Watterott electronic

ARM Cortex-M3 WebRadio

Version 3

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Revision 04/22/10
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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](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:

<table>
<thead>
<tr>
<th>Vsupply</th>
<th>Idle</th>
<th>Idle &amp; Ethernet active</th>
<th>Standby</th>
<th>Standby &amp; Ethernet active</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 V</td>
<td>95 mA</td>
<td>125 mA</td>
<td>55 mA</td>
<td>80 mA</td>
</tr>
<tr>
<td>20 V</td>
<td>55 mA</td>
<td>70 mA</td>
<td>30 mA</td>
<td>45 mA</td>
</tr>
<tr>
<td>30 V</td>
<td>40 mA</td>
<td>45 mA</td>
<td>20 mA</td>
<td>30 mA</td>
</tr>
<tr>
<td>40 V</td>
<td>30 mA</td>
<td>35 mA</td>
<td>15 mA</td>
<td>25 mA</td>
</tr>
<tr>
<td>48 V</td>
<td>25 mA</td>
<td>30 mA</td>
<td>15 mA</td>
<td>20 mA</td>
</tr>
</tbody>
</table>

*Idle clock: PLL @ 33.3 MHz
Standby clock: Crystal @ 8.0 MHz*
2.2 Hardware Diagram

- microSD Socket [http://www.watterott.net/webradio/Molex-492250821.pdf]
- S65 Display [http://www.watterott.net/projects/misc#displays]
- IR Receiver [http://www.watterott.net/webradio/TSOP17.pdf]
- TPS2375 [http://focus.ti.com/docs/prod/folders/print/tps2375.html]
- RJ45 Ethernet
- TI TPS2375 PoE Controller
- Power Management 5V, 3.3V, 2.8V, 1.0V
- USB Power Out for USB Speaker
- Line Out
- S65 Display 176x132 16bit LCD
- microSD Card
- Ramtron FM25Vxx Serial F-RAM (optional)
- VLSI VS1053 Audio Codec
- IR Receiver RC5
- Rotary Encoder with switch
2.3 Schematics
Normal Line-Out | Line-Out for Headphones
---|---
VS_GBUF | not mounted | 0
VS_GND | 470 | 10
VS_RL | 10μF | 10
VS_CR | 10μF | shorted
VS_CLR | 2.2μF | not mounted
VS_CL | 2.2μF | not mounted

Further Infos: VLSI AppNote: Connecting analog outputs

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

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2.4 Component Placement
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

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left/Right</td>
<td>Scroll up/down</td>
</tr>
<tr>
<td>Normal press</td>
<td>Select/Enter</td>
</tr>
<tr>
<td>Long press</td>
<td>Back/Abort</td>
</tr>
</tbody>
</table>

3.1.2 Remote Control

Every IR Remote Control with RC5 code is supported.

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x Power</td>
<td>Standby on/off</td>
</tr>
<tr>
<td>OK</td>
<td>Select/Enter</td>
</tr>
<tr>
<td>Up/down</td>
<td>Scroll up/down</td>
</tr>
<tr>
<td>Volume +/-</td>
<td>Volume control and in a menu scroll page up/down</td>
</tr>
</tbody>
</table>

3.1.3 Webinterface

Type in your browser [http://192.168.0.50](http://192.168.0.50) or [http://webradio](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..”.

![Webinterface Screenshot]
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 enhancement (0...15 dB)
TrebleFreq=15000       Treble limit frequency (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 \texttt{0x0000} and for the Firmware is \texttt{0x5000}. The Bootloader can be up to 20kByte.

3.3.1 Using OpenOCD

1. Install \texttt{OpenOCD} and the drivers for your JTAG-Dongle.

2. Download the OpenOCD Config-Package and latest Firmware: 
   \url{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 \texttt{FIRMWARE.BIN} and the Loader binary to \texttt{LOADER.BIN}.

4. Run the respective batch file:

   ![Batch file output](image)

   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.


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.
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.