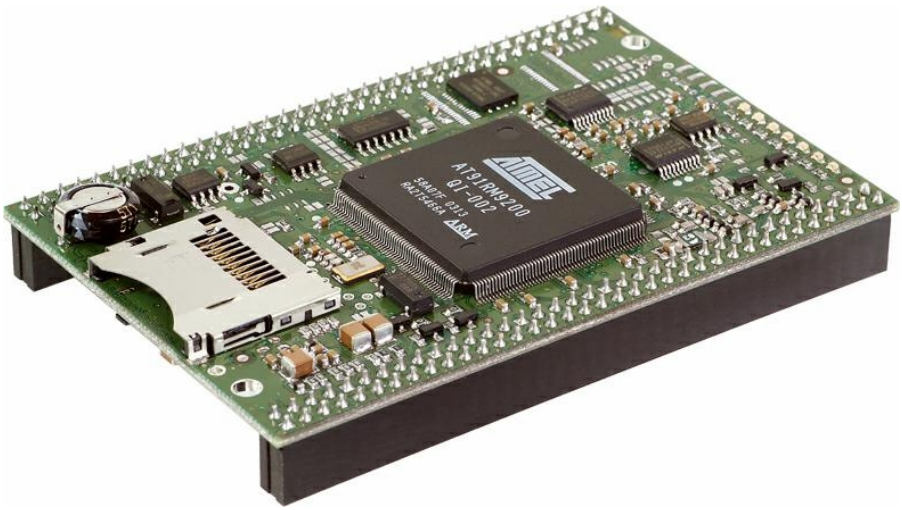


CentiPad Hardware Documentation

for CentiPad112

Autor: Marcus Hasenstab
Version: 1.01
Date: 061120
www.centipad.de

Notes:
- ESD warning will be changed to English version

Table of contents

1 Introduction

1.1 Focus

Currently CentiPad is among the most compact Universal Embedded Linux systems. This manual gives the user an overview of the main functionality of the CentiPad and a guide for using it in different hardware environments..
Please read this manual before developing your application – it will be well worth the effort.

1.2 CentiPad Documentation Overview

- CentiPad Hardware Documentation
- CentiPad Breakout Board Documentation with Quickstart Guide
- CentiPad Breakout Board Schematic
- CentiPad Programming Model
- CentiPad Application Handbook
- The latest documentation is available at www.centipad.com

1.3 Safety guidelines

For your own safety and correct operation please follow all of these safety guidelines.
Warranty will be void for damage resulting from disregarding this manual.
No responsibility will be taken by the manufacturer for secondary damages!
No responsibility will be taken for material or personal damage resulting from disregarding this manual.

Only use in dry environment with no flammable gases.

When changing the environmental conditions let the equipment acclimate.

Don't modify the device.

Don't operate devices showing visible damage, no response, or after long storage in an unfavorable environment.

Supply sufficient cooling.

Remove power supply before accessing internals of a device.

Handle with care.

Avoid storage or operation in high humidity conditions.

1.4 Life support policy

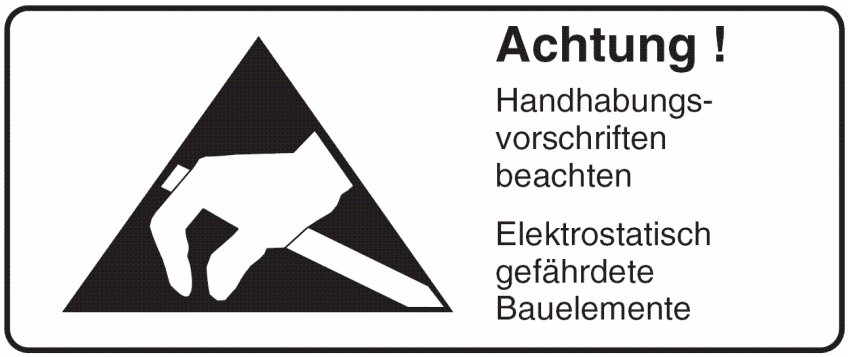
HARETOD does not authorize or warrant any of its products for use in life support systems, without the specific written consent of Marcus Hasenstab Ingenieurdienstleitungen.
Life support systems are equipment intended to support or sustain life, and whose failure to perform, when properly used in accordance with instructions provided, can be reasonably expected to result in personal injury or death.

1.5 Protection against electrostatic discharge (ESD)

This device contains components sensitive to electrostatic discharge. Even a discharge too small to notice may result in destruction or reduced performance.

Use the following precutions against ESD:

- use a properly installed anti-ESD-mat
- wear ESD-bracelets
- follow ESD grounding techniques
- leave the device in its ESD-shielding package until installation. When outside its shielding lay the device on a grounded surface
- don't touch components in the device
- hold PCB at the edges



1.6 operational safety

All devices are submitted to extensive functional tests before leaving the factory. But even with very reliable devices defects are possible.
A defect in the device may result in consequential damages. It's the users responsibility to provide protection accordingly. The manufacturer denies responsibility for an kind of defects.

1.7 Warrenty regulations / product liability

Warranty and product liability claims are void even during the legal warranty period

- if the device is not operated according to the manuals.
- If the device is opened
- If the device is modified
- If the device is improperly operated

Components which are inherently subject to wear (e.g. batteries, connectors) are exempt from warranty.

1.8 Legend

Verdana Bold	subtitle, highlighted text
Courier New bold	command, command result, programm code
Courier New bold italic	path or local directory
Courier New	captures the readers attention
Under Construction	passage under construction

1.9 Legal stuff

The right to make technical changes is reserved!

2 Specification

2.1 Electrical

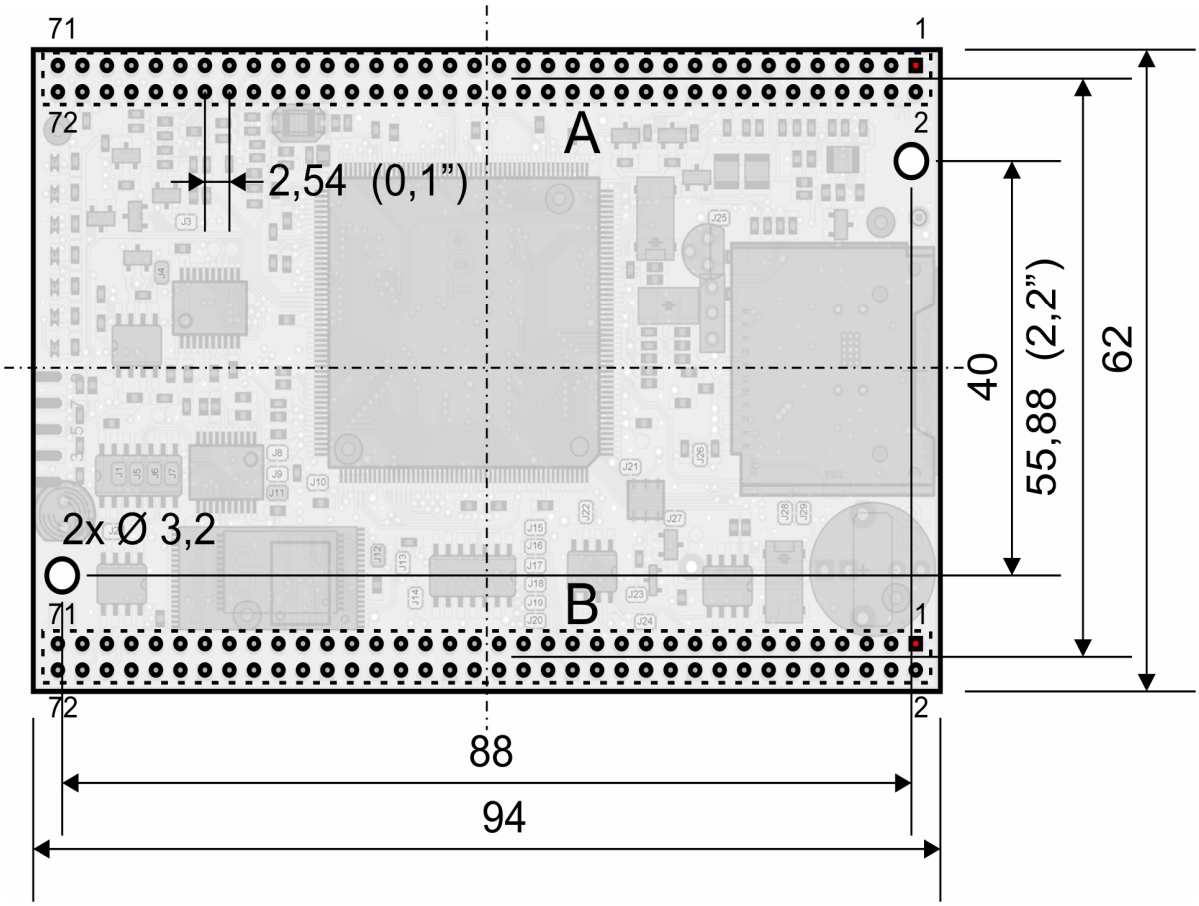
Supply:	- 4,5V..5,5V 210mA (max. 500mA)
CPU:	- AT91RM9200, ARM9 @ 180MHz
SDRAM:	- 32/64MByte SDRAM
DataFlash:	- 2/4MByte serial DataFlash, bootable
MiniSD:	- MiniSDCard-Sockel on Board, bootable, additionally on external bus
EEPROM:	- 256kBit (different capcity possible), bootable
External Bus:	- Data-/Address-/Control-Bus (A0..15, D0..15) - buffered - 5V tolerant - active only on access (EMI-optimized) - extended 3,3V Businterface possible (A16..A22, Fast IRQ, Wait, IRQ0)
TWI:	- Two-Wire Interface - mostly I^2C compatible - selectable 3,3V or external signal level von 3,3V...12V
TWI-Pad:	- 8pin SOIC Pad, e.g. for a TWI-Device or AVR-ATtiny13
Speaker:	- GPIO-Port with Open-Drain-Transistor, e.g. for piezo speaker
PortX:	- 2 GPIO-Signals, compatible to peripheral level 3,3V...12V
1-Wire:	- 1-Wire-Bus-Controller for 1-Wire Devices
CAN-Controller:	- buffered CAN-Controller for CAN-Devices V_{CANH}/ V_{CANL} -8V..+18V, V_{diff} 1,5V..3,0V, max. 1MBit/s
Ethernet:	- 10/100MBit/s HD/FD PHY - automatic CrossOver
Serial Interface:	- TTYD: debug port, RS232 RX/TX, bootfähig - TTY0: 3,3VRS232, RX/TX/RTS/CTS - TTY1: RS232, RX/TX/RTS/CTS (optional RS485 driver) - TTY2: RS232 RX/TX - TTY3: 3,3VRS232, RX/TX/RTS/CTS
SPI-Interface:	- 3.3V, MISO, MOSI, SCK
USB Host:	- USB2.0 compliant Fullspeed Hostport 12MBit/s - provides the CentiPad supply voltage via thermal fuse
USB Device:	- USB2.0 compliant Fullspeed Deviceport 12Mbit/s - 'selfpowered' oder 'buspowered' Device - bootfähig
Sound:	- full-Duplex - Stereo LineIn - Stereo LineOut - Stereo Headphone - Microphone In
RTC:	- GoldCap- or Battery-Puffered - timed power on
GPIO:	- GPIO0..5, In/Out - 3,3V compatible
Indicator LEDs:	- System Active LED - 6 indicator LEDs on GPIO 0...5
JTAG:	- optional mountable JTAG-connector

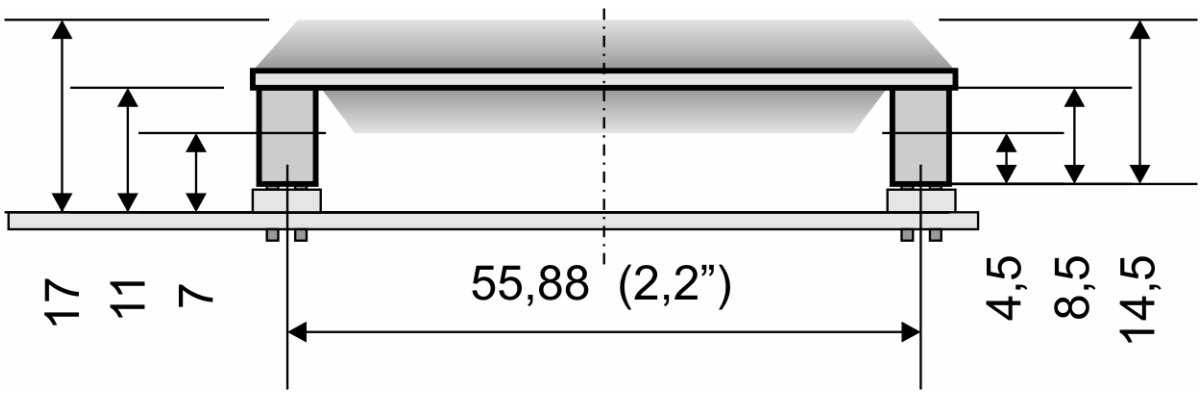
2.2 Absolute maximum ratings

Supply voltage	4,8V..5,25V	
Total current on all supply lines	700mA	
processor pins	3,3V	±8mA
buffered bus pins Input	0..5,5V	2mA
buffered bus pins Output	3,3V	±24mA

2.3 dimensions

dimensions: 94mm x 62mm x 15mm (height over carrier board 17mm)
Interface: two dual-line 2,54mm female 72 pin connectors





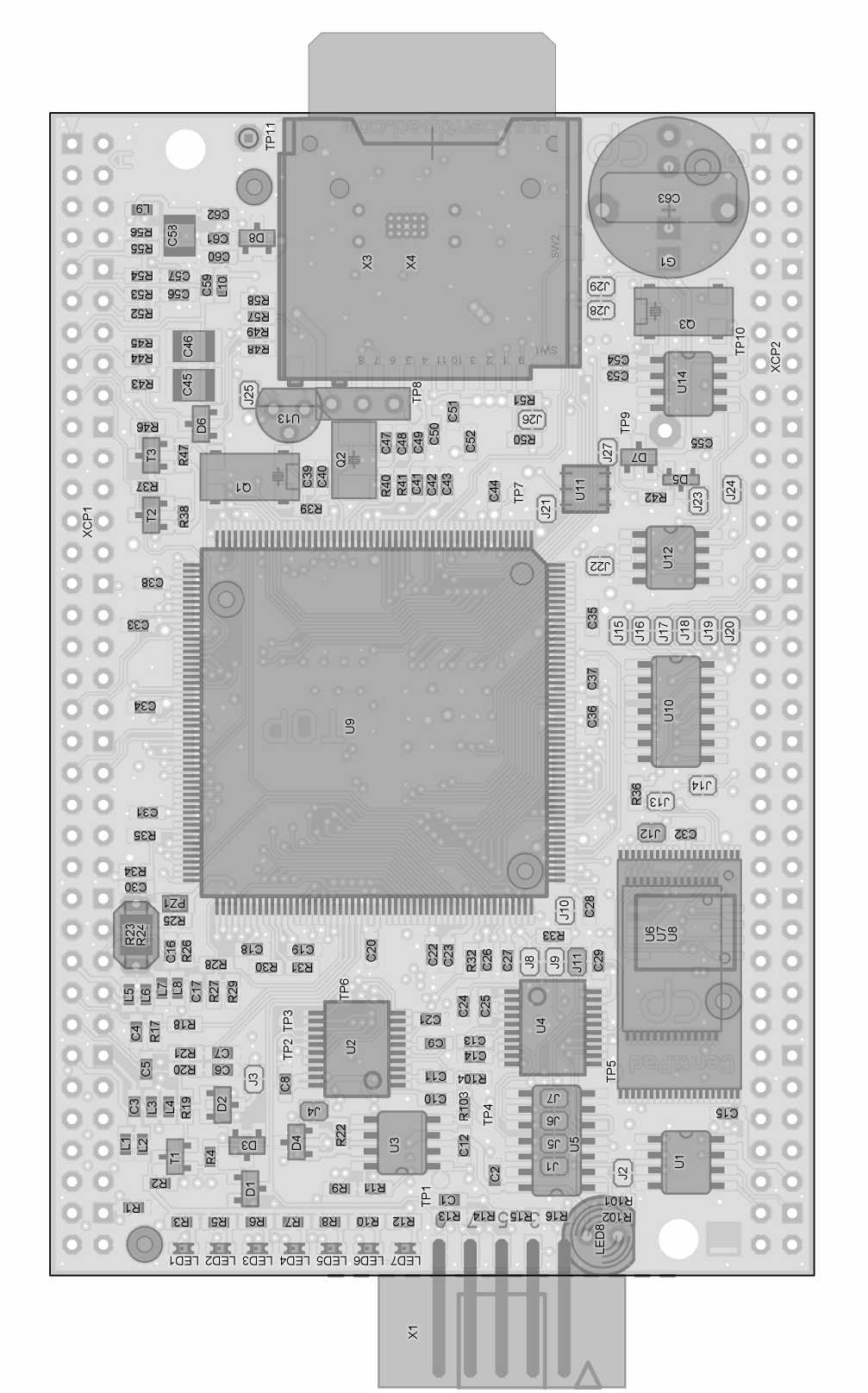
All dimensions in mm

2.4 environmental conditions

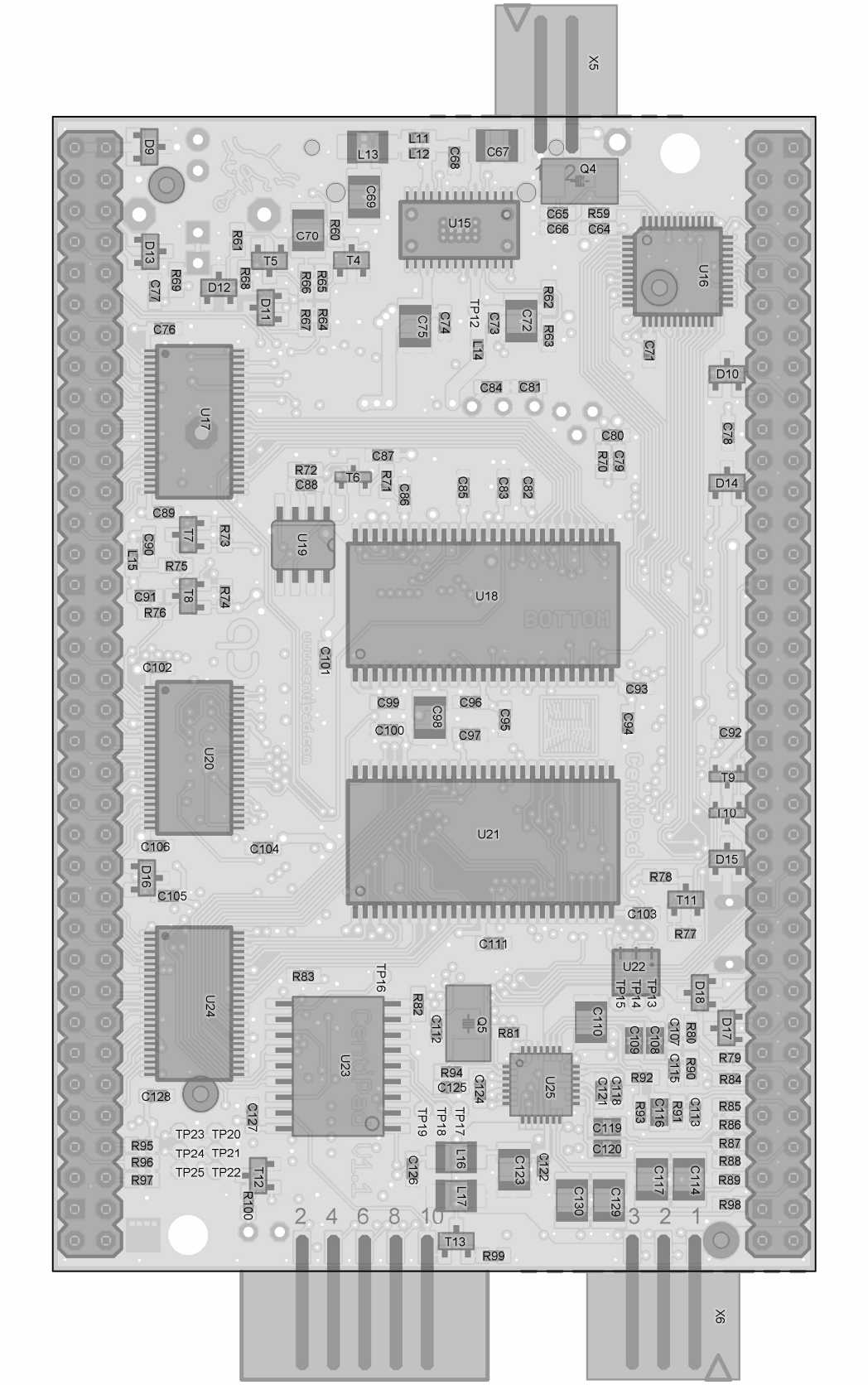
Relative humidity: 10%..90% non condensing
Temperature range: +5°C bis +70°C
Important: in environmental temperatures exceeding +40°C the CPU must be cooled or the clock rate must be reduced to 150MHz.

3 configuration

3.1 Top view



3.2 Bottom view



3.3 Soldered jumpers

Board revision CentiPad112:

Name	Standard	description
J1,J2,J5,J6,J7 J8,J9,J10,J11	-	jumpers to switch TTY1 between RS232 and RS485 RS232 with V24 level: only J11 closed (Standard) RS232 with 3,3 level: only J1,J5,J6,J7 closed RS422 operation: only J2, J8, J10 closed RS485 operation: only J2, J9, J10 closed
J3	open	jumper to switch between Self-/Bus-Powered USB-Device; if closed the complete CentiPad will be Host-powered. Observe total power consumption by CentiPad and peripherals. Observer USB-driver settings. Open = self powered, closed = bus powered
J4	closed	120Ω CAN bus terminination
J12	100Ω	BootFlash Read; open = no flash read, closed = flash read/write Normally closed by 100Ω resistor. Bridge the side facing the edge to prevent faulty firmware from booting (SPI-MISO will be shorted on CPU side).
J13	open	BootFlash Write Protect; open = write enable, closed = write disable
J15..J20,J14	open	jumper to connect the unbuffered address lines A16..A22 to ConB27..33
J21	open	connection between board power and the power supply pin of the 1wire pad U11, open for devices with parasitic power supply
J22	closed	Boot-EEPROM-I2C-Address select; offen= 0xA0, gebrückt = 0xA7/0xAF (with 24xx mounted, the address line must be pulled down)
J24	open	EEPROM Write Protect; open = write enabled, closed = read only
J25	open	connects board power to 1wire powerof 1wire-pad U13; open if devices with parasitic power supply are used
J26	open	MiniSD Write Protect; open = write enabled, closed = read only; driver dependend!
J27,J23	J27	RTC-Goldcap is always charged via 5V supply: J27 closed (standard) Operation with clock battery G1: J23,J27 open Goldcap charging via 3,3V peripheral voltage: J23,J27 open If needed, J23 can reduce the Goldcap charge voltage
J28	open	Start on power up – if closed CentiPad autimatically starts when 5V power is supplied. This jumper connects the PWR_EN\-signal to GND. Caution: the Bootloader-Menu will not show through release of the PWR_EN\-signals
J29	closed	RTC System Start, when this jumper is closed, the RTC-alarm can start the system power supply and thus start the sleeping CentiPad. This function is driver dependend, normally closed, not active on reset RTC. Connects PWR_EN\ to the open-collector INT\-output of the RTC.

Caution: if closed, CentiPad will only power down if INT\ is cleared.

3.4 Testpads

Board revision CentiPad112:

Name	Name	Beschreibung
TP1	TXCAN	CAN Controller TXD,3,3V
TP2	DTXD	DTXD 3,3V
TP2	DRXD	DRXD 3,3V
TP4	RXCAN	CAN Controller RXD,3,3V
TP5	INVALID#4	U4 RS232 Invalid# Pin
TP6	INVALID#2	U2 RS232 Invalid# Pin
TP7	+3.3	+3,3V Peripherie-Spannung
TP8	+1.8F	+1,8V filtered Core-voltage
TP9	RTC_VDD	RTC power supply
TP10	RTC_CLKOUT	32768Hz RTC clock
TP11	GND	digital ground
TP12	+1.8	+1,8V Core-voltage
TP13	U22_6	U22 Pin 6
TP14	U22_5	U22 Pin 5
TP15	U22_4	U22 Pin 4
TP16	RX0BF\	CAN Controller RX0BF\-Pin
TP17	TX2RTS\	CAN Controller TX2RTS\-Pin
TP18	TX1RTS\	CAN Controller TX1RTS\-Pin
TP19	TX0RTS \	CAN Controller TX0RTS\-Pin
TP23	I2C_VCCOUT	filtered I2C reference voltage
TP25	GND	digital ground

3.5 Parts / mounting options

board revision CentiPad112:
CentiPad is a generic embedded Linux board targeted at various applications. Different configurations are possible according to the customer needs. This paragraph gives an overview of possible variations:

Name	Standard	Description
R23/R24	R24	CentiPad USB Host Thermo-fuse.
U4	mounted	RS232 driver for TXD1, RXD1, RTS1, CTS1
U5	-	RS422/RS485 driver at serial 1
X6	-	three pin connector PSK3 for GND, TXDD, RXDD
U21/U18	mounted	SDRAM, with U21 only, the SDRAM-Bus is operated at 16bit width, U21 and U18 together, provide the CPU with a 32bit-SDRAM-Bus resulting in higher performance. 16MB or 32MB are possible, if both banks are fitted, the chips should be identical
U6/U7/U8	-	verious Flash-Sizes are possible, CASON8 and TSSOP cases are possible.
R32	mounted	BMS – Boot Mode Select, if R32 is mounted, the AT91RM9200 boots from ist internal 128k Bootrom.
U17,U24,U20	mounted	Bus Driver for external Data/Address-bus
R100,T12,LED8	-	can be used to drive a LED via the TC-pin
U14,G1,C63	-	RTC, Goldcap C63 or battery G1 alternatively
U25	mounted	if no sound system is required, U25 and ist analog periphery can be omitted
T11,R78,R25,PZ1	-	pads to connect a Piezo-beeper
U23, U3	mounted	CAN master and driver
U19	-	1-wire-Interface
U13,U22,U11	-	pads for 1-wire-devices

U1	-	pad for additional I2C-Device, e.g. EEPROM
U12	mounted	configuration-EEPROM
U16	mounted	Ethernet PHY with peripherals

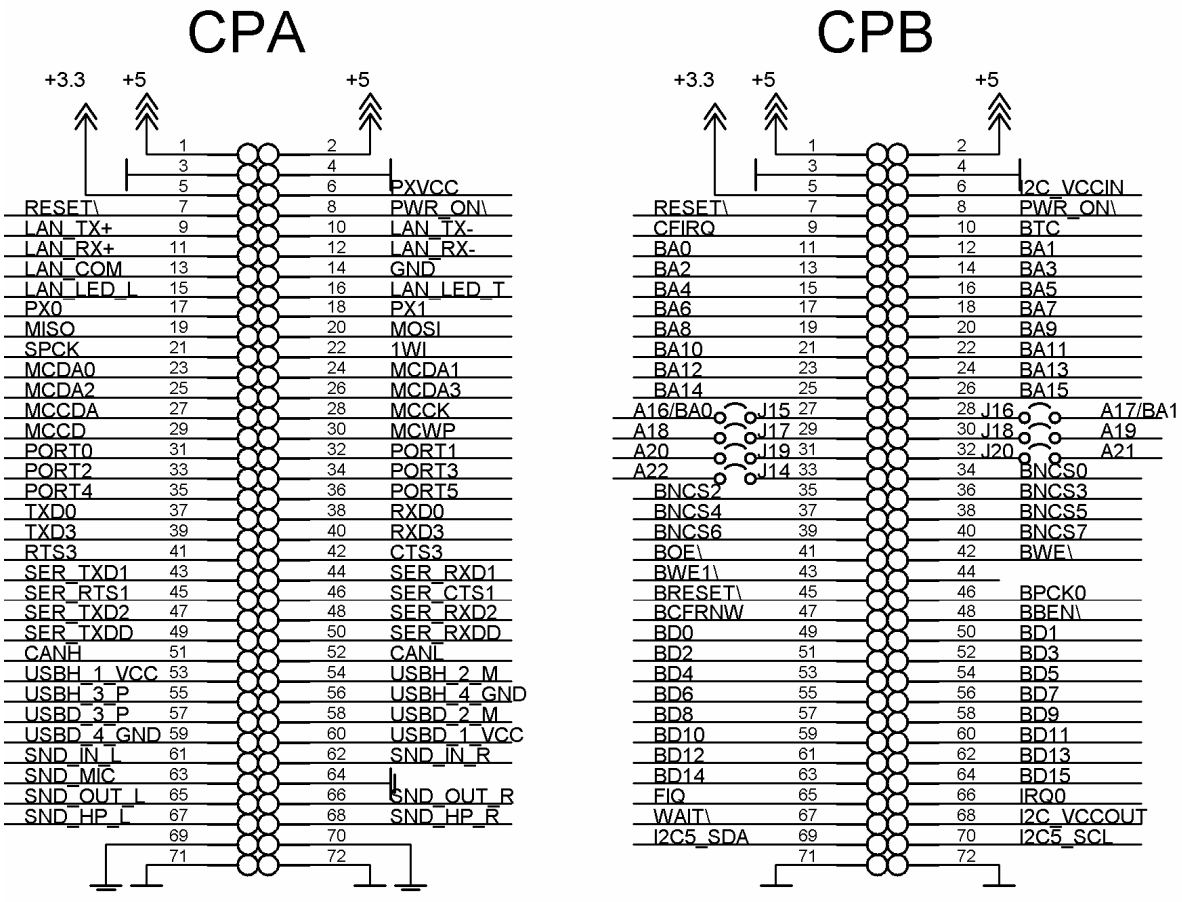
ESD-Diodes	**Signal**	**Description**
D3	USBD_1_VCC	USB-Device-power-supply
D4	CANH, CANL	CAN Data
D8	+5	power-supply
D9	+5	power-supply X5
D12	RESET\	Reset input
	PWR_ON\	PWR_ON\ input
D16	I2C5_SDA	TWI Data
	I2C5_SCL	TWI Clock
D17	USBD_3_P	USB Data P
	USBD_2_M	USB Data M
D18	USBH_3_P	USB Host Data P
	USBH_2_M	USB Host Data M
D10	PX0, PX1	PortX
D14	1WI	1-Wire

4 ExpansionPort

4.1 description

The ExpansionPort connects the CentiPad to the outside world. The connector is a 2,54mm (0,1inch) standard grid, which is independent of special single source connectors. Both terminal strips are double row, 72pin. The middle distance between the terminal strips is 55,88mm (2,2inch).
The ExpansionPort is specific to the CentiPad, since no standard interface even remotely covers the plethora of its peripheral interfaces.
The ExpansionPort devides into CPA with the integrated peripherals (Sound, SD-Card, LAN, USB, RS232, …) and CPB with the buffered processor bus with 16 address- and 16 datalines as well as the Controllbus. This bus is augmented by additional unbuffered address lines and the CF and I2C-Interface.

4.2 Pinout



CPA

Pin	Name	Signal type	Peripheral device	Signal	Signal type	Alternative1	GPIO
1	+5 (in)	Pow	Power				
2	+5 (in)	Pow					
3	GND						
4	GND						
5	+3.3 (out)	Sup					
6	PXVCC	Pow					
7	RESET\	I/O					
8	PWR_DOWN	I/O					
9	LAN_1_TX+		LAN				
10	LAN_2_TX-						
11	LAN_3_RX+						
12	LAN_6_RX-						
13	LAN_COM						
14	GND						
15	LAN_LED_L	O					
16	LAN_LED_T	O					
17	PX0	Port 3,3..12V comp.		RTS0		Ser0	PA21
18	PX1			CTS0			PA20
19	MISO	I	SPI				PA0
20	MOSI	O					PA1
21	SPCK	O					PA2
22	1WI	I/O	1-Wire				
23	MCDA0	I/O	SD / MMC				PA29
24	MCDA1	I/O		RD0		Sync.Serial 1/ 2	PB3
25	MCDA2	I/O		RK0			PB4
26	MCDA3	I/O		RF0			PB5
27	MCCDA			TD0			PA28
28	MCCK						PA27
29	MCCD	I					PB25
30	MCWP	I					PB2
31	PORT0	I/O	Port I/O				PC0
32	PORT1	I/O					PC1
33	PORT2	I/O					PC2
34	PORT3	I/O					PC3
35	PORT4	I/O					PC4
36	PORT5	I/O					PC5
37	TXD0	O	Ser0				PA17
38	RXD0	I					PA18
39	TXD3	O	Ser3	NPCS2	O	SPI Select	PA5
40	RXD3	I		NPCS3	O		PA6
41	RTS3	O		TK0		Sync.Serial 2/2	PB0
42	CTS3	I		TF0			PB1
43	SER_TXD1	O	Ser1	TX+		RS422 / RS485	PB20
44	SER_RXD1	I		RX+			PB21
45	SER_RTS1	O		TX-			PB26
46	SER_CTS1	I		RX-			PB24
47	SER_TXD2	O	Ser2				PA23
48	SER_RXD2	I					PA22
49	SER_TXDD	O	SerDebug	RTS2 (V24)	O	Ser2	PA31
50	SER_RXDD	I		CTS2 (V24)	I		PA30
51	CANH	I/O	CAN				
52	CANL	I/O					
53	USBH_1_VCC	Pow	USB Host				

54	USBH_2_M	I/O	
55	USBH_3_P	I/O	
56	USBH_4_GND		
57	USBD_3_P	I/O	USB_Device
58	USBD_2_M	I/O	
59	USBD_4_GND		
60	USBD_1_VCC	I	
61	SND_IN_L	AI	Sound
62	SND_IN_L	AI	
63	SND_MIC	AI	
64	AGND		
65	SND_OUT_L	AO	
66	SND_OUT_R	AO	
67	SND_HP_L	AO	
68	SND_HP_R	AO	
69	AGND		
70	AGND		
71	GND		
72	GND		

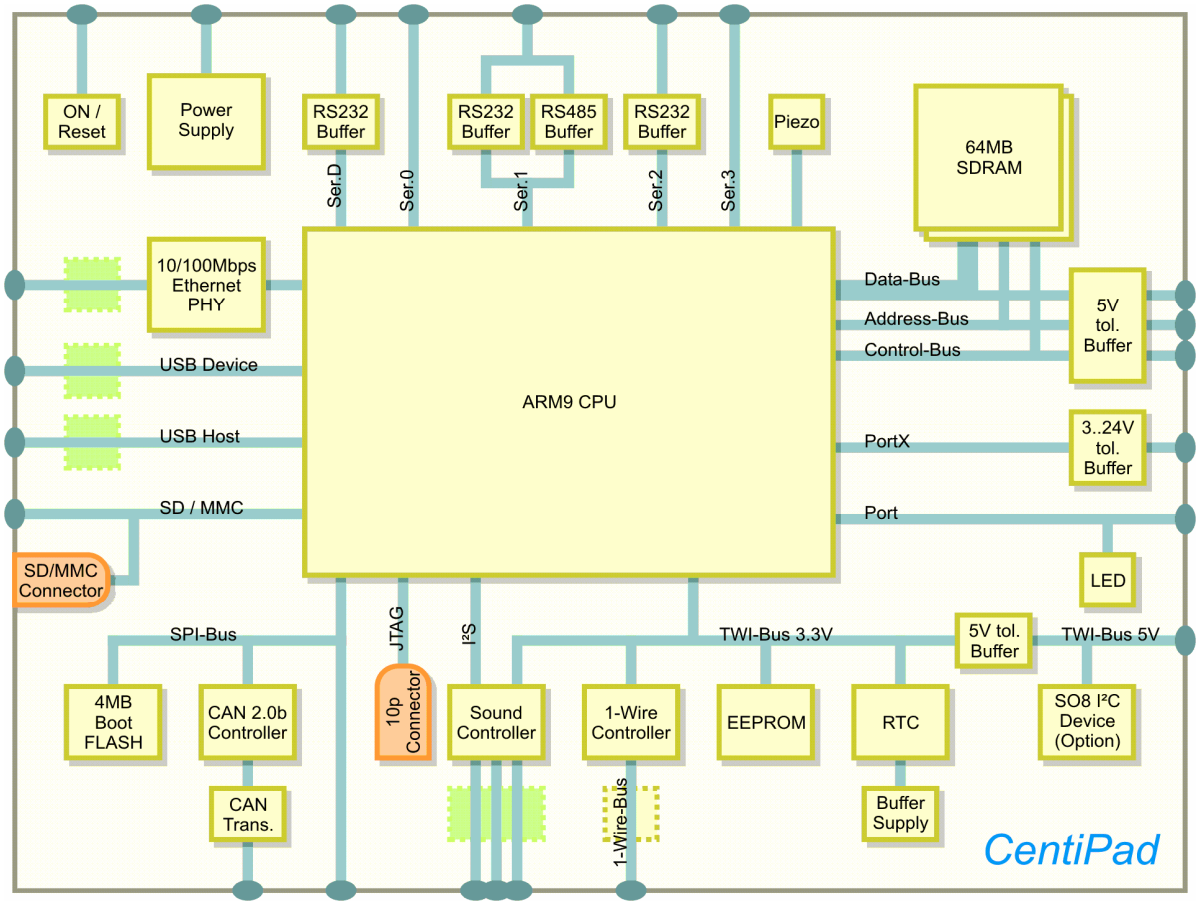
CPB

Pin	Name	Signal type	Peripheral device	Signal	Signal type	Alternative 1	GPIO
1	+5 (in)	Pow	Power				
2	+5 (in)	Pow					
3	GND						
4	GND						
5	+3.3 (out)	Sup					
6	I2C_VCCin	Pow					
7	RESET\						
8	PWR_ON\						
9	CFIRQ						PA19
10	BTC	BO	Port	A23	BO	Bus	PC7
11	BA0	BO	Address Bus	BS0		H/L Select	
12	BA1	BO		BS2			
13	BA2	BO					
14	BA3	BO					
15	BA4	BO					
16	BA5	BO					
17	BA6	BO					
18	BA7	BO					
19	BA8	BO					
20	BA9	BO					
21	BA10	BO					
22	BA11	BO					
23	BA12	BO					
24	BA13	BO					
25	BA14	BO					
26	BA15	BO					
27	A16/BA0	O		BA0		SDRAM Bank	
28	A17/BA1	O		BA1			
29	A18	O					
30	A19	O					
31	A20	O					
32	A21	O					
33	A22	O					
34	BNCS0	BO	Chip Select				
35	BNCS2	BO					
36	BNCS3	BO					
37	BNCS4	BO		CFCS		Compact Flash	PC10
38	BNCS5	BO		CFCE1			PC11
39	BNCS6	BO		CFCE2			PC12
40	BNCS7	BO					PC13
41	BOE\	BO	Ctrl Bus	CFOE			
42	BWE\	BO		CFWE			
43	BWE1	BO		CFIOR			
44		BO		CFIOW			
45	BRESET\	BO					
46	BPCK0	BO					PB27
47	BCFRNW	BO		CFRNW			PC9
48	BBEN\	BO					
49	BD0	BI/O	Data Bus				
50	BD1	BI/O					
51	BD2	BI/O					
52	BD3	BI/O					
53	BD4	BI/O					

54	BD5	BI/O			
55	BD6	BI/O			
56	BD7	BI/O			
57	BD8	BI/O			
58	BD9	BI/O			
59	BD10	BI/O			
60	BD11	BI/O			
61	BD12	BI/O			
62	BD13	BI/O			
63	BD14	BI/O			
64	BD15	BI/O			
65	FIQ	OC	Interrupt		PB28
66	IRQ0	OC			PB29
67	WAIT\	OC	Wait		PC6
68	I2C_VCCOUT	Sup	I2C		
69	I2C5_SDA	I/O			PA25
70	I2C5_SCL	I/O			PA26
71	GND				
72	GND				

5 System components

The AT91RM9200 integrates an ARM9 CPU with diverse peripherals. On the CentiPad those are usually fitted with external drivers and connected to the ExpansionPort CPA/CPB. Thais chapter provides an overview of the components and their interdependencies.



5.1 Power supply / Power Management

5.1.1 Power consumption

Due to the low power consumption and to reduce EMI, the internal power supply is provided by linear regulators which convert the 5V supply to 3,3V peripheral- and 1,8V core-voltage.
The 3,3V peripheral voltage is available at the ExpansionPort and may be loaded up to 250mA.
The 5V supply is also provided on the ExpansionPort, the external load must be limited to 500mA (minus the 3,3V-peripheral current).

Current consumption:

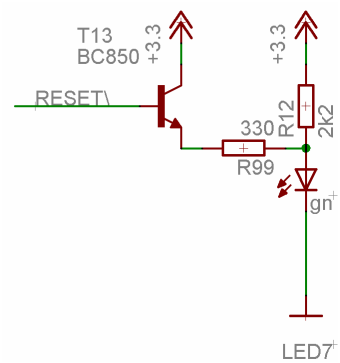
CPU 180MHz	- 140mA (KIT-light)
CentiPad Powerdown	- 60µA (5V-supply, waiting for Power Enable, RTC Goldcap fully charged)
Sound playback	- 170mA (madplay)

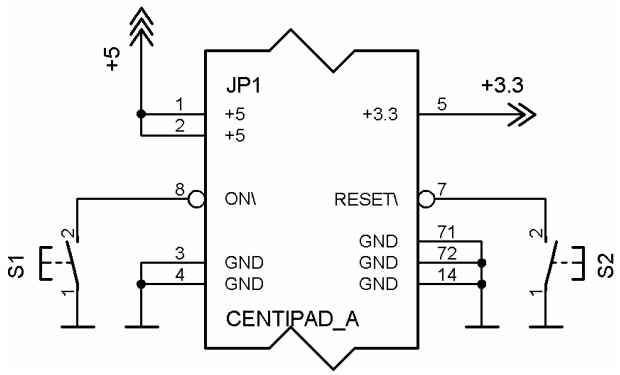
5.1.2 Power up

The green System active LED7 signals the 3,3V peripheral supply by glowing dimly. When RESET\ is high LED7 lights up. If J28 is closed, CentiPad automaticall starts when the 5V power is available.

5.1.3 Power On/OFF-key

If J28 is open a low signal at PWR_ON\ starts the 3,3V peripheral voltage. 250ms after the peripheral volatge has stabilized the voltage regulator releases the RESET\-line – LED7 ligzts up, CentiPad starts. At startup PWR_ON\ must be held low for at least 500ms.





If J28 is open, CentiPad switches off when RESET\ is held low longer than one 1s. For this feature a driver must set up the internal PullUp at PC15. This functionality is implemented in the bootloader.

5.1.4 Power On/Off via Software

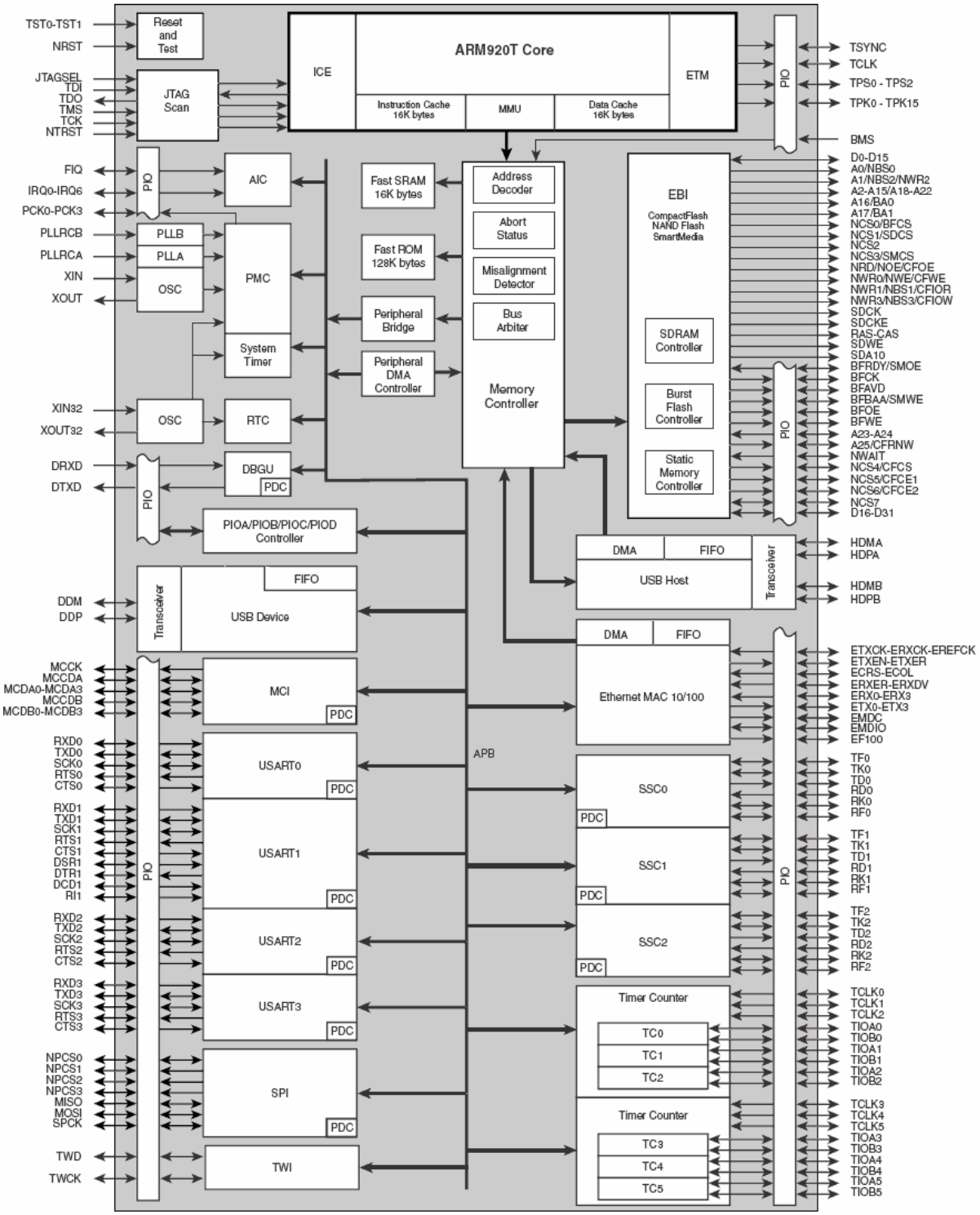
If J28 is open, software can shut the system down via the signals PWR_SWITCH_DETECT (input PC15) and PWR_DOWN\ (output PC14).
PC14 and PC15 are normally configured as inputs. To power down, PC14 must be configured as output and be pulled low. CentiPad will switch off after about 1s.
PC15 can read back the status of the PWR_ON\ line. If PWR_ON\ is pulled low during normal operation, the application software could initiate a controlled shutdown.

5.1.5 PowerOn via RTC

The integrated real time clock can wake up the CentiPad at a programmed time. This could be used for a datalogger application which powers th system up at certain times for a measurement and then executes a shutdown.
If the system is configured for software on/off and J29 is closed, the RTC can pull the PWR_EN\ signal low.

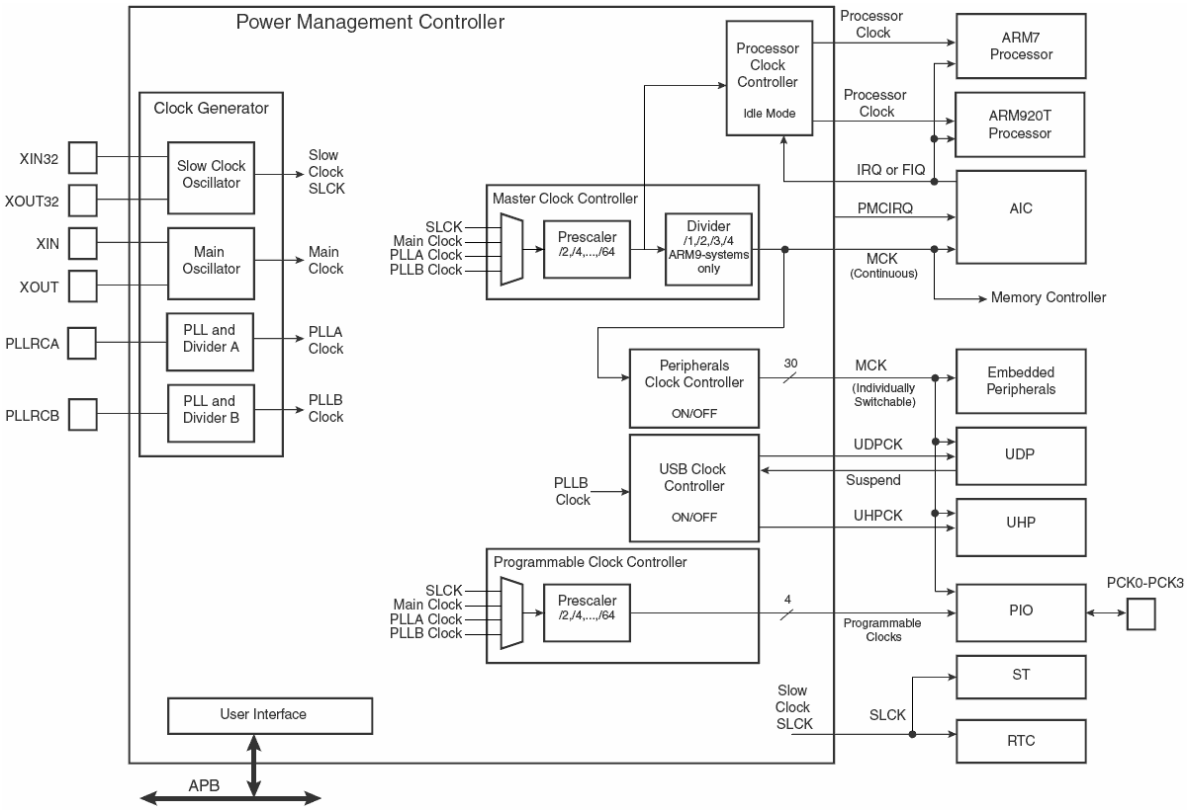
5.2 CPU

The CentiPad CPU is an ARM920T based AT91RM9200 microcontroller.
The CPU yields 200MIPS at 180MHz clock rate and contains 16kByte Data and Instruction Cache.



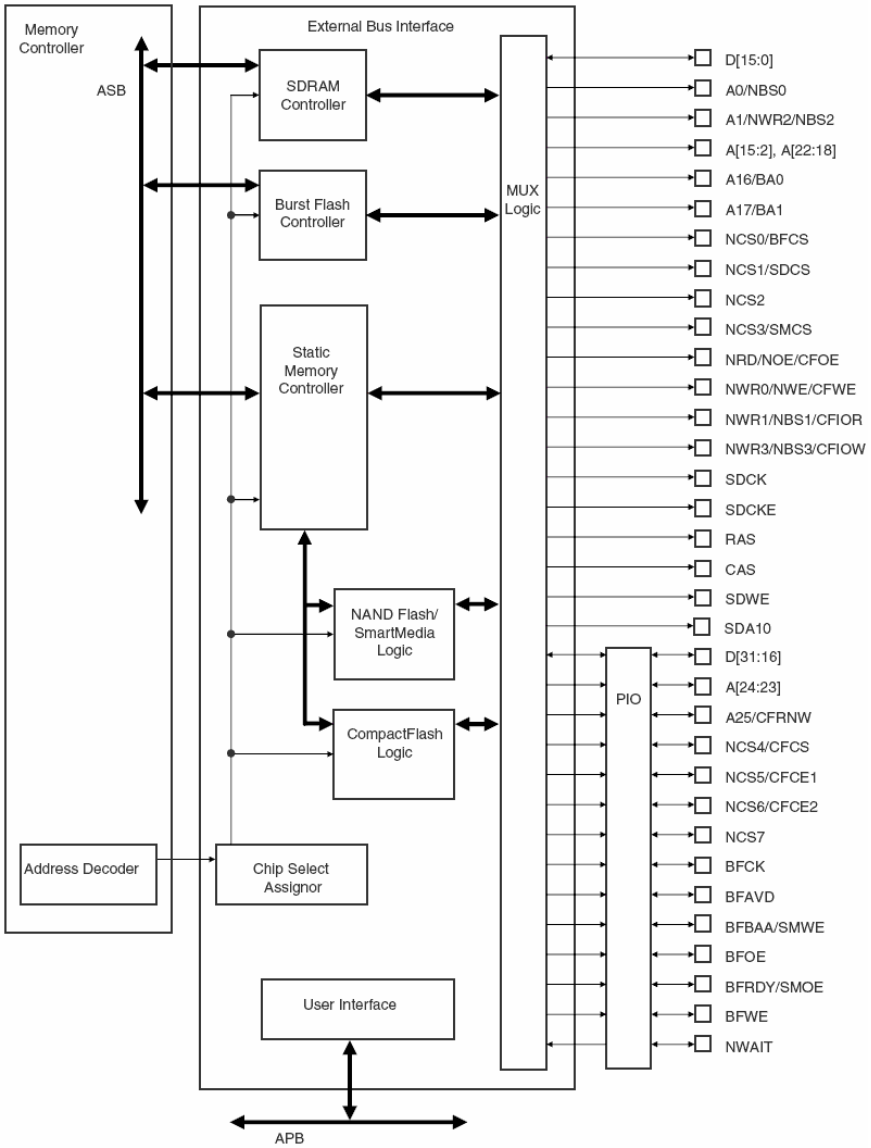
[aus AT91RM9200 Datasheet]

A 32768Hz reference clock is used to calculate the parameters for the internal PLLs, which generate the the processor clock (PLLRCA, nominal 180MHz) and the USB (PLLRCB, nominal 96MHz).



[aus AT91RM9200 Datasheet]

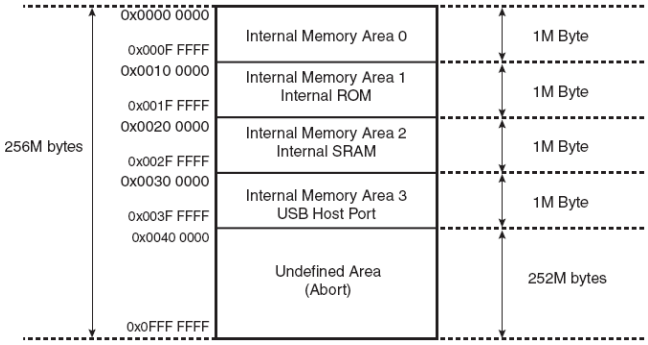
The External Bus Interface provides connectivity for SDRAM, SDcard, Compact Flash and static memory.



[from AT91RM9200 Datasheet]

The CPU contains various peripherals which are described below. As usual with highly integrated microcontroller parts, the user can select between different peripheral configurations. Most pins have multiple possible configurations.

The control registers are located in a 256MB memory segment.



[from AT91RM9200 Datasheet]

5.3 SDRAM

The AT91RM9200 contains a SDRAM-Controller for direct connection of SDRAM-parts. Alternatively CentiPad may be fitted with one or two MT48LC16M16A2 (32/64MByte) or MT48LC8M16A2 (16/32MByte). When using two SDRAM chips, both must be the same type.
If only one memory chip is mounted the access is 16bit only, causing a performance reduction.

System connection:
- External Bus Interface
- NCS1: External Memory Area 1
- 0x20000000 - 0x23FFFFFF (64MB)

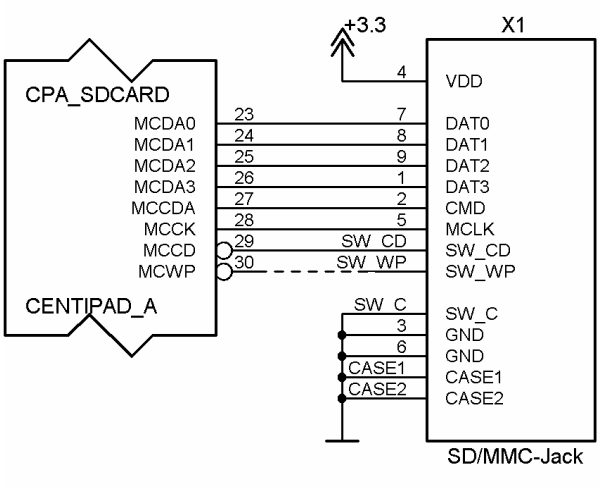
5.4 DataFlash

CentiPad is fitted with a serial DataFlash (16/32/64Mbit 2/4/8MByte). This device is bootable and provides memory for operating system and applications.

System connection:
- SPI-Interface
- NPCS0-Chipselect

The DataFlash is shipped with the maintech-bootloader and Linux installed. The bootloader is automatically executed at power-up. See chapter „bootloader".
Note: the DataFlash is partitioned into three sections: bottloader stage1/2 and mass storage.

5.5 MiniSD / SD / MMC



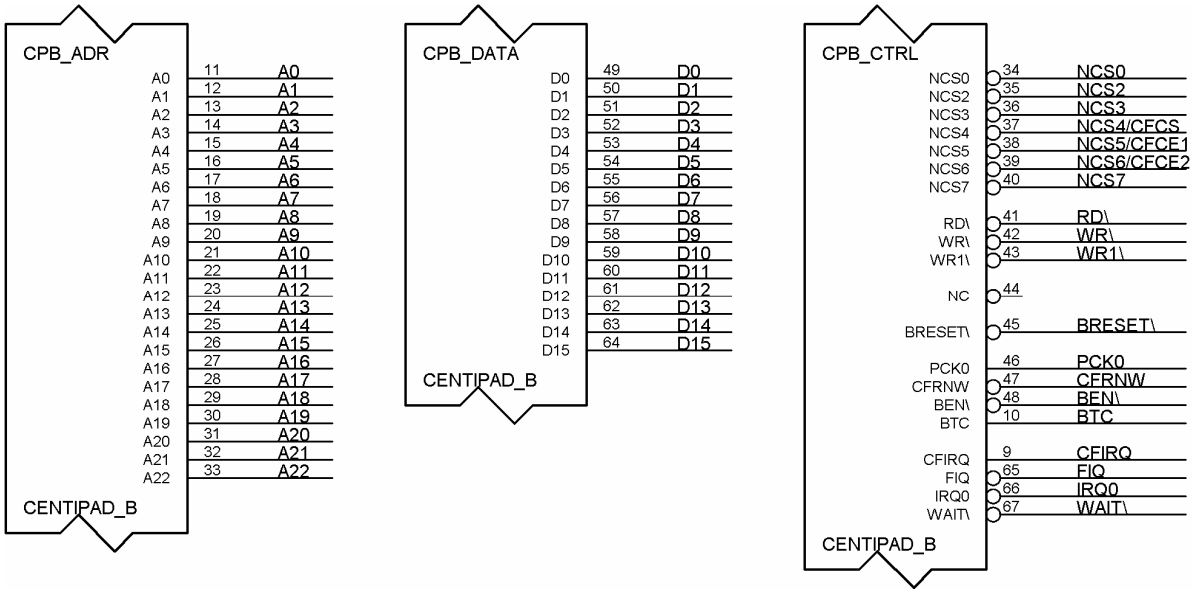
CentiPad is fitted with a bootable MiniSDcard connector. This storage can supplement the DataFlash and provide ample memory to applications.
The signal lines are available on the ExpansionPort, thus enabling the usage of a custom SD-Card connector.

System connection:

-	MCDA0..3	: ConA 23..26	: 4bit Data
-	MCCDA	: ConA 27	: Cmd
-	MCCK	: ConA 28	: Clock
-	MCCD	: ConA 29	: Card Detect
-	MCWP	: ConA 30	: Write Protect

Differences between memory devices:
mmc: MultiMediaCard, 1bit interface
SDcard: Secure Data card, 1..4bit interface, many SDcards can be accessed like a mmc-card.

5.6 External Data Bus



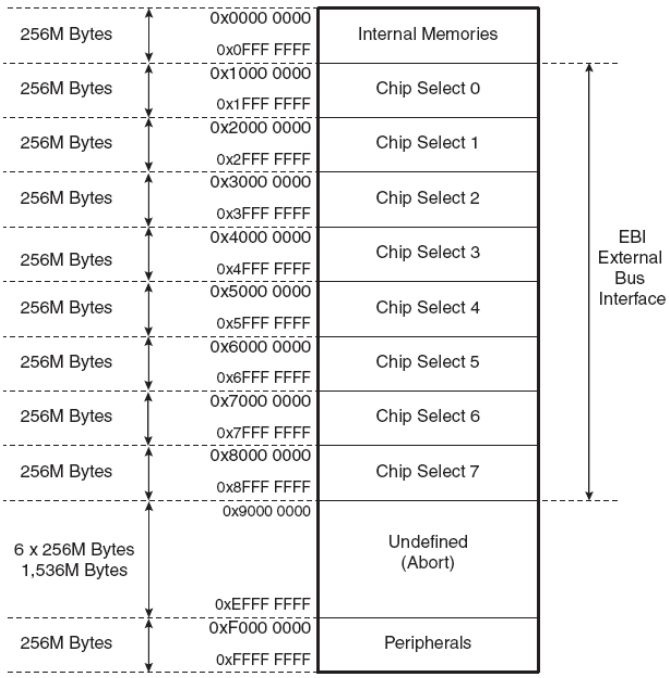
The ExpansionPort CPB carries the External Bus Interface signals.

- Data-/Address-/Control-Bus
- 5V tolerant 3,3V-IO-Buffer
- buffered A0..15, D0..15 are active only at external bus access (EMI-optimized)
- low-active NCSx are ANDed into a low-active BUSEN\-Signal. BUSEN\ enables the IO-Buffer (Tristate)
- if J15..J22,J14 are closed A16..A22 are provided unbuffered at ConB27..33

System connection:

- BD0..BD15 : ConB 49..64 : Buffered 16bit Data
- BA0..BA15 : ConB 11..26 : Buffered 16bit Address
- A16/BA0 : ConB 27 : direct processor address line
- A17/BA1 : ConB 28 : direct processor address line
- A18..A22 : ConB 29..33 : direct processor address line
- BNCS0 : ConB 34 : Buffered Chip Select
- BNCS2..7 : ConB 35..40 : Buffered Chip Selects
- BTC : ConB 10 : Buffered A23, otherwise GPIO
- BOE\ : ConB 41 : Buffered Output Enable
- BWE\ : ConB 42 : Buffered Write Enable
- BBS1 : ConB 43 : Buffered IORD or Low Word Select
- BBS3 : ConB 44 : Buffered IOWR or High Word Select
- BRESET\ : ConB 45 : Buffered Bus Reset
- BPCK0 : ConB 46 : Buffered Programmable Clock 0
- BCFRNW : ConB 47 : Buffered CF Read Not Write / A25
- BBEN\ : ConB 48 : Buffered BUSEN\ signal

AT91RM9200 EBI memory areas of SMC (Smart Memory Controller):



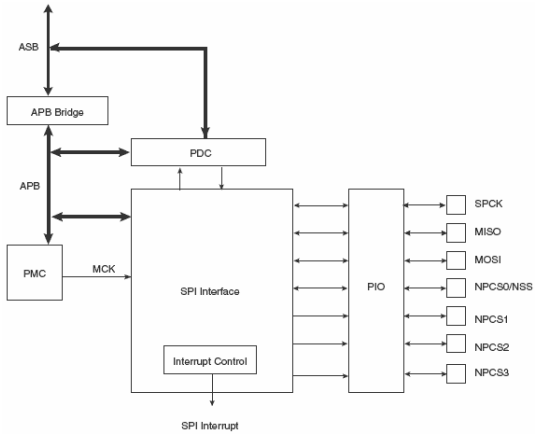
[from AT91RM9200 Datasheet]

Usage of the 8 ChipSelects:

	variant	**standard**	**special**
NCS0	SMC/BurstFlash		
NCS1	SMC/SDRAM	SDRAM	
NCS2	-	-	LCD on CentiBOB
NCS3	SMC/Flash/SM		
NCS4	SMC/Flash/SM/CF		
NCS5	SMC/Flash/SM/CF		harddisk / CF
NCS6	SMC/Flash/SM/CF		harddisk / CF
NCS7	SMC		pre-activation of bus

As soon as a NCSx-line is activated the 74LVC16245 bus driver become active. Each driver has a propagation delay of less than 7ns. The drivers are not short-circuit proof! The input voltage during operation must not exceed 5,25V! When CentiPad is powered down, external devices must be powered down as well.
Some bus devices require the address, data and control lines to be active before chip select. This issue is solved by pre-activating one NCSx-line before the bus-cycle. On the CentiBob NCS7 is used.

5.7 SPI-Bus



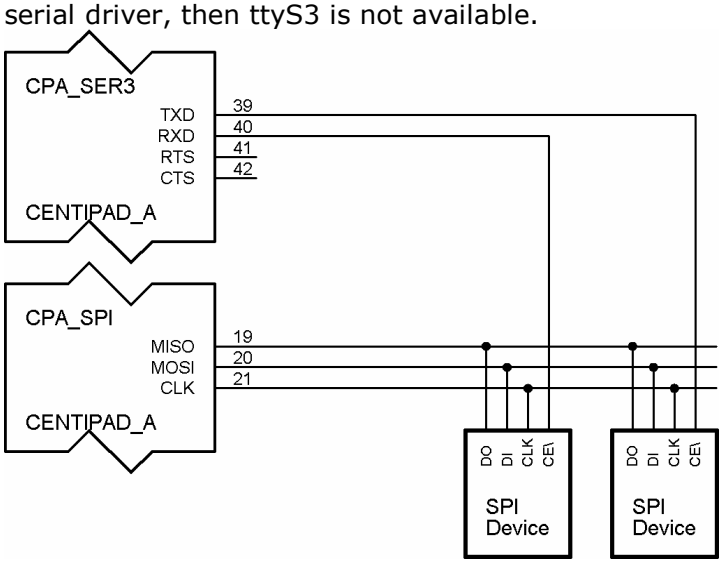
[from AT91RM9200 Datasheet]

The CPU's synchronous peripheral interface bus is used internally on the CentiPad and is available for external extensions. The SPI-controller provides 4 chips select lines which can be augmented by the Port0..5 lines.

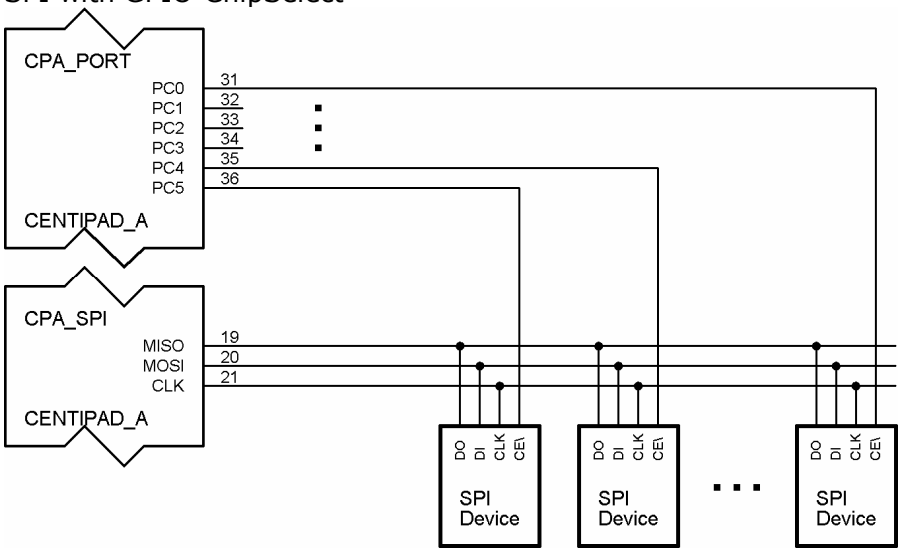
System connection:

Chipselect	**Device**
NPCS0	Boot Flash
NPCS1	CAN-Controller
NPCS2	ExpansionPort ConA39
NPCS3	ExpansionPort ConA40
Port0..5	ExpansionPort ConA31..36

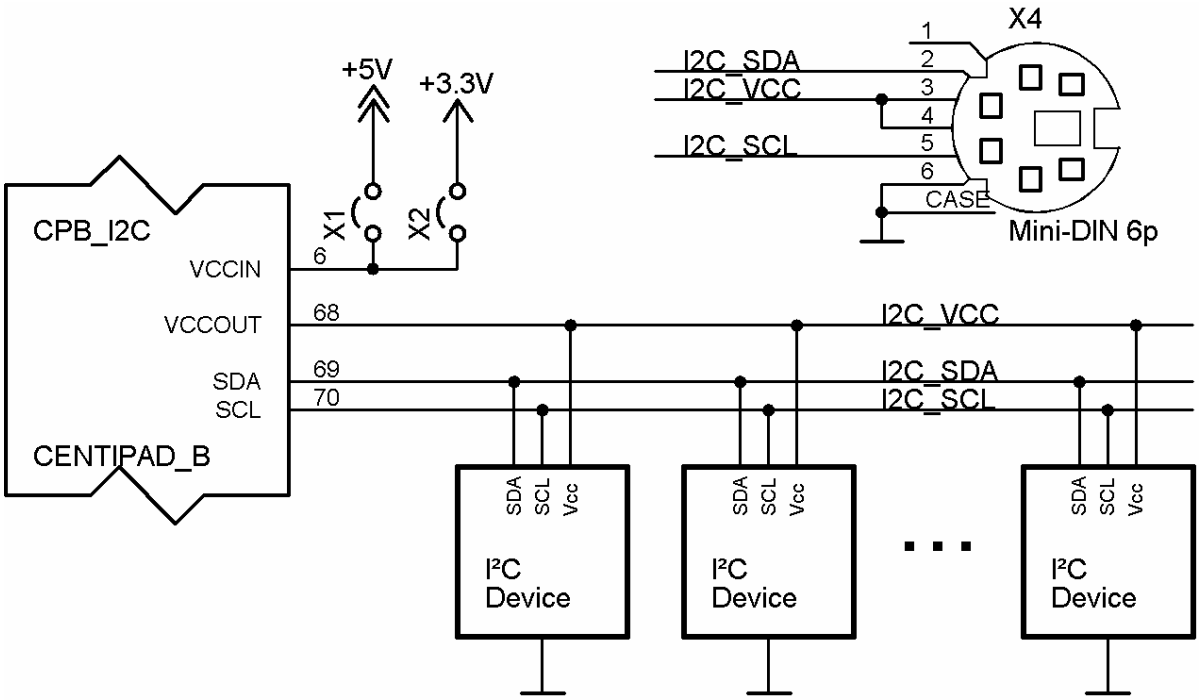
CentiPad Linux maps the the chip selects to /dev/spi0..spi3.
Caution: NPCS2 and NPCS3 are shared with the serial interface 3. These chip selects are available only if the serial interface is deactivated. If the SPI-driver is loaded before the serial driver, then ttyS3 is not available.



SPI with GPIO-ChipSelect



5.8 TWI – Two Wire Interface / I²C



The CPU features a TWI-interface which is used by internal components and is available on the ExpansionPort.
A special feature is the extended signal level range of the external interface, if the external system provides a higher level reference at ConB 6. If ConB6 remains open, the internal 3,3V reference is used.
CentiPad includes the mandatory TWI-pullup-resistors.
The TWI-bus is limited to 100kHz, since this is the maximum signaling rate of the soundchip.
Caution: The busdrivers are limited to 8mA. The TWI-bus is sensitive to line impedances. After connecting external components the bus stability should be tested thoroughly.

System connection:

I2C_VCCIN	: ConB 6	: input for optional external signaling voltage reference 3,3V..5V
I2C_VCCOUT	: ConB 68	: filtered output for pullup voltage of the external TWI-interface, is 3,3V or the external reference voltage. This line can be loaded up to 50mA, higher loads will damage the CentiPad.
I2C_SDA	: Con 69	: Open-Collector-Data line
I2C_SCL	: Con 70	: Open-Collector-Clock line

Adress: A6..A0:

Adresse:	**Device:**
$18	DS2482-100
$19	WM8731
$50	EEPROM U12 (J22 open), maintech-configuration (standard)
$51	PCF8563 RTC
$57	EEPROM U12 (J22 closed), external EEPROM

5.9 EEPROM

Standard outfit is one ST24C64 with 8kB. EEPROMs with the same pinout can be used alternatively. The EEPROM at TWI-Address $57 contains the bootloader configuration data (a.g. MAC Address and Startup information). Please refer to maintech-Bootloader-Docu, if the EEPROM is to be used for user applications.

For internal address usage refer to „System structure/I2C-Bus".

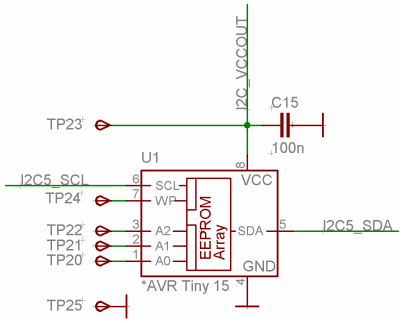
If jumper J22 is opened the EEPROM will be reconfigured from TWI-address $57 to address $50. Thus the system-configuration can be read from an EEPROM on the carrier board.

5.10 RTC

The RTC is either GoldCap- or battery-buffered and provides the operating system with the current time at startup. Via the INT\-line of the PCF8563-04 the sleeping CentiPad can be started.
Compare to chapter „power supply".

System connection:
TWI $51

5.11 TWI-Pad

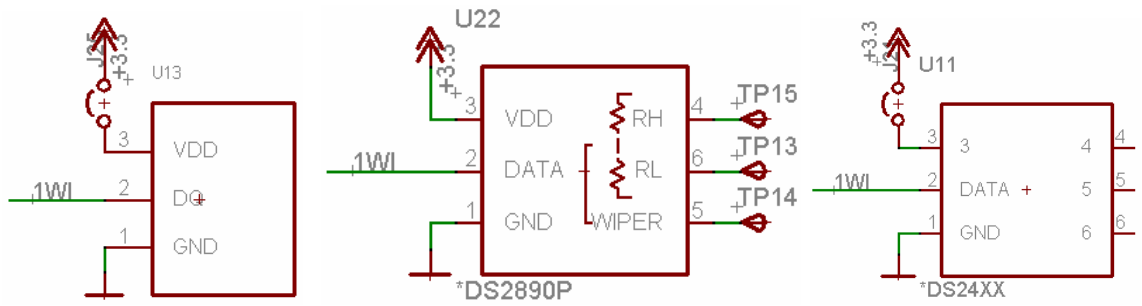


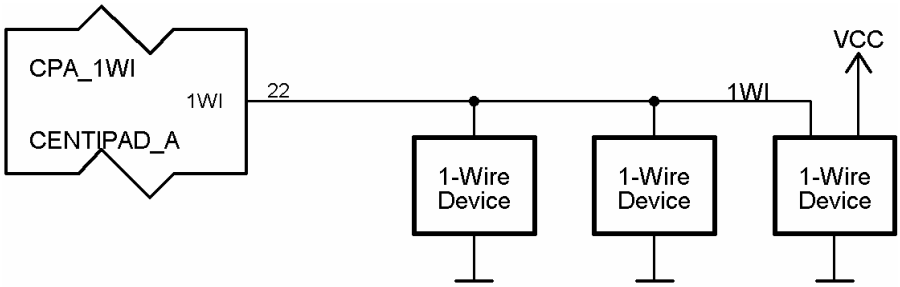
The TWI-Pad U1 provides space for a 8-Pin TWI-Device or a Tiny1x-AVR.

5.12 1-wire-Controller

The Dallas 1wire bus is provides a 2/3-wire bus interface for distributed sensorics (Data, Ground, optional power supply). The 1wire interface uses PWM-signaling and would pose quite a CPU load when implemented via GPIO. The CentiPad features the DS2482-100 TWI-to-1-wire-Bus-Controller, thus prividing an interface to multible 1wire devices with minimal bus load.
Many 1wire-device use parasitic power supply via the data line (compare to respective datasheet, CentiPad has a strong PullUp onboard). CentiPad provides pads for 1wire devices:

- U13 DS18B20 Temperature sensor
- U22 DS2890 Potentiometer
- U11 DS24xx EEPROM





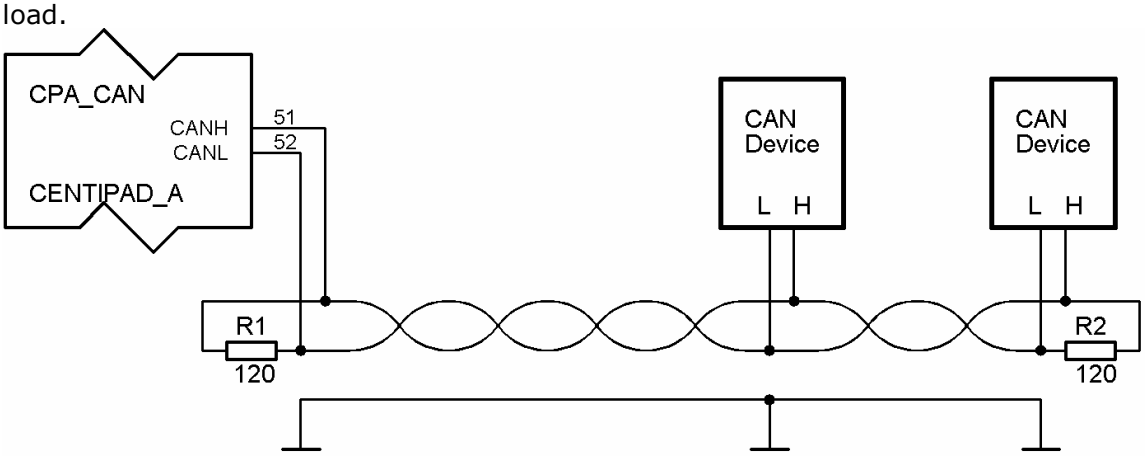
System connection:

- 1WI : ConA 22 : Data
- +3,3V : ConA 5 : optional +3,3V supply
- GND : ConA 71/72 : ground

Caution: 1wire-Devices are limited to 3,3V Signals. Higher voltages will destroy the 1wire-Master-Chip.

5.13 CAN-Controller

The CAN-Controller with buffer provides connection for CAN-Devices with minimal CPU-load.



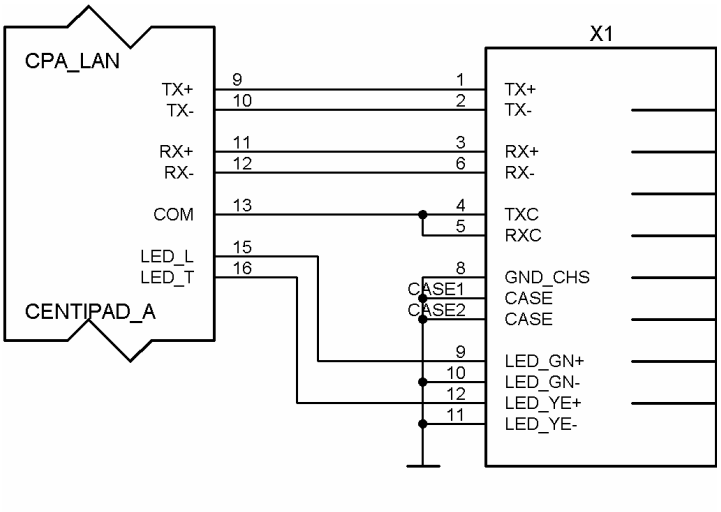
Maximum data rate is 1Mbit/s.
The CAN-Controller connects via SPI-Bus, NPCS1 to the CPU.
The 12MHz clock for CAN-Controller and Soundchip are provided by PA24/PCK1.
Via PB23 the CAN-Controller may send an interrupt to the CPU.

5.14 Ethernet

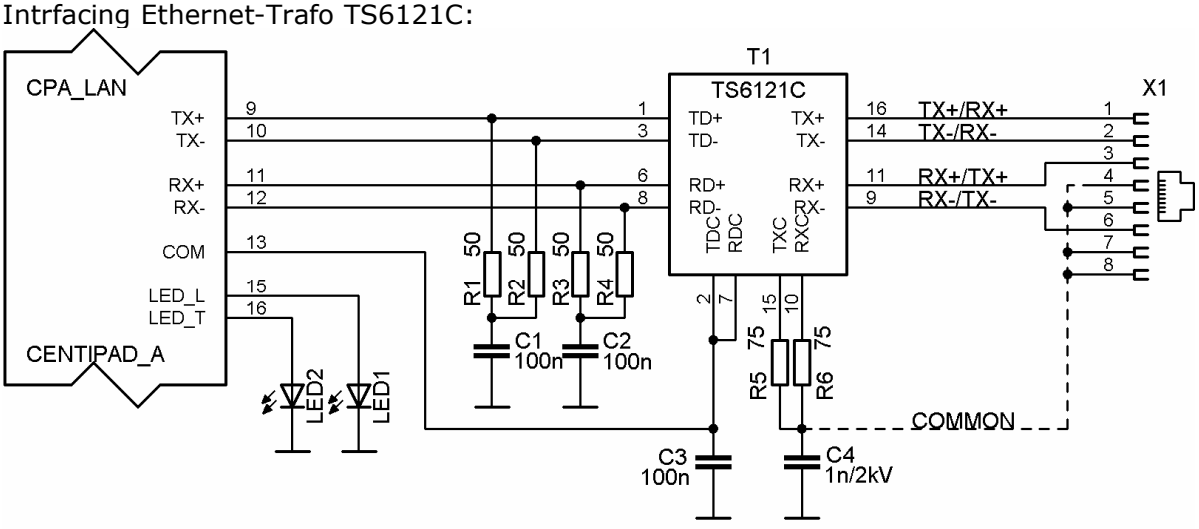
CentiPad utilizes the RTL8201CP 10/100Mbit Ethernet PHY with automatic CrossOver-detection/handling.
The PHY provides signals for the externally (e.g. at the housing front) connected RJ45-interface LU1T041F-43 with integrated transformer or s single ethernet-transformer TS612C with external RJ45.

The PHY contains no fixed MAC-Address. During setup the MAC is loaded into the PHY via the LAN-driver. The MAC-Address is usually stored in the EEPROM and loaded by the maintech-Bootloader.

The recommended RJ45-socket LU1T041F-43 contains the trafo and two StatusLEDs:



Intrfacing Ethernet-Trafo TS6121C:



System connection:

- LAN_TX+ : ConA 9 : TX-Trafopin ‚+'
- LAN_TX- : ConA 10 : TX-Trafopin ‚-'
- LAN_RX+ : ConA 11 : RX-Trafopin ‚+'
- LAN_RX- : ConA 12 : RX-Trafopin ‚-'
- LAN_LED_L : ConA 15 : LED- 'L', Link-LED, glows on connect
- LAN_LED_T : ConA 16 : LED-'T', Traffic-LED, blinks on data transfer

- LAN_COM : ConA 13 : LAN Reference potential
- GND : ConA 14 : GND

5.15 Serial interfaces

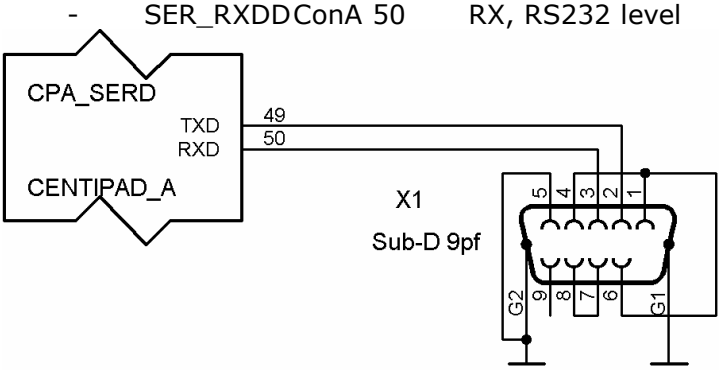
CentiPad features five serial interfaces on external Bus ConA.

5.15.1 SerD – RS232 Debug interface

An unprogrammed AT91RM9200 can be booted via TTYD. Transfer protocol is XMODEM. U2 generates RS232 conform output levels of ±5V.

Pinout:

- SER_TXDD ConA 49 TX, RS232 level
- SER_RXDD ConA 50 RX, RS232 level



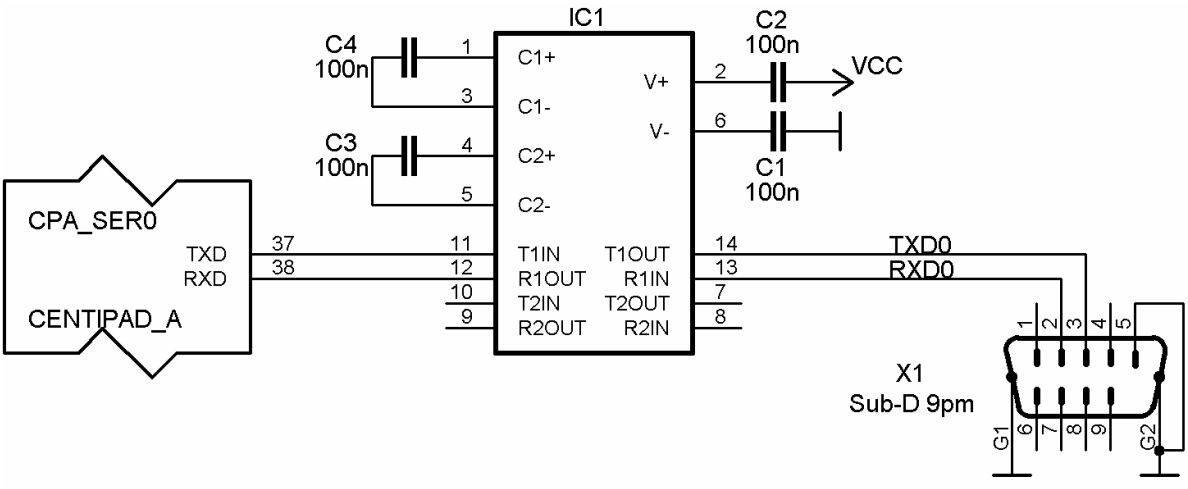
5.15.2 Ser0 – 3,3V RS232 interface

The Ser0 CPU-lines are connected unbuffered to the external bus. Voltage levels are 0..3,3V.

pinout:

- SER_TXDD ConA 43 TX, 3,3V level
- SER_RXDD ConA 44 RX, 3,3V level

Example: Ser0 with external RS232-level shifter



5.15.3 Ser1 – RS232/RS422/RS485 interface

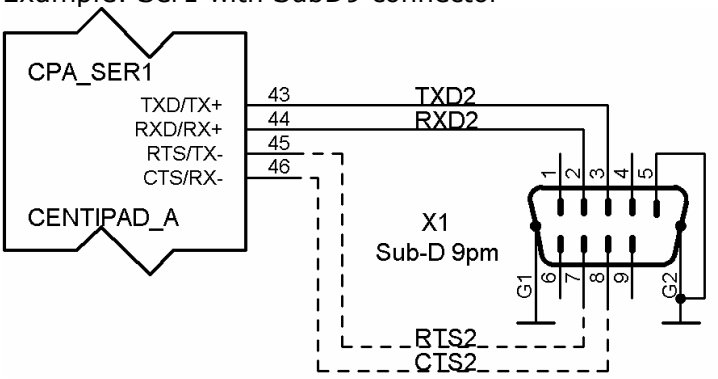
In standard fitting Ser1 is a RS232-interface including RTS/CTS-Handshake-lines. Optionally the RS232-driver (U5, MAX3224) can be augmented by a RS485-driver (IU5, MAX491CSD). This provides an optional RS422 or RS485-Interface. Both mounting variants are possible simulataneously. The operating mode is selected by solder jumpers. In RS485 mode the lines TX+ and RX+ as well as TX- and RX- must be connected.

The following options are available:
- RS232-with V24 level: only J11 closed
- RS232-with 3,3 level: only J1,J5,J6,J7 closed
- RS422 operation: only J2, J8, J10 closed
- RS485 operation: only J2, J9, J10 closed

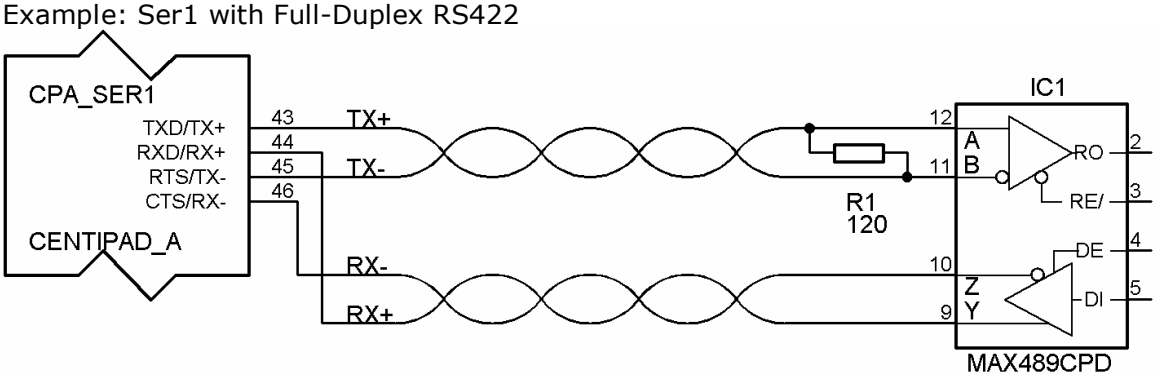
pinout:

-	SER_TXD1 ConA 43	TX, RS232 level / RS422/RS485 TX+
-	SER_RXD1 ConA 44	RX, RS232 level / RS422/RS485 RX+
-	SER_RTS1 ConA 45	RTS, RS232 level / RS422/RS485 TX-
-	SER_CTS1 ConA 46	CTS, RS232 level / RS422/RS485 RX-

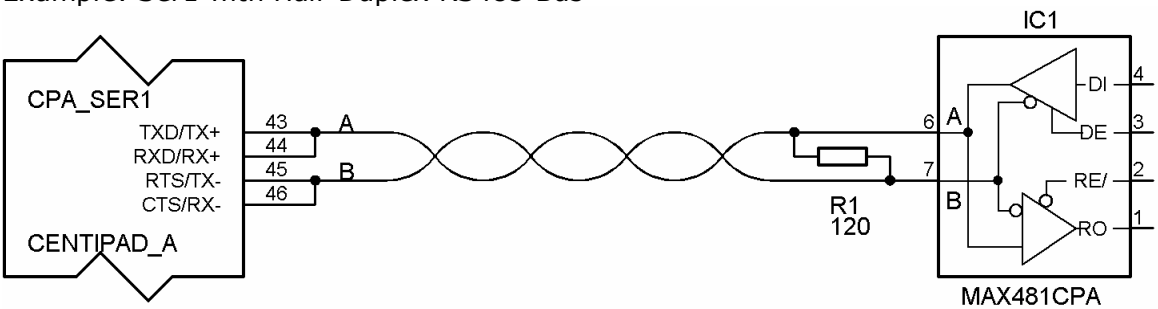
Example: Ser1 with SubD9 connector



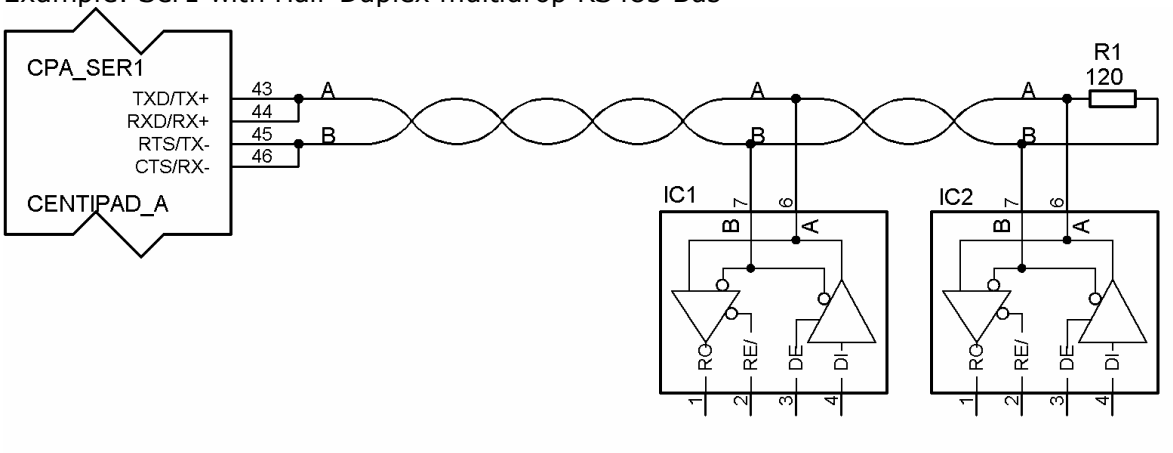
Example: Ser1 with Full-Duplex RS422



Example: Ser1 with Half-Duplex RS485 Bus



Example: Ser1 with Half-Duplex multidrop RS485 Bus



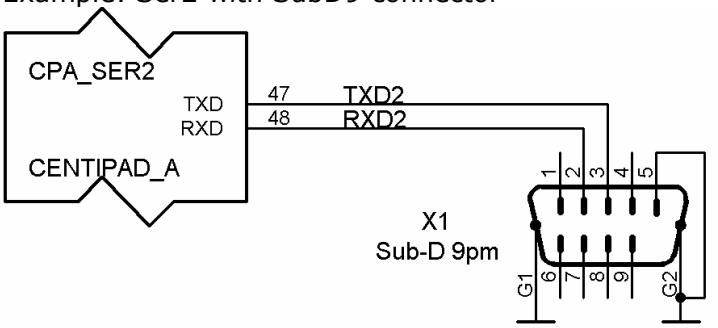
5.15.4 Ser2 – RS232 interface

U2 generates RS232 conform output levels of ±5V.

pinout:

- SER_TXD2 ConA 47 TX, RS232 level
- SER_RXD2 ConA 48 RX, RS232 level

Example: Ser2 with SubD9 connector



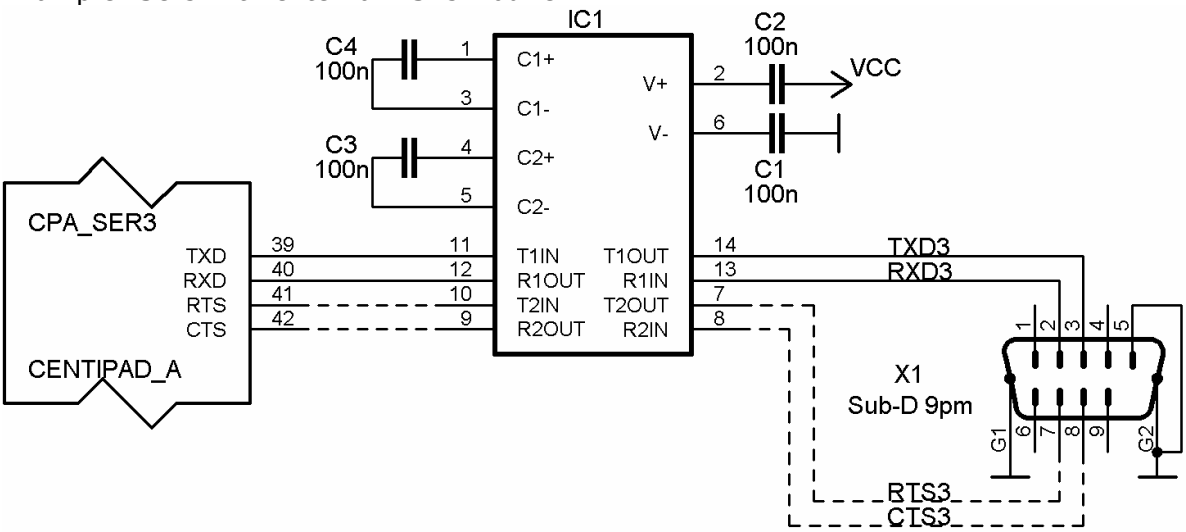
5.15.5 Ser3 – 3,3V RS232 interface

The Ser3 CPU-line are available unbuffered at the ExpansionPort. Voltage range is 0..3,3V.
Caution: the RXD3/TXD3 are claimed by the standard SPI-driver.

pinout:

- TXD3 ConA 39 TX, 3,3V-level
- RXD3 ConA 40 RX, 3,3V-level
- RTS3 ConA 41 TX, 3,3V-level
- CTS3 ConA 42 RX, 3,3V-level

Example: Ser3 with external RS232-buffer

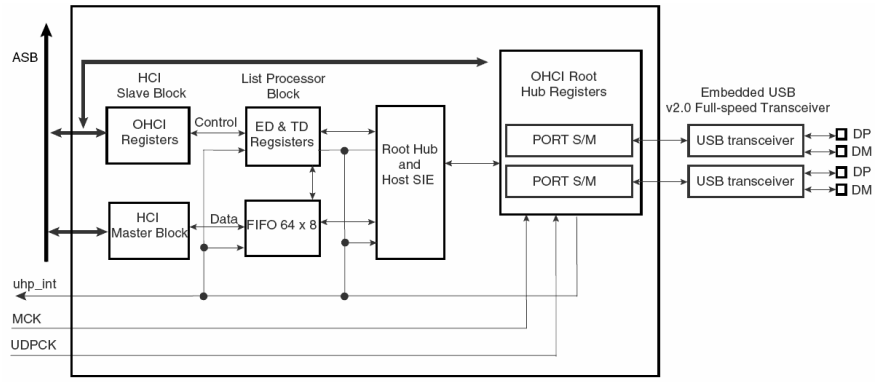


5.16 USB host Port

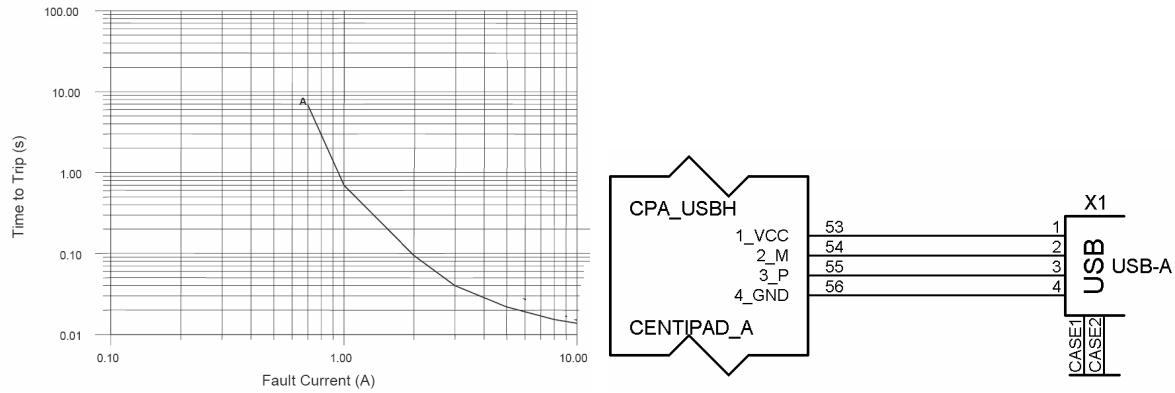
The host port is USB2.0 compliant Fullspeed (12 Mbit/s).
The CentiPad supply voltage (5 Volt) is fed fuse protected into a connected device. When external devices are connected the supply voltage must provide sufficient power. The maximum supply current is 500mA.

Measured output voltage under load:

load [Ω]	voltage [V]	current [mA]
-	5	0
12	4,37	364
6	3,92	653
4	3,48	0,87
0	0	270



[from AT91RM9200 Datasheet]



[from fuse datasheet]

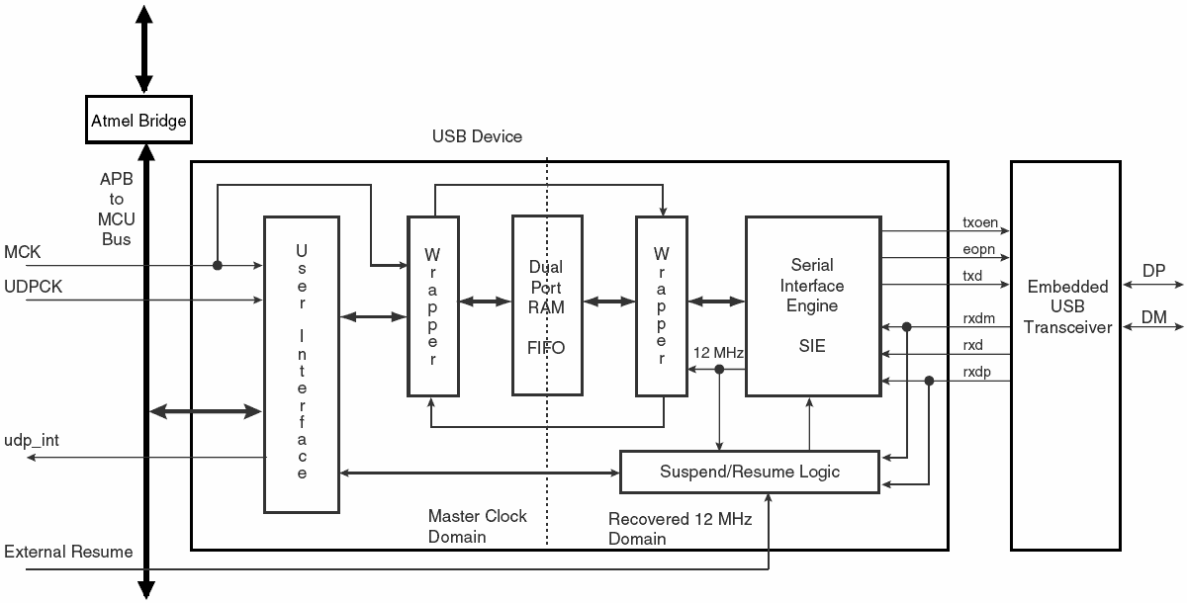
System connection:

- USBH_1_VCC ConA 51
- USBH_2_GND ConA 52
- USBH_3_P ConA 53
- USBH_4_M ConA 54

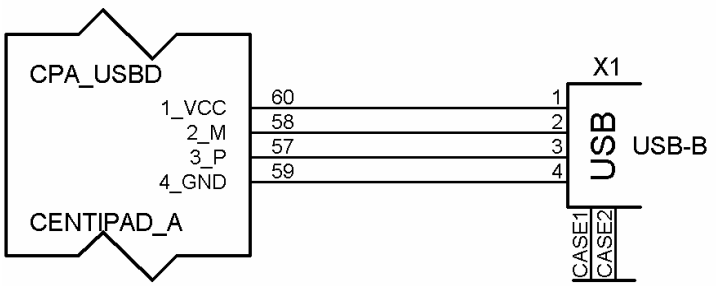
Note: the USB-GND-is filtered CentiPad-GND

5.17 USB device Port

The device port is USB2.0 compliant full-speed (12 Mbit/sec). CentiPad may be operted as self powered or bus powered USB-Device.
When operated as buspowered Device (J3 closed), the USB-Hostcontroller must supply sufficent current during enumaration. The USB-Power is directly connected to the CentiPad power. This conform to the USB standard, but will work (as many USB-battery chargers or reading lights demonstrate).
CentiPad can be booted via USB-interface.



[from AT91RM9200 Datasheet]



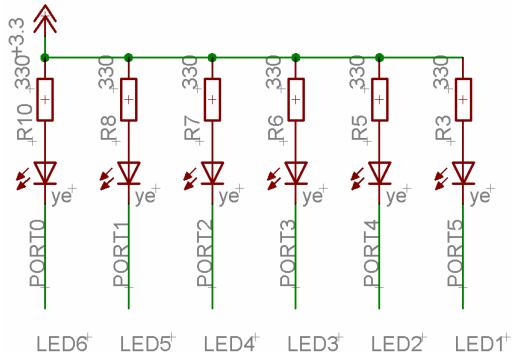
System connection:

- USBD_1_VCC ConA 60
- USBD_4_GND ConA 59
- USBD_3_P ConA 57
- USBD_2_M ConA 58

Note: the USB-GND-is filtered CentiPad-GND

5.18 GPIO / Indicator LED

During debugging a test-LED is a welcome feature. CentiPad provides 6 GPIO-Pins with LEDs. At the same time these GPIO-pins are connected unbuffered to the ExpansionPort. Normally the LEDs will not prevent other usage of the GPIOs, but can be removed if necessary.

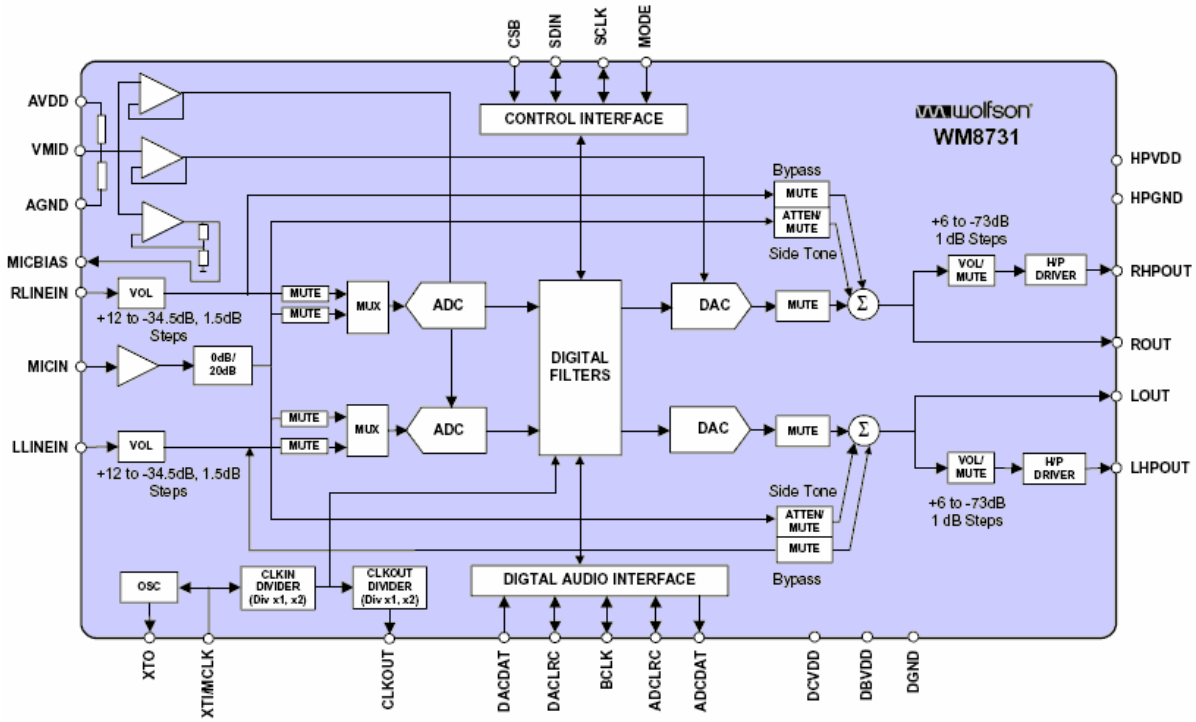


System CONNECTION:

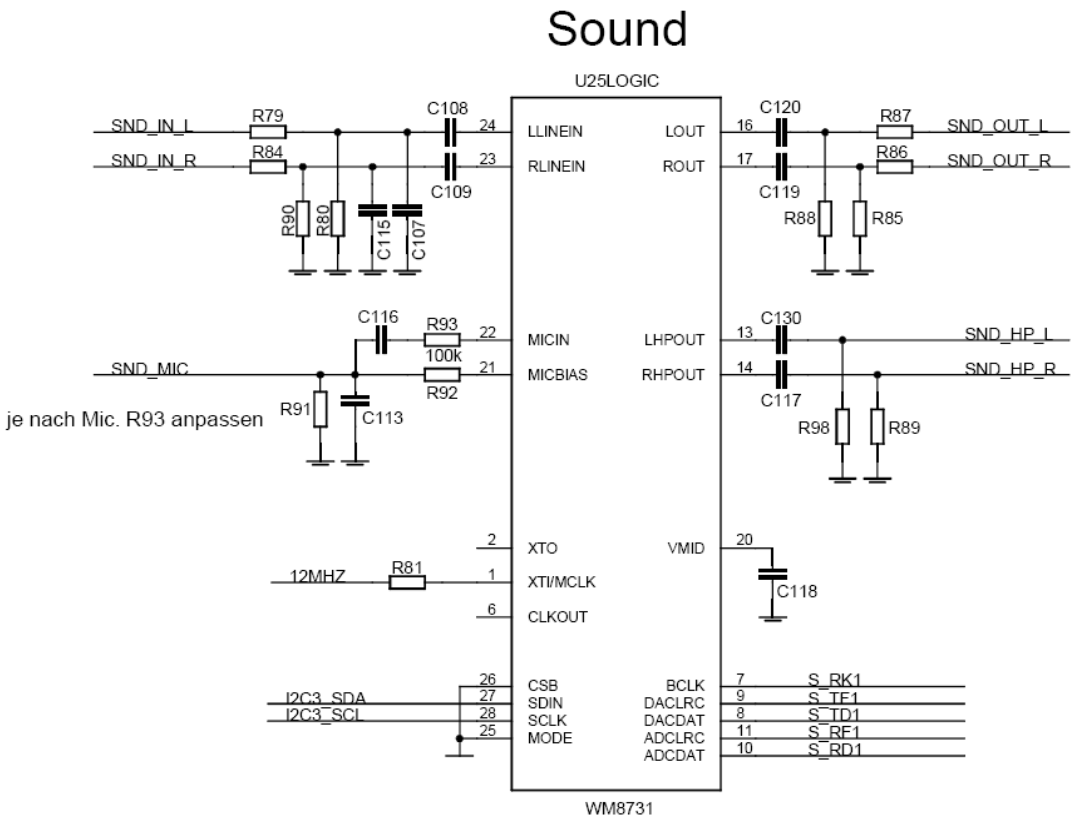
- PORT0 : ConA 31 : GPIO PC0
- PORT1 : ConA 32 : GPIO PC1
- PORT2 : ConA 33 : GPIO PC2
- PORT3 : ConA 34 : GPIO PC3
- PORT4 : ConA 35 : GPIO PC4
- PORT5 : ConA 36 : GPIO PC5

Note: the CPU-GPIO-line are high impedance at Reset/Boot. Albeit the LEDs provide a High-level (Pullup) . Thais is especially of importance when the pins are used as outputs (compare „power driver").

5.19 Soundsystem



[from WM8711 Datasheet]

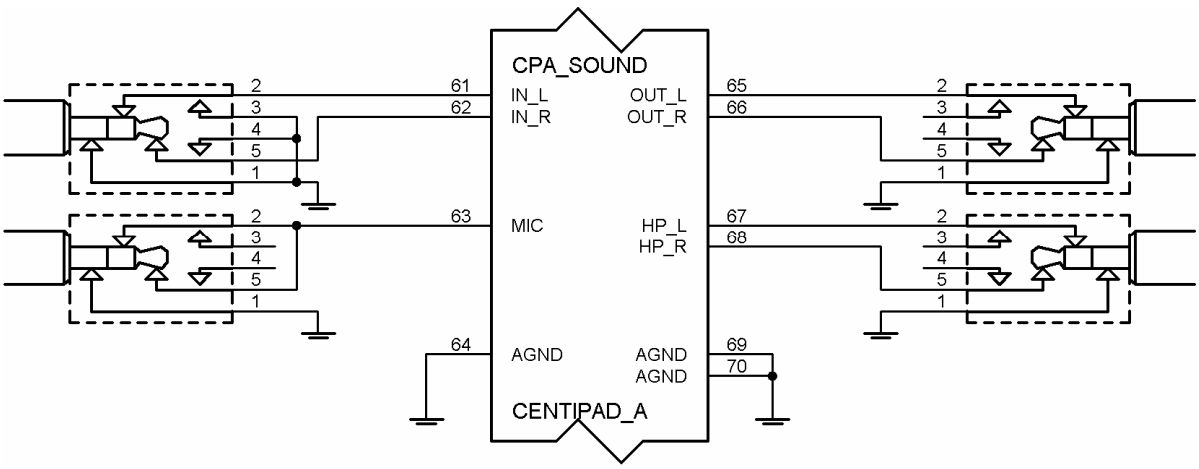


[from CentiPad Programmers Model]

The WM8731 provides the CentiPad with high quality Soundsystem.

Simultaneous Record and Playback (at the same sampling speed) enables e.g. full-duplex VoIP-applications.
The soundchip is run in its USB-compatibility and is fed by the 12MHz PCK1 clock of the CPU.
The soundchip configuration is loaded via the TWI-interface (SPI in later revisions), the sound data a transmitted via the synchronous serial interface 1.
Since the WM8731 has only a single interface-clock-line, the SSI must be programmed in a way that RK1 mirrors the signal of TK1 (compare to SSC description in AT91RM9200 datasheet).
The sound system provides filtered Analog-Ground-lines, which are to be used upon connection of external devices (ConA 64,69,70).

System connection:
- Stereo LineIn
  - left/right : ConA 61/62
  - Ground : ConA 64
- Stereo LineOut
  - left/right : ConA 65/66
  - Ground : ConA 64
- Microfone In
  - In : ConA 63
  - Ground : ConA 64
- Stereo Headphone Out
  - left/right : ConA 67/68
  - Ground : ConA 70

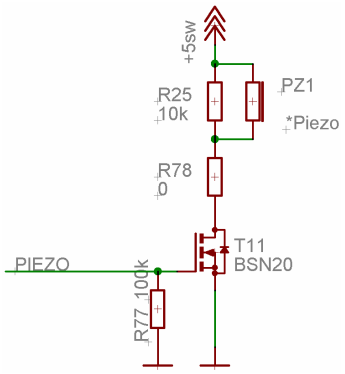


[application example]

Interface specification:
- Stereo LineIn : Vin < 3V
- Stereo LineOut : Vout < 3V
- Microfone In : Vbias = 2,3..2,6V
- Stereo Headphone Out : maximum output power:
  30mW at 32Ω / 50mW at 16Ω (according to datasheet)

Compare to TWI-Bus address structure „Systemstructure/I2C-Bus".

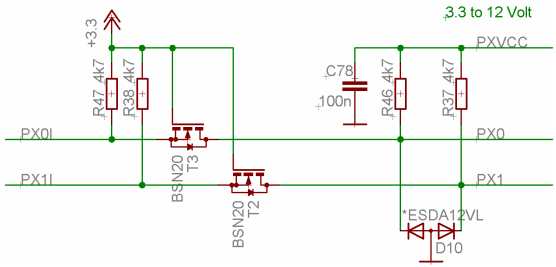
5.20 PIEZO-SPEAKER



The shown parts can be retrofitted. Then CentiPad features a Piezo-Beeper.
The PIEZO-signal is connected to PB7 of the CPU. This is either a GPIO or TIOB3. The Timer-output directly modulate the piezo-beeper.
This option provides simple sound output on CentiPads without soundchip.

System connection:
- optionally mounted on CentiPad

5.21 PortX



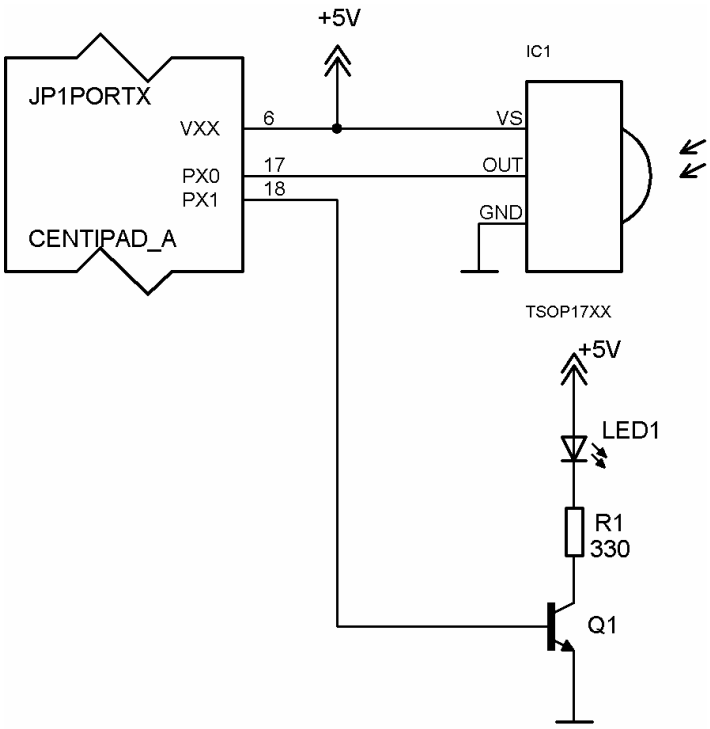
The PortX provides CentiPad with two pins allowing In-/Output-voltages between 3,3 and 10V. The desired peripheral voltage must be provided at PXVCC.
When used with 12V peripheral voltage, the ESD-Diode D10 must be removed.

System connection:

- PX0 : ConA 17 : GPIO, PX0I -> PA21
- PX1 : ConA 18 : GPIO, PX1I -> PA20
- PXVCC : ConA 6 : Reference voltage

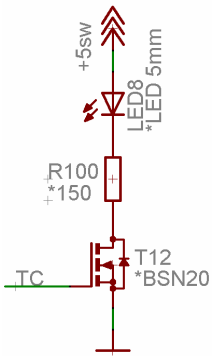
Mode of operation:
PXxI as Input, the X-Port is now an input with 4,7kΩ Pullup toward PXVCC.
PXxI as output, the X-Port is now an Open-Collector-output with 4,7kΩ Pullup toward PXVCC.

5.21.1 Infrared remote control at PortX



Fitted with external infrared transmitter/receiver CentiPad becomes an IR-transmitter/receiver.

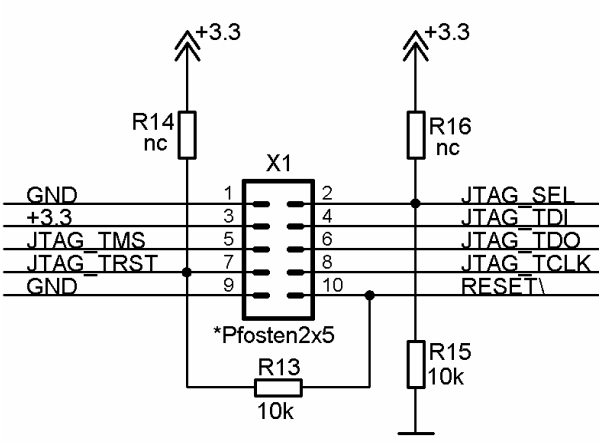
5.22 Option LED



When the shown parts are retrofitted, CentiPad has another LED-output. The TC-signal is connected to PA19, which can be either GPIO or directly modulated by TIOA1.

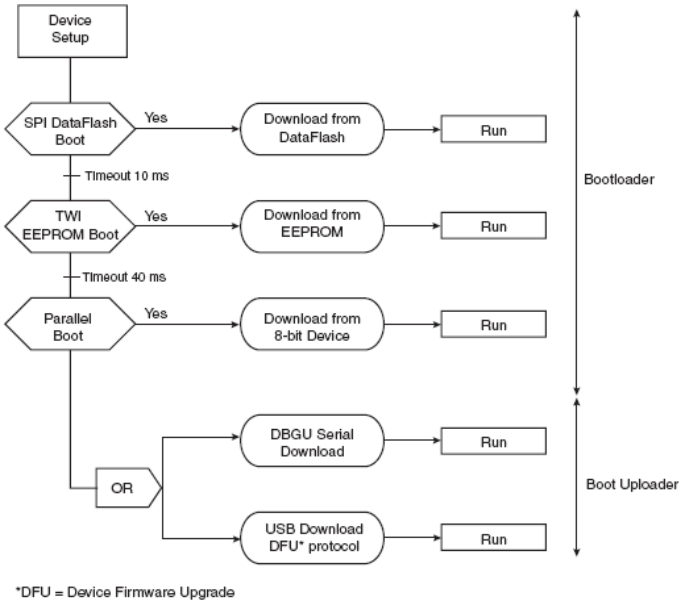
5.23 JTAG

X1 is an optional JTAG.connector. This interface is configurable by resistors to support different JTAG procedures.



6 Appendix

6.1 Systemstart



[from AT91RM9200 Datasheet]

At power up the AT91RM9200 internal boot program searches external devices for 8 valid ARM Exception Vectors.
The search order is:
- DataFlash on SPI NPCS0
- EEPROM on Address $A0 on I2C-Bus
- 8-bit memory on EBI NCS0

If a valid sequence is found, code will be transferred into the internal SRAM. This will initialize the Debug-interface and the USB-Device-Port.
After this the code will be loaded into the internal SRAM via the USB Device Firmware Upgrade Protocol (DFU) or the serial XMODEM Protocol Code.

[from AT91RM9200 Datasheet doc1768.pdf, chapter Bootload]

CentiPad is shipped with the maintech-Bootloader, which will be loaded from the DataFlash on SPI NPCS0. The bootloader supports booting from the following devices:
- DataFlash
- SD-Card
- Ethernet
- USB

The selected configuration is stored in the TWI-EEPROM at $57.