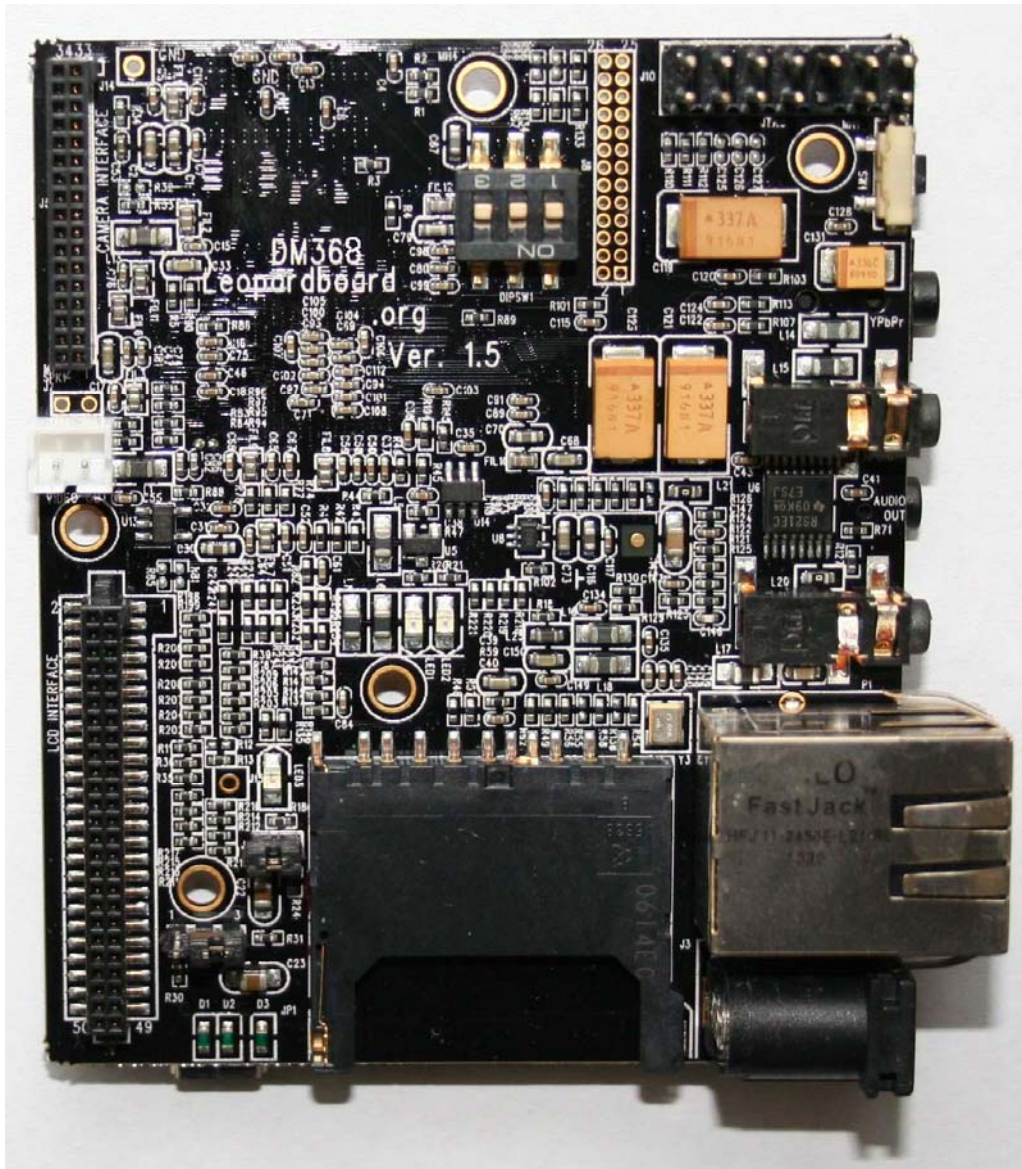




LeopardBoard 368 Hardware Guide

Rev. 1.0

Jan 3, 2011

LeopardBoard.org provides the enclosed product(s) under the following conditions:

This evaluation kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by LeopardBoard.org to be a finished end-product. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards.

The kit can't be returned, it can be exchanged if it is defect.

The user assumes all responsibility and liability for proper and safe handling of the goods; it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

LeopardBoard.org assumes **no liability for the changes to this document without notice, customer product design, software performance, no guarantees as to the correctness or accuracy of the information provided in this document.** For additional information on LeopardBoard.org environmental and/or safety programs, please visit LeopardBoard.org.

No license is granted under any patent right or other intellectual property right of LeopardBoard.org covering or relating to any machine, process, or combination in which such LeopardBoard.org products or services might be or are used.

WARRANTY: The LeopardBoard 368 is warranted against defects in materials and workmanship for a period of **30 days** from purchase. This warranty does not cover any problems occurring as a result of improper use, modifications, exposure to water, excessive voltages, abuse, or accidents. All boards will be returned via standard mail if an issue is found. If no issue is found or express return is needed, the customer will pay all shipping costs.

Mailing Address:

LeopardBoard.org
47061 Warm Springs Blvd
Fremont, CA 94539
USA

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What's included?

1. This section is a description of what comes in the box when the LeopardBoard 368 is purchased and Optional Parts provided for purchasing. See Figure 1



Figure 1. LeopardBoard 368 in Box

NOTE: Standard package only includes LeopardBoard 368; all other optional parts are sold separately.

1.1 LeopardBoard 368, see Figure 2.

- o Part number: LI-TB02
- o Full featured, low cost high performance platform.
- o Capable of streaming 1080P H.264 video at 30fps.

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=30&categoryId=13>

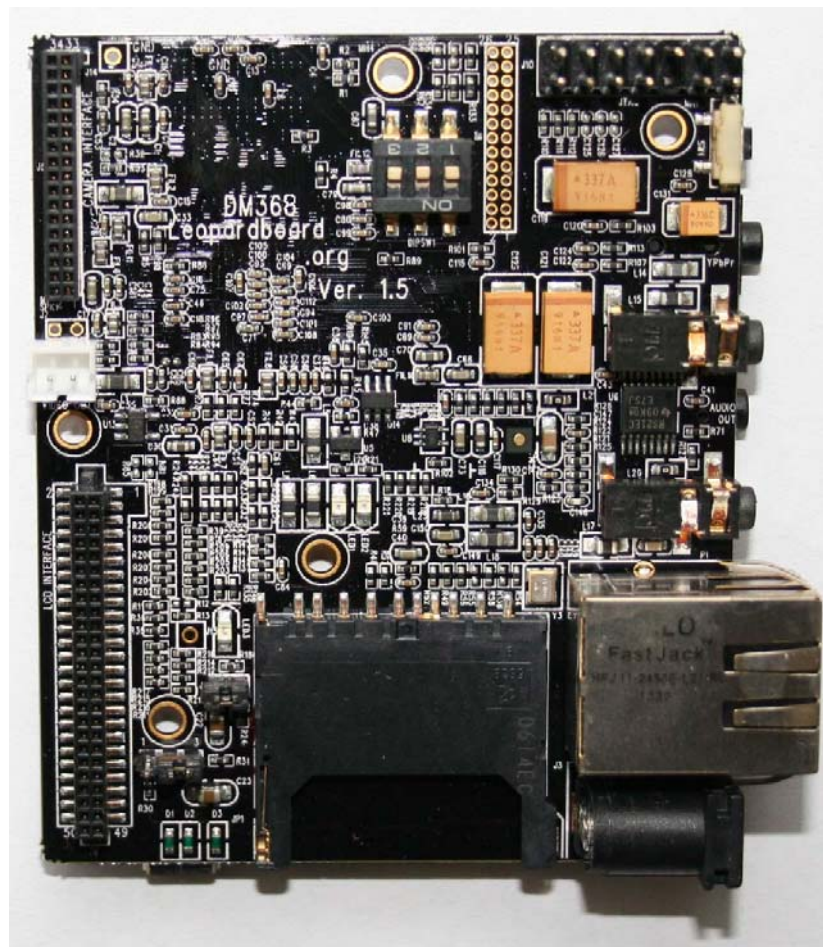


Figure 2. LeopardBoard 368

1.2 **Optional Parts**, not included in the package, these parts have to be purchased separately

1.2.1 Serial Cable, see Figure 3.

- o Part number: LI-SER-01
- o One end is Female DB9 connector
- o Another end is 2.5mm Stereo Plug connector
- o Cable Length: 70"

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=14&categoryId=13>



Figure 3. Serial Cable

1.2.2 +5V DC Power Adapter, see Figure 4.

- o Part number: LI-PS5-01
- o Wall Mount AC/DC Switching Power Supply (2-prong)
- o Universal AC Input
- o Power Input Frequency: 50/60Hz
- o DC Output: [5VDC@2.5A](#)
- o Polarization: Positive Center
- o Cord Plug: 2.1mm I.D. x 5.5mm O.D. x 12mm Female
- o Cable length: 43"

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=13&categoryId=13>



Figure 4. +5VDC Power Adapter

1.2.3 Mini-B USB Cable, see Figure 5.

- o Part number: LI-USB-01
- o One end: Mini-B
- o One end: Type-A

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=15&categoryId=13>



Figure 5. Mini-B USB Cable

1.2.4 26-pin Flex Cable , see Figure 6

- o Part number: LI-VIC-01
- o For DVI board to control Pico-Projector, Vision Kit.
- o Length: 4”

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=31&categoryId=13>



Figure 6. 26-pin Flex Cable

1.2.5 Camera Boards

1.2.5.1 VGA Camera Board, see Figure 7.

- o Part number: LI-LBCMVGA
- o Sensor: Micron/Aptina 1/11" CMOS Sensor MT9V113
- o # of Pixels: VGA (648 x 488 pixels)
- o Output Data Format: YUV (YCbCr)
- o Optical Filter: Infrared Coating at 650nm+/-10nm
- o Focal Length, F#: $f=1.34+/-0.1\text{mm}$, $F2.8+/-5\%$
- o Vertical View Angle: 66°
- o Focus Distance: 40cm+/-2cm
- o Focus Range: 20cm to Infinity
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=8&categoryId=13>

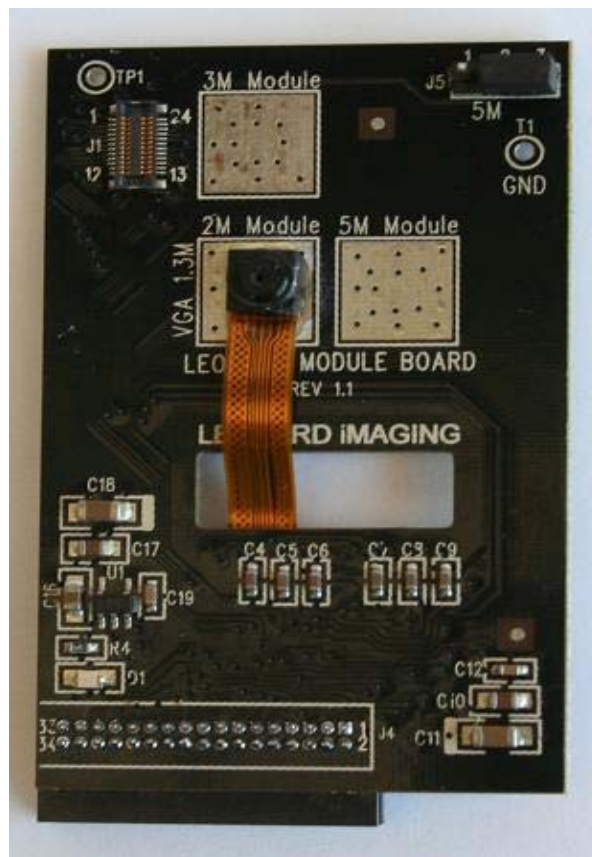


Figure 7. VGA Camera Board

1.2.5.2 1.3 Mega-pixel Camera Board, see Figure 8

- o Part number: **LI-LBCM1M1**
- o Sensor: Aptina 1/4" CMOS Sensor MT9M112
- o # of Pixels: 1.3Mega (1280 x 1024 pixels)
- o Output Data Format: YUV (YCbCr)
- o Optical Filter: Infrared Coating at 650nm+/-10nm
- o Focal Length, F#: $f=4\pm 0.1\text{mm}$, $F2.0\pm 5\%$
- o Vertical View Angle: 59.30
- o Focus Distance: 120cm+/-2cm
- o Focus Range: 60cm to Infinity
- o RoHS compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=9&categoryId=13>

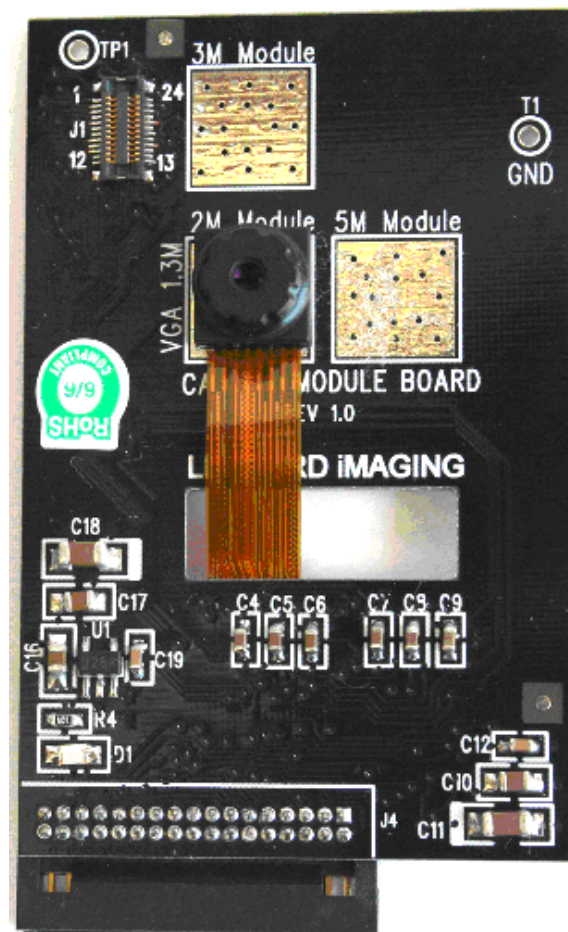


Figure 8. 1.3M Camera Board

1.2.5.3 2 Mega-pixel Camera Board, see Figure 9

- o Part number: **LI-LBCM2M1**
- o Sensor: Aptina 1/4" CMOS Sensor MT9D112
- o # of Pixels: 2Mega (1600 x 1200 pixels)
- o Output Data Format: YUV (YCbCr)
- o Optical Filter: Infrared Coating at 650nm+/-10nm
- o Focal Length, F#: $f=3.79+/-0.1\text{mm}$, F2.0+/-5%
- o Vertical View Angle: 61°
- o Focus Distance: 120cm+/-2cm
- o Focus Range: 60cm to Infinity
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=10&categoryId=13>

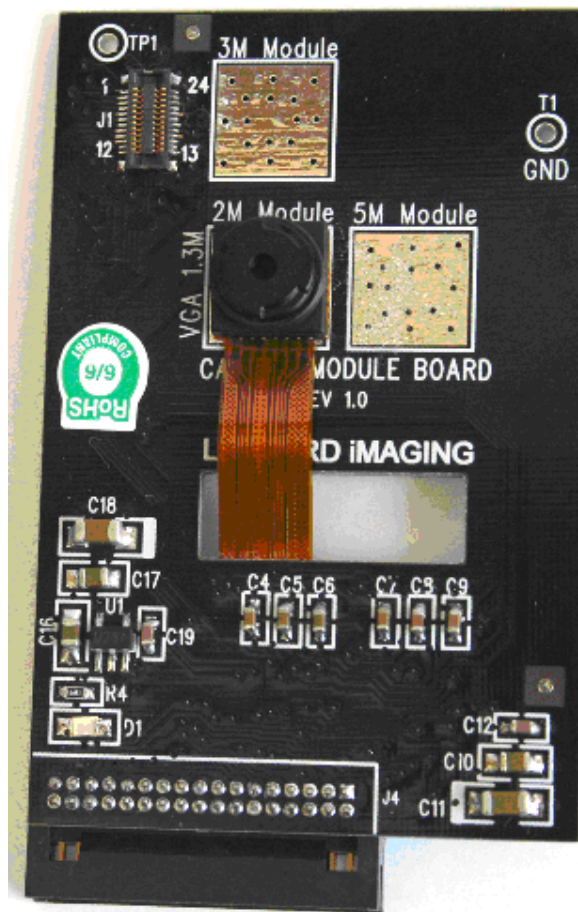


Figure 9. 2M Camera Board

1.2.5.4 3 Mega-pixel Camera Board, see Figure 10

- o Part number: **LI-LBCM3M1**
- o Sensor: Aptina 1/4" CMOS Sensor MT9T111
- o # of Pixels: 3Mega (2048 x 1536 pixels)
- o Output Data Format: YUV (YCbCr)
- o Optical Filter: Infrared Coating at 650nm+/-10nm
- o Focal Length, F#: $f=3.78+/-0.1\text{mm}$, F2.8+/-5%
- o Vertical View Angle: 61.40
- o Focus Distance: 120cm+/-2cm
- o Focus Range: 60cm to Infinity
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=11&categoryId=13>



Figure 10. 3M Camera Board

1.2.5.5 5 Mega-pixel Camera Board, see Figure 11

- o Part number: **LI-LBCM5M1**
- o Sensor: Aptina 1/2.5" CMOS Sensor MT9P011
- o # of Pixels: 5Mega (2592 x 1944 pixels)
- o Output Data Format: RGB
- o Optical Filter: Infrared Coating at 650nm+/-10nm
- o Focal Length, F#: $f=6.12\pm 0.1\text{mm}$, F2.8+/-5%
- o Vertical View Angle: 60.30
- o Focus Distance: 120cm+/-2cm
- o Focus Range: 60cm to Infinity
- o RoHS Compliance

Where to Buy: <http://shop.leopardimaging.com/product.sc?productId=12&categoryId=13>



Figure 11. 5M Camera Board

1.2.5.6 5 Mega-pixel Camera Board, see Figure 12

- o Part number: **LI-5M03**
- o Sensor: Aptina 1/2.5" CMOS Sensor MT9P031
- o # of Pixels: 5Mega (2592 x 1944 pixels)
- o Pixel Size: 2.2 μ m x 2.2 μ m
- o Support 720p @ 60 fps
- o Pixel Dynamic Range: 70.1dB at full resolution
- o Output Data Format: RGB
- o Also Comes with CS mount (no lens)
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=17&categoryId=13>

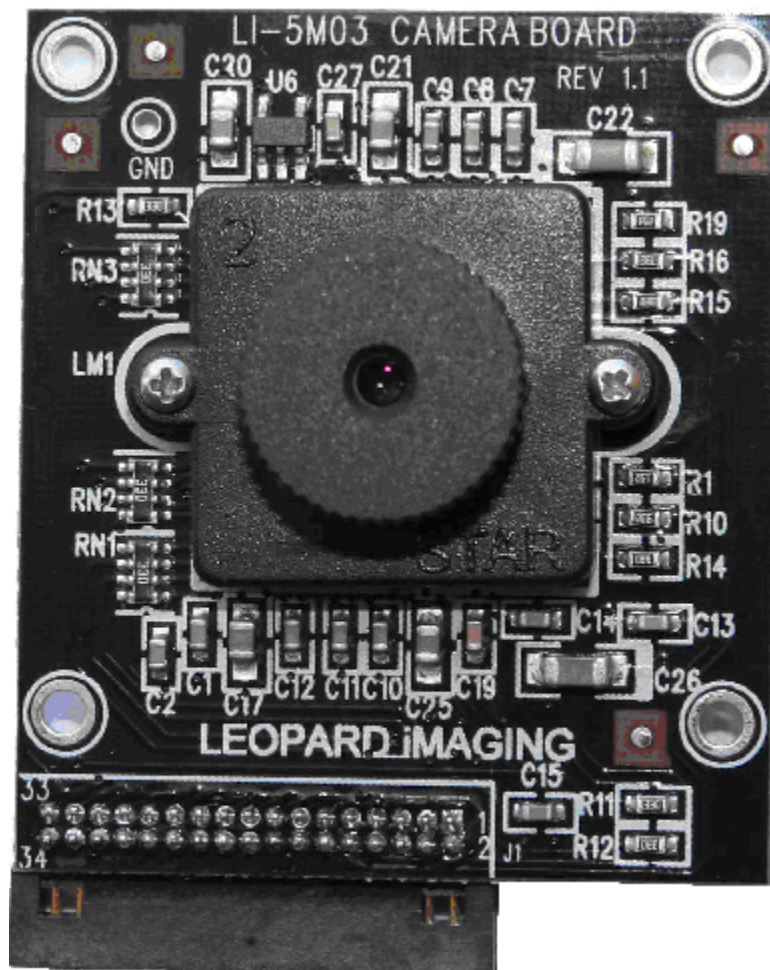


Figure 12. LI-5M03

1.2.5.7 WVGA Global Shutter Camera Board, see Figure 13

- o Part number: **LI-VM34LP**
- o Sensor: Aptina 1/3" CMOS Digital Sensor MT9V034
- o # of Pixels: VGA (752 x 480 pixels)
- o Pixel Size: 6µm x 6µm
- o Max Data rate: 27 Mega pixel Per Second
- o Frame rate: 60 fps at full resolution
- o Responsivity: 4.8 V/lux-sec (550nm)
- o Support either M12 lens or CS-Mount lens
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=29&categoryId=13>

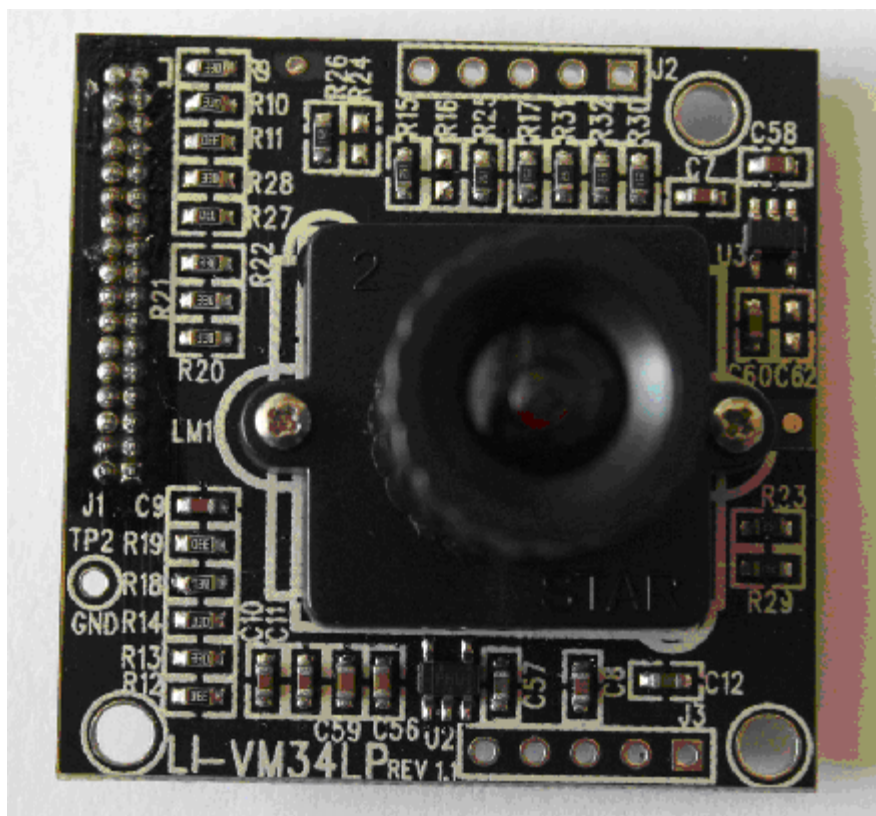


Figure 13. WVGA Camera Board

1.2.5.8 Omni Vision 720p Camera Board, see Figure 14

- o Part number: **LI-OV720**
- o Sensor: Omnivision 1/4" CMOS Sensor OV9712
- o WXGA (1280 x 800), 30fps
- o Pixel size: 3um x 3um
- o Output Data Format: 10-bit raw RGB data
- o Focal Length, F#: $f=3.45\pm 0.1\text{mm}$, $F2.8\pm 5\%$
- o View Angle: 65.9
- o Focus Range: 40cm to Infinity
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=49&categoryId=13>

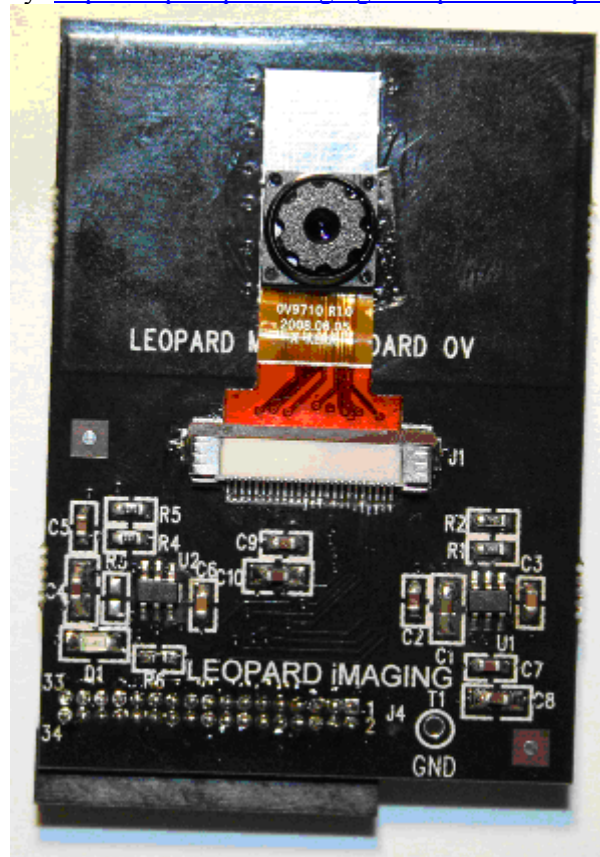


Figure 14. Omni Vision 720p
Camera Board

1.2.5.9 Omni Vision 1080p Camera Board, see Figure 15

- o Part number: **LI-OV1080**
- o Sensor: Omnivision 1/3" CMOS Sensor OV2710
- o # of Pixel: 1920 x 1080
- o Image size: 1080p @ 30fps
- o Pixel size: 3um x 3um
- o Output Data Format: 8-/10-bit raw RGB data
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=52&categoryId=13>



Figure 15. Omni Vision 1080p
Camera Board

1.2.6

DVI board, see Figure 16

- o Part number: **LI-DV11**
- o Support standard DVI output
- o Pico DLP compatible
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=27&categoryId=13>

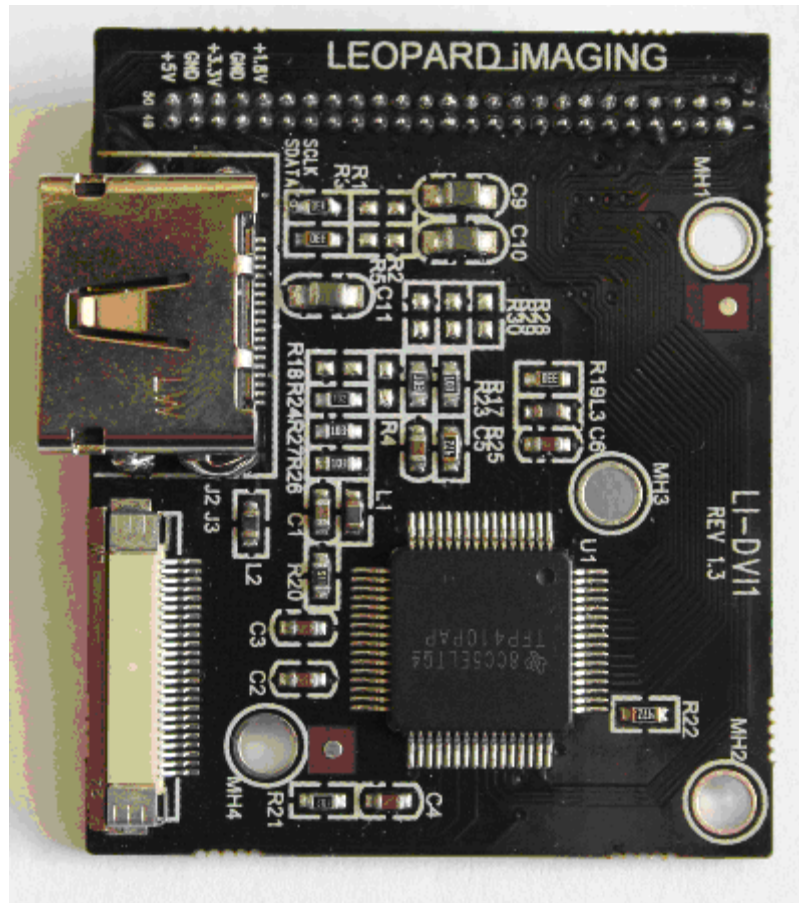


Figure 16. DVI Board

1.2.7 Video Input board, see Figure 17

- o Part number: **LI-VI365**
- o Support standard S-video/Composite video input
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=47&categoryId=13>

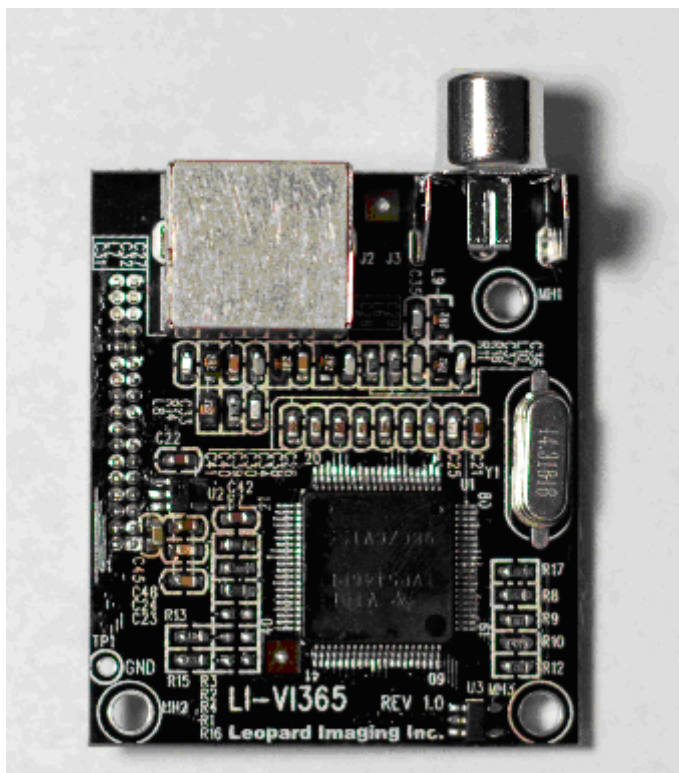


Figure 17. Video Input Board

1.2.8 HD Component Video Input Board, see Figure 18

- o Part number: **LI-HDI365**
- o Support Component Video input
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=48&categoryId=13>

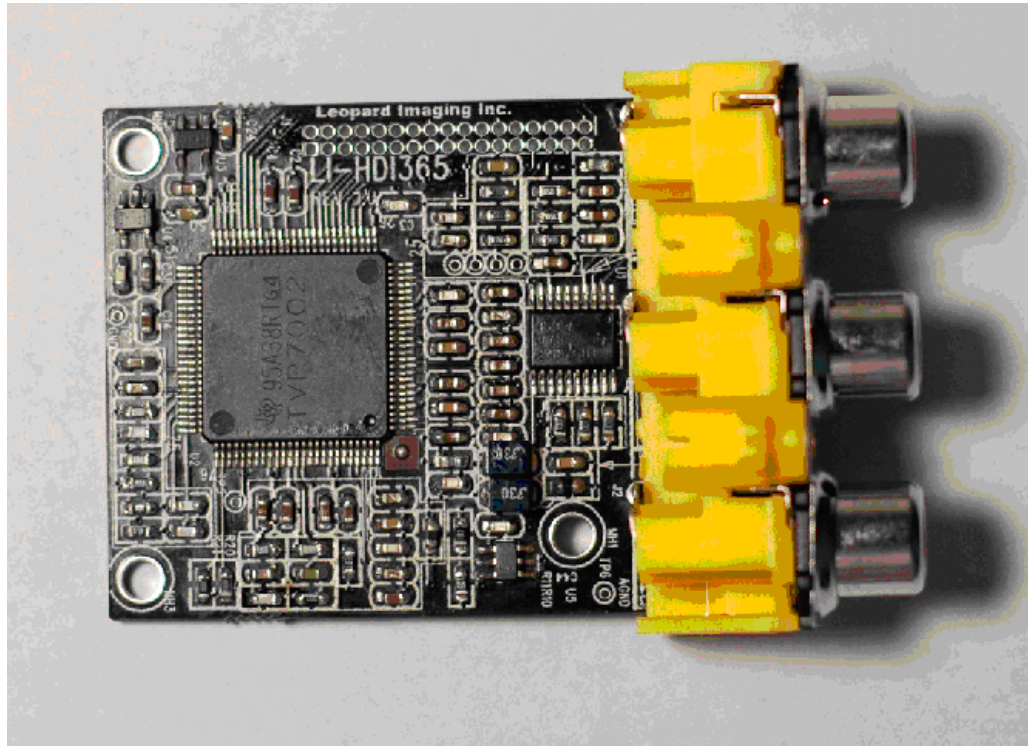


Figure 18. HD Component Video Input Board

1.2.9 Component Video Adapter Cable, see Figure 19

- o Part number: **LI-VIC-02**
- o Convert Stereo phone jack to Y/Pb/Pr RCA connector
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=28&categoryId=13>



Figure 19. Component Video Adapter Cable

1.2.10 Cam Flex Cable, see Figure 20

- o Part number: LI-CAMFLEX
- o Length: 2"
- o Connect between camera board and Leopard Board
- o RoHS Compliance

Where to buy: <http://shop.leopardimaging.com/product.sc?productId=32&categoryId=13>



Figure 20. Cam Flex Cable

LeopardBoard 368 Specification

- This section covers the specifications of the LeopardBoard 368 and it also provides a high level description of the major components and interfaces that make up the LeopardBoard 368.

2.1 LeopardBoard 368 features

Table 1 provides a list of the LeopardBoard 368 features.

	Features
Processor	TMS320DM368 Processor
NAND Flash	2Gb Micron NAND Flash (256MB)
DDR2 SDRAM	1Gb Micron DDR2 SDRAM (128MB)
Camera Interface	VGA, 1.3M, 2M, 3M and 5 Mega-pixel CMOS Sensors supported
Audio In/Out	AIC3104 Audio chip, Stereo Audio In/Out, 2.5mm Stereo Plug connector
JTAG Port	JTAG Debug Port
Serial Port RS-232	UART Debug Port, 2.5mm Stereo Plug connector
USB 2.0 Port	USB 2.0 HS (Device can be powered by USB port), support both Host and Device Mode
SD Card Slot	SD/MMC Slot
Power Management	TPS650532 Power management chip
Power Input	+5V Power Input, 2.1mm I.D. x 5.5mm O.D. x 12mm Female
Composite Video Output Port	PAL/NTSC Output
Component Video Output Port	HD Component YPbPr Output
Network Interface	10/100 Ethernet
LCD/DVI Interface	LCD/DVI Interface through adapter board
Expansion Port (Not Populated)	SD/MMC, I2C, UART, McBSP, GPIO, 3.3V power supply
PCB Board Mechanical	3" x 2.5" (76.2mm x 63.5mm)

2.2 LeopardBoard 368 Function Block, see Figure 21

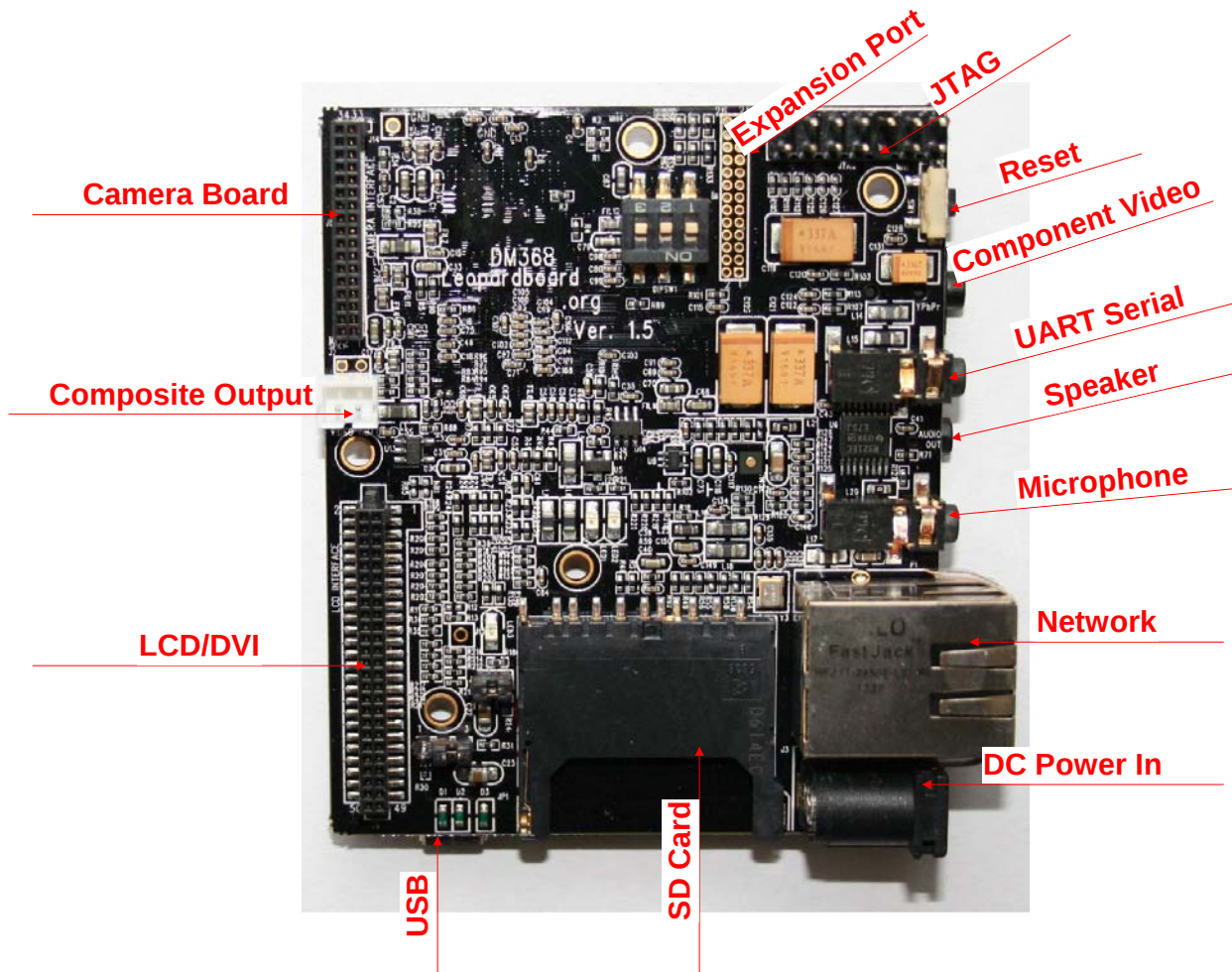


Figure 21. LeopardBoard 368 Function

The following sections provide more detail on each feature and components on the LeopardBoard 368.

2.3 DM368 Processor

The LeopardBoard 368 takes TMS320DM368 as its main processor. The DM368 is a highly integrated, programmable platform for digital still camera, digital photo frames, IP security cameras, video door bell application, etc. This ARM9-based DM368 device supports production-qualified H.264, MPEG-4, MPEG-2, MJPEG and VC1/WMV9 codecs providing customers with

the flexibility to select the right video codec for their application. The DM368 also enables seamless interface to most additional external devices required for a complete digital camera implementation. The image sensor interface is flexible enough to support CCD, CMOS, and various other interfaces such as BT.565, BT.1120. The DM368 also offers a high level of integration with HD display support including, 3 built-in 10-bit HD Analog Video Digital to Analog Converters (DACs), DDR2/mDDR, Ethernet MAC, USB 2.0, integrated audio, Host Port Interface (HPI), Analog to Digital Converter, and many more features saving developers on overall system costs as well as real estate on their circuit boards allowing for a slimmer, sleeker design. The DM368 processor core is an ARM926EJ-S RISC processor offering speeds up to 432MHz. The ARM926EJ-S is a 32-bit processor core that performs 32-bit and 16-bit instructions and processes 32-bit, 16-bit, and 8-bit data. The core uses pipelining so that all parts of the processor and memory system can operate continuously. See Figure 22

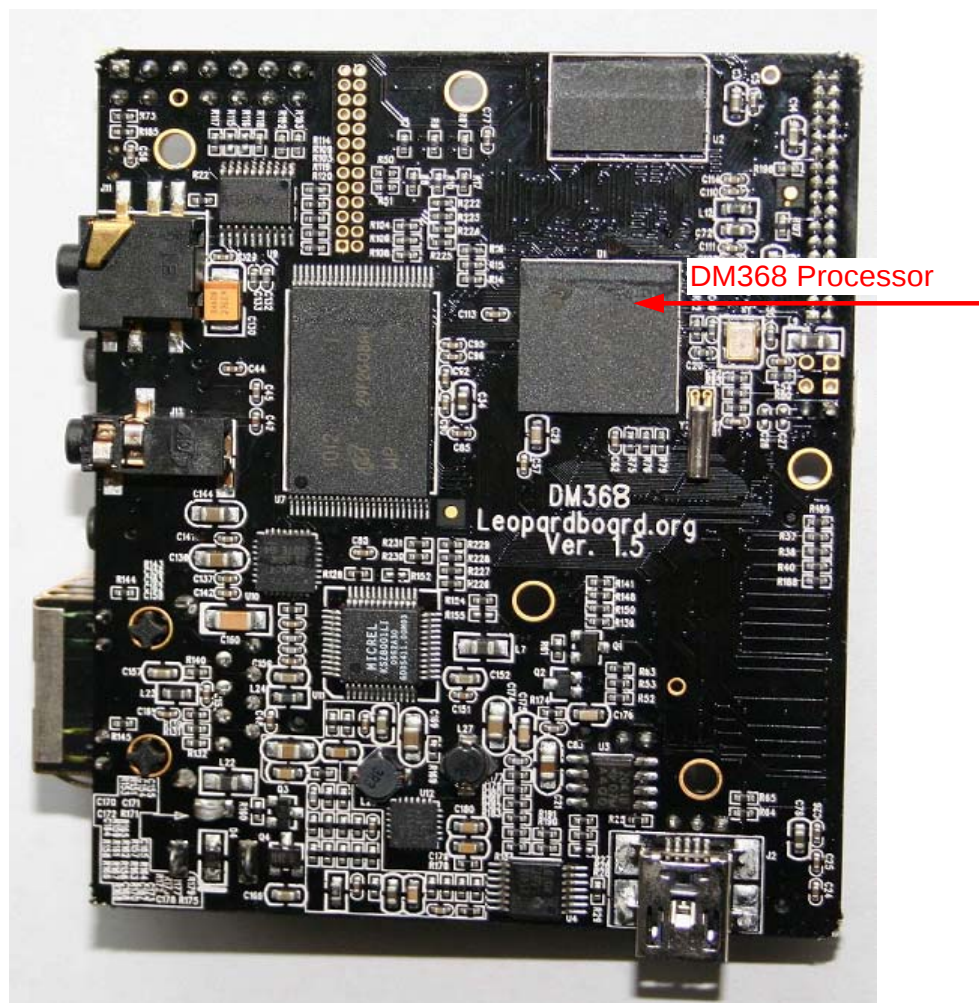


Figure 22. DM355 Processor

2.4 Flash Memory

The Micron Flash Memory is used in LeopardBoard 368, it is a +3.3V powered, 256M x 8-bit, 2Gb SLC NAND Flash. It is compatible with 1Gb NAND Flash, see Figure 23.

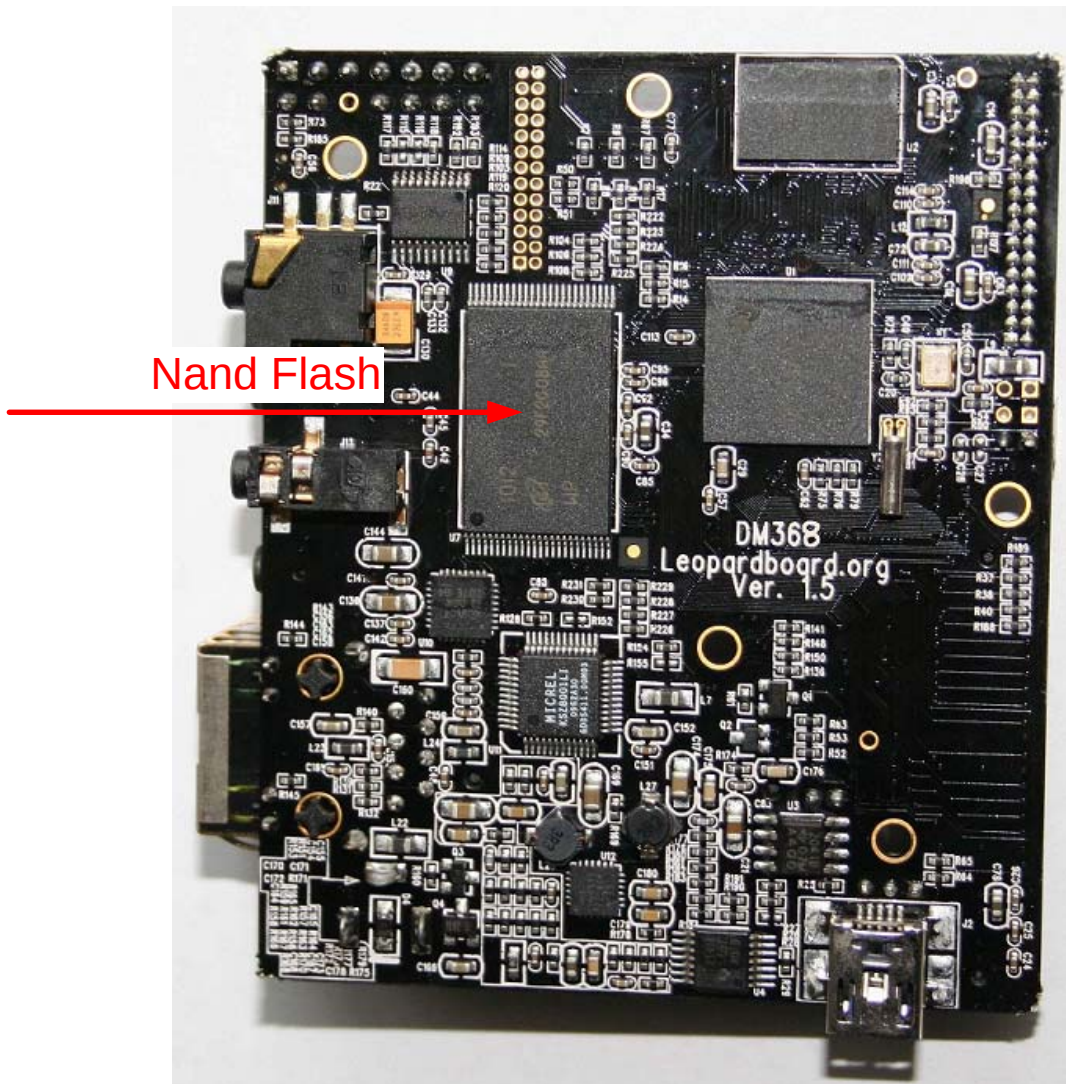


Figure 23. NAND Flash

2.5 DDR2 SDRAM

The Micron DDR2 SDRAM is used in LeopardBoard 368, it is a +3.3V powered, 8M x 16 x 8 banks, 1Gb DDR2 SDRAM, see Figure 24

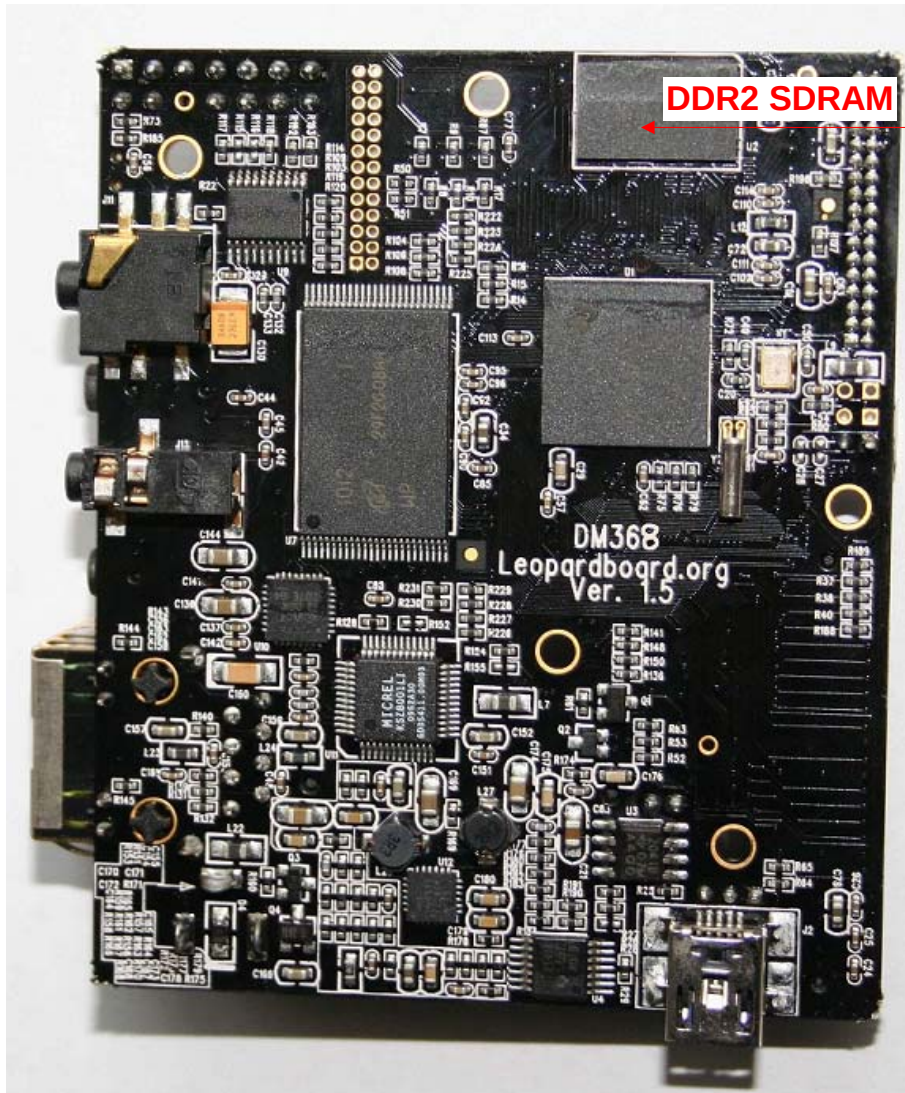


Figure 24. DDR2 SDRAM

2.6 Camera Interface

LeopardBoard 368 supports wide range of CMOS Imagers from VGA, 1.3M, 2M, 3M to 5 Mega-pixel CMOS sensors, see Figure 25.

Camera Interface

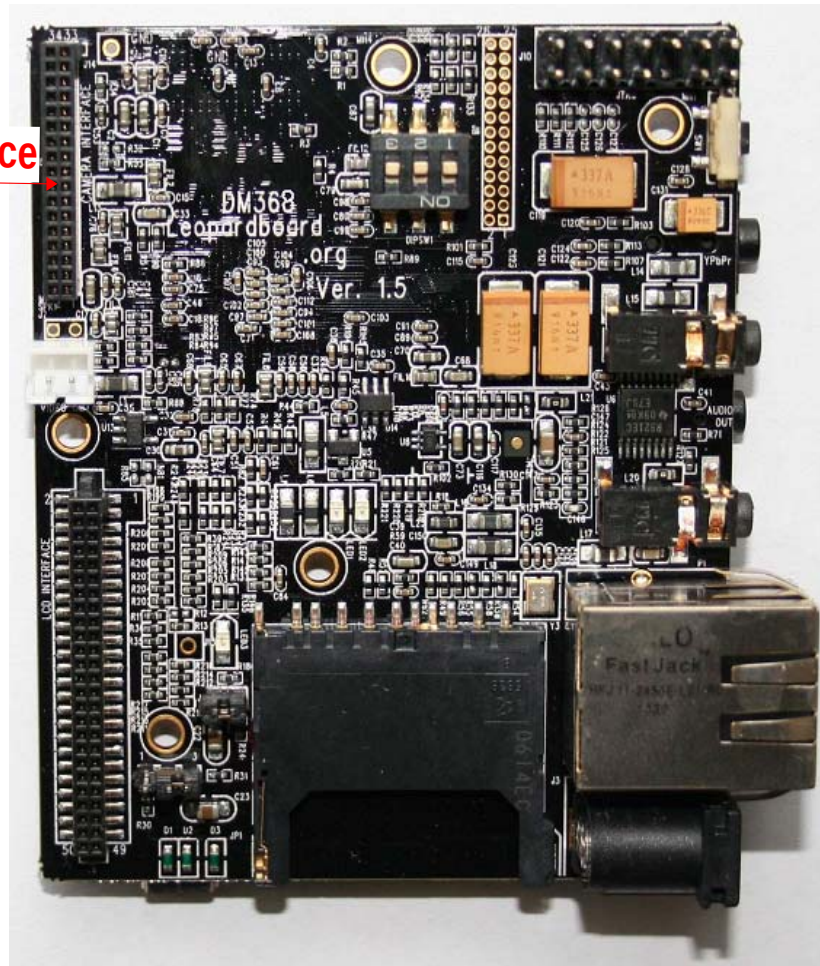


Figure 25. Camera Interface

Camera interface Pin assignment, see Figure 26.

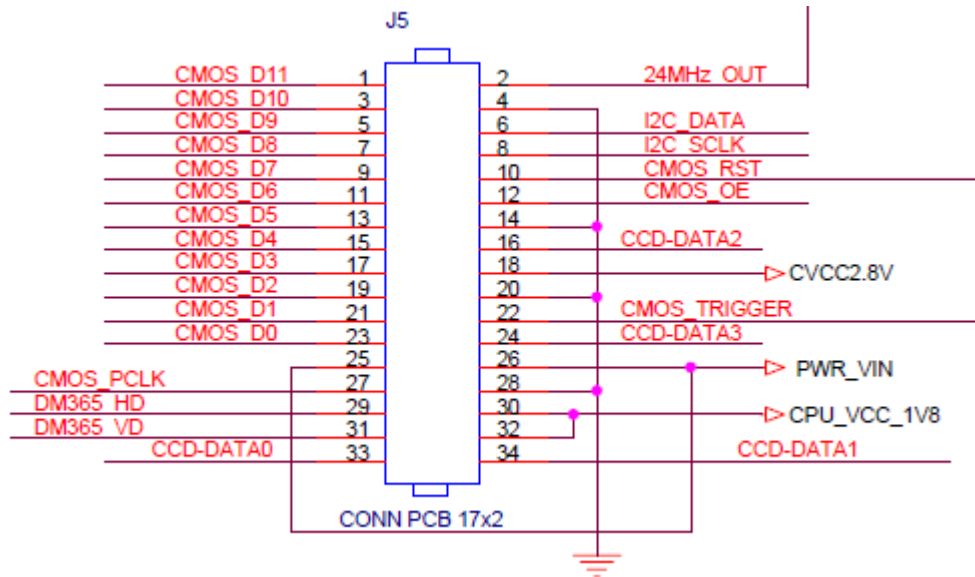


Figure 26. Camera Interface Pin assignment

2.7 Audio Input

Low power stereo audio CODEC TLV320AIC3104 is used in LeopardBoard 368; a 2.5mm standard stereo audio input jack is provided to receive stereo audio input to CODEC, see Figure 27.

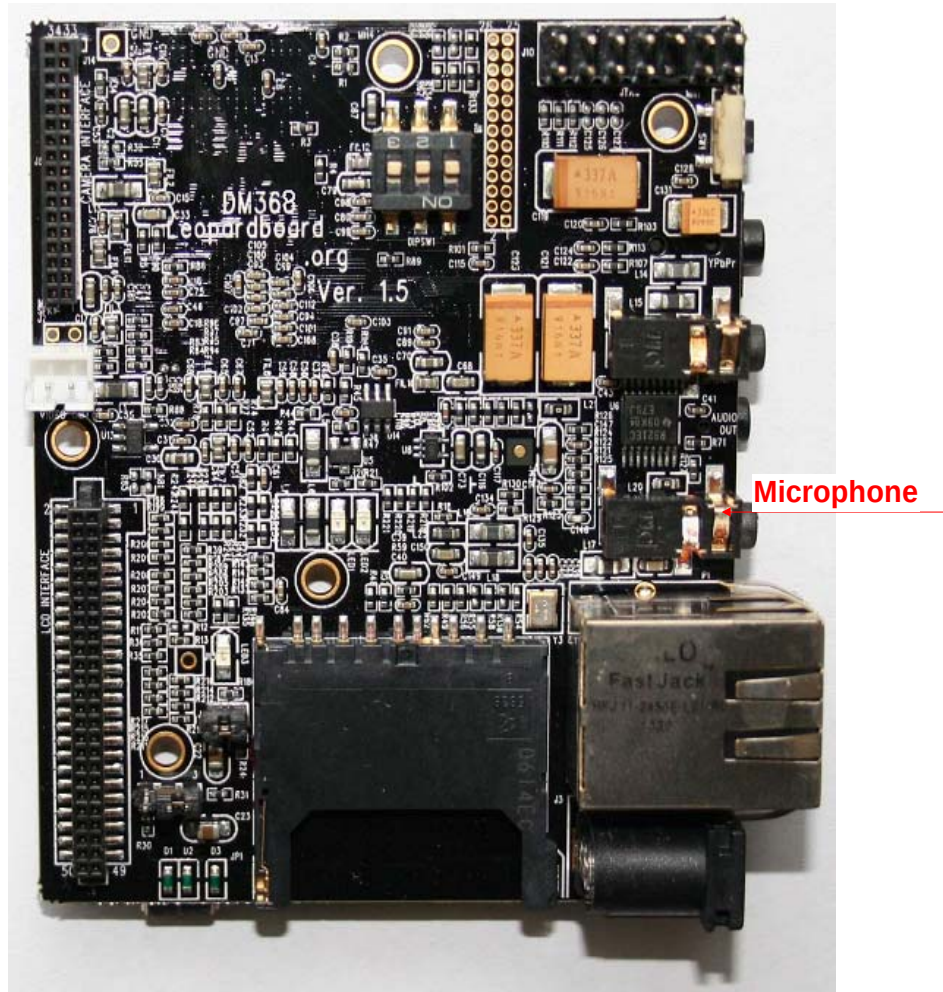


Figure 27. Audio Input

2.8 Audio Output

A 2.5mm standard stereo audio output jack is provided to access the stereo output of the onboard output CODEC, see Figure 28.

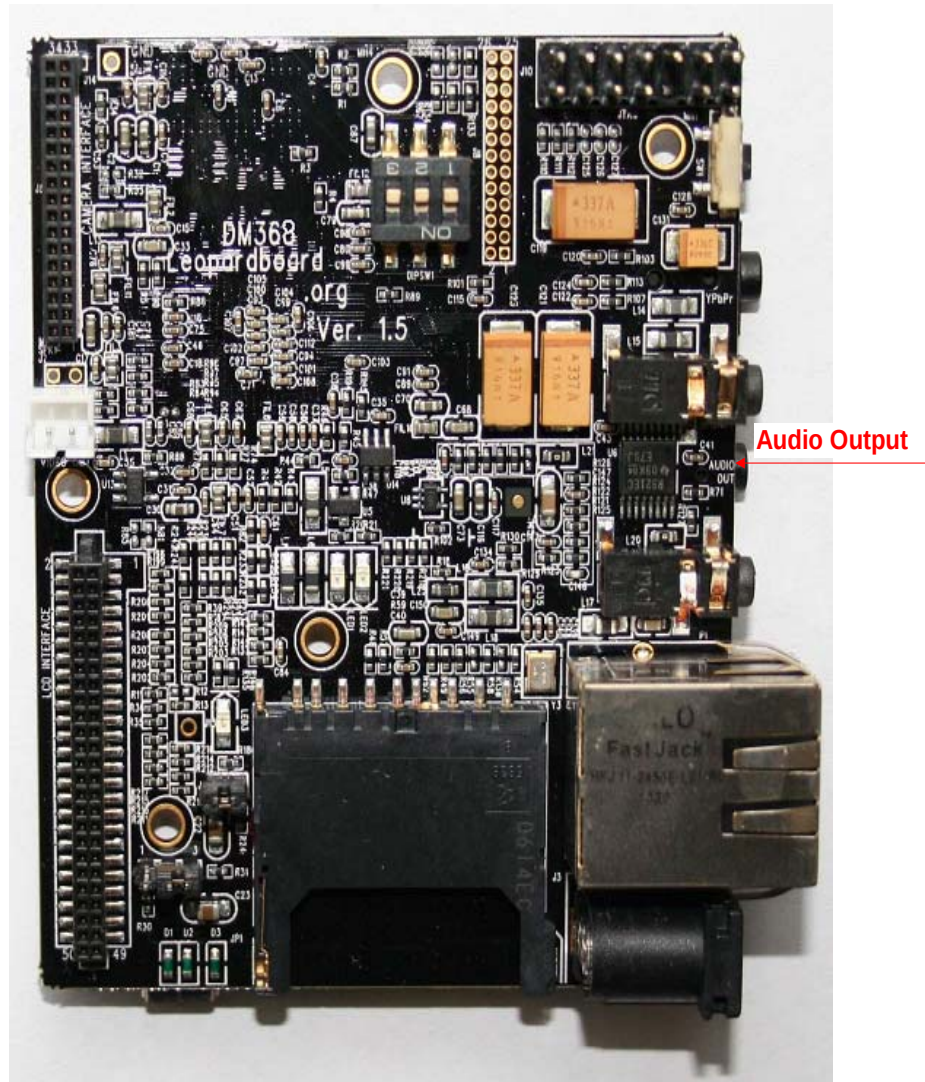


Figure 28. Audio Output

2.9 JTAG Port

A 14 pin JTAG header is provided on the LeopardBoard 368 to facilitate the SW development and debugging of the board by using various JTAG emulators, see Figure 29.

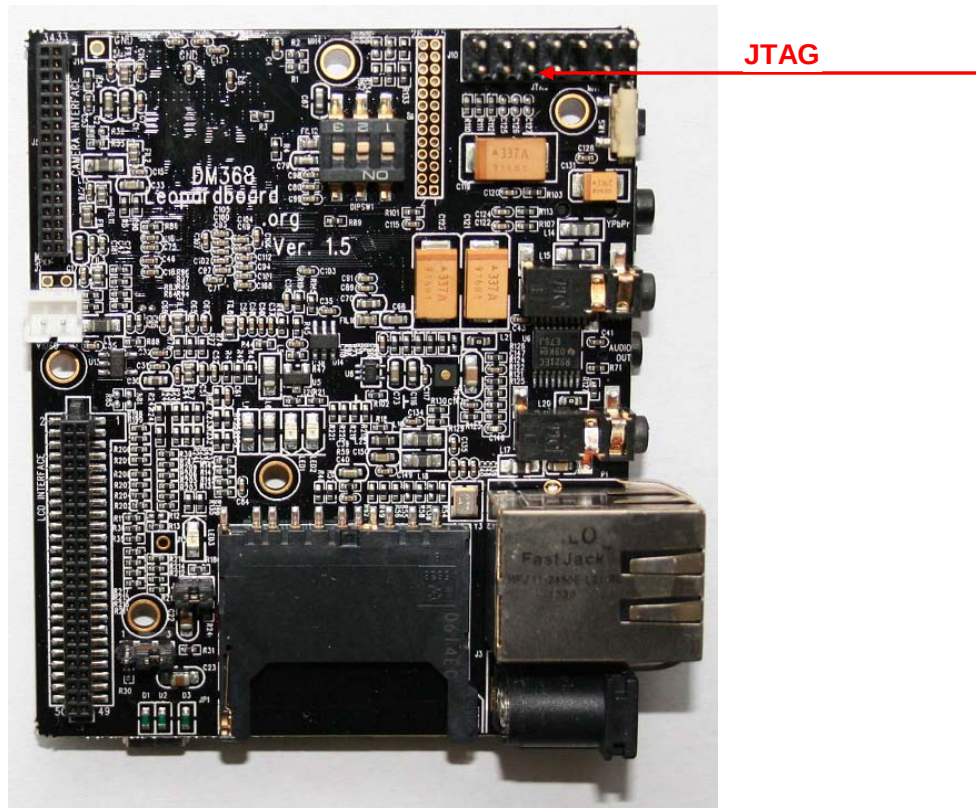


Figure 29. JTAG Connector

JTAG connector pin assignment, see Figure 30.

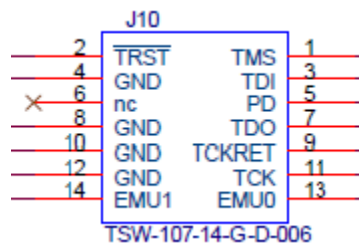


Figure 30. 14-pin TI JTAG Interface

2.10 Serial Port: RS-232

Support for RS232 is provided by a 2.5mm stereo audio jack on the LeopardBoard 368 for access to an onboard RS232 transceiver. It does require a 2.5mm stereo audio jack to DB9 Female converter cable, which is an accessory part, to access the serial port, see Figure 31.

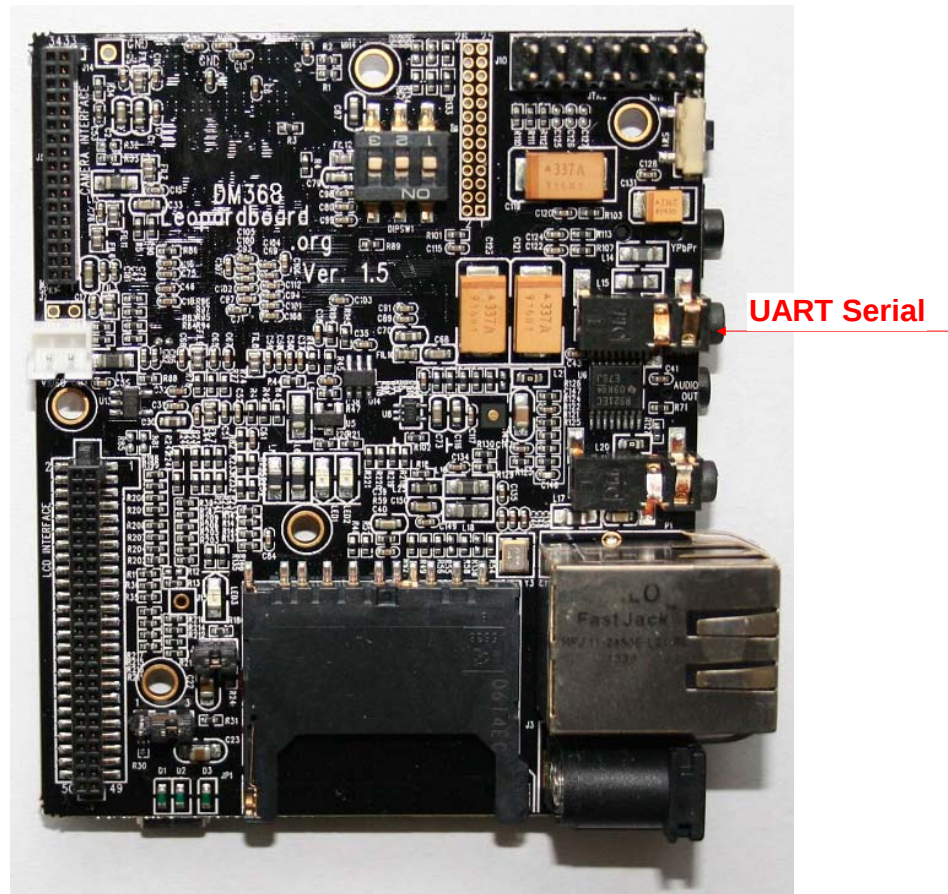


Figure 31. UART Serial Port

2.11 USB 2.0 Port

The LeopardBoard 368 requires a mini-B to USB type-A cable. LeopardBoard 368 can be accessed through USB cable, there is an option to provide +5V power to the LeopardBoard 368 if external +5V power supply is not used, see Figure 32.

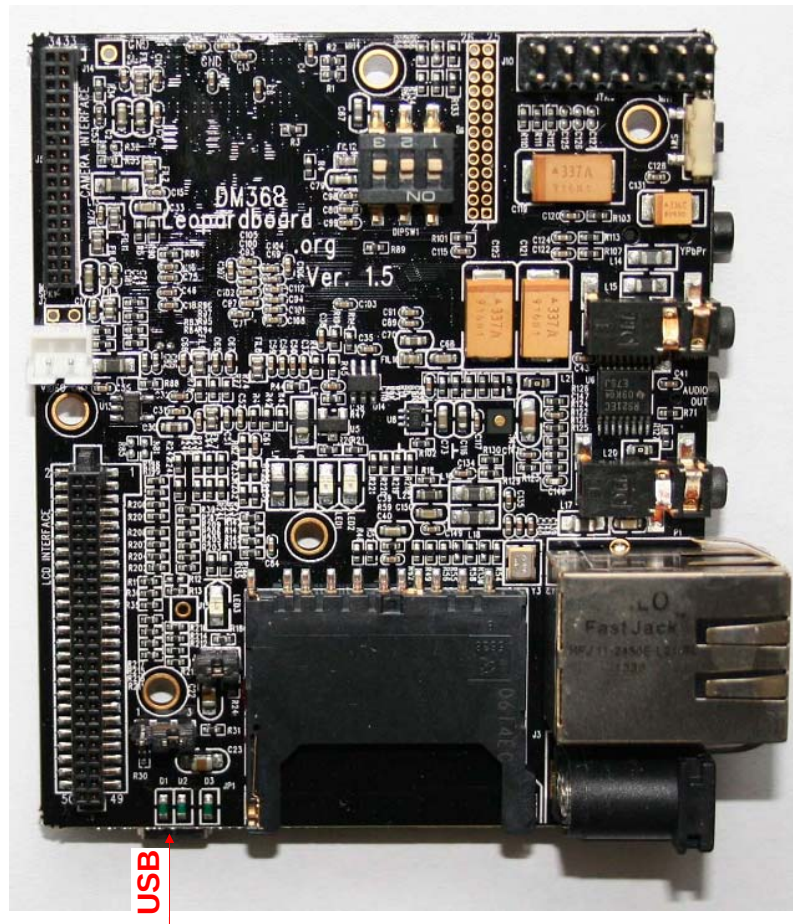


Figure 32. USB 2.0 Port

2.12 SD Card Slot

A SD Card connector is provided as a means for expansion and can support such devices, but not limited as SD memory card, miniSD card, GPS modules, WiFi card, and Bluetooth card, see Figure 33.

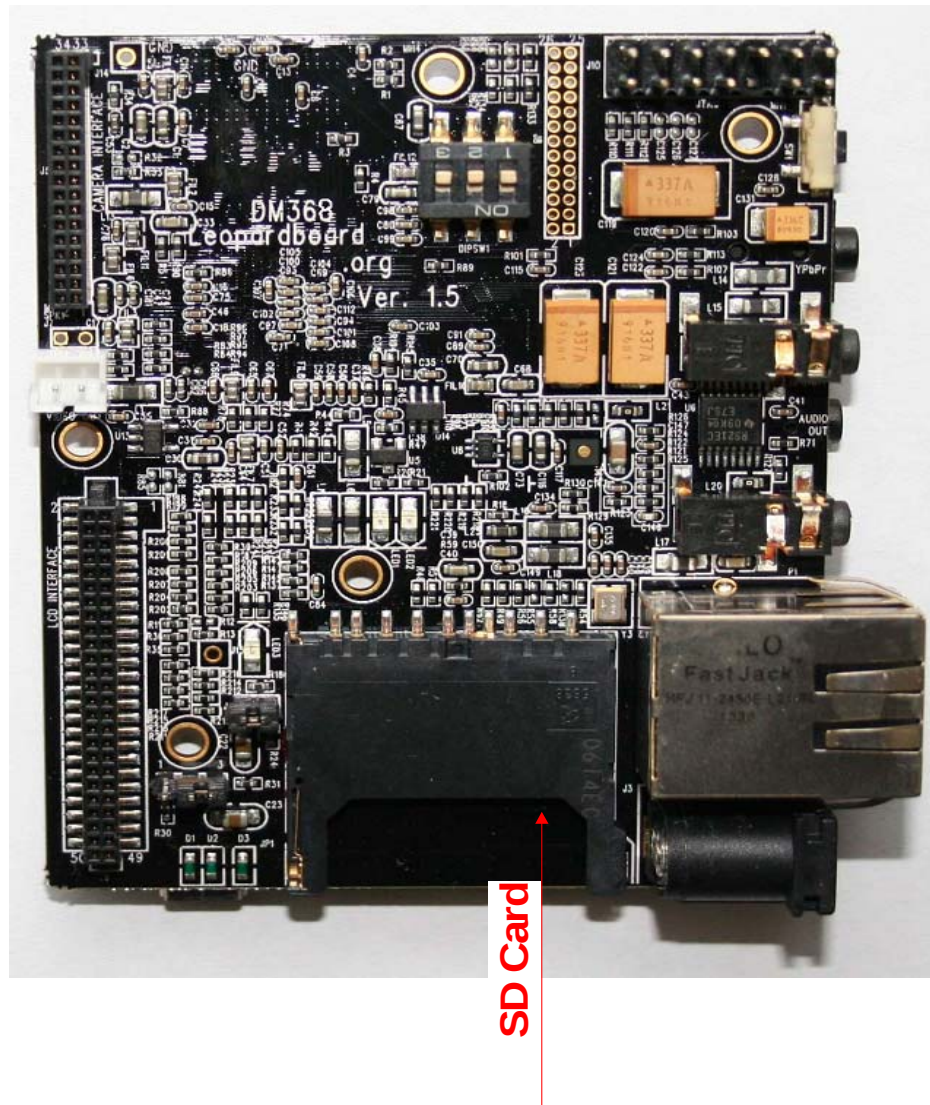


Figure 33. SD Card

2.13 Power Management

A powerful 5-Channel Power Management IC with two step down converters and 3 low-input voltage LDOs chip TPS650532 is provided in LeopardBoard 368. It serves all powers on the board, see Figure 34.

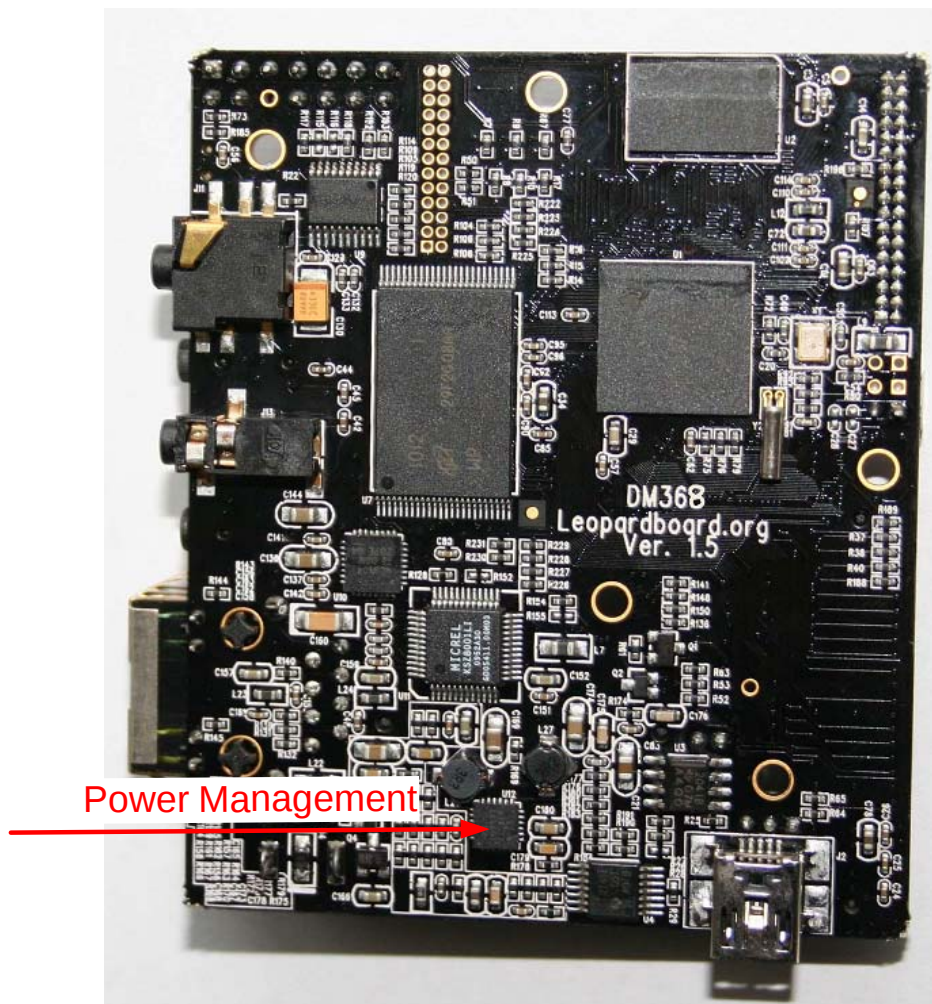


Figure 34. Power Management

2.14 Power Input

A 2.1mm standard power jack is provided in LeopardBoard 368 for +5VDC power supply, the LeopardBoard 368 power consumption is less than 2W, which includes 5M camera board power consumption running at 720p @ 30fps.

A standard 2.1mm jack wall supply is needed, which is an accessory part, power can also be supplied via the USB connector as an alternative supply,

When external power supply is provided, it will remove the power path from the USB connector.

DO NOT plug in anything but 5V to the power jack, or the board will be possibly damaged although the board has over voltage protection function, see Figure 35.

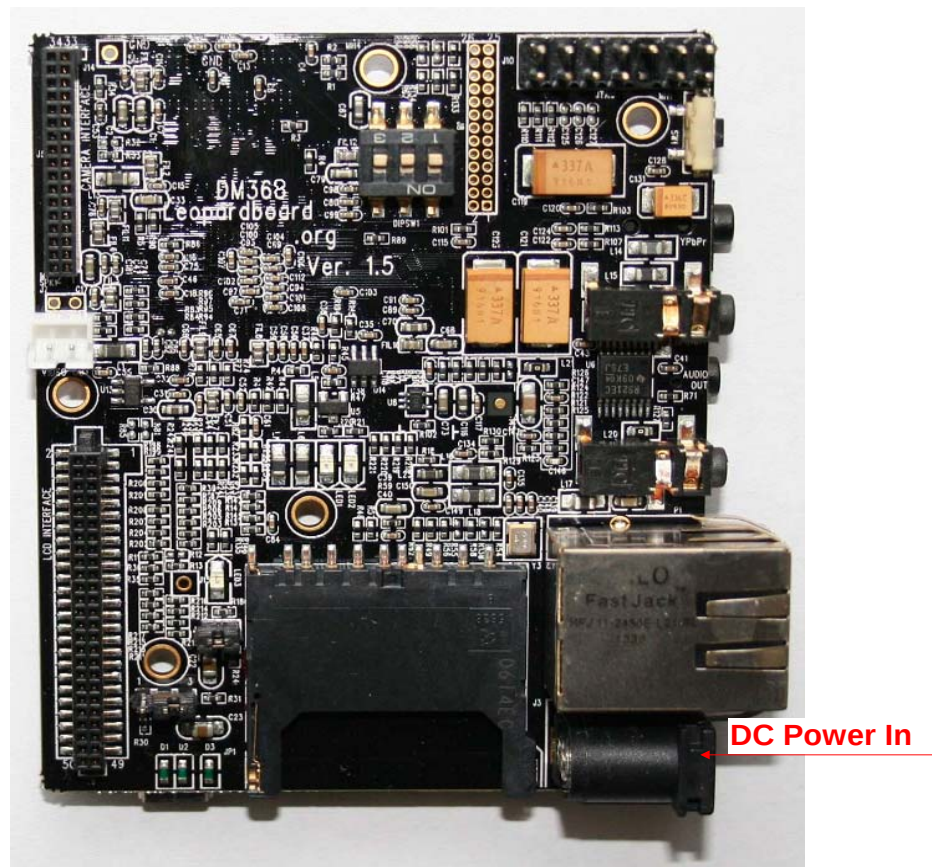


Figure 35. DC Input

2.15 Composite Video Output Port

A two video pins is provided to access composite video output of LeopardBoard 368. It supports NTSC or PAL format output to a standard TV. The default is NTSC, but can be switched to PAL by software, see Figure 36.

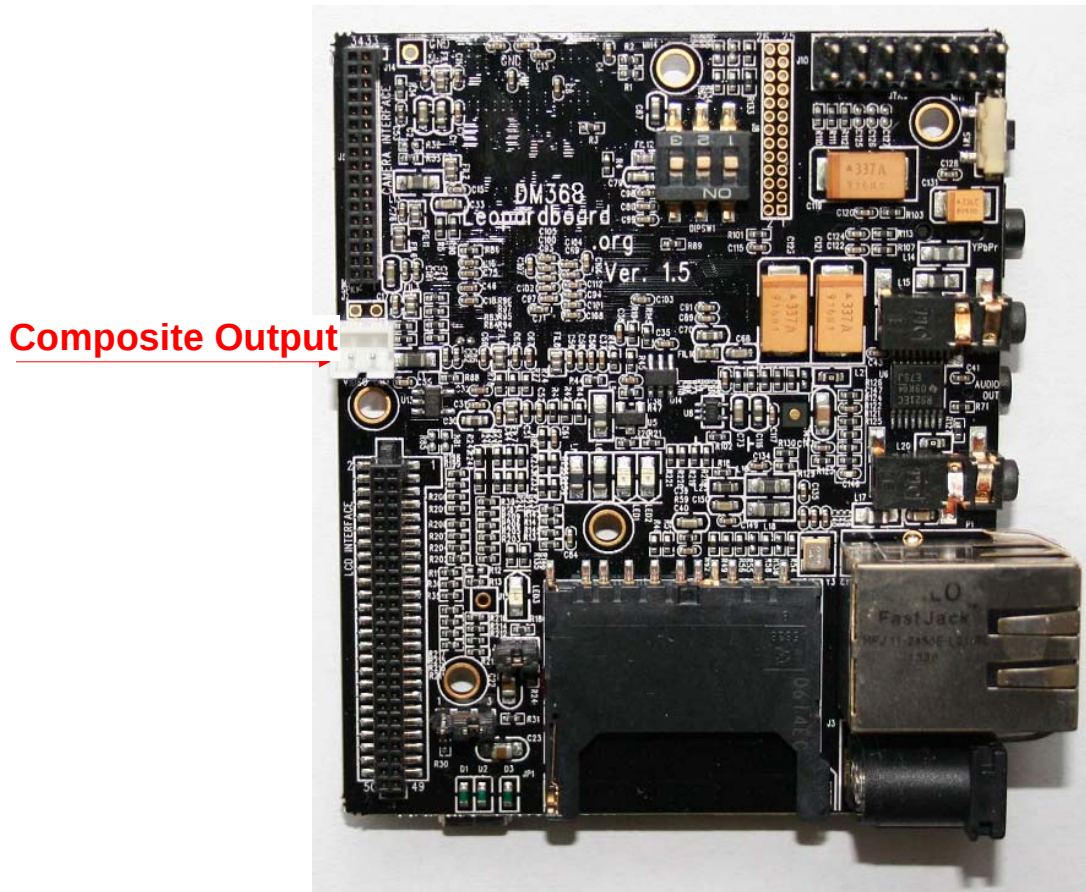


Figure 36. Composite Output

2.16 Component Video Output

LeopardBoard 368 has provided a jack to access component video output supporting YPbPr format to output to a TV or other component. See Figure 37.

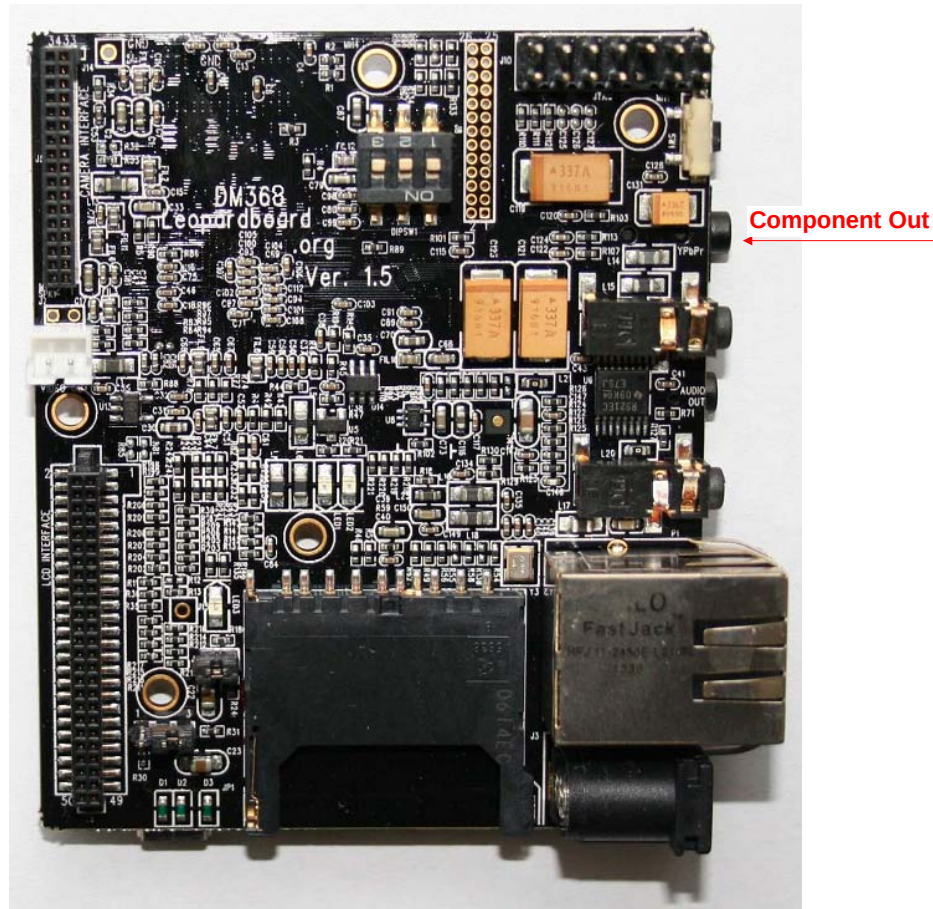


Figure 37. Component Video Output

2.17 Network Interface

Network is provided in LeopardBoard 368, this is a standard RJ-45 connector for 10/100 Mbps Ethernet networks, see Figure 38.

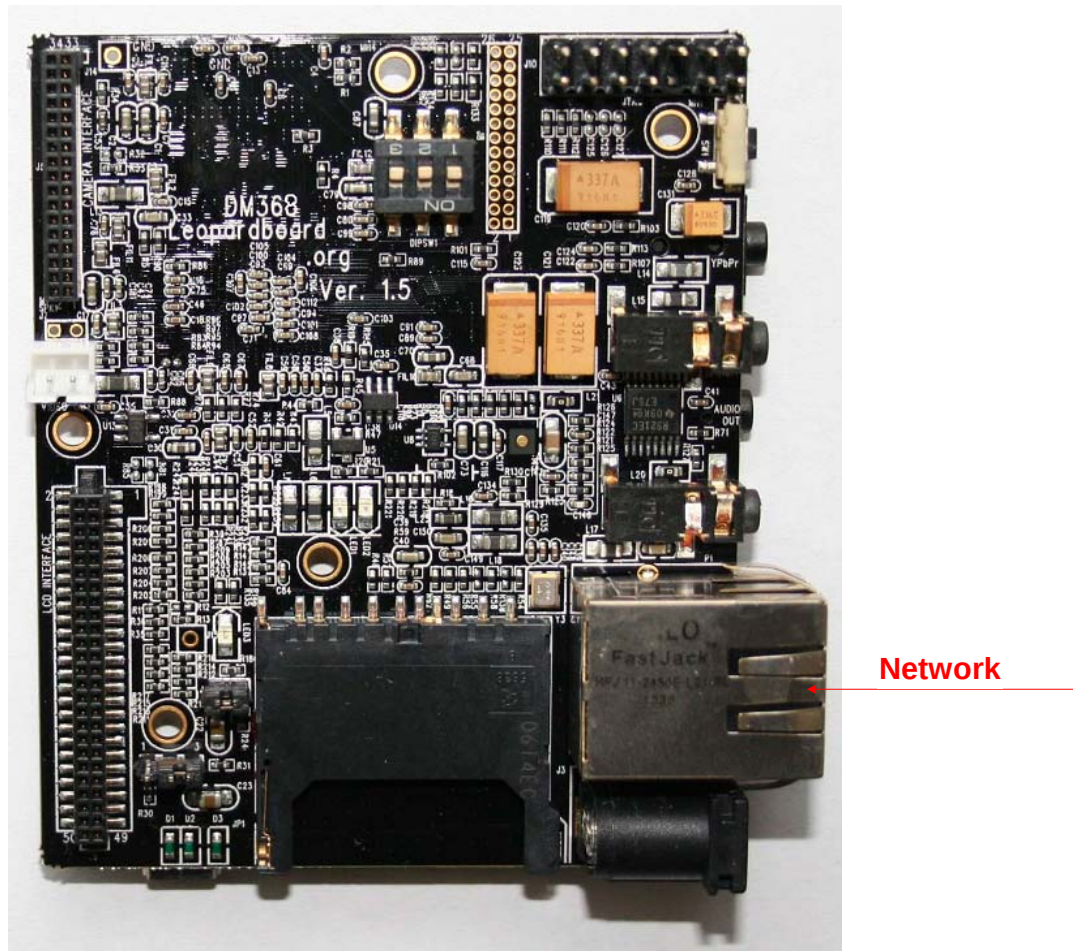


Figure 38. Network Interface

2.18 LCD/DVI Interface

LeopardBoard 368 provides a 50-pin connector, which is fully compatible with DM368EVM expansion connector; it supports LCD daughter card or DVI daughter card, see Figure 39.

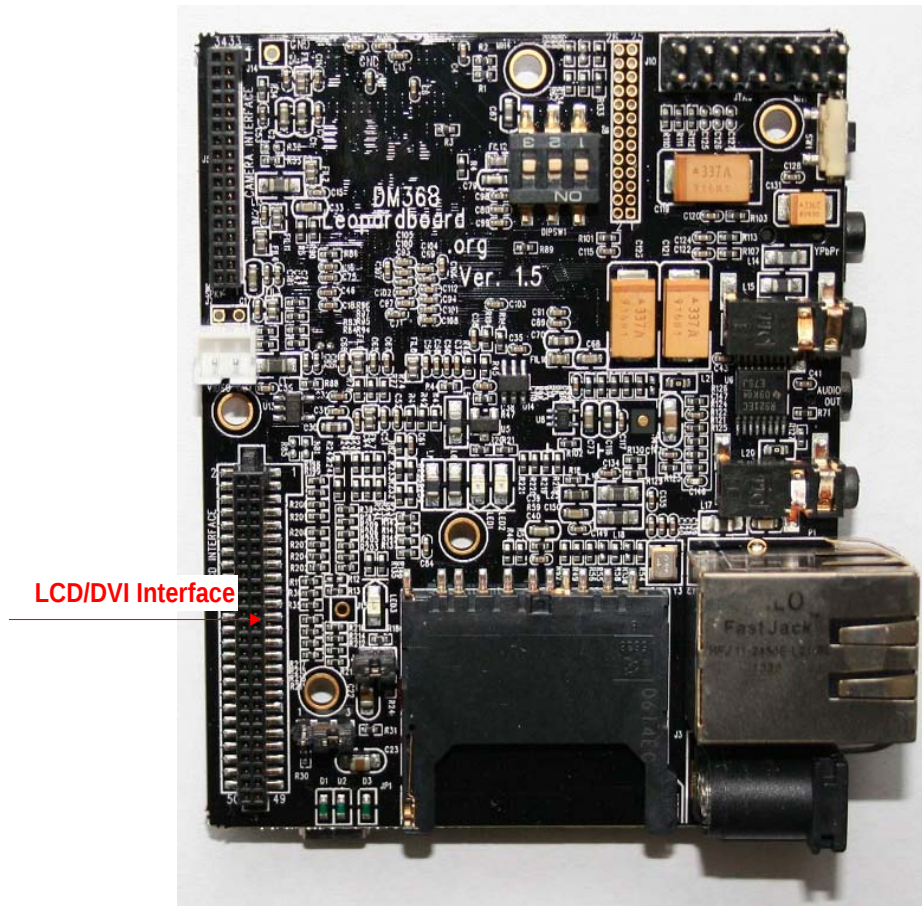


Figure 39. LCD/DVI Interface

LCD interface pin assignment, see Figure 40

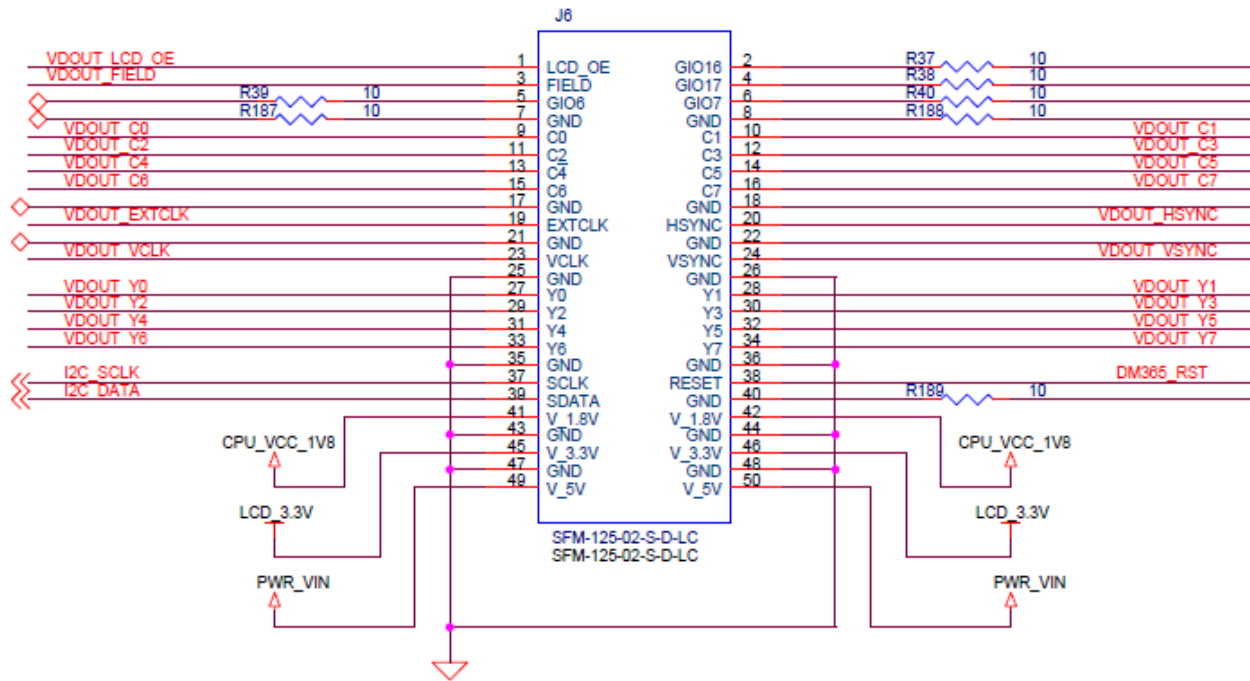


Figure 40. Pin Assignment for LCD Interface

2.19 Expansion Port

A 26-pin connector is provided as expansion port to support the following functions, see Figure 41.

- SD/MMC
- I2C
- UART
- McBSP
- GPIO
- 3.3V power supply.

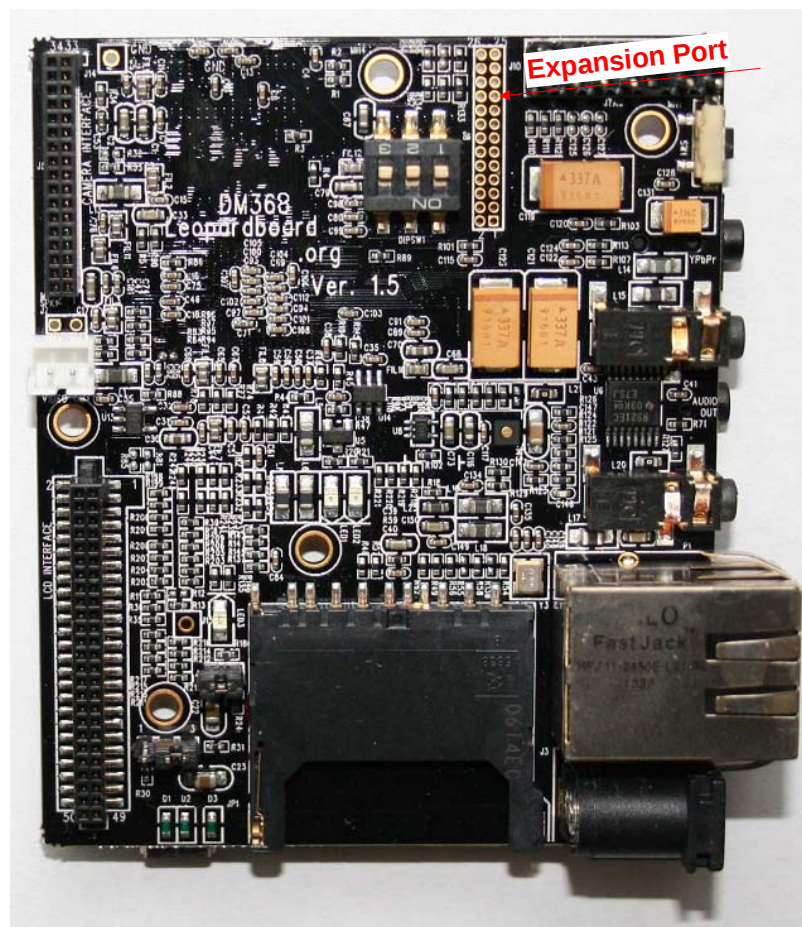


Figure 41. Expansion Interface

Expansion port pin assignment, see Figure 42.

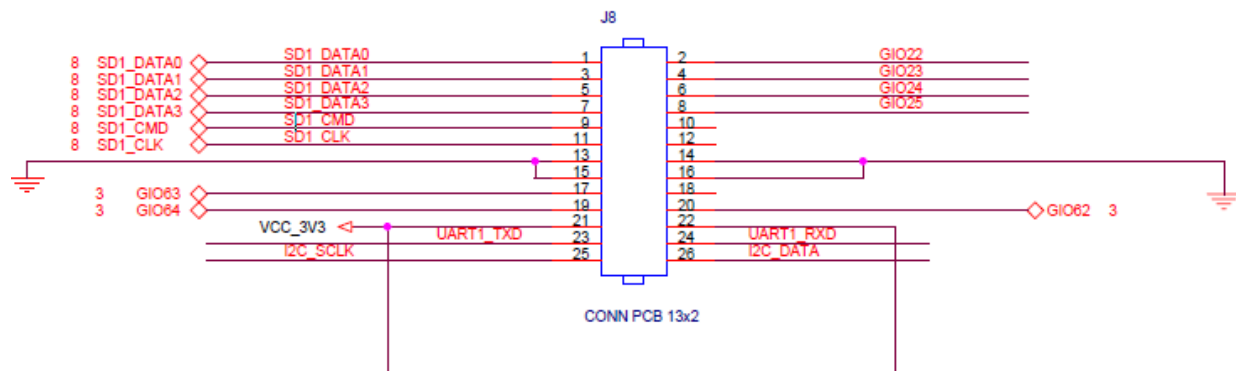


Figure 42 Pin Assignment for Expansion port

2.20 Reset Button

Reset button can reset board to power-up status. See Figure 43

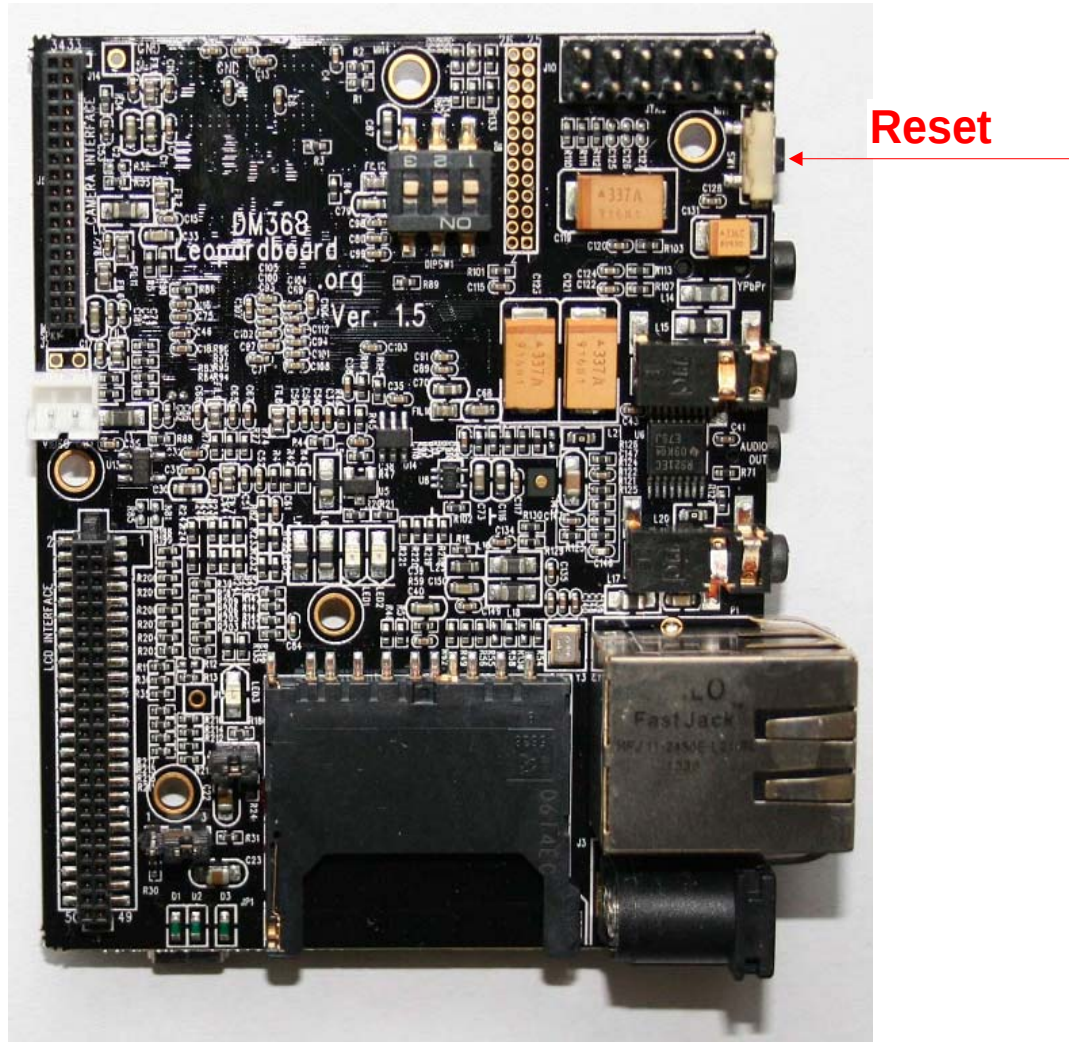


Figure 43. Reset Button

2.21 DIP Switch

LeopardBoard 368 has included a DIP switch for boot up control. See **table 2** for boot control modes.

EM_A13, #1	EM_A12, #2	EM_A11, #3	BOOT MODE
0	0	0	Nand Boot Mode
0	1	0	SD Boot Mode
0	1	1	UART Boot Mode
1	0	0	USB Boot Mode
1	1	0	EMAC Boot Mode

("0"= off, "1"= on)

Figure 44 shows the DIP switch on LeopardBoard 368

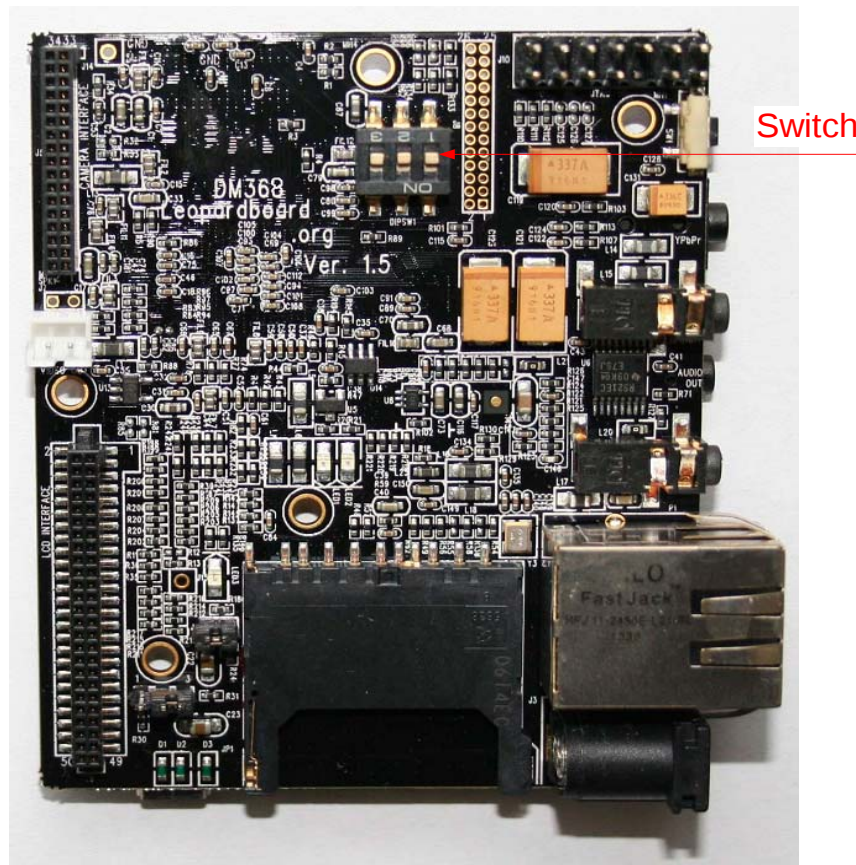


Figure 44 DIP Switch

PCB Board Mechanical Specification

Board Size:	3.0" x 2.5"
Max height:	0.67" with RJ45 Connector
Layers:	6
Color:	Black
PCB thickness:	.062"
RoHS Compliant:	Yes
Weight:	1.5 Oz