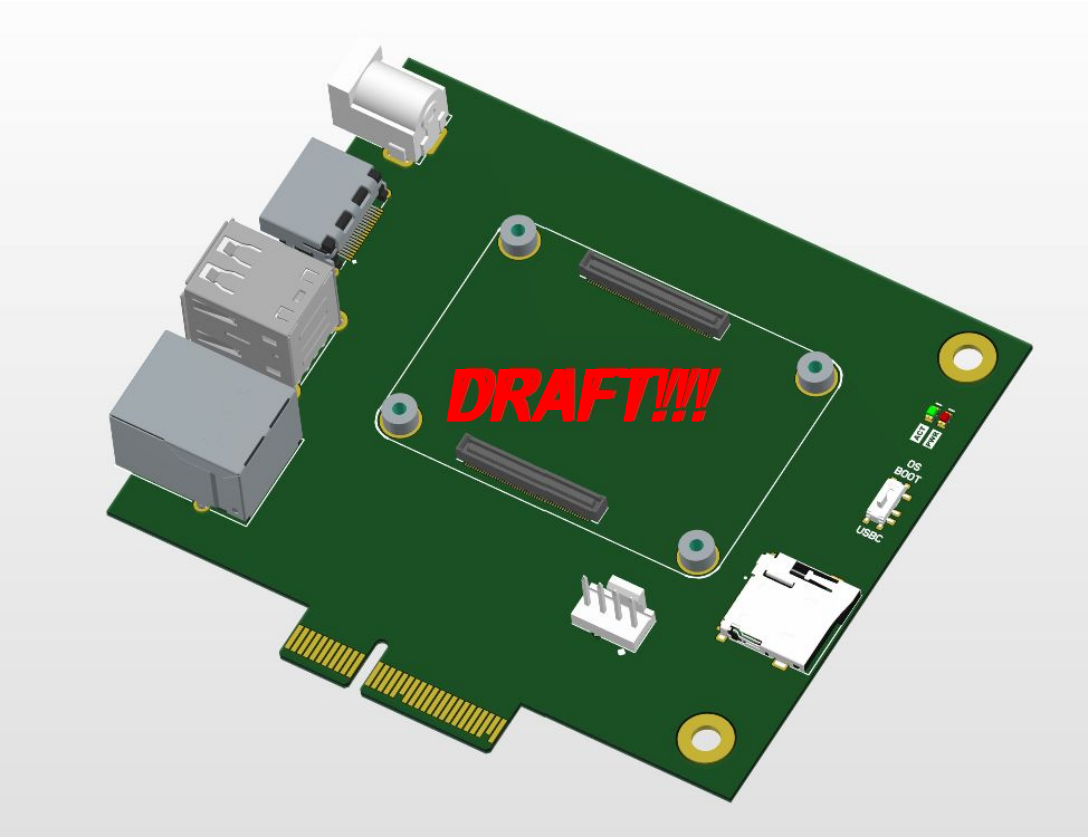
CM4 Module -> GPU card

PCB Project:	CM4GPU
Version:	V1
Revision:	R1
Project State:	DRAFT
Variant:	FULL
Print date:	27.10.2022

TOP VIEW



Page	Index
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01	Cover page
02	Block diagram
03	Top schematic
04	CM4 module - part #1
05	CM4 module - part #2
06	USB C interface
07	USB Hub
08	PCIe x4 slot
09	HDMI
10	100/1000M Ethernet
11	MicroSD card
12	MISC
13	Power supply
14	PCB marking and mechnics
15	Hardware changelog

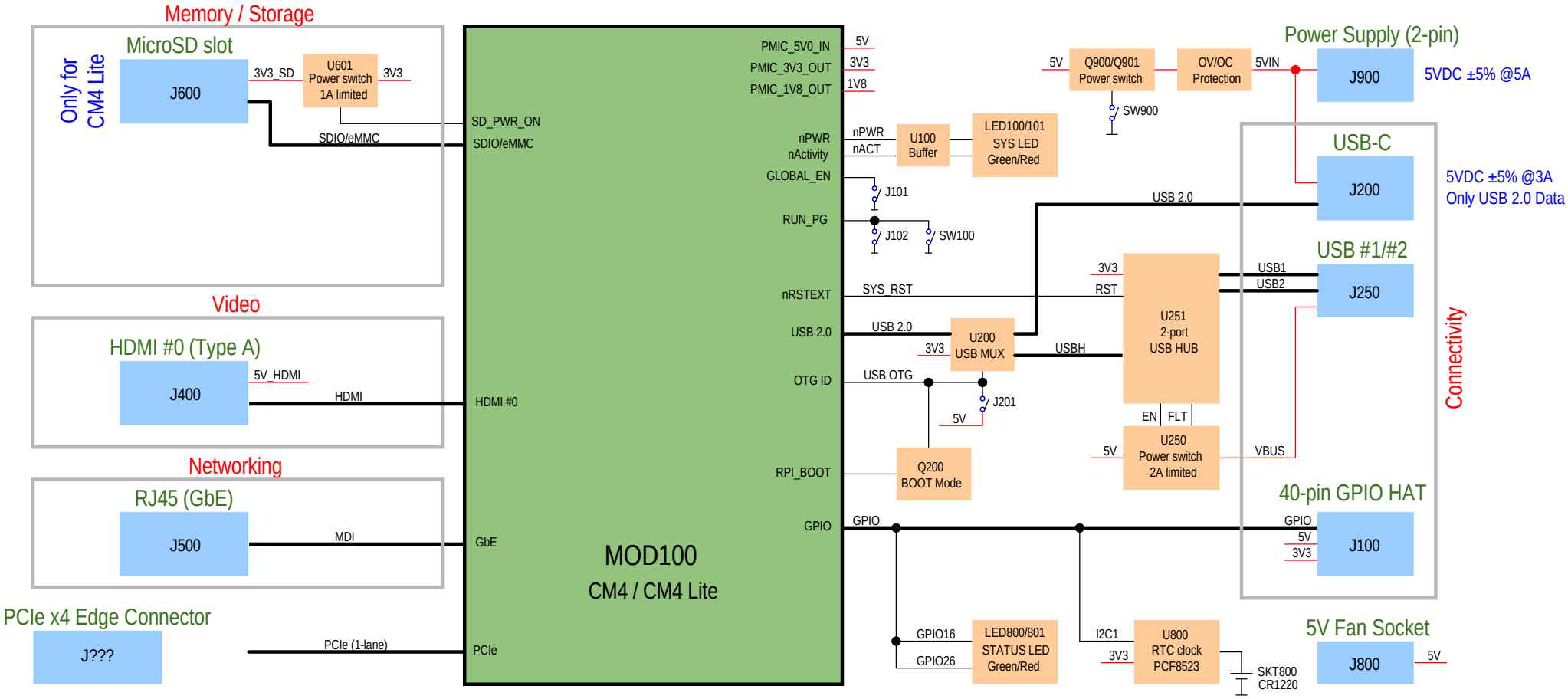
[02]Block_diagram.SchDoc

[03]Top.SchDoc

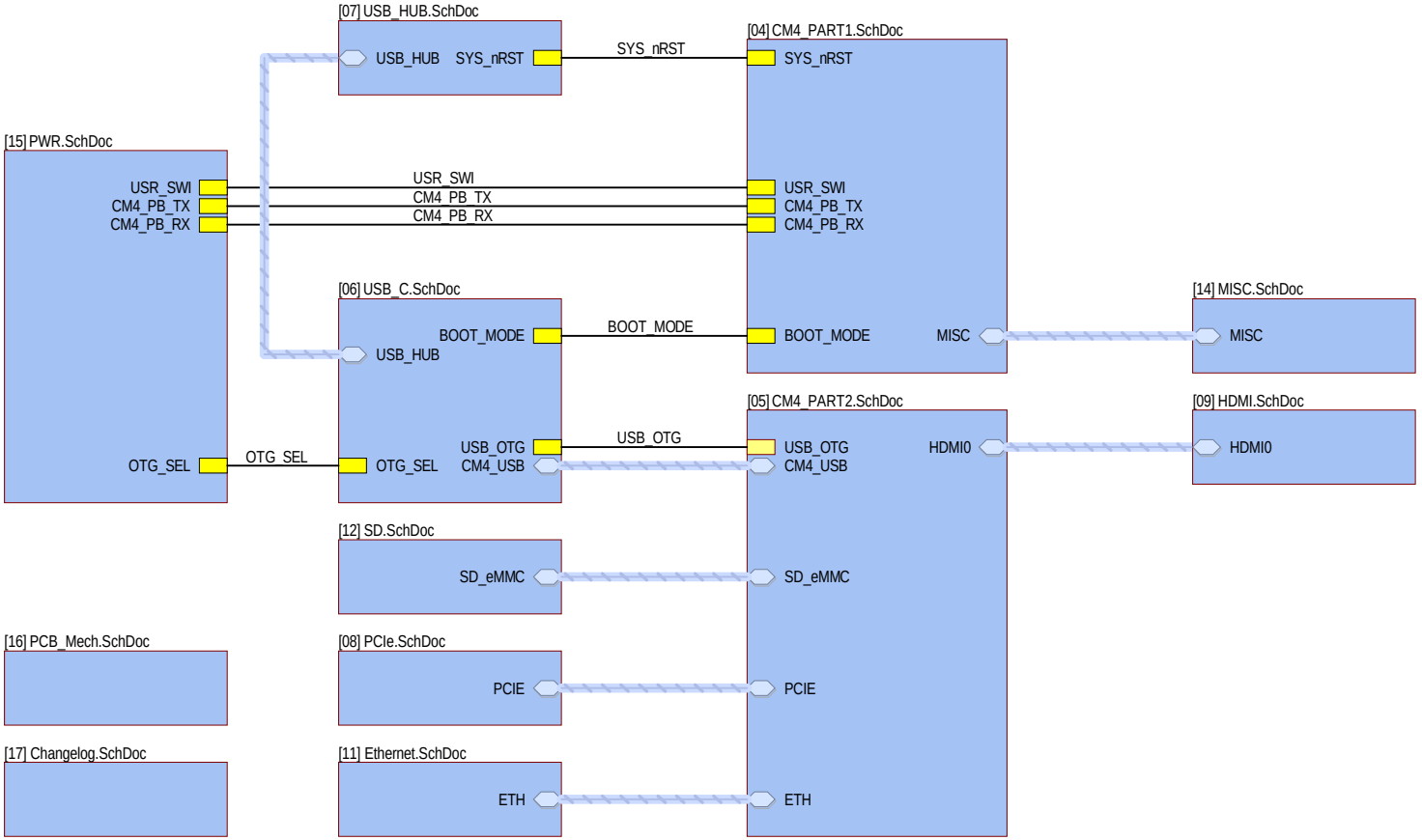
PCB
PCB BARE BOARD

mirko electronics
Mirko Electronics
Smoka Wawelskiego 1
30-535 Kraków, Poland

Size	A3		
Title	CM4GPU	Version	V1
Project:	CM4 Module -> GPU card	Revision	R1
Variant:	FULL	RefDes:	-
Designer:	M. Folejewski	Sheet:	1 / 15
File Name:	[01]Cover_page.SchDoc	Printed:	27.10.2022

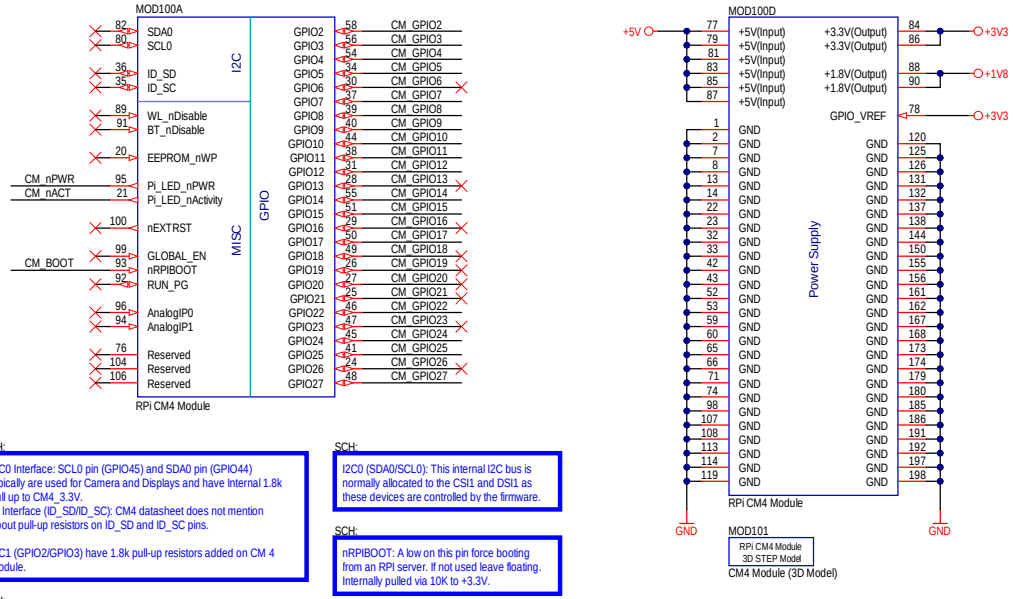


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size: A4
Title: Block diagram		Version: V1
Project: CM4 Module -> GPU card		Revision: R1
Variant: FULL	RefDes: 1-99	
Designer: M. Folejewski	Sheet: 2 / 15	
File Name: [02] Block_diagram.SchDoc	Printed: 27.10.2022	



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size A4
Title Top schematic		Version V1
Project: CM4 Module -> GPU card		Revision R1
Variant: FULL	RefDes: 1-99	
Designer: M. Folejewski	Sheet: 3 / 15	
File Name: [03] TOP.SchDoc	Printed: 27.10.2022	

CM4 MODULE (PART #1)



SCH:
I2C0 Interface: SCL0 pin (GPIO45) and SDA0 pin (GPIO44) typically are used for Camera and Displays and have Internal 1.8k pull up to CM4_3.3V.
ID Interface (ID_SD/ID_SC): CM4 datasheet does not mention about pull-up resistors on ID_SD and ID_SC pins.

I2C1 (GPIO2/GPIO3) have 1.8k pull-up resistors added on CM 4 module.

SCH:
I2C (ID_SD/ID_SC): This I2C bus is normally used for identifying HATs (HAT ID EEPROM) and controlling CSI0 and DSI0 devices.

At boot time this I2C interface will beinterrogated to look for an EEPROM that identifies the attached board andallows automagic setup of the GPIOs (and optionally, Linux drivers).

DO NOT USE these pins for anything other than attaching an I2C ID EEPROM. Leave unconnected if ID EEPROM not required.

SCH:
I2C0 (SDA0/SCL0): This internal I2C bus is normally allocated to the CSI1 and DSI1 as these devices are controlled by the firmware.

SCH:
nRPIBOOT: A low on this pin force booting from an RPI server. If not used leave floating. Internally pulled via 10K to +3.3V.

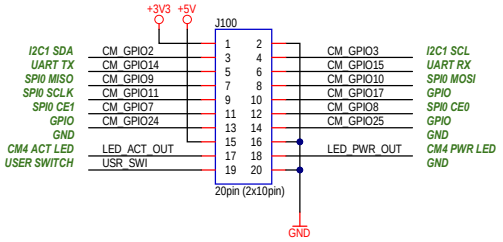
SCH:
EEPROM_nWP pin: Leaving floating NB internally pulled up to CM4_3.3V via 100k (VIL <0.8V) but can be grounded to prevent writing to the on board EEPROM which stores the bootcode.

SCH:
1.8V and 3.3V Outputs +/-2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power off or GLOBAL_EN being set low.

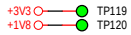
SCH:
GLOBAL_EN: Drive low to power off CM4. Internally pulled up with a 100K to +5V.

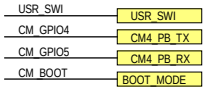
16-PIN GPIO HEADER

reserved for future use

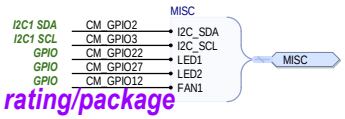


TESTPOINTS (DEBUG)





GPIO pins - connect to specific devices



components - display 4 parameters: val/tol/pwr rating/package

power rail nets - use Google convention (e.g. PP3300)

Used GPIOs:

GPIO2 - I2C1 SDA
GPIO3 - I2C1 SCL

GPIO14 - UART TX
GPIO15 - UART RX

GPIO9 - SPI0 MISO
GPIO10 - SPI0 MOSI
GPIO11 - SPI0 SCLK
GPIO8 - SPI0 CE0
GPIO7 - SPI0 CE1

GPIO17 - GPIO (LCD SPI)
GPIO24 - GPIO (LCD SPI)
GPIO25 - GPIO (LCD SPI)

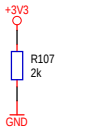
GPIO22 - GPIO (USER LED1 Green)
GPIO27 - GPIO (USER LED2 Red)
GPIO12 - PWM0/GPIO (FAN #1)

GPIO4 - TXD3 (PBC)
GPIO5 - RXD3 (PBC)

Raspberry Pi Pinout

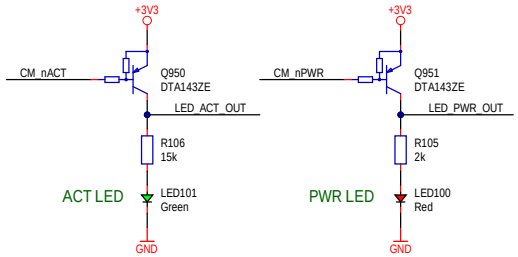
3v3 Power	1	2	5v Power
GPIO 2 (I2C1 SDA)	3	4	5v Power
GPIO 3 (I2C1 SCL)	5	6	Ground
GPIO 4 (GPCLK0)	7	8	GPIO 14 (UART TX)
Ground	9	10	GPIO 15 (UART RX)
GPIO 17	11	12	GPIO 18 (PCM CLK)
GPIO 27	13	14	Ground
GPIO 22	15	16	GPIO 23
3v3 Power	17	18	GPIO 24
GPIO 10 (SPI0 MOSI)	19	20	Ground
GPIO 9 (SPI0 MISO)	21	22	GPIO 25
GPIO 11 (SPI0 SCLK)	23	24	GPIO 8 (SPI0 CE0)
Ground	25	26	GPIO 7 (SPI0 CE1)
GPIO 0 (EEPROM SDA)	27	28	GPIO 1 (EEPROM SCL)
GPIO 5	29	30	Ground
GPIO 6	31	32	GPIO 12 (PWM0)
GPIO 13 (PWM1)	33	34	Ground
GPIO 19 (PCM FS)	35	36	GPIO 16
GPIO 26	37	38	GPIO 20 (PCM DIN)
Ground	39	40	GPIO 21 (PCM DOUT)

3V3 LOAD



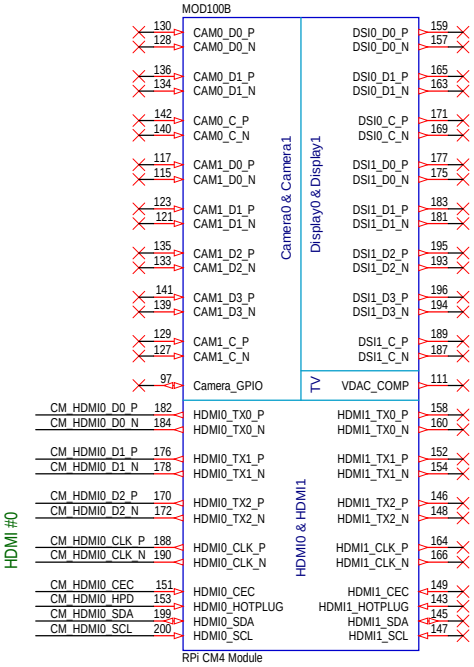
SCH:
Extra load on the 3V3 power rail to fix the HDMI issue with 5V LED.

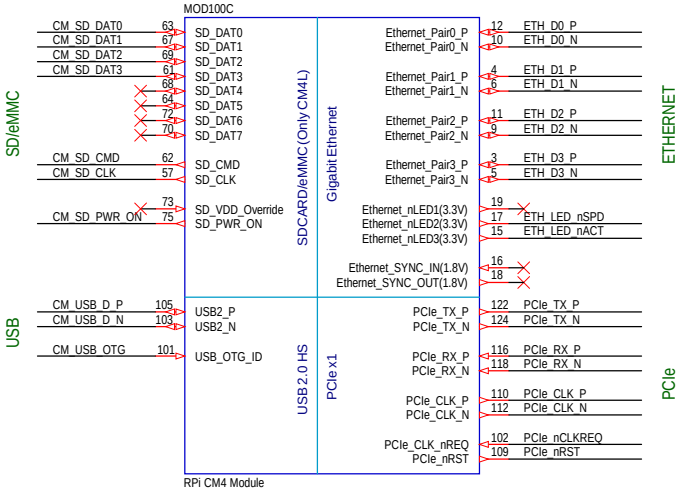
SYS LEDs



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A3
Title: Compute Module 4 (Part #1)		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: FULL	RefDes: 100-199		
Designer: M. Folejewski	Sheet: 4 / 15		
File Name: [04] CM4_PART1.SchDoc	Printed: 27.10.2022		

CM4 MODULE (PART #2)

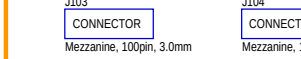


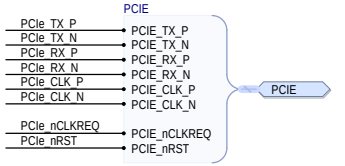


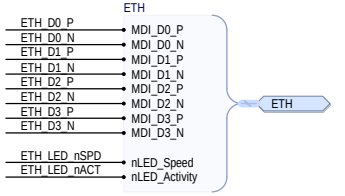
SCH:

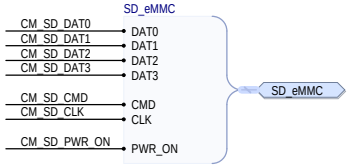
USB_OTG_ID: Input (3.3V signal) USB OTG Pin. Internal pulled up. The USB_OTG pin is used to select between USB host and device that is typically wired to the ID pin of a Micro usb connector. To use this functionality it must be enabled in the OS that is used. If using either as a fixed slave or fixed master, please tie the USB OTGID pin to ground.

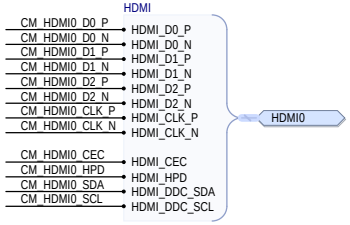
MEZZANINE CONNECTORS











LAYOUT:

Route MIPI signals as matched length 100 Ohm differential pairs, each signal within a pair should ideally be matched to better than 0.15mm.

Route USB signals as matched length 90 Ohm differential pairs. The P N signals should ideally be matched to 0.15mm.

Route HDMI signals as matched length 100 Ohm differential pairs, each signal within a pair should ideally be matched to better than 0.15mm. Pairs don't typically need any extra matching as they only have to be matched to 25mm.

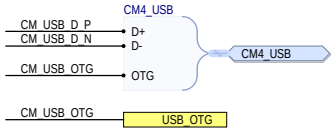
LAYOUT:

Route Ethernet signals as matched length 100 Ohm differential pairs with suitable clearances. Length matching between pairs should be better than 50mm, so in the typical case no length matching is required. However the signals within a pair need to be length matched, ideally to better than 0.15mm.

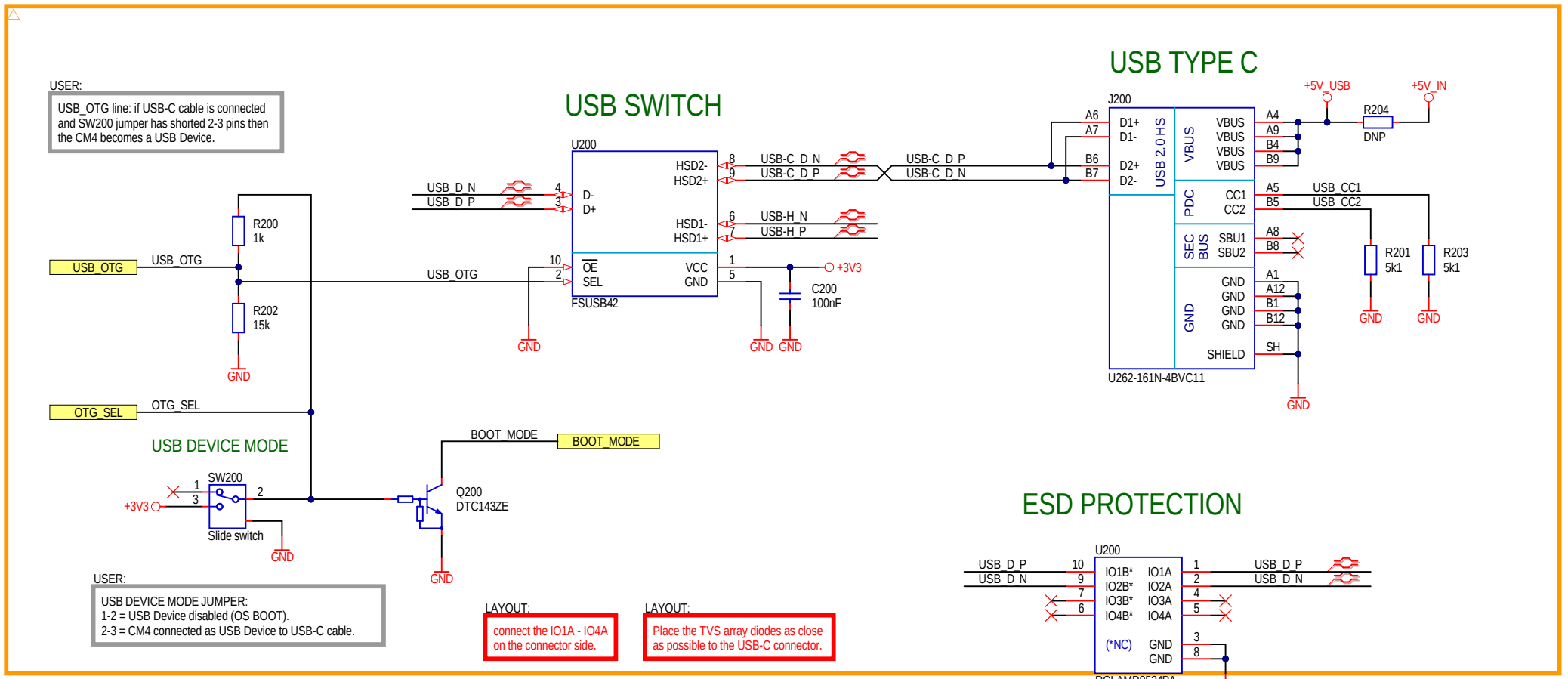
Route PCIe signals as matched length 90 Ohm differential pairs with suitable clearances. There is no need to match the lengths between pairs, only the signals within a pair need to be length matched ideally to better than 0.1mm.

LAYOUT:

Impedance matching:
90 Ohm -> PCIe, USB
100 Ohm -> HDMI, Ethernet, MIPI (CSI, DSI)

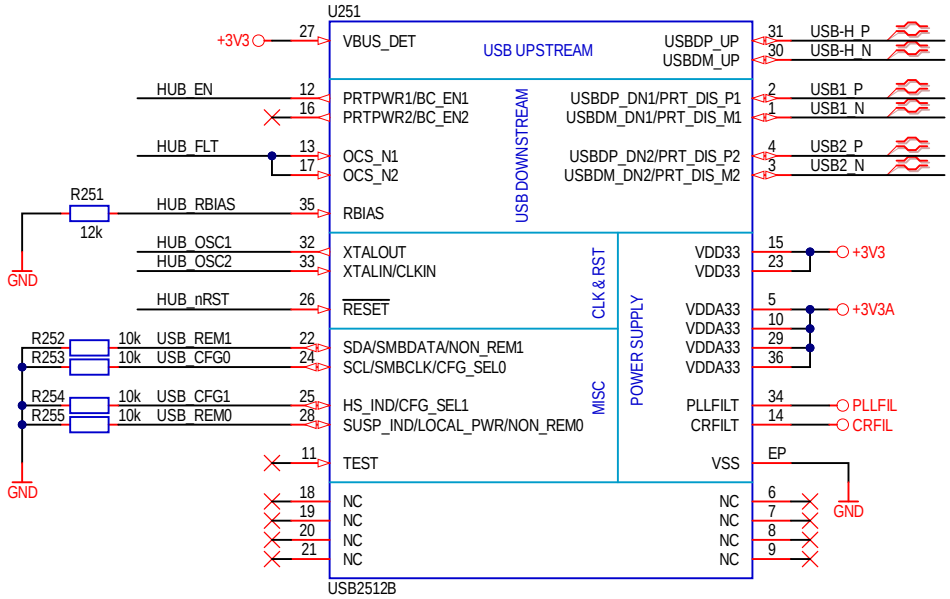


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size B
Title Compute Module 4 (Part #2)			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 100-199	
Designer: M. Folejewski		Sheet: 5 / 15	
File Name: [05] CM4_PART2.SchDoc		Printed: 27.10.2022	

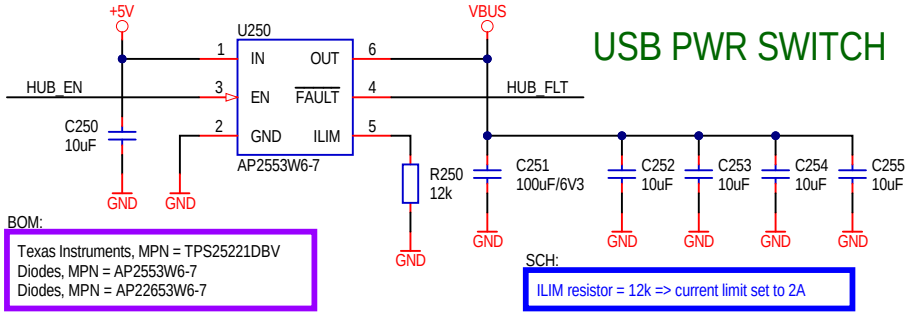


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size: A4
Title: USB-C interface and USB switch		Version: V1
Project: CM4 Module -> GPU card		Revision: R1
Variant: FULL	RefDes: 200-249	
Designer: M. Folejewski	Sheet: 6 / 15	
File Name: [06] USB_C.SchDoc	Printed: 27.10.2022	

2-PORT USB HUB



USB PWR SWITCH



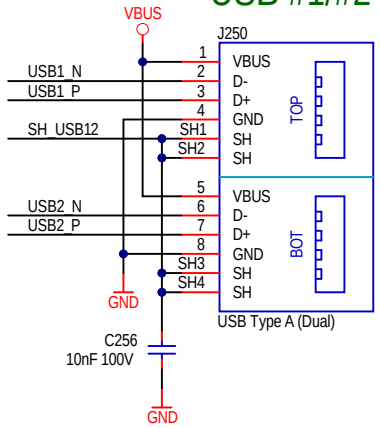
BOM:

Texas Instruments, MPN = TPS25221DBV
Diodes, MPN = AP2553W6-7
Diodes, MPN = AP22653W6-7

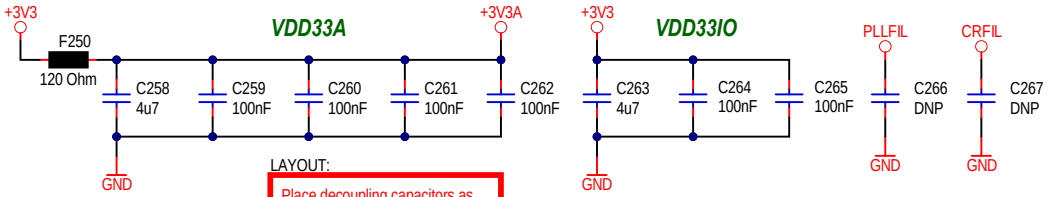
SCH:

ILIM resistor = 12k => current limit set to 2A

USB #1/#2



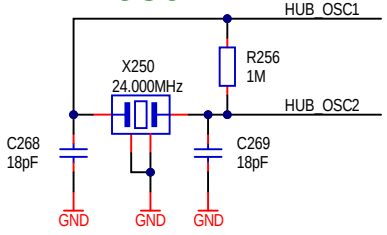
DECOUPLING CAPACITORS



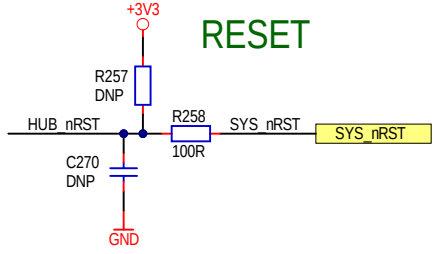
LAYOUT:

Place decoupling capacitors as close as possible to USB hub.

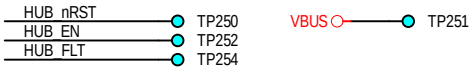
OSC



RESET



TESTPOINTS (DEBUG)

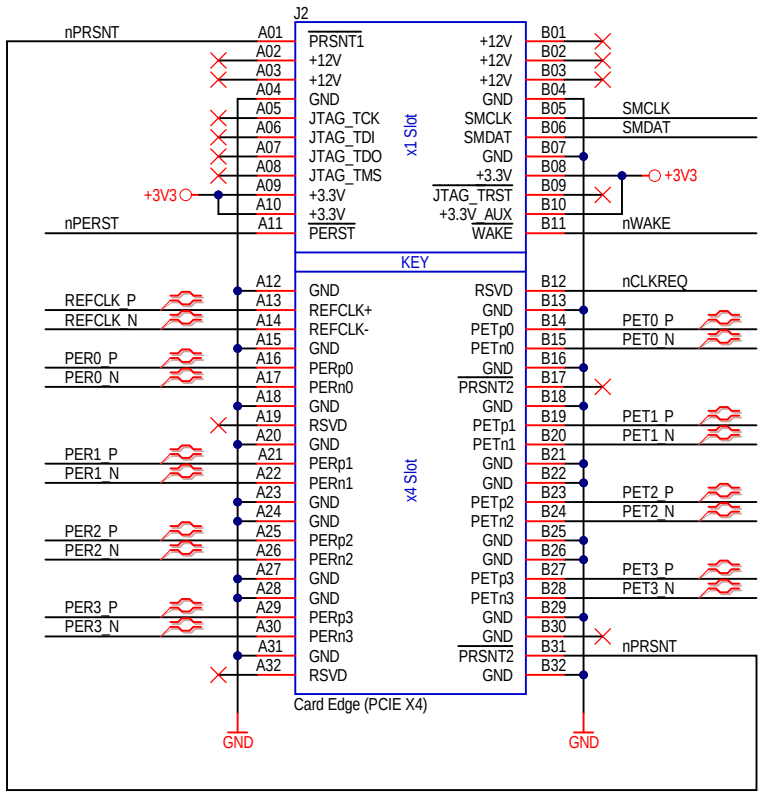


LAYOUT:

Route USB signals as matched length 90 Ohm differential pairs.
The P N signals should ideally be matched to 0.15mm.

mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A4
Title: 4-port USB 2.0 hub		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: FULL	RefDes: 250-299		
Designer: M. Folejewski	Sheet: 7 / 15		
File Name: [07] USB_HUB.SchDoc	Printed: 27.10.2022		

PCI Express x4



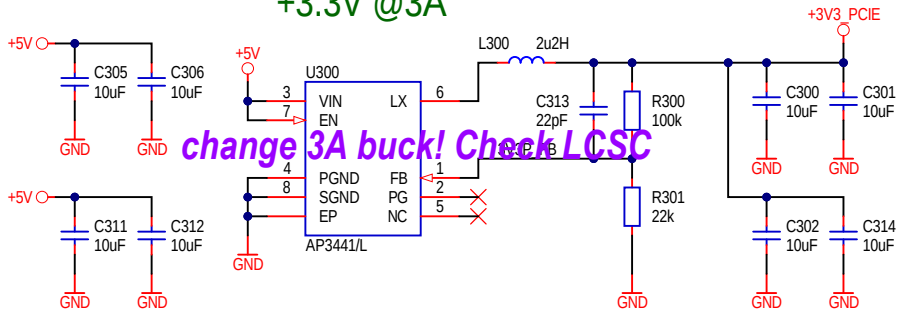
SCH:

PCIE x4 reference board: PINE64 -ROCKPro64
https://files.pine64.org/doc/rockpro64/rockpro64_v21-SCH.pdf

LAYOUT:

Route PCIe signals as matched length 90 Ohm differential pairs with suitable clearances. There is no need to match the lengths between pairs, only the signals within a pair need to be length matched ideally to better than 0.1mm.

+3.3V @3A



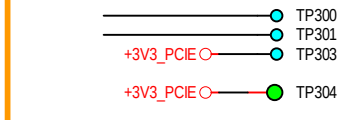
LAYOUT:

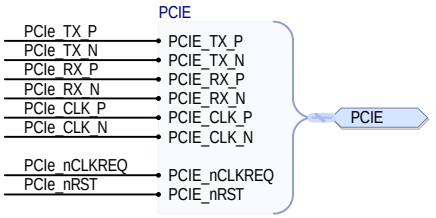
Place decoupling capacitors as close as possible to the Buck converter.

BOM:

2.2uH -> compatible components (7.3x6.6x2.4mm):
Changjiang Microelectronics Tech, MPN = FXL0624-2R2-M
Sumida, MPN = 0624CDMCCDS-2R2MC
AVX, MPN = LMLP07B7M2R2DTAS

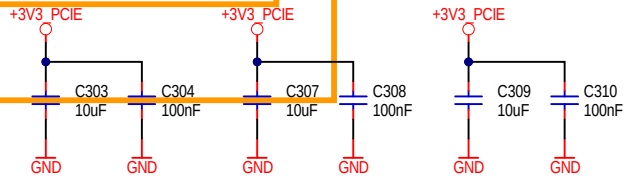
TESTPOINTS (DEBUG)





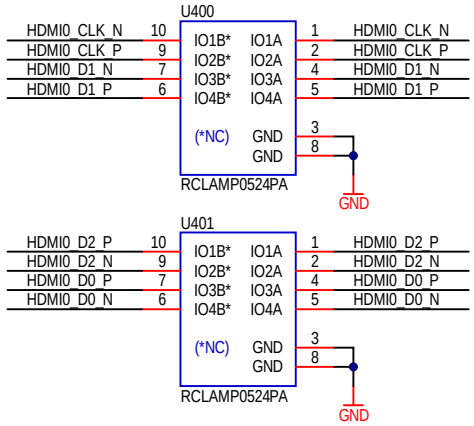
LAYOUT:

Place decoupling capacitors as close as possible to M.2 connector.

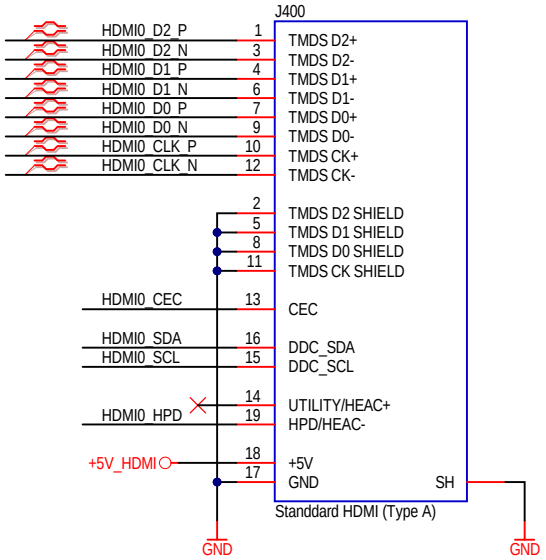


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A4
Title: M.2 PCIe x1 Socket		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: FULL	RefDes: 300-399		
Designer: M. Folejewski	Sheet: 8 / 15		
File Name: [08] PCIe.SchDoc	Printed: 27.10.2022		

ESD PROTECTION



HDMI #0 (TYPE A)



BOM:

HDMI #0 connector:
Wurth Elektronik, MPN = 685 119 134 923
BOOMELE, MPN = HDMI-001
Description: Type A (Standard), 19 pins, 0.50mm pitch, horizontal, SMD.

LAYOUT:

Route HDMI signals as matched length 100 Ohm differential pairs, each signal within a pair should ideally be matched to better than 0.15mm. Pairs don't typically need any extra matching as they only have to be matched to 25mm.

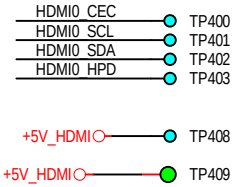
LAYOUT:

connect the IO1A - IO4A on the connector side.

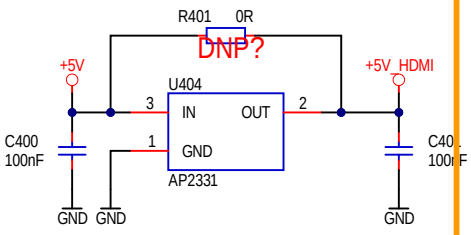
LAYOUT:

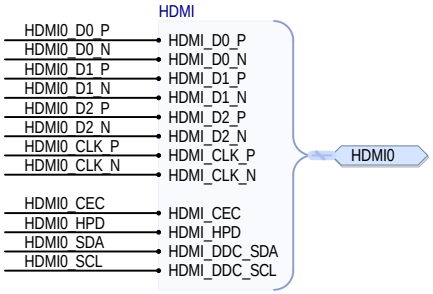
Place the TVS array diodes as close as possible to the HDMI connector.

TESTPOINTS (DEBUG)



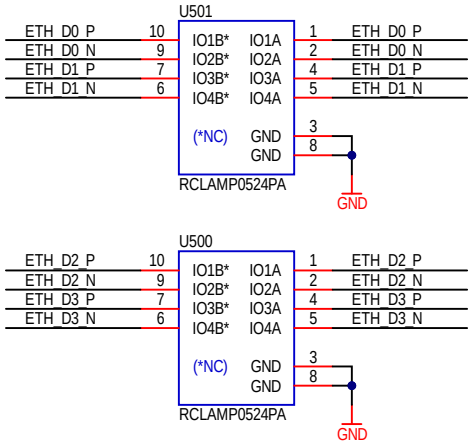
5V POWER SWITCH





mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title HDMI Interface			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 400-449	
Designer: M. Folejewski		Sheet: 9 / 15	
File Name: [09] HDMI.SchDoc		Printed: 27.10.2022	

ESD PROTECTION



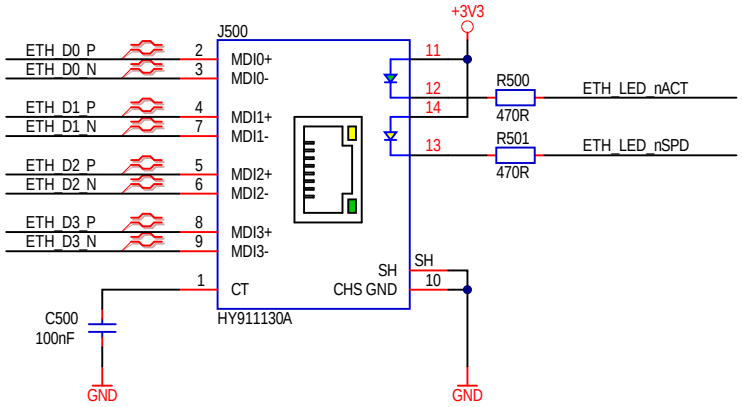
LAYOUT:

connect IO1A - IO4A on the connector side.

LAYOUT:

Place TVS array diodes as close as possible to RJ45 connector.

100/1000M ETHERNET



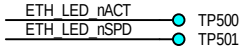
LAYOUT:

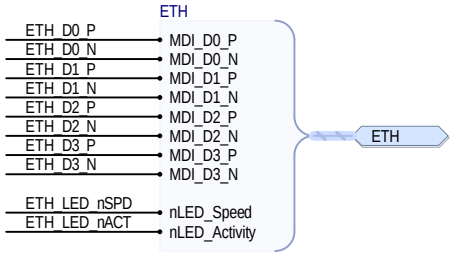
Route Ethernet signals as matched length 100 Ohm differential pairs with suitable clearances. Length matching between pairs should be better than 50mm, so in the typical case no length matching is required. However the signals within a pair need to be length matched, ideally to better than 0.15mm.

BOM:

RJ45 -> compatible connectors:
HanRun, MPN = HR911130A (HY911130A)
Link-PP, MPN = LPJG0806FBNL
Description: 100/1000M RJ45, Tab-down, G/Y LEDs

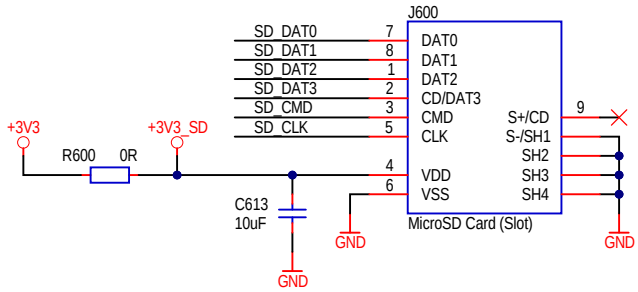
TESTPOINTS (DEBUG)





mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title 100/1000M Ethernet interface			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 500-599	
Designer: M. Folejewski		Sheet: 10 / 15	
File Name: [11] Ethernet.SchDoc		Printed: 27.10.2022	

MICRO SD CARD



SCH:

Used MicroSD card slot: Hmax = 2.00 mm

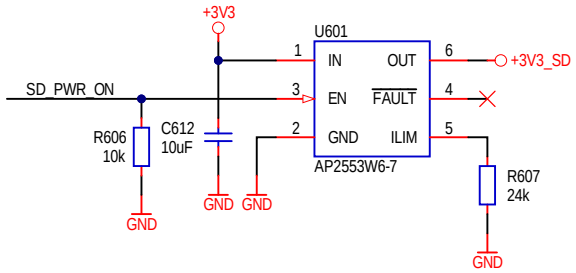
USER:

SD Card only for CM4 Lite module with no on-board Flash memory chip (eMMC).

BOM:

MicroSD slot -> compatible components:
GCT, MPN = MEM2055-00-190-01-A
SOFNG, MPN = TF-015
HOAUC, MPN = HYC77-TF09-200
XUNPU, MPN = TF-115

PWR SWITCH



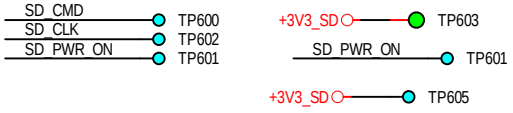
BOM:

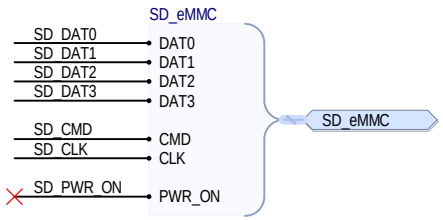
Texas Instruments, MPN = TPS25221DBV
Diodes, MPN = AP2553W6-7
Diodes, MPN = AP22653W6-7

SCH:

ILIM resistor = 24k => current limit set to 1.05A

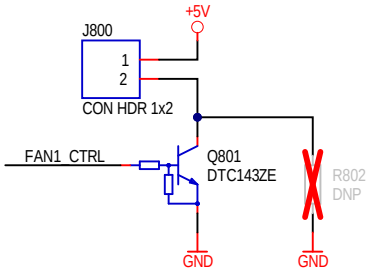
TESTPOINTS (DEBUG)





mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title MicroSD slot			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 600-699	
Designer: M. Folejewski		Sheet: 11 / 15	
File Name: [12] SD.SchDoc		Printed: 27.10.2022	

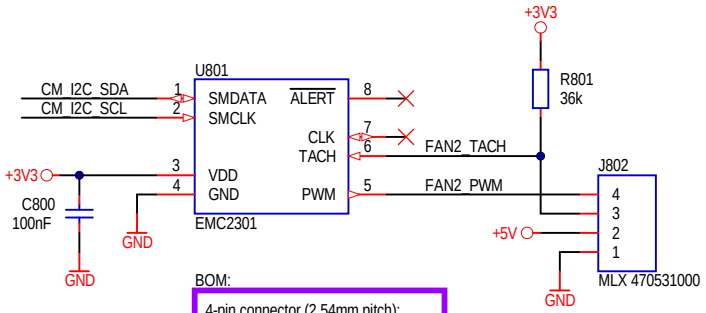
FAN1 (5VDC, ON/OFF)



USER:

FAN1 can be controlled by FAN1_CTRL line (by static GPIO level or by using PWM mode).
FAN1 control can be disabled (always on) by assembly R802 jumper.

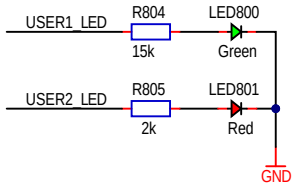
FAN2 (5VDC PWM CTRL IC)

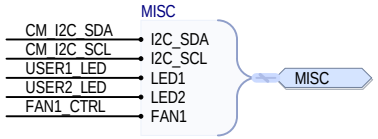


BOM:

4-pin connector (2.54mm pitch):
Molex, MPN = 47053-1000.
PINREX, MPN = 744-81-04TW30.

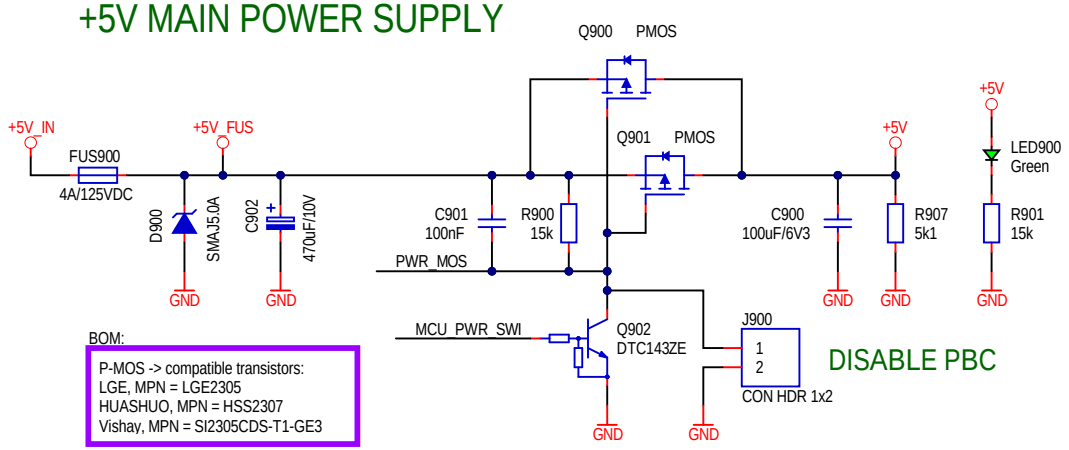
USER LEDs



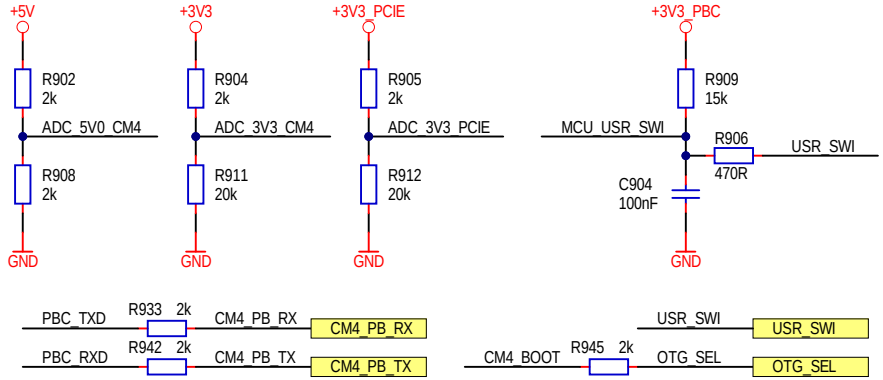


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title MISC			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 800-899	
Designer: M. Folejewski		Sheet: 12 / 15	
File Name: [14] MISC.SchDoc		Printed: 27.10.2022	

+5V MAIN POWER SUPPLY



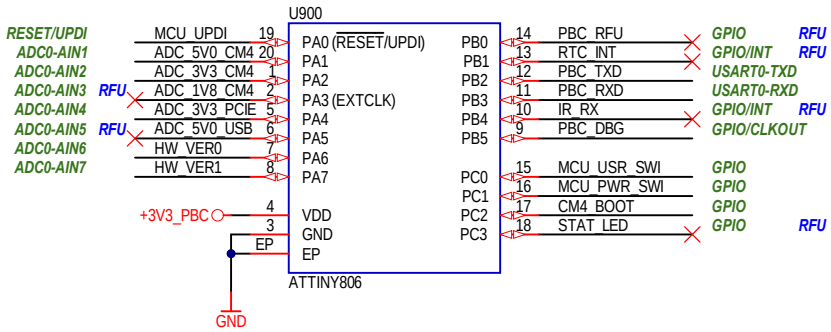
PBC INTERFACE



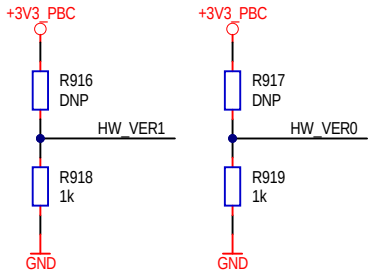
remove PMIC or add EC for future use

PUSH-BUTTON CONTROLLER

MCU

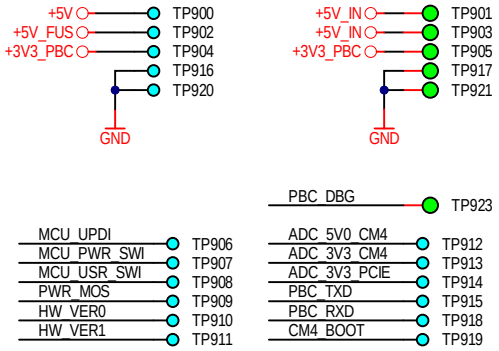


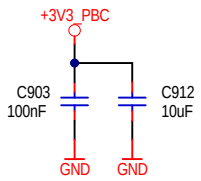
HARDWARE VERSION



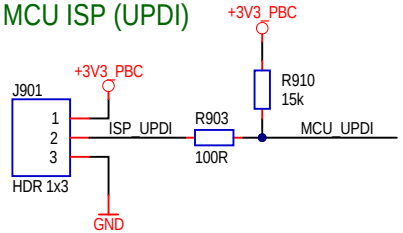
HV_VER = 0000_0000 => BitPiRat (0000) + GEN2.1 (0000)

TESTPOINTS (DEBUG)

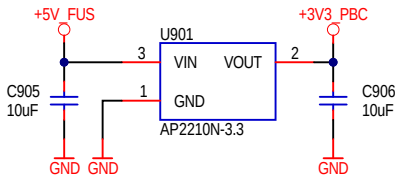




MCU ISP (UPDI)



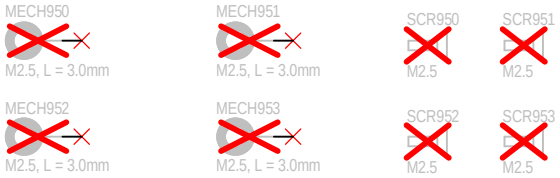
3.3V/300mA LDO



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A4
Title: +5V power supply and push-button controller		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: FULL	RefDes: 900-949		
Designer: M. Folejewski	Sheet: 13 / 15		
File Name: [15] PWR.SchDoc	Printed: 27.10.2022		

PCB MOUNTING HOLES

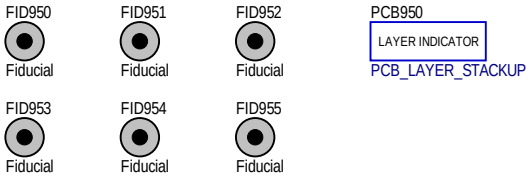
M2.5 STEEL SPACERS



BOM:

SMT Steel Spacer with internal Thread M2.5, L = 3.0mm:
Use Wurth Elektronik, MPN = 977 403 015 1.

PCB MARKING



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title PCB marking & mechanical parts			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: 950-999	
Designer: M. Folejewski		Sheet: 14 / 15	
File Name: [16] PCB_Mech.SchDoc		Printed: 27.10.2022	

Hardware changelog

2022.10.27:
- project has started;
- imported schematics from existing designs;

mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title Hardware changelog			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: FULL		RefDes: -	
Designer: M. Folejewski		Sheet: 15 / 15	
File Name: [17] Changelog.SchDoc		Printed: 27.10.2022	