Khepera®

RADIO BASE USER MANUAL

Version 1.0

K-Team S.A.

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Documentation author

K-Team
Ch. de Vuasset, CP111
1028 Préverenges
Switzerland

info@k-team.com
http://www.k-team.com

Trademark Acknowledgements

NOTICE:

- The contents of this manual are subject to change without notice.
- All efforts have been made to ensure the accuracy of the content of this manual. However, should any error be detected, please inform K-Team.
- The above notwithstanding, K-Team can assume no responsibility for any error in this manual.

TABLE OF CONTENT

1 INTRODUCTION

The radio base station is an intelligent compact radio modem that can be controlled using a standard RS232 connection. It is adapted to communicate with one or more Khepera radio turrets. This base station, like every turret, has its own local processor for management of the whole communication procedure, which includes the data encoding, transmission and reception, error detection and correction. The radio base station make it possible, for a host computer, to communicate with Khepera robots equipped with radio turrets.

1.1 How to use this manual

This manual is organised into six chapters and an appendix. To learn how to make the best use of your radio base station you are urged to read all of chapters 2 through 5. You need to read chapter 6 if you use the software LabVIEW®. The appendix can be referred to as necessary.

Chapter 1	gives you a general introduction.
Chapter 2	describes some important warnings.
Chapter 3	explains the contents of the package.
Chapter 4	explains the functionality of the radio base station.
Chapter 5	explains how to connect the radio base station to the host computer.
Chapter 6	is addressed to users of LabVIEW®. It shows simple virtual instruments (VI) to control the radio base functionality.
Appendix A	details the commands of the communication protocol.

2 SAFETY PRECAUTIONS

Don't plug or unplug any connector when the base station is powered. All connections must be made when the base station is switched OFF. Otherwise damages can occur.

Switch OFF the base station if you will not use it for more than a day. Please disconnect the power supply removing it from the wall socket.

If you have any question or problem concerning this module, please contact your Khepera dealer.

3 UNPACKING AND INSPECTION

Please check that you have a complete package. You should find:

- Documentation.
- The radio base station equipped with an antenna.
- A power supply

4 THE RADIO BASE STATION

4.1 Overview

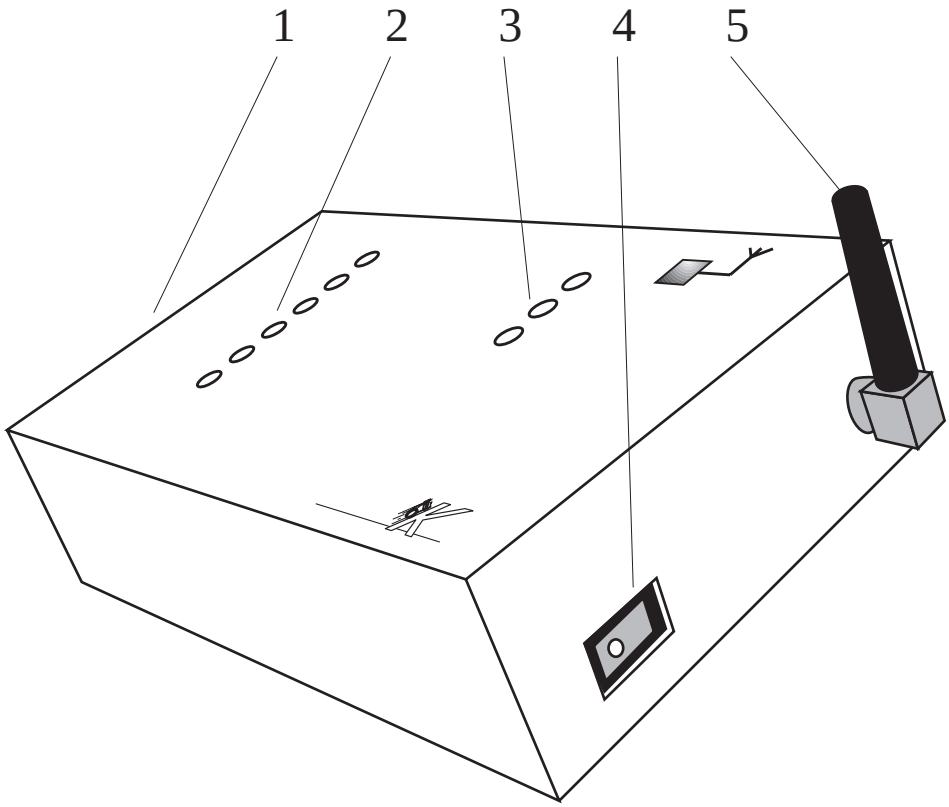


Figure 1: Overview of the turret layout.

Make an external inspection of the turret. Note the location of the following parts:

1. RS232 connector.
2. RS232 LEDs indicators.
3. Radio LEDs indicators.
4. Power supply jack.
5. Antenna.

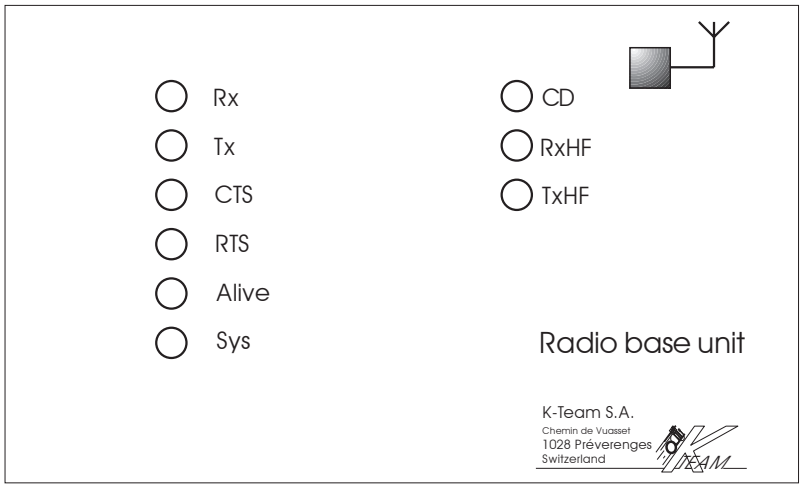


Figure 2: Layout of the LEDs on the radio base station.

Description of the several LED indicators:

Rx	Receive RS232 data (data transfer from host to base station)
Tx	Transmit RS232 data (data transfer from base station to host)
CTS	Clear To Send of the host (indication from the radio base station to the host computer that the radio is ready to send).
RTS	Request To Send of the host (indication from the host computer to the radio base that the computer is ready to send).
Alive	Shows that the station is active (blinking at 2 Hz).
Sys:	Reserved.
CD:	Carrier detect. When ON, the turret is detecting an active radio channel.
RxHF:	Receive radio data (data transfer from a radio turret to the base station)
TxHF:	Transmit radio data (data transfer from the base station to a radio turret)

The communication between the radio base and the host computer is made by a RS232 serial link configured at **9600 baud, 8 data bits, 1 start bit, 2 stop bits, no parity and hardware flow control with RTS and CTS signals**.

4.2 Introduction to the Khepera communication structure

This section explains the Khepera BIOS communication structure. This structure explains also how the radio base station can be used.

On Khepera, the SerCom protocol, which implements the standard RS232 protocol used to control Khepera remotely, is based on the COM (communication) module of the

BIOS. The COM module has a choice between several physical communications channels. On Khepera, the two main communication channels are the RS232, managed by the SER module, and the local turrets network, managed by the MSG module. The SER module includes all calls to manage the RS232 hardware. The MSG module includes all calls to manage the hardware devoted to the communication with the extension turrets processors. The choice between SER and MSG channels is made by the COM module at boot, and depends on the turrets presents on the Khepera and their configuration. If there is an extension turret configured as communication channel, this choice is set as main communication channel. If no turrets are found, the SER module is used. On the radio turret, the running mode switch 6 allows selection of the turret as main communication channel or as simple extension turret (see the Khepera radio turret user manual for more details).

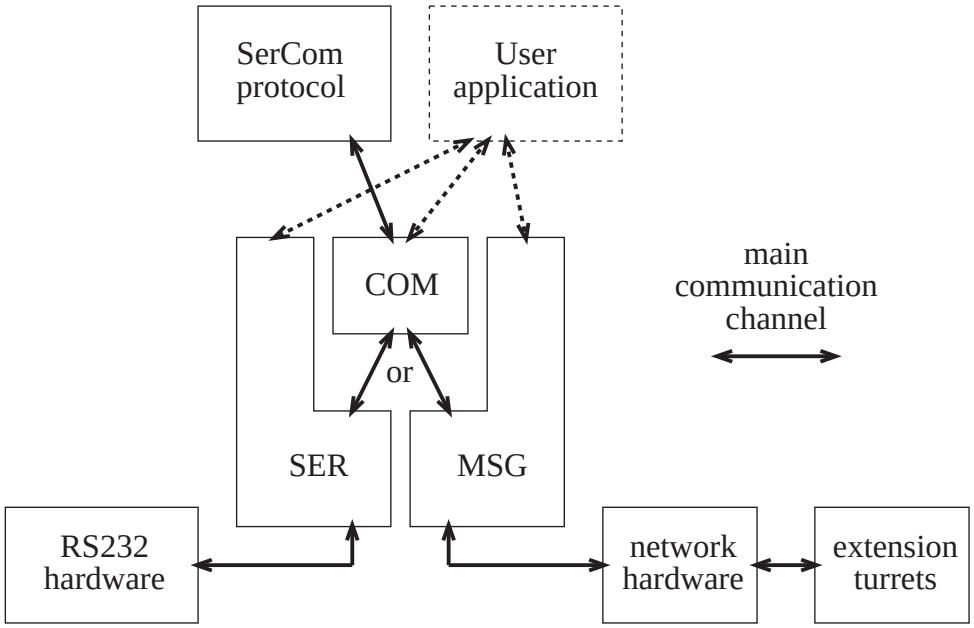


Figure 3: Communication channels in the Khepera BIOS structure

If the radio turret is set as main communication channel, all messages of the SerCom protocol are sent and received on the radio link to and from the turret with ID 0 (radio base). In this configuration, the RS232 serial link is not used by the SerCom protocol. The radio link takes the role of main communication channel and the radio base station is the standard communication partner. The radio base station forwards all radio messages on its RS232 in transparent mode. All messages that the radio base station receives on its RS232 port (except the * command) are forwarded to the radio channel. This means that the radio base station and a radio turret on a Khepera can replace in a transparent way the RS232 wired connection.

4.3 Radio network and turret ID

The radio network is composed of a maximum of 31 Khepera equipped with radio turrets and by one radio base station connected to the host computer, as illustrated in

figure 4.

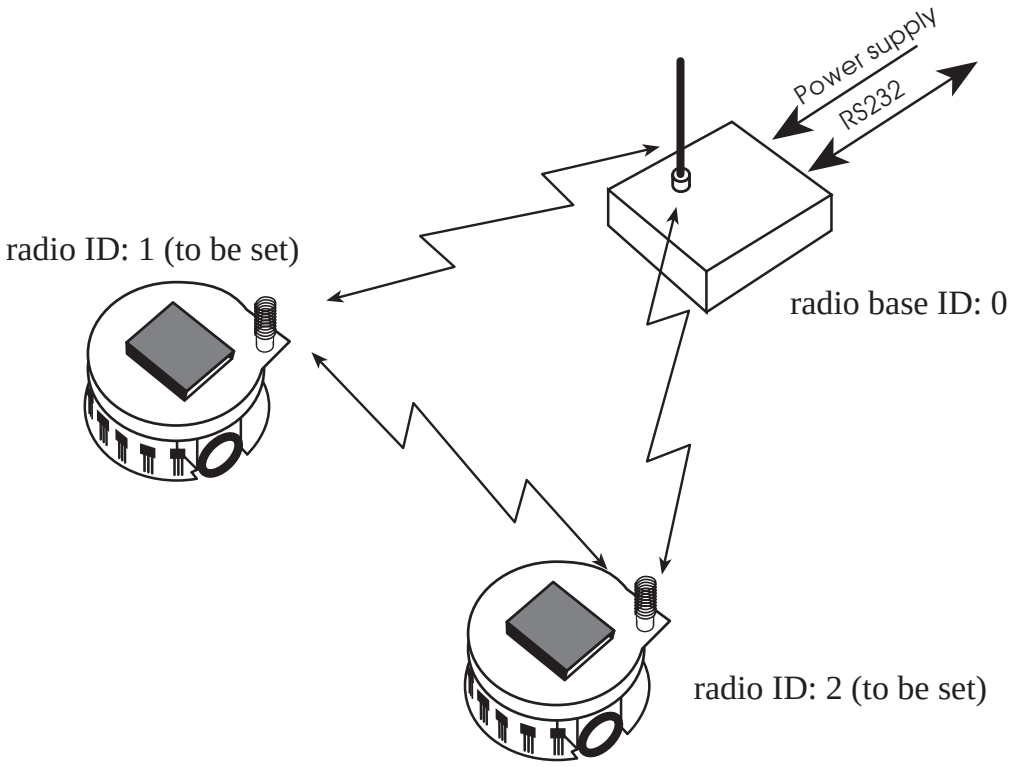


Figure 4: Radio network typical configuration

The network is based on ID numbers associated with each robot present in the radio network. The radio base station ID is always 0. The ID of a radio turret can be set on the radio turret itself using the ID selector (see the Khepera radio turret user manual for more details). **The radio turret ID should be never set to 0.**

4.4 Radio properties and correct data transmission

The radio channel is a half duplex channel, which means that reception and transmission of data are mutually exclusive. The default state of the radio module is reception. As soon as data has to be transmitted, the state changes and the data is transmitted.

The state of the radio module is visualized on the RxHF (radio receive) and on the TxHF (radio transmit) LEDs.

The data transmitted on the radio channel is encapsulated in messages including information on the type of message, the sender ID, the destination ID, length of data and a checksum for error correction. The receiver acknowledges the reception of the message. The sender considers the message as correctly sent only if acknowledged by the receiver. If no acknowledgment is received in a given timeout, the message is sent again. The same procedure is repeated until a maximum number of repetitions is reached. If all repetitions fail, the message is considered lost.

This protocol process is visualized on the Khepera radio turret only (see the Khepera radio turret user manual for more details).

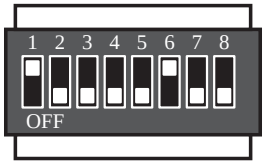
The data encapsulation and transmission protocol add an important quantity of information and time delay to simple data transmission. This ensures correct data transmission and is therefore necessary. Due to the fact that the added information and time delay is independent from the quantity of data, optimal results in data transmission speed are achieved with data having a length of 16 bytes (max length of data in a message).

WARNING: environmental conditions can drastically influence the transmission quality. Distance of transmission and quantity of data lost depend on several factors: proximity of metallic structures, other radio devices and noise emission from computers can all cause interferences. In a good environment no data should be lost. If data is lost, please check the environmental conditions.

5 CONNECTIONS

This configuration allows the communication between the robot and a host computer through the radio link. On the host computer side the link is made by a RS232 line and the radio base station. On the Khepera robot the link is supported by the radio turret.

The Khepera robot has to be set in a SerCom mode and be equipped with a radio turret. The radio turret switch number 6 has to be set ON to support radio transmission as main communication channel (COM). An ID has to be selected for each radio turret which will be used on the network. For first tests, set the turret ID to 1. The test settings are illustrated by figure 5.



Turret ID: 1 used as main communication channel

Figure 5: Settings of the radio turret for the communication test.

For the radio base station, the following connections must be made:

- Between the radio base station and the host computer by a standard RS232 cable. This cable is not in the package because there are several standards at the level of the host connector. You can easily find this cable by your host computer dealer.
- Between the radio base station and the power supply with the cable fixed to the power supply.

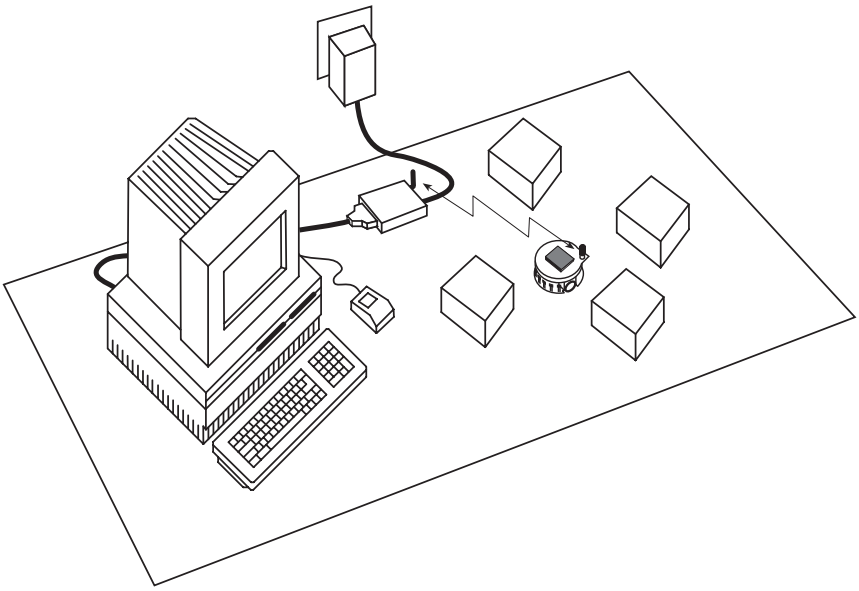


Figure 6: Communication set-up.

To test the radio connection please do the following manipulations:

- Run a terminal emulator on your host computer (for instance Hyper Terminal on PCs, Microphone on MACs, tip on UNIX or minicom on linux) connected to the serial port on which you have connected the robot. **Configure your terminal as following: 9600 baud, 8 data bits, 1 start bit, 2 stop bits, no parity and hardware flow control with RTS and CTS signals.**
- Plug the mural power supply of the radio base station to the main.

Your terminal should display a welcome message:

```
ROM of the radio station, ...
```

- Type ***1** and then return to get the connection with robot with radio ID 1.
- Switch the Khepera robot ON (batteries or power supply), or, if it is already connected, **reset the robot** pressing on the reset button.

Your terminal should display:

```
ROM of minirobot KHEPERA,...
```

When doing this, you should be able to track the data from the Khepera to your computer looking to the Tx LEDs on the radio turret, the RxHF LED on the radio base station (the CD and TxHF LEDs should also blink) and the Tx LED also on the radio base station.

If the robot does not respond as indicated, check the points mentioned above and retry. If the Tx LED on the radio base station blinks but your computer does not show any message, check the configuration of your serial port and terminal emulator, as well as the connection between interface/charger module and host computer.

6 USING LABVIEW®

This chapter is to familiarise you with the LabVIEW® environment in the context of Khepera radio use. LabVIEW® is a product of National Instruments (http://www.natinst.com). To this end, the examples are presented in an increasing order of complexity. Our advice is to follow the chronological order of presentation. Please refer to the LabVIEW manuals for more information about this software.

The following examples and the files distributed with this product are based on LabVIEW® version 5. LabVIEW® runs on your PC, Macintosh® or SUN® workstations, and can control the functionality of the Khepera robot using the SerCom serial communication protocol.

6.1 Set up of the serial link

Set your environment as presented in section 5.

To enable the exchange of information between your computer and the radio base, you have to configure the serial link of your host computer.

Be sure that the connection cable is connected at both ends (Radio base and RS232 interface of your host), that the robot and the radio station are powered, then start LabVIEW® and open the Set-up virtual instrument (called “VI”). The panel illustrated in figure 7 should appear.

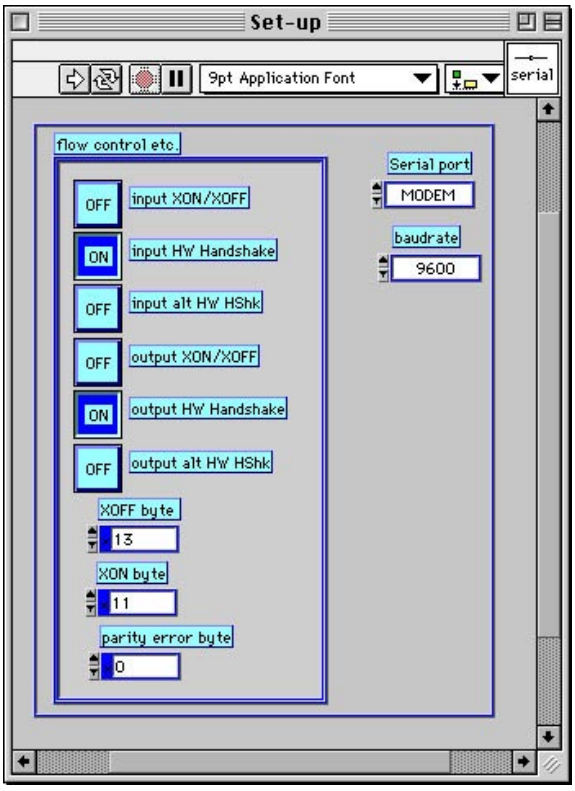


Figure 7: Set up panel for serial link initialisation.

Now, select the serial port on which the robot is connected. This selection depend on which port you use and the type of computer you have. This choice must be made for every module that you will use.

Then click once on the run arrow  at the top of the window.

A stop icon  appears for a few seconds, after what the front panel returns to its initial state.

That's all! The serial link with Khepera is set to 9600 baud. It will remain so until you quit LabVIEW®.

6.2 Khepera selection

The radio base station can communicate with several Khepera. To communicate with a specific Khepera you have to select it. The selection is made by the Set_channel VI. If you open it, the panel illustrated in figure 8 should appear.

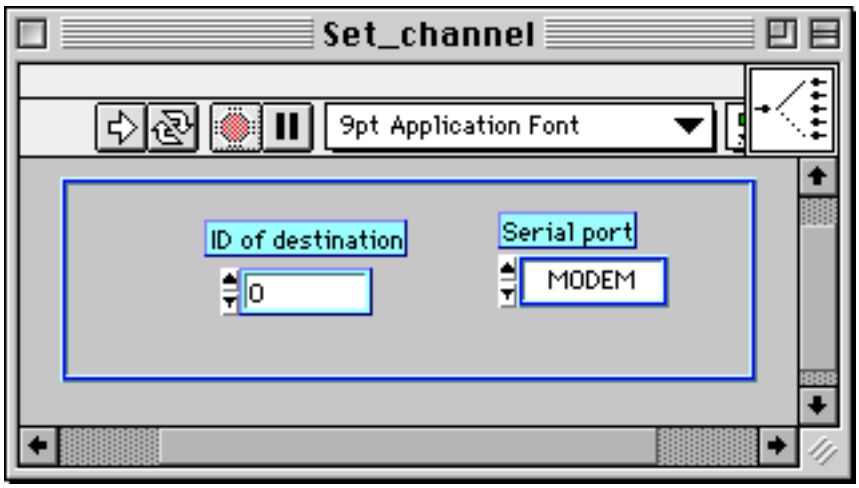


Figure 8: Set_channel panel for selection of the robot you want to communicate with.

Now, select the robot you want to address (number 1 in our test example). Then click once on the run arrow at the top of the window. The radio base will now send and receive data only to and from the Khepera with radio turret with ID number 1. You can change the channel by running again this same VI with another ID.

At this stage your configuration works like a wired connection to robot having ID 1. All standard VIs you run will work correctly and act on robot with ID 1.

6.3 Motors

We will now control the displacement of the robot. Open the Motors VI that comes with the Khepera robot (the original one). Now your screen displays the following panel:

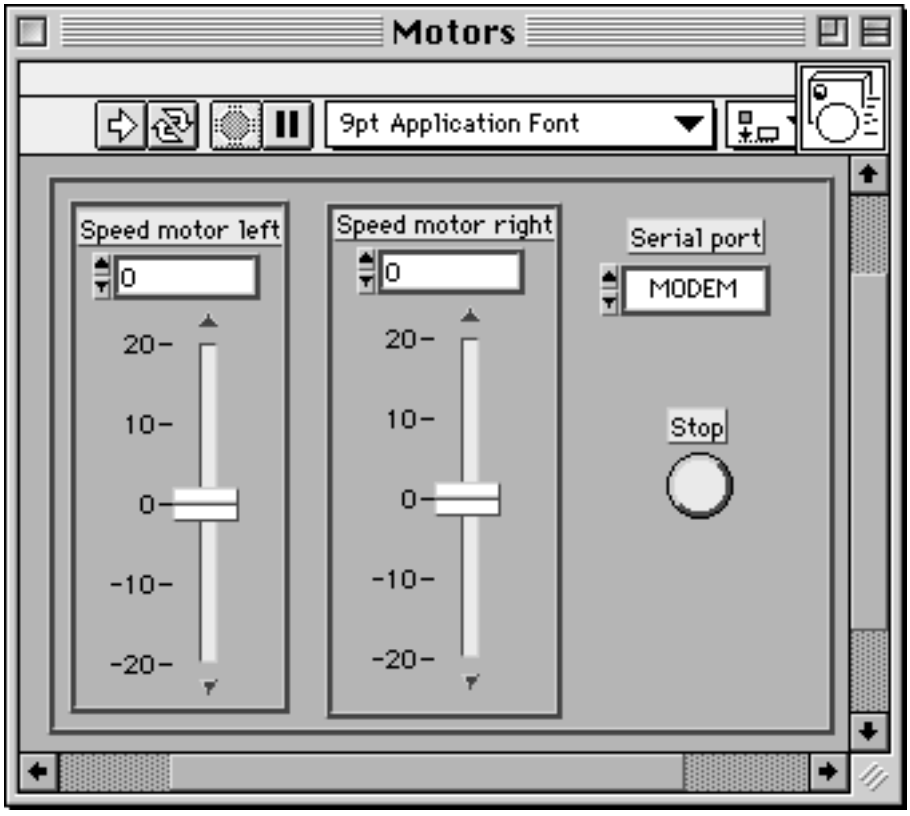


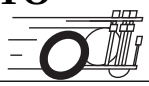
Figure 9: Motors panel: 2 sliders controlling the speed of each wheel.

Control directly each one of the motors by simply putting the desired speed values in the corresponding slider. This can be made moving the slider or entering the desired speed in the digital display placed between the sliders and their names.

Possible values are constrained (only on the sliders) between -20 and +20 so to take care of the mechanics. To transmit your order to the robot, just click once on the arrow. You can change the values and click on the arrow again to validate your choice. You see that the robot continues moving at the same speed until new values are send.

If you are getting bored with clicking on the arrow, try one click on the double arrow  . Click on the stop icon to stop the execution.

APPENDIX A COMMUNICATION PROTOCOL TO CONTROL THE RADIO TURRET



The radio base module plays the role of a transparent radio bridge between the host computer and the Khepera robot equipped with a radio turret in communication mode. The communication between the radio base and the host computer is made by a RS232 serial link configured at **9600 baud, 8 data bits, 1 start bit, 2 stop bits, no parity and hardware flow control with RTS and CTS signals**.

The only command available on the radio base module is a switch command:

* Destination selection

Format of the command: *ID_destination

Format of the response: no response

Effect: Switches the communication channel to communicate with the Khepera equipped with the radio turret with ID “ID_destination”. The radio turret ID has to be selected on the radio turret switches. Every string sent to the RS232 of the radio base after this selection will be directly sent to the corresponding Khepera radio turret. If “ID_destination” is set to -1, the communication is established with all radio turrets simultaneously. Every string sent to the radio base after this selection will be distributed to all radio turrets. The use of this last addressing mode is basically reserved to programmers who want to write specific software. For standard communications, this mode does not guarantee that the message is received properly by all robots. Moreover, with the standard protocol, all Khepera robots will answer simultaneously, generating no correct answers.