Watterott electronic

ARM Cortex-M3 WebRadio

Version 3

www.watterott.net

Revision 04/22/10

Table of Contents

1 Overview

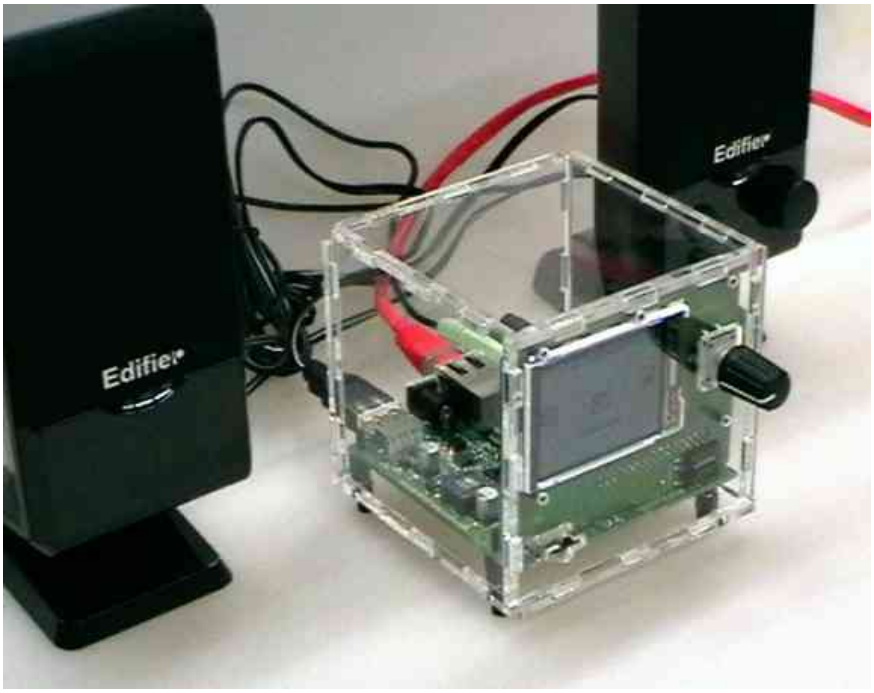
The ARM WebRadio is an embedded Internet Radio based on an ARM Cortex-M3 Microcontroller and VS1053 Audio Codec.
The VS1053 can decode various audio formats: Ogg Vorbis, MP3, AAC, WMA, FLAC, WAV, MIDI

Project Website: http://www.watterott.net/projects/webradio-arm

1.1 Features

- **Open-Source Hardware**
  - Microcontroller: LM3S6950 ARM Cortex-M3 from Luminary Micro / TI
  - Audio Codec: VS1053 from VLSI
  - Display: S65 LCD with 176x132 pixel and 16bit color
  - microSD Socket
  - Rotary Encoder
  - IR Receiver (RC5)
  - Power Supply through PoE (Power over Ethernet)

- **Open-Source Software**
  - Play Shoutcast / Icecast Streams
  - Play audio files from the memory card
  - Get current time and date from NTP Server
  - Alarm Clock



2 Hardware Description

2.1 Specification

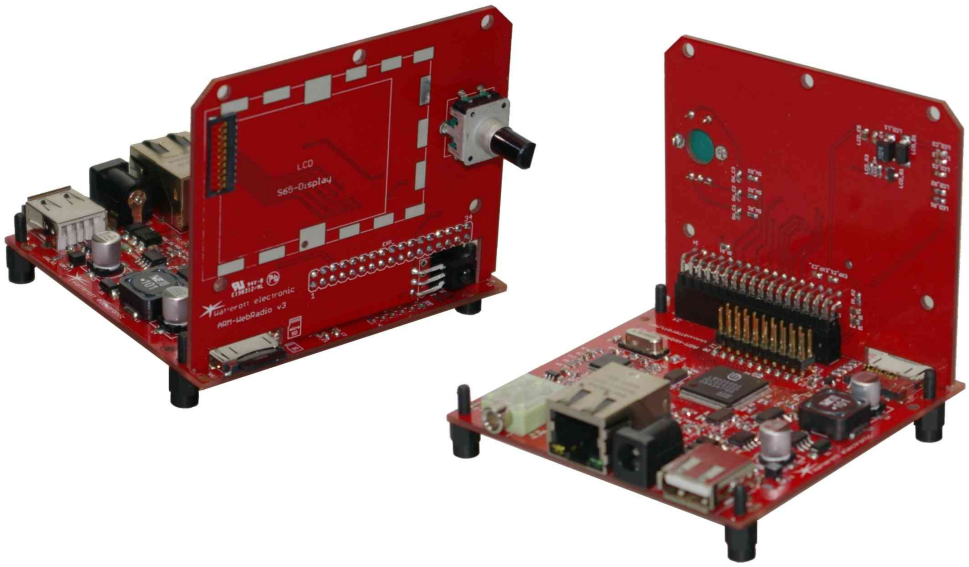
- Dimensions
  - Main PCB: 80 x 80 mm
  - Display PCB: 65 x 80 mm
  - Enclosure: 90 x 90 x 90 mm

- Power Supply: PoE (IEEE 802.3af) or external 10 V - 40 V

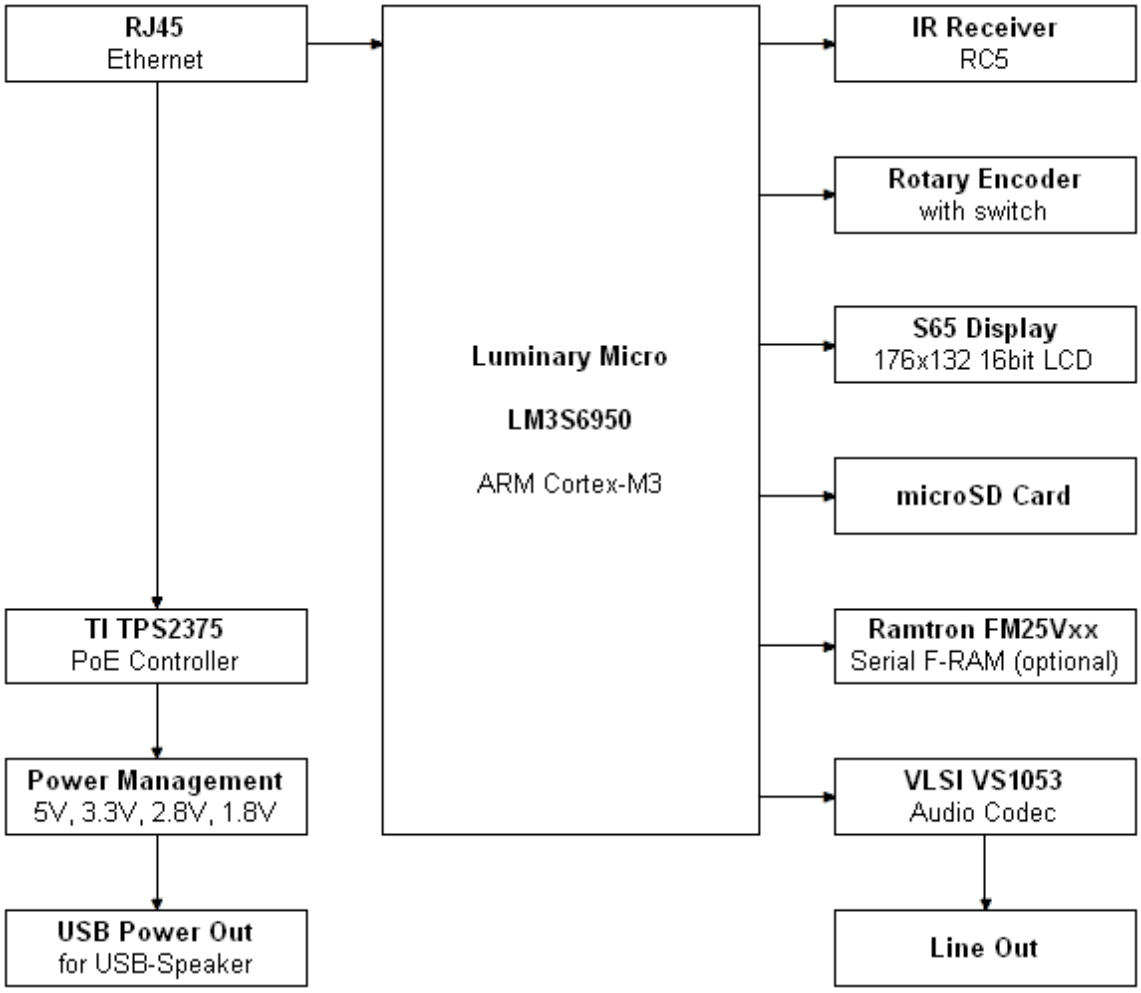
- Power Supply Current:

Vsupply	Idle	Idle & Ethernet active	Standby	Standby & Ethernet active
10 V	95 mA	125 mA	55 mA	80 mA
20 V	55 mA	70 mA	30 mA	45 mA
30 V	40 mA	45 mA	20 mA	30 mA
40 V	30 mA	35 mA	15 mA	25 mA
48 V	25 mA	30 mA	15 mA	20 mA

Idle clock: PLL @ 33.3 MHz
Standby clock: Crystal @ 8.0 MHz

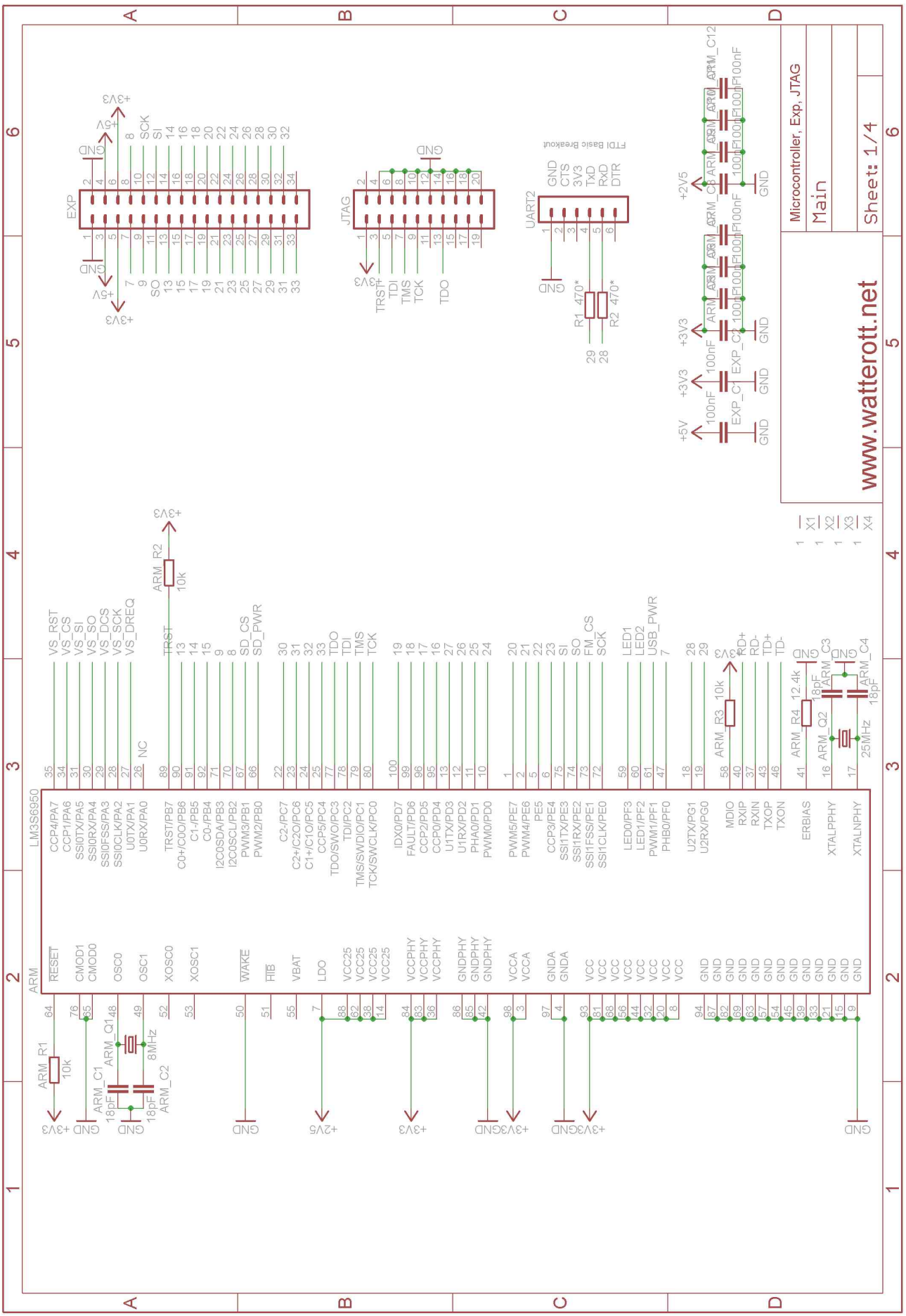


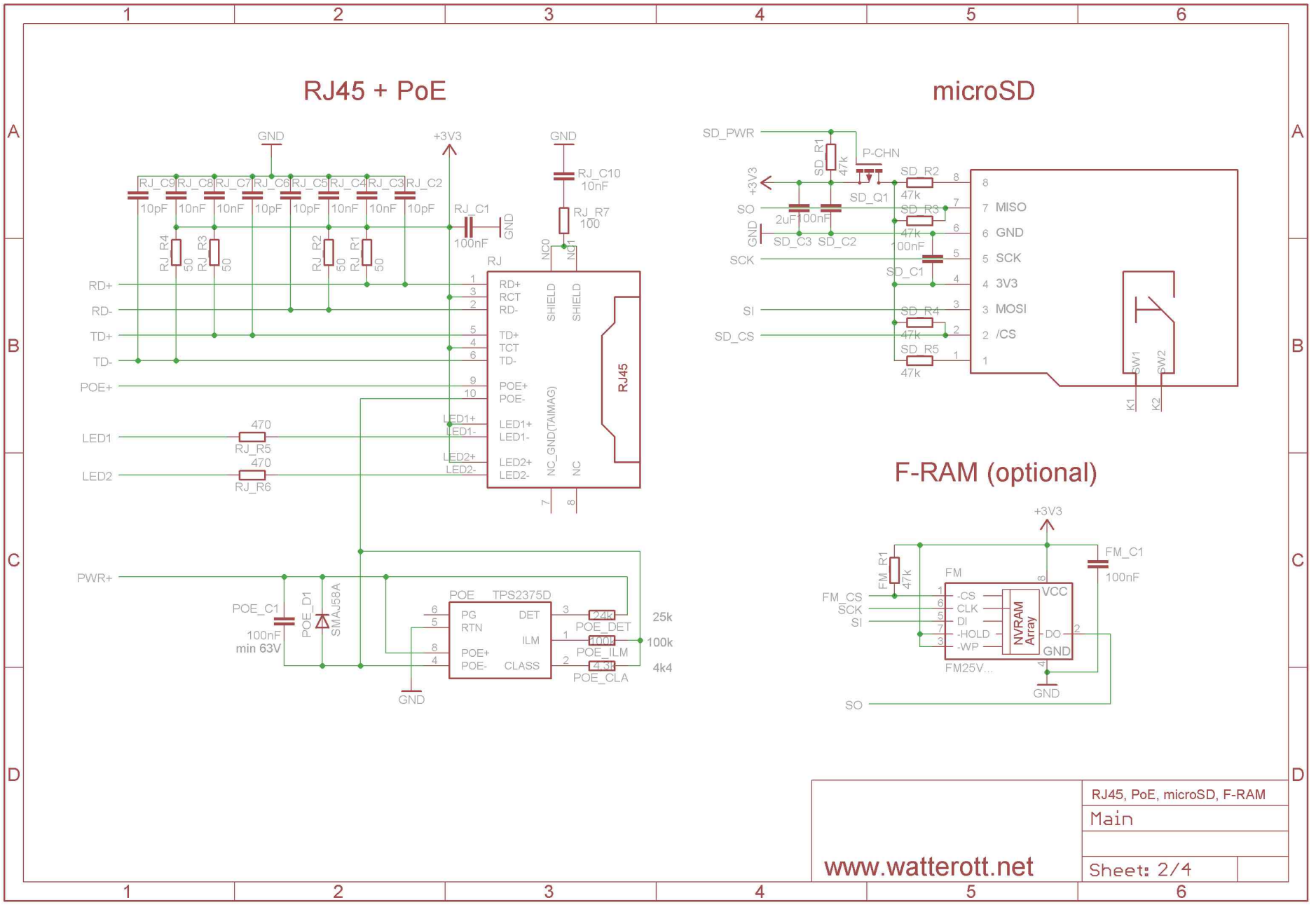
2.2 Hardware Diagram



- LM3S6950 http://www.luminarymicro.com/products/LM3S6950.html
- Crystals http://www.abracon.com/Resonators/abm7.pdf
- VS1053 http://www.vlsi.fi/en/products/vs1053.html
- microSD Socket http://www.watterott.net/webradio/Molex-492250821.pdf
- FM25Vxx http://www.ramtron.com/products/nonvolatile-memory/serial.aspx
- S65 Display http://www.watterott.net/projects/misc#displays
- Rotary Encoder http://www.watterott.net/webradio/PEC12.pdf
- IR Receiver http://www.watterott.net/webradio/TSOP17.pdf
  http://www.watterott.net/webradio/TSOP348.pdf
  http://www.watterott.net/webradio/SFH5110.pdf
- TPS2375 http://focus.ti.com/docs/prod/folders/print/tps2375.html
- Power http://datasheets.maxim-ic.com/en/ds/MAX5035.pdf
  http://www.watterott.net/webradio/TS1117.pdf
  http://focus.ti.com/docs/prod/folders/print/lp2985.html
- RJ45 Jack http://www.watterott.net/webradio/WE-7499211121.pdf

2.3 Schematics




RJ45 + PoE
microSD
F-RAM (optional)
GND
+3V3
RJ_C9
RJ_C8
RJ_C7
RJ_C6
RJ_C5
RJ_C4
RJ_C3
RJ_C2
10pF
10nF
RJ_C1
100nF
RJ_C10
RJ_R7
100
RJ_R4
RJ_R3
RJ_R2
RJ_R1
50
RJ
NC0
NC1
RD+
RD-
TD+
TD-
POE+
LED1
LED2
470
RJ_R5
RJ_R6
RCT
TCT
POE-
LED1+
LED1-
LED2+
LED2-
SHIELD
NC_GND(TAIMAG)
NC
RJ45
PWR+
POE_C1
100nF
min 63V
POE_D1
SMAJ58A
POE
TPS2375D
PG
RTN
DET
ILM
CLASS
24k
POE_DET
100k
POE_ILM
4k3
POE_CLA
25k
100k
4k4
SD_PWR
SD_R1
47k
P-CHN
SD_Q1
SD_R2
SD_R3
SD_R4
SD_R5
SO
SCK
SI
SD_CS
2uF
100nF
SD_C3
SD_C2
SD_C1
MISO
MOSI
/CS
3V3
SW1
SW2
K1
K2
FM_R1
FM_C1
FM
FM_CS
-CS
CLK
DI
-HOLD
-WP
VCC
DO
NVRAM Array
FM25V...
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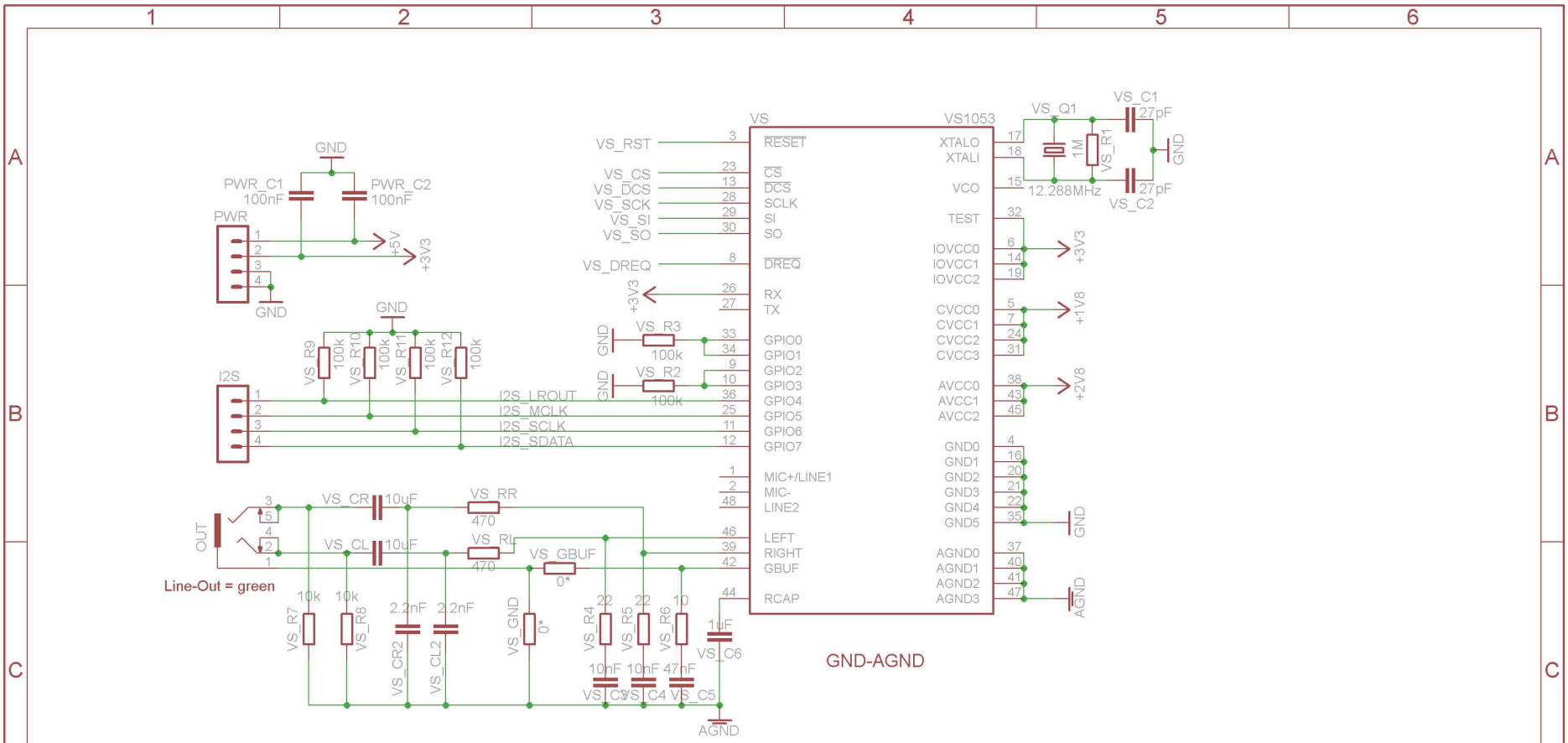
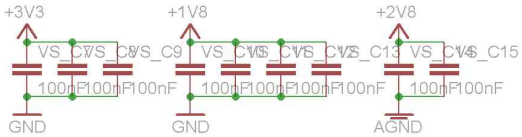
RJ45, PoE, microSD, F-RAM
Main
Sheet: 2/4



	Normal Line-Out	Line-Out for Headphones (Dont use with USB powered speakers)
VS_GBUF	not mounted	0
VS_GND	0	not mounted
VS_RR	470	10
VS_RL	470	10
VS_CR	10uF	shorted
VS_CL	10uF	shorted
VS_CR2	2.2nF	not mounted
VS_CL2	2.2nF	not mounted

Further Infos: VLSI AppNote: Connecting analog outputs

Note: For VS1033 U4 has to be a 2.5V regulator.



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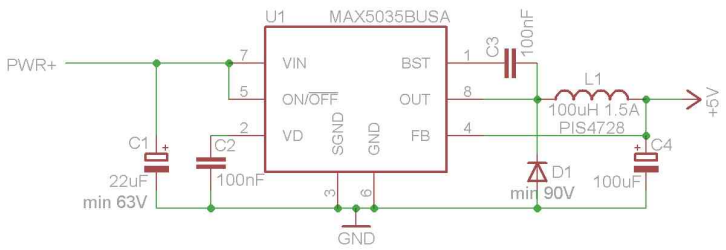
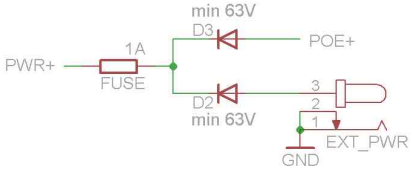
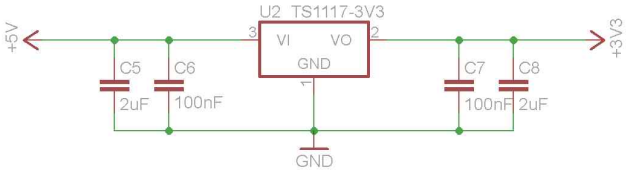
Audio Codec

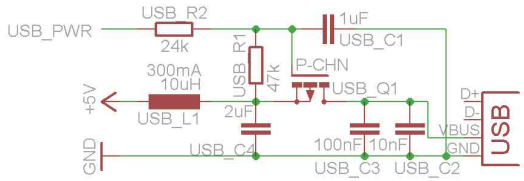
Main

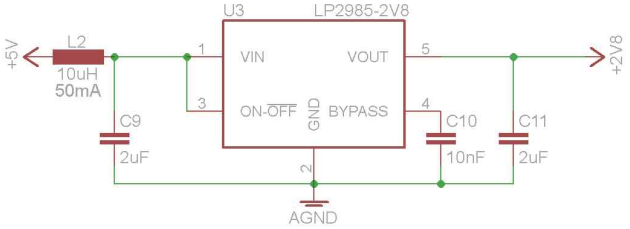
Sheet: 3/4

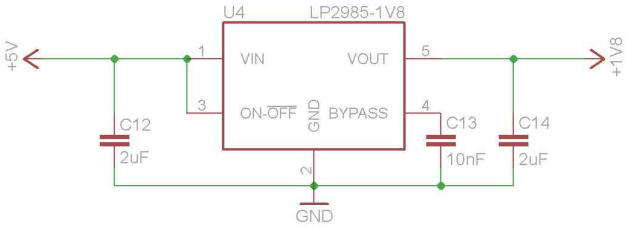












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Power Management

Main

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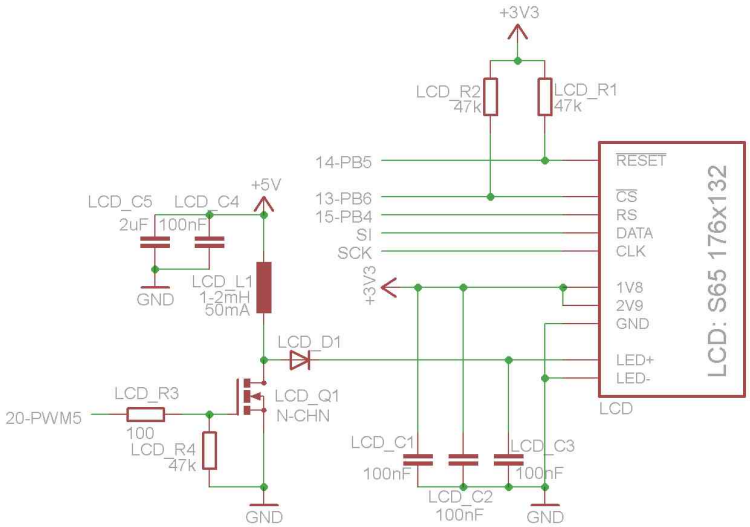
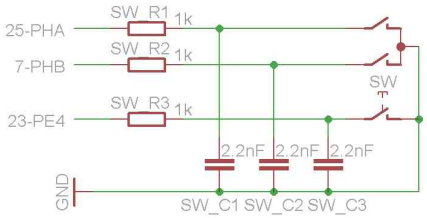
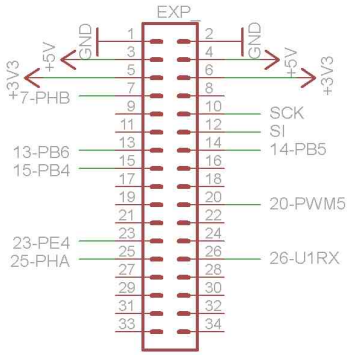
Display

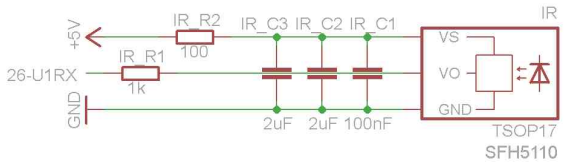


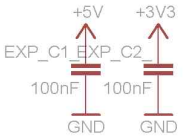
Rotary Encoder





IR-Receiver





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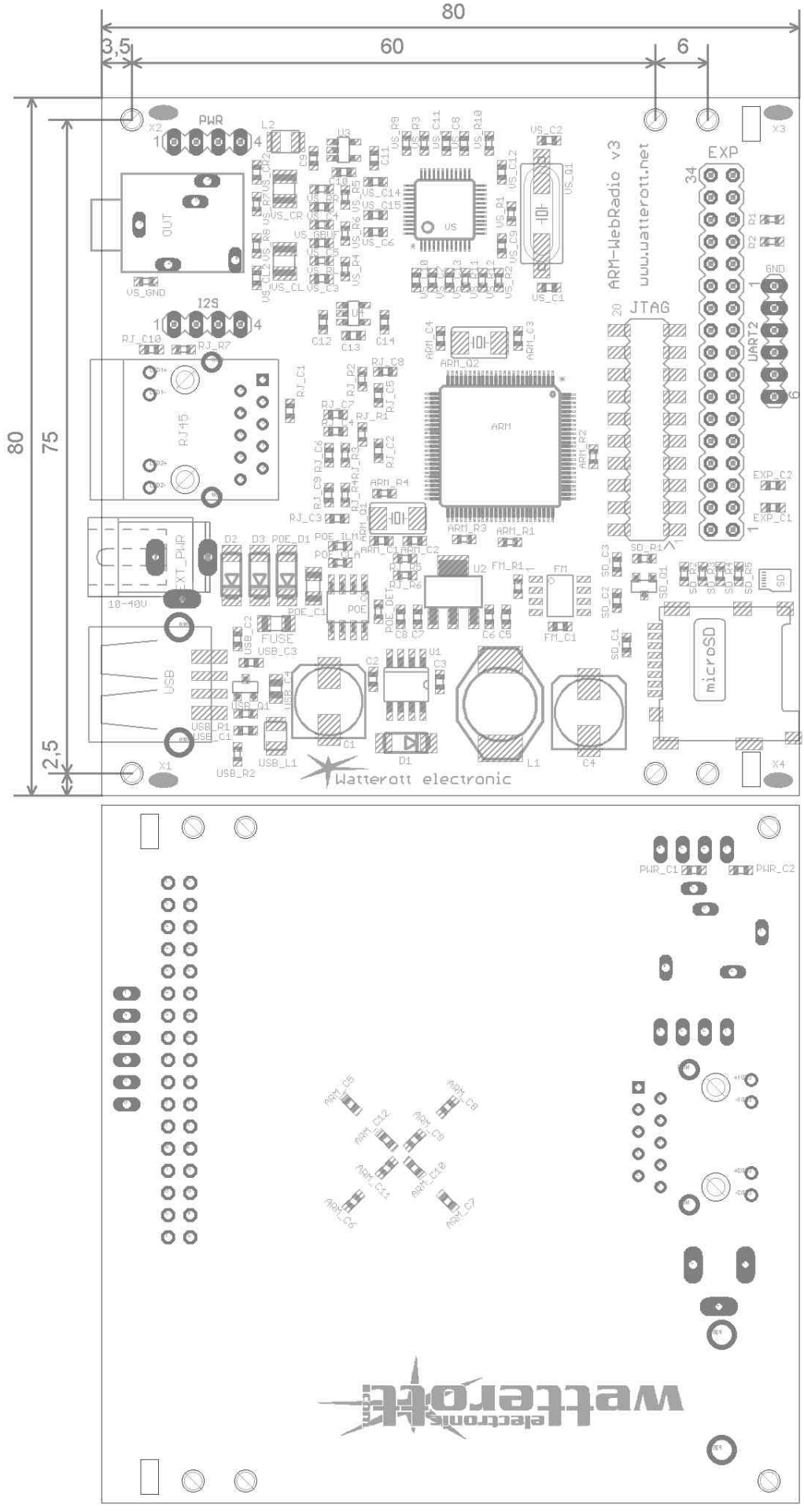
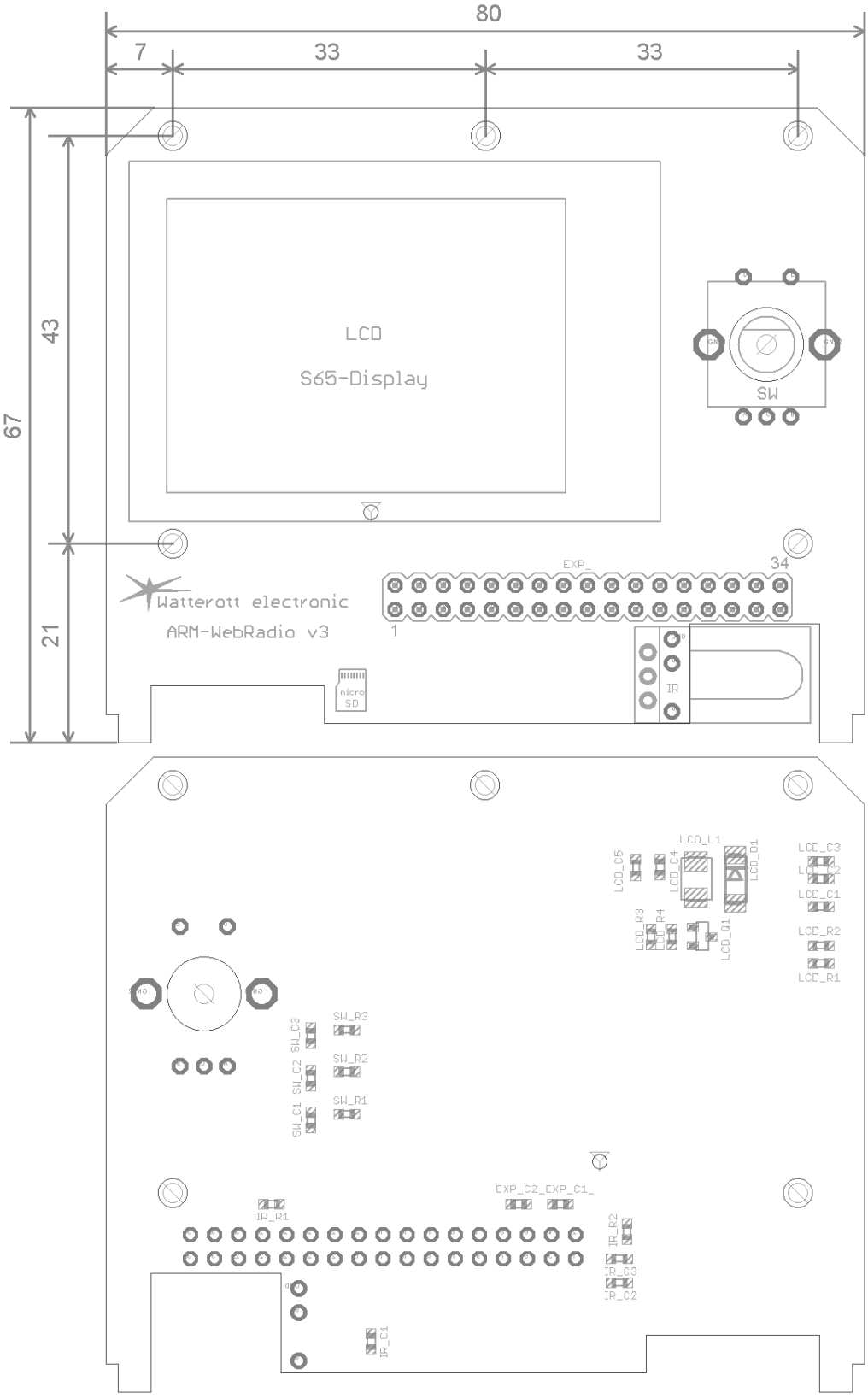
Expansion	
EXP	
Sheet: 1/1	

2.4 Component Placement




80
7
33
33
67
43
21
LCD
S65-Display
SW
EXP_
34
1
Watterott electronic
ARM-WebRadio v3
micro SD
IR
LCD_L1
LCD_C5
LCD_C4
LCD_D1
LCD_C3
LCD_C1
LCD_R3
LCD_R4
LCD_Q1
LCD_R2
LCD_R1
SW_R3
SW_C3
SW_R2
SW_C2
SW_R1
SW_C1
EXP_C2_EXP_C1_
IR_R1
IR_R2
IR_C3
IR_C2
IR_C1

2.5 Start-up

1. Solder all missing components to the PCBs. (Pictures: **2.1 Specification**)

   Note: The SMD capacitors have to be soldered to the bottom of the Main PCB.

   On the EXP PCB there are pins for TSOP17 and TSOP348 / SFH5110 (the 3 pins with the same spacing).

2. Test the device on a laboratory power supply with 12V and 200mA current limit.

   The supply current should be around 50mA. If not check the PCBs.

3. If everything is okay, the display shows some information (VS type, SD-Card...).

4. Flash the Firmware: Manual section **3.2.1 Firmware Update**

   (A microSD-Card is required and as default all WebRadio kits have a LPH88 display.)

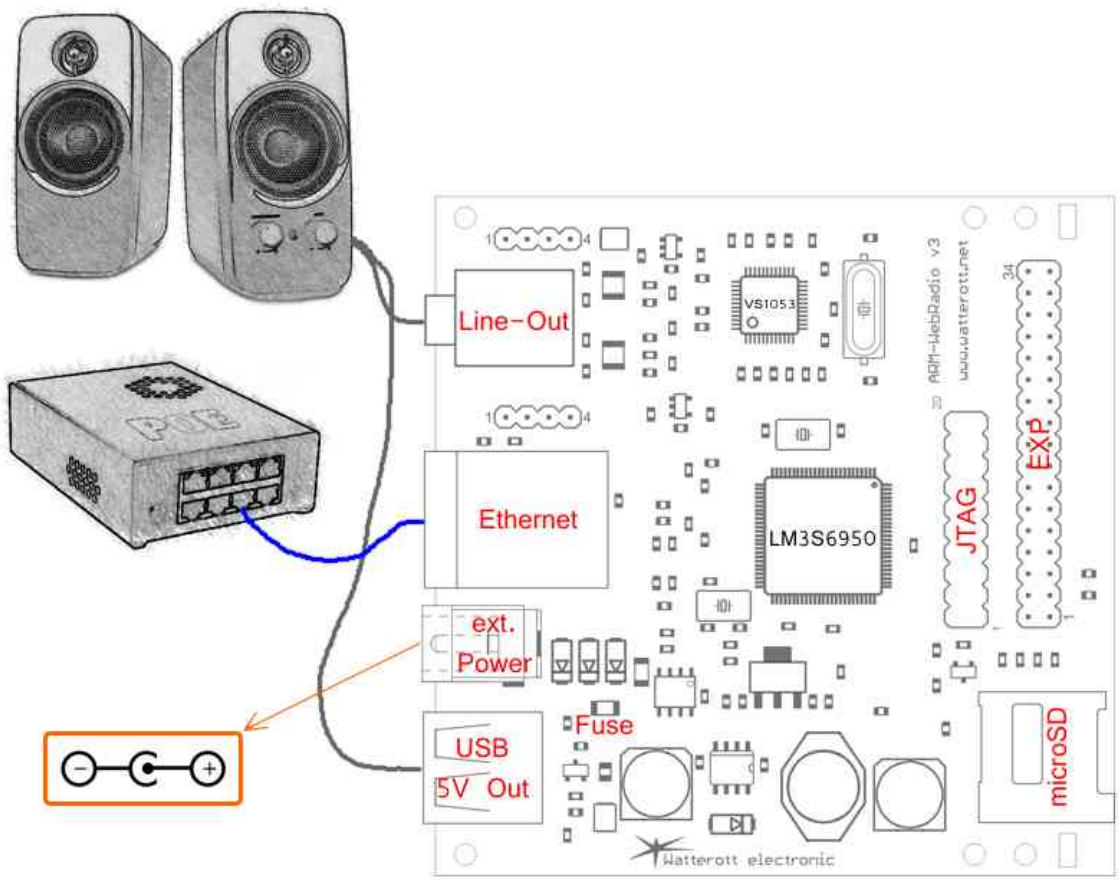
Known Issues:

Some microSD cards draw a high power on current which causes a reset of the WebRadio. Try to add an additional capacitor (around 4.7uF) parallel to SD_C2 or SD_C3.

2.6 Connection Details

The WebRadio can be powered through PoE (Power over Ethernet) or with an external power supply (2.1mm jack).

The device has an inverse-polarity, over-voltage and over-current protection.



3 Software Description

3.1 Firmware

The WebRadio can be controlled with the Rotary Encoder, a Remote Control or via the Webinterface. The settings are saved on the memory card.

3.1.1 Rotary Encoder

Key	Function
Left/Right	Scroll up/down
Normal press	Select/Enter
Long press	Back/Abort

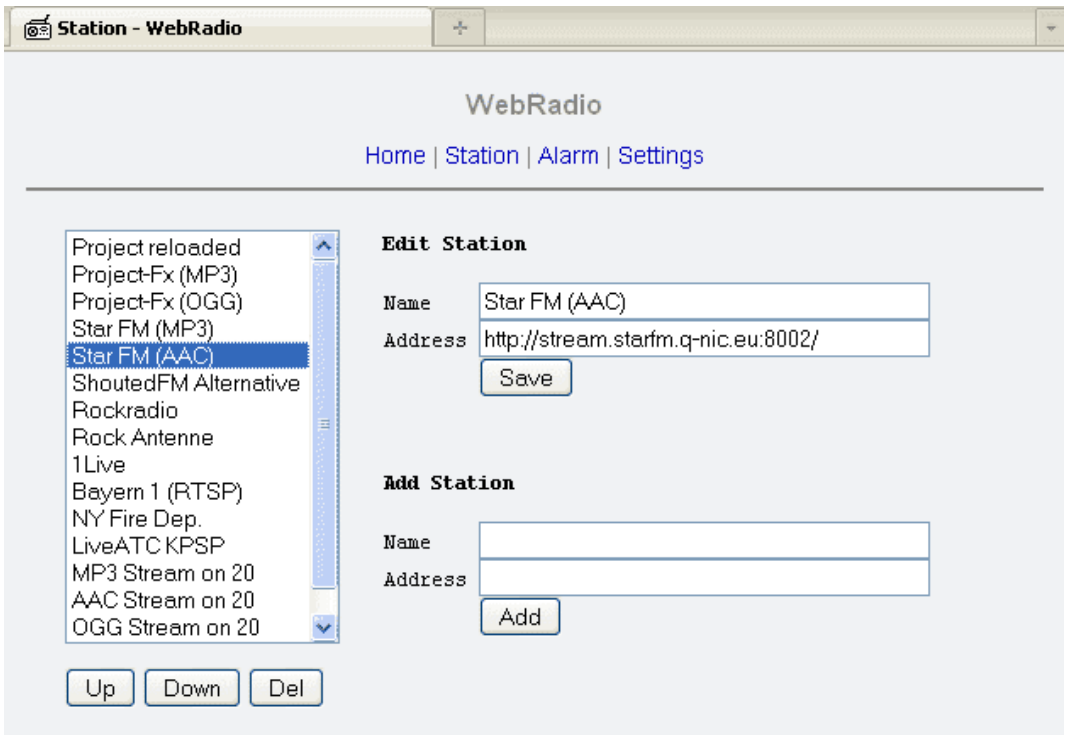
3.1.2 Remote Control

Every IR Remote Control with RC5 code is supported.

Key	Function
2x Power	Standby on/off
OK	Select/Enter
Up/down	Scroll up/down
Volume +/-	Volume control and in a menu scroll page up/down

3.1.3 Webinterface

Type in your browser http://192.168.0.50 or http://webradio to access the webinterface. These are the default addresses. The current IP can be found in the settings menu under the item “Info..”.



3.1.4 Settings

The settings can be changed in the settings menu or via the Webinterface. They are saved in the following files in the root directory of the memory card. The file system of the card has to be FAT16 or FAT32.
For examples have a look in the SVN repository:
http://code.google.com/p/arm-webradio/source/browse/#svn/trunk/doc/card_example

SETTINGS.INI

INI-File with settings.

`[SETTINGS]`	
`PlayMode=0`	Play mode (0=normal, 1=one-by-one)
`AutoStart=`	Auto start file (Station item number or path to Card file)
`IRaddr=0`	IR Address (0=TV1, 1=TV2, 5=VCR2, 6=VCR2)
`IRkeyPower=12`	IR Power key
`IRkeyUp=32`	IR Up key
`IRkeyDown=33`	IR Down key
`IRkeyOK=38`	IR OK/Enter key
`IRkeyVolP=16`	IR Volume + key
`IrkeyVolM=17`	IR Volume - key
`Name=WEBRADIO`	NetBios and UPnP Name (max 15 characters)
`MAC=00:1E:E5:12:34:56`	MAC Address
`DHCP=1`	DHCP, if fails use below settings (0=off, 1=on)
`IP=192.168.000.050`	Device IP (xxx.xxx.xxx.xxx)
`NetMask=255.255.255.000`	Device NetMask (xxx.xxx.xxx.xxx)
`Router=192.168.000.001`	Router IP (xxx.xxx.xxx.xxx)
`DNS=192.168.000.001`	DNS Server IP (xxx.xxx.xxx.xxx)
`NTP=078.046.194.189`	NTP Server IP (xxx.xxx.xxx.xxx)
`TimeDiff=3600`	Time difference to GMT in seconds (3600 = 1h = GMT+1)
`Summer=0`	Summer time (0=off, 1=on)
`Volume=40`	Default Volume (0...100 %)
`BassFreq=150`	Bass limit frequency (20...150 Hz)
`BassAmp=9`	Bass enhancemanent (0...15 dB)
`TrebleFreq=15000`	Treble limit freqency (1000...15000 Hz)
`TrebleAmp=0`	Treble control (-8...7 dB)
`AlarmVol=70`	Alarm volume
`AlarmFile1=4`	Alarm file 1 (Station item number or path to Card file)
`AlarmFile2=1`	Alarm file 2, if 1st file not working
`AlarmFile3=/alarm.mp3`	Alarm file 3, if 2nd file not working
`ColorBG=255,255,255`	Background color (Red,Green,Blue)
`ColorFG=000,000,000`	Foreground color (Red,Green,Blue)
`ColorSel=255,000,000`	Selection color (Red,Green,Blue)
`ColorEdge=000,144,240`	Edge color (Red,Green,Blue)

ALARM.INI

INI-File with alarm times (max. 8).

```
[ALARM]
TIME1= 08:00:MoTuWeThFrSaSu
TIME2=!09:00:Tu
TIME3= 12:34:Mo
```

!	Alarm is off / inactive
-	Alarm: go into Standby
all other	Alarm: play the Alarm file

Mo=Monday, Tu=Tuesday, We=Wednesday, Th=Thursday, Fr=Friday, Sa=Saturday, Su=Sunday

STATION.PLS

PLS-File with audio streams.

```
[PLAYLIST]
NUMBEROFENTRIES=1
FILE1=protocol://domain:port/filepathname
TITLE1=Stream-Name
```

SHARE.PLS

PLS-File with network shares.

```
[PLAYLIST]
NUMBEROFENTRIES=1
FILE1=protocol://user:password@domain/filepathname
TITLE1=Share-Name
```

3.2 Bootloader

The Bootloader is pre-programmed in every WebRadio and can write a new Firmware to the Microcontroller flash memory. The Firmware binary is read from the memory card.

3.2.1 Firmware Update

1. Copy the Firmware to the root directory of a memory card with FAT16 or FAT32 file system and rename the file to “FIRMWARE.BIN”.

2. Power off the WebRadio.

3. Power on the WebRadio while pressing the Rotary Encoder.

4. The Bootloader menu appears:

`Start Application`	Run the current Firmware
`Flash /FIRMWARE.BIN`	Program FIRMWARE.BIN from the memory card
`Flash /FIRMWARE.BAK`	Program FIRMWARE.BAK from the memory card
`Backup Firmware to /FIRMWARE.BAK`	Save current Firmware to FIRMWARE.BAK on memory card

5. Select “Flash /FIRMWARE.BIN”.

6. Now the Firmware is flashed to the Microcontroller and it will start after the programming is complete.

3.3 Programming via JTAG

The flash start address for the Bootloader is **0x0000** and for the Firmware is **0x5000.** The Bootloader can be up to 20kByte.

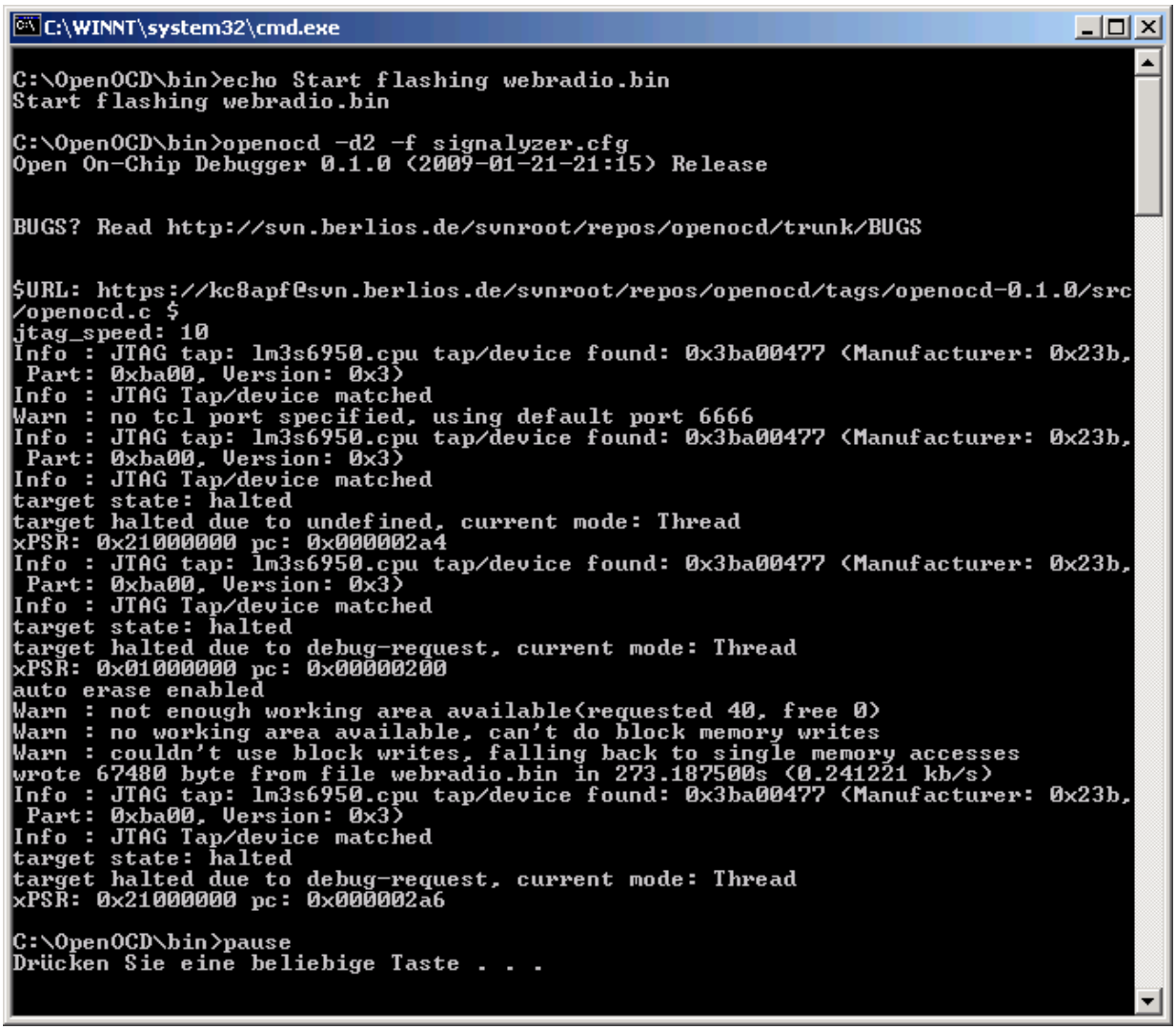
3.3.1 Using OpenOCD

1. Install OpenOCD and the drivers for your JTAG-Dongle.

2. Download the OpenOCD Config-Package and latest Firmware: http://code.google.com/p/arm-webradio/downloads

3. Copy the binary file and the files from the OpenOCD Config-Package to one directory. Rename the Firmware binary to FIRMWARE.BIN and the Loader binary to LOADER.BIN.

4. Run the respective batch file:



5. Wait till the program download is completed. The programming time can be up to several minutes.

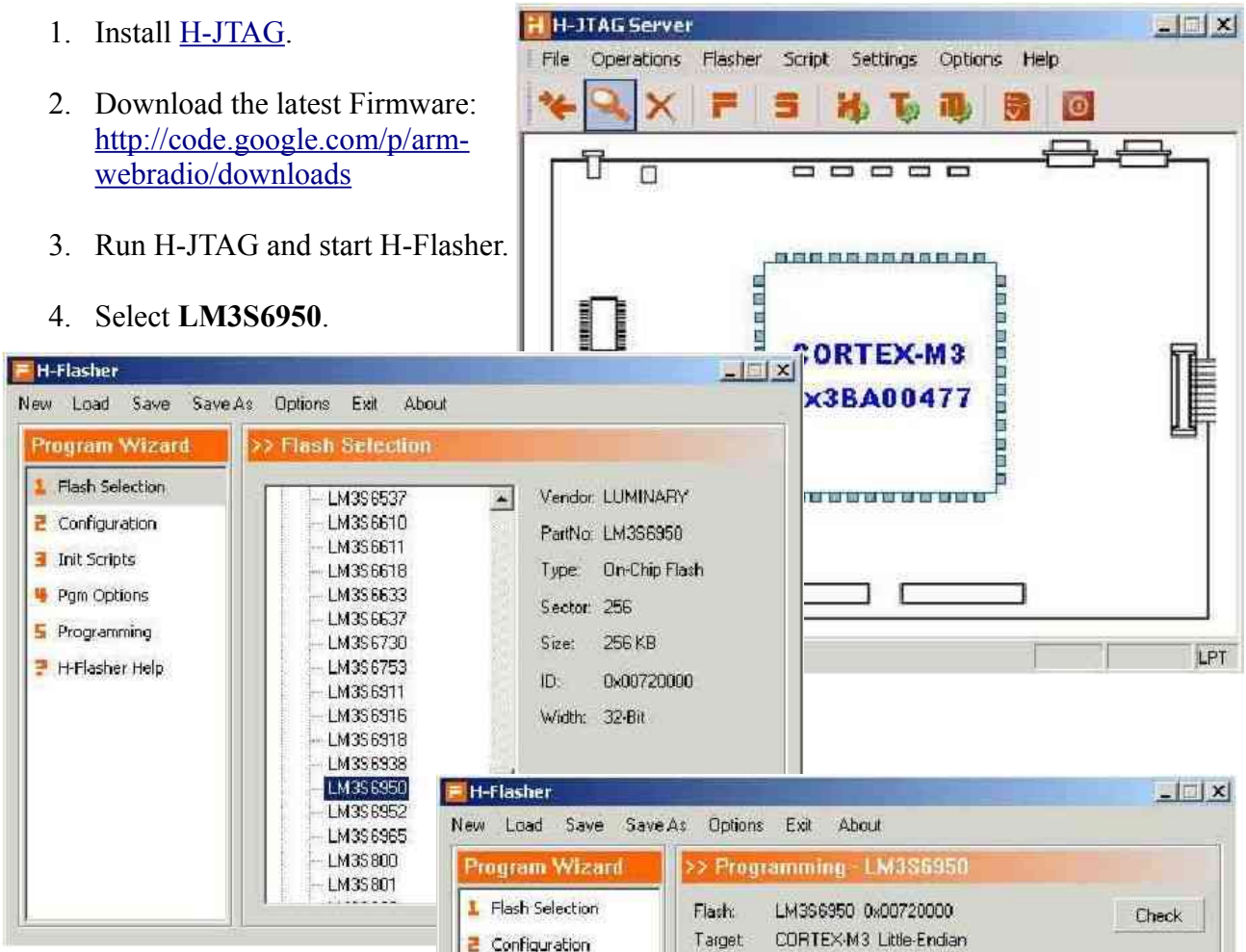
3.3.2 Using H-JTAG

1. Install H-JTAG.

2. Download the latest Firmware: http://code.google.com/p/arm-webradio/downloads

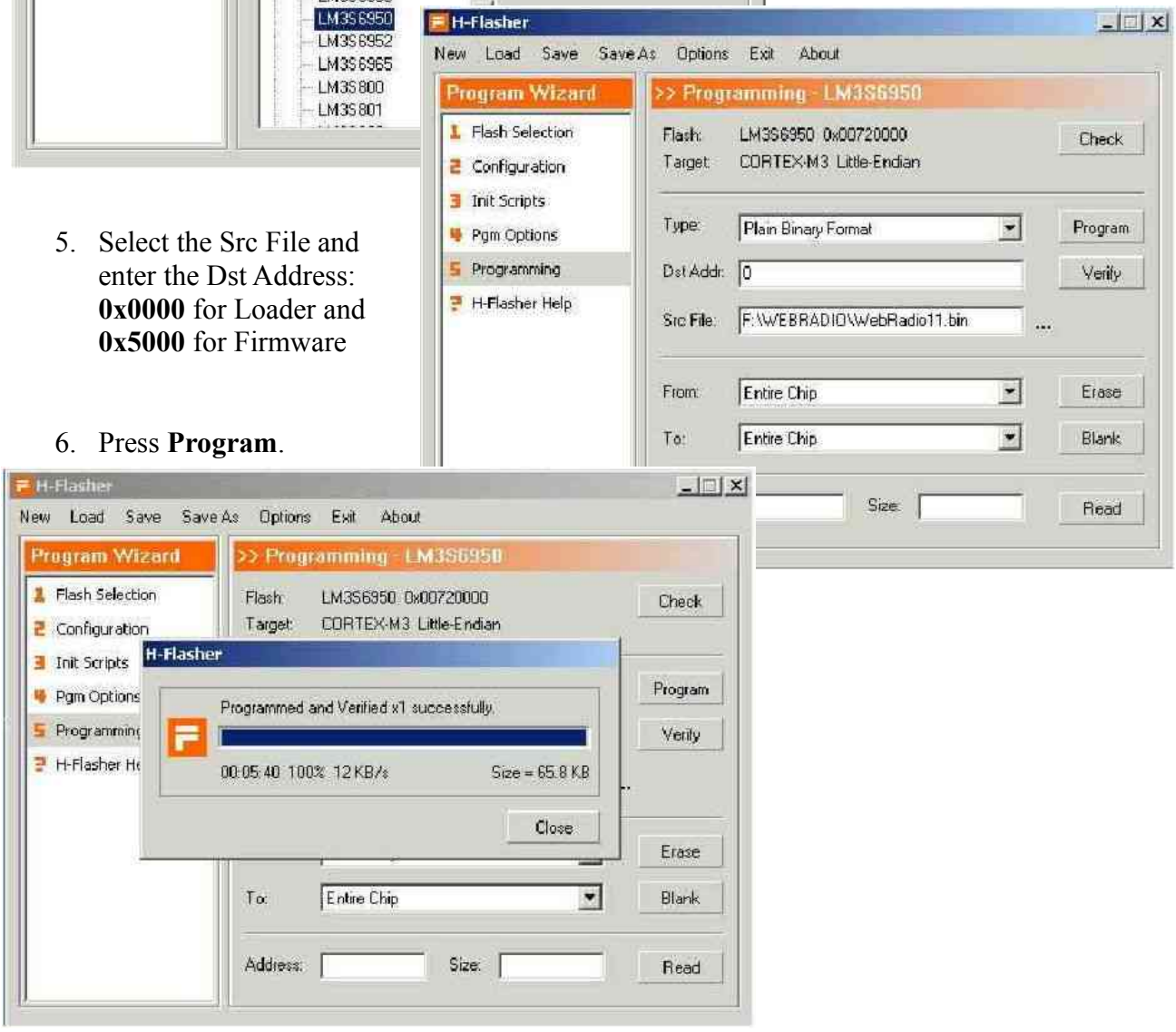
3. Run H-JTAG and start H-Flasher.

4. Select **LM3S6950**.



5. Select the Src File and enter the Dst Address: **0x0000** for Loader and **0x5000** for Firmware

6. Press **Program**.

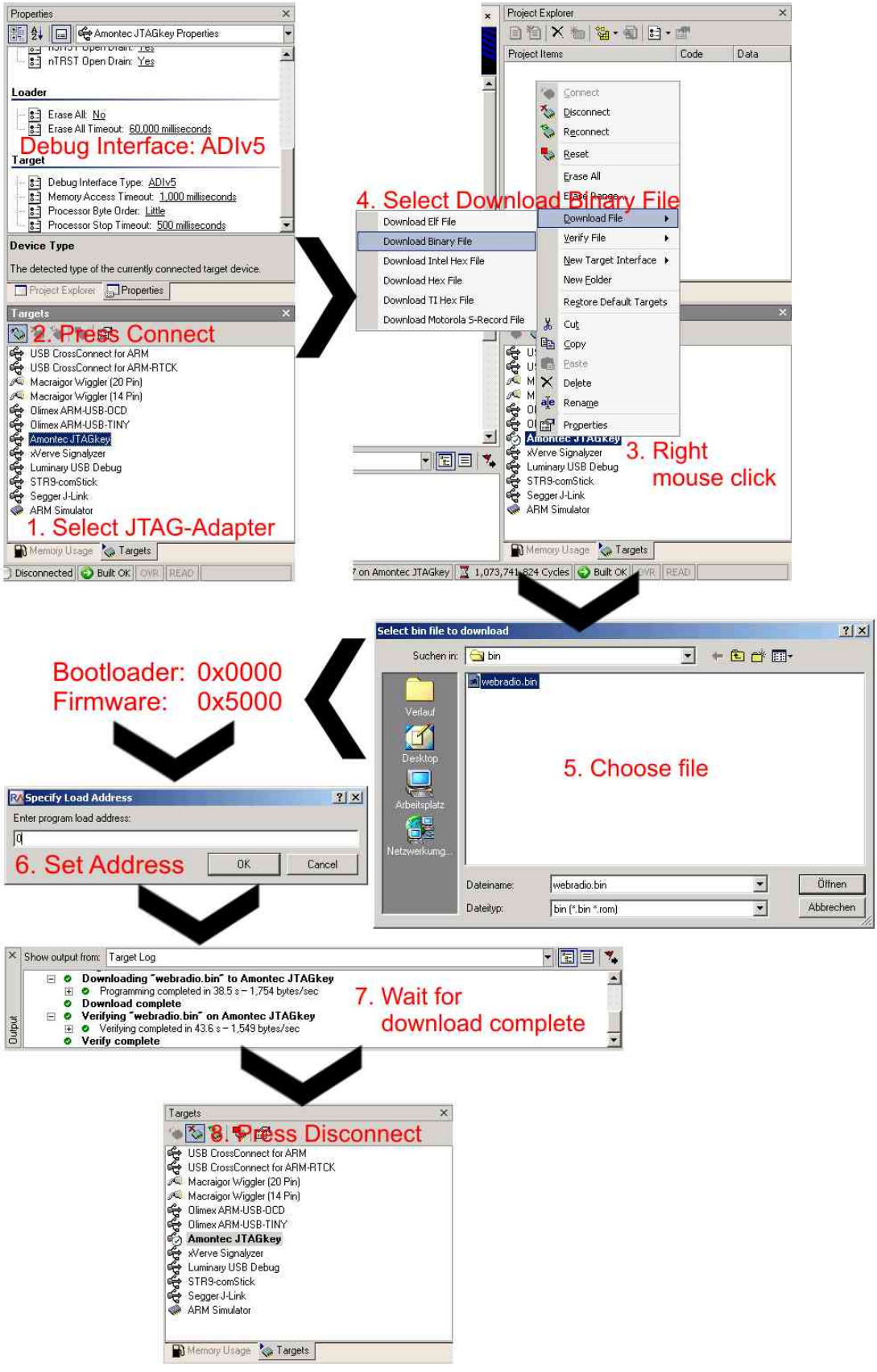


3.3.3 Using CrossWorks for ARM

1. Install CrossWorks for ARM.

2. Download the latest Firmware:
   http://code.google.com/p/arm-webradio/downloads

3. Run CrossWorks:



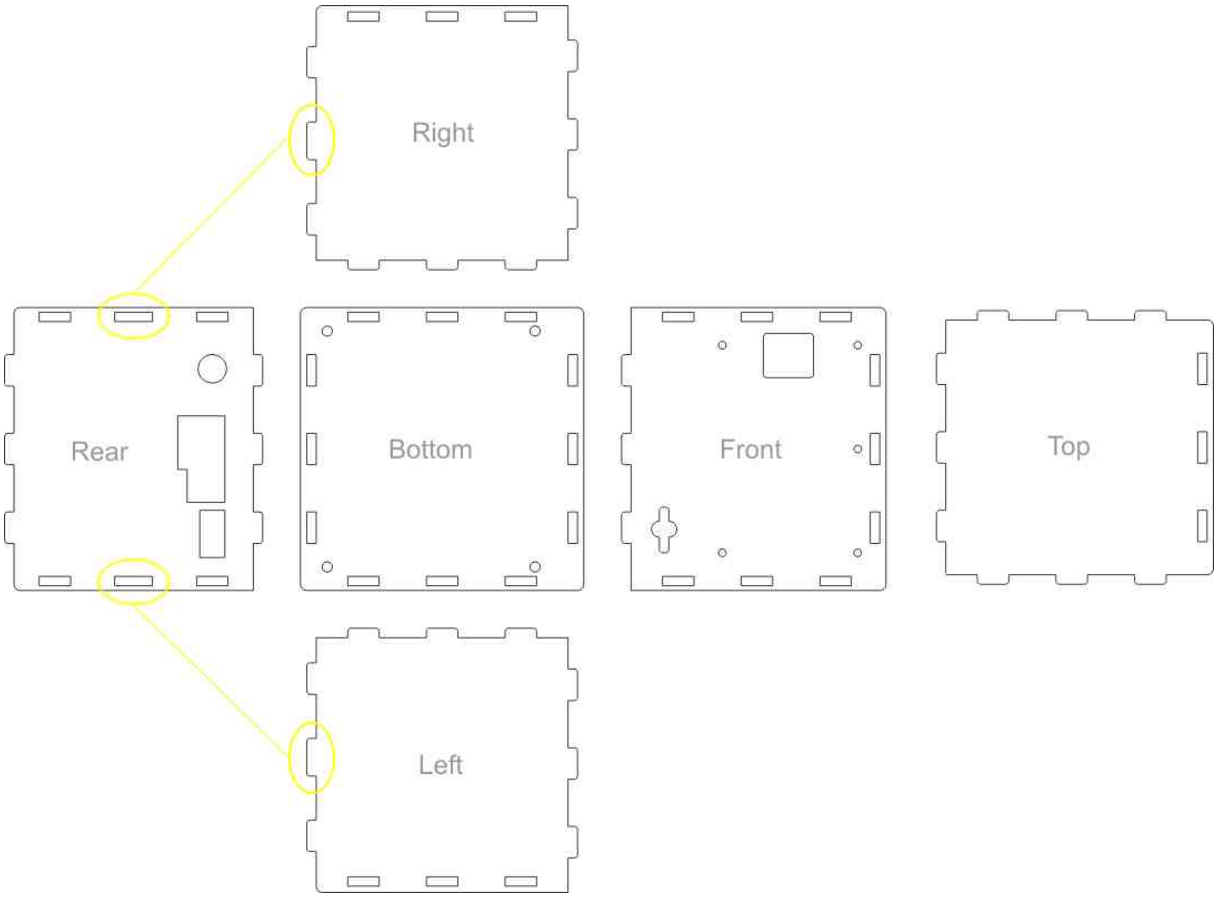
3.4 Source Code

The source code is hosted on Google Code: http://arm-webradio.googlecode.com

You can build the source code with Rowley's CrossWorks for ARM or CodeSourcery Sourcery G++ for ARM (EABI).

4 Enclosure

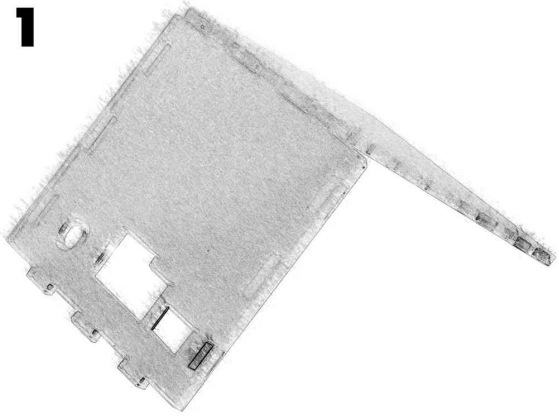
The case parts are made of 3 mm laser-cutted plexiglass.



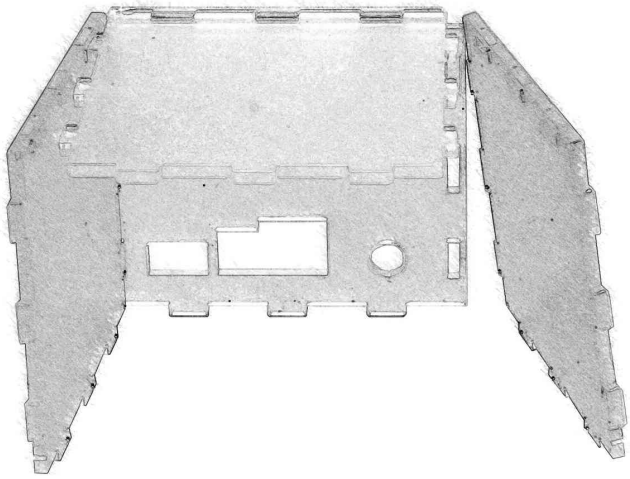
4.1 Building the Enclosure

1. Put the **top** and **rear** part together.
2. Add the **left** and **right** side.
3. Mount the **Display-PCB** to the **front** plate with the plastic screws.
4. Put the top, rear, left, right parts and **front** together.
5. Assemble the **bottom** plate to the enclosure with the plastic screws.
6. Finished.

1



2



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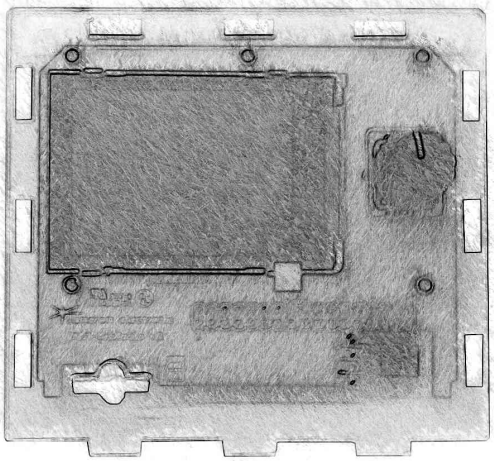

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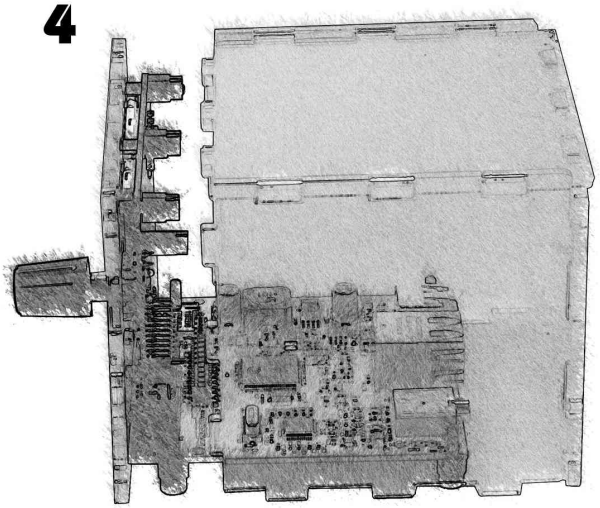

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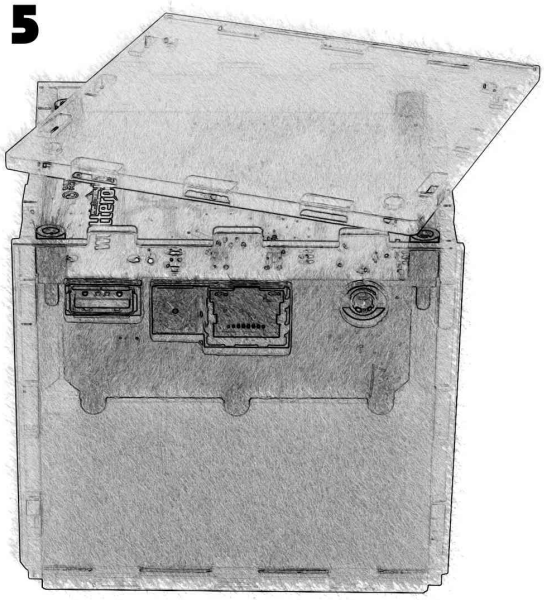

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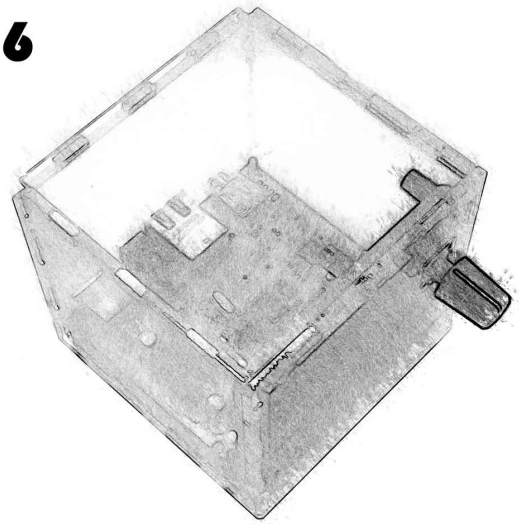

5 Revision History

Revision 04/22/10

Start-up section updated.

Revision 02/21/10

Minor changes in Source Code section.

Revision 01/28/10

Added Start-up section.

Revision 01/08/10

First version.