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1. PRODUCT DESCRIPTION WIRELESS

1.1. Introduction

The "Wireless" transmission module from is an extension set for the ASURO robot that is also suitable for other robot models such as the Global Specialties' Arduino (AAR) Robot. The "Wireless" transmission module contains the circuits for standardized infrared communication so that you can continue to use the ASURO USB-IR transceiver with the ASURO Flash software.

Moreover this extension module offers space for an APC220 or a Bluetooth compatible module. Both modules are based on radio transmission.

The main advantage of radio transmission is the fact that ASURO doesn't need any visual contact with the control unit, the control range is bigger and the robot is easier to control e.g. via an android mobile phone.

The "Wireless" transmission module is supplied fully mounted. Only the contact pins need to be soldered. Almost all components are pre-soldered so that you need no extra time for the soldering. The challenge of the set lies in the programming of the control software. Programming tutorials are available on the website. The control can be done via a PC or an android mobile phone. Visual Basic offers a programming environment for the transmission application on the PC. The example application is user-adjustable. You can connect to the Bluetooth module via a mobile phone so that the system can send data both ways. This communication takes place in an android environment that is quickly developing towards a control system for mobile radio transmission. The ASURO extension set, this manual and the available software offer you the opportunity to get acquainted with Android.

Enjoy your extension set and its RF modules!

2.5.1 CAUTION

- Read this manual carefully in advance to fully understand how to assemble this product.
- Children below 14 should only assemble this product with the help of adults.
- Be careful about tools. Especially be careful about sharp tools such as nippers or a cutter knife to prevent any injuries or accidents.
- Never assemble the kit when a younger child is around. The child might touch sharp tools or swallow parts or the vinyl bag.
- Be careful about sharp edges of parts.
- Do not mix old and new or rechargeable and non rechargeable batteries.
- Take out the batteries when you do not use the robot for more than a week

2. Bluetooth

2.1 History

The Bluetooth technology was developed by the company Ericsson. Bluetooth is an open standard for wireless transmission between units over short distances. Just imagine mobile radio units with a wireless headphone connection or data transfer between mobile radio units or a GPS receiver that sends wirelessly data to a phone.

In 1994, Ericsson developed Bluetooth as a wireless way of communication between mobile radio units and other systems. Jaap Haarsen who worked at that time for Ericsson, developed the most important technical part. The name Bluetooth comes from the king of the vikings Harald Bluetooth. Initially, Bluetooth was the name of the project and as no better alternative had been found, this name has been kept for the end product.

The communication system spreads very quickly and after a short time, the biggest electronic companies come together to set up the 'Bluetooth Special Interest Group' (SIG).

A worldwide application needs to be made available worldwide.

Therefore a universally applicable frequency has been searched and found in the 2,45GHz frequency range.

2.2 Technology

Bluetooth is a radio transmission of speech and data over short distances. The selected communication structure is a point to multi-point link which means that one transmitter can transmit to several receivers. As soon as two Bluetooth units start communicating, a so-called "piconet" is set up. Several pico networks make a scatter network.

Within a pico network Bluetooth supports a maximum of 8 active units whereas 127 units can operate a communication link that is temporarily kept in a passive state (parked) (fig. 1).

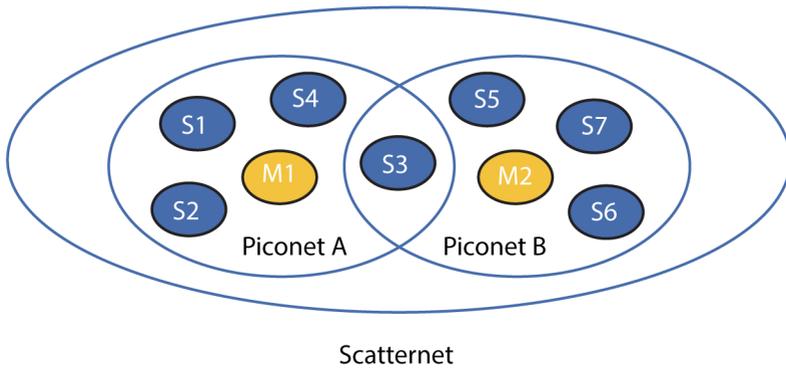


Fig. 1 : Scatternet

The energy consumption of Bluetooth is extremely low: 30 micro-amps in passive standby mode and 8 to 30 milli amps in active state. This low consumption allows Bluetooth to be used also in battery powered mobile units.

Bluetooth systems are divided in 3 different categories:

Category 1: Projects for long distances (up to 100m)

Category 2: For standard distances (up to 10m)

Category 3: For short distances (10cm to 1m)

3. Android

3.1 Background information

Android is an "open source" platform for mobile units such as Smartphones and Tablets that has been developed by the company Android Inc.. In 2005, Android was taken over by the company Google.

The unveiling of the Android distribution in 2007 was announced with the founding of the Open Handset Alliance, a consortium of 40 hardware, software, and telecommunication companies devoted to advancing open standards for mobile devices .

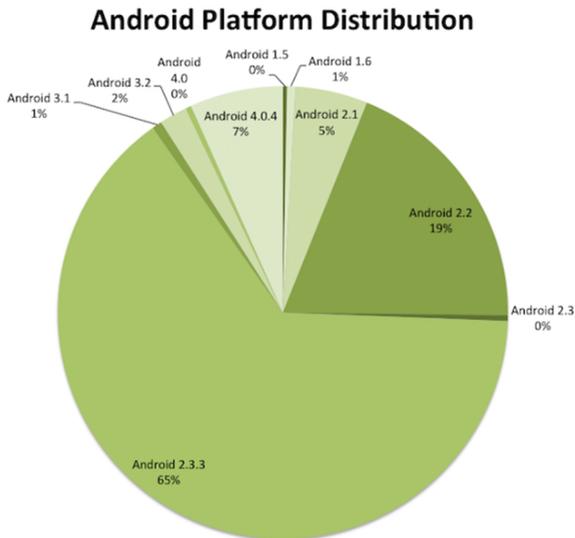
Android is based on a Linux kernel and the Java program environment. The SDK development tool (Software Development Kit) allows not only Google but also other developers to create applications. They can subsequently offer these applications to the android market. On this market, end users can search and install applications. Here you can also find information about the applications. The distribution of applications whether they are free of charge or charged, is promoted. The developers are allowed to offer these applications also outside the android market.

The applications are developed for a specific android version. However they are retrocompatible. That means that an application that has been developed for android 2.2 can also be run under 2.3. The versions published so far are listed in the fig. 2 table.

The number of users per version is indicated in fig. 3 below the table.

Jelly Bean	Android 4.1	07-13-2012
Ice Cream Sa	Android 4.0	19-10-2011
Honeycomb	Android 3.1	10-05-2011
Honeycomb	Android 3.0	02-02-2011
Gingerbread	Android 2.3	06-12-2010
Froyo	Android 2.2	20-10-2010
Eclair	Android 2.0	26-05-2010
Donut	Android 1.6	15-08-2009
Cupcake	Android 1.5	30-04-2009
Erste Publikation	Android 1.1	10-02-2009

Fig. 2 : Android-version



Source: developer.android.com, June 2012

Fig. 3 : Users per Version

3.2 The Software Development Kit (SDK)

Google unveiled the SDK software so that users are able to write their own applications for a smartphone, a tablet PC or both. The SDK contains a collection of various helpful tools such as a debugger tool and an emulator plus a series of example applications and tutorials on the website.

Open following link to download the SDK:

<http://developer.Android.com/sdk>

On this page you will find the installation files and extensive instructions on how to install the SDK.

3.3 Eclipse

Eclipse is an open source framework of the Eclipse Foundation, a non-profit association for software development environment. The most popular application is the development environment for the Java programming language.

The SDK contains an Eclipse plug-in that enables a programmer to easily start, compile, debug and emulate an android project.

The Eclipse programme is an open source software and can be downloaded on following

<http://www.eclipse.org/downloads/>

3.4 Hello World

The "Hello World" programming instructions explain how easy it is to transfer the text "Hello World" in an application to a terminal. The instructions explain step-by-step, up to the very last step, how to represent the "Hello World" in the emulator.

The website of the tutorial is:

<http://developer.Android.com/resources/tutorials/hello-world.html>

4. The Wireless control set

The "Wireless" control set allows you to install an APC220 module or a Bluetooth module on ASURO or other robots. Thus you can communicate with the ASURO not only via Infrared but also via RF frequencies. The advantage of the high frequencies is that the transmitter and receiver no longer need to be in visual contact.

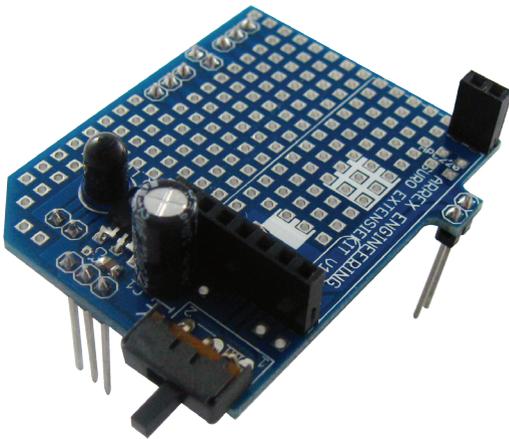
ASURO can communicate with the PC if an APC220 is installed on the Wireless radio set. You will find further information on this subject in chapter 'APC220'. The Bluetooth module allows you to communicate with the PC and an android smartphone. You will find further information in chapter 'Bluetooth Module'.

4.1 Specifications

The "Wireless" control set includes:

- IR-receiver or transmitter for the Flash transmission to ASURO
- Socket for the APC220 or Bluetooth RF module
- Switch for the IR or RF transmission
- Experiment board to build an additional circuit
- Connection options for free gates of ASUR

The following figures show the layout of the PCB. The free experimentation area for the additional circuit is clearly visible. There will be even some space left below the APC220 because it is installed in some distance from the PCB.



Please note!

The switch on the PCB allows 2 positions: (1) Infrared connection or (2) Bluetooth / APC220 communication.

If you want to transfer the software via Flash into ASURO or if you wish to communicate via Infrared, this switch must be set to 'IR'.

If you want to communicate via Bluetooth or APC220, the switch must be set to the other position.

Fig. 4 : Wireless extension kit

4.2 Installation on the ASURO robot

The installation of the "Wireless" radio modules can be explained in 3 steps:

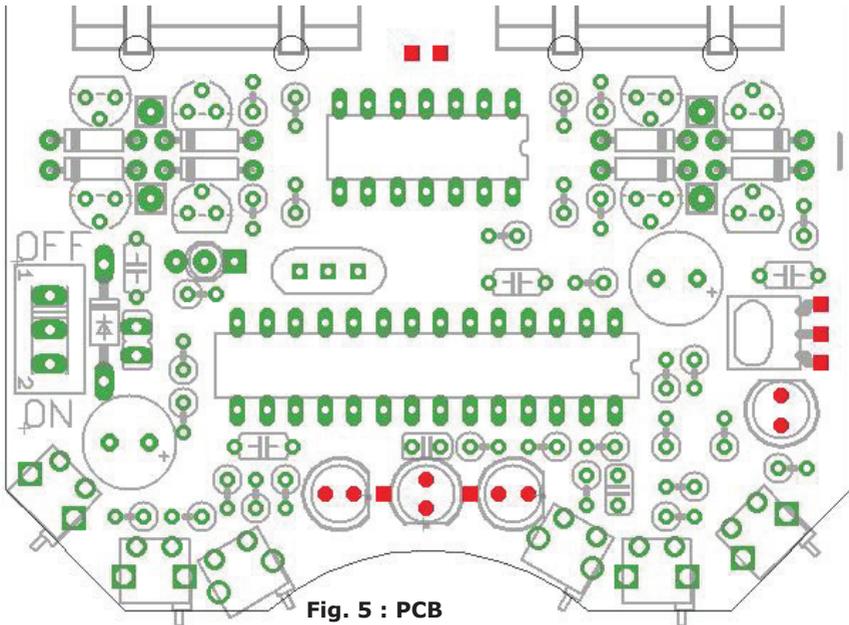
Step 1.

First of all the ASURO PCB must be prepared as follows for the installation of the "Wireless" radio module:

1. Unsolder the components at the locations marked in red and remove them from the PCB (fig. 5). Use a specific soldering iron or special unsoldering tin to unsolder the components.

Caution:

Make sure not to damage the solder lugs because you will need them later for the re-soldering.



B.2. Solder the supplied socket parts on these connection areas. Install the 1x3 socket on the connectors featuring three adjacent areas. The shape of the area is not important. Now you can solder the remaining 1x2 sockets on the free connection areas

Step 2.

Install now the ASURO extension set on the ASURO PCB. The set should fit accurately into the previously installed socket parts.

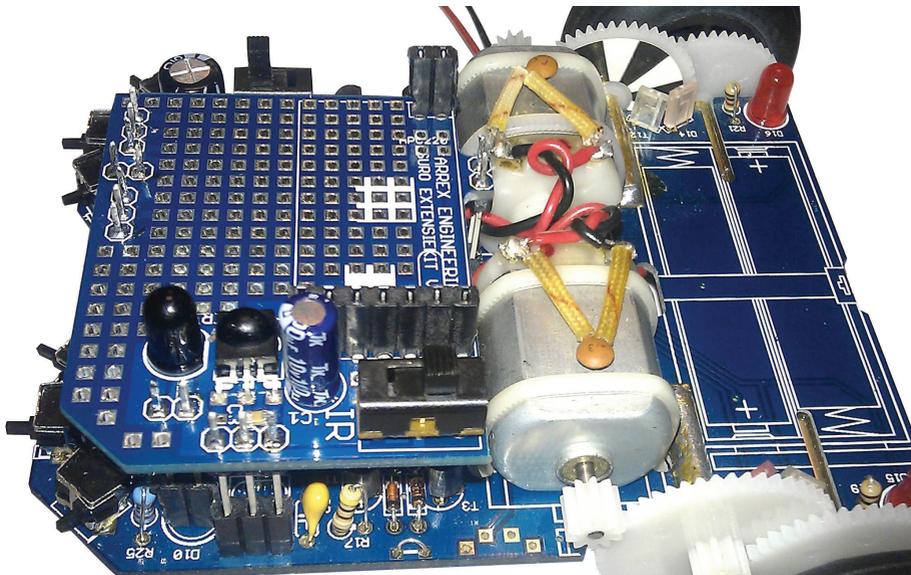


Fig. 6 : ASURO with radio control PCB (Side view)

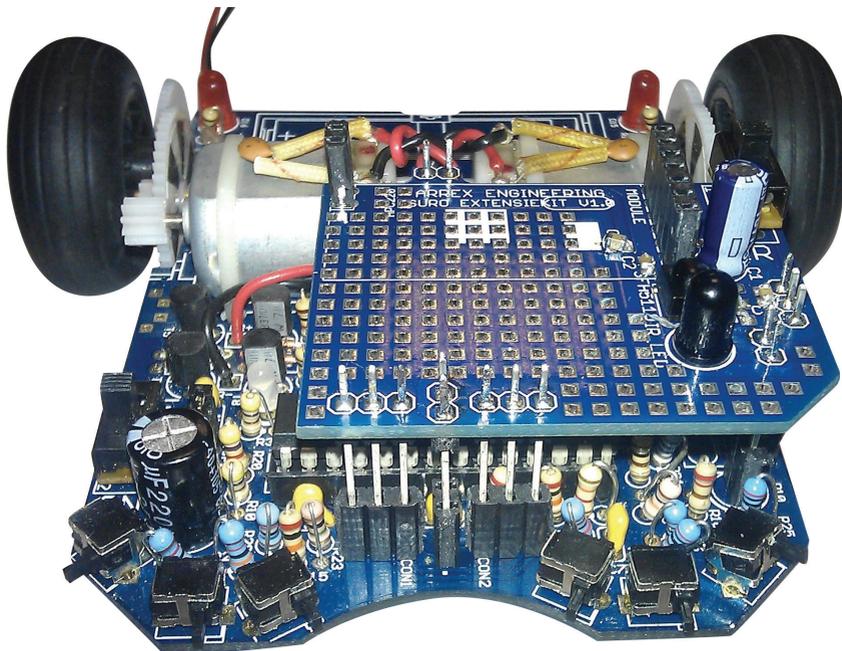


Fig. 7 : ASURO with radio control PCB (Front view)

Step 3.

Install now either the APC220 or the Bluetooth module.

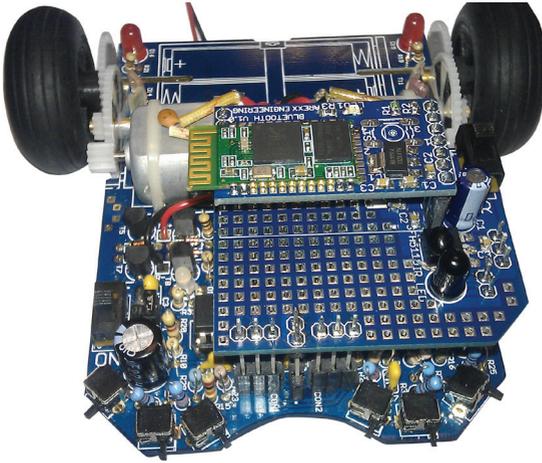


Fig. 8 : ASURO with Bluetooth



Fig. 9 : ASURO with APC-220

The installation of the hardware is finished. Now you can establish a connection with the various applications.

In chapter 'APC220' we explain how you can control ASURO via the APC220 module.

The chapter 'Bluetooth module' explains how the Bluetooth communication will work.

5. APC220/Bluetooth with PC radio data communication

In order to install a communication link between the PC and Asuro we need a dongle. We decided to use the RP6v2 Programmer adapter (WT Dongle).



Fig. 10 : RP6v2 USB Programmer (WT Dongle)

For wireless communication from the PC we prefer the APC220 radio data module or a Master Bluetooth module. These modules are modest in energy consumption and easy to install, which are convincing details in choosing the components for robotic designs.

5.1 Setup for the wireless PC-communication link

Frequency and baud-rate for the APC220-modules will be setup at standard values with the help of the WT-dongle. For this purpose a special software for the WT-dongle has been written in Visual Basic (VB), which provides us with an easy setup. This software may be found in the APC-220 application's software.

Connect the WT-dongle with the PC by USB-cable. Additionally the RP6v2 programmer adapter requires the installation of a driver software. The most recent driver will be found at the RP-robot's section in our website.

The APC220- respectively Bluetooth-module is to be inserted at the WT-dongle. Use the Visual Basic program APC-220 application to setup the APC-220 and to control the robot.

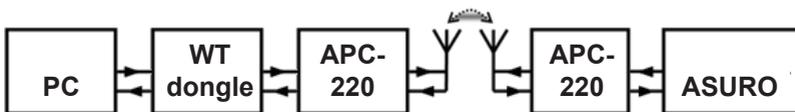


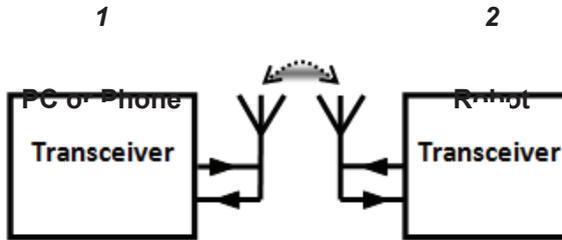
Fig. 11 : Communications example PC <--> Robot

The blockdiagram shows how the wireless communication setup is between PC and robot.

5.2 Preparation for the wireless communication

Important!

The robot cannot communicate through a wireless connection yet. Besides the hardware modification, when the wireless extension PCB is mounted on the robot, a program must be loaded.



TRANSCIVER 1

In case of Android communication, an application should be loaded in an Android Smartphone or tablet. In case of PC communication, transceiver 1 is placed on RP6v2 USB Program Adapter (WT dongle) and the application must be installed on the PC.

TRANSCIVER 2

First the extension set must be installed with the RF module APC-220 or Bluetooth. Finally, the correct software has to be loaded in the robot.

The software depends on the robot type:

***.HEX (Hex file) for:**

- ASURO
- RP6(v2)
- ROBOT ARM

***.PDE (Arduino file) for:**

- AAR Arduino robots

6. APC220



In combination with the APC220 module, ASURO can be controlled via the "ASURO control" program that needs to be installed on the PC. "ASURO Control" can be downloaded from the website. The software has been written in Visual Basic and is available to the user as a variable source.

The ASURO software needs to be slightly adjusted. This software is also an open source product.

The adjustment is necessary because the system has to transfer a protocol that includes a control byte and a set of information bits. Fig. 12 shows how the application (in orange) transmits the signal for the data request at the PC. The ASURO system replies with the reply data in red.

Protocol from ASURO to PC:



Fig. 12 : Communications example

The ASURO software contains some functions to send requests to the sensors and to control the motors. If the control program sends a request, ASURO transmits immediately the data to the client. At this stage you have the option to add 4 more information bytes to the signal. This could e.g. be a thermometer that is connected to the free connectors of the extension set.

The following text describes the code for the data transfer of this kind of measurement data.

This code shows that the system calls a few functions in Battery () e.g. in order to measure the battery voltage. This function supplies a value between 0 and 255 that is processed in the PC program and displayed on the terminal. The bytes 10 to 13 are free and can be freely programmed.

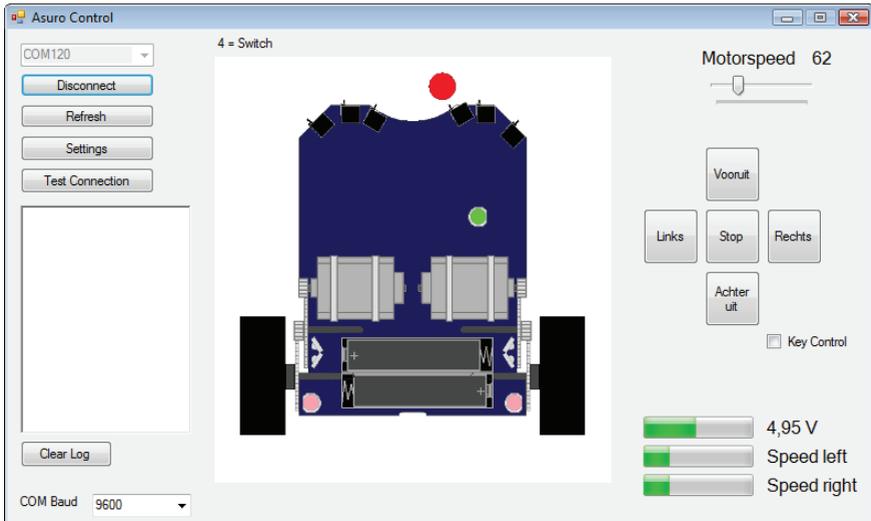


Fig. 13 : Asuro Control Software (Visual Basic)



Once the application 'ASURO CONTROL' has been started, the program displays the screen above. Now you can get in contact with ASURO and control the robot. The WT dongle must be connected to the PC. When the WT dongle is connected, a click on the 'Refresh' function triggers a request to all connected COM ports.

Once you have selected the correct COM port for the WT dongle, the connection will be established by clicking on the 'Connect' function on the ASURO control screen. This command triggers the link between the WT dongle and the 'ASURO Control'.

Consequently the motor speed and the battery voltage will be displayed in the bottom right corner of the screen. As soon as a switch on the front panel of the robot is activated, the program marks this switch as a red dot. This way the program shows a collision on the 'ASURO Control' display. The program display of the application shows also the color change of the ASURO LEDs.

The ASURO robot can be controlled via buttons on the right side. The speed is set via a slider on the upper right side. Moreover is it possible to control the robot via a keyboard. To this end, you need to tick on the field 'Key Control'.

- W: Forwards
- A: Left
- S: Backwards
- D: Right
- E: Stop

There are several ways to set the operating frequency of the APC220. If several APC220's are operating close to each other, the protocol will make sure that the data will be sent to the right ASURO.

However, it is recommended to avoid this kind of situation and if possible, choose different transmission frequencies as some programs communicate several times per second with ASURO.

The APC220 operating parameters are set in the PC program and can be adjusted. Click on 'Settings' in the main dialogue page of the program so that following contents are displayed (Fig. 14) :

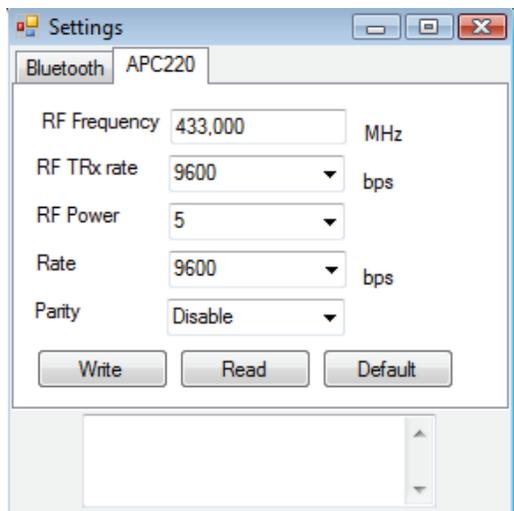


Fig. 14 : Settings in Control Programm

7. The Bluetooth Module

You can control ASURO via a PC or a smartphone if you install a Bluetooth Slave module inside the extension module. To do that, you need to install a Bluetooth Master module on the WT dongle. The difference between the Slave and the Master module is shown in fig. 15 and 16.



Afb. 15 : Slave



Afb. 16 : Master

Those Bluetooth modules are only available in the ARX-WRL KIT

The master module (right-hand side) is marked with a white dot on the upper IC. Moreover the module features a switch.

The slave module (left-hand side) has no white dot and no switch.

Once both modules are switched on, the Master will look for a Slave and establish automatically a connection. Once the connection has been established, the Master will save the slave address.

If the connection is interrupted and the Master is looking for its slave again at a later stage, the system will only look for the Slave whose address has been saved.

This situation is shown by the blue LED. In this procedure following operating modes are defined:

- Fast flashing:** *Slave and Master are not connected together*
- Steady on:** *Slave and Master connected together*
- Slowly flashing:** *The Master is not connected but it has saved a slave address. In this case you can erase the saved address by pressing the switch.*

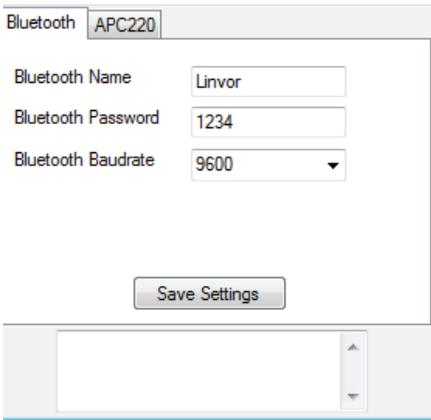


Fig. 17 : Bluetooth Settings

You can choose a name for the Bluetooth Slave module. In order to let the system communicate with another Bluetooth unit, the adjustment of the baud rate and the PIN code has been installed as an option.

You can change these parameters in the 'settings' menu on the main page. Click on 'settings' in the software to display following contents.

The module that you want to adjust must be in the WT dongle when you make the changes. The changes will be saved by clicking on the item 'save settings'.

The Log protocol shows if the saving process was successful. If this is not the case, a so-called 'time-out' is announced.

Please note:

The name of the Master module cannot be changed. Once you have saved the baud rate and the PIN code, a time-out is announced. This is normal.

Once the Bluetooth Master module has been installed in the WT dongle or the Slave in the ASURO extension kit, a communication link can be established with ASURO exactly as for the APC220.

Start the 'ASURO Control' program. The COM port remains the same and the same steps as described in the APC220 chapter are executed.



Bluetooth[®]

8. Android mobile phone application

If you want to control ASURO via a mobile phone, you need to install the Bluetooth Slave module on the ASURO extension kit.

After that, you have to install the 'ASURO Bluetooth' application on your mobile phone. This software is available on the Global Specialties website. In the same area you can download the source code for this application so that you can input the source and match it to your own needs.

Most android mobile phones are fitted now with the operating system Android. Therefore this application has been written for Android 2.1 or Android 2.1 or higher.

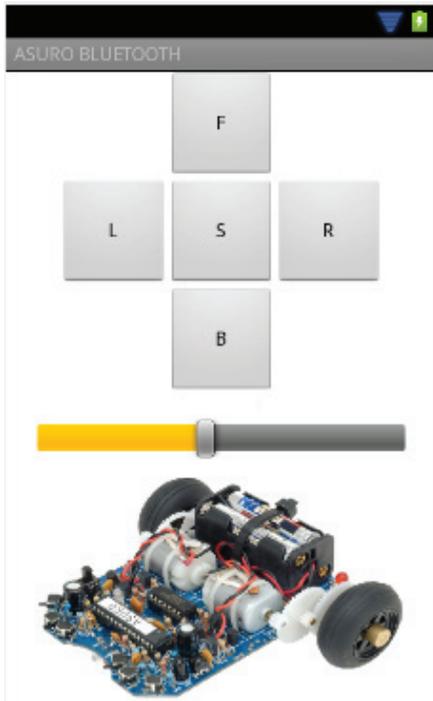


Fig. 18 : ANDROID APP

After the start of the application, the program is asking for permission to start Bluetooth if this hasn't happened yet. The interface is very clear.

As soon as you click on the 'options' key of the unit, the program opens a window with the message 'Connect a device' and 'Disconnect'.

These commands are self-explanatory: first of all, the phone has to establish a connection with the Slave module.

With the command 'Connect a device' you are asking the phone to search for Bluetooth units nearby. As soon as the name of a Slave module appears, you can click on the name and the system will establish the connection.

Once the link has been set up, you can control ASURO via the application.

7. Background Information

7.1 APC220

Communication between the PC and Asuro may be accomplished by a APC220 radio data module, which is a transceiver from Appcon Technologies.

A transceiver is a combination of a transmitter and a receiver in a single chip, which allows us to transmit and receive signals by using only one singular device.

The transceiver has been equipped with a UART-interface, which enables the module to communicate with a PC or a micro-controller.



Fig. 20 : RF Communication



Fig. 19 : APC-220

The module's energy consumption is low ($\pm 30\text{mA}$) and installation is rather simple. These features are the basic reasons to choose the module for wireless communications.

The communication range at a baud-rate of 9600 bps is specified at a maximum of 250m and at 1200 bps at 1200 meters. These specifications may be found in the data-sheet.

In a previous project (Wild Thumper) the same APC220-module was implemented and extensively tested. In these tests a 200m-range for reliable communications was confirmed.

The disadvantage for this receiver is the missing proprietary protocol for transmitting data. Therefore we will have to define this protocol for transmitting data.

7.2 Bluetooth

Bluetooth is an open standard for exchanging data between systems over short distances and has been developed by Ericsson as an RF-communication link between mobile phones and other equipment. Communication uses the 2,45 Ghz-band and does not require a line-of-sight connection. The high GHz-frequency band allows Bluetooth-signals to penetrate and pass concrete materials as long as they do not contain metals.

Bluetooth-systems may be considered as alternatives for cable-connections and is used to interconnect all sorts of equipments. The developers concentrated on cheap radio-technology, which enables us to integrate Bluetooth in any electronic design.

Bluetooth's low energy consumption (30 micro-amperes in 'hold mode', respectively 8-30 mA during active communication phases) allows us to use the system in mobile equipment which depend on battery power supplies. Standard Bluetooth-systems (class 2) ranges up to 10 meters.

Modern mobile phones usually have been provided with Bluetooth-modules, which is a good reason for us to install Asuro- and other Global Specialties robots with Bluetooth compatible devices.



8. Visual Basic

An application will be needed to use a PC to control the Asuro robot. A great variety of programming languages is available for such applications.

Initially normal students will not be experienced in developing applications. Therefore we decided to choose Visual Basic, which provides an easy way to develop applications.

Visual Basic (VB) is a programming language and a development tool, allowing is to create software for the Windows operating system. The attribute "Visual" refers to the Graphical User Interface (GUI) and the attribute "Basic" refers to the programming language BASIC (Beginners All-Purpose Symbolic Instruction Code).

The project had been set up to work with Visual Basic 2010, which is the most recent version available today.

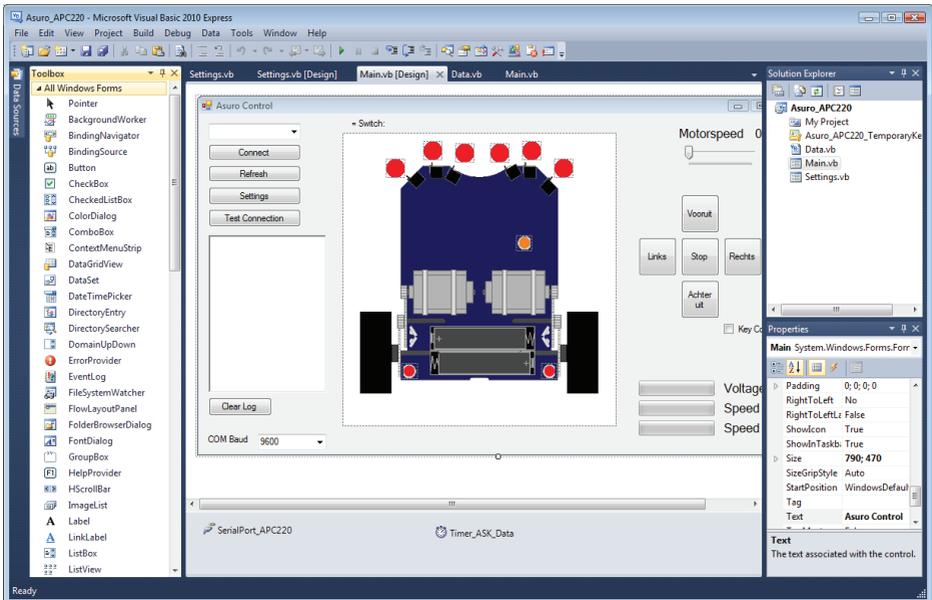


Fig. 21: ISP connector

Fig. 21 illustrates the main program's window. In the left box we may identify the area to insert buttons, timers and text-boxes. As a user you might adapt attributes for these elements' and refer to these elements in your programming code.

If you press the 'refresh' - button at the window the button's driver software will be activated.

```
Private Sub Button_Refresh_Click  
    (ByVal sender As System.  
    Object, ByVal e As System.EventArgs)  
    Handles Button_Refresh.Click  
    GetSerialPortNames()  
End Sub
```

On activating the 'refresh' - button the above sample code will call the function 'GetSerialPortNames()'.



8.1 Software Development Kit

In order to enable users to write their own applications for smart-phones, tablets or both Google released a Software Development Kit (SDK). This SDK provides us with a number of sophisticated tools, such as a debugger and an emulator. The relevant website also contains a great number of sample applications and tutorials.

The SDK Manager (figure 22) allows the user to add platforms to his development workspace. He may also choose to install various sample applications.

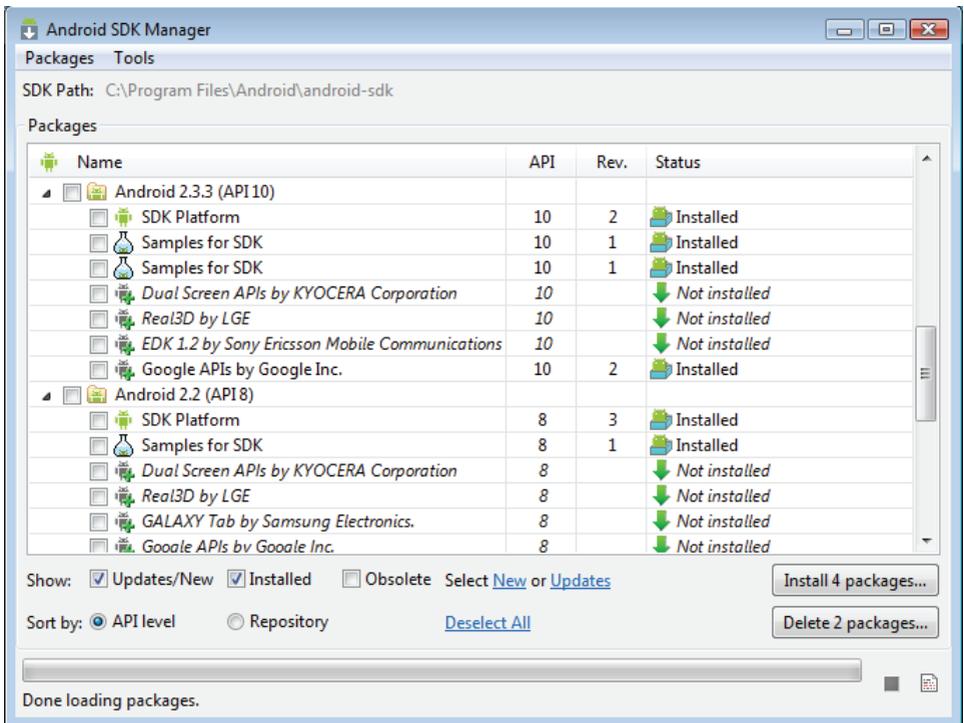


Fig. 22 : SDK Manager

The SDK also provides us with a Virtual Device Manager (figure 23). This Android Virtual Device Manager enables the user to define a virtual device, which allows the designer to emulate and debug his newly created software.

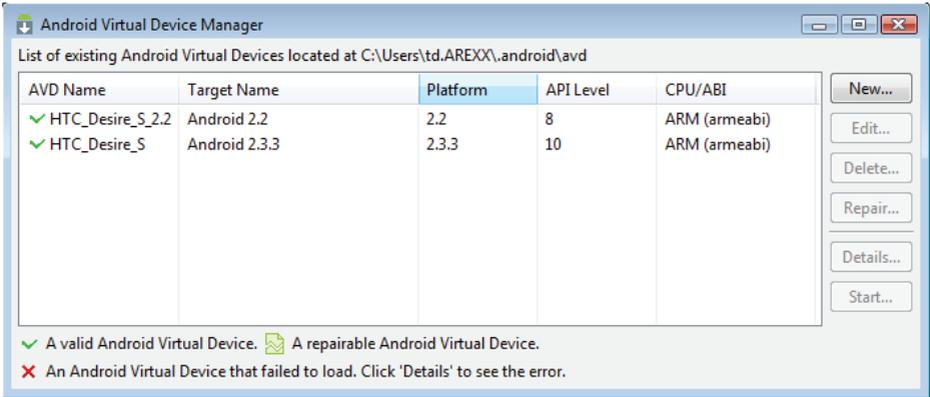


Fig. 23 : Virtual device manager

You may download the SDK from the following website:
<http://developer.android.com/sdk>

This site provides us with the installation package including detailed instructions for the SDK's installation procedure.

7.5 Eclipse

Eclipse is an open-source software framework, designed by the Eclipse Foundation for software development purposes. The most popular application is a development environment for the programming language Java.

The SDK has been equipped with an Eclipse plugin, which enables a software developer to easily start an Android project, including compiling, debugging and emulating the software.

At completion, the designer will create an .apk-file for the application's installation, which may be transferred to any Android phone.

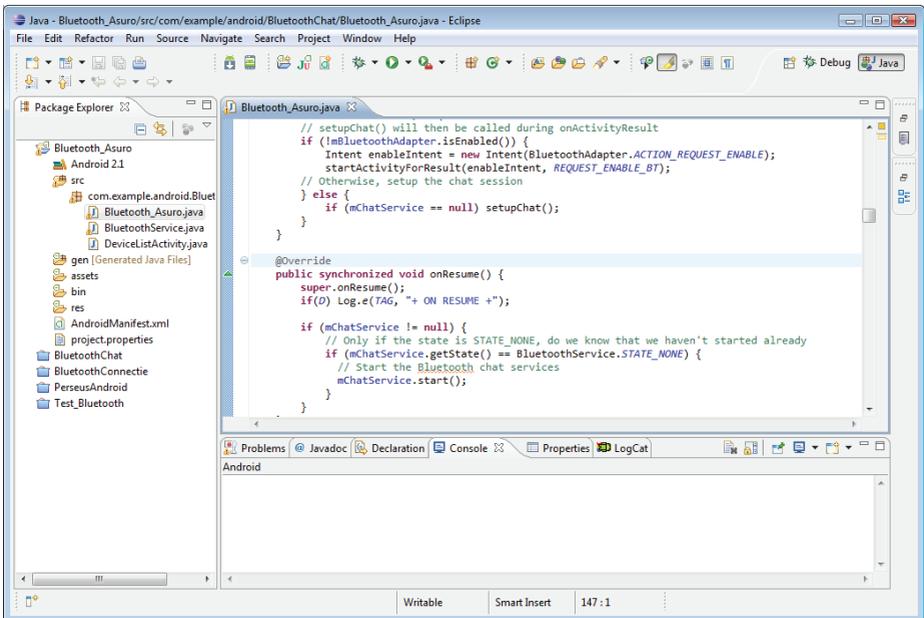


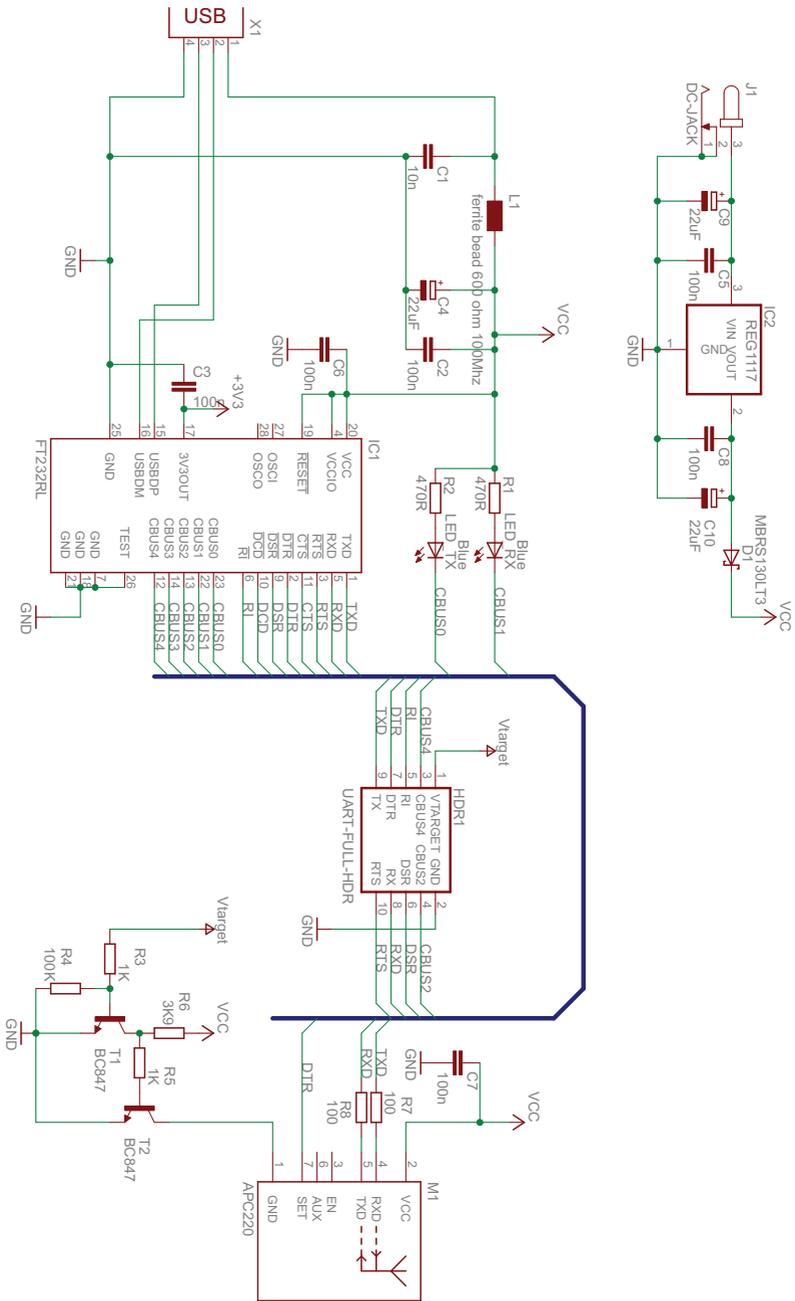
Fig. 24 : ECLIPSE

The freeware Eclipse-software is available for download at the web-site:

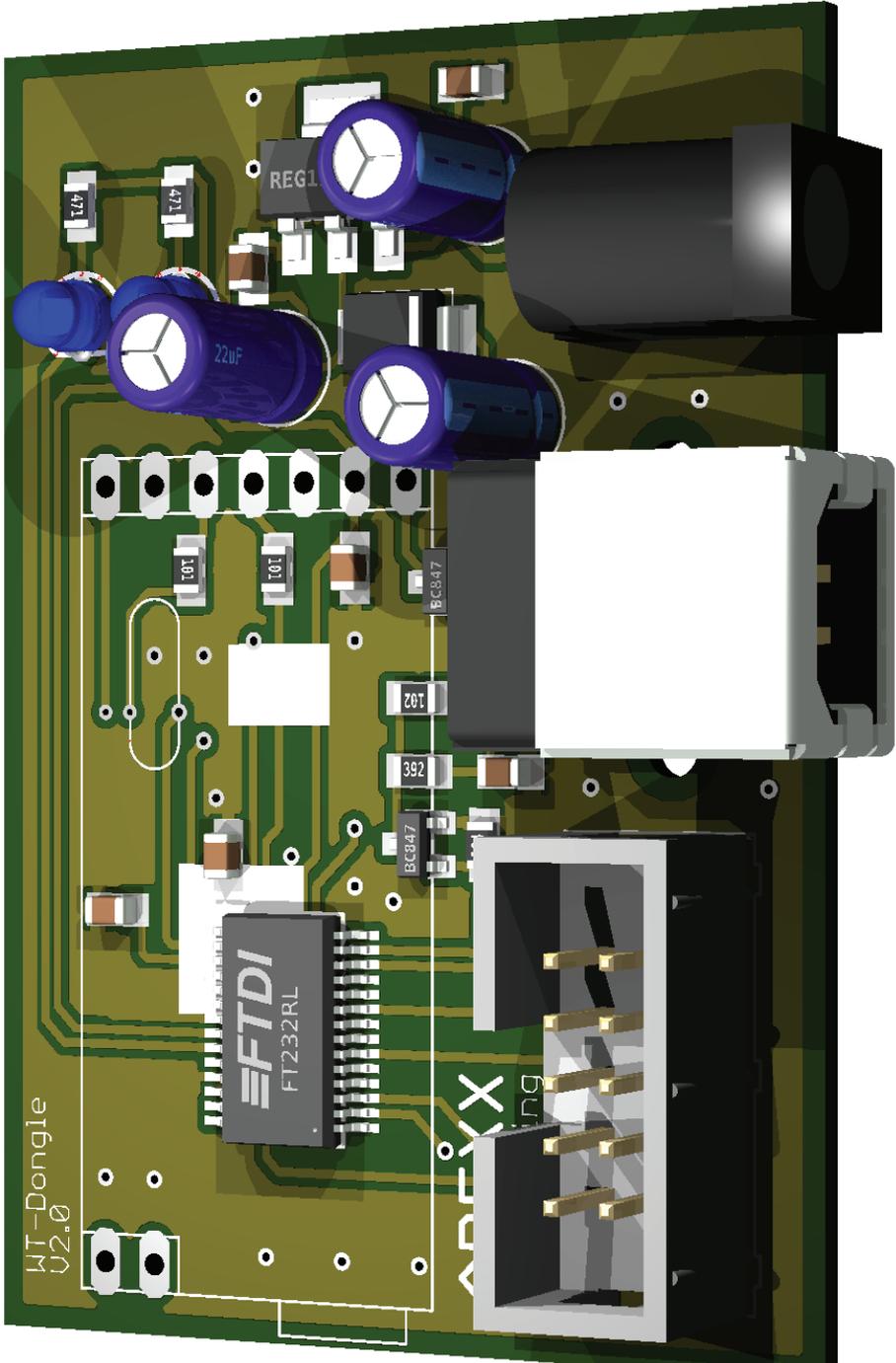
<http://www.eclipse.org/downloads/>

APPENDIX

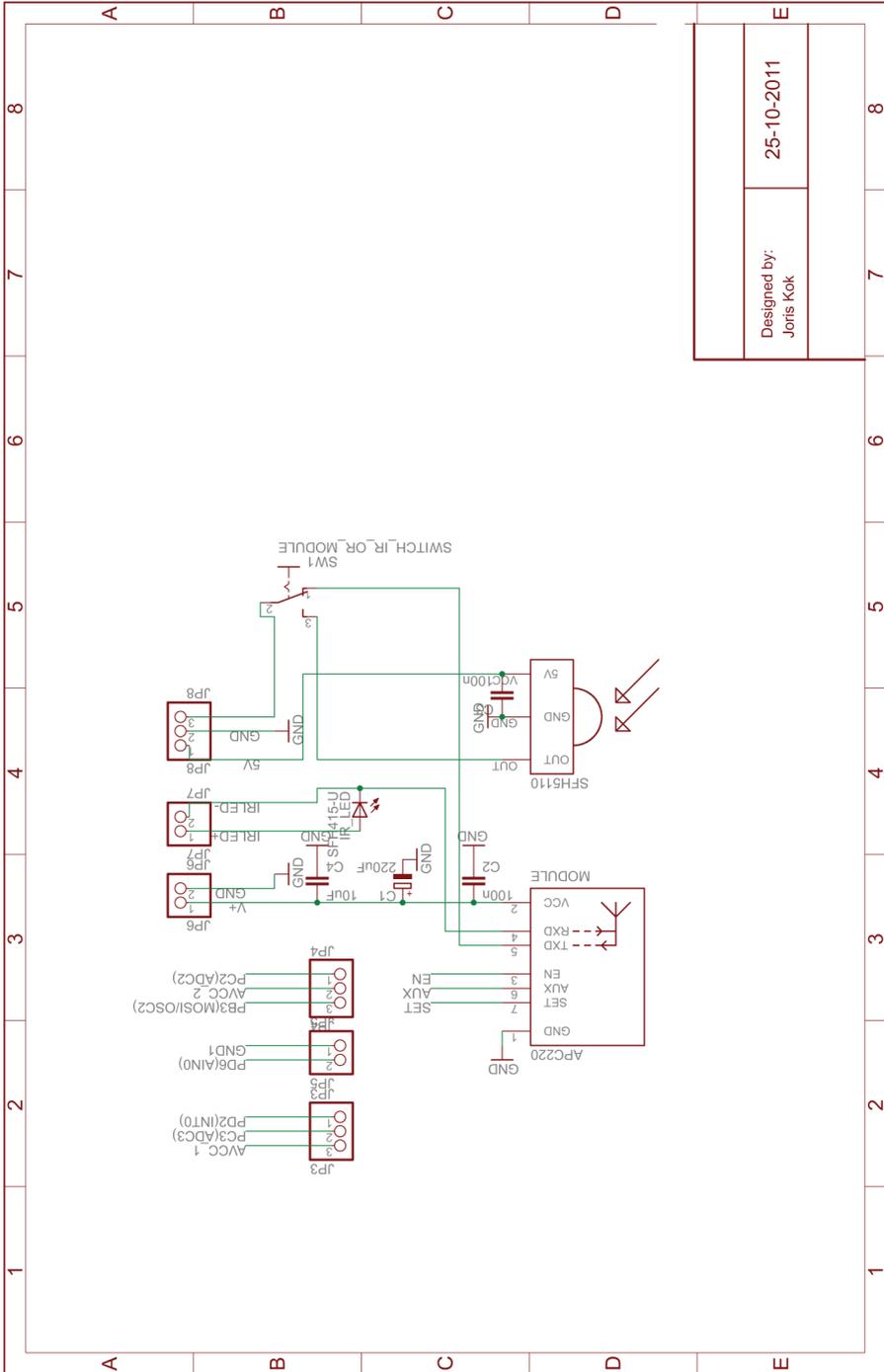
B. Circuit diagram RP6v2 Programmer (WT DONGLE)



A. RP6v2 USB Programmer (WT DONGLE)



D. CIRCUIT DIAGRAM EXTENSION KIT



Designed by: Joris Kok	25-10-2011
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C. WIRELESS EXTENSION KIT

