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Magellan Pro Compact Mobile Robot User's Guide

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PREFACE

Preface

Welcome To the World of RWI Research Mobile Robotics

Welcome and congratulations! You have made a wise decision in purchasing your new robot from RWI, a division of IS Robotics, Inc. RWI is the acknowledged industry leader in the exciting field of cutting-edge mobile robotics. Everyone at RWI is eager to help you get your robot up and running as quickly and easily as possible. Spend a few moments reading through the documents supplied with your new robot.

Technical Support From RWI

RWI wants your research robot to work for you. As you work with your robot, you may encounter questions or problems that are not adequately addressed in the documentation. When this happens, contact RWI technical support. The best and most convenient way to contact technical support is by filling out the technical support request form at our website: www.rwii.com/rwi/rwisupport.html.

Email Support

RWI technicians and engineers prefer email support dialogues. Email allows RWI to preserve both problem descriptions and solutions for future reference.

If you have hardware or software questions not addressed in this User's Guide or other documentation, please email your question to support@rwii.com. Do not direct your email to a specific individual. This ensures that your question will receive attention from the engineer or technician best suited to help you. Be sure to include your name, university or business, robot serial number, a detailed description of your problem, and your phone number. An RWI technician or engineer will get back to you, usually within 24 hours, and, in some cases, within minutes.

Web Page Support

Our web page, http://www.rwii.com (or http://www.isr.com) includes some support information. Authorized Mobility users can download the latest releases of the Mobility software and documentation from the software section of the site. As new support pages are brought up, RWI will announce them via a mailing list.

Mailing List Support

The mailing list users@rwii.com provides users of Mobility and other RWI research robotics products a forum to share ideas, concerns, and thoughts. RWI will make important announcements through this list. These could include announcements, software updates and patch announcements, solutions to commonly experienced problems, and late-breaking RWI and robotics news.

NOTE: This is a public list; all subscribers will see all posts. To subscribe, send a message to: users-request@rwii.com. In the subject line type "subscribe". It will ignore any text in the body of the email. RWI uses a mailing list manager called SmartList.

Phone Calls

We understand that, occasionally, a phone call may be necessary. Call 603-532-6900 for support, or fax us at 603-532-6901. If you do call with a question please have your robot within easy reach when you call.

Documentation

Some RWI research robots are equipped with hardware and software from other suppliers. Since the exact configuration of each robot may be different, documentation for third-party extensions is presented separately. Think of the third-party documents as appendixes to this User's Guide.

Using This Guide

This User's Guide, in combination with the other documents you have received, is your tool for getting started with your robot. The first two chapters show you how to set up radio communication between your robot and your base computer. The next chapters identify the important parts, connectors, switches, and other features of your robot and how to set it up for operation. The final chapters tell you how to drive your robot, and perform routine maintenance. The appendixes provide warranty information, a list of available accessories, rFLEX Control system details, and other related information.

Documentation Feedback

RWI wants all its documents to be complete, accurate, friendly, and helpful. We welcome feedback to help us improve our documentation. If you find an error in a document, feel an explanation is unclear, or feel something is missing or incomplete, please send email to docs@rwii.com.

CHAPTER 1

Setting Up Communication With a Robot Without an On-board PC

Connect the Batteries

The batteries are disconnected for safety during shipping and must be connected. See "Installing a Battery" in the Maintenance chapter for battery compartment location and proper connection procedure.

Setting Up Communication With Your Robot

Perform the following steps to set up communication with your robot.

1. Make sure your base station radio is connected properly to your base station computer and the power to the radio is on. (See the InfoWave Operating Guide supplied with your shipment.)
2. Open a connection to your base station radio. Start up the program minicom (a serial communication program that should be installed as a part of the RedHat Linux installation on your base station computer) by doing the following:
   i. login as "mobility" and enter
   ii. sudo minicom -s
   iii. enter the Mobility password (the default Mobility password is mbyrwi)

iv. set the editable serial port setup parameters to the following:

E – Bps/Par/Bits: 57600 8N1

F – Hardware Flow Control: No

G– Software Flow Control: No

3. Press Esc and save the setup as dfl.
4. Select "Exit" (do not select "Exit from minicom").
5. Type
   wmej
6. Press return. You should see the message
   OK
7. Type
   wml
8. Press return. You should see a listing of the configuration information for your radio. It should look something like this (the information after the equals sign on each line is likely to be different from what is shown here):
   Version=WAVE85.VC0
   Date=02-03-1998
   PN=83E80A70F33C8196129596FA087A249A
   ID=EE82BC
   My Address=1
   Maximum Frame Length=512
   Echo=On
   Response=On
   Type of RS232 Port=DCE
   Radio Rx Destination=Async. RS-232 Port
   Current Baud Rate=57600
   Default Baud Rate=115200
   Wireless Link=Disconnected
   Identification Name=INNOMEDIA TECHNOLOGY
   INC.
   OK
9. Turn on your robot by clicking the rFLEX Controller knob (see "The rFLEX Control System" section for the location and user instructions for the rFLEX Control system). After a second or so, the rFLEX power indicator will light up green. After about ten seconds or so, you will see the rFLEX menu screen. As soon as the screen appears, the wireless radio communication link to your robot is established.

10. Turn the rFLEX Controller knob until the box labeled "System I/O" is highlighted; then click the knob. You will see the rFLEX System I/O screen.
11. From your minicom connection, type

    wms<num>

    where <num> is your robot's radio address. You should see the following:

    Connecting...

    Connected to address <num>

    OK

    But if you see instead

    Connecting...

    Partner not found

    !

    Disconnected

    !

    OK

    then something is wrong with the connection. The simplest possibility is an address conflict with another Innomedia InfoWave radio operating in the vicinity. Check to make sure that all other Innomedia InfoWave radios in the vicinity are off. If you can then successfully communicate with your robot, you will need to change either your robot's radio address, or the conflicting device's radio address, or both.

    If you still cannot establish communication with the robot after turning off all other Innomedia InfoWave radios, or if you need to change radio addresses, send an email to RWI support (support@rwii.com) and a technician will contact you.
12. Once you are connected to the robot's radio, anything you type into minicom should appear on the System I/O console on your robot.

    If everything you type shows up clearly and accurately, you have a good, solid communication link with your robot.

    If nothing appears, or if what you type is garbled on the rFLEX screen, you could have a baud rate conflict. Be sure minicom is set to 57600 baud. If that does not help, contact RWI technical support (email to support@rwii.com).
13. To disconnect the radios and break off communication with your robot, in minicom, type

    |||<cr>

    (Three vertical bar characters followed by a carriage return.)

    You should see

OK
Now, type
wmd
You should see
Disconnected!
OK

CHAPTER 2

Setting Up Communications With a Robot With an On-board PC

Connect the Batteries

The batteries are disconnected for safety during shipping and must be connected. See "Installing a Battery" in the Maintenance chapter for battery compartment location and proper connection procedure.

On-board PC

You robot's on-board PC was shipped fully configured, running the latest version of RedHat Linux. Before you can communicate with your robot over your wireless LAN, you will need to do the following:

1. Set up communication with your Robot's PC.
2. Configure the network.

NOTE: Please read and review ALL the information in this chapter BEFORE attempting to actually set up communication with your robot.

Setting Up Communication With Your Robot's PC

ONE of the following scenarios will apply to you:

1. You want to use a terminal emulator program to communicate with your robot over a serial cable. Go to "Connecting Your Robot To Your Computer With the Serial Cable" on page 2 - 2.
2. You want to use a keyboard and monitor directly connected to your robot. (This is a less-desirable method. It will work, but it is awkward.) Go to "Connecting To Your Robot With a Temporarily Attached Keyboard and Monitor" on page 2 - 3.

Connecting Your Robot To Your Computer With the Serial Cable

To connect your robot across a serial cable to your own desktop or lab computer that is running a terminal emulator program, first connect the serial cable to the on-board computer's ttyS0 port by performing the following steps:

1. Open up your robot, find the on-board computer, and locate the ttyS0 port. (See the "Computer and Radio Ports" illustration for the location of the port.)
2. Unplug the cable that is plugged into the ttyS0 port and plug in the serial cable from your workstation. The serial port on your workstation is now connected to the robot's on-board PC.

   NOTE: At this point, the rFLEX Host Console screen is non-operational. That is, the boot-up sequence will not be displayed upon it, nor will its Shutdown PC or Kill PWR functions work. (See the "rFLEX Control System" section for details.)

3. Turn on your robot by pressing the rFLEX Controller knob. See the "Turning On Your Robot" section for instructions. When you hear a series of two tones (low, high), your robot's computer has successfully booted up
4. Start up your terminal emulator program on your desktop or lab computer. (Use 9600 8N1.)
5. You will see a Linux login prompt on your desktop computer.

   NOTE: You may need to press <Enter> first to see the prompt.

You are now ready to log into the robot's on-board computer system and set the IP address.

Connecting To Your Robot With a Temporarily Attached Keyboard and Monitor

1. Connect a monitor and keyboard (temporarily!) to the PC inside your robot. (See the "Computer and Radio Ports" illustration for the location of the ports.)
2. Turn on your robot. See the "Turning On Your Robot" section for directions.
3. The robot's PC will boot up. When you hear a series of two tones (low, high), your robot's computer has successfully booted up. On the monitor you have temporarily attached, you will see the step-by-step boot up process.

   Eventually, you will see a Linux login prompt. You are now ready to log into the robot's on-board computer system and set the IP address.

Configuring the Network

To configure the network, you must obtain certain information from your system administrator and you must configure your system.

Contact Your System Administrator

You must get the following information from your system administrator (be sure to write it all down):

1. Full-qualified domain name (hostname and domain name)
2. Legal, valid IP address for your location
3. The netmask
4. The name server
5. The default gateway

Configure Your System

You must configure your system as follows:

1. Login as "root" to the robot's PC, using the default password "rwirwi"
2. Run the program "linuxconf --text"
3. The Configuration Menu screen will be displayed. Press Enter.
4. Select "Basic host information". Press Enter.
5. From the Configuration Menu screen set the following parameters:

i. Enter the full-qualified domain name in the "Hostname" field.

ii. Enter the full-qualified domain name in the "Primary name + domain" field.

iii. Enter the IP address in the "IP address" field.

iv. Enter the netmask in the "Netmask (opt)" field.

v. Using the Tab key, select "Accept", then press Enter.

6. You are now back at the Configuration Menu screen. Select "Name server specification (DNS)" and press Enter.
7. Enter the nameserver in the "Nameserver 1" field. Select "Accept" and press Enter.

   NOTE: If your site does not use DNS, enter the IP and hostnames in the /etc/hosts file.

8. You are now back at the Configuration Menu screen. If it is not always selected, select "Routing and gateways", then press Enter.
9. Select "Defaults" and press Enter.
10. Enter the default gateway in the "Default gateway" field. Select "Accept" and press Enter.
11. You are now back at the Configuration Menu screen. Select "Quit", then press Enter.
12. The Status of the system screen will be displayed. Using the arrow keys, select "Activate the changes", then press Enter.

If you had swapped serial cables to connect your robot's external serial port to your desktop or lab computer, now is the time to put the cables back the way they were.

Reboot your robot's computer. See the "Turning On Your Robot" Section of Chapter 4 for the proper procedure. When you hear a series of two tones (low, high), your robot's computer has successfully booted up.

Setting Up Your Radios

Perform the following steps to set up the BreezeCom AP-10D access point radio.

1. Connect both antennas.
2. Connect the power supply.
3. Connect the access point radio to your 10-BaseT LAN using a standard Ethernet cable.
4. The "PWR" light should be lit once the unit is plugged in.

5. If the "IFR" light is lit, there's too much radio interference in the current location. Select an alternate location for the radio.
6. On your desktop computer, type

   ping <hostname>

   to make sure you can talk to the robot over the wireless network.
7. If you had a keyboard and monitor temporarily attached to the robot's PC, disconnect them now and use TELNET from your desktop or lab computer to interact with your robot's on-board PC.

   NOTE: RWI does not recommend, and will not support, connecting monitors and keyboards to robots' PC's, except during initial startup procedures, or as a temporary measure only while performing diagnostics.

To turn off your robot refer to the "Turning Off Your Robot" sections in Chapter 4.

CHAPTER 3

Getting To Know the Magellan Pro Mobile Robot

Safety First!

CAUTION: Magellan Pro is a powerful and rugged indoor piece of equipment. Although the Magellan Pro mobile robot is compact, portable, and relatively light (50 pounds), it is not a toy. To prevent injury to persons and damage to your robot or other equipment, review this important safety information.

CAUTION: An important safety feature on your Magellan Pro is the ***emergency stop button.*** This large, conspicuous, red button is mounted on the top of your robot. To halt Magellan Pro at any time, push the emergency stop button.

rFLEX – The New Approach to Mobile Robot Architecture

RWI's rFLEX Control System provides standardized controls and user interface across our whole family of robots. The large, easy-to-read rFLEX screen gives you simple, menu-driven access to all your robot's basic systems. And your Linux serial console text can be directed right to the rFLEX screen.

RWI's modular FARnet robot control bus connects all the nodes in your robot system. Hot-pluggable nodes let you reconfigure your robot system quickly and easily. You get visual diagnostic capabilities, including a window into the robot's FARnet network topology. To keep your robot up-to-date, RWI offers web-downloadable flash upgrade.

The Mobility Robot Software Development Environment

With RWI's Mobility robot software development environment, there is never a need to scrap or rewrite your robot applications as your research evolves or as you acquire new hardware and new robot platforms. With the Mobility software's unprecedented level of code re-use, and RWI's dedication to providing top-to-bottom integration, you will finally be able to concentrate on your projects and your research, rather than constantly re-writing application code and porting programs to work on new robots.

Unpacking The Magellan Pro Mobile Robot

Carefully examine your Magellan Pro robot and check the outer surfaces for any signs of damage. If you see damage, note details in writing, and take photographs if possible.

Figure 3 - 1, "Magellan Pro Compact Mobile Robot (Top View)," on page 3 - 8 provides a view of the top of Magellan Pro. Take a few moments to familiarize yourself with the location of safety features and connectors.

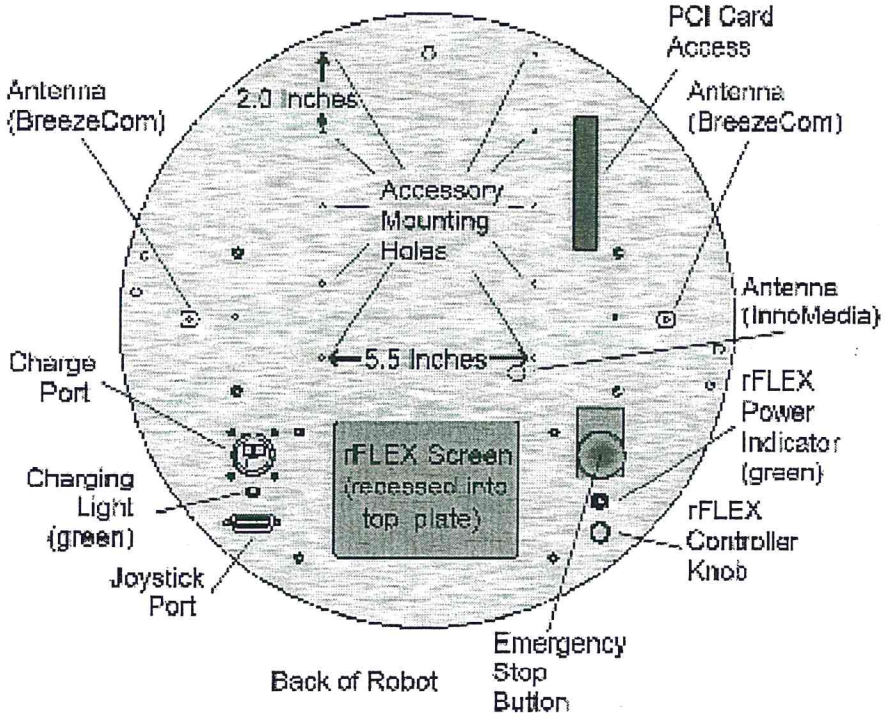

FIGURE 3 - 1. Magellan Pro Compact Mobile Robot (Top View)

Locating Important Features of your Magellan Pro Robot

See Figure 3 - 1, "Magellan Pro Compact Mobile Robot (Top View)," on page 3 - 8 for the location and identification of the following details.

Emergency Stop Button

The emergency stop button is the large red button on the top of the robot. Press it to halt your robot at any time.

rFLEX Controller Knob

The rFLEX Controller knob is your access to the rFLEX screen and allows you to turn on the power and select menu items in the rFLEX Control system.

rFLEX Power Indicator

The rFLEX Power indicator lights green when the rFLEX Control system is powered on.

rFLEX Screen

The rFLEX screen is recessed into the top surface of your robot. This is where you control your robot. rFLEX provides a graphical interface to basic robot functionality and controls the low-level motion and sensing of your new Magellan Pro.

Joystick Port

The joystick port is where you connect the joystick supplied with your Magellan Pro so you can manually drive your robot.

Charge Port

The charge port is where you connect the battery charger.

Antenna Mounting Holes

Your Magellan Pro comes with antenna mounting holes for the optional BreezeCom or InnoMedia radio.

Accessory Mounting Holes

The top plate of the Magellan Pro robot has ten accessory mounting holes with 4-40 threads arranged in two rows 5.5 inches apart. The holes in each row are 2.0 inches apart. Use these holes to mount optional equipment and accessories, such as cameras.

NOTE: There are sixteen panels around the robot's perimeter.

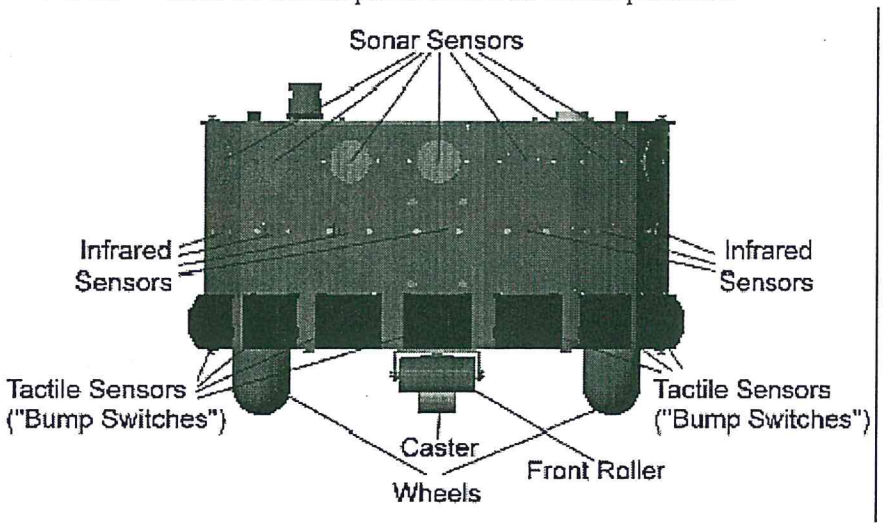

FIGURE 3 - 2. Magellan Pro Robot — Side View

See Figure 3 - 2, "Magellan Pro Robot — Side View," on page 3 - 10 for the location of the following equipment.

Sonar Sensors

The Magellan Pro has 16 sonar sensors around the upper perimeter.

Infrared Sensors

The Magellan Pro has 16 infrared sensors around the middle perimeter.

Tactile Sensors ("Bump Switches")

The Magellan Pro has 16 tactile sensors around the lower perimeter.

Wheels and Caster

The Magellan Pro has two drive wheels on the sides, a passive (not powered) caster in the rear, and a roller in front to minimize tipping during quick stops.

Computer and Radio Ports

Access to the optional on-board computer is provided from the connector panel, which has keyboard, monitor, serial, and radio connectors or ports. See Figure 3 - 3, "Computer and Radio Ports," on page 3 - 11 for the location of the ports.

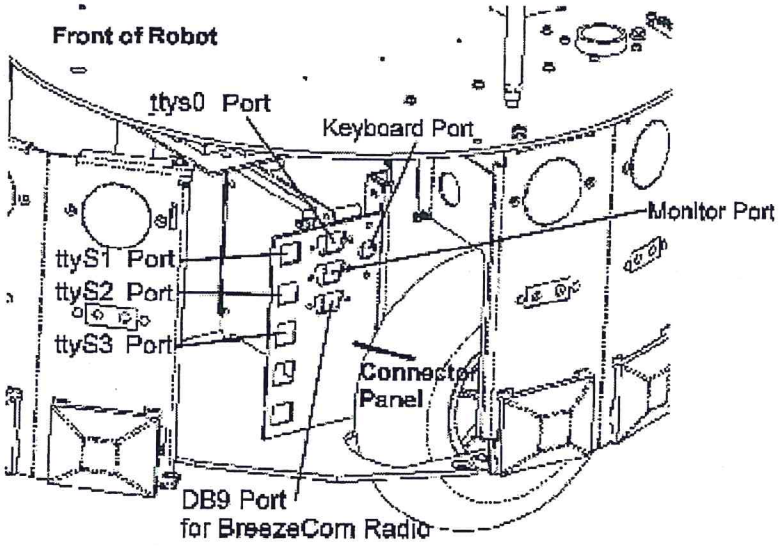

FIGURE 3 - 3. Computer and Radio Ports

Auxiliary and PC Power Ports

The auxiliary and PC power ports (see Figure 3 - 4, "Auxilliary and PC Power Ports," on page 3 - 12) provide connections for auxiliary equipment and the PC's power. Refer to "Board Pinouts" on page H - 58for pinout information.

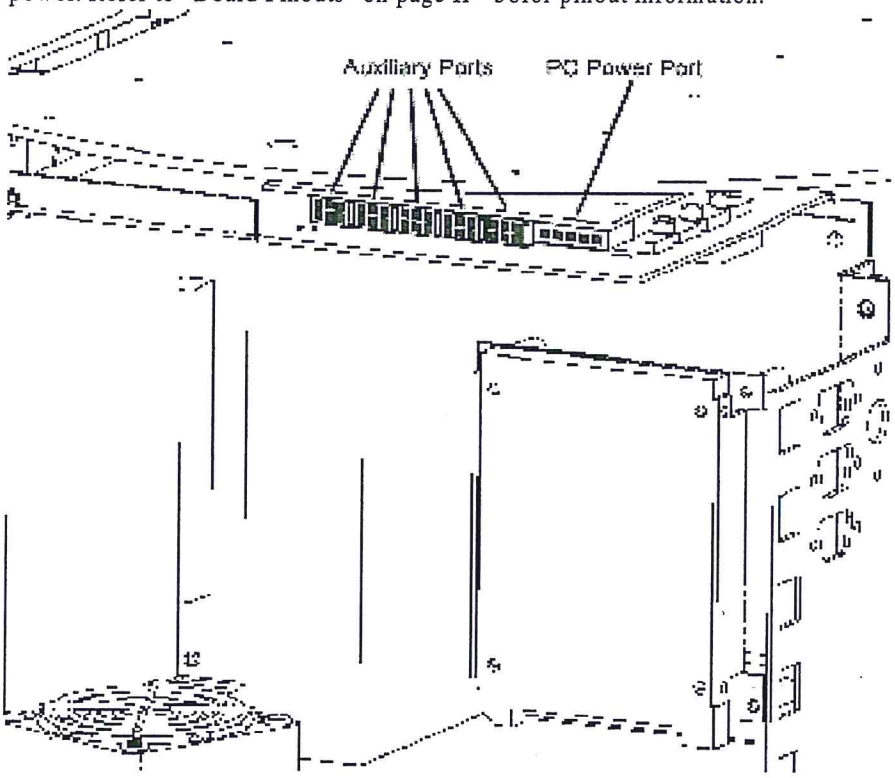

FIGURE 3 - 4. Auxilliary and PC Power Ports

CHAPTER 4

Magellan Pro Initial System Checkout

Power Verification

Before attempting to power up your robot, verify that the batteries are installed, connected, and charged (see "Battery Maintenance" on page 6 - 37).

Turning On Your Robot

To turn on your robot, you use the rFLEX Control system — described in detail on the following pages. First, push ("click") the rFLEX Controller knob (see Figure 3 - 1, "Magellan Pro Compact Mobile Robot (Top View)," on page 3 - 8) to turn on the power. (After a second or two, the rFLEX Power indicator will light up green.) Examine the rFLEX screens until you are familiar with the information contained in each. Then perform the system checkout tests (see "Testing Your Magellan Pro Mobile Robot" on page 4 - 25) using the rFLEX menu as your interface. Then you will be ready to operate your robot.

The rFLEX Control System

The rFLEX Control system is a simple, intuitive user interface for robot management, configuration, and diagnostics.

The rFLEX Controller Knob

The rFLEX Controller knob provides access to the rFLEX Control system. There are two actions that you can perform with the knob: push (or "click") the knob and turn the knob left or right.

1. Pushing (or "clicking") the knob by gently pressing it until you hear and feel a distinct click, selects the item that is highlighted on the rFLEX screen.
2. Turning the knob moves the focus highlight from element to element on the rFLEX screen. Whenever you see the focus highlight moving, you are in Selection Mode.

   Selection Mode

   In Selection Mode, a highlight travels from element to element on the rFLEX screen. To select a highlighted element, click the rFLEX Controller knob.

   Value Mode

   After you have selected an element whose value can be changed, you are in value mode. Turning the knob will cause the value of the selected element to change. This is how you specify numeric values, select from a number of text choices, or scroll regions of the screen.

The rFLEX Menu Screen

The rFLEX menu is your center of navigation among the various screens and modes of the rFLEX Control system.

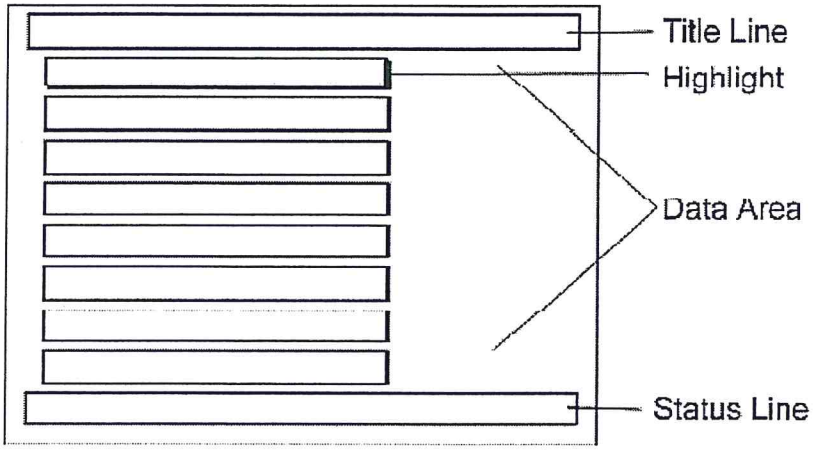

FIGURE 4 - 1. rFLEX Screen Data Areas

All rFLEX screens are divided into three areas with a highlight that moves from element to element as you turn the rFLEX Controller knob.

1. The title line at the top displays the name of the screen.
2. The data area in the middle displays the system parameters.
3. The status line at the bottom displays motor and power status.

The spinning slash in the status line indicates all systems are within normal operating parameters. The highlight indicates which element is selected.

The rFLEX Control System Screens

The rFLEX Control system user interface is organized around a set of screens. The first screen — the one you will see when you click the rFLEX Controller knob to turn your robot on — is the rFLEX Menu screen (see Figure 4 - 2, "rFLEX Menu Screen," on page 4 - 16). To display the other screens, turn the rFLEX Controller knob until the screen you want is highlighted, then click the knob.

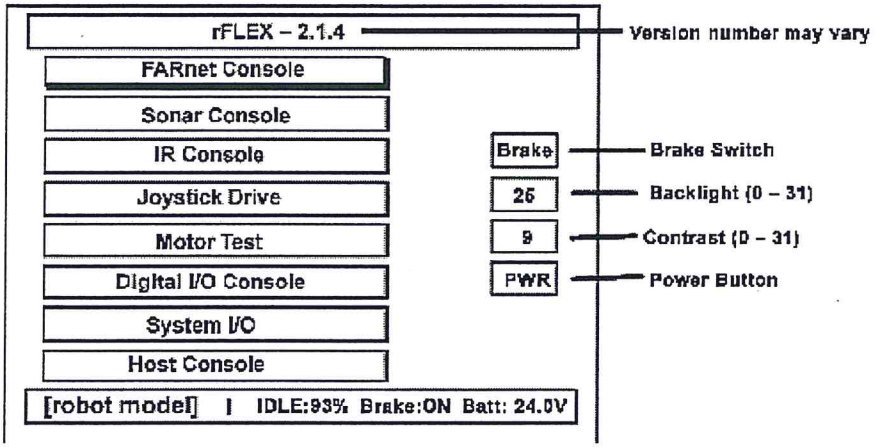

FIGURE 4 - 2. rFLEX Menu Screen

On all other rFLEX screens, there is a button labeled "Menu." Selecting that button always takes you back to the rFLEX Menu screen. Before proceeding to the other screens, adjust the backlight and contrast settings (each ranges from 0 to 31) until you can easily and clearly see and read the screen in your environment and lighting conditions. The following are the rFLEX screens you can select from the rFLEX Menu screen:

1. FARnet Console
2. Sonar Console
3. IR Console
4. Joystick Drive
5. Motor Test
6. Digital I/O Console
7. System I/O
8. Host Console

The FARnet Console Screen

The FARnet Console screen (see Figure 4 - 3, "FARnet Console Screen," on page 4 - 17) shows each of the nodes, or devices, on your robot's FARnet internal network.

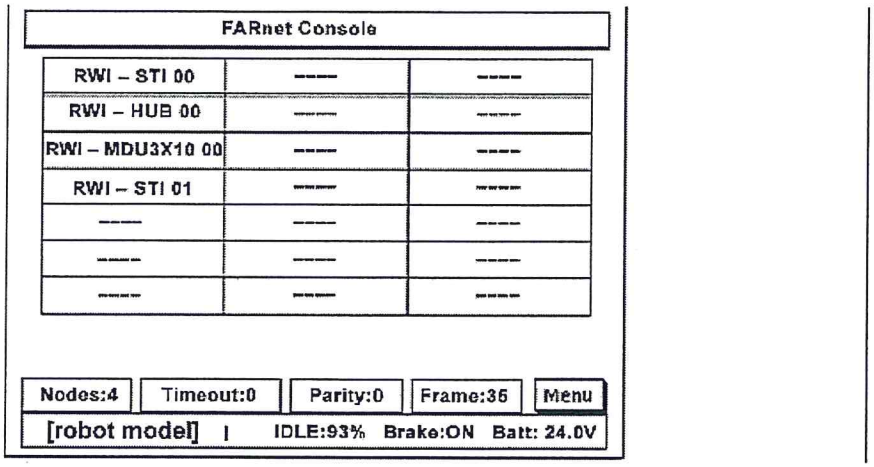

FIGURE 4 - 3. FARnet Console Screen

This screen displays sonar sensor boards, IR sensor boards, motor drive units (MDUs), and so forth. It is used mainly for diagnostics.

The Sonar Console Screen

The Sonar Console screen (see Figure 4 - 4, "Sonar Console — Sonars OFF," on page 4 - 18), displays the activities of the sonars, and lets you perform some simple tests to ensure that the sonars are working properly.

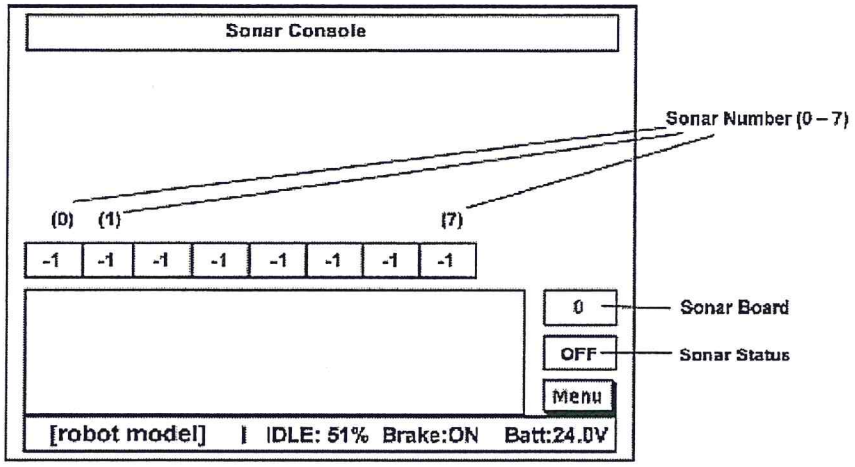

FIGURE 4 - 4. Sonar Console — Sonars OFF

The IR Console Screen

The IR Console screen (see Figure 4 - 5, "IR Console — IRs OFF," on page 4 - 19), displays the activities of the IR sensors. It lets you calibrate the IR sensors and perform some simple tests to ensure that the sensors are working properly.

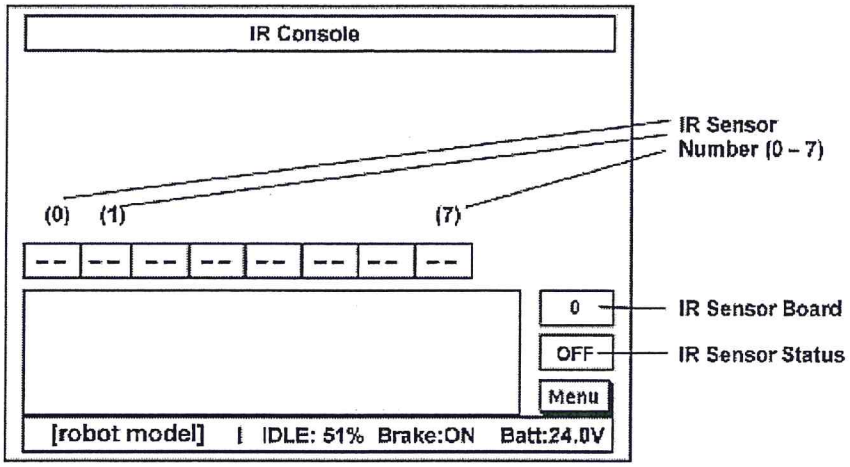

FIGURE 4 - 5. IR Console — IRs OFF

The Joystick Drive Screen

The Joystick Drive screen provides information on the robot's motion control system (see Figure 4 - 6, "Joystick Drive Screen," on page 4 - 20).

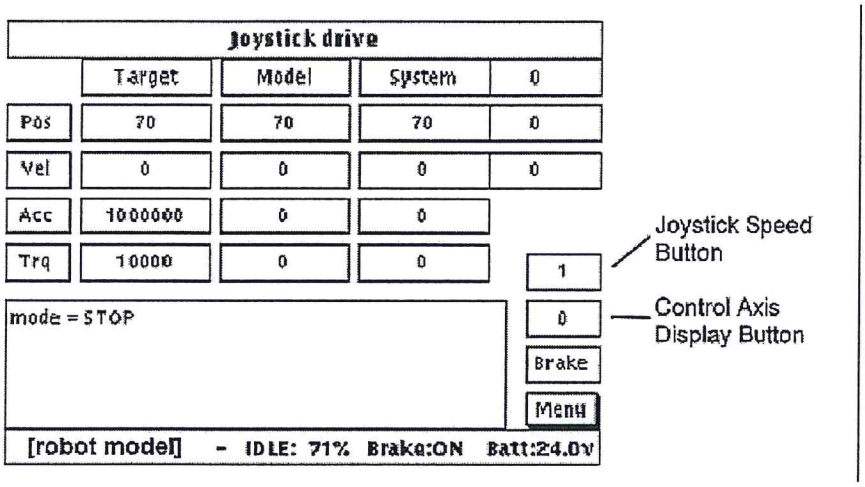

FIGURE 4 - 6. Joystick Drive Screen

The Joystick Speed button sets the robot's speed and is the only parameter you need to set: 1 is slowest and 3 is fastest. It is analogous to the mouse speed on your personal computer.

The Control Axis Display button selects which motor axis information is displayed: (0) for translation motion, and (1) for rotation motion.

The Brake button turns the brakes on and off. The status line will read "Brake:ON" or "Brake:OFF". The brakes must be off to drive the robot.

The Motor Test Screen

The Motor Test screen (see Figure 4 - 7, "Motor Test Screen," on page 4 - 21) allows testing of the motors in"open loop" mode and provides motor parameter information as the motors are being tested.("Open loop" simply means that feedback from the motor to the sensors will not adjust the input parameters. In a"closed loop" system, the motor sensors will adjust the motor input parameters based on the feedback from the motor.)

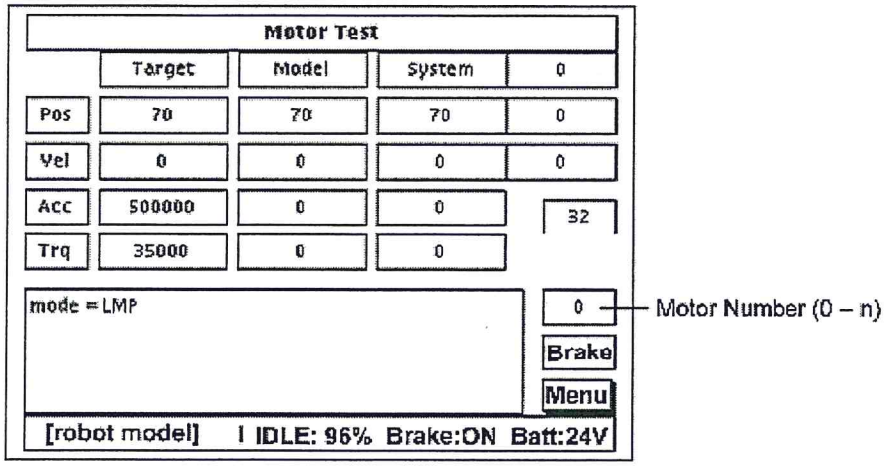

FIGURE 4 - 7. Motor Test Screen

The four buttons at the lower right side of the data area provide the following information:

1. **Pulse width value**: This lets you specify the pulse width (and thus the power) being sent to the motor. The range is 0-255. The default setting (32) is very weak and will barely turn the wheel(s). Leave this setting at the default while you perform the motor tests.
2. **n**: Motor number: 0–n; n+1 is the number of motors your robot has.
3. **Brake**: Turn brakes on or off.
4. **Menu**: Return to rFLEX Menu.

The Digital I/O Console Screen

The Digital I/O Console screen (see Figure 4 - 8, "Digital I/O Console," on page 4 - 22) lets you see a "map" of your robot's digital subsystems. Digital I/O can originate at several different types of FARnet nodes. The entries show digital I/O bits from each of the robot's subsystems that can have an off/on status at any time.

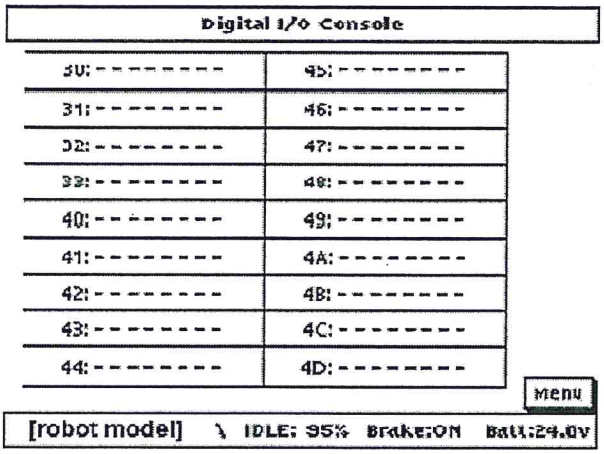

FIGURE 4 - 8. Digital I/O Console

The System I/O Screen

The System I/O screen (see Figure 4 - 9, "System I/O Screen," on page 4 - 23) is used only in specialized circumstances, such as when setting up robot communications with an InnoMedia radio.

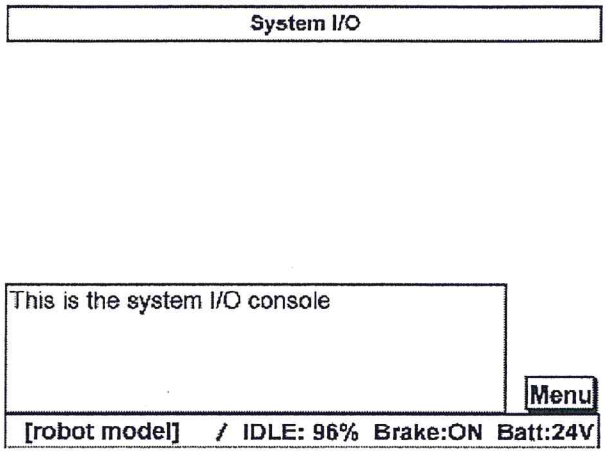

FIGURE 4 - 9. System I/O Screen

Host Console Screen

The Host Console screen (see Figure 4 - 10, "The Host Console Screen," on page 4 - 24) is a scrolling log of the robot's computer activities.

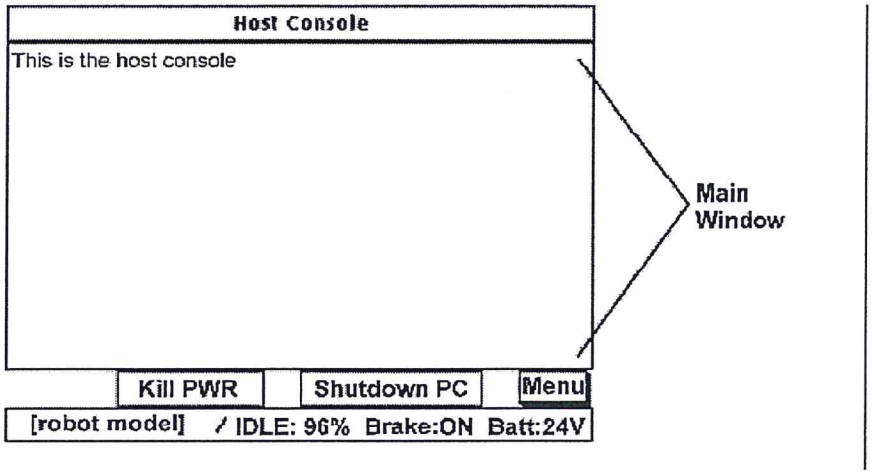

FIGURE 4 - 10. The Host Console Screen

You can shut down the robot's PC from the Host Console screen and then turn the robot off.

1. Turn the rFLEX knob until the box labeled "Shutdown PC" is highlighted; then click the knob. The PC will shut down cleanly. The Host Console will scroll through the entire shutdown process.
2. When you hear a series of two tones (high, low), the robot's PC is safely shut down.
3. To turn the robot off, turn the knob until "Kill PWR" is highlighted and click the knob. When the screen goes blank, your robot has been safely powered off.

CAUTION: Always click "Shutdown PC" before you click "Kill PWR". If you click the "Kill PWR" button without first safely shutting down the PC, the PC will crash.

Testing Your Magellan Pro Mobile Robot

Various parameters should be tested before driving your robot. Use the rFLEX Control system to perform these tests.

Testing the Sonars

Your robot is equipped with 16 sonar sensors, eight on the front door and eight on the rear door (see Figure 4 - 12, "Sonar Locations," on page 4 - 26).

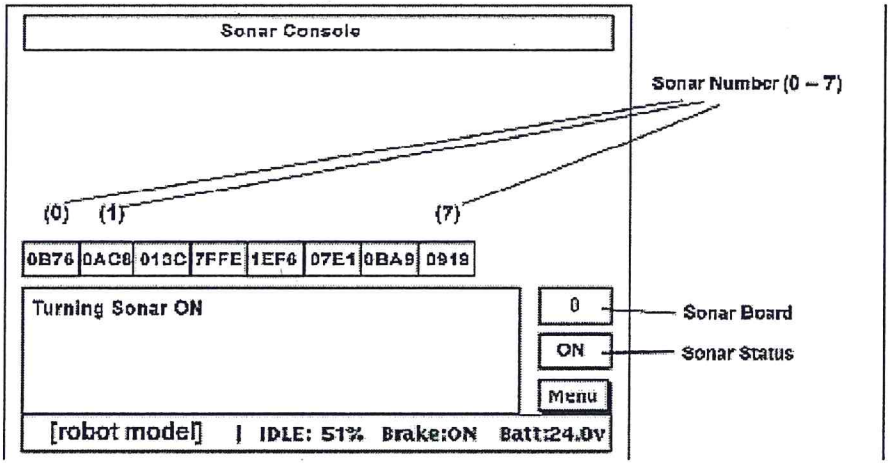

FIGURE 4 - 11. Sonar Console — Sonars ON

From the rFLEX Menu screen, select the Sonar Console screen (see Figure 4 - 11, "Sonar Console — Sonars ON," on page 4 - 25) and perform the following steps to test the sonars:

1. Turn the knob until the box reading "OFF" (the Sonar Sensor Status box) is highlighted. Click the knob to turn the sonars on (the box will now read "ON"). You should hear the sonar system working (a faint, rapid clicking).
2. To select a particular sonar board, turn the knob until the Sonar Board box showing the sonar board number is highlighted. Click the knob. Then, turn the knob until the board number you want to test is in the box. Then, click the knob. You can now see the readings from the sonars controlled by the selected board in the small boxes in the data area of the screen.

   There are two sonar boards on the Magellan Pro — "0" and "1". Sonar board "0" controls the sonars on the rear door and board "1" controls the sonars on the

front door. The sonars are numbered from one to eight on each door, starting from where the door opens and moving clockwise (see Figure 4 - 12, "Sonar Locations," on page 4 - 26).

3. To test a particular sonar sensor, cup your hand directly over that sonar sensor and slowly move it back and forth. For example, cover sonar "1" on board "0" and watch the first box in the rFLEX Sonar Console screen.You should see the sonar values changing. The reading should display around 100, 10D, 10E — somewhere in that range. This means the reading is as close as the sonar can sense accurately. Now, remove your hand. Check the reading again.

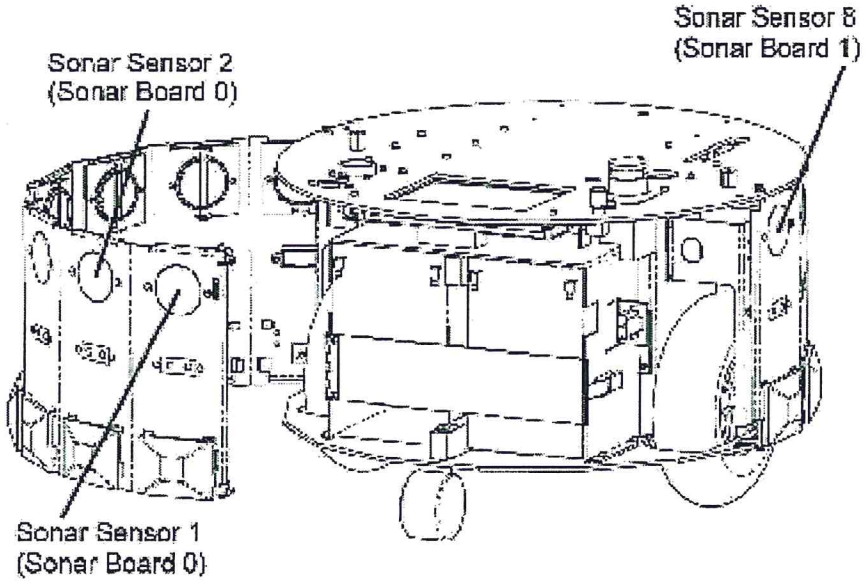

FIGURE 4 - 12. Sonar Locations

If the displayed sonar readings seem to be changing with appropriate values, your robot's sonar sensors are operating properly.

The displayed sonar readings should roughly correspond to the distance in millimeters to the object being sensed within a radius of about 25' (8.5m).

NOTE: All sonar readings are in hexadecimal notation so the readings will look like those in Figure 4 - 11, "Sonar Console — Sonars ON," on page 4 - 25.

A reading of 7FFE means "no echo returned.". This means there is no obstacle within sensing range (beyond 25 feet) of that particular sonar or the object is covering the sonar sensor. A reading of 7FFF indicates no response from the sonar controller.

Testing the IRs

Your robot is equipped with 16 IR sensors, eight on the front door and eight on the rear door (see Figure 4 - 14, "IR Locations," on page 4 - 28).

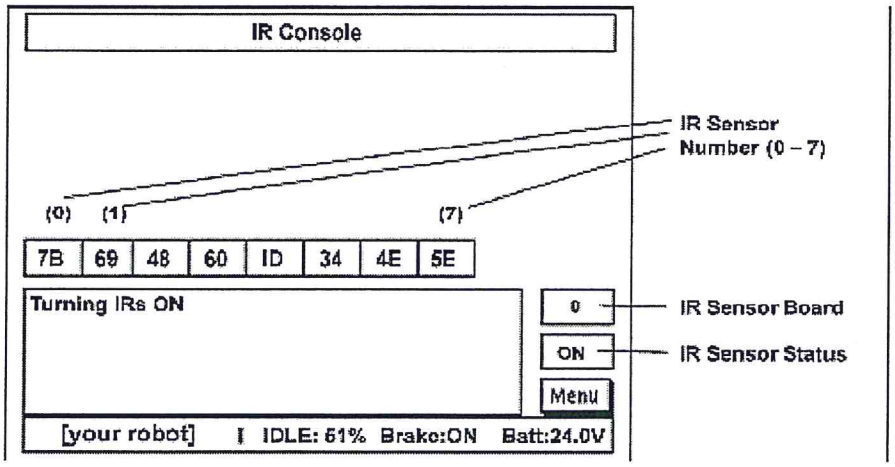

FIGURE 4 - 13. IR Console — IRs ON

From the rFLEX Menu screen, select the IR Console screen (see Figure 4 - 13, "IR Console — IRs ON," on page 4 - 27) and perform the following steps to test the IRs:

1. Turn the knob until the box reading "OFF" (the IR Sensor Status box) is highlighted. Click the knob to turn the IRs on (the box will now read "ON").
2. To select a particular IR board, turn the knob until the IR Sensor Board box showing the IR board number is highlighted. Click the knob. Then, turn the knob until the board number you want to test is in the box and click the knob. You can now see the readings from the IRs controlled by the selected board in the small boxes in the data area of the screen.

   There are two IR boards on the Magellan Pro — "0" and "1". IR board "0" controls the IRs on the rear door and board "1" controls the IRs on the front door. The IRs are numbered from zero to seven on each door, starting from where the

door opens and moving clockwise (see Figure 4 - 14, "IR Locations," on page 4 - 28).

3. To test a particular IR sensor, move a piece of paper slowly back and forth between 30 and 60 centimeters (one to two feet) from the sensor. Be sure that the paper is directly in front of the sensor because, unlike sonar sensors, the detection cone of the IR sensor is very narrow. For example, move a piece of paper back and forth in front of IR "0" on board "0" and watch the first box in the rFlex IR Console screen. The IR values change as you move the paper, and, if you hold it quite still, the values should change very little if at all. The values will vary from one sensor to the next. On a typical robot, at 30 centimeters the values range from 57 to 85 and at 60 centimeters they range from 3e to 6b. Note that the numbers increase, and change more rapidly, as the paper gets closer to the sensor. If the displayed IR readings seem to be changing with appropriate values, your robot's IR sensors are operating properly.

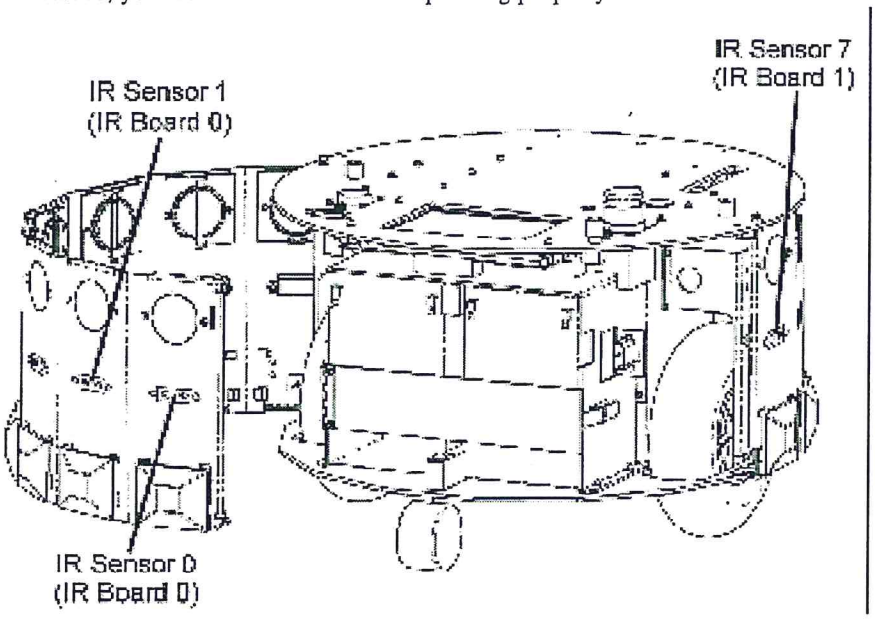

FIGURE 4 - 14. IR Locations

NOTE: All IR readings are in hexadecimal notation so the readings will look like those in Figure 4 - 13, "IR Console — IRs ON," on page 4 - 27.

Testing the Motors

From the rFLEX Menu screen, select the Motor Test screen (see Figure 4 - 7, "Motor Test Screen," on page 4 - 21) and perform the following steps to test your robot's motors.

CAUTION: If you are testing a new robot, don't skip this test! It is very important to ensure that your robot's motors are operating properly.

1. Plug the supplied joystick into your robot's joystick port (see Figure 3 - 1, "Magellan Pro Compact Mobile Robot (Top View)," on page 3 - 8.
2. Turn the rFLEX knob until the button labeled "Brake" is highlighted and click the knob. This turns off the robot's brakes.The status line now reads Brake:OFF.
3. Turn the knob until the motor number button is highlighted. Turn the knob until the box reads "0." Then click the knob.
4. Initialize the joystick by "double clicking" the Trim button. See Figure 5 - 1, "The Joystick Assembly," on page 5 - 34 for the location of the joystick controls and "The Joystick" on page 5 - 32 for complete instructions on how to use the joystick.
5. Push and hold down the Drive button on your joystick while you push the joystick lever forwards and backwards.
6. Your robot's left wheel will move slowly. If it does not, check again to ensure that you correctly enabled the motor drive. The numbers in the boxes in the data area will also change as the wheel moves.
7. Turn the rFLEX Controller knob to select motor number "1" to test the other motor. Push and hold down the Drive button on your joystick while you push the joystick lever forwards and backwards. You should see the robot's right wheel move slowly. The numbers in the boxes in the data area will also change as the wheel moves.

Testing the Digital Input/Output

From the rFLEX Menu screen, select the Digital I/O Console screen (see Figure 4 - 8, "Digital I/O Console," on page 4 - 22) and perform the tests of digital input/output. For the Magellan Pro configuration the Digital I/O Console screen reports only the tactile sensors (lines 40 and 41). When a digital I/O signal is triggered (a tactile sensor is depressed), one of the dashes on the Digital I/O Console will change to an "x".

The tactile sensors are mapped the same way as the sonar sensors — from the opening on the rear door and moving clockwise, the rear door sensors are 1 through 8 and are represented by dashes 1 through 8 in line 40; from the opening on the front door and moving clockwise, the front door sensors are 1 through 8 and are represented by dashes 1 through 8 in line 41.

Turning Off Your Robot With The rFLEX Control System

If you do not have an optional radio installed in your robot, using the rFLEX Control system is the only way to turn off your robot. Go to the rFLEX Menu screen, turn the rFLEX Controller knob until PWR is highlighted; then click the knob. This will cleanly shut down the robot's PC then shutdown the power. When you hear a series of two tones (high, low) and the rFLEX screen goes blank, your robot has been safely powered off. You can also turn off the robot from the Host Console screen. See "Host Console Screen" on page 4 - 24 for instructions.

Turning Off Your Robot Remotely Via TELNET

To turn your robot off using the optional radio, verify which radio you have installed and follow the appropriate directions below.

Robot With On-board PC and BreezeCom Radio

You can also shut down your robot's on-board computer remotely, via TELNET interface.

1. TELNET to the robot.
2. Login as "mobility" using the password "mbyrwi".
3. Type: "su."

   Answer with the root password "rwirwi".
4. Type: "/sbin/shutdown -h now".
5. Type "exit" twice to leave the root shell and exit the TELNET session to the robot.
6. When the robot shuts down correctly, you'll hear a series of two tones (high, low).

Robot With No On-board PC, InnoMedia Radio Connection

To disconnect the radio connection and break off communication with your robot, in mini-com (running on your desktop or lab computer), type:

|||<cr> (That's three vertical bar characters followed by a carriage return.)

"OK" will be displayed

Now, type:

wmd

"Disconnected!" will be displayed

"OK" will then be displayed

CHAPTER 5

Operating Your Magellan Pro

Your interface with the Magellan Pro robot is the rFLEX Control system. Read carefully "The rFLEX Control System" on page 4 - 14 and the following sections before trying to operate your robot.

Turning On Your Magellan Pro

Use rFLEX to turn on your robot as described in "Turning On Your Robot" on page 4 - 13.

The Joystick

Your robot comes supplied with a joystick. Before driving your robot with the joystick make sure you understand how the controls work and that you have a large, clear unobstructed space in which to drive the robot.

Joystick Controls

The controls on the joystick adjust the fine-tune trim and free play for forward/backward motion and left/right motion. See Figure 5 - 1, "The Joystick Assembly," on page 5 - 34 for location of the controls.

Trim Button

The trim button initializes the joystick software and trim settings. Double click the trim button when first using the joystick and after changing the trim settings.

Drive Button

The drive button enables motion. Hold down the drive button to drive the robot.

Fine-Tune Knob

The fine-tune knobs center the joystick for forward/backward and left/right positions.

Fine-Tune Indicators

The fine-tune indicators show how much the fine tune knobs have been turned and move as the fine tune knob is turned.

Free-Play Slider

The free-play sliders adjust the amount of free play (no resistance) in the joystick movement. In the top position for the forward/backward and left position for the left/right sliders, there is no resistance throughout the full motion of the joystick; in the center positions, there is resistance in the outer circle of motion; in the bottom and right positions, there is resistance throughout the motion of the joystick. These two sliders can be set independently.

Driving With The Joystick

To drive your robot with the joystick, do the following:

1. Plug the joystick assembly into the robot's joystick port.

2. With the joystick in the center, quickly "double-click" the trim button (see Figure 5 - 1, "The Joystick Assembly," on page 5 - 34). This will initialize the joystick software and center the joystick input.
3. If the status line on the rFLEX Joystick Drive screen does NOT show Brake:OFF, turn the rFLEX Controller knob until Brake is highlighted, then click the knob to turn the robot's brakes off.
4. Hold down the drive button and move the joystick to drive the robot. (If you do not hold down the drive button, the robot will not move.)
5. Select the speed button on the rFLEX Joystick Drive screen and change the values by turning the rFLEX Controller knob. Set the speed to a low value (1) at first. Go slowly to get a feel for the precision of motion control, then set the speed to a higher number and drive a bit faster.
6. Drive your robot around the large, open area you have selected, always watching for possible hazards, both to the robot and to surrounding people and objects.

The steering trim and drive trim fine-tune knobs are used to make precise adjustments in the responsiveness of the joystick for forward/backward and left/right motion. After making a trim adjustment, double click the trim button to input the new settings.

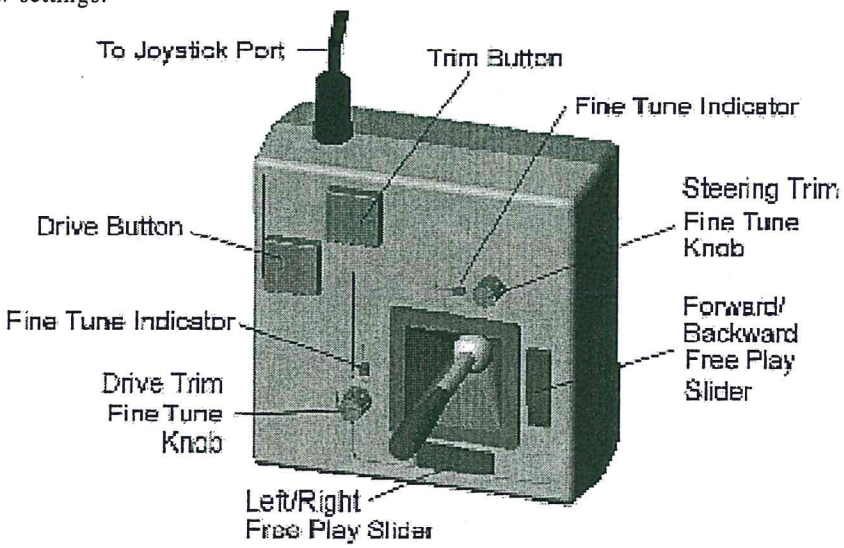

FIGURE 5 - 1. The Joystick Assembly

Turning Off Your Magellan Pro

Use the rFLEX Control system to turn off your robot as described in "Turning Off Your Robot With The rFLEX Control System" on page 4 - 30.

CHAPTER 6

Magellan Pro Maintenance

Maintenance

Your Magellan Pro robot is designed for easy access to interior components to allow routine maintenance.

Opening Your Magellan Pro Robot

Magellan Pro is equipped with two doors for tool-free access to the batteries, on-board computer, and other internal components. Each door encompasses eight of the robot's sixteen flat side panels, and hinges on the side of the robot.

Although Magellan Pro is cylindrical, the side of the robot where the rFLEX screen on the top is mounted and the caster on the bottom is mounted is the rear, and the opposite side is the front.

CAUTION: Make sure your Magellan Pro robot is turned off before performing maintenance on the interior components.

There are two spring latches on each door — one on the top and one on the bottom (see Figure 6 - 1, "Rear Door Open — Battery Compartment," on page 6 - 37). Squeeze the latches together and gently pull the door out.

CAUTION: Metal objects dropped or inadvertently placed inside can cause dangerous and destructive electrical arcing.

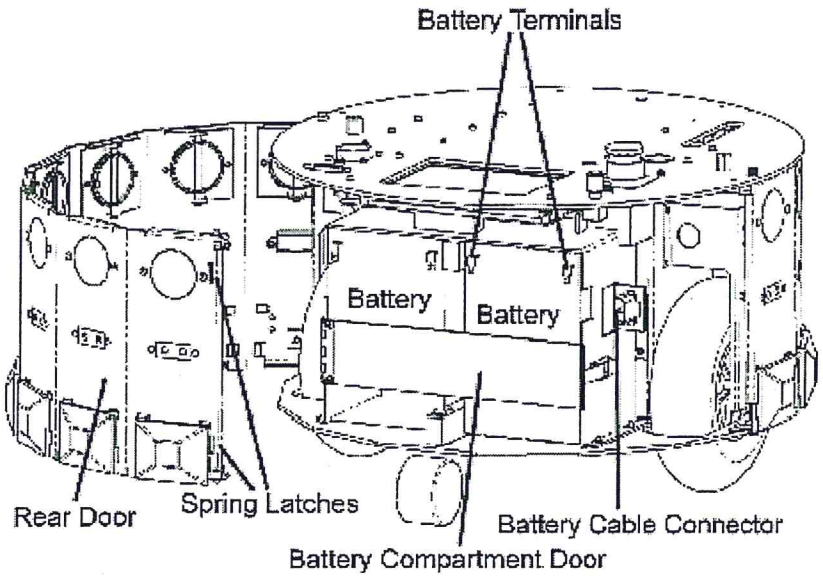

FIGURE 6 - 1. Rear Door Open — Battery Compartment

Battery Maintenance

Your robot's two sealed lead-acid batteries are considered "non-spillable." However, you still need to observe prudent safety practices when working with these batteries.

CAUTION: Make sure your Magellan Pro robot is turned off before opening the battery compartment.

CAUTION: On each battery are two metal terminals. If these terminals are connected with an electrical conductor of any kind, the battery will deliver large amounts of current instantly. This can cause severe burns.

Removing a Battery

To remove a battery, perform the following steps:

1. Open the rear access door (below the rFLEX screen) by squeezing the spring latches together.
2. Unlatch and open the battery compartment door.
3. Unplug the batteries from the battery cable connectors.
4. Grasp the battery through the cut-out areas of the battery compartment and carefully slide the battery out of the compartment.

CAUTION: Always handle the Magellan Pro batteries with the same respect with which you would handle a car battery.

Installing a Battery

To install a battery, perform the following steps:

1. Carefully slide the battery into the battery compartment, making sure the wire harness is facing out.
2. Plug the battery into the battery cable connectors.
3. Close and latch the battery compartment door.
4. Close the rear access door and make sure the spring latches are properly in place.

CAUTION: Always handle the Magellan Pro batteries with the same respect with which you would handle a car battery.

Charging the Batteries

Your Magellan Pro needs external power to recharge its batteries and to provide power to the on-board systems while the batteries are charging. The charger sup-

plied with your robot allows the Magellan Pro to remain powered up 24 hours a day.

NOTE: During normal robot operation, there is no need to power the Magellan Pro down while charging the batteries. The batteries may be charged while the robot is off or on (or even while it is operating).

AC Power

Before plugging in any AC-powered equipment that arrived with your Magellan Pro, verify that the equipment accepts the AC voltages used in your country. RWI tries to anticipate and include the correct adapters, but verifying the suitability of the equipment to your AC power is *your responsibility*.

The battery charger supplied with your Magellan Pro robot supports 100 – 120 volts AC as well as 220 – 240 volts AC. Ensure that the voltage switch setting on the battery charger matches the voltage of your main power source.

CAUTION: Before connecting the robot's battery charger to an AC wall outlet, be sure that the input voltage is compatible with the AC voltage in your country.

Do not run the batteries down below 20% full, since this will reduce the useful life of the batteries. It is acceptable to give the batteries a ½ hour "freshening charge" before extended use.

The Magellan Pro lead-acid batteries will achieve highest capacity when charged at, or slightly above, room temperature.

How To Charge the Batteries

1. Move the robot to a safe location near an AC outlet.
2. Ensure your charger is the correct one for your AC voltage.
3. Plug in the supplied AC charger cable to an AC wall outlet.
4. Locate the Magellan Pro charge port. (See Figure 3 - 1, "Magellan Pro Compact Mobile Robot (Top View)," on page 3 - 8.)
5. Connect the charger cable to the Magellan Pro charge port.

How Long To Charge

Fully charged batteries will enable you to get the best and longest performance from your Magellan Pro robot. A fully charged Magellan Pro robot will run approximately 8–10 hours between charges. (If you have accessories attached to your robot, your running time will be somewhat less.)

CAUTION: To avoid overcharging and causing damage to the batteries, do not leave the robot connected to the charger for more than four hours if the robot's computer is turned off.

You may leave the robot plugged into the charger indefinitely if its internal computer is turned on.

Whenever you recharge the batteries, the recharge time needed will vary depending on the extent to which the batteries are discharged. A lower battery voltage requires a longer charge cycle, though eight hours on the charger (with the computer turned on) is usually enough to ensure a good charge regardless of the degree of discharge. As you work with your Magellan Pro, you will become familiar with the time needed to deliver a full charge based on the duration of run time.

CAUTION: If you expect frequent power losses of extended durations (four plus hours of no power), shut everything down. If the power is off for long enough, the batteries could become discharged sufficiently to be damaged by leaving the robot on.

Battery discharge does not automatically shut off the robot.

Charger Tuning Procedure

The 24V charger that comes with your robot is factory tuned to charge at the proper level when all devices and accessories are powered up. In the event that accessories are added to the robot, creating a greater power draw, the charge output should be adjusted to compensate. You will need a voltmeter (sensitive to 0.10 Volts DC) and a small regular slotted or Phillips screwdriver.

1. Power up the robot and all accessories.
2. Open the rear door (behind the FARnet screen).
3. Plug the charger into a wall receptacle and check the charger output with the voltmeter to ensure there is power.
4. Unscrew the cap on the charge connector and plug in the charger.
5. Unplug the left battery connector. (The robot is now running off the charger.)
6. Place the positive lead of the voltmeter on the nut of the diode output (see Figure 6 - 2, "Charger Diode Location," on page 6 - 41).

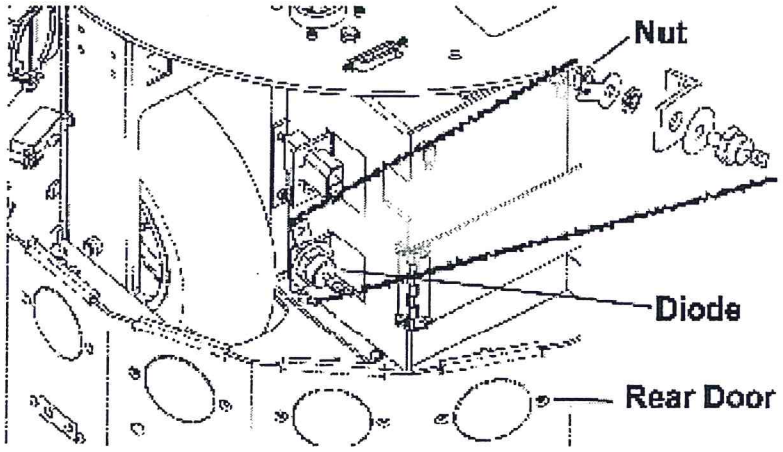

FIGURE 6 - 2. Charger Diode Location

7. Attach the negative lead of the voltmeter to the chassis.
8. Adjust the charger output level (see Figure 6 - 3, "Charger Output Adjuster Location," on page 6 - 42). Turn the adjustment screw clockwise to increase the voltage level. The voltage level at the diode output with battery disconnected

should be 27.8 Volts. When this level is reached, reconnect the battery before disconnecting the charger.

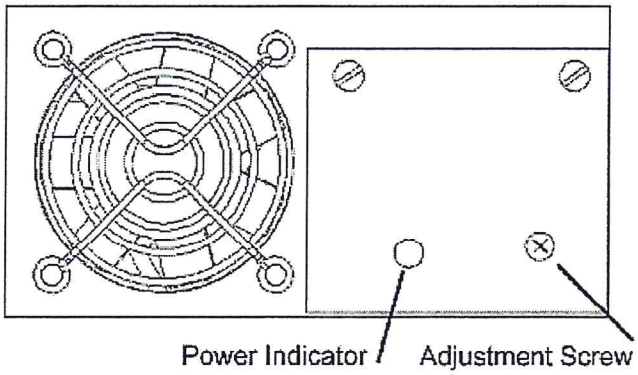

FIGURE 6 - 3. Charger Output Adjuster Location

Wheels

Magellan Pro uses two drive wheels and one passive caster. Its ability to turn on its center makes this robot extraordinarily agile and maneuverable.

Motor Amplifier and Wheel Numbering

Magellan Pro has two motors and a motor amplifier (sometimes called "motor amp"). Motor 1, on the right side of the robot, controls the right side wheel. Motor 0 on the left side of the robot, controls the left side wheel. The two wheels can move completely independently of one another.

If you ever need to install a new motor amplifier, take special care to ensure that the motor amplifier dip switches on the new board are set exactly the same as the dip switches on the old board. Also be sure the connections to the motors and encoders on the new motor amplifier are plugged into the same ports as the ones for the old motor amplifier.

CAUTION: Incorrect dip switch settings may result in erratic and unexpected movement.

Cleaning Magellan Pro

To clean your robot, carefully wipe down the outer enclosure with lint-free cloth dampened in a solution of vinegar in water.

Spare Parts and Accessories

RWI makes it quick and easy for you to get replacement parts and optional accessories (see APPENDIX C "Available Accessories For the Magellan Pro Robot"). Just: call RWI directly at **603-532-6900** and ask for **accessory sales.**

OR

Send email describing what you want to **sales@ rwii.com.**

OR

See the "Robot Accessories" section on the RWI web site at **http://www.rwii.com.**

You can get extra tires, joysticks, batteries, antennas, and more.

APPENDIX A

Warranty Information

Warranty

Your IS Robotics, Inc., robot is warranted to the original purchaser to be free from defects in materials and workmanship for a period of one year from the shipping date. During this warranty period, the RWI Division of IS Robotics, Inc., will repair or replace, at its sole discretion, any defective components free of charge.

This warranty does not apply to any robot, which has been damaged by accident, negligence, mis-application, or that has been repaired, altered or modified in any way by unauthorized agencies. This warranty does not apply to batteries, anodized or painted finishes, or hard disk drives.

The RWI Division of IS Robotics, Inc., expressly disclaims and excludes all other warranties, expressed, implied and statutory, including without limitation warranty of merchantability and fitness for a particular application or purpose.

The RWI Division of IS Robotics, Inc., expressly disclaims and excludes all liability for incidental and consequential damages.

In the event that service is required, please notify RWI Support at support@rwii.com so we can determine the best course of action. ***The RWI Division of IS Robotics, Inc. is not responsible for any damages incurred during shipping of components.***

APPENDIX B

Magellan Pro Specifications

Specifications

Specifications	
Size	Circular — 16 inches (40.6 cm) diameter
Height	10 inches (25.4 cm) without optional accessories
Ground Clearance	2.25 inches (5.7 cm)
Weight	50 pounds (22.7 kg) with laser; 40 pounds (18.2 kg) without laser
Body	Formed and welded aluminum
Color	Red (standard) or special order
Translate Speed	2.5 meters per second
Rotate Speed	270 degrees per second
Payload	20 pounds (9.1 kg)
Drive	2-wheel, PWM
Steering	Differential
Turn Radius	Zero (turns on center)

Tires	2 soft foam rubber, 6.5 inch (16.5 cm) diameter
Batteries	2, 12V, 12 Amp hours
Run Time	8 – 10+ hours without accessories
Aux voltages	5V, 12V, battery voltage
Aux power ports	5
Motion Control	RWI rFLEX Control System
Motors	2 high torque, 24V DC servo motors
Computer	Optional mini computer system
Software	RWI Mobility Robot Infrastructure
I/O Ports	RS-232, joystick
Safety	One emergency stop button
Warranty	One year parts and labor
Sonar Sensors	Sonar: 16, one on each perimeter panel Infrared: 16, one on each perimeter panel (not yet implemented) Tactile: 16, on lower edge of each perimeter panel

APPENDIX C

Available Accessories For the Magellan Pro Robot

Accessories

The following accessories are available for the Magellan Pro robot:

- SICK Laser Range Finder
- Newton Labs Cognachrome Vision System
- Mini-PC (300 MHz, AMD-K6 processor with 4GB hard drive, 32MB RAM). Computer is PII or PIII configurable.
- Frame grabber for mini-PC
- Color camera that plugs into frame grabber
- InnoMedia RS-232 Radio
- Custom-fitted, foam-lined carrying case, and extra batteries
- Bench-mounted battery charger

APPENDIX D

Hard Reset of the rFLEX Control System

Hard Reset of the rFLEX Control System

In some cases, for testing purposes, it is necessary to "hard reset" the rFLEX controller.

CAUTION: This hard reset procedure is NOT a normal operating procedure and is NOT a power switch. The rFLEX Control system supports shutdown through its normal interface.

Should it ever become necessary (for example, during diagnostic procedures), follow this procedure to perform a "hard reset."

Locate and gain access to the underside of the circuit board upon which the rFLEX screen is mounted. Then find the hard reset button on this board (see Figure D - 1, "rFLEX Hard Reset Switch Location," on page D - 49).

The hard reset button is a small (about 1/8 inch diameter) white button located near the edge of the circuit board closest to the bottom of the rFLEX screen. It is just to the left of the three modular connectors, and just to the right of a gray one-inch ribbon cable that connects to the joystick port.

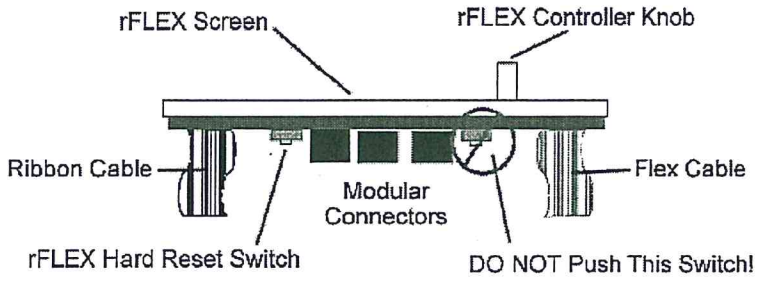

FIGURE D - 1. rFLEX Hard Reset Switch Location

CAUTION: There is an identical switch just to the right of the three modular connectors. DO NOT PUSH THIS SWITCH! It is a power switch, and pushing it will crash your system!

Once you've located the hard reset button, press it once to effect a hard reset of the rFLEX controller.

CAUTION: Be sure to proceed carefully. Do not inadvertently disconnect any cables, or knock any important parts out of position!

APPENDIX E

Serial Communications With the rFLEX Control System

Serial Communications With the rFLEX Control System

The procedures described in this section are not part of initial robot startup, nor are they everyday operational procedures.

The rFLEX Control system provides a serial interface that will connect to on-board computer systems as well as external host computers for firmware upgrades, and so forth. APPENDIX F *Firmware Upgrades For the rFLEX Control System* describes use of the serial interface to upgrade the firmware of your robot's rFLEX Control system processor. A standard RJ-12 serial cable may be used to connect the rFLEX Control system to a standard PC serial port.

To ensure that the serial interface between the rFLEX Control system and your host system is operating properly, perform the following steps:

1. Connect the serial cable to your robot's serial port.
2. Start a terminal emulator program on the computer with the serial port (for example, your desktop computer) that's connected to the rFLEX Control system, using 115,200 0r 38,400 baud, no parity, 8 data bits and I stop bit (N,8,l) configuration. You may also use the rFLEXComm utility program provided on some platforms.

3. If your rFLEX Control system is not already powered on, turn it on by pressing the rFLEX Controller knob until the rFLEX Power Indicator lights up green (a few seconds).
4. Quickly, press several times the return key on the computer on which you are running the terminal emulator. This will send the return character to the rFLEX Control system. If communications are working properly, you will get the following response:

```
+-----------------------------------+
| RWI 5307 rFLEX Controller Board |
+-----------------------------------+
FPGA Program Utility (fpga.dat)
programming done
Press any key to abort auto exec.
Loading application...
rom-config version:        V0.03 (3)
serial num:                100
board version:             A
clock speed:               44900000
console:                   uart0 115200baud
fpga version:              0.22
dbg>
```

If you get the above response, two-way communications between the rFLEX Control system and your host computer are working properly. (Version numbers and parameters might change between rFLEX releases, but this is purely a communications test.)

If you see the following instead of the above printout, then you may have only one-way communications. Or, you may have waited too long between pressing the knob and pressing <return> on the terminal emulator or rFLEXComm.

```
+-----------------------------------+
| RWI 5307 rFLEX Controller Board |
+-----------------------------------+
FPGA Program Utility (fpga.dat)
programming done
Press any key to abort auto exec.
Loading application...
Running Init()
```

If these procedures were executed properly, communication between your host computer and the rFLEX Control system has been established.

NOTE: The rFLEXComm utility program will allow you to perform

several other tests, but requires that the rFLEX Control system board be fully booted and operational.

To exit this mode and resume normal operations, perform a hard reset of the rFLEX Controller. See APPENDIX D *Hard Reset of the rFLEX Control System* for instructions on performing a hard reset.

APPENDIX F

Firmware Upgrades For the rFLEX Control System

The code in the rFLEX Control system has two levels. One is a debugger / monitor that allows updating of the flash ROM, modifying the default baud setting and is responsible for loading the main executable.

rFLEXComm accepts the following options:

rFLEXComm [port] [file to load] [normal baud] [upload baud]

Any options not given are set to defaults. There is no way to specify the file without specifying the port, as there is no key before each option to indicate what it is. The place within the command line of an option indicates what that option is.

port	the comm port (/dev/???)
file to load	the file to upload into the rFLEX when ^U is pressed
normal baud	baud rate to use when not uploading a file
upload baud	baud rate to use when uploading a file

To upload the file for updating your rFLEX.

1. Connect a serial cable.
2. Run rFLEXComm.

```
cd bin
./rFLEXComm /dev/cur0 Magellan-1.2.1.srec 115200
```

3. Type ^U and then hard reset the rFLEX. (See APPENDIX D *Hard Reset of the rFLEX Control System* for instructions.)

It will take about 2 1/2 minutes for the code to upload. Then you will see a prompt asking you to type "yes".

4. At the prompt type "yes"<enter>.

CAUTION: Do NOT interrupt the reprogramming process. Normally, the monitor will not be updated so the system will always be bootable into the monitor for updating / fixing.

5. When you see the message, "restarting," reboot the rFLEX. It will now boot the new code.

Getting Help in rFLEXComm

Typing "help" at the dbg> prompt will provide information on rFLEXComm functions.

```
dbg> help
baud <num>:set baud rate
console <num>:set console uart
load:load program (via uart)
load <name>:load program (from flash)
exec:start program
call:start program
run:start program
dir:list flash files
poke.b <add> <val> :
poke.w <add> <val> :
poke.l <add> <val> :
source <name> :execute cmds (from flash)
if wait <ms> <cmd...> :execute cmd after <ms> unless keystroke
if fail <cmd...> :execute cmd if not okay
if okay <cmd...> :execute cmd if okay
fail :clear okay
okay :set okay
echo ... :
help :this message
exit :exit sourced file
```

Listing the Flash Files From rFLEXComm

Use the "dir" command at the dbg> prompt to list the flash files:

```
dbg> dir
FFE10060 : 41164 : fpga.dat
FFE1A170 : 9829*: load/progfpga
FFE1C818 : 9148*: load/update-cfg
FFE1EC18 : 11117*: load/peek
FFE217C8 : 6484*: load/info
FFE23158 :142877*: demo
FFE45FB8 : 360*: executive.hlp
FFE46160 : 25 : update-cfg
FFE461C0 : 122 : executive.txt
FFE46280 : 39 : executive.exe
FFE462E8 : 207 : executive.rc
dbg>
```

APPENDIX G

Changing the rFLEX Baud Rate

Changing the rFLEX baud rate is something most users will seldom or never have to do. You might need to change the baud rate IF you have a non-RWI PC in your robot, or some other kind of non-standard setup.

Run rFLEXComm (command line options will vary, depending upon your robot):

```
cd bin
./rFLEXComm /dev/cur0 Magellan-1.2.1.srec 115200
```

At the dbg> prompt:

1. Type 'baud 38400' (or whatever baud you want).
2. You should get some junk on the screen as the rFLEX changes baud rates.
3. Type '^C' (CTRL/C) to stop rFLEXComm.
4. Restart rFLEXComm, this time with the normal baud argument changed to your new baud rate.
5. Press enter to get a new 'dbg>' prompt at the new baud rate.
6. Enter 'source update-cfg'. This will set the new baud rate as the default in a set of flash parameters.

Sample Output from rFLEXComm

```
[tyson@tramp bin]$ ./rFLEXComm /dev/cua1 ../../mkflash/RWImonitor.srec 115200
port = /dev/cua1
filename = ../../mkflash/RWImonitor.srec
normal baud = 115200
upload baud = 115200

+-------------------------------------+
| RWI 5307 rFLEX(tm) Controller Board |
+-------------------------------------+

FPGA Program Utility (fpga.dat)
programming done
Press any key to abort auto exec.
Loading application...
rom-config version: V0.03 (3)
serial num:        100
board version:      A
clock speed:       44900000
console:           uart0 115200baud
fpga version:      0.22
dbg>baud 38400
à{{à{ààResetting tty mode... done.
Exiting.
[tyson@tramp bin]$ ./rFLEXComm /dev/cua1 ../../mkflash/RWImonitor.srec
38400
port = /dev/cua1
filename = ../../mkflash/RWImonitor.srec
normal baud = 38400
upload baud = 115200

dbg> source update-cfg
user config utility
usr config updated
dbg>
```

Your rFLEX controller's baud rate is now updated.

APPENDIX H

Board Pinouts

Micro-Fit Connectors

The pins on these connectors are rated for five amps.

RWI suggests trying to limit power requirements on these connectors to about three amps for battery and +5V, and about one or two amps for +12V. Look at the total power consumed on each power supply to determine your actual limit. After powering on the robot's on-board PC, there are about 24 – 45 watts of +5V and +12V available.

When you shut off the robot, the power to these connectors will be shut off as well.

If you perform a hard reset of the PC (see APPENDIX D *Hard Reset of the rFLEX Control System*), the +5V and +12V supplies will briefly shut off. ATX motherboards have a control signal to ATX power supplies; some motherboards use this feature to power cycle themselves during reset. The battery signal will not cycle when this happens.

Molex 6-Pin Micro-Fit Connectors

Molex 3.00mm (.118") Pitch Micro-Fit 3.0 Wire-to-Wire Receptacle

If your robot has a PC, its power supply contains six (6) black 6-pin Molex® Micro-Fit connectors.

Molex part number: 43025

Voltage: 250V
Current: 5.0A max.
Contact resistance: 10mΩ max.
Dielectric withstanding voltage: 1500V AC
Insulation resistance: 1000 MΩ min.
Molex part number: 43025-0600
Molex product Spec: PS-43045

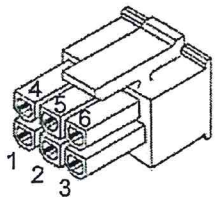

TABLE H - 1. Pin-Out For Molex 6-Pin Micro-Fit — Wire End

4: +5V	5: +12V	6: battery
1: GND	2: GND	3: GND

FIGURE H - 1. Molex 6-Pin Micro-Fit — Wire End

Molex 6-Pin Micro-Fit — PC Board End

Molex part number: 43045-0600

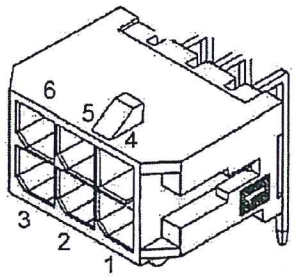

TABLE H - 2. Pin-Out for Molex Micro-Fit — PC Board End

6: battery	5: +12V	4: +5V
3: GND	2: GND	1: GND

FIGURE H - 2. Molex 6-Pin Micro-Fit — PC Board End

Molex 3.00 (.118") Pitch Micro-Fit 3.0 Terminal — Female

Molex part number: 43030

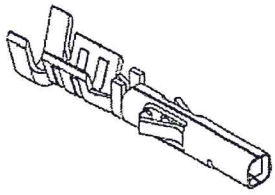

FIGURE H - 3. Molex Micro-Fit — Wire Reference

Mini-Fit Connectors

Each of the Mini-Fit connectors can handle up to about 10 amps. However, the sum of all the connectors should not exceed 30 amps. If your robot is equipped with an on-board PC, the PC will be plugged into one of the six mini-fit connectors, and

will account for about two amps plus whatever you might have added to its AUX power connectors.

Pins 4 and 5 are switched off when the robot is switched off.

Pin 1, motion enable, will have about 14V on it when the robot's brakes are off; it will have 0V when the robot's brakes are on. This signal is used to power the enabling part of the motor amp circuits.

RWI uses Pin 1 to power the coils in the motor amp relays, plus a few ICs. If you want your robot's motion system to shut down when the emergency stop button is pressed, use this signal.

Molex 5-Pin Mini-Fit Connectors

Molex 5-Pin Mini-Fit Jr. Receptacle, Single Row

If your robot has a PC, its FARnet board contains six (6) white 5-pin Molex Mini-Fit Jr. connectors.

Molex part number: 39-01-4051

Voltage: 600V
Current: 9.0A max.
Contact resistance: 10mΩ max.
Dielectric withstanding voltage: 1500V AC
Insulation resistance: 1000 MΩ min.
Molex product Spec: PS-5556-0001

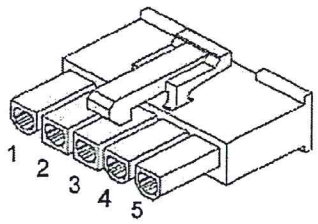

TABLE H - 3. Pin-Out For Molex 5-Pin Mini-Fit — PC board End

1:Motion enable	2: GND	3: GND	4: Battery	5:Battery

FIGURE H - 4. Molex 5-Pin Mini-Fit — Wire End

Molex Mini-Fit, Jr. Header, Vertical, Single Row With Pegs

Molex part number: 39-30-2050.

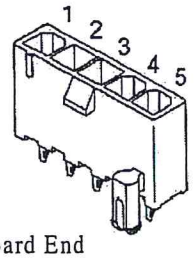

TABLE H - 4. Pin-Out For Molex 5-Pin Mini-Fit — PC board End

1:Motion enable	2: GND	3: GND	4: Battery	5:Battery

FIGURE H - 5. Molex 5-Pin Mini-Fit — PC Board End

Molex Mini-Fit Wire Family Terminal Crimp, Female

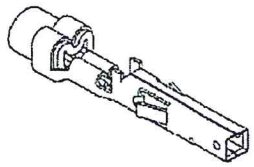

FIGURE H - 6. Molex Mini-Fit — Wire Reference

Serial Connectors

DB-9 Connector

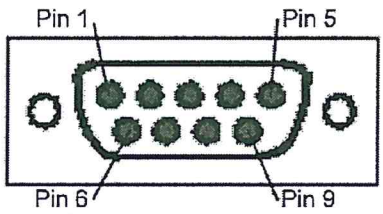

TABLE H - 5. Pin-Out DB-9 Connector

1: CD	2: RxD	3: TxD	4: DTR	5: Signal ground
6: DSR	7: RTS	8: CTS	9: Not used	

FIGURE H - 7. DB-9 Connector

RJ-12 Connector

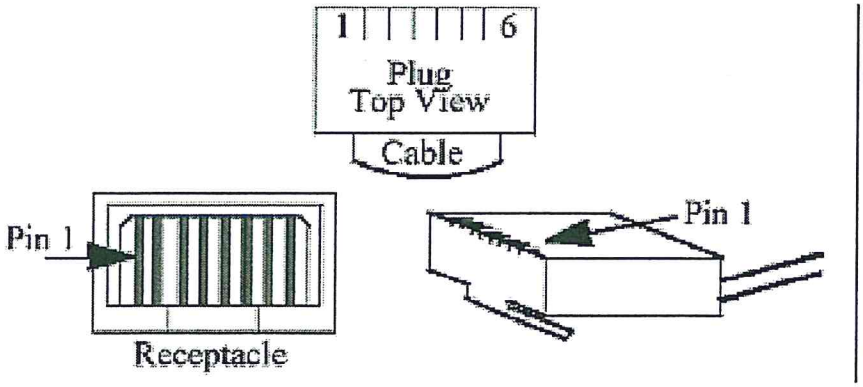

TABLE H - 6. Pin-Out RJ-12 Connector

1: DTR	2: Ground	3: TxD	4: RxD	5: DCD	6: Not connected

FIGURE H - 8. RJ-12 Connector

APPENDIX I

Calibrating the IR Sensors

IR Sensor Calibration

The IR Sensors (GP2D02 from Sharp Corp.) on your robot need to be recalibrated regularly to get good quality data. This procedure uses the Mobility software that is either installed on your robot's internal computer or on your base station computer.

When Mobility is installed, all the Mobility software is placed in a single directory hierarchy. The root of that hierarchy is referred to as $MOBILITY_ROOT in our documentation because the Mobility software expects the environment variable MOBILITY_ROOT to be set to the pathname of that hierarchy. Robots are shipped with the Mobility software placed in the home directory of the 'mobility' user with a name that incorporates the Mobility release number. The 'mobility' user's MOBILITY_ROOT environment variable is automatically set up at login. For example, $MOBILITY_ROOT might be /home/mobility/mobility-b-1.1.7.

For additional information see *Mobility Robot Integration Software User's Guide*.

Calibration Procedure

The calibration procedure requires editing a file in Mobility and checking the readings from the senors.

1. Place a piece of paper facing each IR sensor at a distance of 0.6 meters, and record the hexadecimal readings from the rFlex IR Console screen. Board 0 controls the sensors on the rear door of the robot and board 1 the front. Sensor 0 is adjacent to the latch of the door and sensor 7 is next to the hinge.
2. Find the file "ircalibration" that is located in the Mobility user home directory. If the file is not there, copy the file "$MOBILITY_ROOT/ircalibration.template" to the home directory. Please refer to the file $MOBILITY_ROOT/etc/ircalibration.template for the file format.
3. Edit the file and replace the hexadecimal numbers for each board and sensor with the corresponding numbers you recorded from the rFLEX IR Console screen when the paper was 0.6 meters in front of each sensor.
4. To verify, run the base server, and run MOM. In MOM, right-click on the IR/Raw object. Select "Numeric Vector View" from the pop-up menu. This displays the sensor readings in meters. Verify that the readings are accurate by placing an object at various distances between 0.1 and 0.8 meters.

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