all associated antenna connections. B) Ensure that the radio antenna is properly seating on at least a 6" diameter ground plane. C) Ensure the antenna is screwed on tight to the base. D) Check coverage map of area (Advanced Installers can use Hyper Terminal to see radio coverage strength. See section below)
MSG light blinking	A) Check antenna and all associated antenna connections. B) Ensure that nothing obstructs GPS antenna's view of the sky. (metal, concrete ceilings, rooftops, tall buildings) The GPS must be able to see at least 40% of the sky. (Advanced Installers can use Hyper Terminal to determine if GPS antenna is connected properly.
COV light is blinking in a known coverage area	A) Mobile may need to be rebooted by recycling the power (note: user will lose any unsaved location information by cutting power to mobile) B) Check coverage map of area

7.2 Hyper Terminal / Field Laptop Setup

Field Laptop minimum requirements:

Computer/Processor:

- Pentium Class Processor 233 MHz or higher processor

Operating System:

- Windows 95, Windows 98, or Windows NT, Windows ME, Windows 2000 *(If you are running Windows NT, you are required to run Windows NT Service Pack 3)*

Memory:

- For Windows 95 and Windows 98: 16 MB of RAM *(minimum)*

For Windows ME, 2000: 32 MB of RAM (minimum)

Software Required:

- HyperTerminal

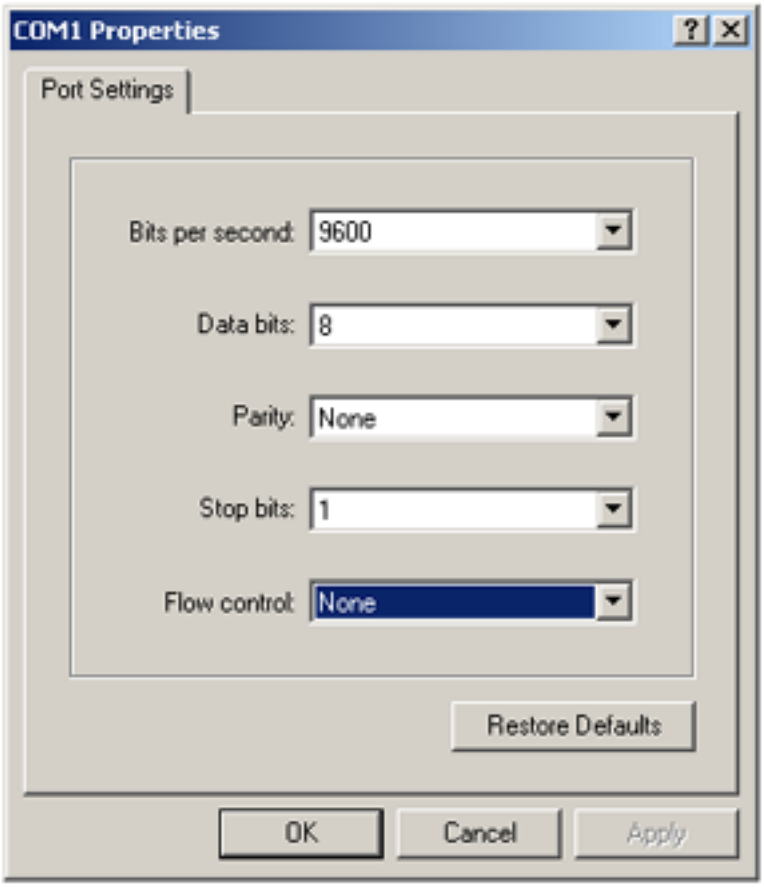
-For communication with The MARCUS Radio Module (MRM); you must use HyperTerminal.
-To set up a HyperTerminal connection, click **Start** on Windows bar, then **programs**, then **accessories**, **communications**, and select **HyperTerminal**

Once HyperTerminal is open select the following:

1. Make new connection; type **MARCUS** and then select an icon
4 Under Connect to/Connect using: select **COM1**, and then click **OK**

5 Under COM 1 properties/ Use the following settings:

Bits per Second: **9600**
Data bits: **8**
Parity: **none**
Stop bits: **1**
Flow control: **None**
Click **OK**



The laptop will now be ready to communicate with the MARCUS Radio Module. Please review section 7.3 for instructions on using Hyper Terminal once the mobile is installed.

(note: It is not required that a laptop be used to install The MARCUS Radio Module. The information obtained through the use of Hyper Terminal may be helpful in troubleshooting any problems with the installation or with the area of the country the installation is taking place. The set up, and the use of Hyper Terminal is recommended for advanced installers only.)

7.3 Hyper Terminal (Advanced Installation and Diagnostics)

Advanced Installers may use a laptop computer and a serial cable to communicate with, and investigate a mobile. With the Hyper Terminal application, installers can determine if the GPS antenna is working properly, and if the mobile is in strong or weak radio coverage. (please refer to the "Making a Hyper Terminal Connection" above)

1) Boot up a laptop with a serial cable connected to both the laptop, and the MRM.
2) Run the MARCUS **Hyper Terminal** program.
3) Upon connection, press the "**Enter**" key twice.
4) Type just the letters **M O B I T E X**
5) Then press the "**Enter**" key once more.
This should log you into the mobile locally.

(note: sometimes, the user must go through steps 1 through 5 twice to log in correctly)

Once logged into the mobile, you can check on the antenna properties.

Type **"/g"** to see if the GPS antenna is:

a) connected
b) not connected
c) has a short

Type **"/c"** to see pertinent stats for the mobile such as:

a) RSSI
b) MAN #
c) Versions of Firmware for the radio and the GPS

RSSI is the mobile's current radio coverage. The normal range for RSSI radio coverage is between –55 and –90. Anything between –91 and –256 is weak coverage. Anything higher than –55 is in very strong coverage.

IMPORTANT NOTE: It is possible while using Hyper Terminal to perform functions that will wipe the system's program, that is why we **STRONGLY RECOMMEND** that **ONLY** the two above functions be used out in the field. In the event that a mobile's program is erased, the unit will need to have its firmware loading again by mailing it to Discrete Wireless, or sending the mobile back to your Dealer.

Appendix A: Loading New Firmware

Occasionally Discrete Wireless will release a newer version of firmware for the MARCUS Radio Module. The version of firmware on your unit can be determined by following sections 2.3 and 7.2 of this Installation Guide. If a laptop computer is not available, you can email Discrete Wireless at customersupport@discretewireless.net , provide us with the MAN# of the mobile unit, and we can inform you as to whether or not there is a new version of firmware for that particular unit.

1. The newest version of firmware can be obtained from either your dealer or from Discrete Wireless Inc. It will be a few small files, and can be sent in a WINZIP zip file easily over email, or picked up on a diskette.
2. Make a new folder on your C drive and name it firmware29. (The number reflects the version of firmware so 2.9 will be 29, 3.0 would be 30 etc.)
3. Place the firmware files into that folder by either cut and paste or un-zipping the files into that location.
4. Connect a serial cable to the computer and to the MARCUS unit. If you have two serial ports, use port COM 1.
5. Open a MSDOS prompt (Command Prompt in Windows 2000) and change directory to the folder containing the firmware.

   Win 95/98- DOS will open on **C:\windows>** Type (without quotes) **"cd .."** You should then see C:\>, then type **"cd firmware29"**. You should then see **C:\firmware29>**

   Windows 2000- Command Prompt opens right on the C drive. Simply type **"cd firmware29"** and you should see **C:\firmware29>**
6. Now, with the mobile powered up, type **"L"** then **Enter**.
7. You should see **C:\firmware29>prog load dw.dll**

Connecting to device… having difficulty finding device. Check cabling. At this point, pull the power from the mobile, and then replace the power again within a few seconds. You should see a progress bar as the first step is loaded into the unit.

When the progress is finished, the next command should be automatically entered for you and you should see **C:\firmware29>prog wipe –f**

Connecting to device… having difficulty finding device. Check cabling. Again pull power from mobile and replace for the last time. You should see a new progress bar, and when it completes, the new firmware is loaded on the mobile.

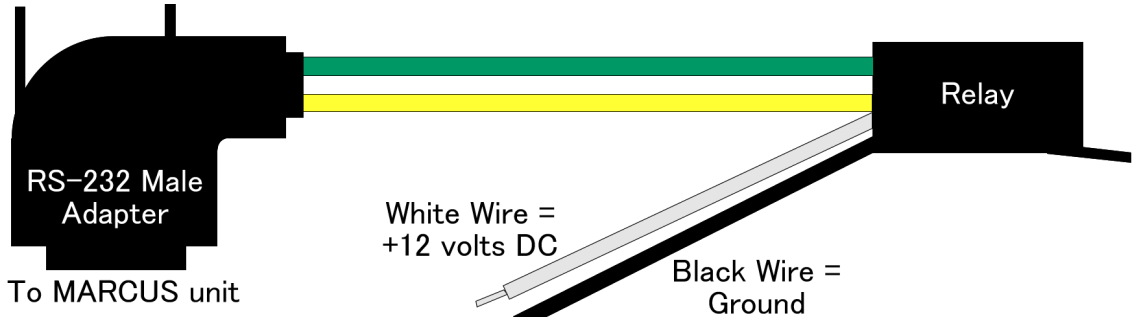
7. You can verify the new firmware version by using the HyperTerminal section of this Installation Guide.

Appendix B:
Installation of the MARCUS PTO/IDLE Sensor

The MARCUS™ PTO/IDLE Sensor is used to gather PTO (Power Take Off) or IDLE (Engine On/Off) information from a vehicle. These events are recorded, and then transferred wirelessly to the Discrete Wireless™ Gateway and can be viewed through the MARCUS™ Web Application.

The sensor is a relay switch that is wired along any +12-volt DC line that powers on and off along with the desired event. When a vehicle's PTO is engaged, or the engine is started, the current on the +12-volt DC wire closes the relay and sends a message through the RS-232 serial port located on the side of the MARCUS™ Radio Module. When the event is finished, and the +12-volt DC wire loses power, a second message is sent signaling the end of the event.

(NOTE: Before installation of the MARCUS™ sensor, Discrete Wireless Customer Service must be contacted to enable the sensor on the wireless network. Please contact Discrete Wireless at customersupport@discretewireless.net or call 404-365-2080. Please be prepared to supply the type of sensor install, (PTO or IDLE) and the MAN# of the MARCUS™ unit the sensor will be used with.)



Installing the MARCUS PTO Sensor

1) Determine the nature of the PTO device and where to find a good +12 volt DC hot lead when the device is activated. (This can be a wire coming off of a light that turns on when the PTO is activated, or any +12 volt wire that turns hot upon activation of the PTO.)
2) Carefully crimp onto the suitable wire. Add a 3-amp fuse in-line between the relay and the hot wire.
3) Run the wire up to the final placement point of the MARCUS™ Radio Module. (Note: it may be necessary to add wire to the sensor in order to reach the MARCUS™ unit)
4) Attach the hot wire that was just added to the white wire coming out from the relay.
5) Attach the black wire coming out of the relay to a suitable metal ground.
6) Plug in and screw down the RS-232 serial adapter to the MARCUS™ unit.
7) Test PTO Sensor (see After Installation Testing section below)

Installing an IDLE / ENGINE Sensor

1) Behind the ignition switch, determine which wire has +12 volt DC power when the engine is turned on. (Wire must lose power when engine is turned off)
2) Be aware of an accessory loop wire, which will contain voltage if the key is turned to the accessory position, without actually starting the car.
3) Once the correct wire has been determined, crimp on extra wire and a 3 amp fuse, and run the hot wire to the final placement point of the MARCUS™ Radio Module.
4) Attach the hot wire that was just added to the white wire coming out from the relay.
5) Attach the black wire coming out of the relay to a suitable metal ground.
6) Plug in and screw down the RS-232 serial adapter to the MARCUS™ unit.
7) Test IDLE / ENGINE Sensor (see After Installation Testing section below)

After Installation Testing

To test your sensor installation in the field:

1) Power up the MARCUS™ unit. Be sure the radio, GPS antennas, and the sensor's serial adapter are plugged in, and that it is possible to see all three red lights.
2) If powering up the MARCUS™ unit for the first time, it could take a few minutes before all lights become solid. If powering up inside a garage, or under cover of some kind, the MSG light may not come on. The MSG light is not needed for the sensor testing.
3) With at least solid PWR (power) and COV (radio coverage) lights, either engage the PTO on the vehicle, or start the car.
4) When working correctly, the activation and the de-activation of the sensor will cause the COV light to blink for a few seconds, and then return to a solid state. You may either watch for the COV light to blink, or examine the relay, which will produce a small click when being engaged or disengaged.
5) If everything appears to be working, continue on to finalize the installation.

To see if your sensor is working on our website:

1) Go to www.discretewireless.com.
2) Enter your account login and password.
3) Click "**REPORTS**" and then choose either the "**START / STOP**" or the "**SENSOR**" report.
4) If the unit is working correctly, you will see sensor data in both of these reports.

APPENDIX C:

Example of a MARCUS™ Install Field Report
Detail of Services Provided
Per Vehicle

☐ INSTALL ☐ UN-INSTALL ☐ MAINTENANCE ☐ FIRMWARE
Field Report Number:

Detail	Description
MAN	
Serial No.	
VIN	
Location Of Mobile	
Power Source	
Radio Ant SKU	
Mount SKU	
Firmware	
Battery Box SKU	
Anti-Tamper Box SKU	
Door Sensor SKU	
Marker Button SKU	

Additional Description:

Appendix D: Technical Specifications

System/ Component	Manufacturer	Description
MARCUS™ Radio Module	Discrete Wireless, Inc.	MARCUS™ Radio Module Dimension: 4" x 3" x 1.385" Weight: 1.00 pound
GPS Receiver	Trimble	L1 frequency, C/A code, 8 channel continuous tracking receiver Accuracy: <25 m SEP without SA Acquisition Time: 20 seconds typical with current almanac, position, (TTFF) time and ephemeris 45 seconds typical with current almanac, position, and time Reacquisition after signal loss: < 2 seconds Operating Temperature: -40ºC to +85ºC Operating Humidity: 5% to 95% non-condensing, 60ºC Power: +3.3 ± 0.3 volts, 0.22 watts "Keep Alive" battery power: 3.0-3.6 volts 2-5 micro amps Serial Ports: 1-NMEA 0183 or Binary (4800 or 9600 bps) 1-Binary RTCM SC-104 9600 bps Dimension: 2.6" x 1.25" x 0.48" H Weight: 0.4 ounces
GPS Antenna	Various	Low profile active micro patch antenna with 5 meter cable Antenna Gain: 24 dB Attachment: Magnetic Mount Power: 3.3 volts @ 8 mA Connector: MCX Dimensions: 1.65" x 1.99" x 0.55"

Wireless Modem		**MARCUS™ Radio Module** RIM 902M (Research In Motion) OEM Radio Modem Operating Frequency: Transmit 896-902 MHz Receive 935-941 MHz Transmit Power: 2.0 Watts @ antenna port Power Supply: 4.1-4.75 volts 10 micro amps, sleep mode 0.2 mA, battery stand-by mode 57 mA, receive/express stand-by 1.7 amps, transmit mode 21.5 mA, average consumption (94% standby, 5% receive, 1% transmit @ 4.5 volts) Serial Communication: 3.0 volt asynchronous serial port Link Protocol: Radio Access Protocol (RAP) Mobitex Asynchronous Communications (MASC) Link Speed: 9600 bps Dimensions: 2.74" x 1.65" x 0.33" Weight: 1.2 ounces Operating Temperature: -30°C to +70°C Operating Humidity: 5% to 95% Relative Humidity, non-condensing Vibration Testing: Meets IEC 68-2-6 Part 2

Appendix E: Technical Pictures of MARCUS

Front Plate with Red LEDs

Pwr - Power On when solid
Cov - Radio coverage when solid
Msg – GPS coverage when solid

MARCUS™ Radio Module

Back Plate With Connectors

Left Connector (MCX): GPS Antenna
Center Left Connector (6 pin): Power - + 12 Volts DC on bottom right pin and Ground on top right pin
Center Right Connector (9 Pin): RS-232 - use supplied 9-pin RS-232 connector
Bottom Right Connector (SMA): Radio Antenna

If you have any other questions, please contact Discrete Wireless Customer Support at customersupport@discretewireless.net or call 404-365-2080.