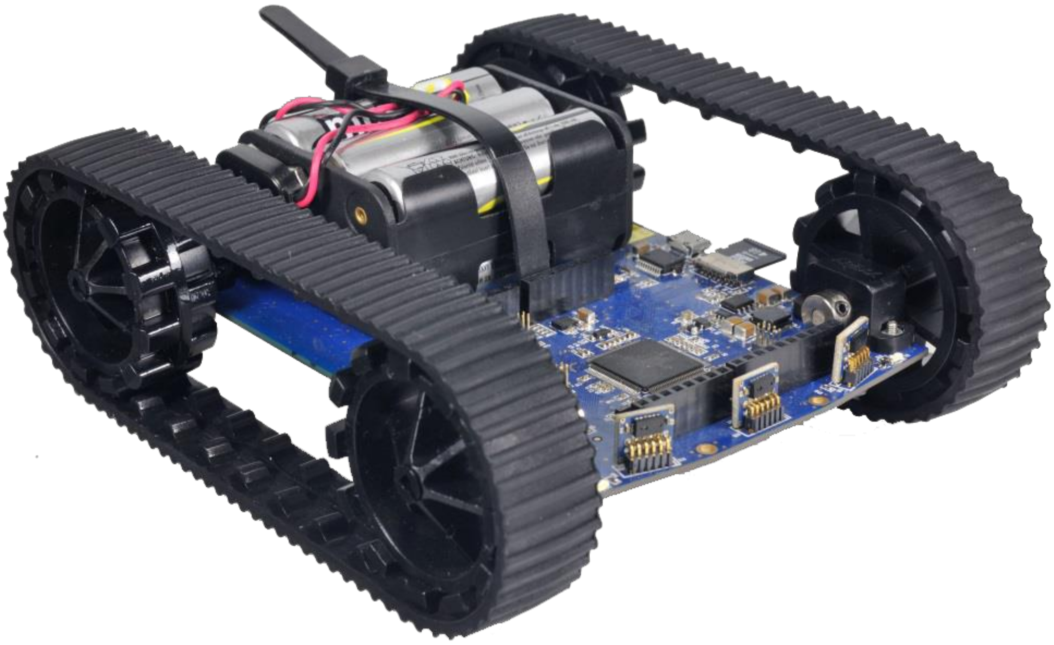
AREXX Engineering

Developed by JM^3 Engineering

JM3-MARVIN-01

User Manual



Marvin IoT Robot

www.arexx.com

The latest updates are available at jm3-engineering.com!

Imprint **© 2016-2017 AREXX Engineering** Nevistraat 16 8013 RS Zwolle The Netherlands Tel.: +31 (0) 38 454 2028 Fax.: +31 (0) 38 452 4482	This manual is protected by the laws of Copyright. It is forbidden to copy all or part of the contents without prior written authorization! Product specifications and delivery contents are subject to changes. The manual is subject to changes without prior notice. You can find free updates of this manual on **http://www.arexx.com/**

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Information about limited warranty and responsibility

The warranty granted by AREXX Engineering is limited to the replacement or repair of the Module and its accessories within the legal warranty period if the default has arisen from production errors such as mechanical damage or missing or wrong assembly of electronic components except for all components that are connected via plugs/sockets.

The warranty does not apply directly or indirectly to damages due to the use of the robot. This excludes claims that fall under the legal prescription of product responsibility.

As soon as you make irreversible changes (for example, soldering other components, drilling holes, etc.) on the robot or its accessories, or the robot is damaged as a result of non-observance of these instructions will void any warranty claim!

It cannot be guaranteed that the supplied software will satisfy individual expectations or will run completely error-free and without any interruption. Moreover the software can be freely changed and is loaded into the unit by the user. Therefore the user carries the full risk regarding the quality and performance of the unit including all software. AREXX Engineering guarantees the functionality of the supplied application examples provided the respect of the conditions specified in the data sheet. If the purchased hardware or the PC software turns out to be faulty or insufficient, the customer carries all costs for service, repair or correction. Please note the relevant license agreements on the SD-Card respectivly the Info-Box in browser!

Important! - Before using this robot for the first time, please read the operating instructions carefully! It explains the correct handling and informs you about possible dangers. It also contains important information that should not be known to all users.

Precautionary Notes

- Check the polarity of the voltage.
- Always keep the electronic equipment dry. In the case of moisture immediately remove the batteries or the power supply to power down the device. This precaution is needed to keep it from short circuiting. Drying is needed to avoid corrosion.
- Remove batteries before long-term storage respectively remove the power supply if the robot is not to be used for some time.
- Before using the device always check the status of the equipment including the cabling.
- As soon as you think the device cannot be used in a secured way you must remove the power supply and take precautions the device cannot be used unintentionally.
- Ask an expert if you feel unsafe or unsure in handling the device.
- Never operate the robot in unfavourable locations or inconvenient conditions.
- The equipment does contain highly sensitive parts. Electronic modules are quite sensitive to electrostatic discharge (ESD). Only handle devices at the edges and avoid direct contact to the parts on the PCB.

Normal use

This product has been designed as an experimental tableau for all persons who feel interested in robotics. The main goal for this platform is the experience to learn programming the device in C/C++-language. The robot is not to be considered as a toy! The device is not suitable for children under 14 years of age.

The robot has been designed for indoor use. The device should not be exposed to moisture or damp. Please be careful to avoid condensation vapor, which may generate moisture if you transport modules from a cold environment into a warm room. Wait a while and do not activate modules until the devices have been acclimatized to the room temperature.

Any other type of mode of operation as prescribed may cause damage and risks such as short circuit, fire and shocks, etc. the robot is to be used in closed, dry environments. The device shall not be exposed to moisture or water.

Laser Security Notes Proximity Sensor
VL6180X 80/87 DocID026171 Rev 7

The VL6180X Proximitiy Sensor is equipped with a laser source and a laser control module. The output power of the laser light source is designed and limited to always comply with the safety limits according for Class 1 Laser sources. This also includes singular accidents according to IEC 60 825-1:2007. As long as the device is being operated within the range and operating conditions as specified in the data sheets by ST Microelectronics the optical laser output power will be restricted to the specified limits.

The optical laser output may never be raised and under no circumstances any optical lenses are allowed to be used for focusing the light beam!

For security reasons we discourage to look into the laser light source.

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No.50, dated June 24, 2007.

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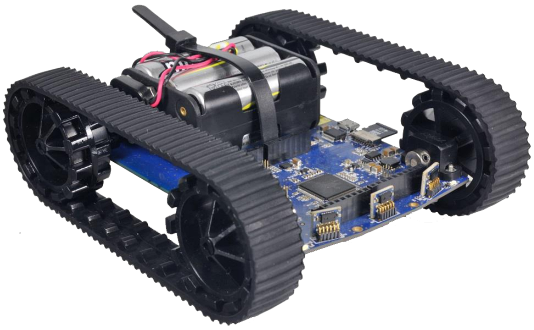


Figure 0.1 Marvin Robot

Marvin - iRP WebIDE - for browsers on PC, Notebook and Tablet *1) *2)

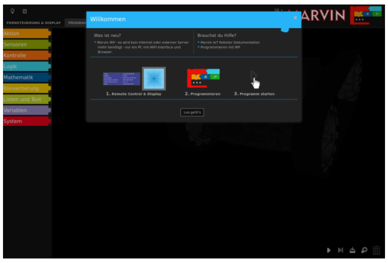


Figure 0.2 Welcome-Screen

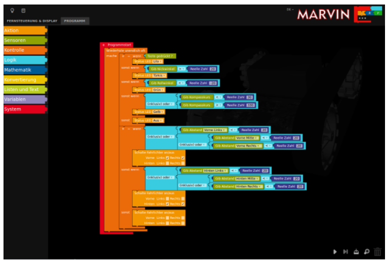


Figure 0.3 Program-Screen

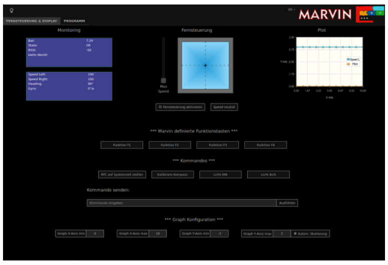


Figure 0.4 Remote Control and Status Display

***1) Apple iPAD or MacBook can store programs only on the robot, not on local disk.**

***2) Firefox, Google Chrome (PC/Notebook/Samsung Galaxy Tab A) and Safari (iPad Pro/MacBook Air) are tested - Internet Explorer or Edge are not supported.**

1 Introduction

The JM3 IoT robot, called Marvin, impresses with its equipment and performance. Main components are the TIVA TM C microcontroller with ARM Cortex-M4F and 512KByte Flash, 256KByte SRAM, 6KB EEPROM, and the CC3100 WI-FI® Network Controller that meet the standards 802.11 b/g/n with up to 16Mbps data rate, multi-connection, TCP and UDP. Optimal adapted PCB antenna, infrastructure & ad-hoc mode with a range >25m under normal conditions.

In addition, the Marvin is equipped with high-tech sensor technology, a 9D gyro / compass, several proximity sensors which operate almost independently of the reflection characteristic of the obstacle surface. These sensors can also measure the ambient brightness. A battery buffered real-time clock and the Arduino compatible expansion header are also included. The header can be used for own hardware developments or other existing Arduino Shields (software must be developed by themselves).

The powerful micro-gearbox motors with high-resolution odometry guarantee a high speed of the robot with its rubber drive. The power is supplied by 6 standard AA or NiMH batteries.

A virtual display can be found in the browser (Firefox, Google Chrome, Safari) on a PC/Notebook, Mac or Tablet. In addition, the Marvin robot can be remote controlled.

The graphical programming interface "Marvin - iRP" allows beginners to enter the world of programming in a simple way - especially for students and kids, because **it is not required to learn a programming language first** and no software development environment must be installed.

The C/C ++ option is for advanced programmers and experts. The programming under C/C++ with FreeRTOS with a complete library of all hardware drivers (virtual display, button, UART, SPI, I2C, DMA, ADC and timer etc.) is the base for own developments. The JM3 RobotTool for Linux and Windows allows to upload programs (hex-code).

Marvin provides all the possibilities to program and control a robot, either way via the graphical iRP interface or with C++.

Accessories (not included)

- AA batteries (Ultra Power) or rechargeable batteries NiMH e.g. Ansmann HR06 Typ 2700
- Charger MW3310HC / 1 A Charging current setting
- USB-Kabel (Micro-B / Type A)

Sensor module extensions:

Extension Board (Arduino compatible, iRP programable)

- Interface with socket prepared for barometer or GPS module
- For your own hardware extensions

2 Manual

2.1 Marvin robot hardware

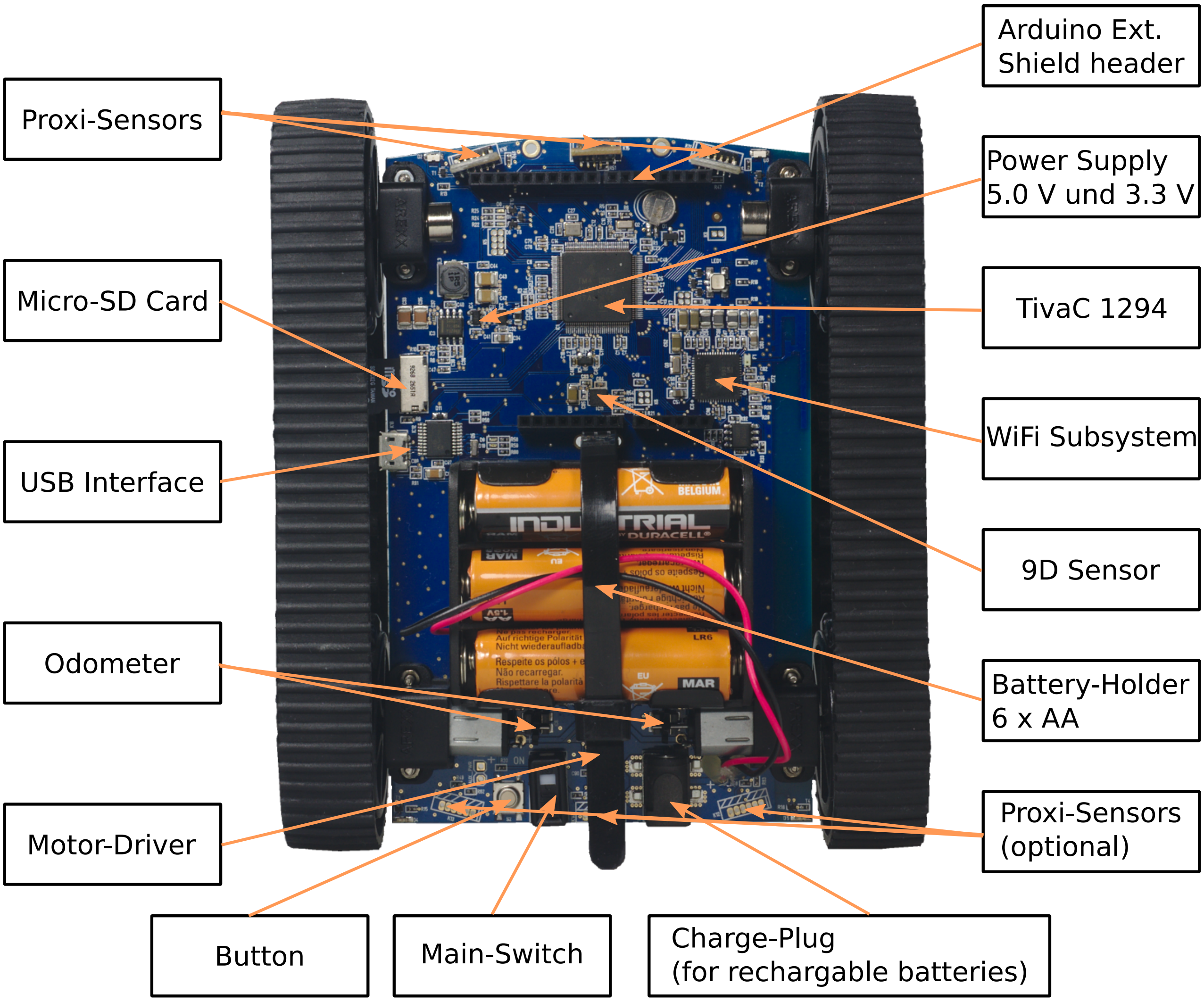


Figure 2.1 Marvin robot hardware

Hint: **The best thing to handle the Marvin robot is to grab it on the battery compartment or on the chains. In addition, it should be avoided to touch directly to the electronics (microcontrollers, etc.) as precaution agaist electrostatic discharge (ESD!).**

2.2 Marvin robot equipment and accessories

2.2.1 Features

The IoT robot provides many new possibilities:

- TIVA TM C- mikro controller ARM Cortex-M4F Core (Floating Point) with 512KByte Flash, 256KByte SRAM, 6KB EEPROM, CC3100 WI-FI® 802.11 b/g/n – up to 16 Mbps, optimized PCB antenna, Infrastructur- and Ad-Hoc Mode, Flash-ROM 8Mbit
- Virtual display on PC or Tablet-PC.
- 3x Proximity / Ambient Light Sensor (Time of Flight) in front at the center
  - right and left.
  - optional (retrofitted): 3 x rear (right, center, left)
- 9D - Gyro and compass sensor
- RTC with backup battery (recharging during operation)
- 1 x RGB status LED
- Status LEDs for Wi-Fi®
- 2 x LEDs USB (Rx, Tx)
- 2 x headlights (white) and 2x backlights (red)
- USB programming / Wi-Fi configuration (Micro USB connector)
- Micro SD-Card reader
- SMD button
- Arduino expansion plug - separate UART, SPI, I2C; 6 ADC, up to 8 GPIOs
- Interrupt capable, up to 4 PWM channels for servos
- 6 Cell power supply for AA batteries or rechargeable batteries for long operating times
- Slide switch and AUX battery input
- Switching regulator for high efficiency of the power supply
- Powerful micro-transmission motors with high-resolution odometry for high speed
- Rubber chain drive
- Application examples for Marvin iRP and remote control via Firefox or Google Chrome browser (PC, notebook or tablet)
- Robot programming tool (supports all AREXX robots) and USB drivers for Linux and Windows 7
- C++ Software Development Pack (GCC ARM Compiler (Linux), C++ Software Library, Application Examples)
- Micro SD card (robot documentation, iRP software and firmware: RobotTool, sample programs)

2.2.2 Detection range of the proximity-sensors

The sensors have a detection range (FoV) of 25° and a range of approx. 30 cm. Distances below 10 cm are displayed as zero. This ensures that the robot can avoid the obstacles without having to go backwards.

The two external sensors are twisted at +15° or -15° to the robot zero axis to achieve a wider angle of detection. The representation of the resulting detection range shows a slight overlap of the individual sensors.
This ensures that all obstacles in the travel path are recognized.
The picture also applies to the optional rear sensors.

FoV Proximity sensors (Representation of all three sensors):

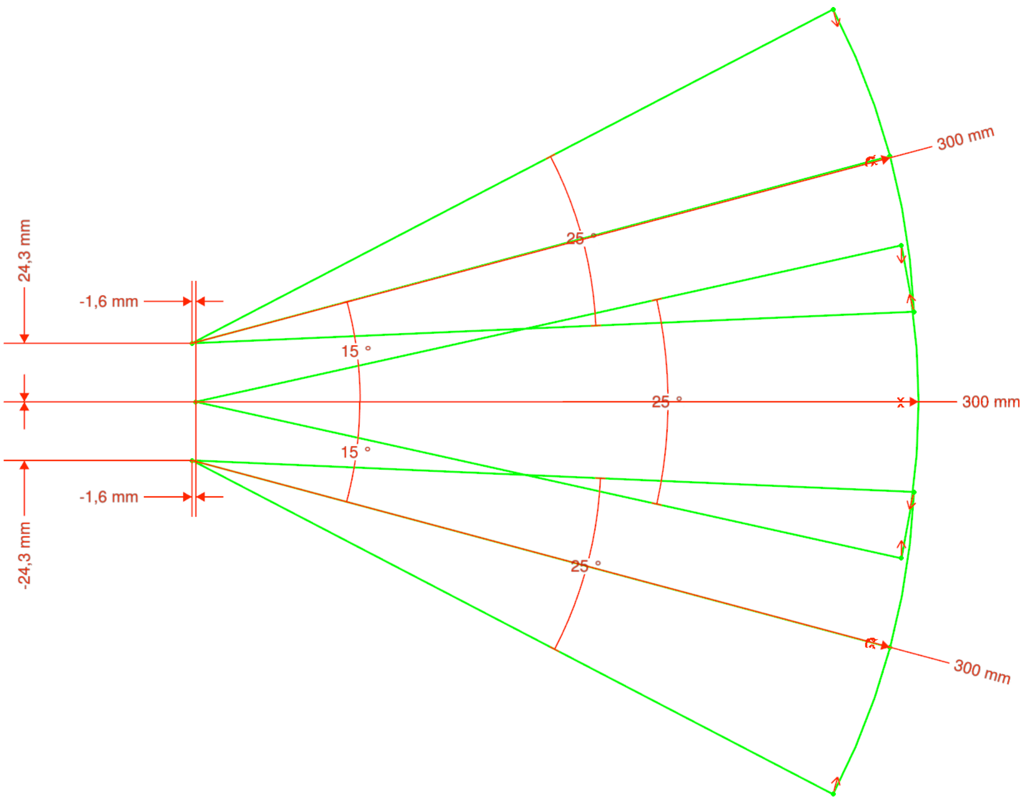


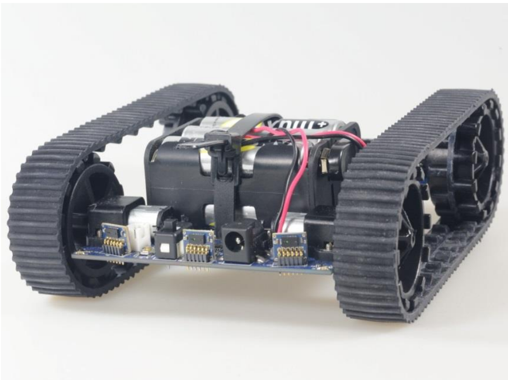
Figure 2.2 Field of View of the proximity sensors

2.2.3 Installation of additional proximity sensors (rear)

The sensors have a pitch of 1.27mm - half as much as usual. Therefore you should have a soldering iron with a fine tip and a power of approx. 50 W power.

Pay attention to the vertical position of the sensors and do not make them stand out. It is recommended to first solder only one pin, then align the sensor and then solder all other pins. The details on activating the sensors can be found in subsection 2.4.4.

Hint: **Don't forget to activate the new sensors by software!**



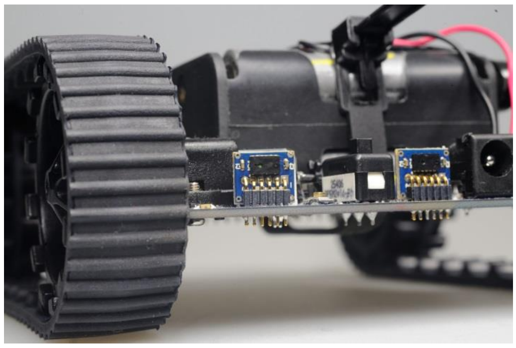


Figure 2.3 Marvin with rear proximity sensors

Hint: **It is best to exercise soldering on a PCB before - be economical with the solder. Too much solder can cause shorts between the PINs!**

2.3 Commissioning

2.3.1 Documentation and software

The complete documentation and the Marvin-iRP Web IDE software can be found on the enclosed Micro SD card. It can be downloaded via the Marvin web interface and is then in the corresponding folder for downloads of the computer.
The SD card uses the ext4 file system known from Linux and can not be read by Windows PCs or MacBooks without special support programs. Any updates are distributed via disk images that are written to the Micro SD card with a helper program. For this purpose a suitable micro SD card adapter is included on USB.

Hint: **In the delivery condition, the robot is set to the WiFi AdHoc mode so that it can communicate directly with a PC with a Wifi interface (Notebook, T-Tablet, etc.).**

There are a variety of micro SD cards that have different characteristics and are available in Marvin may not work properly. SD-XC cards as well as SanDisk Ultra cards are generally not supported!

Marvin software updates consist of the disk image with the iRP software.
It also contains the appropriate firmware (hex-file).
The versions of iRP software version and firmware version are always the same!

2.3.2 iRP WebIDE

The web interface software and the Marvin documentation are already on the enclosed Micro SD card. If the micro SD card is not already inserted in the robot, please do so carefully now.

Figure 2.4 Marvin with inserted SD Karte

Hint: **The Micro SD card usually does not have to be removed from the robot. It is protected so that it is protected from damage. However, you should not touch the robot so the Micro SD card is damaged!**

2.3.3 iRP connection with PC/Tablet

There are generally two different operating modes like the Marvin robot can be connected to the PC/Notebook via WiFi:

- WiFi - Infrastructure mode: Connect Marvin to a network (WiFi router or access point)
- WiFi - AdHoc Mode: here you can connect the Marvin directly to the notebook or tablet PC.
  - SSID: Marvin
  - IP: 192.168.1.1
  - Password: IoT-Robot

Hint: **The password is case-sensitive!**
Only in the AdHoc Mode is the SSID of the Marvin robot visible, since in infratructure mode the Marvin connects to your router which has its own SSID.

Please delete the browser cache if the iRP screen is not loaded correctly!

2.3.3.1 WiFi - AdHoc mode

This mode is set when the robot is delivered. It provides the fastest way to program or control the robot.

To connect the robot to the PC / notebook, perform the following steps:

1. Switch on PC / Notebook with WiFi interface
2. Turn on the robot - the green WiFi status LED is lit.
3. Search for wireless networks on the PC / Notebook in the WiFi menu - here you should find the SSID "Marvin".
4. Pair the robot with the PC by entering the password and activate the connection.
5. Open the browser and enter the IP 192.168.1.1. You should see Figure 2.5 in the browser.
   That's it - you can now familiarize yourself with the menu and load and run a first small program!
6. Load the sample program "running lights"
7. You should now see the status LED glowing in different colors changing every 1sec.

2.3.3.2 WiFi - Infrastruktur mode

This mode must first be configured on the robot with the JM3 Robot Tool and logged on to the WiFi router. The Marvin supports DHCP and an IP address is automatically assigned.

Hint: **If necessary, change the firewall settings so that the Marvin robot can connect to the network!**

Please delete the browser cache if the iRP screen is not loaded properly!

Here is the process for conversion to infrastructure mode:

1. Install the JM3 Robot Tool (installation - see chapter 4)
2. Connect the robot to the computer (Micro USB cable)
3. Open the Robot Tool, turn on the robot, and connect.
4. Proceed as follows:
   a) Connect robot via USB
   b) Change to terminal window (tab)
   c) Send the following commands to the robot:
      - wlan DEFAULT - “Enter”
      - Turn the robot OFF and ON when it is displayed in the window
      - wlan STA addprofile “SSID of your router” “password of your router” - “Enter”

      Hint: **Please note that the terminal history should be switched off when the “addprofile” command is sent. Otherwise, your password will be stored in plain text on the PC!!! For more information on the commands and how to enter spaces, see section 2.5**

      - wlan STA MODE - “Enter”
      - Turn the robot OFF and ON when it is displayed in the window

   d) Check the assigned IP address (DHCP router) for the Marvin robot
      - wlan getIP - “Enter”
        The current IP address is now displayed in the terminal window.

5. Then open the browser and enter the IP address, for example: 192.168.1.120
   You should see Figure 2.5 in the browser.
   That's it - you can now familiarize yourself with the menu and load and run a first small program!
6. Load the sample program "running lights"
7. You should now see the status LED light up in different colors changing every 1 sec.

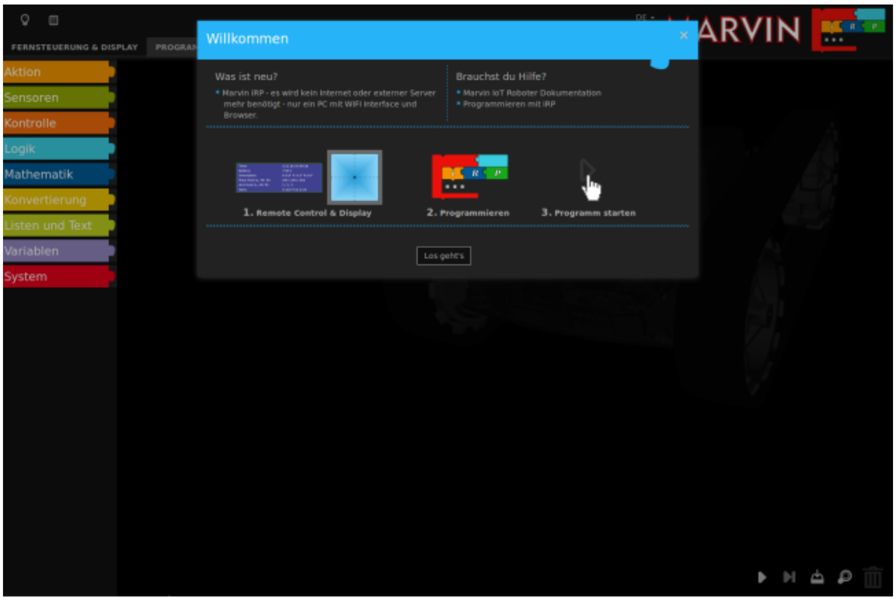


Figure 2.5 Marvin WebIDE Welcomescreen

2.3.4 Status LEDs

To the status display of the robot (RGB-LED):

- blue - normal function
- Purple (blinking) - battery voltage low
- Yellow - no SD card or function impairment, Notes on USB Interface.
- green - busy (SD recovery)
- blue/green (blinking) - no firmware
- yellow/red (blinking) - firmware programming
- red - functional malfunction - please turn robot On and Off

There are also three LEDs to display the status of the WIFI subsystem:

- red - Connection problem with WiFi network
- yellow (blinking) - transmitting data
- yellow (permanent) - WiFi connection stuck
- green - connected to WiFi network, this is always the case in AdHoc mode and is independent of the HTTP connection.

2.3.5 System Display

The key system status of the robot will be displayed in the “System Display”:

The System Display shows the following elements (Figure 2.6):

- Date and Time: - system date and time
- Battery - battery voltage
- Orientierung (Orientation) - compass heading (H:), pitch angle (P:), roll angle (R:)
- Proximity sensors (L/M/R) - distances left, mid, right
- Brightness sensors (L/M/R) - brightness left, mid, right
- Gyro sensor - angular turn rate in roll-axis (R:), pitch-axis (P:), yaw-axis (Y:)

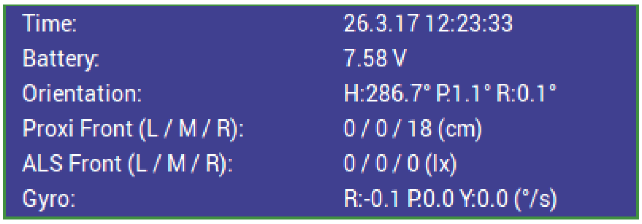


Figure 2.6 System Display

2.4 Calibration of sensors and set system time

The Marvin robot supports the calibration of compass, gyro (rotational speed sensor) and distance sensors. These functions are initiated in the Remote Control and Display window (see also subsection 3.1.1) with the specific command buttons or via the command line interface (Figure 2.7). In addition, the real-time clock of the robot can be synchronized with the system time of the PC/Notebook.

Hint: **Calibration is usually only required once, and all recorded calibration data are stored in the robot.**

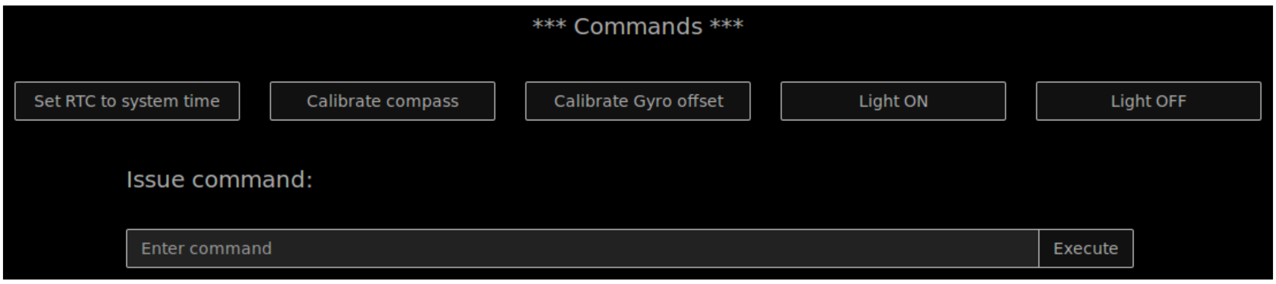


Figure 2.7 Command line interface

2.4.1 RTC - set system time

Setting the real time clock in the Marvin robot is initiated by pressing the "Set RTC" button. This completes the setting of the clock.

Hint: **The time now also continues with Marvin switched off for several months. The battery is recharged by switching on the robot.**

2.4.2 Calibration of the 3D compass

The procedure for calibrating the 3D compass is described below. The alignment to NWSE is automatically detected. A key must only be pressed or a command executed to start/stop.

Hint: **The references to the sky direction facilitate a complete calibration - but are not absolutely necessary. It is important to go through a complete circle!**

2.4.2.1 Step 1 - preparation

Turn on the Marvin robot and connect the robot to the web interface in the browser. Take a compass and determine the directions for north, east, south and west - remember the points.

Hint: **You can skip this step if no compass is availble. Important is to cover the full circle.**

2.4.2.2 Step 2 - calibration mode on

Go to the remote control and display page and click the button "Calibrate compass".

In the picture you see the imaginary axes related to the Marvin. The x-axis is red, the y-axis is green and the z-axis is blue. Yellow is the inclination vector whose angle is not exactly known and depends on the location on the earth. If the inclination vector and the x-axis are on a line then it can expected to be the maximum of the measured value. This is necessary for a good calibration.

2.4.2.3 Step 3 - process

- Hold the robot to the north and tilt it upwards by 90 ° and then down.
- Hold the robot approximately horizontally to the north and tilt it 90 ° to the left and then to the right.

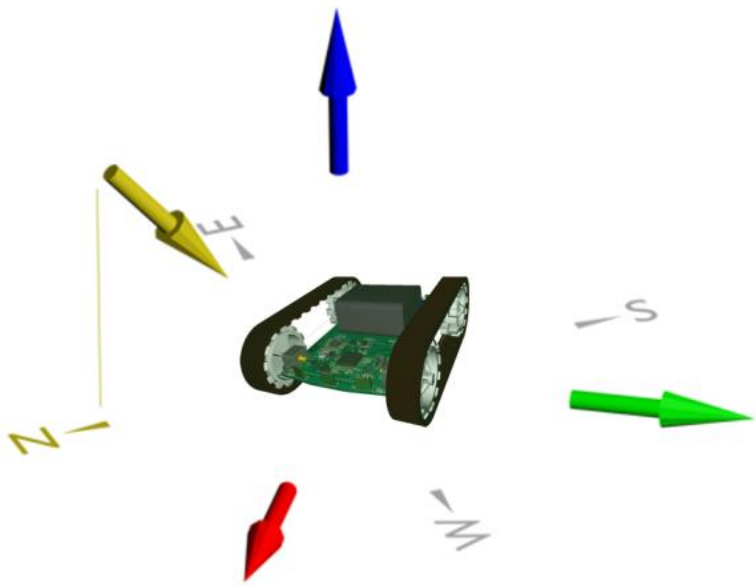


Figure 2.8 Cardinal points and inclination vector

- Repeat this for east, south and west, or a complete circle, if possible with intermediate values, which increases accuracy.

Hint: **Do not tilt the Marvin too quickly during calibration!**

2.4.2.4 Step 4 - finalization of calibration

After completing the procedure, close the calibration mode by clicking on the corresponding button “Finalize calibration” and check the result by aligning the robot with the corresponding and known direction of the sky.

2.4.3 Calibration of the 3D gyroscope

Calibrate the gyro by pressing the “Calibrate Gyro Offset” button. The button will now show “calibration - please wait” - this is done until the process is finished.

Hint: **The calibration runs independently. Of course, the robot must not be moved.**

2.4.4 Proximity sensors activation

The proximity sensors are activated or deactivated using the “conf” command. Details are in Table 2.1. For example, to activate the sensor in the center at the rear, enter the following in the command line:

- conf add RM “Enter” and subsequently
- conf save RM “Enter”

This would have added the RM sensor (rear center) and saved the configuration permanently and the sensor is ready for operation.

2.4.5 Calibration of the proximity sensors

The calibration of the distance sensors is described below. For this purpose, an iRP auxiliary program must be executed and the measured values must be noted for each sensor.
In addition, you need a ruler with a length of 30 cm to 50 cm. The values are then written into the robot with the command interface Figure 2.7 and stored there.

Hint: **The calibration of the distance sensors is not absolutely necessary and provides an option to get more accurate results.**
Beginners should not do this.

2.4.5.1 Step 1 - preparation

Turn on the Marvin robot and connect the robot to the web interface in the browser.

- Place the ruler in front of the respective sensor, so that the imaginary line of sight of the sensor is coincident with the ruler.
- Start the iRP program “Distance sensor calibration”.
- Go to the “remote control and display page”.

In the lower display Figure 2.9, the distance raw values are displayed:

- FM (Front Mid) 0 - 255
- FL (Front Left) 0 - 255
- FR (Front Right) 0 - 255
- RM (Rear Mid) 0 - 255
- RL (Rear Left) 0 - 255
- RR (Rear Right) 0 - 255

Hint: **You can use the white Marvin Box for distance measurement!**

2.4.5.2 Step 2 - process

Now measure the respective minimum and maximum value of the detection range.

- To do this, approach the obstacle (Marvin Box) from approx. 35 cm until the raw value is set to a value smaller than 255 in the display.
- Find the exact point and write the raw value and the measured distance at the ruler.
- Approach the Marvin with the obstacle (Marvin Box) further until the raw value no longer changes in the display (minimum value).
- Find the exact point and write the raw value and the measured distance at the ruler.

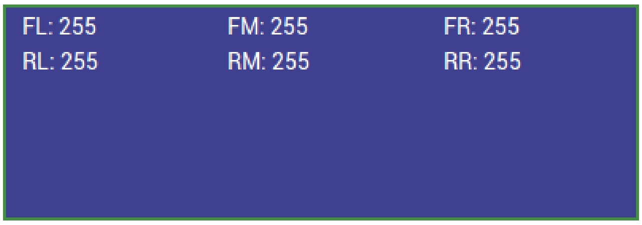


Figure 2.9 iRP auxiliary program data on user screen

Enter the following in the command line:

- cal prox FM 23 135.0 300 170 “Enter”

  In this example, the front mid sensor (FM) with the lower raw value of “23” and the measured distance “13.5” together with the measured distance “300” and the upper raw value of “170” would be used for calibration.

Hint: **All distances must be entered in “mm”!**

2.4.5.3 Step 3 - verfication

After performing the procedure the robot needs a power cycle to use the calibration data. Then check the result for the left, right, and center position sensor. For:

- ca. 13 cm muss 0
- ca. 30 cm muss 30
- > 30 cm muss 255 are displayed.

2.5 Command line interface (CLI)

Table 2.1 describes all commands with syntax that are available.

Table 2.1 CLI Kommandos

Command	Description
cal cmps	activates/deactivates the compass calibration mode.
cal gyro [--state]	calibrates Gyro offsets. If the parameter "–state" is specified, the current progress is output.
cal prox "sensor" "xNear" "mmNear" "xFar" "mmFar"	calibrates sensor: FL/FM/FR/RL/RM/RR.
conf "cmd" "sensor"	configures the proximity sensors: FL/FM/FR/RL/RM/RR. Commands (cmd): "add" "del" "read" "save"
light "on/off"	Toggles driver lights on/off.
setrtc "H_M_S_W_D_M_Y"	Set RTC to system time.
wlan AP ssid "SSID"	Set SSID in AdHoc mode to "SSID".
wlan AP passwd "passwd"	Set password in AdHoc mode to "passwd".
wlan AP txpwr "pwr"	Set transmit power in AdHoc mode to "pwr". "pwr" Is a number between 0 and 15. "0" is the maximum transmit power. Maximum efficiency is reached at"pwr" = 4.
wlan AP channel "ch"	Set WLAN channel in AdHoc mode. "ch" is a number between 0 and 13. "ch" = 0 for automatic channel selection.
wlan AP MODE	Switches Marvin to AdHoc mode.
wlan STA addprofile "SSID" "passwd"	Joins the network with the SSID "SSID" and the password "passwd". In the future, it will automatically try to connect to this network.
wlan STA delprofile "ID"	Deletes the WLAN profile with ID "ID". The ID "-1" deletes all profiles.
wlan STA txpwr "pwr"	Set transmit power in Infrastruktur mode to "pwr". "pwr" is a number between 0 and 15. "0" is the maximum transmit power. Maximum efficiency is reached at "pwr" = 4.
wlan STA ipcfg "DHCP" | "IP" "mask" "gw" "dns"	Enabled in Infrastructure mode DHCP or sets a static IP address. "IP", "mask", "gw" and "dns" are IPv4 addresses.
wlan STA MODE	Switches Marvin to Infrastructure mode.
wlan STA SCAN	Scans for available WLAN networks.
wlan DEFAULT	Resets the WLAN module to factory settings.
wlan getIP	Returns the current IP address.
version	Outputs firmware version number.
security updatekey "key.der"	Copy HTTPS key from the SD card to the WiFi module.
security updatecert "cert.der"	Copy HTTPS certificate from the SD card to the WiFi module.
security htpasswd "user:passwd"	Set web server username and password.

The "security" commands are only available in C ++ mode under Linux

3 Programming with iRP

The graphical programming language Marvin - iRP is easy to learn and requires none previous knowledge of a programming language like C/C++.

The various function blocks allow to create and execute programs on a logical level.

3.1 Introduction in iRP

3.1.1 Basic operation

The general handling of a PC and browser is a prerequisite.

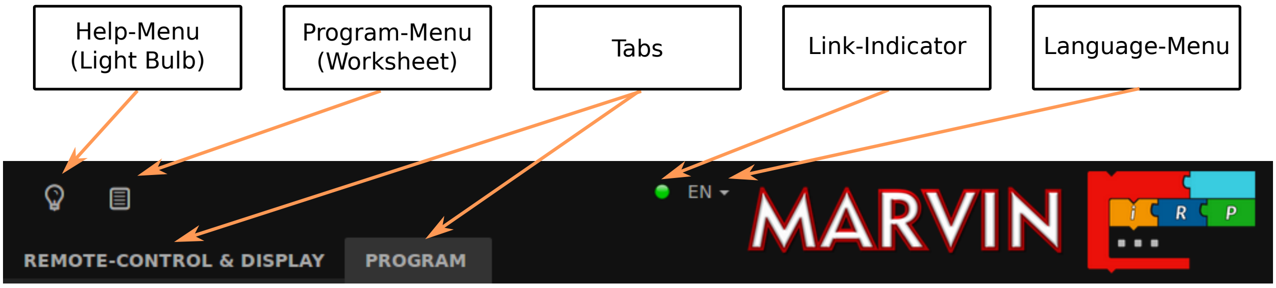


Figure 3.1 Marvin WebIDE Menu bar

The link indicator is located to the left of the language menu.

- A green light indicates a good connection.
- A red light indicates a short-term interruption or use of the entire bandwidth for downloading documents from the SD card.
- If there is a longer error, a pop-up message is displayed on the screen.

3.1.1.1 The language setting symbol

- You can easily set the language using the language selection field.
- In addition, you can see the “Zoom” and “Pan” buttons at the bottom right hand side.

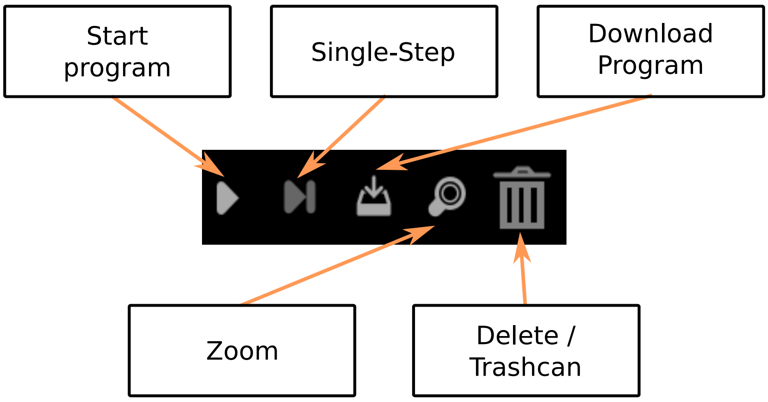


Figure 3.2 Marvin WebIDE program buttons

Hint: **Other languages such as Spanish, Italian, French and Chinese (simplified) are supported. The online help is currently only available in German and English.**

3.1.1.2 The light bulb symbol

- Find the help function for the iRP blocks with brief explanations.
- Notes on documentation and software.
- General notes about the program (info) and you can get the start screen displayed again.

3.1.1.3 The Worksheet symbol

- Here you can edit your programs, e.g. load, store etc. .
- Marvin SD card programs (menu to load and save)
- You can also select the iRP mode (Beginner, Intermediate, Expert) set to. The dark gray color indicates the selection.

3.1.1.4 Remote control and display Tab

- Here are two displays, a remote control panel and a plotter area.
- The two virtual displays are divided into a fixed area where system values are displayed (for example, the battery voltage) and a user area (user display).
  In the user area you can display values from your program.
- In addition, you can make settings and send commands (section 2.5).

3.1.1.5 Program Tab

- Here you can edit your programs, e.g. Load, save, etc. .
- You can also select the iRP mode (Beginner, Advanced, Expert) set to.

3.1.2 iRP help

A help function to the iRP blocks is always easily accessible in the browser.

- Click on the light bulb symbol (picture shown at the top left) or
- Click on the question mark on the right side of the screen.

The help sidebar scrolls to the currently used block automatically. (see Figure 3.3).

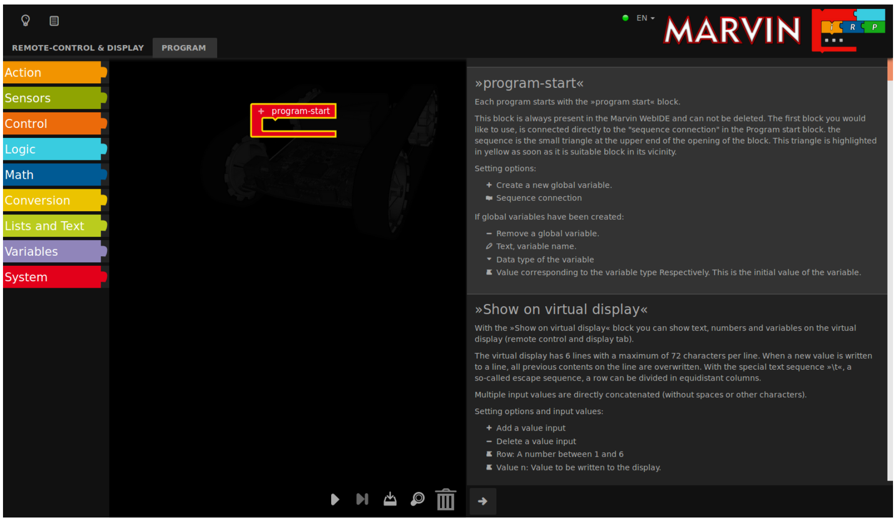


Figure 3.3 The Marvin WebIDE Helpbrowser

3.1.3 My first program

- A new program is simply merged together from the iRP blocks.
- If blocks are not logical matching, you can not attach them to the other block. In the example, the block “real number” does not logically match to a “integer” (Figure 3.4).

3.1.4 Program execution

- A program can be “started” via the menu in the program tab or with the start button.

Figure 3.4 Mismatch of block types in iRP

- Next to the “start button” is a “step button” (step by step execution of the program to the breakpoint), the download button, the zoom function and the trashcan - for blocks which are no longer required.

3.1.5 Program load or saved

- Here you can load or save your programs. The location can be selected as usual.
- It is also interesting to insert already developed parts of the program. So you can build up a more comprehensive program from different program modules - see example: “Drive a square with compass”.
  In this example there is a function included which does an averaging of the measurment values - this could be a useful sub-function in other programs as well.

3.1.6 Program errors (Debugging)

If an error occurs during programming, an indication is given and the corresponding block is highlighted (see Figure 3.5)

Hint: **A very useful feature is the ability to set breakpoints to stop the program and display an interesting value or state in the virtual display. This simplifies the debugging, since the internal state of the software can be displayed easily!**

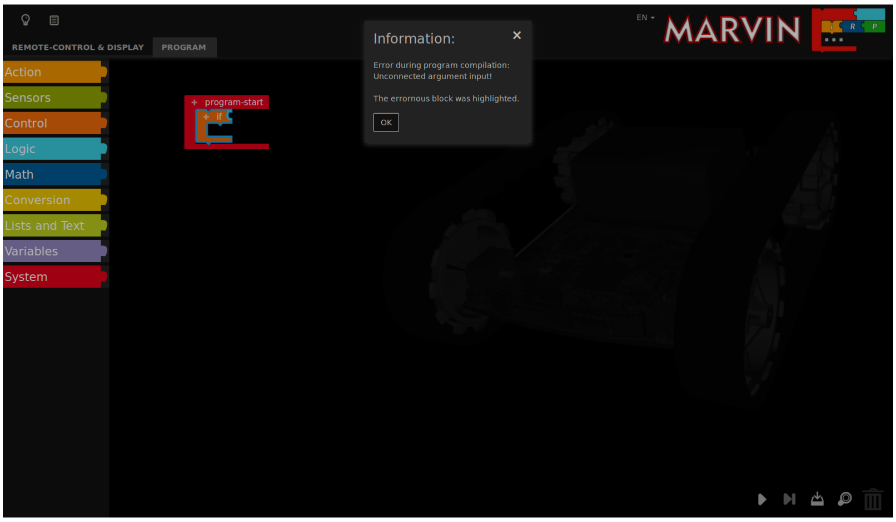


Figure 3.5 Beispiel für einen Compiler Fehler

3.1.7 Program code (source code) viewer

For further debugging, it may be helpful to look at the source text - but this is rather something for advanced and experts. The selection is made by means of the program tab “source code” - in this case outputs as C++ source, C++ header and assembler are possible (Figure 3.6).

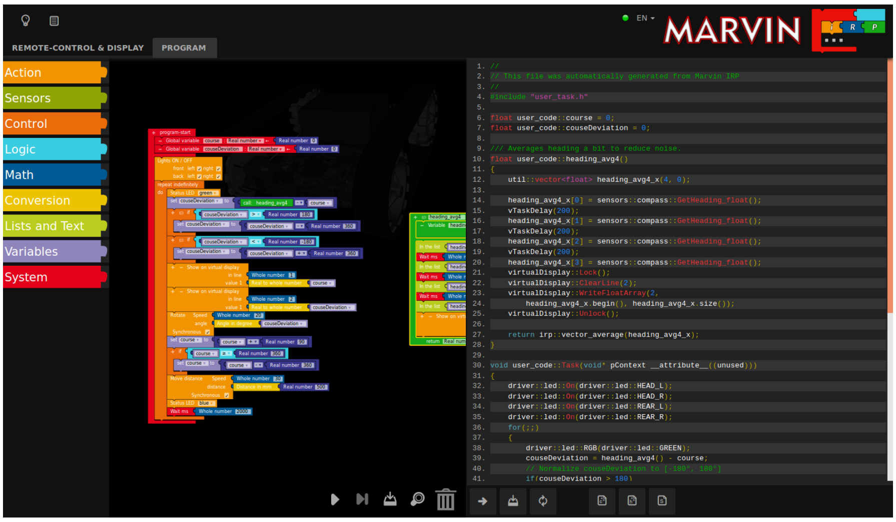


Figure 3.6 Example for generated C++ code

4 JM3 Robot-Tool 2.0

4.1 Linux

- Copy the JM3 Robot Tool to a folder and run the program “launch_robotTool.sh”!

Hint: **Further details see install.txt**

- Click on the “Add Robot” icon - enter the name (freely selectable), the hostname and the USB port you are using and go to the next step.
- Select the robot type, e.g. “Marvin”. The available USB port name can be looked up in the system configuration - the USB port is usually “/dev/ttyACM0”. Just type in the correct USB port e.g. “/dev/ttyACM0”. As interface type, select “UART” with a baud rate “0” (default).
- Click OK
- Click on “Add File” to select the hex-file with the new program. The search simply goes over the path with “SelectFile”. Select the hex-file you want to load into the micro controller. As a further step select the type, e.g. “Marvin”.
- Click OK.
- Select the robot and the program in the listed links.
- Click “Upload program” (at the top of the toolbar)
- Click “Save” (at the top of the toolbar), if you want to save the created robots and programs.

4.2 Mac OSX

- Copy the JM3 Robot Tool to a folder and run the program “robottool.app”.
- Click on the “Add Robot” icon - enter the name (freely selectable), the hostname and the USB port you are using and go to the next step.
- Select the robot type, e.g. “Marvin”. The available USB port name can be looked up in the system configuration - the USB port is usually “/dev/tty.usbmodem1421”. Just type in the correct USB port e.g. “/dev/tty.usbmodem1421”. As interface type, select “UART” with a baud rate “0” (default).
- Click OK
- Click on “Add File” to select the hex-file with the new program. The search simply goes over the path

with “SelectFile”. Select the hex-file you want to load into the micro controller. As a further step select the type, e.g. “Marvin”.

- Click OK.
- Select the robot and the program in the listed links.
- Click “Upload program” (at the top of the toolbar)
- Click “Save” (at the top of the toolbar), if you want to save the created robots and programs.

4.3 Windows 7

- Copy the JM3 Robot Tool to a folder and run the file “robottool.exe”.
- Click on the “Add Robot” icon - enter the name (freely selectable), the hostname and the USB port you are going to use.
- Select the robot type e.g. “Marvin”. The correct COM Port can be checked in the Device Manager - often this is “COM3”. Just type in the correct COM port e.g. “COM3”. As interface select “UART” and the baud rate should be set to “0” (default).
- Click OK
- Click on “Add File” to select the hex-file with the new program. The search simply goes over the path with “SelectFile”. Select the hex-file you want to load into the micro controller. As a further step select the type, e.g. “Marvin”.
- Click OK.
- Select the robot and the program in the lists on the left.
- Click “Upload program” (at the top of the toolbar)
- Click “Save” (at the top of the toolbar), if you want to save the created robots and programs.

4.4 Load your own programs created under C/C++

To upload a self-written program (hex-file) into the micro-controller you must have installed the **JM3 RobotTool** before you can continue (Figure 4.1).

4.4.1 Upload (Marvin application)

- Start the **JM3 Robot Tool** It is assumed that the robot tool has already been prepared as described above.
- Click on "Add File" to select the hex-file with the new program. The search simply goes over the path with "SelectFile". Select the hex-file you want to load into the micro controller. As a further step select the type, e.g. "Marvin".
- Click OK.
- Now select the robot entry from the list e.g. "Marvin" and the hex-file by clicking on it one by one (highlighted light gray) and click "Upload".
- Click on "Save" (at the top of the toolbar), if you want to save the created robots and programs.

4.4.2 Upgrade Firmware (Bootloader)

The firmware of the Marvin robot also allows to flash the bootloader itself to a later version. This requires the following steps.

- Select the new boot loader (hex-file) as described above.
- A click on “Upgrade Firmware” executes the update.

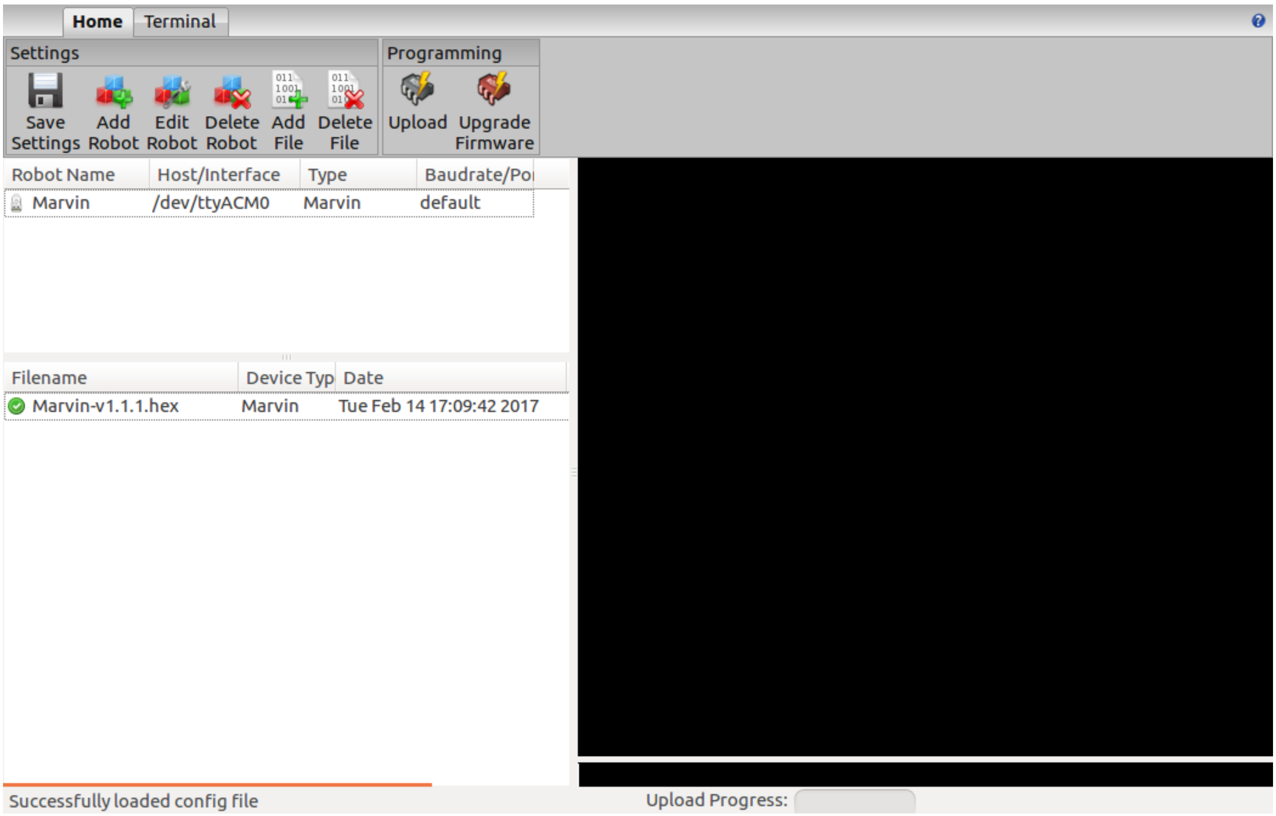


Figure 4.1 The JM3 Robot-Tool

4.5 Terminal window

The terminal feature in the JM3 RobotTool allows serial data to be received and sent. It can also record data and save it to a file. Various settings are available “Settings”:

- Connect to robot “Connect” allows data to be received.
- Disconnect connection to robot “Disconnect”.
- Send data to the robot “Right side - lower window” - commands can be entered here at any time. Please set line-ending characters to “LF” (line feed).
- The program supports “undo” using the arrow keys (up and down) and “refresh” with F5.

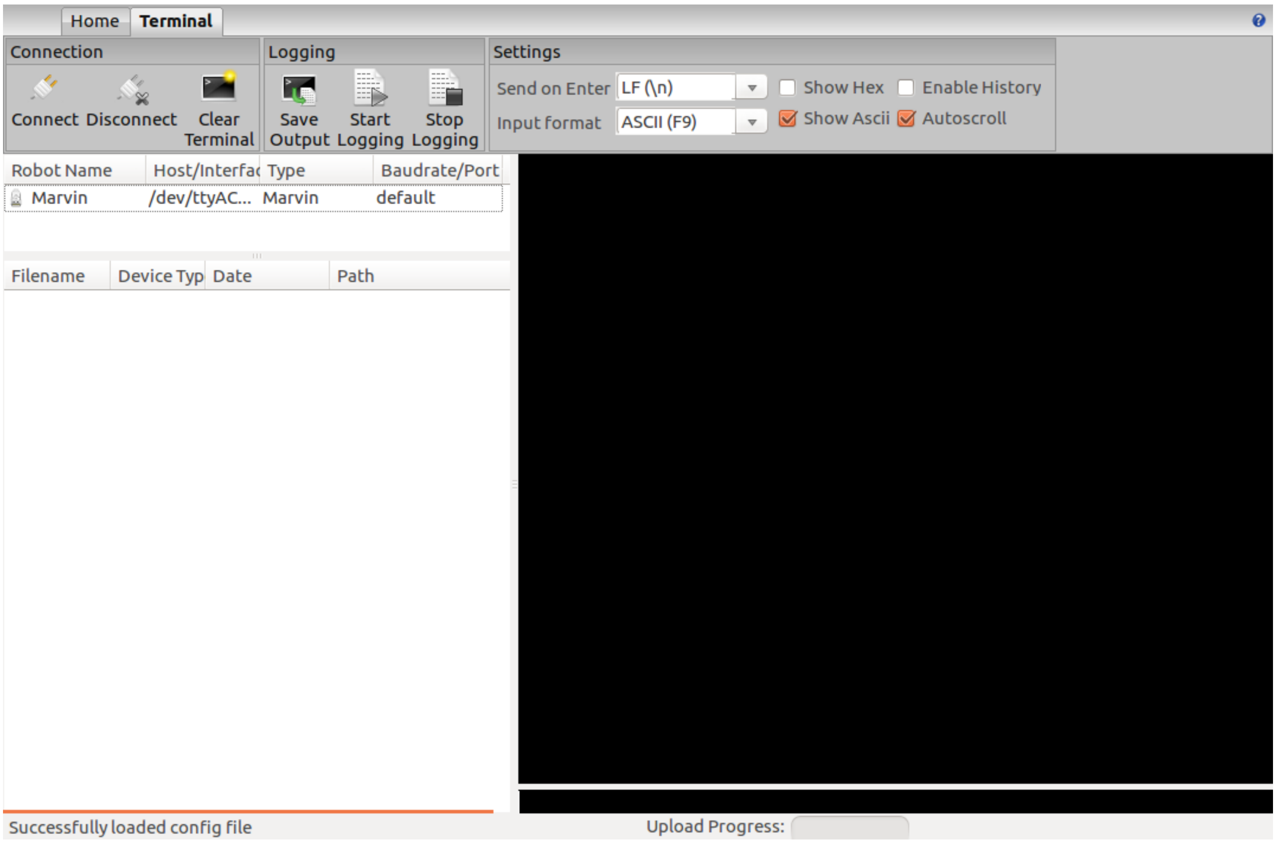


Figure 4.2 The JM3 Robot-Tool - Terminal window

4.6 Firmware and iRP Micro SD-Card update

In the following is a description of a software update process.

Firmware update (all Operating Systems):

The firmware update is performed with the JM3 Robot Tool. Details are described in chapter 4.

- Connect to the PC/Notebook using a USB cable (Mirco-B / TypeA).
- Start the JM3 Robot Tool and select the “Firmware.hex” file.
- Turn on the Marvin robot and connect to the PC/Notebook.
- Start it with a click on the “Upload icon”.

Hint: **Firmware and iRP SD card image always belong together!**
After an update always delete the browser cache!

4.6.1 Micro SD-Card update (Ubuntu-Linux):

The SD card update is started either by double-clicking on the image file (*.img), or by running an “right-click” on the image file, and selecting “Writing drive image”. After this, a window “Restore drive image” appears.

- Select your Micro SD card.
- Start the image update with “restore ...”
- Wait until the image has been copied completely.
- Please “eject” the drive.

4.6.2 Micro SD-Card update (Linux - general):

The SD card image is executed with the command “dd”.

- Insert the SD card with the USB adapter.
- Open a terminal window.
- Check the ID “/dev/sdX” of the SD card by running the command “sudo fdisk -l”.
- Note the ID of the SD card (it must have a size of approximately 2GBytes and contain exactly one Linux partition).
- “Unmount” the SD card with the command “sudo umount /dev/sdX”.
- Start the image update with the command “sudo dd bs=1M if=myImage.img of=/dev/sdX”.

Attention: **Use the correct filename and ID. Otherwise all data on the computer can be destroyed!!!**

- Wait until the image has been copied completely.
- Please “eject” the drive.

4.6.3 Micro SD-Card update (Mac OSX):

The SD card image is executed with the command “dd”.

- Insert the SD card with the USB adapter.
- Open a terminal window.
- Check the ID “/dev/diskN” of the SD card by running the command “sudo diskutil list”.
- Note the ID of the SD card (it must have a size of approximately 2GBytes and contain exactly one Linux partition).
- “Unmount” the SD card with the command “sudo diskutil unmountDisk /dev/diskN”.
- Start the image update with the command “sudo dd bs=1m if=myImage.img of=/dev/diskN”.

Attention: **Use the correct filename and ID. Otherwise all data on the computer can be destroyed!!!**

- Wait until the image has been copied completely.
- Please “eject” the drive.

4.6.4 Micro SD-Card update (Windows OS):

The SD card image is performed with the “win32DiskImager” tool.

- Start the program and select the new SD card image.
- Start the image update.
- Wait until the image has been copied completely.
- Please eject drive ’.

5 Option: C/C++ Software

The C++ programming language has emerged from the C language and represents an extension and improvement of C.

All in all the more modern language which gives a better readability of the code and a much better protection against side effects (e.g. enums / namespaces instead of often unclear #define instructions). Assembler and C program parts can be easily combined with C++ code.

Special advantages and the reduction of program code in case of using multiple instances of h/w drivers can be achieved - e.g. one instead of two UART drivers. Easier portability of the developed program code represents a further advantage.

The used Extended Embedded C++ implementation does not allow the following C++ features which you may know from PC programming - but which does not make sense for embedded Systems are:

- RTTI
- Exceptions

The libraries needed for the creation of own programs (h/w driver etc.) and a few application programs are supplied with the package.

Hint:	**This option is for advanced users and experts.**
	C/C++ software development and the Realtime Operating System FreeRTOS are not suitable for beginners!
	The knowledge to deploy the entire Linux based toolchain and GCC compiler including their configuration is required.

5.1 Software package for Marvin

The Marvin software package consists of the web interface software, the operating system (FreeRTOS) with API functions and a library with all hardware drivers, e.g. the virtual display, ADC, timer, I2C, UART, LED and keypad.
For further information and possibilities please read the descriptions of the modules and the corresponding data sheets!

5.1.1 Toolchain

As compiler, the GCC for ARM (arm-none-eabi-gcc) must be used under Linux. Additionally, the following packages are required: make, newlib, arm-none-eabi-gcc and python. Any editor for the change of the source code can be used.
The programming (s/w upload) is possible via the USB connection and the “JM3 Robot Tool”. Your program can be loaded quickly and effectively into the TIVA C.

If you need full access to the microcontroller, you need a TIVA JTAG Interface (e.g., TM4C1294 “Connected Launch Pad” EK-TM4C1294XL). In addition you have to solder the 8 PIN JTAG header (RM1.27) on the PCB and a suitable connection cable must be build.

5.1.2 Software-Library

The software library also includes features such as compass, tilt measurement, real-time clock, motor control and a user interface for the configuration of the WiFi interface.
The Web Interface can display various values on the virtual display in the browser.
All functions (blocks) known from iRP and others are available in the library. C++ code generated with iRP can be exported and transferred to a new C++ project.
This also simplifies the transition from iRP to C++ code development.

5.1.3 Marvin function buttons

The Marvin function buttons in the Remote Control and Display tab Figure 5.1 can only be used with your own C++ programs.

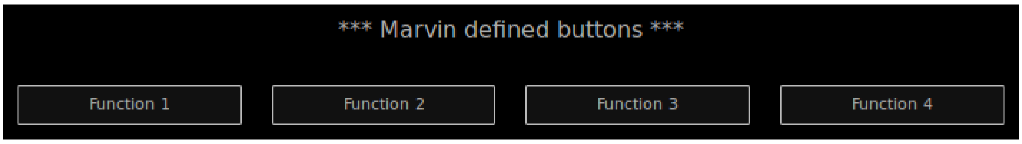


Figure 5.1 Marvin function buttons in Remote control and display tab

5.2 Demo software description

The demo programs of iRP can be exported and used in your own C++ programs. The iRP Web IDE - “Remote control and display” can also be used as a virtual display.

6 Technical data

6.1 Dimensions and weight

Width:	125 mm
Length:	148 mm
Height:	50 mm
Weight:	195 g (without batteries)

6.2 Power supply and power requirement

VCC	=	8.4 V	± 5%	=> 6 AA cells

Hint: **The absolute maximum is bei 10.0 V !!!**

ICC_{AVR}	=	160mA	+40.0 mA / -20.0 mA	=> without Arduino Extension

Hint: **Battery lifetime:**
ca. 5 h (Driving operation - engines at 50%)
ca. 10 h while programming with iRP

6.3 Supply voltages experiment board

VDD_3V3:	Iout,max	≤	50 mA
VDD_5V0:	Iout,max	≤	50 mA
VBat_M (VSS):	Iout,max	≤	200 mA

6.4 Further information

All other data can be taken from the following IC data sheets!

Controller:	Texas Instruments	TM4C1294KCPDT
Motor Driver:	Texas Instruments	DRV8833CPWP
9D-Sensor:	ST Microelectronics	LSM9DS1TR
Proxi-Sensor:	ST Microelectronics	VL6180X

7 Schematic details

7.1 Arduino Extension Board

Arduino Shields are supported by the Hardware. All common interfaces such as I2C, SPI, UART ADC and GPIOs or various timer outputs supoorting frequency or PWM generation e.g. for servo control. An input capture function is available for measuring frequencies and duty cycles.

Table 7.1 Pin out Arduino compatible header

Pin 1	=	IOREF	Pin 17	=	IO_1
Pin 2	=	RESET	Pin 18	=	IO_2
Pin 3	=	VDD_3V3	Pin 19	=	IO_3
Pin 4	=	VDD_5V0	Pin 20	=	IO_4
Pin 5	=	GND	Pin 21	=	IO_5
Pin 6	=	GND	Pin 22	=	IO_6
Pin 7	=	VSS (V_Bat)	Pin 23	=	IO_7
Pin 8	=	ADC_X5	Pin 24	=	CS_X
Pin 9	=	ADC_X4	Pin 25	=	MOSI_X
Pin 10	=	ADC_X3	Pin 26	=	MISO_X
Pin 11	=	ADC_X2	Pin 27	=	SCK_X
Pin 12	=	ADC_X1	Pin 28	=	GND
Pin 13	=	ADC_X0	Pin 29	=	NC
Pin 14	=	RX_X	Pin 30	=	SDA_X
Pin 15	=	TX_X	Pin 31	=	SCL_X
Pin 16	=	IO_0			

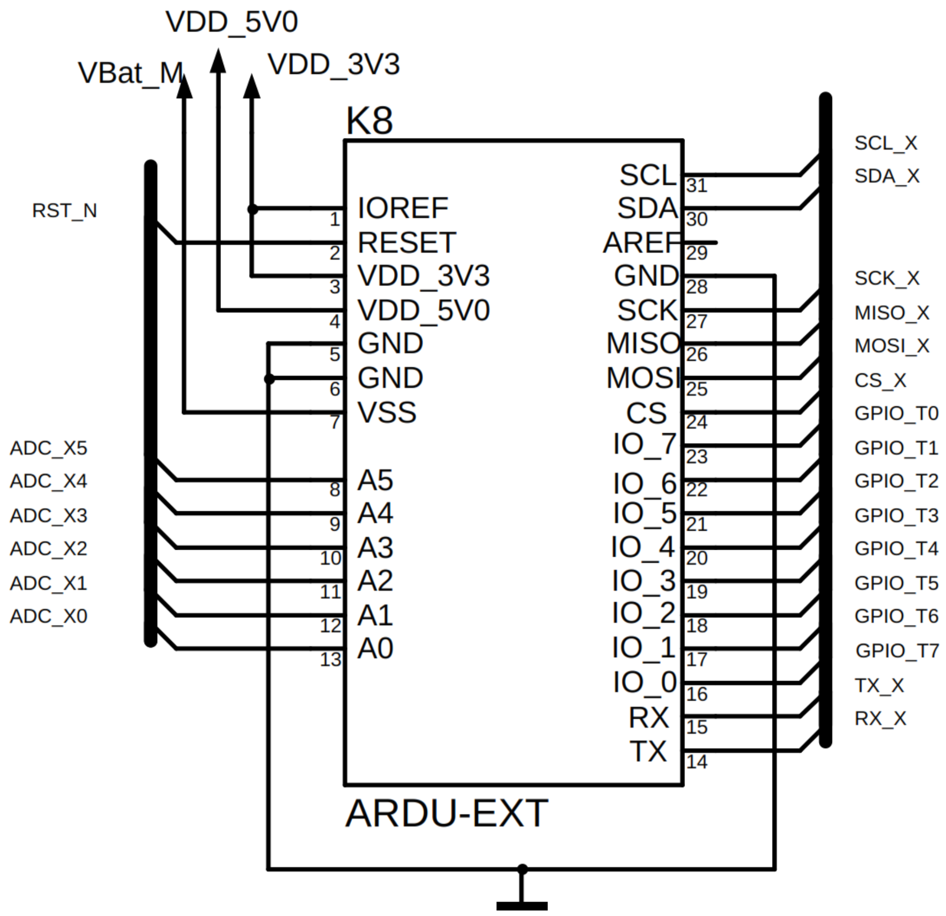


Figure 7.1 Marvin Arduino header - schematic

7.2 Pin mapping TM4C129EKCPDT

Table 7.2 TM4C129EKCPDT Pin mapping

Pin	Name	Function	Signal
1	PD0	SSI2DAT1	MISO_SD
2	PD1	SSI2DAT0	MOSI_SD
3	PD2	SSI2FSS	CS_SD
4	PD3	SSI2CLK	SCK_SD
5	PQ0	SSI3CLK	WIFI_SPI_CLK
6	PQ1	SSI3FSS	WIFI_SPI_CS
7	VDD		
8	VDDA		
9	VREFA+		
10	GNDA		
11	PQ2	SSI3DAT0	WIFI_SPI_MOSI
12	PE3	AIN0	ADC_X3
13	PE2	AIN1	ADC_X4
14	PE1	AIN2	ADC_X2
15	PE0	AIN3	ADC_X5
16	VDD		
17	GND		
18	PK0	GPIO	SD_Present
19	PK1	GPIO	INT_2_A/G
20	PK2	GPIO	INT_1_A/G
21	PK3	GPIO	NC
22	PC7	GPIO	INT_M
23	PC6	GPIO	DRDY_M
24	PC5	GPIO	WIFI_RST
25	PC4	GPIO	WIFI_HOST_INT
26	VDD		
27	PQ3	SSI3DAT1	WIFI_SPI_MISO
28	VDD		
29	PH0	GPIO	PROX_RL_CS
30	PH1	GPIO	PROX_RM_CS
31	PH2	GPIO	PROX_RR_CS
32	PH3	GPIO	NC

Pin	Name	Function	Signal
33	PA0	U0RX	RX_X
34	PA1	U0TX	TX_X
35	PA2	SSI0CLK	SCK_X
36	PA3	SSI0FSS	CS_X
37	PA4	SSI0DAT0	MOSI_X
38	PA5	SSI0DAT1	MISO_X
39	VDD		
40	PA6	GPIO	REAR_R
41	PA7	GPIO	REAR_L
42	PF0	M0PWM0	Motor_L - AINT1
43	PF1	M0PWM1	Motor_L - AINT2
44	PF2	M0PWM2	Motor_R - BIN1
45	PF3	M0PWM3	Motor_R - BIN2
46	PF4	M0FAULT0	nFault
47	VDD		
48	GND		
49	PG0	I2C1SCL	SCL_PRX
50	PG1	I2C1SDA	SDA_PRX
51	VDD		
52	VDD		
53	EN0RXIN		NC
54	EN0RXIP		NC
55	GND		
56	EN0TXIN		NC
57	EN0TXIP		NC
58	GND		
59	RBIAS		
60	PK7	I2C4SDA	SDA_9D
61	PK6	I2C4SCL	SCL_9D
62	PK5	GPIO	SWITCH
63	PK4	GPIO	CHARGE
64	WAKE_N		

Pin	Name	Function	Signal
65	HIB_N		
66	XOSC0		
67	XOSC1		
68	VBAT		
69	VDD		
70	RST_N		
71	PM7	TSCCP1	GPIO_T7
72	PM6	TSCCP0	GPIO_T6
73	PM5	GPIO	GPIO_T5
74	PM4	GPIO	GPIO_T4
75	PM3	T3CCP1	GPIO_T3
76	PM2	T3CCP0	GPIO_T2
77	PM1	T2CCP1	GPIO_T1
78	PM0	T2CCP0	GPIO_T0
79	VDD		
80	GND		
81	PL0	I2C2SDA	SDA_X
82	PL1	I2C2SCL	SCL_X
83	PL2	GPIO	LED3_B
84	PL3	GPIO	LED2_G
85	PL4	GPIO	LED1_R
86	PL5	GPIO	WIFI_LED_GREEN
87	VDDC		
88	OSC0		
89	OSC1		
90	VDD		
91	PB2	GPIO	HEAD_R
92	PB3	GPIO	HEAD_L
93	PL7	GPIO	WIFI_LED_YELLOW
94	PL6	GPIO	WIFI_LED_RED
95	PB0	GPIO	ODO_L
96	PB1	GPIO	ODO_R

Pin	Name	Function	Signal
97	TDO	TDO	TDO
98	TDI	TDI	TDI
99	TMS	TMD	TMS
100	TCK	TCK	TCK
101	VDD		
102	PQ4	GPIO	nHIB
103	PP2	GPIO	PROX_FR_CS
104	PP3	GPIO	PROX_FM_CS
105	PP4	GPIO	PROX_FL_CS
106	PP5	GPIO	NC
107	PN0	GPIO	INT_FL
108	PN1	GPIO	INT_FM
109	PN2	GPIO	INT_FR
110	PN3	GPIO	INT_RL
111	PN4	GPIO	INT_RM
112	PN5	GPIO	INT_RR
113	VDD		
114	GND		
115	VDDC		
116	PJ0	U3RX	USB_TX
117	PJ1	U3TX	USB_RX
118	PP0	GPIO	NC
119	PP1	GPIO	NC
120	PB5	GPIO	NC
121	PB4	AIN10	ADC_BAT
122	VDD		
123	PE4	AIN9	ADC_ML
124	PE5	AIN8	ADC_MR
125	PD4	AIN7	NC
126	PD5	AIN6	ADC_BBAT
127	PD6	AIN5	ADC_X0
128	WD7	AIN4	ADC_X1

7.3 PCB Print

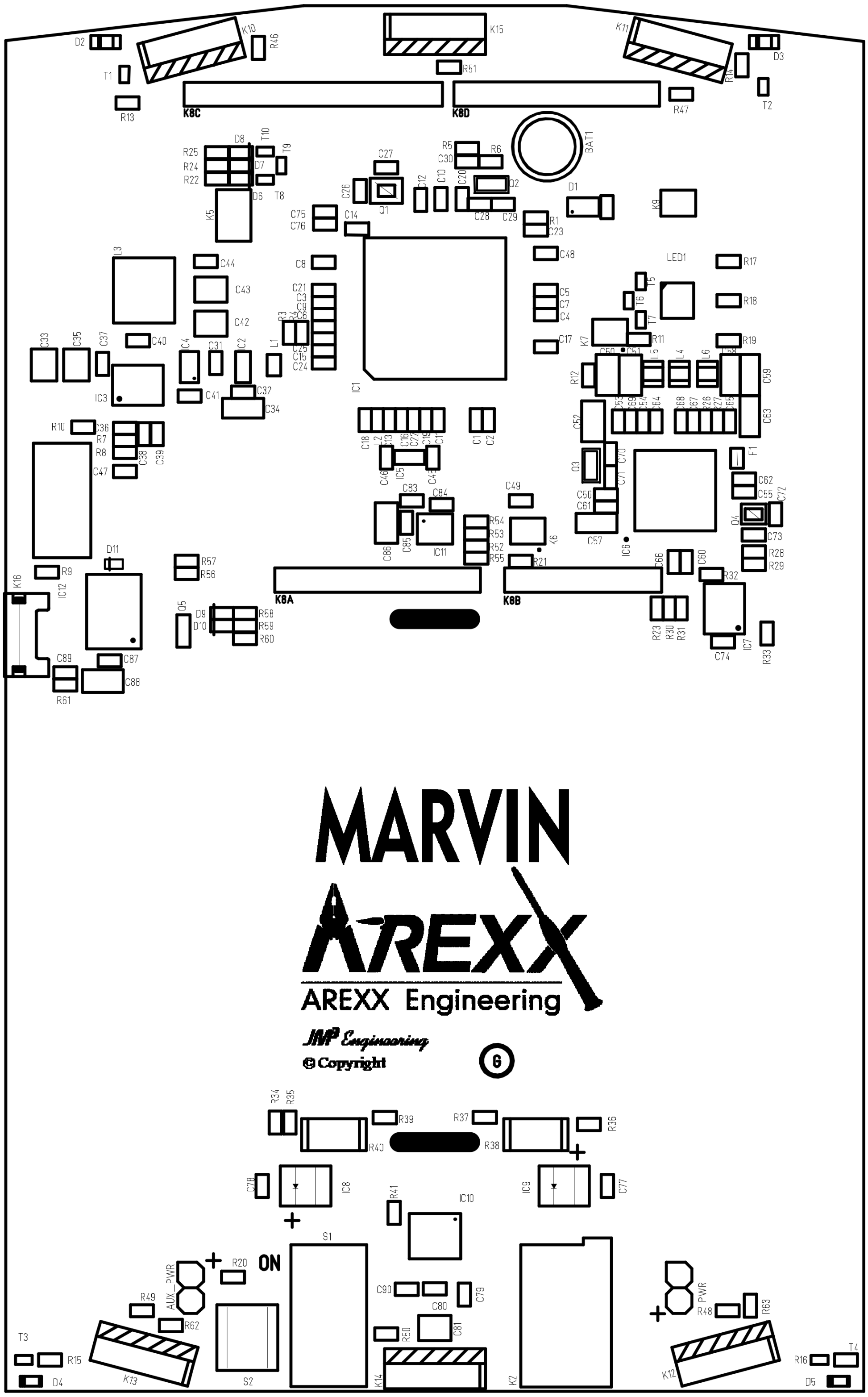


Figure 7.2 Marvin PCB Print

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