WM9707 AMR WITH SPDIF OUTPUT

Audio Modem Riser (AMR) Card Reference Design

Product Preview, August 2000, Rev 1.0

DESCRIPTION

The WM9707 AMR is an audio only daughter card implementation of the Intel Audio Modem Riser (AMR) Rev 1.01 specification[i]. This card can also be used in systems supporting the ACR 1.0 specification[vi].

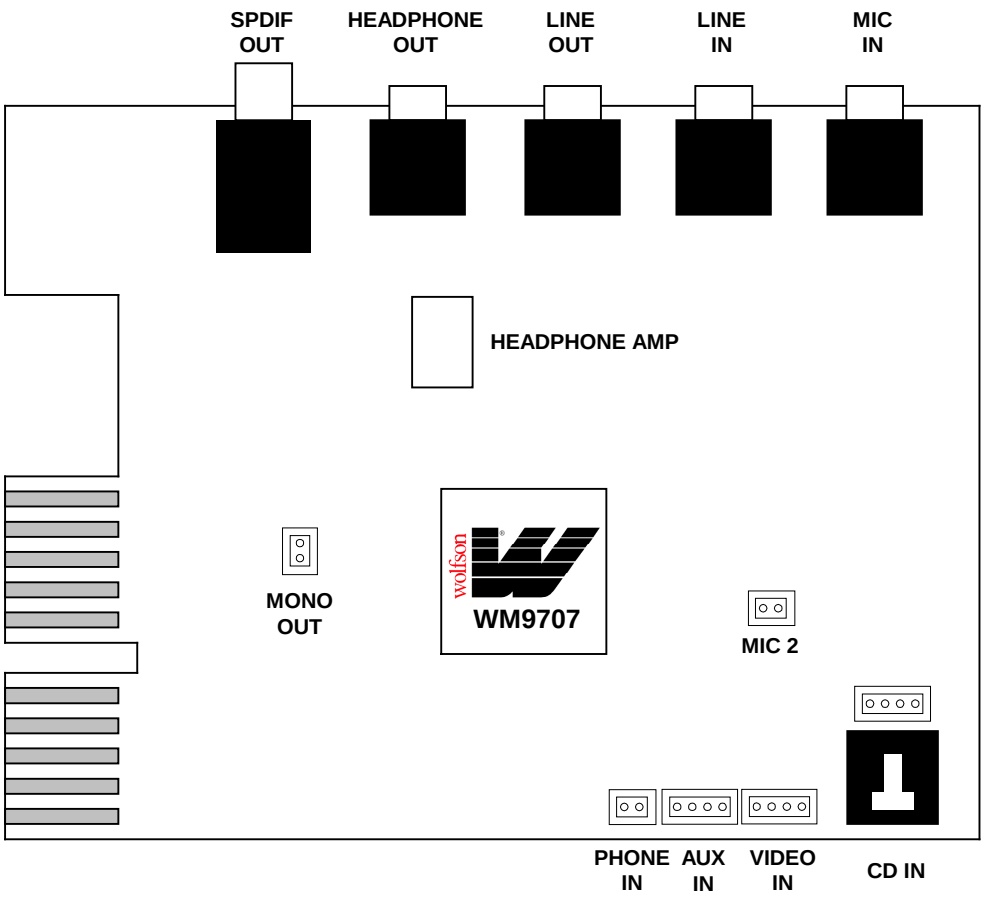
The design supports the connectivity requirements of a typical sound card. Inputs include Phone, AUX, Video, CD (Mitsumi and Sony types) and Mic1/2. Outputs include Line Out, Mono, Headphones and digital SPDIF .

The Audio Codec used in the design is the WM9707 Rev 2.1 Stereo Audio Codec[ii]. The WM9707 is fully compliant with the Intel 2.1[iii] AC'97 Codec specification and supports primary/secondary ID selection as well as variable audio and modem sample rates with the additional function of a digital SPDIF output.

FEATURES

- Reference design for WM9707 Revision 2.1 Audio Codec with SPDIF output
- AMR audio only add-in card conforming to Intel AMR card specifications
- May be used in systems supporting the ACR (Advanced Communications Riser) 1.0 specification
- Analogue connections for Line In, Line Out, MIC-In and Headphone
- Design kit available including schematics (PADS®) layout and Gerber files and bill of materials
- Meets Microsoft's® PC'97, PC'98 and PC'99[iv] requirements and advanced audio performance requirements

BLOCK DIAGRAM



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INTRODUCTION

The WM9707 AMR is an audio only daughter card implementation of the Intel Audio Modem Riser (AMR) Rev 1.01 specification. This card will support both primary codec down and primary codec up configurations. A block diagram of the card is shown in Figure 1.

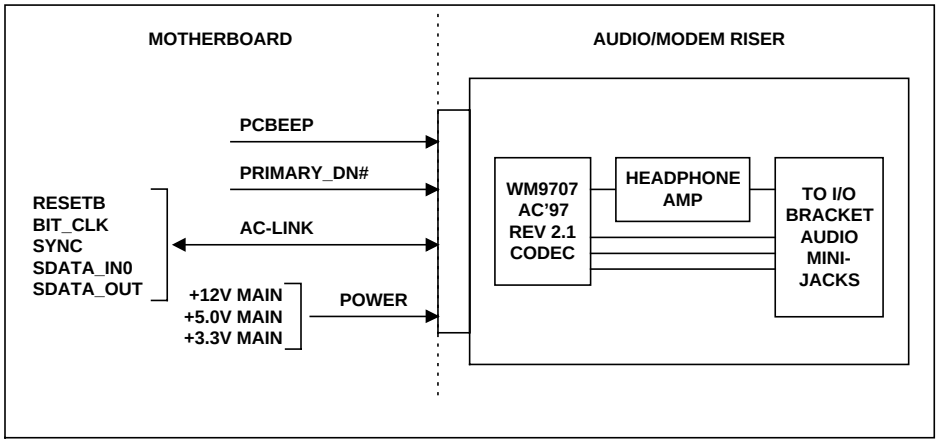


Figure 1 Block Diagram of WM9707 AMR

The card is designed to fully utilise the performance of the WM9707 Stereo Audio Codec and achieves signal-to-noise ratios of better than 95dB on replay and 92dB for the record path. The board performance is comparable to a typical PCI soundcard.

WM9707 AC'97 AUDIO CODEC

The WM9707 is fully compliant with Rev 2.1 of the AC'97 specification. The WM9707 comprises a stereo 18-bit Codec, plus a comprehensive analogue mixer with 4 sets of stereo inputs, plus phone, 2 microphone, and PC-beep inputs. Additionally, a bi-directional serial interface allows transfer of control data and DAC and ADC words to and from the AC'97 controller.

WM9707 supports operation as either a master or a slave codec. Configuration of the device as either a master or as a slave, is selected by tying the CID pin (pin 45 on the package). Fundamentally, a device identified as a master (CID = 0) produces BITCLK as an output, whereas a slave (CID = 1) must be provided with BITCLK as an input.

The WM9707 incorporates a 5-pin digital serial interface that links it to the motherboard based AC'97 controller via the AMR bus. AC-link is a bi-directional, fixed rate, serial PCM digital stream. It handles multiple input and output audio streams, as well as control register access employing a time division multiplexed (TDM) scheme.

The DACs and ADCs on this device support all the recommended sample rates specified in the Intel Rev 2.1 specification for both audio and modem rates. Default rate is 48ks/s. If alternative rates are selected, the AC'97 interface continues to run at 48k words per second, but data is transferred across the link in bursts such that the net sample rate selected is achieved. It is up to the AC'97 Rev 2.1 compliant controller to ensure that data is supplied to the AC link, and received from the AC link, at the appropriate rate.

An additional feature that the WM9707 supports that is not a requirement of the Rev2.1 specification from Intel is a digital SPDIF output (pin 48 on the package). The fixed rate, 48kHz sample rate SPDIF output, may be enabled through writing to the SPDIF enable bit in register 5Ch or pulling pin 44 high.

AUDIO MODEM RISER SPECIFICATION

The Audio Modem Riser Specification, originally defined by Intel Corporation, is an open industry standard specification that defines a motherboard riser board and interface.

The specification supports various configurations for audio and modem partitioning within the PC. The riser module can include audio only, modem only, or audio and modem functions depending on the need of the manufacturing OEM. The backbone of the AMR interface is an AC'97 compliant link, power signals and digital IO for defining for example, the status of the codec on the riser module.

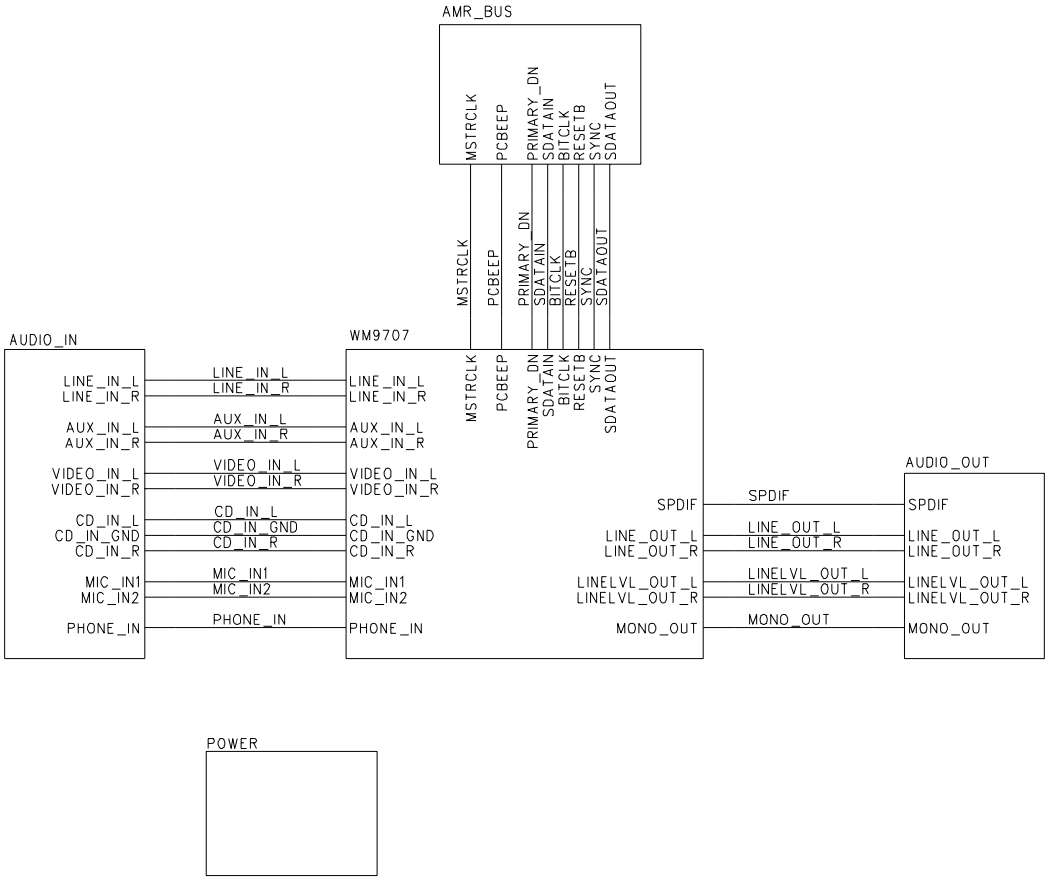
The AMR specification has been superseded by the Advanced Communications Riser (ACR). This card is fully compliant with this specification and can be used without modification in systems designed to the ACR 1.0 specification.

DESIGN IMPLEMENTATION

The WM9707 AMR reference design is implemented using a hierarchical design methodology. This allows the design to be split into logical parts that are easy to explain and follow.

FUNCTIONAL DIAGRAM

The Functional Diagram on Sheet 1 of the schematic depicts the interconnectivity of the other five sheets. The flow of data can easily be seen from this.



Sheet 1 Functional Diagram

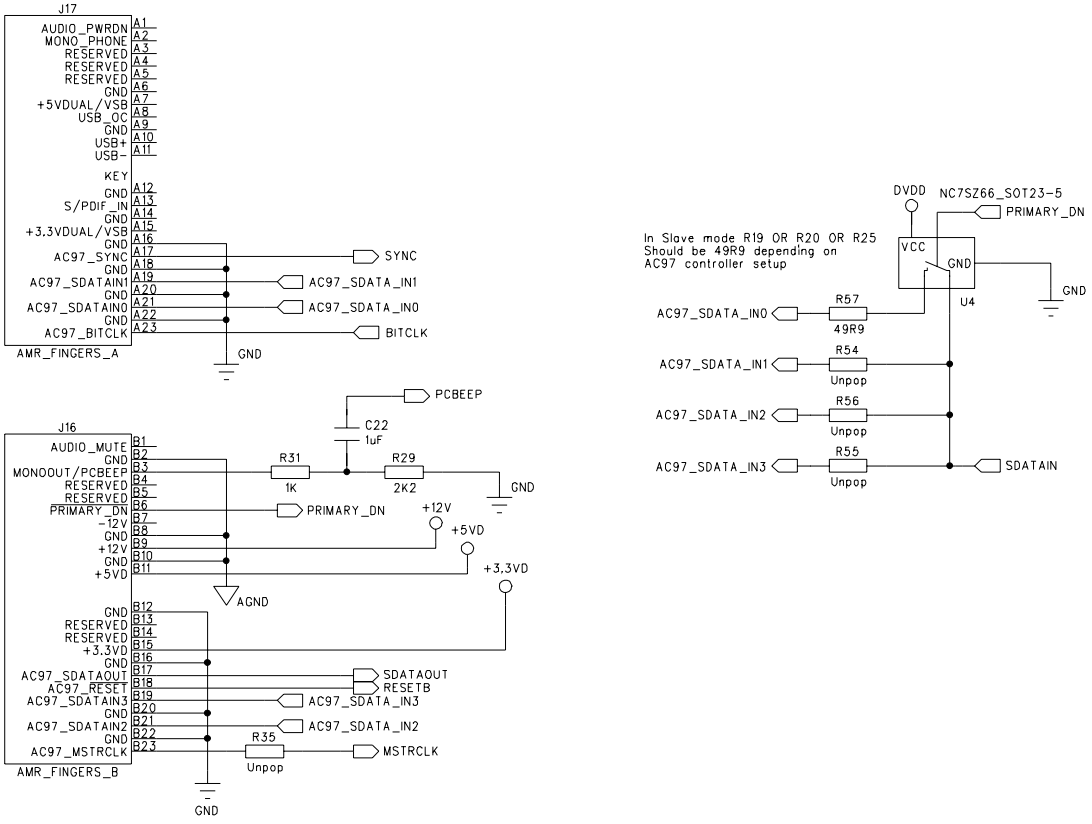
AMR_BUS

Signal flow in and out of the AMR bus is shown on Sheet 2.

The ground references defined in the AMR specification have been partitioned on the reference design to provide a separate “clean” analogue ground (AGND) from that used for the digital signals (GND).

The PRIMARY_DN# functionality defined in the AMR specification is used to gate switch U4 when the board is plugged into systems which have a primary codec on the motherboard. This puts the AC97_SDATA_IN0 output into a high impedance state and prevents contention on the AC’97 link. The codec on the AMR reference design can then act as a slave, outputting data on AC97_SDATA_IN1, AC97_SDATA_IN2 or AC97_SDATA_IN3, by populating either R54, R56 or R55 with a 49R9 resistor*. If there is a PRIMARY_DN# codec on the motherboard, the PRIMARY_DN# will be active (low) and will therefore put the AMR codec into slave mode. To configure the AMR codec as a master codec in this situation, pins 1 and 2 on switch U4 must be shorted together. In addition, R39 must be depopulated to avoid forcing the AMR codec into slave mode.

*Note: In order to operate the WM9703 as a slave device, R35 needs to be populated with 0R and X1, C33 and C34 need to be unpopulated. A MSTRCLK then needs to be supplied from the master device through the AMR connector. In slave mode, it must also be noted that BITCLK becomes an input to the WM9703.



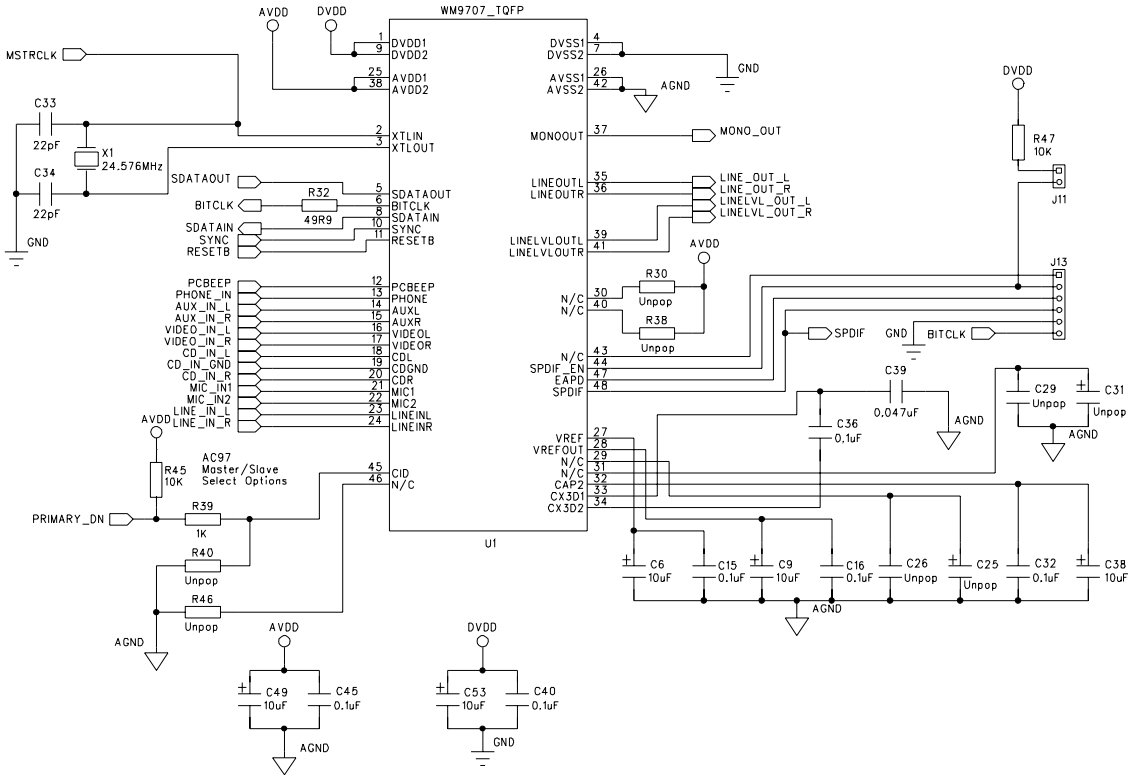
Sheet 2 AMR BUS

WM9707

Connection to the WM9707 codec is shown on Sheet 3.

The CID pin (pin 45) is configured via resistor R39 and R40. With the connections as shown (i.e. R40 = unpopulated and R39 = 1K), the WM9707 will be configured as a master device unless the board is plugged into a system with a primary codec on the motherboard. In which case the PRIMARY_DN# will be active and force CID low putting the device into slave mode. A further option for configuring the CID pin is available by populating the R40 site with a 0ohm resistor. Refer to the WM9707 datasheet for further details.

A 6-pin header (J13) is provided for external connection of the WM9707 EAPD pin, SPDIF enable, SPDIF output and BITCLK signal. These can be used as described in the WM9707 datasheet. The SPDIF output can be hardware enabled by inserting a jumper link in header J11.



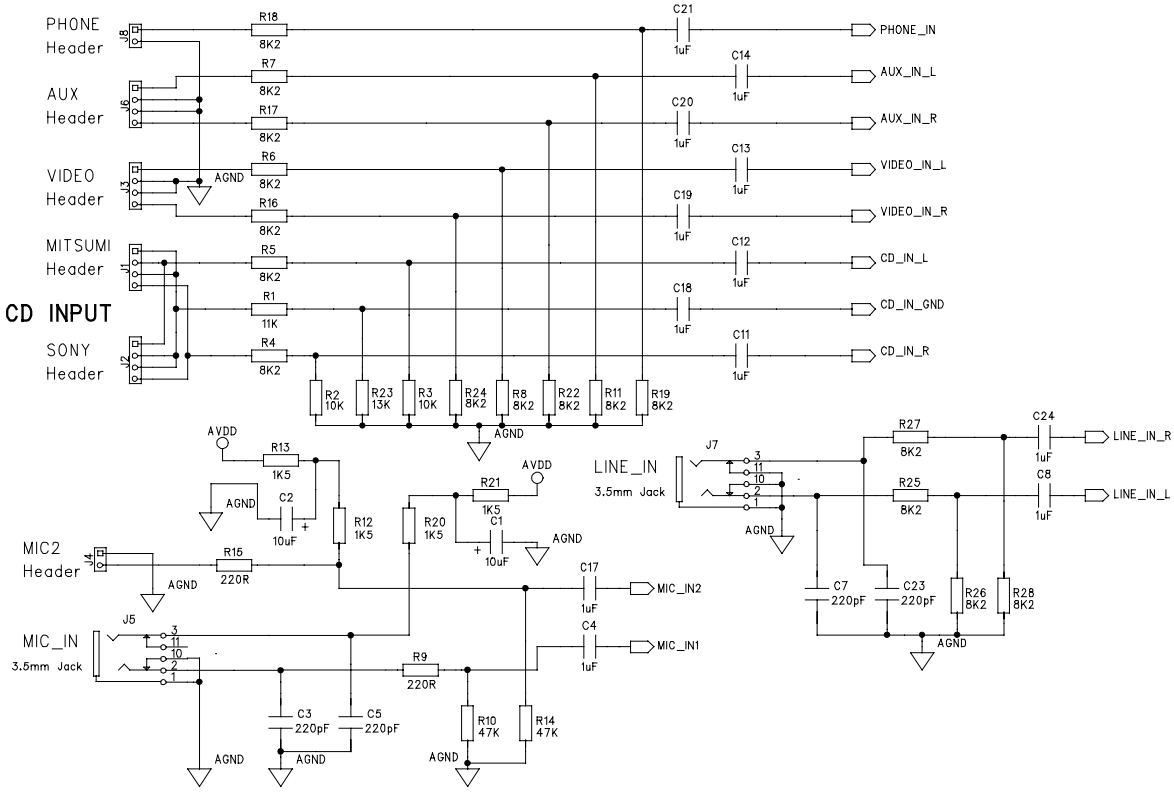
Sheet 3 WM9707 Codec

AUDIO_IN

All the external audio input signals to the board are shown on Sheet 4.

To prevent damage to the WM9707 and to allow for the full 2Vrms input signal defined in the PC'99 specification, all the audio input signals of the reference design (apart from MIC) have been potted down by a simple resistor divider. This provides approximately 7dB of attenuation to the input signal.

The microphone input circuits to the reference design provide support for 3-pin electret (bias on ring), 2-pin electret (tip and ring shorted together) and 2-pin dynamic microphones. The bias circuits for the microphone inputs provide the required drive characteristics stipulated in the PC'99 System Design Guide, Chapter 17, "Audio Components". The WM9707 can be programmed to give a +20dB gain on the microphone input path if required – refer to the datasheet.



Sheet 4 Audio In

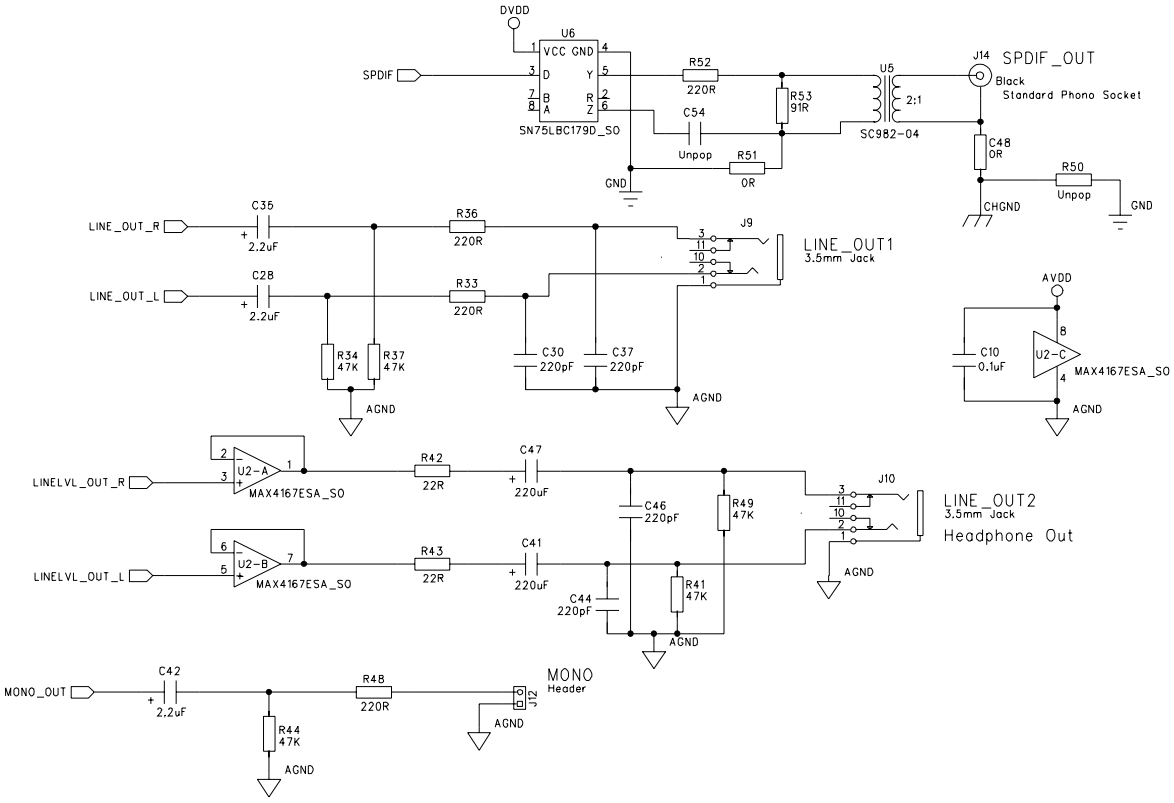
AUDIO_OUT

The audio outputs from the reference design are shown on Sheet 5.

The Mono and Line Out signals are passed to the output connectors via passive high-pass filters. This enables the signals to meet the bandwidth suggested in the PC'97 Hardware Design Guide FAQ[v] and AC couple the outputs. These outputs are capable of driving a 10Kohm load.

The Line Level outputs are buffered through a MAX4167 op-amp which is capable of driving impedances as low as 32ohms i.e. headphones.

The SPDIF output is buffered through an SN75LBC179 line driver and then transformer coupled to a phono socket. This arrangement provides the correct impedance matching and drive capability detailed in the IEC60958 specification. It also gives the board electrical isolation from cable born interference via the SC982-04 audio transformer.



Sheet 5 Audio Out

POWER

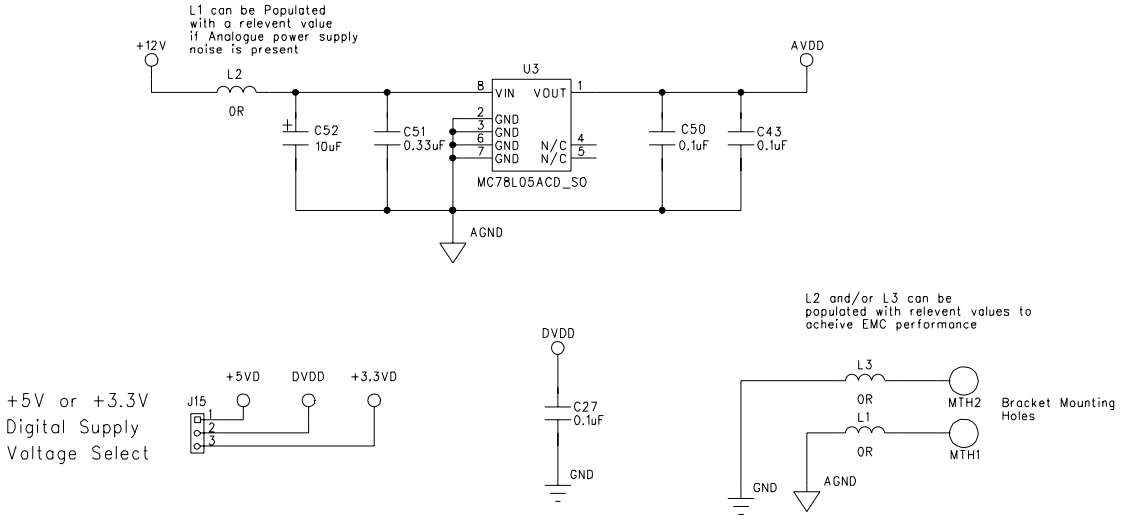
The power supply circuitry for the reference design is shown on Sheet 6.

The analogue +5V supply to the codec is provided from the regulated down +12V AMR Bus supply. An MC78L05ACD regulator with suitable bypassing is used for this purpose. If the +12V system supply proves to be excessively noisy, LINK L2 can be replaced with a suitable inductor.

The digital supply is taken directly from the AMR Bus +5VD and +3.3VD power signals. This is jumper selectable on the board.

Note: For SPDIF output operation on this AMR, the DVDD supply for the board must be +5VD. The WM9707 does support SPDIF output with DVDD at +3.3V but due to the SN75LBC179D line-driver having a fixed operating voltage of +5V the SPDIF output will not work below this level.

In order to allow for possible EMC compliance testing issues with the board, the connections to the PC bracket have been left as unpopulated sites (L1 and L3). These can easily be linked out or populated with suitable components at test time.



Sheet 6 Power

GROUNDING AND LAYOUT CONSIDERATIONS

The pin-out of the WM9707 allows the simple partitioning of the analogue and digital ground planes on the board. Returning ground currents can then flow in their respective ground planes, and the crosstalk between them is minimised. A connection between the two ground planes is made with a 1.27mm track close to the codec to maintain the proper reference potential for each ground plane.

In order to allow for possible EMC compliance testing issues with the board, the connections to the PC bracket have been left as unpopulated sites (L1 and L3). These can easily be linked out or populated with suitable components at test time.

All the front panel 3.5mm jack connections have 220pF capacitors connected to ground to guard against high frequency noise which might cause the board to fail EMC tests.

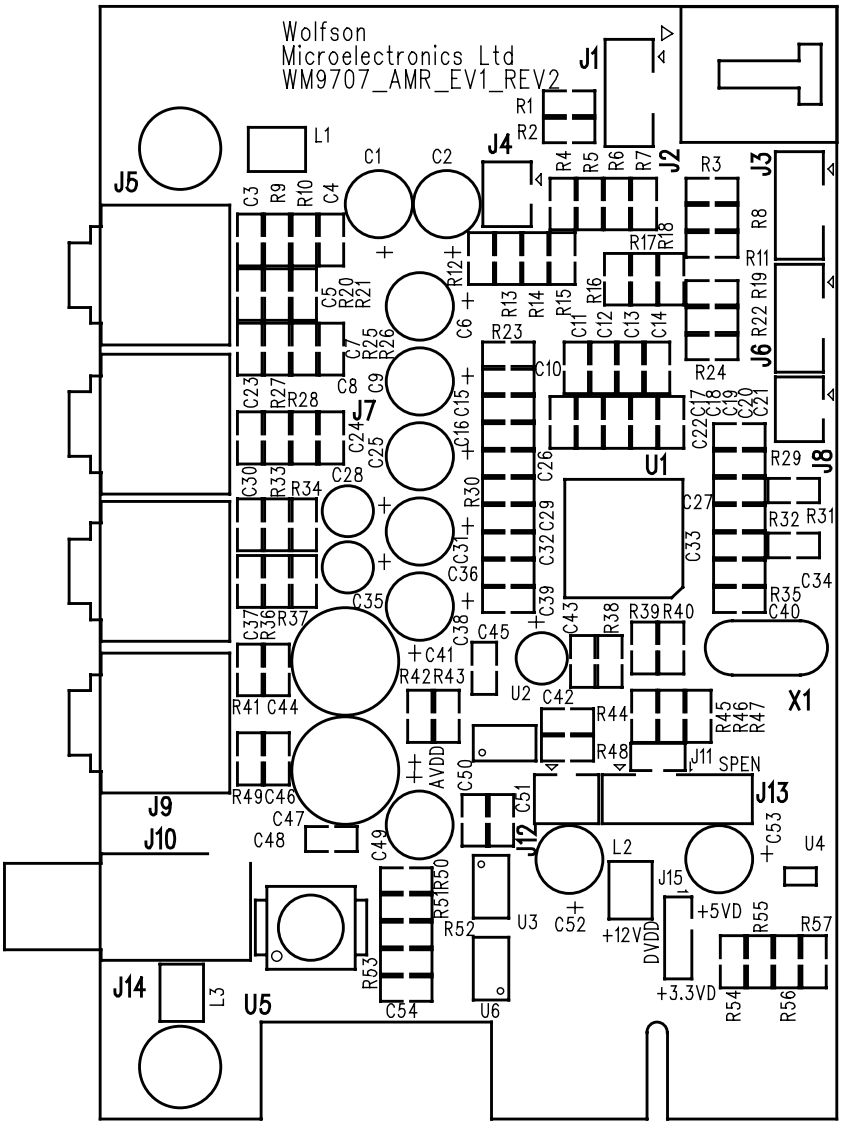


Figure 2 Top Layer Silkscreen

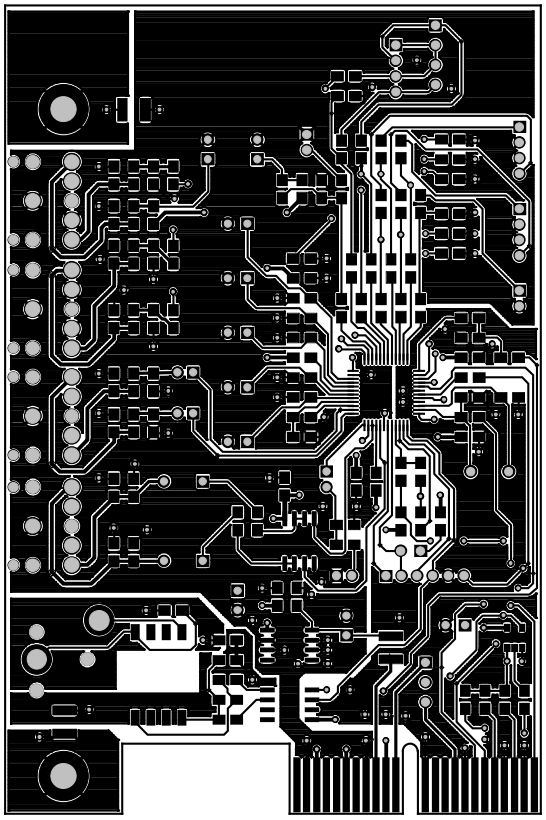


Figure 3 Top Layer

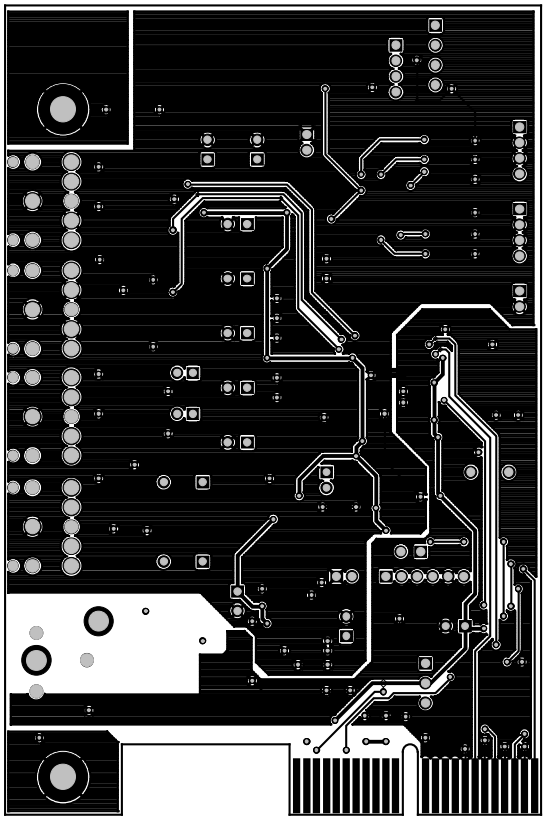


Figure 4 Bottom Layer

REFERENCES

i Intel Audio Modem Riser Specification, Rev 1.01. September 10, 1998 http://developer.intel.com/pc.supp/platform.ac97/index.htm

vi Advanced Communications Riser (ACR) specification http://www.acrsig.com

ii Wolfson Microelectronics, WM9707 AC'97 Rev 2.1 Audio Codec with SPDIF Output Datasheet, http://www.wolfson.co.uk/9707fr.htm

iii Intel Audio Codec AC'97 Component Specification, Rev 2.1 http://developer.intel.com/pc.supp/platform/ac97

iv Intel and Microsoft, PC'99 System Design Guide http//www.microsoft.com/hwder/desguide/

v The PC'97 Hardware Design Guide FAQ http://www.microsoft.com/hwtest/faqs/aud.htm