



# Technical Note

## Digital Mozart II Module

### 1 Introduction

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The original design of Mozart II includes everything an audio system designer needs in terms of digital to analog conversion and analog signal management ready to feed to analog amplifiers or outputs. Basically, ADC,DAC, FM tuner and all volume control and equalization are built-in.

Some applications do not make use of analog output (for instance, connecting the module to some digital audio processor does not require analog) or will make use of their own converters for feature or cost reasons. Therefore, Mozart II can be delivered as “digital only”, which means only the digital stream is provided to the outside world.

The general considerations on Mozart II use can be found in the master documentation for the full-fledged module. This document only describes the changes between the two versions. It is therefore recommended to read the full-fledged version documentation before this one.

A reference schematic for Mozart II Digital implementation is provided.

### 2 Clocking

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As in any digital audio system, clocking is an important point. Mozart II is using I2S 3-Wire protocol by default and needs a Master Clock frequency to be provided on I2S\_REF pin and equal to 11.2896MHz or 12.288MHz. The internal module dividers provide the according I2S\_LRCK, I2S\_BCLK and the I2S\_DATA is latched conforming to I2S 16 bits per channel standard. Awox may carry on particular studies upon customer request for specific unsupported sound peripherals.

### 3 DACs and amplifiers

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#### 3.1 SUPPORTED DACS

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The reference DAC for use with Mozart II Digital is Wolfson Micro WM8711. This low-cost DAC allows simple and easy construction of analog products using Mozart II Digital. It is the one that is used on the Analog variant of the module and is therefore not part of the reference schematic for sake of explanation; Mozart II Digital makes little sense versus the analog variant if the same peripherals are used; the goal is to be able to use feature-rich peripherals for mid to high-end devices. Please contact AwoX for more information.

#### 3.2 AMPLIFIERS

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The reference digital amplifier, Class-D, for use with Mozart II Digital is the Cirrus Logic CS4525. It has provision for analog parts without adding external circuitry while still giving the benefit of the low-cost and simplicity of Mozart II Digital.

## 4 Other Peripherals

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### 4.1 S/PDIF

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The optical and coaxial outputs for S/PDIF are driven by a Cirrus Logic CS8406 S/PDIF encoder. Software re-sampling is used for non-native frequencies. The Quartet II reference schematic includes this part configured to drive an optical transmitter. To support coaxial SPDIF output, please contact AwoX for more information.

### 4.2 FM TUNER

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The reference tuner for use with Mozart II Digital is the Silicon Labs Si4704. The tuner has analog outputs, which means that its use on a daughterboard requires proper analog signal handling. The part is the same that is used on the analog variant of Mozart.

## 5 Daughterboard Schematic Description

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Front Panel, iPod , and Rear Panel Interface are identical to the digital version (with the exception of the Line Out replaced by Line In for demonstration purposes, but this input is directly managed by the amplifier used).

Therefore, the description only highlights the Main Board which is quite simple.

### 5.1 AUDIO AMP SECTION (PAGE 1)

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The amplifier U4 and the module use external I2S clocking, providing the main frequency from crystal Y2.

### 5.2 FM TUNER & INTERCONNECT (PAGE 2)

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The FM tuner requires the use of a band-pass filter for proper FM reception. It uses its own external clock (Y3). Note that the interrupt line to the processor is shared and therefore open-drain, J20 is the connection to interface board.

### 5.3 5.3 POWER & CONNECTORS (PAGE 3)

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Strictly identical to analog version.



# Technical Note

## Using Mozart II

### 1 Introduction to Mozart II Module

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#### HARDWARE FEATURES

- RaLink RT3050/RT3052 system-on-chip
- Memory
  - 32 MB 133 MHZ SDRAM (64 MB optional)
  - 32 MB NAND flash memory for system
- FM Tuner
- Audio
  - Stereo output (L/R RCA, daughterboard\*) w/ headphones and line level
  - Stereo input (L/R RCA, daughterboard\*)
  - I2S output, 16bits stereo
  - SPDIF output (Optical/RCA, daughterboard\*)
- Storage
  - USB 2.0 host (daughterboard\*)
- Network
  - 10/100Mb Ethernet MAC & PHY
  - Onboard Wireless LAN 802.11b/g/n
  - Encryption support: 40- and 128- bit WEP, WPA, CCX, TKIP & AES
  - WPS 2.0 security
- Interface
  - Control LCD screen via SPI; supports monochrome and color TFT
  - Support for keyboard, up to 16 keys and one rotary encoder
  - Infrared decoder function for RC5 & NEC
  - Adjustable analog output within 0 ~ 3,3V range
  - External FM antenna (mini jack, daughterboard\*)
- Clock
  - Alarm, wake-up, snooze and sleep features
- Power Supply required
  - 3.3V for main activity
- Dimensions
  - 80 x 60 x 17 mm

#### SOFTWARE FEATURES

- Stored in NAND flash memory, fully upgradable via the Internet
- Audio decoders
  - MP3
  - WMA
  - WAV
  - AAC-LC
  - Real
- AwoX streaming engine
  - HTTP
  - MMS
- Internet Radio Directory
  - vTuner Internet
  - baracoda
- Digital Media Player (compliant with DLNA 1.5 guidelines)
- Digital Media Renderer (compliant with DLNA 1.5 guidelines)
- Linux Kernel 2.6.21
- Linux Drivers
  - Monochrome 128x64 LCD and QVGA TFT
  - Keyboard/keypad input
  - Wi-Fi Interface
  - FM tuner with optional RDS
  - Full-speed USB 2.0 host
  - Ethernet
  - SPDIF transmitter
  - Wi-Fi STA and AP

### 2 Introduction to Mozart II Module

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AwoX S.A. has developed and is manufacturing an electronic module, codenamed “Mozart II”, that allows building many types of connected audio platforms at the cost of simple expansion boards for power supply, network connection, audio outputs and man-machine interface. All the standard peripherals of such a device can be connected to the module which will be able to drive them with few or no additional glue.

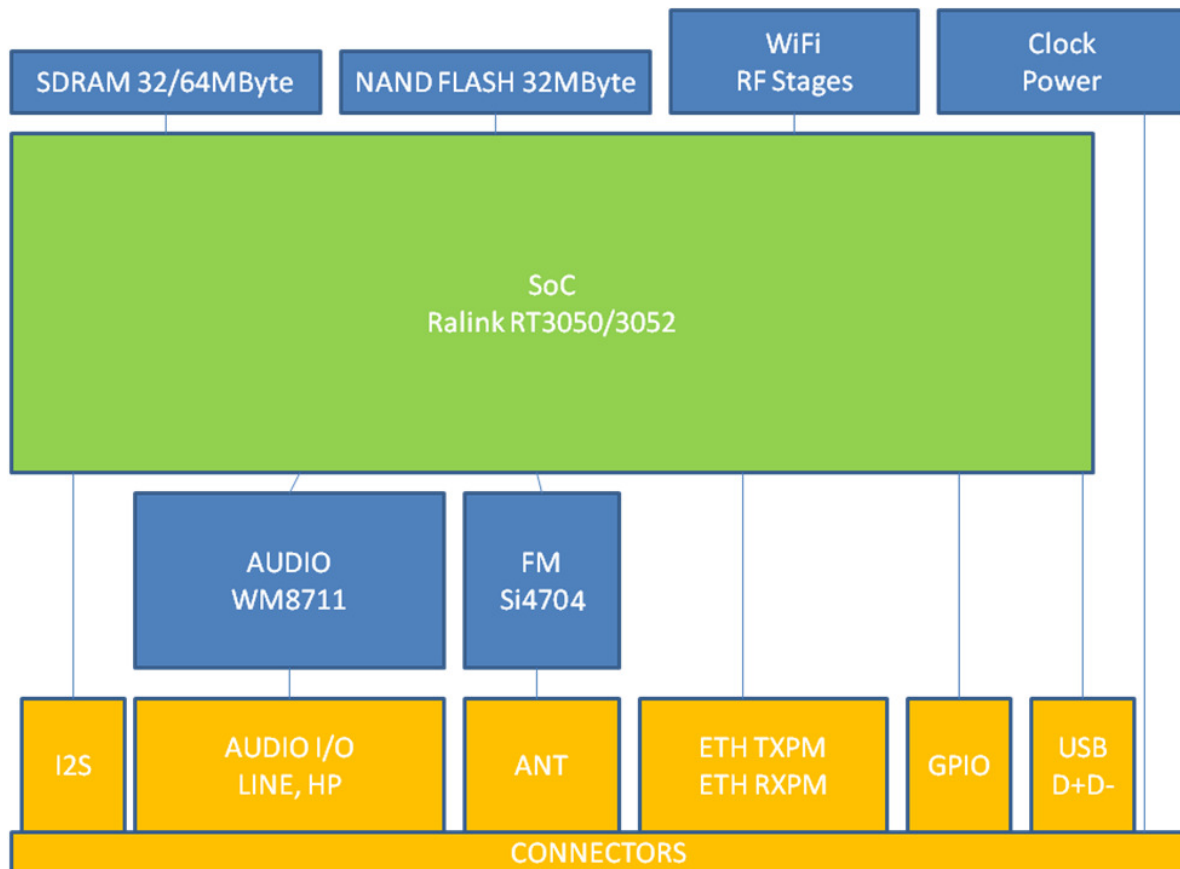
The module requires +3.3v, 1.2 A power supply.

The module is delivered with operating system and applications. There is a standard peripheral / function support set that can be customized upon request. The module has built-in features but is also able to support external peripherals. Customer support for additional peripherals can be integrated after feasibility study.

Additionally, the module comes with a set of preprogrammed pins for standard uses, but most of them have multiplexing capabilities allowing for different usage patterns. Please contact your local sales representative for customization information or feasibility questions.

Overall, the Mozart II module allows for easy design of equipment with standard features as well as room for customization and evolution. Custom design services (for both hardware and software) are available.

### 3 Module Block Diagram



### 4 Standard Features and Peripherals

#### 4.1 MODULE INTERNALS

On the module itself, the “smart” peripherals available are a stereo PLL FM tuner, an audio codec with line in, line out and amplified headphones output, and a built-in Ethernet PHY for 100baseT networks. The module has an internal Wi-Fi interface. The FM tuner audio output is available on the main connector as well as the Codec Line In. The module features 32MB of fully reprogrammable NAND flash and RAM. FM Tuner and Audio Codec are internally linked to the I2C bus, which might be shared with external peripherals.

All the internal peripherals are supported by the software distribution, as well as some external peripherals. The module has its own reset circuitry, which generates an externally available signal for resetting external devices. This reset line will be asserted at power on, when a power supply failure is detected, or when the software reboots the module (this can happen after firmware upgrade for instance). If the reset line is not used by an external device, care must be taken to reset the device at least under power on and power failure conditions by additional means.

## 4.2 EXTERNAL CONTROLS & INPUTS

The module features a number of pins that allow sensing data from the outside world as well as control information. Several digital I/O pins are available. All digital inputs are interrupt-capable in order to trigger predetermined software behaviors upon given external conditions. Digital outputs are 3.3v CMOS outputs; their maximum output current is 10 mA.

## 4.3 EXTERNAL BUSES

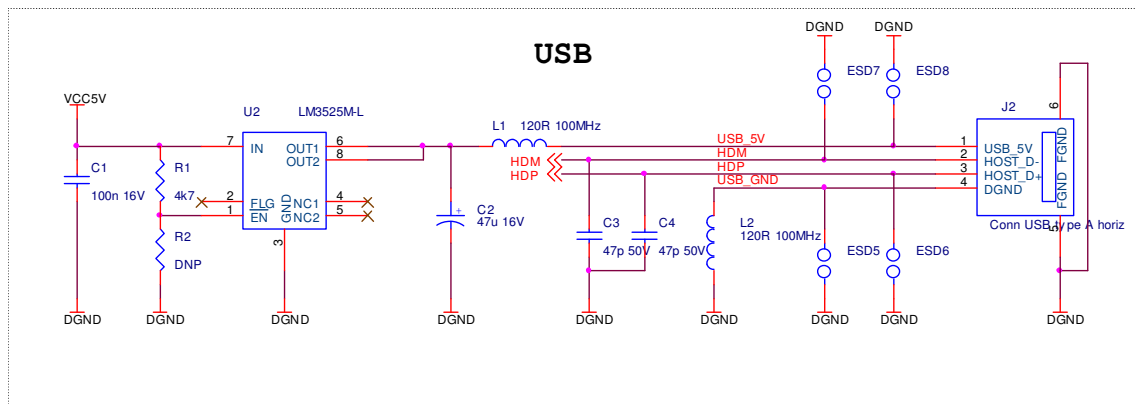
### 4.3.1 I2C

The module acts as an I2C compatible master controller. The default bus speed is 100KHz. The bus level is 3.3v; the module already has 4k7 pull-up resistors on both SCL and SDA lines. The external lines, if used without repeater, should be kept as short as possible.

### 4.3.2 USB

Signals for an USB host interface are available. The interface is fully compliant with USB 2.0 fullspeed standard. The powering of external USB devices is left to the integrator and must comply with USB constraints (coil decoupling of powering and appropriate impedance matching and adaptation of lines).

Most often, the host interface will be used for USB keys or mass storage devices. Should more USB ports be needed, an external hub can be added on the module port.



USB Mass Storage Support is part of the standard software delivery. Note that USB device or OTG can be supported but is not part of the standard implementation

## 4.4 AUDIO SECTION

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### 4.4.1 LINE OUT

The module has a Line Out stereo connection. The lines are DC coupled with a 1.35V offset and a 0.7Vpp modulation range. Depending on the software configuration, the modulation level can be fixed or may follow user volume settings.

### 4.4.2 FM OUT

The analog outputs of the FM tuner are available to provide flexibility for out-of-module analog paths. The normal way to use them is to link to Line\_In pins; if an external multiplexer has to be used, then the SELECT signal can be used to distinguish between FM and external source.

### 4.4.3 LINE IN

The module has a Line In stereo connection. The lines are DC coupled and will accept a 0.7Vpp modulation range. Depending on the software configuration, the input level can be fixed or may follow user settings. Input impedance is 47kOhms.

### 4.4.4 HP OUT

The module has a Headphones amplified stereo connection. The lines are DC coupled with a 1.35V offset and will drive 16 Ohm headphones at up to 30 mW and 32 Ohm headphones at up to 15 mW.

## 4.5 VOLUME CONTROL STRATEGIES

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The module features two audio outputs; one is a line-level output and one is a headphones output. Both can be controlled by software independently, however the way to use them depends on the global design of the target product and the envisioned use cases.

The headphones output is capable of driving standard 32 Ohm headphones at up to 15 mW output power. It is up to the customer to decide whether this is enough or not; if not external amplification must be used.

If headphones plug need to be added, there are two solutions:

- Use the module headphones output. In this case, if internal speaker cut-off is required, it must be implemented in relationship with the amplifier.
- Use the amplifier output to drive the headphones.

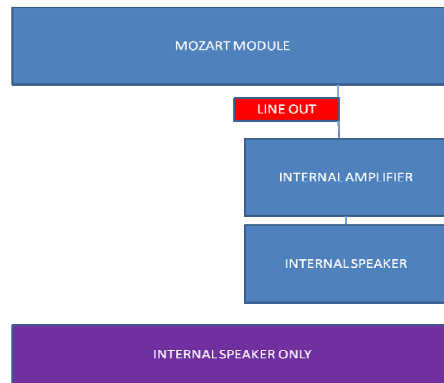
When simultaneous speakers and line out is required, in most cases the volume of the line outputs will not vary. In this case, the only solution is to use the headphones output to feed the internal amplifier (with jack before or after amplifier), and to connect the line outputs directly to the line out connector.

The module has a STANDBY and a MUTE signal. The MUTE signal will be active as soon as the module is not producing audio signals. The STANDBY signal needs to control powering of the amplifier, while the MUTE signal can be used to make sure audio outputs from the module will be turned down. It is important to note that at initialization time, the audio output of the module can produce spurious sounds – this is why the external logic must take care of not amplifying them.

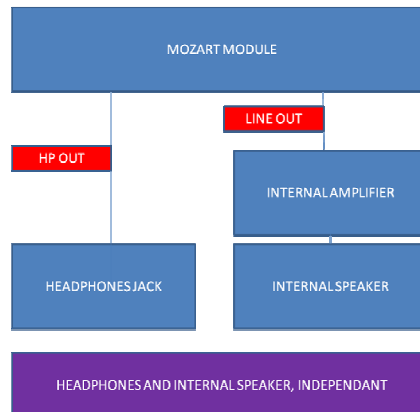
In case of required mono internal speaker, the internal amplifier will be monophonic as well and will be fed with a mix of the left and right signals. In this case, it will not be possible to have a design on which the headphones jack will be connected to the internal amplifier – the only way to have stereo output is to use the amplified outputs of the module.

It is important to note that the integrity of the audio outputs cannot be guaranteed while the module initializes. The module has a MUTE signal that must be used to physically remove the signal at places where it would be audible (namely, the audio amplifier). The MUTE signal is raised as soon as the module is not outputting any sound on its audio outputs in standard software deliveries. It is highly recommended to design the external circuitry with an amplifier that supports built-in muting instead of using additional circuitry.

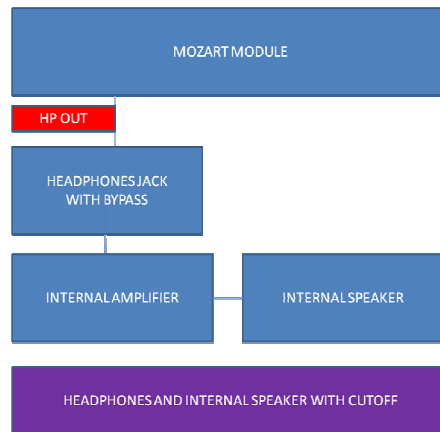
The following drawings illustrate how to use outputs from the module in various cases. The simplest possible equipment has only internal speaker; if the device is monophonic then left and right channels must be mixed before use – the output from the module will always be stereo; using only one channel will not be sufficient.



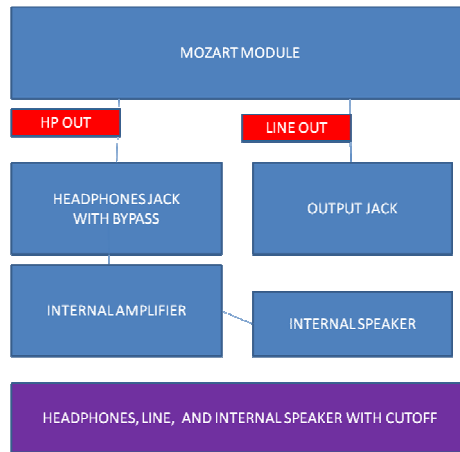
Adding headphones output is only at cost of the connector (the internal amplifier can be mono or stereo of course). However, this configuration does not allow automatic cutoff when headphones are plugged in:



If cutoff is required, it must be either managed outside of the module, or the following scheme can be used. In this case, impedance match at amplifier input is different from the LineOut feed:



For complete equipment, Line Outputs can be used as well. In this kind of structure, the Line Outputs will often be fixed-volume:



Finally, “accessory” devices will not have internal speakers (but they can still use headphones !). Internal amplification is removed in this case and the amplifier feed is connected directly to output jacks.

## 4.6 USING LINE INPUT

The Line In terminals can be used to grab audio from an external source, such as an MP3 player, CD player, cassette deck, iPod, etc. The audio analog is routed through the internal DAC therefore sound control for it is available. The Line Input and the FM tuner mode are exclusive.

If no Line In is requested, then the FM Out should be tied directly to Line In.

## 4.7 POWERING CONSIDERATIONS

The module requires 3.3v power rail. The 3.3v is the main power supply and, as all digital power supplies, is highly subject to digital commutation bursts and high current flows. It is therefore important that this line presents low impedance, is well decoupled, and not too long from the power supply location.

There is no recommended scheme for powering – it really depends on the kind of peripherals used in the rest of the device. If the main PSU is +5V (this will be the case if the device does not have amplification, such as a Hi-Fi accessory) then it makes sense to use linear regulation, while DC/DC scheme could be preferred if the main PSU is +12V. In case of DC/DC use, EMC concerns arise.



Some low-cost circuits will generate spurious oscillations at high frequency, therefore creating unwanted emissions that can go quite high in terms of frequency. It is recommended that the DC/DC converters are well-studied and tested before integration, especially when it comes to noise and stability considerations. Because of the inherent burst structure of the Wi-Fi current consumption, good transient response is a key factor of the power supply design – as well as track impedance and proper grounding & decoupling of the module.

## 4.8 POWER MANAGEMENT FEATURES

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To some extent, the module can manage power supply for itself and the external peripherals and be informed of the type of powering it can count on. However, even if running a Mozart II-based application on batteries can be done, it is not really the primary target of the module – continuous Wi-Fi communication and decoding is not really energy-saving. A possible scenario would be to build a “transportable device” (that is, mobility is a secondary function not supposed to be used every time) so a minimal power management has been put in place.

The module will raise the Standby line when a low power / idle condition is active while reducing its own consumption to a minimum (depending on software strategies and desired system behavior). It is up to the internal circuitry to take the appropriate measures to lower its current consumption (powering down the power amplifier, for instance).

## 5 Variants and extensions

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Mozart II modules can come with some population options for special designs. The most important variant is the so-called “all digital”: this module does not have any analog part (FM tuner and audio codec). Please contact you nearest AwoX sales representative for more information. A separate app note is available for this variant.

## 6 Connectors Description

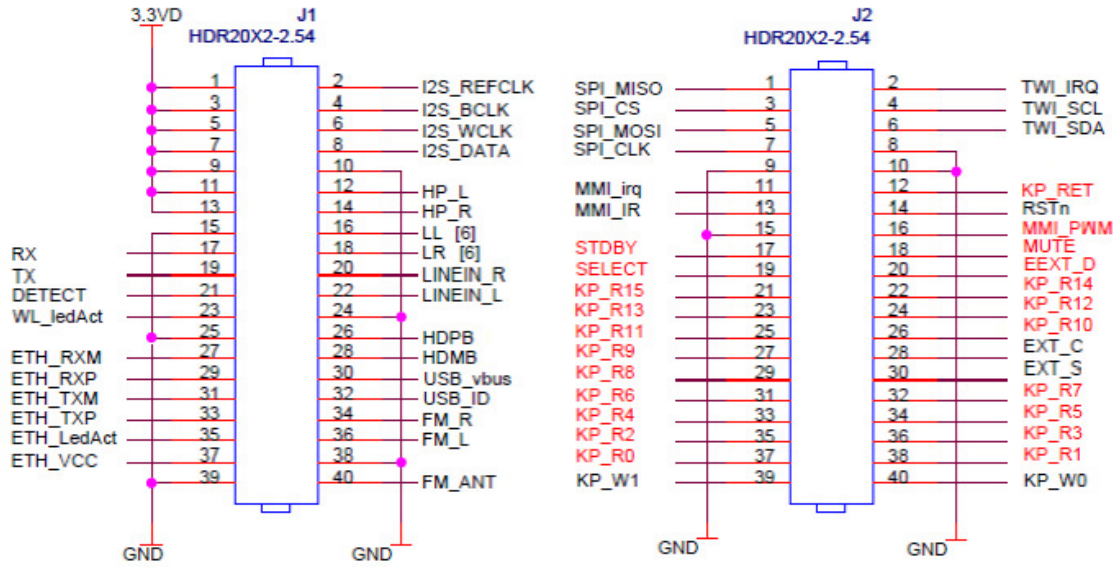
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The Mozart II module has two connectors; 2x20, 2.54mm standard male headers. Reference mating connector to put on daughterboard (female header) is SULLINS PPTC202LFBN-RC (DigiKey S6104-ND).

The regular mounting procedure is to have the module directly plugged to the daughterboard.

Depending on the actual connector selected, the mounting alone might be strong enough to hold during drop tests, however it is strongly recommended to provision for mounting screws or mounting compound.

The signal description can be found below.



J1	ANA/DIG/POWER	I/O	DEFAULT	Comment
1;3;5;7;9;11;13; VDD	POWER	N/A	Power Input 3.3V	
40; FM_ANTENNA	ANA	I	FM antenna input	
10;15;24;25;38;39; GND	POWER	I	System Ground	
2; I2S_REFCLK	DIG	I/O	I2S Master Clock	OUT on analog; IN on digital
4; I2S_BCLK	DIG	I/O	I2S Bit Clock	OUT on analog; IN on digital
6; I2S_WCLK	DIG	O	I2S Word Clock	
8; I2S_DATA	DIG	O	I2S Data Output	
20; LINE_INL	ANA	I	Line Input Left. DC coupled.	
22; LINE_INR	ANA	I	Line Input Right. DC coupled.	
34; FM_R	ANA	O	FM Tuner Output Right	
36; FM_L	ANA	O	FM Tuner Output Left	
16; LINEOUT_L	ANA	O	Line Output Left. DC coupled.	

18; LINEOUT_R	ANA	O	Line Output Right. DC coupled.	
12; HPOUT_L	ANA	O	Headphones Output Left. DC coupled.	
14; HPOUT_R	ANA	O	Headphones Output Right. DC coupled.	
22; WL_LEDACT	DIG	O	Wireless Activity LED.	
35; ETH_LEDACT	DIG	O	Ethernet Activity LED	
33; ETH_TXP	DIG	O	Ethernet Transmit Differential Pair, Positive.	
31; ETH_TXM	DIG	O	Ethernet Transmit Differential Pair, Negative.	
37; VCC_ETH	POWER	O	Ethernet Transmit Reference for common pins of transformer on module side.	
29; ETH_RXP	DIG	I	Ethernet Receive Differential Pair, Positive.	
27; ETH_RXM	DIG	I	Ethernet Receive Differential Pair, Negative.	
17; RX	DIG	I	UART Input	
19; TX	DIG	O	UART output	
21; DETECT	DIG	I	Interrupt capable detection for external accessory detect	
26; HDPB	DIG	I/O	USB Host Differential Pair, Positive	
28; HDMB	DIG	I/O	USB Host Differential Pair, Negative	
30; USB_VBUS	ANA	I	RESERVED	
32; USB_ID	ANA	I	USB ID pin, Connect to GND through 1K resistor	

J2 ID	ANA/DIG/POWER	I/O	DEFAULT	Comment
4; TWI_SCL	DIG	O	I2C-compatible clock line, 400 KHz. Internal 4k7 pull-up to D3V3.	
6; TWI_SDA	DIG	I/O	I2C-compatible data line, 400 KHz. Internal 4k7 pull-up to D3V3.	
2; TWI_IRQ	DIG	I	Interrupt capable line for external I2C devices, such as PCF8574. This line can be shared between devices. Open drain.	
17; STANDBY	DIG	O	Standby. Will raise when the software goes to low-power mode.	
14; RSTn	DIG	I/O	Main system reset. Can be asserted by the module (if reboot is required by software), but also by an external device.	
7; SPI_CLK	DIG	O	SPI Clock	
5; SPI_MOSI	DIG	O	SPI Data Out	
1; SPI_MISO	DIG	I	SPI Data In	
3; SPI_CS	DIG	O	SPI Select	
11; MMI_IRQ	DIG	I	Interrupt capable line for additional MMI devices. Open drain.	
16; MMI_PWM	ANA	O	Adjustable analog level line for MMI devices, for instance display backlight.	
21-37; KP_RX	DIG	O	Keypress X	
18; MUTE	DIG	O	Signal raises when audio muting is required	
20; EEXT_D	DIG	O	Extender Data	

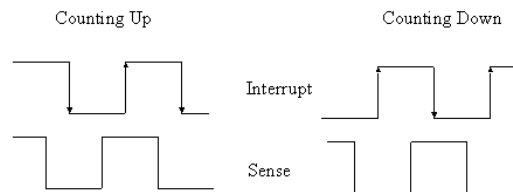
19; SELECT	DIG	O	Signal to control an audio switch when external analog devices are required	
28; EXT_C	DIG	O	Extender Clock	
30; EXT_S	DIG	O	Extender Strobe	
12; KP_RET	DIG	I	Keyboard Keypress Return	
40; KP_W0	DIG	I	Rotary Encoder Signal 0	
39; KP_W1	DIG	I	Rotary Encoder Signal 1	
39; MMI_IR	DIG	I	Infrared Demodulated data input	

## 7 Dealing with Keypad and Rotary

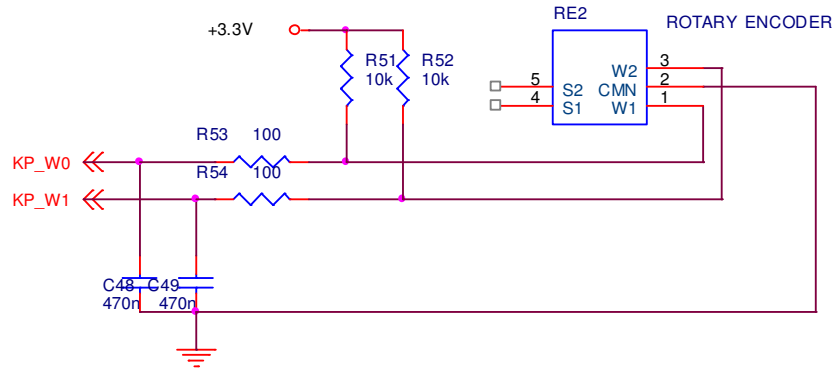
### 7.1 HARDWARE CONSIDERATIONS

The module features support for a matrix keyboard and a rotary encoder. The matrix is 16x1 and does not support simultaneous presses; however both long and short presses can be detected when a matrix configuration is used. All switches used in the matrix must be electrically independent – this is important if a rotary encoder with integrated pushbutton is to be used, since some models have common pins between the rotary encoder itself and the pushbutton. The integrated pushbutton is just treated as part of the general button matrix.

The rotary encoders supported by the module have two switches with a common connection. The two switches should provide signals in quadrature, the order of the rising edges provide the rotation direction and the number of edges the number of “turning steps”. The signals look like this:



A typical application schematic would be as follows. Note that the RC values might need fine-tuning according to the type of encoder used:



The module can support a 16x1 matrix of switches, each of the switches needs to be connected to one row and to the KP\_RET pin. Simultaneous presses are not supported, however short and long presses detection is available.

## 7.2 UNDERSTANDING BUTTON MAPPING

It is important to understand that even if buttons can be changed inside the matrix for routing purposes for instance, the real issue is the application itself. The logic of the application, eg the action of each button in each user screen, is driving the number and function of the buttons – and changing this is not easy at all, even if it might seem simple. Each button has a given function in all the possible states of the application.

If the intended application does not use one of the standard software deliveries, we strongly recommend to have the proposed scheme be validated by us since the software will require customization – once again the physical organization is the smallest issue when it comes to UI/MMI considerations. In all cases, provided that the number and meaning of buttons is the same, the matrix can be layout any way – the software is easy to reconfigure for this matter.

## 8 Dealing with I2C

The I2C bus is used to control internal and external peripherals of the module. The following I2C addresses are used by the module and external devices should not use them (apart from display of course) :

- codec 0x1A
- FM 0x10

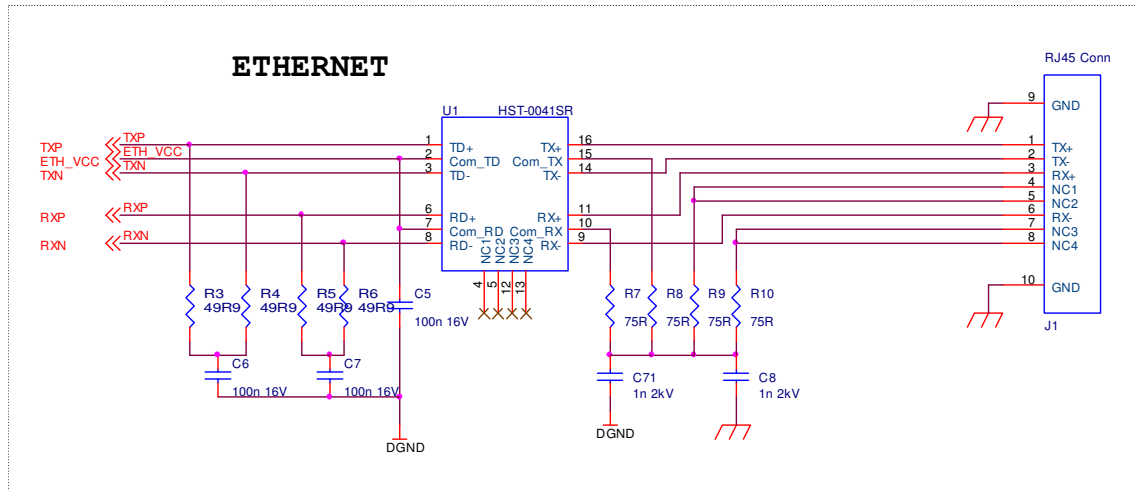
The lines should be kept short. If long wiring is needed because of the product configuration, it is recommended to use an I2C buffer such as NXP's PCA9515.

## 9 Dealing with Ethernet

The module has external connections for the TX and RX differential pairs in addition with link and activity LEDs. In order for the signals to be kept in proper condition, care must be taken for the lines to be routed with impedance matching (90 ohm differential) and with minimal length. The output transformer can be integrated inside the connector or put apart. Activity LED signals can drive LEDs directly (although a limiting resistor is needed); connect LED cathode to +3.3v

Ethernet is a known source of issues regarding EMC considerations. It is recommended to use high-voltage capacitors of x2 class.

It is also recommended to use common-mode filters on the line. Some Ethernet transformers will directly include those CMFs for easier integration.



## 10 Dealing with USB

The module has an external connection for the D+/D- differential pair of USB data. In order for the signals to be kept in proper condition, care must be taken for the lines to be routed with impedance matching (90 ohm differential) and with minimal length.

Powering for the external USB device is left to the device designer. It is recommended that the USB power supply is able to provide 500mA; the module does not provide any kind of negotiation for power supply, however an active high USB\_OC pin can be used to signal an over current condition. Actual current limiting needs to be done by the external electronics; this is a mandatory feature since external devices may fail and break the internals of the device.

It is up to the device designer to select the protection system – mostly following cost reasons. Specialized chips are available from many manufacturers (Sipex, Micrel ...) that allow power control and overcurrent reporting; or Polyswitch® fuses can be used as the simplest protection system.

USB lines must follow the reference schematic with filtering parts located as close as possible to the connector.

## 11 Dealing with Infrared Remote Controls

The module features a direct entry for demodulated infrared signals using the Philips RC5 code. The signal expected from the external demodulator (such as Vishay TSOPxx38 series) must be inverted (those demodulators have an open-drain output). With this part, the connection is direct. An external pullup is not required, however power supply decoupling as recommended in device datasheet shall be put in place.

As for the application button mapping, the kind of remote control used greatly depends on the application software – and customer decision regarding the type of features that will be controllable through the remote control. The most basic application would be volume control and maybe preset control.

## 12 Display / LCM support

128x64 SPI monochrome (RT3050, 32MB RAM)

QVGA SPI COLOR TFT (RT3052 64MB RAM)

## 13 Wi-Fi connectivity

The module comes with a built-in B/G/N Wi-Fi adapter with an optional external antenna connector in standard configurations.

## 14 Physical Mounting Considerations

The connectors of the module are not suitable for mechanical fixation. The module has metalized holes for this purpose, and they also serve as ground points. Therefore, the daughterboard must have the matching grounded holes and the fixation must go through metallic risers. The positioning information is included in this document.

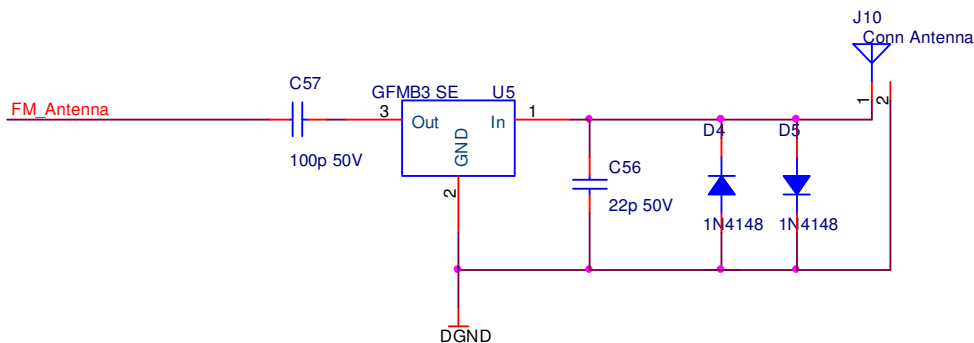
The matching connectors can be of traditional or SMD type. We recommend SMD type, since the routing of differential signals (given the pinout) can prove cumbersome if through-hole parts are used – this is especially true when close matching must be followed, such as Ethernet tracks.

## 15 FM antenna

The module has an integrated silicon tuner that only needs antenna connection to receive FM stereo. The FM tuner can cope (at the expense of software configuration) with worldwide FM standards (US, Japan and Europe). It is highly recommended to feed this input through filtering of spurious signals – prebuilt printed filters are the cheapest way to proceed. A good, proven part is made by Soshin Electric Co, Ltd under the reference GFMB3 SE. Dangling wire or telescopic antennas are suitable for the purpose.

Note that if coaxial cable is used to feed the input, the ground of this cable must be referenced to the DIGITAL ground. Protection against ESD can be achieved through regular diodes between antenna and ground, located as close as possible to the pass-through point of the antenna from the outside to the inside of the device.

### FM antenna



## 16 EMC

Although the module itself has been designed and validated not to radiate by itself, there is a number of external signals that go through the device and that might (depending on their routing and placing) act as antennas.

EMC concerns (according to EN55022 – and FCC Part15 and EN55024) are mostly:

- Radiated emissions



- Immunity to external perturbations, especially ESD. Note that the standard requires tracking of demodulation up to 5GHz.

The first precaution to take is to open signals RF-wise, with low value resistors placed as close to the module connector as possible. This should be done on all GPIOs and I2C lines; in some cases the resistors would be needed at both ends of the track (if the connected device/part is creating noise itself, such as certain LCMs).

If DC/DC converters are used – beware of parasitic oscillations at the output stage; snubbers might be required to stabilize them.

## 17 Muting and Demodulation Issues

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Any device built around a Mozart II module is a complex mixed-signal (digital and analog) system with RF parts (Wi-Fi and FM). In this kind of system, the main problem is to avoid digital or demodulation noise coming out to the audio sections.

The module itself has high quality filtering of the power supply for the audio sections. But it is up to the system designer to make sure the external circuitry (especially audio signal paths and external active parts) will be immune to power supply noise and to Wi-Fi radio waves.

The latter is very important, because many low-cost or old amplifiers (design-wise) are very prone to demodulation of RF signals. We strongly recommend to select parts with recent designs and to make sure with the manufacturer that the selected part is not sensible to the electric fields around 2.4GHz, otherwise Wi-Fi radio waves will create demodulation noise in the speaker. Even though, we recommend taking appropriate measures to protect & shield amplifiers properly – mobile phones are also very likely to generate demodulation noise.

In the case of power operational amplifiers, it is good practice to insert resistors (HF wise, around 4k7) in the positive and negative lines, as close to the device as possible. While this is not always efficient, we recommend keeping PCB footprints for those parts.

It is also recommended that the audio tracks are guarded against other signals by sufficient ground planes.

## 18 Using Mozart II as a slave companion

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Some devices might want to keep their existing designs (control processor, display, buttons...) and add Internet Radio functionality through the module. This might make sense, but one must not underestimate the amount of development required to handle all the new features brought in by the device. It might even prove impossible – scrolling through long lists using one line of text and two buttons is not a nice user experience.

In fact, the general rule is that the “smartest” part must handle the UI and treat the other one as slave. For instance, a very basic CD player will never have the level of complexity required by internet radio features – if one wants to build an “Internet Radio CD player” the way to go is to make a custom development on Mozart II to have it drive the CD pickup electronics for instance. Other devices might have a less balanced choice; for those Mozart II has a full software library that can come on top of several communication links to be remotely controlled by another processor.

The detailed description of this option is beyond the scope of this document. Please contact your nearest AwoX sales representative for detailed information.

## 19 Extensions and Customization

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The main goal of Mozart II is to allow manufacturers to easily build Internet Radio and network streaming devices. The fastest way to reach this is to reuse the reference parts & schematics with the

standard software delivery. However, there are many reasons for which customization might be needed – functional reasons, cost, parts reuse, market difference, etc.

There is a number of available options on the Mozart II module. We provide a coherent reference package, but it would be cumbersome to list in details all the possible modifications. Moreover, with new designs being built, the amount of available extensions is growing up.

Most of the time, changing the design around the module will require changes or additions in the software. As of now, the software development model is closed, which means that AwoX does not provide development kits for the module. Changes must then be discussed between the integrator and AwoX before starting actual product development.

At the time of writing, customizations include:

- Changing display
- Using capsense buttons
- Alternate remote controls
- ...

## 20 Feasibility & Design Review

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It is highly recommended that the customer submits the envisioned design to AwoX hardware engineering team for review first. Not everything can be written and this will greatly reduce the learning curve and probability of mistakes.

Same remark appears to desired customizations.

## 21 Playback capabilities

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### 21.1 CODECS

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#### 21.1.1 INPUT

##### PCM (WAV)

- **Codec details:** N/A
- **Bit rates:** N/A
- **Containers:** .wav, .aiff, .aif, aifc files, HTTP streams

##### WMA9

- **Codec details:** WMA 9, CBR, VBR
- **Bit rates:** Up to 320 kbps
- **Containers:** ASF container .wma files, HTTP, MMS streams

##### MP3

- **Codec details:**

- Full layer 3 support for
  - MPEG1 layer 3 - sampling frequencies: 48 KHz, 44.1 KHz, 32 KHz
  - MPEG2 layer 3 - sampling frequencies: 24 KHz, 22.05 KHz, 16 KHz
  - MPEG2.5 layer 3 - sampling frequencies: 12 KHz, 11.025 KHz, 8 KHz
- Supports constant bitrate, variable bitrate, and free bitrate modes
- Supports mono and all stereo modes (normal stereo, joint stereo, dual-mono)
- **Bit rates:** Up to 320 kbps
- **Containers:** mp3 files, HTTP streams

## AAC

- **Codec details:** MPEG4-LC AAC main profile, mono and stereo.
- **Bit rates:** Up to 320 kbps
- **Containers:** .aac, .3gp, .mp4, .m4a files, HTTP and RTSP streams

## 21.1.2 OUTPUT

- **Channel:** 1, 2
- **Definition:** 16 bits
- **Sampling rate:** 8, 11.025, 12, 16, 22.05, 24, 32, 44.1, 48, 88.2, 96 KHz

## 21.2 STREAMING PROTOCOLS

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The following streaming protocols are supported:

- HTTP
- MMS
- RTSP
- RDT

## 21.3 METADATA EXTRACTIONS

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The player is able to extract metadata from played stream. If found, the following metadata are reported:

- Track Title
- Artist name

No support is provided to extract metadata from other stream than the currently played one.

## 21.4 PLAYLIST SUPPORT

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### 21.4.1 SUPPORTED PLAYLIST FORMATS

The following playlist formats are supported:

- m3u
- pls
- ram

### 21.4.2 PLAYLIST CONTENT

The players always define playlist to be able to handle 'next' and 'previous' buttons and to handle 'repeat all' and 'shuffle' play modes.

- **Internet radio/podcast:** Browsed list of played item
- **Preset Internet radio:** Preset radio list
- **Local file:** Directory of played item (if file) or played playlist
- **From DLNA server:** Container of played item

### 21.4.3 PLAY MODES

When playing a track from a playlist, the player can have one of these play modes:

- **Single play:** When the current track is finished, the player start the next one in playlist until the last track in playlist has been played. At this point, the playback stops.
- **Repeat one:** When the current track is finished, the playback restarts on this track
- **Repeat all:** When the current track is finished, the player start the next one in playlist until the last track in playlist has been played. At this point, the playback starts with the first track of the playlist.
- **Shuffle:** All tracks of the playlist are played in a random order. Except playback order, the behavior is the same than "repeat all" mode

## 21.5 PLAYER CONTROL

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### 21.5.1 BACKGROUND PLAYBACK

The music playback, once started, do not prevent UI browsing. Any browsing action can be done while the playback is done, except the following one:

- Network connection
- Firmware upgrade
- Factory reset

## 21.5.2 COMMANDS

The player supports the following commands:

- **Play:** Start playback of the selected URI
- **Pause:** Pause playback of the selected URI, if this is a file (local or through DLNA). In case of Internet radio, the sound is simply muted (no time shift).
- **Stop:** Stop playback of the selected URI
- **Fast forward:** Change current playback speed; supported speed: X15, X60
- **Fast rewind:** Change current rewind speed; supported speed: X15, X60
- **Next:** Switch to next URI in the current playlist. See playlist support.
- **Previous:** Switch to previous URI in the current playlist. See playlist support.
- **Volume up:** Increment current volume on a 0-20 scale
- **Volume down:** Decrement current volume on a 0-20 scale
- **Mute:** Toggle the mute state. When muted, there is no sound output, but the URI is still played at the current speed.

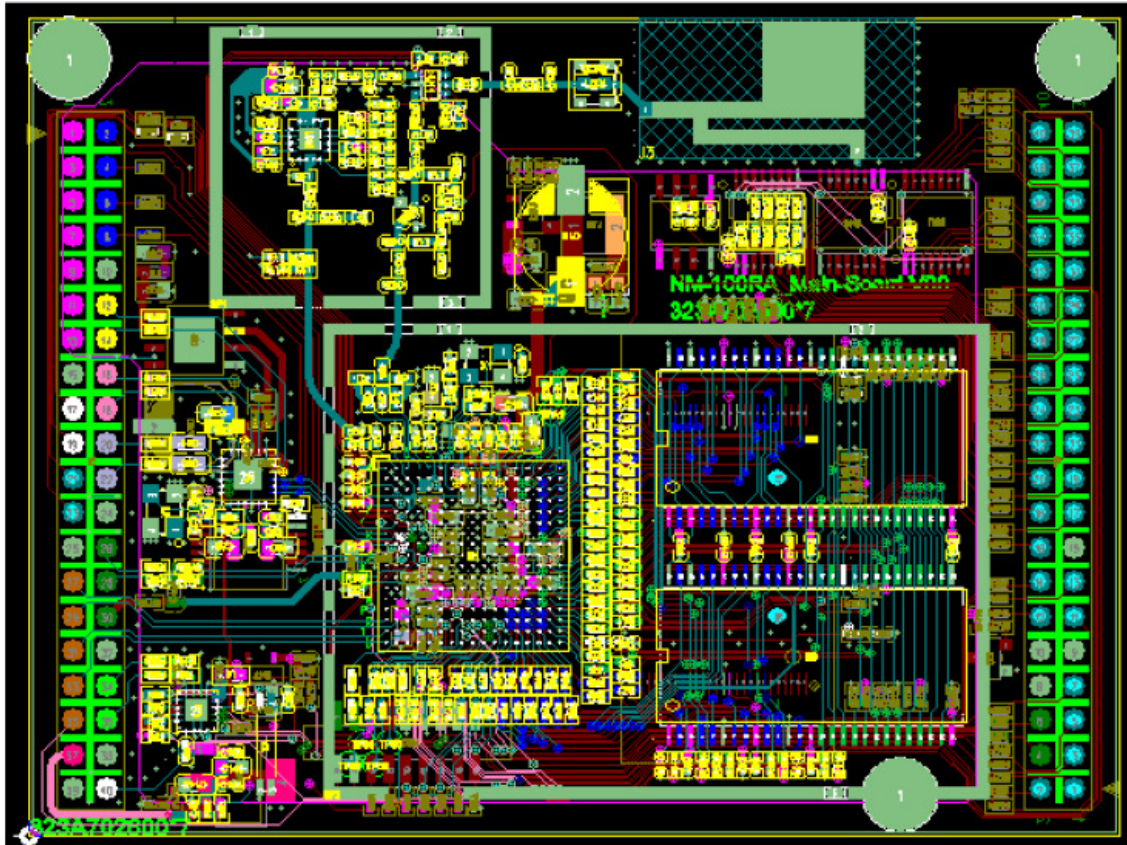
## 22 Mechanical Constraints

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The size of the module is 60x80 mm. Provision for 20mm on top of PCB; the header length is 9mm on bottom side, with PCB thickness of 1.6mm and the Wi-Fi antenna is 10mm high.

A horizontal and vertical clearance area of 35mm around the antenna is required for proper Wi-Fi operation.

An overview of the module from the top follows:



Detailed mechanical placement information can be found in attached DXF file.

## 23 Daughterboard Schematic Description

The attached reference device schematic shows a real-life use of the Analog variant of Mozart II, where the situation is a product that includes Internet Radio, FM, and iPod dock features. The schematic is split into four functional blocks: a main block, a front block, a connector panel and an iPod dock. This arrangement will fit most possible designs. See attached PDF schematics for each block.

### 23.1 MAIN BLOCK

#### 23.1.1 “AUDIO” SECTION (PAGE 1)

U4 is the analog power amplifier (class D), with the associated filtering for HP outputs. U7 allows switching between multiple analog sources such as iPod, Line-In and FM (located on the module itself).

#### 23.1.2 “POWER” SECTION (PAGE 2)

The main block is “hidden” (eg, there is no user-accessible part on it). It provides power & module connector interfacing.

The power & connectors section is quite straightforward. There is a PWM generation of the 5V rail for USB and iPod charging, and 3.3V for the board logic.

The iPod functional block includes a dock connector, an Apple IC authentication chip (thus routes the I<sup>2</sup>C bus). Analog audio and TX/RX signals for iPod control.

The level converter (U6) & DB9 socket besides are not required for a product – it's a provision for development..

## 23.2 FRONT PANEL BLOCK

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### 23.2.1 “OVERVIEW” SECTION (PAGE 1)

This view simply shows the product organization.

### 23.2.2 “FRONT PANEL” SECTION (PAGE 2)

The front panel is a very simple subsystem. One can find here the keyboard buttons, the rotary encoder, the infrared demodulator, the display (black & white or color), the touch screen and the backlight control connectors.

## 23.3 INTERFACE BLOCK

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The interface block is mostly for connectors support. Note that J12, the headphones connector, features an insertion detection so that the functionality is to mute the loudspeaker automatically when headphones are inserted; this is an automatic function of the power amplifier when the proper software configuration is in place.

USB and Ethernet interfaces are routed as explained in the sections above.

## 23.4 IPOD BLOCK

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This block is mostly interconnects but needs to be physically present to mechanically support the iPod connector. The ID resistors near the connector present the device as being able to charge the iPod at up to 1 ampere.

Make note of U2, the special Apple authentication chip. Putting it on this subsystem allows building a product with an iPod variant while keeping the same daughterboard in place.

## 24 Federal Communications Commission Interference Statement

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This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

### **CAUTION:**

Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

### 24.1 LABELING REQUIREMENTS

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This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### 24.2 RF EXPOSURE WARNING

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This equipment must be installed and operated in accordance with provided instructions and the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. End-users and installers must be provide with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

### 24.3 INFORMATION FOR THE OEMS AND INTEGRATORS

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The following statement must be included with all versions of this document supplied to an OEM or integrator, but should not be distributed to the end user.

This device is intended for OEM integrators only.

Please see the full Grant of Equipment document for other restrictions.

This device must be operated and used with a locally approved access point.

### 24.4 INFORMATION TO BE SUPPLIED TO THE END USER BY THE OEM OR INTEGRATOR

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The following regulatory and safety notices must be published in documentation supplied to



the end user of the product or system incorporating an adapter in compliance with local regulations. Host system must be labeled with "Contains FCC ID:PPQ-XXXXX", FCC ID displayed on label.

Where:

- XXXXX shall be AWOXMII2 for Mozart II RT3052 versions.
- XXXXX shall be AWOXMII0 for Mozart II RT3050 versions.

END OF DOCUMENT