KTH Electrical Engineering

APC220 Radio Communication Module and Nexus robots

Quick start guide

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Chapter 1

Setup

This is a guide on how to connect the APC220 radio modules to PC and Nexus robots and have them communicate between each other. You can use use this communication link to transfer commands and position info to the robots and to retrieve data from the robot's onboard sensors. The files needed to test, as well as the manufacturers' manuals for the robots and the radios can be found in the Smart Mobility Lab repository [1], in the NexusRobots directory. Check this document's references to find other useful websites.

Figure 1.1: APC220 Radio Communication Module. [`http://www.dfrobot.com/`]

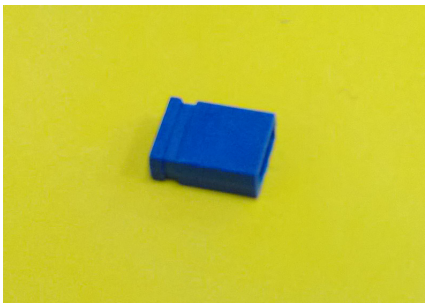
1.1 Hardware

You will need an APC220 module for the PC and one for each Nexus robot you want to communicate with. In order to connect the APC220 module to the PC you will need an USB to TTL converter. If you buy the modules from DFROBOT[1], the shipping list already includes (see figure 1.1):

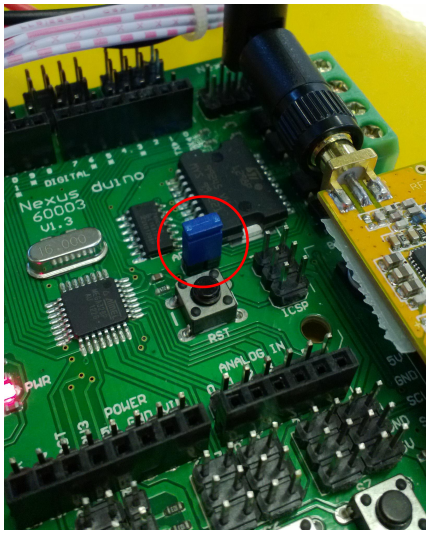
- APC220 module (2 units)
- Antenna for radio communication (2 units)
- USB to TTL Converter (CP210) (1 unit)

In the following we will assume that the hardware at your disposal is the one we just described.

In order to enable the radio module you will need a jumper as well (figure 1.2). The jumper must be removed whenever you upload code to the board (using the USB cable), and then plugged back if you want to communicate wireless.



(a) Jumper.



(b) Jumper plugged to use the radio (here the motor shield is not plugged to the Arduino board.).

Figure 1.2: Usage of jumper.

[1] http://www.dfrobot.com/index.php?route=product/product&product_id=57#.UjGDYNKbs_o

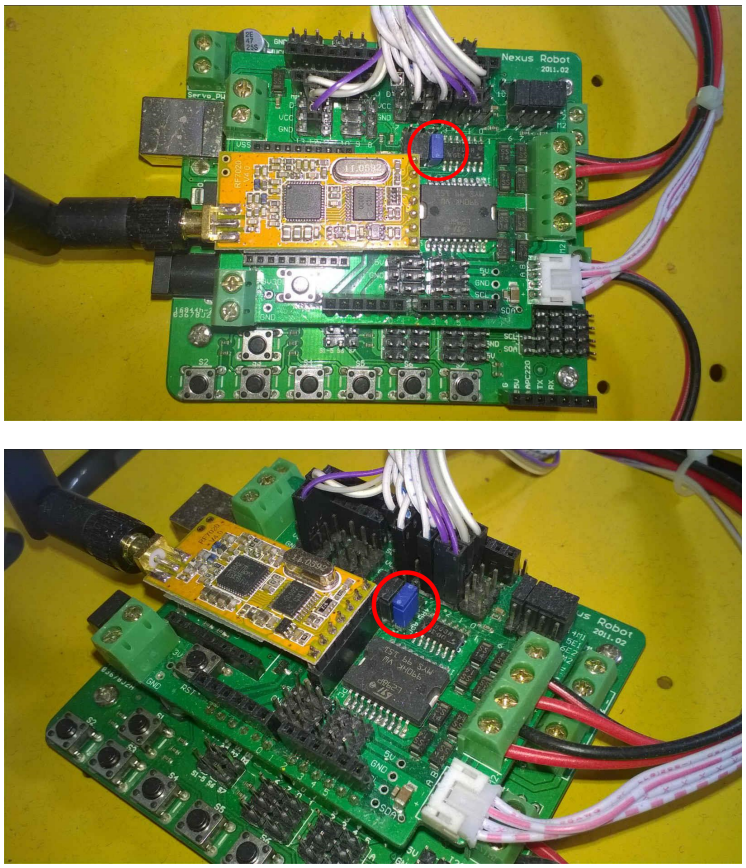


Figure 1.3: Radio and jumper mounted on the motor shield.

1.2 Software (for Windows)

1. Plug the USB-TTL adapter in a USB port of your PC and wait for Windows to find and install the drivers. If Windows is not able to find them, download the .zip file from Silicon Labs[2]. As the download finishes, unzip the folder and run the correct installer, according to your system architecture.

2. Download and install RF-magic software[3] to set up the modules.

We here report the instructions to setup and pair the two APC220 modules.

- Plug one of the modules to an USB port of your PC via the USB-TTL converter and run the RT-magic software as administrator. If a window with

[2] `http://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx`

[3] `http://www.dfrobot.com/image/data/TEL0005/rfmagic.rar`

strange characters appear, do not worry and press OK.

The program GUI appears as in figure 1.4. Select the COM port the device is connected to in the field *PC Series*. As you press *Read R* you should see *Found device!* on the bottom of the window, as in figure 1.4.

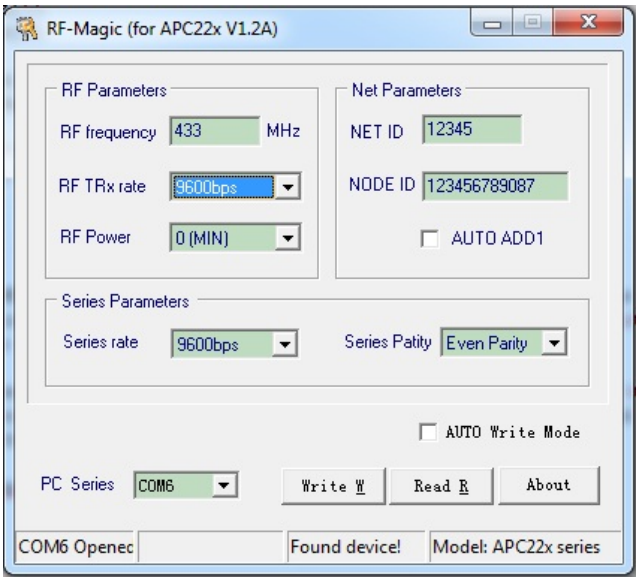


Figure 1.4: RT-magic interface.

- Set up the parameters, these should be ok:

Parameter	**Value**
RF frequency	433[MHz]
RF TRx rate	9600[bps]
RF power	9(MAX)
Series rate	9600[bps]
Series parity	Disable
NET ID	12345
NODE ID	123456789087
AUTO ADD1	(disabled)

Table 1.1: Parameters to insert in the RT-magic window.

Please note: *NET ID* and *NODE ID* are arbitrary. But it is important that *NET ID* is the same for each module of the network and *NODE ID* is different from node to node.

The module we just programmed will be called APC-PC from now on.

- Plug the other module using the USB-TTL connector. Repeat the previous procedure, changing only the *NODE ID* parameter (e.g. to 123456789088).

  This module will be called APC-Robot from now on.

Important note: In order for the communication to work properly, do not plug the Enable (EN) pin of the APC-PC module to the converter. In picture 1.5 said pin has been desoldered.

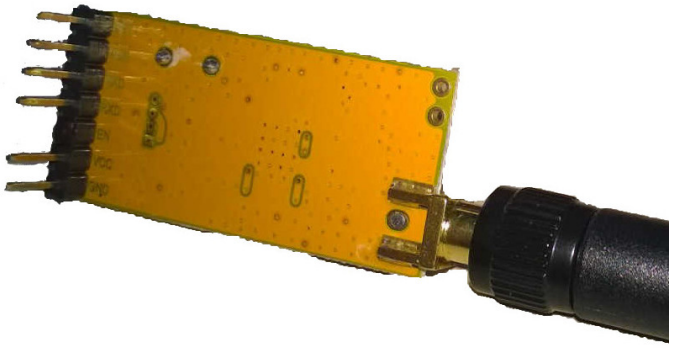


Figure 1.5: Desoldered pin.

Chapter 2

Test communication

We will now setup and execute two easy experiments to check if the communication link works (in both directions).

2.1 Setup

- Download and install the Arduino software in order to be able to upload your programs to the board and test them.[1]
- Plug the APC-PC module in the PC.
- Attach the APC-Robot module on the ATMega328 on the top of the Nexus robot. The board has integrated sockets for the APC220 module, so it is straightforward to attach it (just make sure that the GND pin of the board matches the GND pin on the module).

2.2 Test Arduino to PC communication

1. Connect the robot to the PC through a USB cable and remove the jumper.
2. Launch the Arduino IDE and open the `ASCII table` example.
3. Upload the `ASCII table` example to the board. Make sure to select the right serial port (the `motelist` command in cygwin may come in handy) and the correct board type (`Arduino Duemilanove w/ ATmega328`).

[1] `http://arduino.cc/en/Main/Software`

4. Open the serial monitor (`Tools` → `Serial Monitor`): if an ASCII table is printed, the communication via USB cable is working.

5. Close the serial monitor and disconnect the USB cable.

6. Change the serial port to be the one of the APC-PC module and restart the serial monitor.

7. Place the jumper to enable the radio and press the reset button on the board/motor shield board.

8. You should see the ASCII table printed again, this means that the board is sending it to the PC through the radio module. Reset the board to restart the printing.

2.3 Test PC to Arduino communication

1. Connect the robot to the PC through a USB cable and remove the jumper.

2. Launch the Arduino IDE and open the `rob2pc.ino` file that is in the `Test programs` folder.

3. Upload the file to the board. Make sure to select the right serial port (the `motelist` command in cygwin may come in handy) and the correct board type (`Arduino Duemilanove w/ ATmega328`).

4. Open the serial monitor selecting the port the APC-PC module is connected to.

5. You should see a message asking for a user input on the serial monitor. Otherwise press the reset button on the board/motor shield.

6. The ASCII table should be printed if and only if the string "PRINT" is sent.

2.4 Robot test

The commands to move the robot are described in the manufacturer's manual, available inside the `Robot manuals` folder of the repository. The libraries needed for the robot are located in the `lib` folder.

In order to get the robot's position and orientation in the Smart Mobility Lab you can use the official Qualisys plugins available for Matlab and LabVIEW, as well as the Python library available in the SML repository under `Misc/Python -`

`Qualisys`. For instructions on how to use the Motion Capture system you may refer to the Quadrocopter getting started manual[2] or to the official documentation by Qualisys.

The program `robotcode.ino` in the `Test programs/Robot test` folder can be used to test the correct behavior of the robot. It allows the user to send a control command or a read-state request to the robot. The Python script `ubot.py` in the same folder contains a `Ubot` class to interface with the robot on an upper level.

If the script is executed[3], the robot should move in a straight line, its speed following a sinusoidal profile, and then stop. In the experiment the behavior of the wheels should appear as in this video: `http://youtu.be/RJUu8XVpUkY`

2.4.1 Multiagent scenario notes

If more than one robot is used, you must pay attention to collisions in the communication, in case more than one robot sends a signal to the PC module at the same time.

- You could use a one-way communication, only allowing the PC to send messages. Every message will need to contain some kind of `"ID"` prefix that lets every robot decide if the message is addressed to itself.
- If you need to get some messages back from the robots to the PC, a good solution to avoid collisions is to implement some kind of priority rule, e.g. the robot who is allowed to communicate is always the one that has received the last message, or you may use a token passing protocol.

[2] Available at `http://www.kth.se/ees/forskning/strategiska-forskningsomraden/intelligenta-transportsystem/smart-mobility-lab/resources-1.438545`

[3] Make sure to change the first line of the *main* inserting the COM port the APC-PC module is connected to.

Bibliography

[1] *Google code page for KTH Smart Mobility Lab.* [Online]. Available: `https://code.google.com/p/kth-smart-mobility-lab/`.

[2] ASVResearch, *How to remotely control an Arduino from a PC.* [Online]. Available: `http://www.asvresearch.com/main/index.php/tutorials/tutorial-1`.

[3] Openpilot.org, *APC220 Transceiver Telemetry.* [Online]. Available: `http://wiki.openpilot.org/display/Doc/APC220+Transceiver+Telemetry`.

[4] *Configuring an APC220 RF transceiver with Arduino.* [Online]. Available: `http://allodox.wordpress.com/`.