eRED-MOD

NETWORK AUDIO RENDERER

MODULE DATASHEET

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eRED-MOD-DS
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Preamble

I. About This Datasheet

This document provides the information required for integration and operation of the eRED-MOD Network Audio Renderer. For more information, please refer to the product description available from the engineered SA Web site at www.engineered.ch

II. Company Information

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III. Notice

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IV. Product Warnings and Restrictions

It is important to operate this product within the specified input and output range described in this document. Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the product.

If you have questions regarding the input range, please contact engineered SA customer service prior to connecting the power supply. Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the product. Please consult the datasheet before connecting any load. If you have doubts concerning the load specification, please contact engineered SA customer service.

V. Repair and Maintenance

Routine maintenance is not required. This product is warranted to be free of any defect with respect to performance, quality, reliability and workmanship for a period of SIX (6) months from the date of shipment from engineered SA.

In case it is proven that your product is actually defective during this warranty period only, engineered SA will gladly repair or replace this piece of equipment with a unit of equal performance characteristics.

Should this product be defective after expiration of your warranty period, engineered SA will repair this piece of equipment for as long as suitable replacement components are available. You, the owner, will bear any labor and/or component costs incurred in the repair or refurbishment of the said equipment, beyond the SIX (6) months warranty period. Any attempt to repair this product by anyone during this period other than by engineered or any authorised third party will void your warranty.

In the case you decide to return your product for repair, engineered SA reserves the right to assess any modifications or repairs made by you and decide if they fall within warranty limitations. For no event shall engineered SA be liable for direct, indirect, special, incidental, or consequential damages (including loss and profits) incurred by the use of this product. Implied warranties are expressly limited to the duration of this warranty.

VI. Documentation Release Notice

This document is under revision control and updates will only be issued as a replacement document with a new version number.

Product specifications are subject to change without notice.

1 Introduction

1.1 Highlights

The eRED-MOD module offers a top-notch solution for network audio playback systems. Developed exclusively for High-End systems, it allows for jitter-free, bit-perfect playback with no compromise on sound quality. Thanks to its compatibility with the UPnP AV 2.0 standards, its integration into a home network is easy. Key features for the eRED-MOD include:

- Digital Media Renderer for stereo audio
- UPnP AV 2.0 / DLNA
- Playing and decoding common audio formats* from HTTP streams
- 2-channel asynchronous endpoint for highest quality digital audio stereo playback
- Bit-perfect, jitter free data transmission
- PCM up to 32-bit resolution, sampling rate up to 384 kHz
- Support for DSD64, DSD128 and DSD256
- Support for gapless playback
- Ethernet interface
- I2S/DSD digital audio output
- Hardware mode for easy operation
- SPI interface available for extended features
- Single 3.3V power supply
- Compact design, low EMI

(*) Subject to licensing by the final product manufacturer for the various audio decoders.

The eRED-MOD module is a fully featured and easy-to-integrate OEM solution for network audio playback systems. Our proprietary concept for network audio playback takes care of the asynchronous mode, clock management, formats decoding and UPnP/DLNA support to provide an unprecedented listening experience. Latest high-resolution files, be they DSD or PCM, can be streamed from local or remote servers with perfect clocking and data integrity. This state-of-the-art concept is the solution for network connectivity, technically the best interface for digital music reproduction and a key component for any modern High-End DAC.

The eRED-MOD plays music from file servers or Internet streams, acting as a UPnP AV/DLNA Media Renderer device. Common PCM (Pulse Code Modulation) audio formats are supported, including decoding of lossless FLAC up to 384kHz. One-bit DSD (Direct Stream Digital) is also supported via uncompressed DSF and DFF files.

For optimal performances, Ethernet streaming is based on an asynchronous protocol. Thus, the digital audio output port of the eRED-MOD is synchronized by the external clock and assures jitter-free clocking. Master and slave modes are offered on the I2S port.

1.2 eRED-MOD Block Diagram

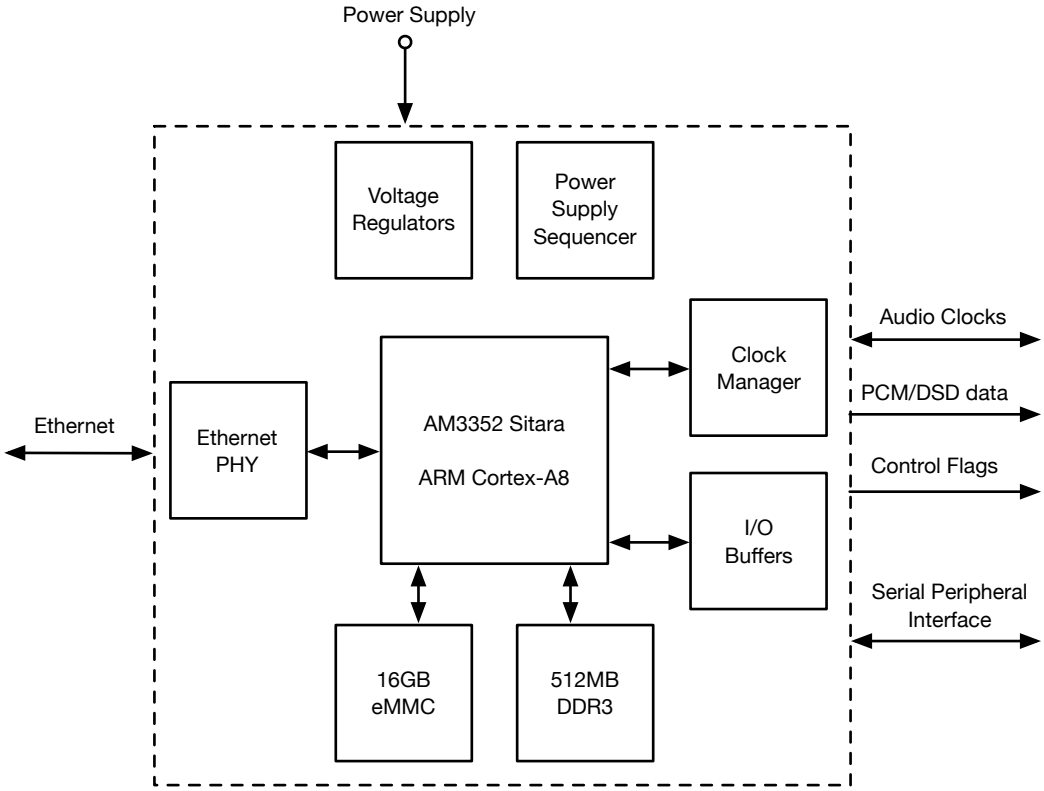

Figure 1-1 – eRED-MOD simplified block diagram

Refer to chapter 4 for more details about eRED-MOD integration, as well as general information relative to network audio systems.

3 Characteristics and Specifications

3.1 Electrostatic Discharge Warning

Many of the components in this product are subject to be damaged by electrostatic discharge (ESD). Customers are advised to observe proper ESD precautions when unpacking and handling the board, including the use of a grounded wrist strap at an approved ESD workstation.

Caution: Failure to observe ESD handling procedures may result in damage to the product.

3.2 Recommended Operating Conditions

Table 3-1 indicates the recommended conditions under which the product should run properly.

Parameter	Recommend Condition
Power supply voltage	3.30 VDC
Operating free-air temperature	$T_{A(min/max)}$: 0 °C / 60 °C

Table 3-1 – Recommended operating conditions

3.3 Absolute Maximum Ratings

The user should be aware of the absolute maximum operating conditions for the eRED-MOD. Failure to comply with these conditions may result in damage to the product. The minimum and maximum values are indicated in Table 3-2.

Parameter	Min.	Max.
Power supply voltage	-0.30 V	3.60 V
Input signal voltage	-0.30 V	3.60 V

Table 3-2 – Absolute maximum ratings

3.4 Electrical Specifications

Parameter	Min.	Typ.	Max.	Unit
External DC supply voltage	3.15	3.30	3.45	V
External DC supply current		250	350	mA
CMOS output high level V_{IH}	2.7	3.10	3.30	V
CMOS output low level V_{IL}	0	0.20	0.40	V

Table 3-3 – Electrical specifications

3.5 Audio Resolution Specification

Parameter	Min.	Typ.	Max.	Unit
PCM digital audio resolution	16		32	bit
PCM digital audio sample rate	32		384	kHz
PCM digital audio dynamic range		32		bit
DSD sample rate	2.8224		11.2896	MHz

Table 3-4 – Audio resolution specifications

3.6 Pin Configuration

The eRED-MOD uses Hirose FX8-60P-SV connectors on PCB's bottom side. For physical location of the pins, refer to chapter 6 Mechanical Data.

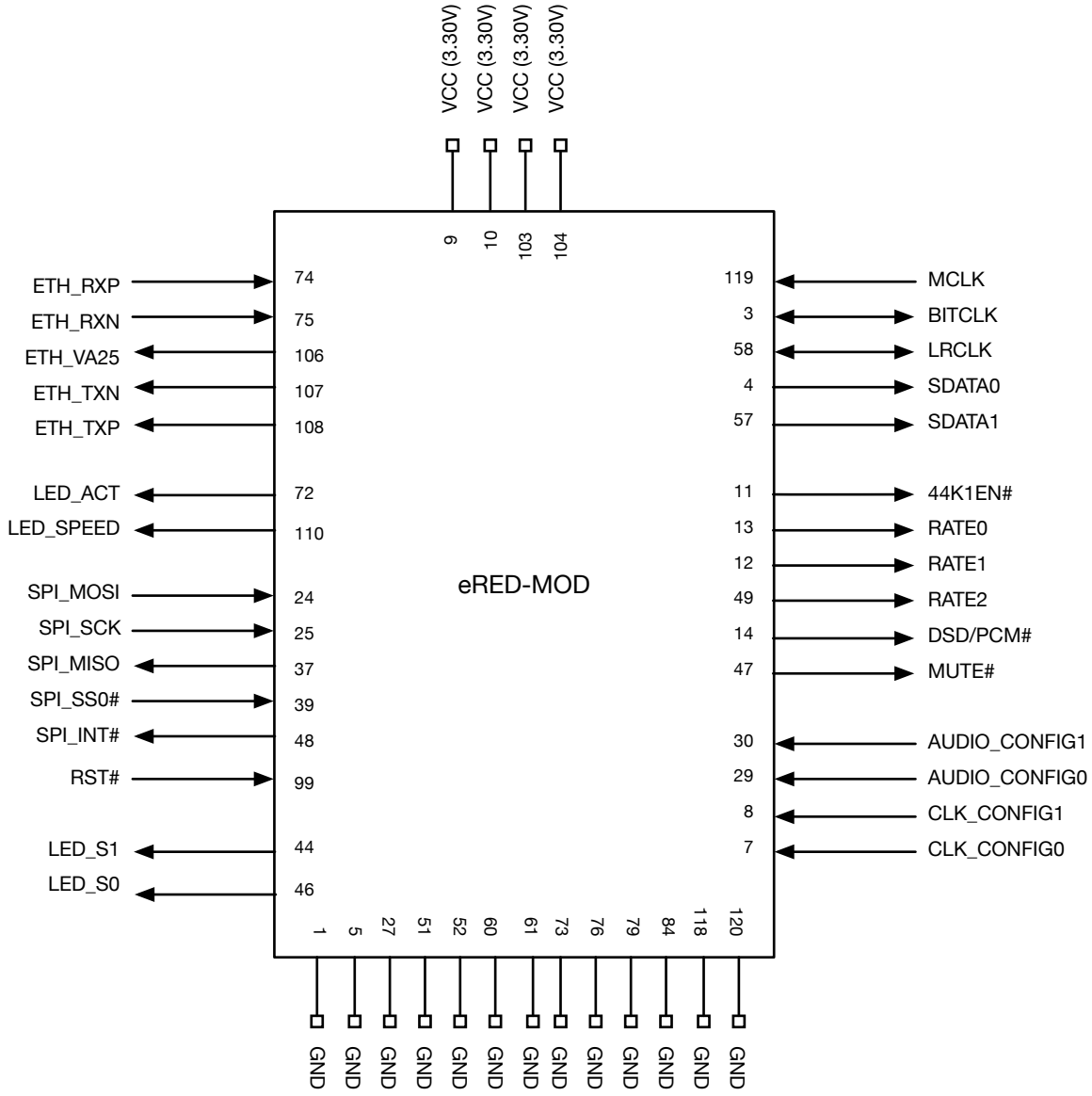

Figure 3-1– eRED-MOD pin configuration

3.7 Pin Functions

Pin assignments are described in the table hereafter. Items not listed here are reserved for factory use and must be left unconnected.

Pin #	Name	Type	Description
1	GND	Power	Ground
3	I2S_BITCLK	Input/output	I2S input/output port BITCLK
4	I2S_SDATA0	Output	I2S output port SDATA0
5	GND	Power	Ground
7	CLK_CONFIG0	Input	audio clock config (1) - unused yet, leave open
8	CLK_CONFIG1	Input	audio clock config (1)
9	VCC (3.3V)	Power	Power supply, 3.30V
10	VCC (3.3V)	Power	Power supply, 3.30V
11	CC_44K1EN#	Output	Audio sampling rate information
12	CC_RATE1	Output	Audio sampling rate information
13	CC_RATE0	Output	Audio sampling rate information
14	CC_DSD/PCM#	Output	Audio data type information
24	SPI_MOSI	Input	Slave SPI data input (1)
25	SPI_SCK	Input	Slave SPI serial clock (1)
27	GND	Power	Ground
29	AUDIO_CONFIG0	Input	Audio processing config (1) - reserved for future use, leave open
30	AUDIO_CONFIG1	Input	Audio processing config (1) - reserved for future use, leave open
37	SPI_MISO	Output	Slave SPI data output
39	SPI_SS0#	Input	Slave SPI chip select (1)
44	LED_S1	Output	System status LED
46	LED_S0	Output	System status LED
47	CC_MUTE#	Output	Audio MUTE signal
48	SPI_INT#	Output	Slave SPI open collector
49	CC_RATE2	Output	Audio sampling rate information
51	GND	Power	Ground
52	GND	Power	Ground
57	I2S_SDATA1	Output	I2S output port SDATA1
58	I2S_LRCLK	Output	I2S output port LRCLK
60	GND	Power	Ground
61	GND	Power	Ground
72	ETH_LED_ACT	Output	PHY LED1
73	GND	Power	Ground
74	ETH_RXP	Input/output	PHY RXP
75	ETH_RXN	Input/output	PHY RXN
76	GND	Power	Ground
79	GND	Power	Ground

Pin #	Name	Type	Description
84	GND	Power	Ground
99	RST#	Input	Master reset (1) - low for reset
103	VCC (3.3V)	Power	Power supply, 3.30V
104	VCC (3.3V)	Power	Power supply, 3.30V
106	ETH_VA25	Power	Ethernet PHY voltage reference
107	ETH_TXN	Input/output	PHY TXN
108	ETH_TXP	Input/output	PHY TXP
110	ETH_LED_SPEED	Output	PHY LED2
118	GND	Power	Ground
119	MCLK	Input	Master clock input for I2S output port (1), Clock Master Mode only
120	GND	Power	Ground

Table 3-5 – Pin functions

(1) This pin has an internal weak pull-up.

4 Application Information

4.1 Typical Network Audio Setup

A network audio setup is typically composed of the following devices:

- Digital Media Server (DMS) – Multimedia files are stored on this device and are made available to the network.
- Digital Media Renderer (DMR) – This device is the rendering output, able to play content from a Media Server and controlled by a Digital Control Point.
- Digital Control Point (DCP) – This device browses the content provided by Media Servers and sends commands to the Media Renderer for rendering the selected media.

Playback starts once the Control Point has sent a file path and "play" command to the Media Renderer. The Media Renderer fetches the file directly from the Media Server, and the data stream does not pass through the Control Point.

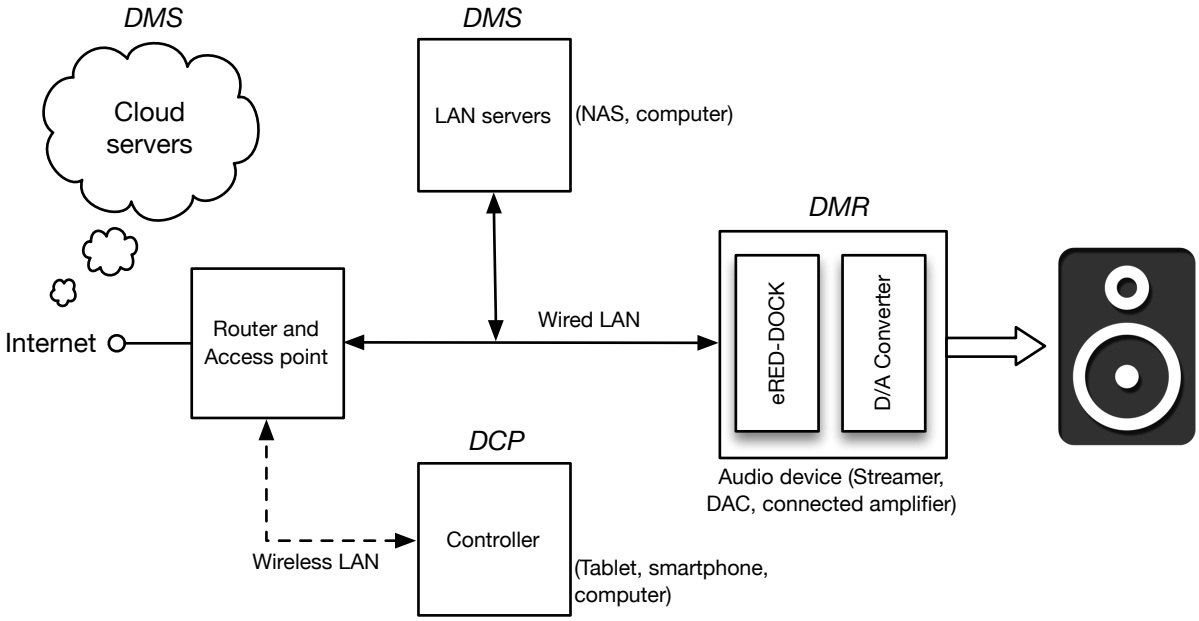

Figure 4-1 - Typical Network Audio Setup

4.2 Audio Formats

The design supports both multi-bit PCM and one-bit DSD (Direct Stream Digital) modulations.

The following stereo audio formats are supported and decoded by the eRED-MOD interface:

- FLAC (Free Lossless Audio Codec)
- WAV (Waveform Audio File Format)
- MP3 (Mpeg Audio Layer 3)
- ALAC (Apple Lossless Audio Codec)
- AAC (Advanced Audio Coding)
- AIFF (Audio Interchange File Format)
- Uncompressed DSF and DFF (DSD stream file)

Standard WAV and AIFF files contain uncompressed pulse-code modulation (PCM) audio data. Like any non-compressed, lossless format, they use much more disk space than compressed formats. Such uncompressed PCM streams are supported up to 384 kHz / 32-bit.

FLAC is an open format with royalty-free licensing. It supports for metadata tagging, album cover art, and fast seeking. The technical strength of FLAC compared to other lossless formats lies in its ability to be streamed and decoded quickly, independently of the compression level. Since FLAC is a lossless scheme, it is suitable as an archive format for CDs and other media owners who wish to preserve their audio collections. The eRED-MOD decodes FLAC files up to a sampling rate of 384kHz.

MP3 and AAC are lossy compressions and encoding schemes for digital audio. These are non-free codecs covered by patents and subject to licensing by the final product manufacturer. The eRED-MOD offers the technical ability to decode such formats, but engineered SA is not responsible for non-free audio codecs licensing.

DSF and DFF files may contain multi-channel audio data and various resolutions. The eRED-MOD supports uncompressed one-bit stereo audio at 2.8224 MHz, 5.6448 MHz and 11.2896 MHz

Note: It is the responsibility of the manufacturer of the final product (the brand) to take care of the licensing and fees for the non-free audio codecs.

4.3 Typical Application

Applications include all types of audio streaming devices, like D/A converters and network bridges. Typically, the digital audio output bus or the eRED-MOD is connected to:

- a Digital to Analog converter (DAC)
- a Digital Audio Transmitter (DIT) in order to output S/PDIF signal
- a DSP to apply digital processing (e.g. oversampling)
- an FPGA for clock and signal routing

Figure 4-2 illustrates a possible eRED-MOD integration within a complete system with D/A conversion for analog outputs as well as digital S/PDIF output where low level management is performed by a local micro-controller (MCU).

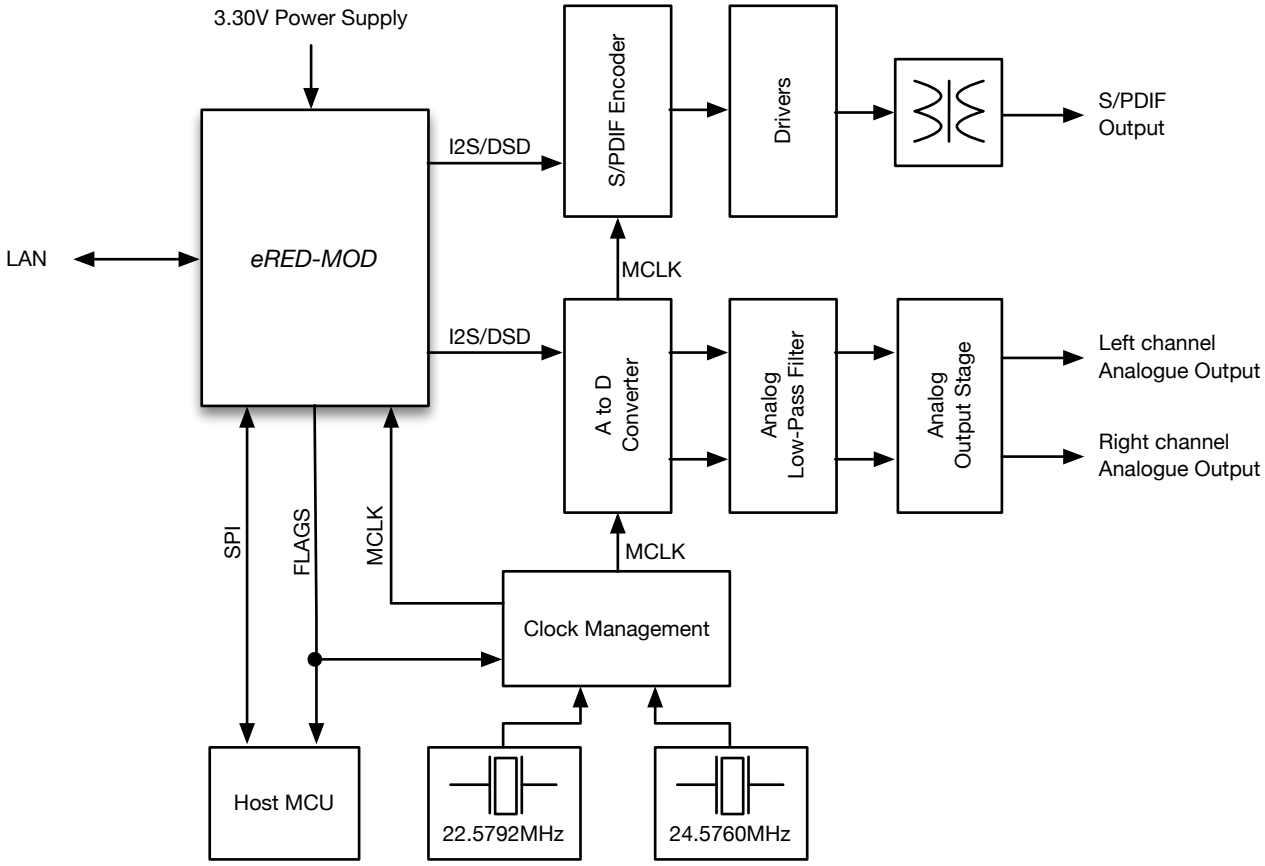

Figure 4-2 – Typical eRED-MOD integration

4.4 Power Supply recommendation

The eRED-MOD operates from a single 3.30V supply. It integrates a voltage supervisor that resets the system when the power supply drops below a defined threshold. Power supply regulation, voltage precision, current capability and connection impedance are important factors to ensure clean operation.

For optimal operation of the device, use good printed circuit board (PCB) layout practices, including:

- Connect low-ESR 0.1 µF and 10 µF X7R ceramic decoupling capacitors close to each supply pin, placed as close to the device as possible. The bypass capacitors are used to reduce the coupled noise by providing low-impedance power sources to the circuitry.
- Module ground pins have to be connected to a low-impedance system reference point, such as the system digital ground plane.

Caution: Failure to respect the power supply polarity and voltage level may result in damage to the product.

4.5 Clock Management

The eRED-MOD implements a sophisticated asynchronous network data transfer with a large buffer in order to avoid jitter and get the highest digital audio playback quality. Thus, the digital audio output bus is driven only by the local clocks.

The I2S output port of the module can be configured as Clock Master or Clock Slave device. This offers flexibility with regards to the host circuitry but has no direct impact on the asynchronous transfer and jitter-free concept. Master or Slave mode is chosen by setting CLK_CONFIG1 as indicated in Table 4-1.

CLK_CONFIG1	LRCLK / BITCLK mode	LRCLK / BITCLK type	MCLK type
Low	Master Mode (default) LRCLK and BITCLK are supplied to the host	output	Unused – leave unconnected
High	Slave Mode LRCLK and BITCLK are supplied by the host	input	input

Table 4-1 – Clock configuration

In Slave Mode BITCLK and LRCLK have to be supplied by an external device, being a D/A converter, an FPGA or any other circuit able to be Clock Master on the digital audio bus.

However, BITCLK and LRCLK frequency have to match the sampling rate of the track being played over the network, which involves the following concept:

- Generating two Master Clocks, for instance: 22.5792MHz and 24.5760 MHz.
- Selecting the appropriate Master Clock by reading the hardware flag 44K1_EN#.
- Dividing the master clock by the appropriate ratio to produce bit clock and left/right clock, according to the hardware flags CC_RATE0, CC_RATE1 and CC_RATE0

When using the eRED-MOD in Master Mode, only the Master Clock has to be supplied. BITCLK and LRCLK are automatically generated by the eRED-MOD according to the current sampling rate. Therefore, the host has only to supply the appropriate Master Clock frequency according to the hardware flag 44K1EN#.

4.6 I2S Digital Audio Bus

The digital audio port is configured in standard I2S. The data signals are made of two lines: SDATA0 and SDATA1. By default, only SDATA0 is used in PCM audio.

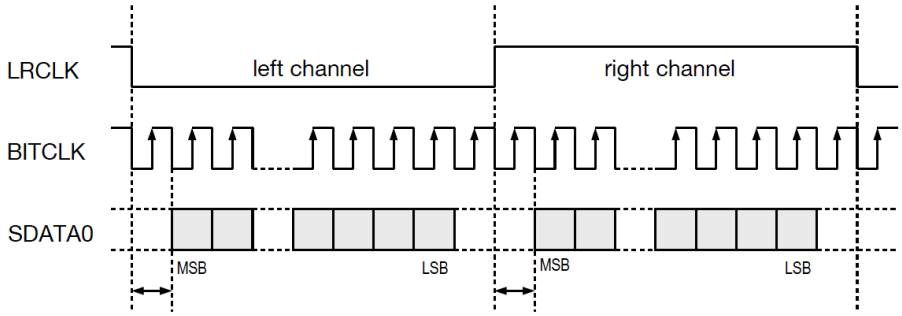

Figure 4-3– I2S data format

Clock management information is made of four signals: RATE0, RATE1, RATE2 and 44K1_EN#. Please note that RATE2 is unused yet and reserved for future upgrades. These flags reflect the sampling frequency of the audio source track currently playing and media server configuration.

LRCLK Frequency	RATE0	RATE1	44K1_EN#
44.1 kHz	High	High	Low
48 kHz	High	High	High
88.2 kHz	Low	High	Low
96 kHz	Low	High	High
176.4 kHz	High	Low	Low
192 kHz	High	Low	High
352.8 kHz	Low	Low	Low
384 kHz	Low	Low	High

Table 4-2 – Relation between sampling frequency and hardware flags

Table 4-3 shows how the audio sampling frequency (LRCLK), the bit clock (BITCLK) frequency and the master clock (MCLK) frequency are related.

LRCLK Frequency	BITCLK Ratio	MCLK Ratio	MCLK Frequency
44.1kHz	64 * Fs	512 * Fs	22.5792MHz
48kHz	64 * Fs	512 * Fs	24.5760MHz
88.2kHz	64 * Fs	256 * Fs	22.5792MHz
96kHz	64 * Fs	256 * Fs	24.5760MHz
176.4kHz	64 * Fs	128 * Fs	22.5792MHz
192kHz	64 * Fs	128 * Fs	24.5760MHz
352.8kHz	64 * Fs	64 * Fs	22.5792MHz
384kHz	64 * Fs	64 * Fs	24.5760MHz

Table 4-3 – relation between left/right clock, master clock and bit clock

4.7 DSD Mode

In DSD mode, PCM_LRCLK/DSDL is reconfigured to output Left-channel DSD data. Right-channel DSD data are transmitted over PCM_SDATA/DSDR.

Pin #	Name	PCM Signal	DSD Signal
3	I2S_BITCLK	BITCLK	BITCLK
58	I2S_LRCLK	LRCLK	DSD data left
4	I2S_SDATA0	PCM data L/R	DSD data right
57	I2S_SDATA1	n/a	n/a
14	CC_DSD/PCM	Low	High

Table 4-4 – pin mapping in PCM and DSD mode

Support for native DSD64, DSD128 as well as DSD256 is provided by the MR-MOD module. DSD data format is indicated by the flag CC_DSD/PCM on pin 14.

CC_DSD/PCM	Data Stream Type
Low	PCM
High	DSD

Table 4-5 – Data stream type

Table 4-6 shows how the DSD frequency is indicated by the hardware flags, and Table 4-7 illustrates the relation between DSD rate, Bit Clock and Master Clock frequencies.

DSD Type	RATE0	RATE1	44K1_EN#
DSD 64	High	High	Low
DSD 128	Low	High	Low
DSD 256	Low	Low	Low

Table 4-6 – Relation between DSD rate and hardware flags

DSD Type	Bit Clock Frequency	Master Clock Frequency
DSD 64	2.8224MHz	22.5792MHz
DSD 128	5.6448MHz	22.5792MHz
DSD 256	11.2896MHz	22.5792MHz

Table 4-7 – Relation between DSD rate, bit clock and master clock

4.8 MUTE# signal

The MUTE# signal indicates that the serial data are no longer valid and therefore should be discarded. In order to avoid switching noise, the DAC shall be muted according to the MUTE# signal and during sampling rate or data format change.

4.9 Ethernet Interfacing

The eRED-MOD integrates an on-board Ethernet interface. Only the RJ45 connector and ESD protection are needed on the backplane board, as shown on the circuit diagram here below.

Using an RJ45 connector jack with integrated magnetics is highly recommended. The magnetics protect against faults and transients, including rejection of common mode signals between the transceiver and the cable. These signals are commonly caused by electromagnetic interference (EMI), either from noise picked up by the cable or from slight impedance mismatches. The magnetics also provide galvanic isolation from Ethernet cables, and offset any DC biasing caused by connected nodes having been powered from different sources.

For optimal operation of the device, use good printed circuit board (PCB) layout practices, including short traces and impedance control according to Ethernet / LAN specifications.

Note: RJ45 connector shown here is based on part number J0011D01NL from Pulse Electronics Corporation for reference only. Pin numbering varies from one manufacturer/model to the other.

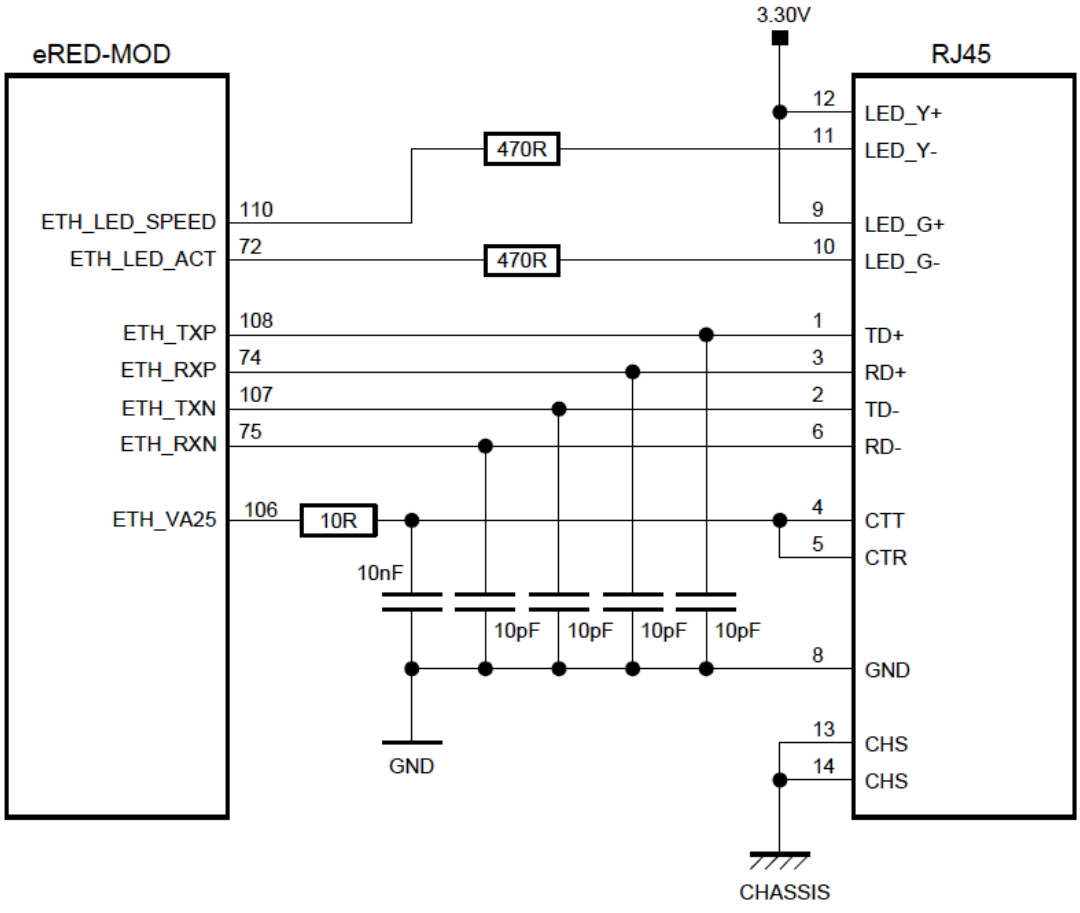

Figure 4-4 – Ethernet interfacing

4.10 Network Connexion

The eRED-MOD is compatible with the UPnP AV/DLNA specification and no specific user configuration is required to integrate it into an Ethernet network. There must be a DHCP server on the network where the eRED-MOD operates so that it can fetch its IP address.

Basic boot status is provided by two signals, as indicated in the table below. These signals can be directly connected to status LEDs for diagnostic.

LED_S1	LED_S0	Description
1	1	Power up. Booting.
1	0	System booted
0	1	System booted. Network configured.
0	0	An error occurred

Table 4-8 – status LED description

5 Serial Peripheral Interface

The eRED-MOD interface features a full-duplex serial port based on the Serial Peripheral Interface standard.

The SPI port communicates in slave mode. It is used to access registers allowing the Audio Render Module to transmit information to the host device, referred as master, and to be configured for the desired operational mode. An interrupt line is provided to indicate a data change and avoid the need for the host to poll the interface continuously. The operation of the SPI port may be completely asynchronous with respect to the audio stream rates.

The SPI port is a five-wire serial interface where SPI_CS# (active low) is the module chip select signal, SPI_SCK is the control port serial clock from the master device, SPI_MOSI is the input data line from master, SPI_MISO is the output data line to the master and SPI_INT is the interrupt line.

6 Mechanical Data

6.1 Module mechanical specifications

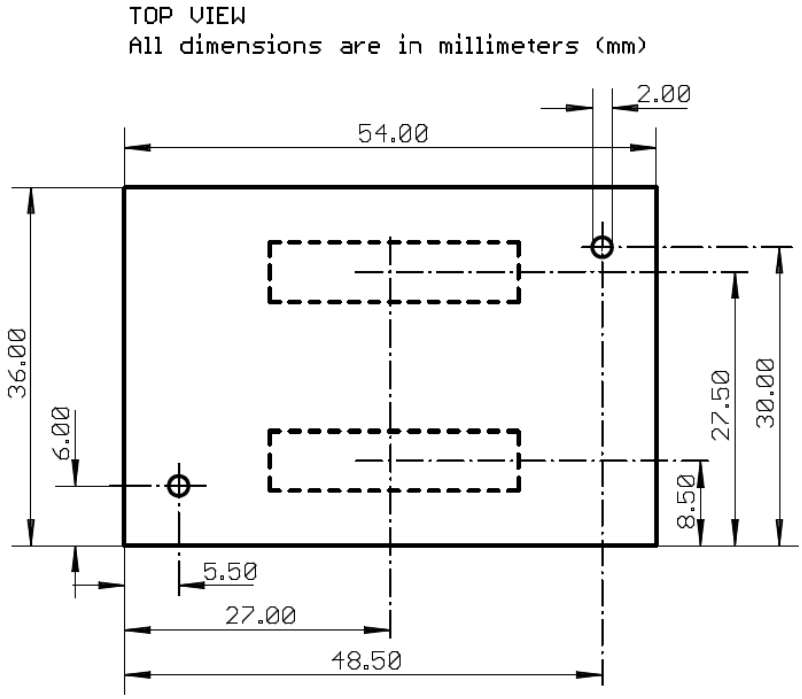

Figure 6-1 – Module dimensions

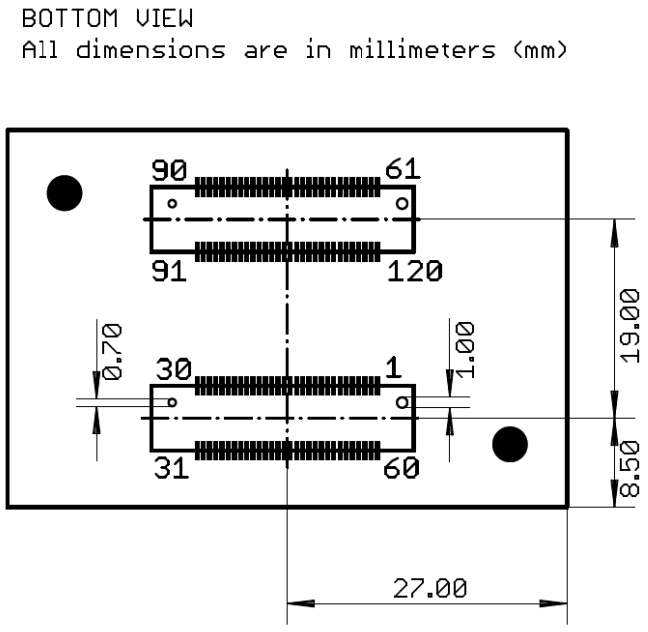

Figure 6-2 – Module bottom view

7 Ordering Information

7.1 Part Number

Part Number	Description
eRED-MOD	Network Audio Renderer

7.2 Kits and evaluation platforms

engineered offers various solutions to evaluate the eRED-MOD streaming technology in full-digital and analog audio environments.

The eRED-DOCK board is mainly a backplane for the eRED-MOD module with on-board clock management and facilitated connexions. It provides digital audio signals and control flags on standard connectors, high quality master clock, isolated S/PDIF and AES/EBU output for easy evaluation.

Please check www.engineered.ch for latest information about evaluation boards availability.