Khepera®

USER MANUAL

Version 5.02

K-Team

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APPENDIX A COMMUNICATION PROTOCOL TO CONTROL THE ROBOT

This communication protocol allows complete control of the functionnalities of the robot through a RS232 serial line. The connection configuration needed is presented in section 5.2. The set-up of the serial line of your host computer must correspond to the one set on the robot with the jumpers (running modes 1 to 3). The protocol is constituted by commands and responses, all in standard ASCII codes. A command goes from the host computer to the robot: it is constituted by a capital letter followed, if necessary, by numerical or literal parameters separated by a comma and terminated by a line feed. The response goes from the robot to the host computer: it is constituted by the same letter of the command but in lower case, followed, if necessary, by numerical or literal parameters separated by a comma and terminated by a line feed.

To better understand this protocol we propose a very simple test as following:

- Set the jumpers of the robot for running mode number 1 (See figure 20).
- Set the connection configuration presented in section 5.2.
- Start a terminal emulator on your host computer with the serial line set to 9600 Baud, 8 bit data, 1 start bit, 2 stop bits, no parity.
- Type the capital letter **B** followed by a carriage return or a line feed.
- The robot must respond with **b** followed by an indication of the version of software running on the robot and terminated by a line feed.
- Type the capital letter **N** followed by a carriage return or a line feed.
- The robot must respond with **n** followed by 8 numbers separated by a comma and terminated by a line feed. These numbers are the values of the proximity sensors presents on the robots.
- Retry the same command (N) putting some obstacles on the front of the robot. The response must change.
- Try other commands:

List of Available Commands

(∏ indicates CR (carriage return) **or** LF (line feed). ¶ indicates CR **and** LF.)

A Configure

Format of the command: A, Kp, Ki, Kd∏

Format of the response: a¶

Effect: Set the proportional (Kp), integral (Ki) and derivative (Kd) parameters of the speed controller. At the reset, these parameters are set to standard values: Kp to 3800, Ki to 800, Kd to 100.

B Read software version

Format of the command: B∏

Format of the response: b, version_of_BIOS, version_of_protocol¶

Effect: Give the version of the software present in the EPROM of the robot.

C Set a position to be reached

Format of the command: C,pos_left,pos_right∏

Format of the response: c¶

Effect: Indicate to the wheel position controller an absolute position to be reached. The motion control perform the movement using the three control phases of a trapezoidal speed shape: an acceleration, a constant speed and a deceleration period. These phases are performed according to the parameters selected for the trapezoidal speed controller (command J). The maximum distance that can be given by this command is (2**23)-2 pulses that correspond to 670m. The unit is the pulse that corresponds to 0.08mm. The movement is done immediately after the command is sent. In the case another command is under execution (speed or position control) the last command replaces the precedent one. Any replacement transition follows acceleration and maximal speed constraints.

D Set speed

Format of the command: D, speed_motor_left, speed_motor_right∏

Format of the response: d¶

Effect: Set the speed of the two motors. The unit is the pulse/10 ms that corresponds to 8 millimetres per second. The maximum speed is 127 pulses/ 10ms that correspond to 1m/s.

E Read speed

Format of the command: E∏

Format of the response: e, speed_motor_left, speed_motor_right¶

Effect: Read the instantaneous speed of the two motors. The unit is the pulse/10 ms that corresponds to 8 millimetres per second.

F Configure the position PID controller

Format of the command: F,Kp,Ki,Kd∏

Format of the response: f¶

Effect: Set the proportional (Kp), the integral (Ki) and the derivative (Kd) parameters of the position regulator. At the reset, these parameters are set to standard values: Kp to 3000, Ki to 20, Kd to 4000.

G Set position to the position counter

Format of the command: G, position_motor_left, position_motor_right∏

Format of the response: g¶

Effect: Set the 32 bit position counter of the two motors. The unit is the pulse, that corresponds to 0,08 mm.

H Read position

Format of the command: H∏

Format of the response: h, position_motor_left, position_motor_right¶

Effect: Read the 32 bit position counter of the two motors. The unit is the pulse, that corresponds to 0,08 mm.

I Read A/D input

Format of the command: I, channel_number∏

Format of the response: i, analog_value¶

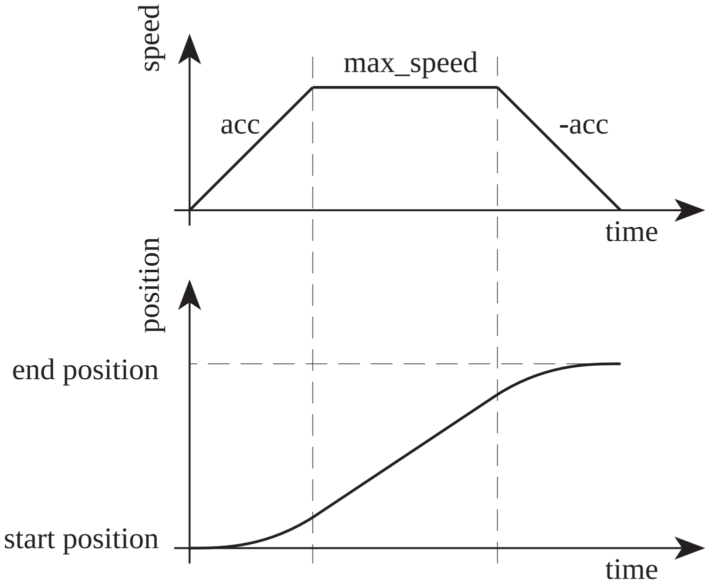
Effect: Read the 10 bit value corresponding to the channel_number analog input. The value 1024 corresponds to an analog value of 4,09 Volts.

J Configure the speed profile controller

Format of the command: J, max_speed_left, acc_left, max_speed_right, acc_right∏

Format of the response: j¶

Effect: Set the speed and the acceleration for the trapezoidal speed shape of the position controller. The max_speed parameter indicates the maximal speed reached during the displacement. The unit for the speed is the pulse/10ms that corresponds to 8 mm/s. The unit for the acceleration is the ((pulse/256)/10 ms)/10 ms, that correspond to 3,125 mm/s^2. At the reset, these parameters are set to standard values: max_speed to 20, acc to 64.



K Read the status of the motion controller

Format of the command: K∏

Format of the response: k, T_left, M_left, E_left, T_right, M_right, E_right¶

Effect: Read the status of the motion controller. The status is given by three numbers for every motor: T (target), M (mode) and E (error). T=0 means that the robot is still on movement. T=1 means that the robot is on the target position. M=0 means that the motor control is in the speed mode. M=1 means that the control is in position mode. M=2 means that the control is in PWM mode. E indicates controller position or speed error.

L Change LED state

Format of the command: L, LED_number, action_number∏

Format of the response: l¶

Effect: Perform an action on one of the two LEDs of the robot. Possible actions are: 0: turn OFF, 1: turn ON, 2: change status. The LED number 0 is the lateral one, the LED number 1 is the frontal one.

N Read proximity sensors

Format of the command: N∏

Format of the response: n,val_sens_left_90°,val_sens_left_45°,val_sens_left_10°,
val_sens_right_10°,val_sens_right_45°,val_sens_right_90°
,val_sens_back_right,val_sens_back_left¶

Effect: Read the 10 bit values of the 8 proximity sensors (section 2.1.6.2), from the front sensor situated at the left of the robot, turning clockwise to the back-left sensor.

O Read ambient light sensors

Format of the command: O∏

Format of the response: o,val_sens_left_90°,val_sens_left_45°,val_sens_left_10°,
val_sens_right_10°,val_sens_right_45°,val_sens_right_90°
,val_sens_back_right,val_sens_back_left¶

Effect: Read the 10 bit values of the 8 light sensors (section 2.1.6.1), from the front left sensor turning clockwise to the back-left sensor.

P Set PWM (pulse width modulation)

Format of the command: P, pwm_motor_left, pwm_motor_right∏

Format of the response: p¶

Effect: Set the desired PWM amplitude (see “Motors and motor control” on page 6 for more details) on the two motors. The minimum PWM ratio is 0 (0%). The maximal forward ratio (100%) correspond to a value of 255. The maximal backwards ratio (100%) correspond to a value of -255.

T Send a message to an extension turret

Format of the command: T, turret_ID, command∏

Format of the response: t, response¶

Effect: Send a command and return the response of the intelligent extension turret with turret_ID. The list of turrets connected and their ID can be requested with the tool “net”. The command parameter takes the same format as a standard command, including an identification capital letter followed, if necessary, by numerical parameters separated by commas and terminated by a line feed. The response takes the same format, starting with the same letter but in lower case, followed, if necessary, by numerical parameters separated by commas and terminated by a line feed. The command and response formats are specific for every module.

R Read a byte on the extension bus

Format of the command: R, relative_address∏

Format of the response: r, data¶

Effect: Read the data byte available at the relative_address (0...63) of the extension bus.

W Write a byte on the extension bus

Format of the command: W, data, relative_address∏

Format of the response: w¶

Effect: Write the data byte at the relative_address (0...63) of the extension bus.