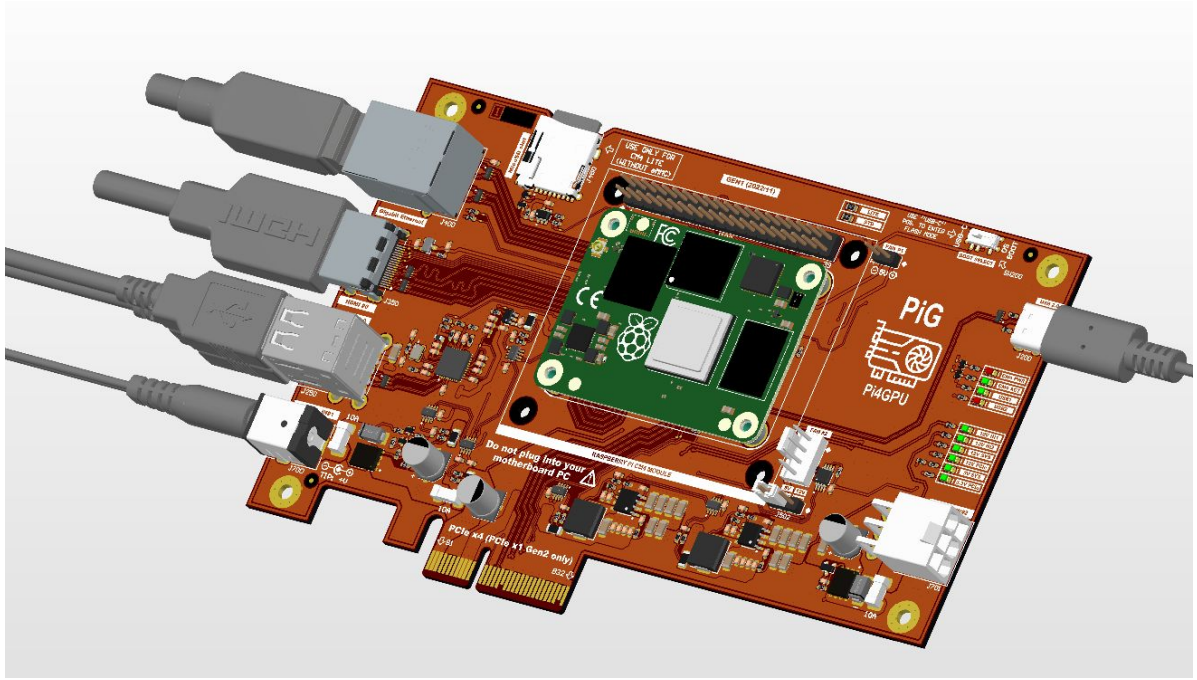
CM4 Module -> GPU card

PCB Project:	Pi4GPU (PiG)
Version:	V1
Revision:	R1
Project State:	DRAFT
Variant:	[No Variations]
Print date:	29.11.2022

TOP VIEW

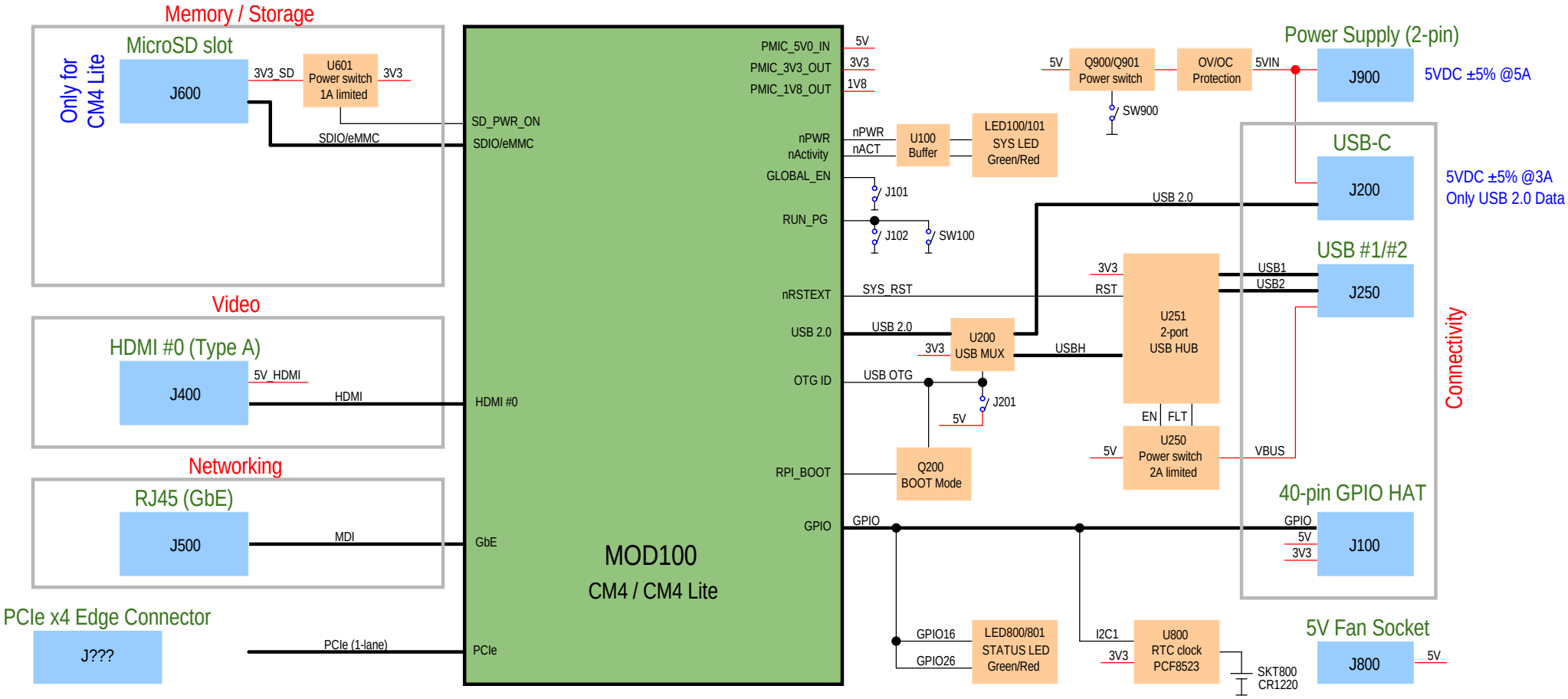


[02]Block_diagram.SchDoc

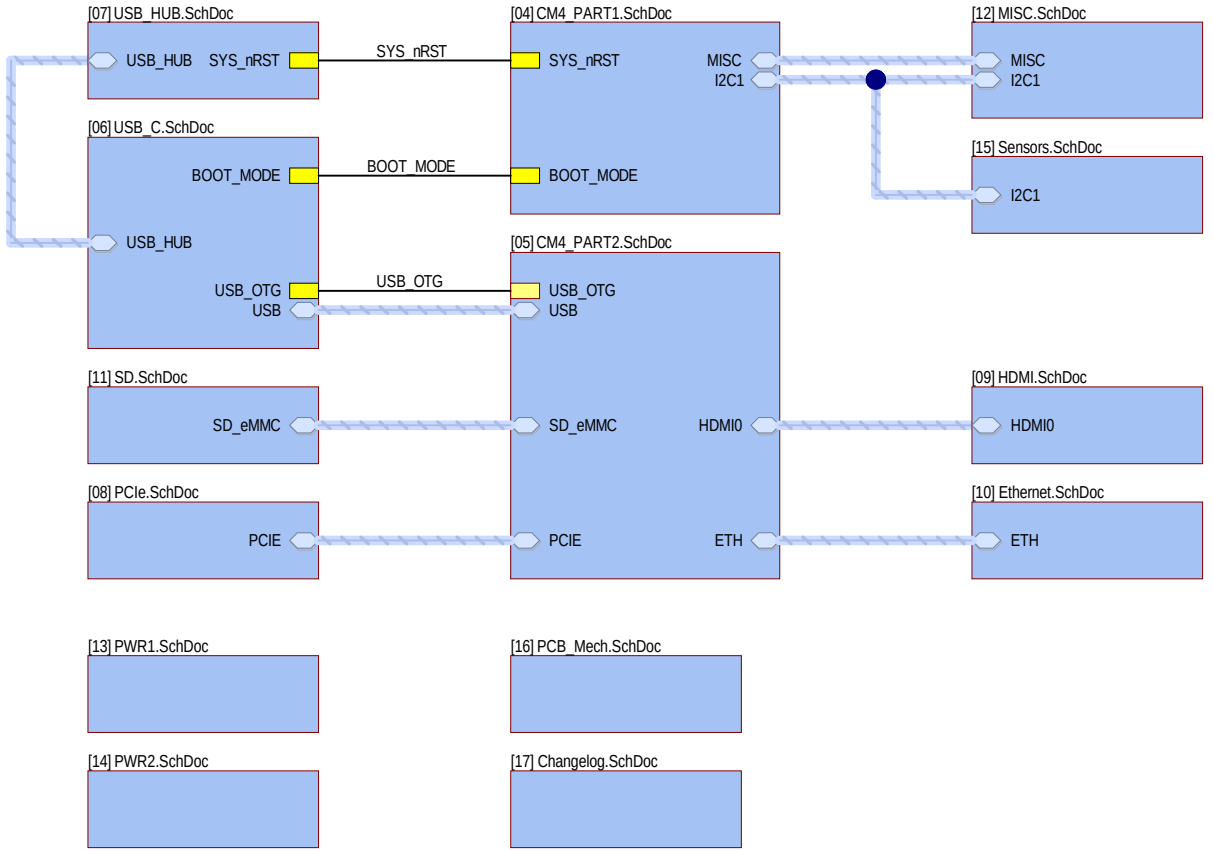
[03]Top.SchDoc

PCB
PCB BARE BOARD

mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A3
Title: Pi4GPU (PiG)			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: -	
Designer: M. Folejewski		Sheet: 1 / 15	
File Name: [01]Cover_page.SchDoc		Printed: 29.11.2022	

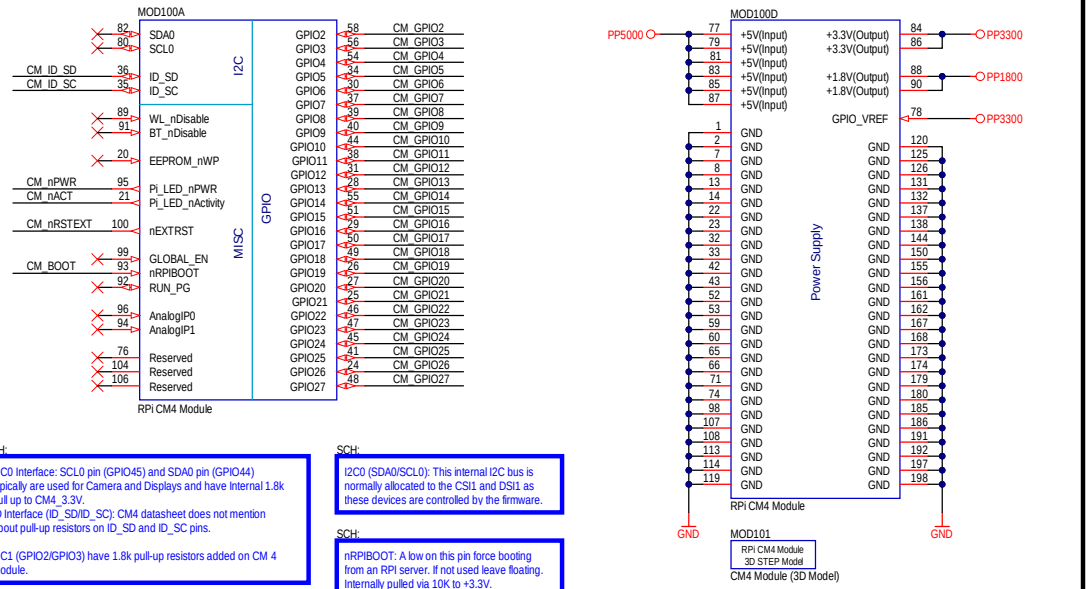


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size: A4
Title: Block diagram		Version: V1
Project: CM4 Module -> GPU card		Revision: R1
Variant: [No Variations]	RefDes: 1-99	
Designer: M. Folejewski	Sheet: 2 / 15	
File Name: [02] Block_diagram.SchDoc	Printed: 29.11.2022	



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: [No Variations]		RefDes: 1-99	
Designer: M. Folejewski		Sheet: 3 / 15	
File Name: [03] TOP.SchDoc		Printed: 29.11.2022	

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:
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:
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).

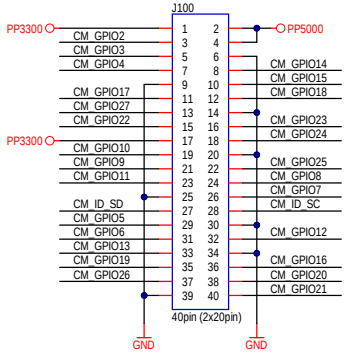
DO NOT USE these pins for anything other than attaching an I2C ID EEPROM. Leave unconnected if ID EEPROM not required.

SCH:
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.

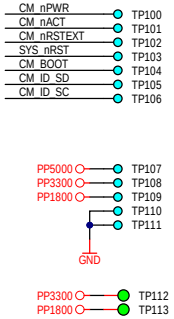
SCH:
1.8V and 3.3V Outputs +/-2.5%. Power Output max 300mA per pin for a total of 600mA. This will be powered down during power off or GLOBAL_EN being set low.

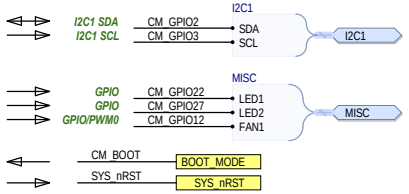
SCH:
GLOBAL_EN: Drive low to power off CM4. Internally pulled up with a 100K to +5V.

40-PIN GPIO HEADER



TESTPOINTS (DEBUG)





Used GPIOs:

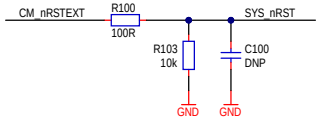
GPIO2 - I2C1 SDA
GPIO3 - I2C1 SCL

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

Raspberry Pi Pinout

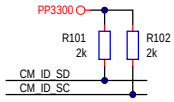
3v3 Power	1	2	5v Power
GPIO 2 (I2C1 SDA)	3	4	5v Power
GPIO 3 (I2C1 SCL)	5	6	Ground
GPIO 4 (GPCLK0)	7	8	GPIO 14 (UART TX)
Ground	9	10	GPIO 15 (UART RX)
GPIO 17	11	12	GPIO 18 (PCM CLK)
GPIO 27	13	14	Ground
GPIO 22	15	16	GPIO 23
3v3 Power	17	18	GPIO 24
GPIO 10 (SPI0 MOSI)	19	20	Ground
GPIO 9 (SPI0 MISO)	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)

GLOBAL RESET



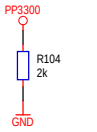
SCH:
nEXTRST: Driven low during reset. Driven high (3.3V) once CM4 CPU has started to boot.

ID I2C

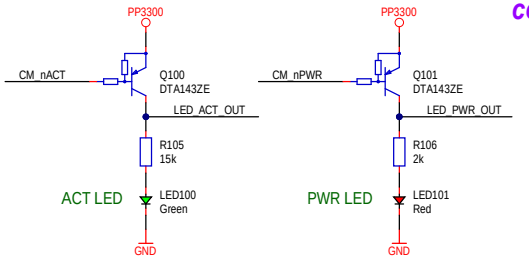


SYS LEDs

3V3 LOAD



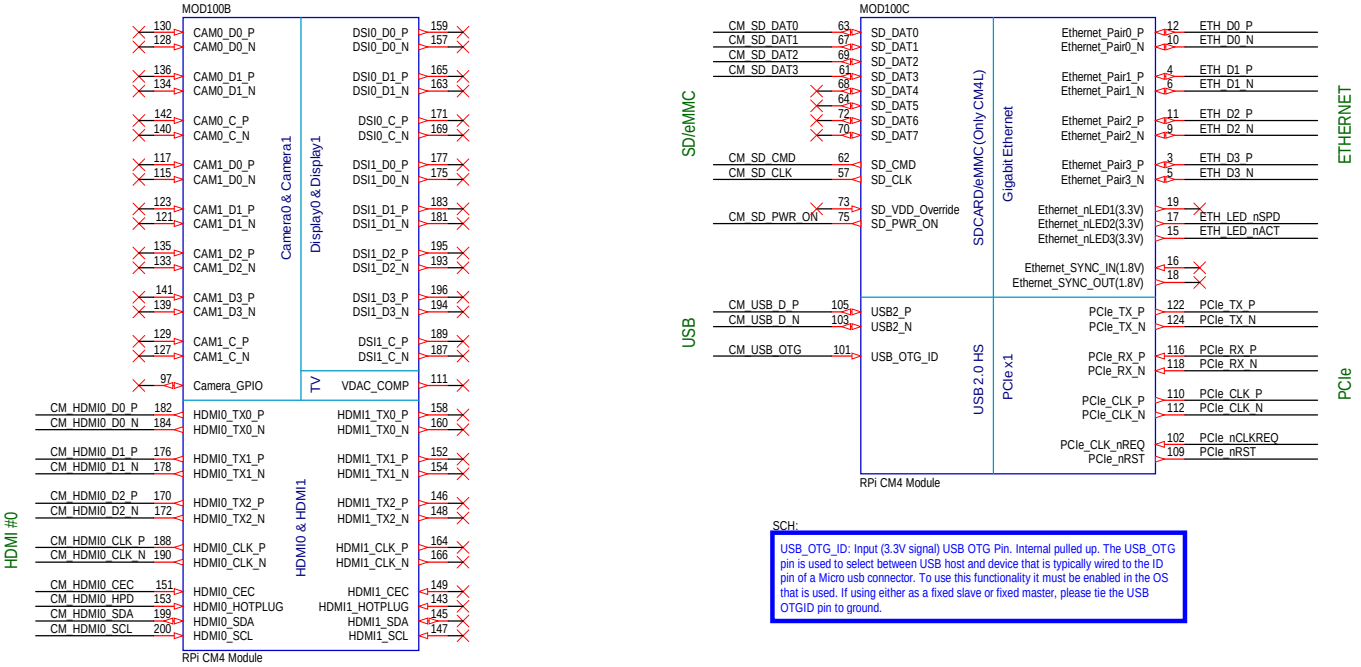
SCH:
Extra load on the 3V3 power rail to fix the HDMI issue with 5V LED.



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

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: [No Variations]		RefDes: 100-199	
Designer: M. Folejewski		Sheet: 4 / 15	
File Name: [04] CM4_PART1.SchDoc		Printed: 29.11.2022	

CM4 MODULE (PART #2)



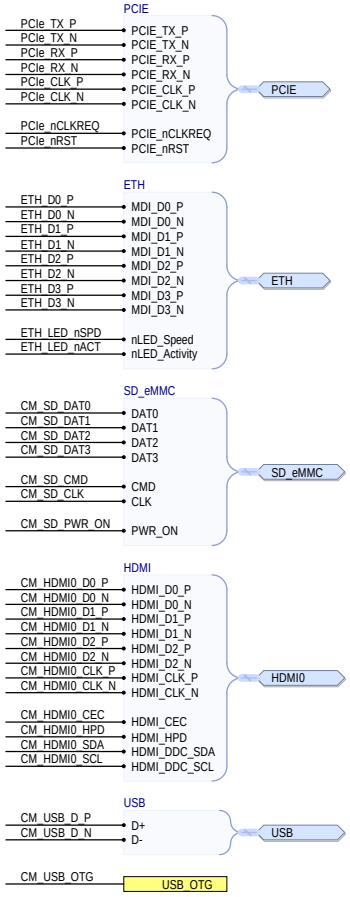
SCH:

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

J101 — CONNECTOR — Mezzanine, 100pin, 3.0mm

J102 — CONNECTOR — Mezzanine, 100pin, 3.0mm



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:

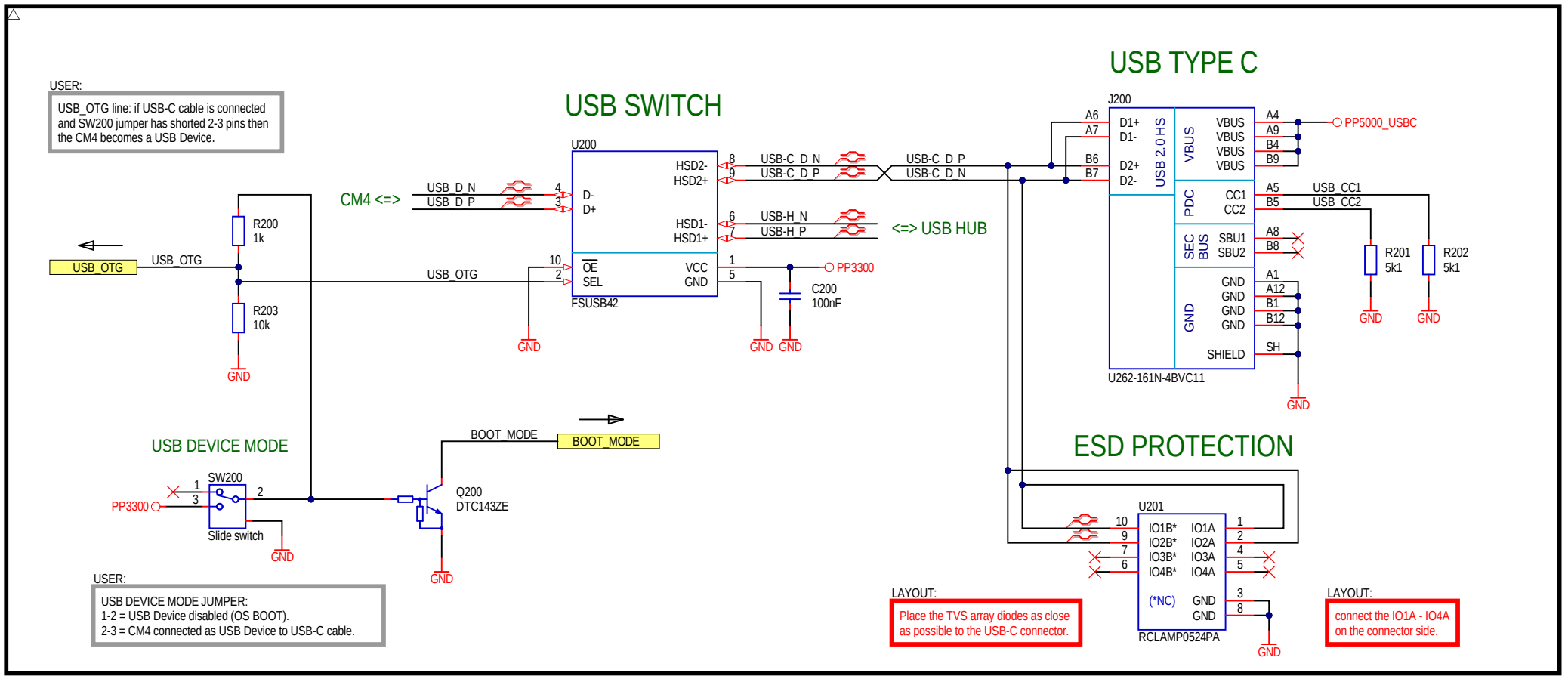
Route Ethernet signals as matched length 100 Ohm differential pairs with suitable clearances. Length matching between pairs should be better than 50mm, so in the typical case no length matching is required. However the signals within a pair need to be length matched, ideally to better than 0.15mm.

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.

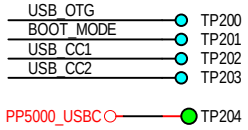
LAYOUT:

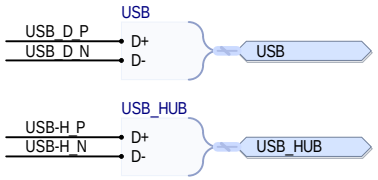
Impedance matching:
90 Ohm -> PCIe, USB
100 Ohm -> HDMI, Ethernet, MIPI (CSI, DSI)

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: [No Variations]		RefDes: 100-199	
Designer: M. Folejewski		Sheet: 5 / 15	
File Name: [05] CM4_PART2.SchDoc		Printed: 29.11.2022	



TESTPOINTS (DEBUG)





BOM:

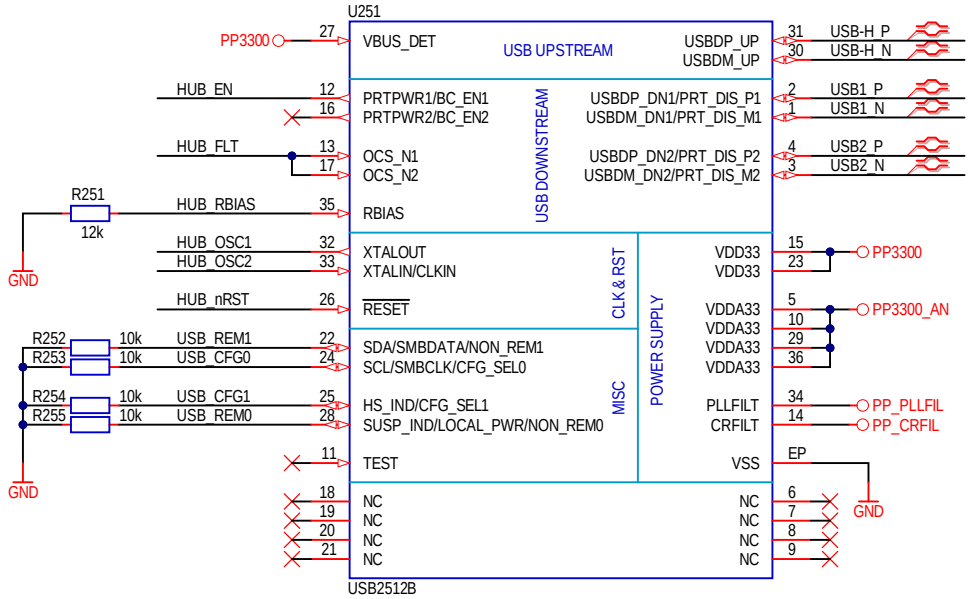
USB 3.1 Type C:
Use XKB Connectivity, MPN = U262-161N-4BVC11.
Description: vertical connector, 16 pins, USB 2.0 only, SMD version.

LAYOUT:

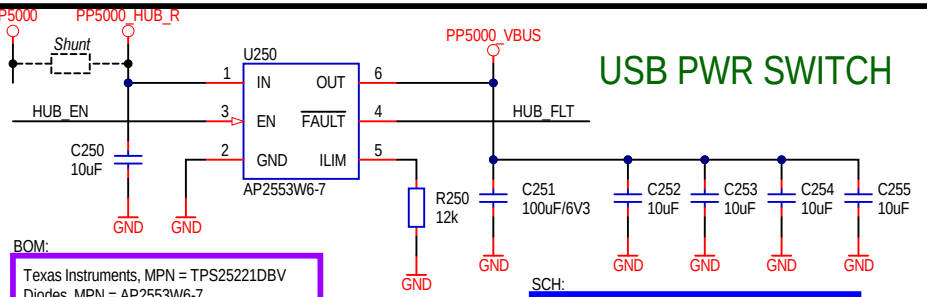
Route USB signals as matched length 90 Ohm differential pairs. The P N signals should ideally be matched to 0.15mm.

mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title: USB-C interface and USB switch			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: 200-249	
Designer: M. Folejewski		Sheet: 6 / 15	
File Name: [06] USB_C.SchDoc		Printed: 29.11.2022	

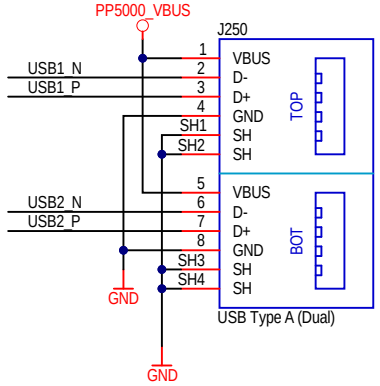
2-PORT USB HUB



USB PWR SWITCH

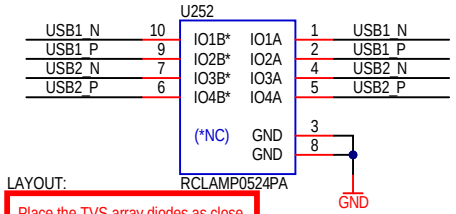


USB #1/#2



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

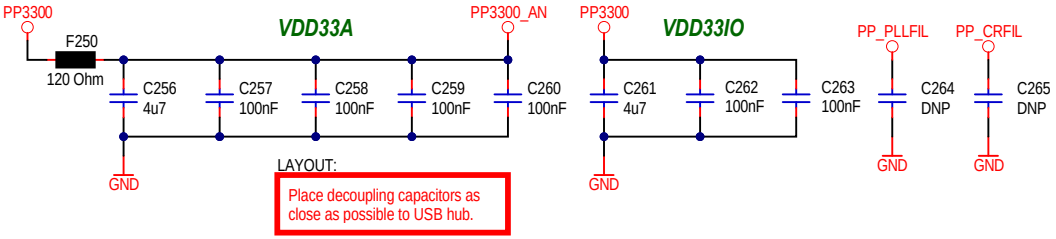
ESD PROTECTION



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

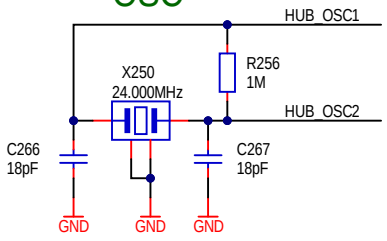
LAYOUT:
connect the IO1A - IO4A on the connector side.

DECOUPLING CAPACITORS

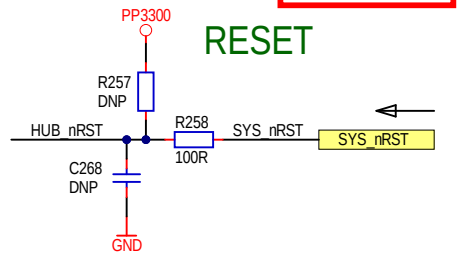


LAYOUT:
Place decoupling capacitors as close as possible to USB hub.

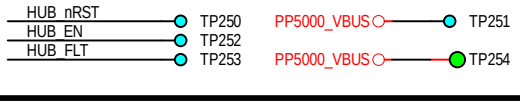
OSC



RESET

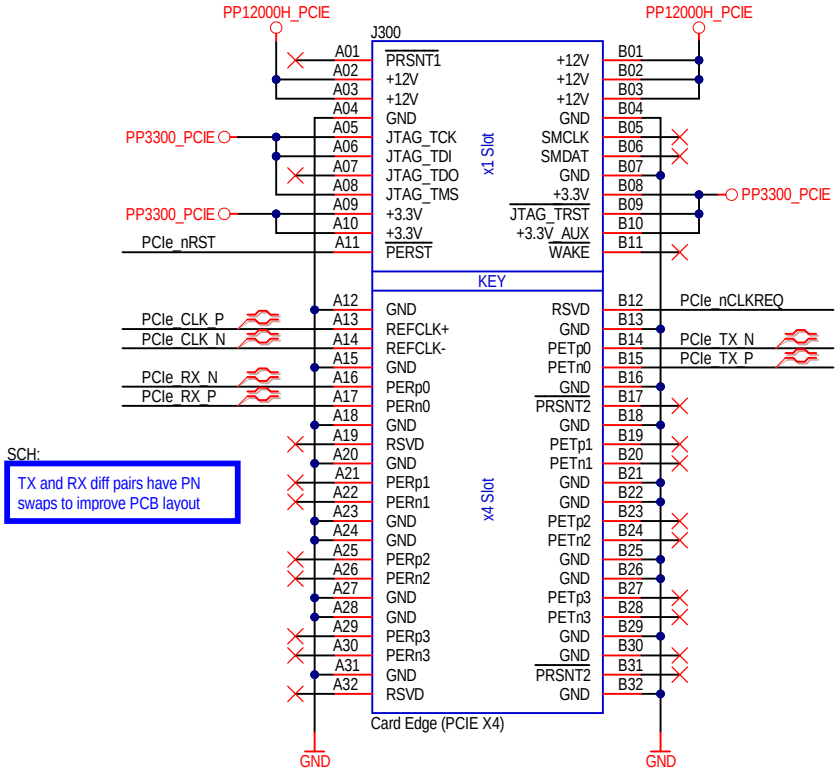


TESTPOINTS (DEBUG)



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A4
Title: 2-port USB 2.0 hub		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: [No Variations]	RefDes: 250-299		
Designer: M. Folejewski	Sheet: 7 / 15		
File Name: [07] USB_HUB.SchDoc	Printed: 29.11.2022		

PCI Express x4 Edge Connector



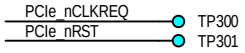
SCH:

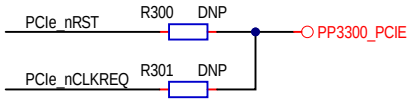
TX and RX diff pairs have PN swaps to improve PCB layout

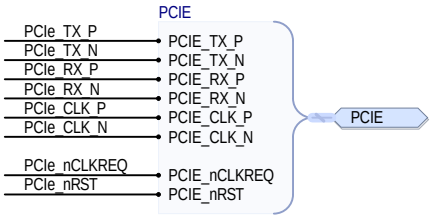
LAYOUT:

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.

TESTPOINTS (DEBUG)

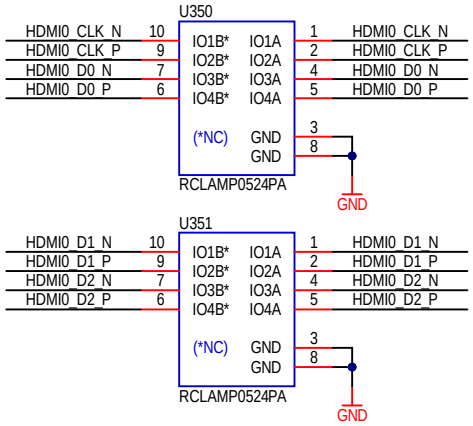






mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title M.2 PCIe x1 Socket			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: 300-399	
Designer: M. Folejewski		Sheet: 8 / 15	
File Name: [08] PCIe.SchDoc		Printed: 29.11.2022	

ESD PROTECTION



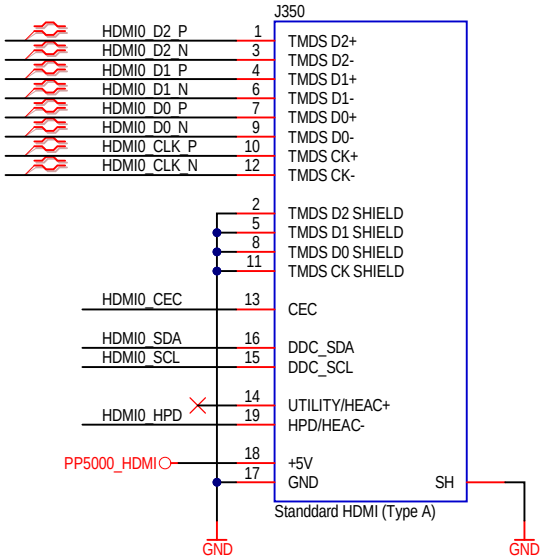
LAYOUT:

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

LAYOUT:

connect the IO1A - IO4A on the connector side.

HDMI #0 (TYPE A)



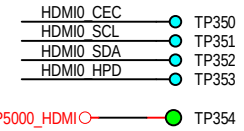
BOM:

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.

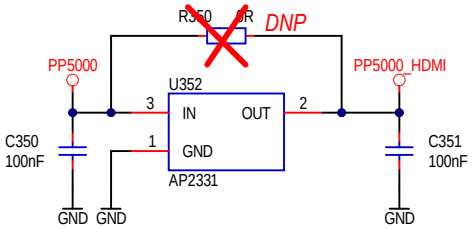
LAYOUT:

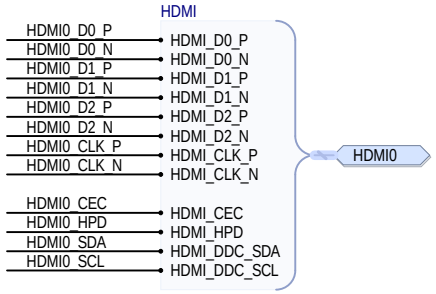
Route HDMI signals as matched length 100 Ohm differential pairs, each signal within a pair should ideally be matched to better than 0.15mm. Pairs don't typically need any extra matching as they only have to be matched to 25mm.

TESTPOINTS (DEBUG)



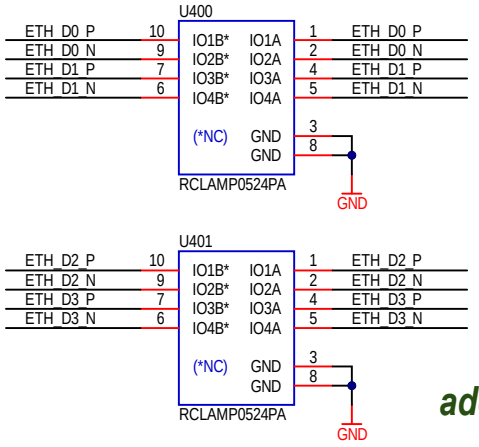
5V POWER SWITCH





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: [No Variations]		RefDes: 400-449	
Designer: M. Folejewski		Sheet: 9 / 15	
File Name: [09] HDMI.SchDoc		Printed: 29.11.2022	

ESD PROTECTION



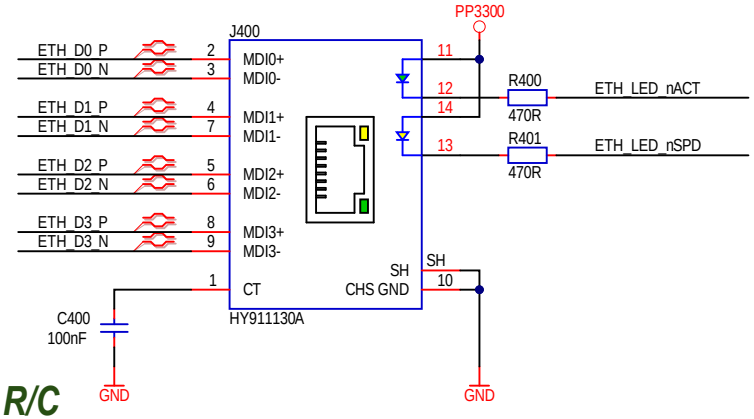
LAYOUT:

connect IO1A - IO4A on the connector side.

LAYOUT:

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

100/1000M ETHERNET



add 4 parameters R/C

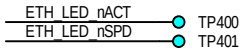
LAYOUT:

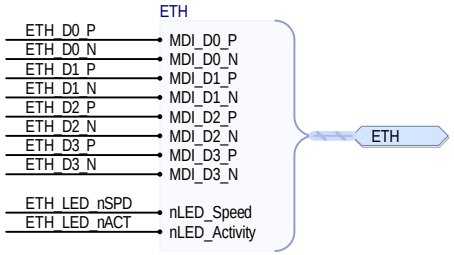
Route Ethernet signals as matched length 100 Ohm differential pairs with suitable clearances. Length matching between pairs should be better than 50mm, so in the typical case no length matching is required. However the signals within a pair need to be length matched, ideally to better than 0.15mm.

BOM:

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

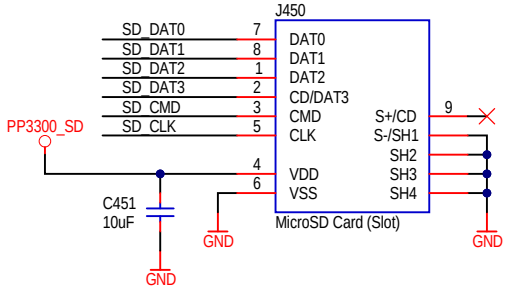
TESTPOINTS (DEBUG)





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: [No Variations]		RefDes: 500-599	
Designer: M. Folejewski		Sheet: 10 / 15	
File Name: [10] Ethernet.SchDoc		Printed: 29.11.2022	

MICRO SD CARD



SCH:

Used MicroSD card slot: Hmax = 2.00 mm

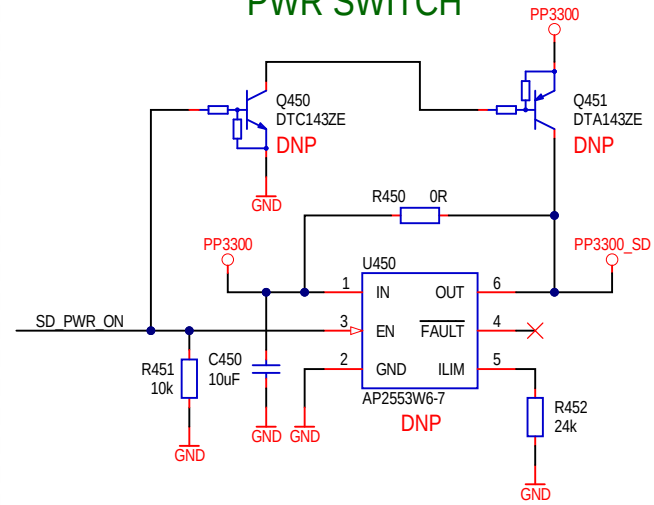
BOM:

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

USER:

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

PWR SWITCH



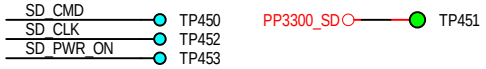
BOM:

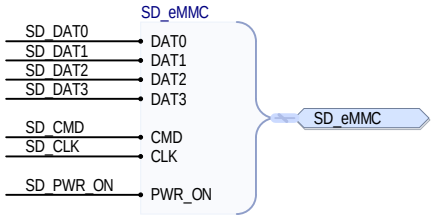
Texas Instruments, MPN = TPS25221DBV
Diodes, MPN = AP2553W6-7
Diodes, MPN = AP22653W6-7

SCH:

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

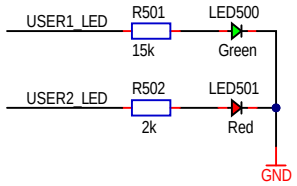
TESTPOINTS (DEBUG)



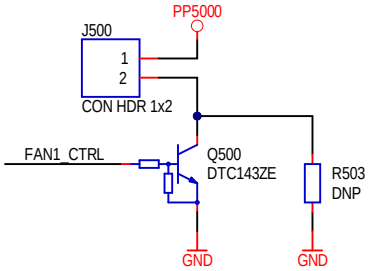


mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title MicroSD slot			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: 600-699	
Designer: M. Folejewski		Sheet: 11 / 15	
File Name: [11] SD.SchDoc		Printed: 29.11.2022	

USER LEDs



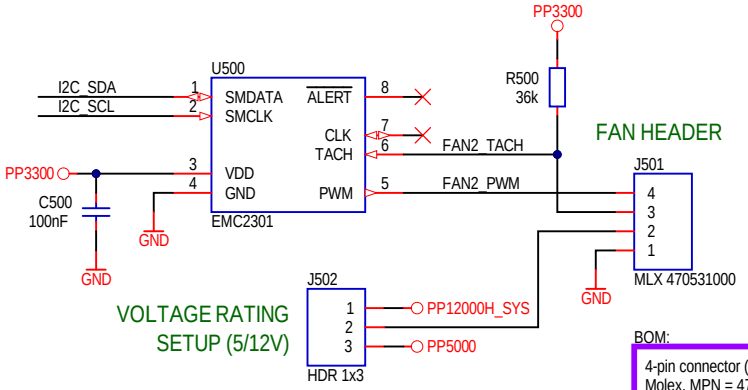
FAN1 (5V, ON/OFF)



USER:

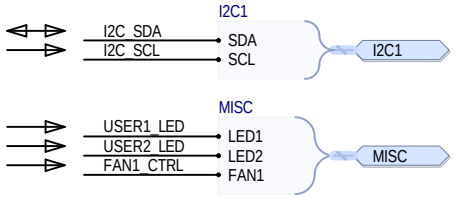
FAN1 can be controlled by FAN1_CTRL line (by static GPIO level or by using PWM mode). FAN1 control can be disabled (always on) by assembly R802 jumper.

FAN2 (5V/12V PWM CTRL IC)



BOM:

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



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: [No Variations]		RefDes: 800-899	
Designer: M. Folejewski		Sheet: 12 / 15	
File Name: [12] MISC.SchDoc		Printed: 29.11.2022	

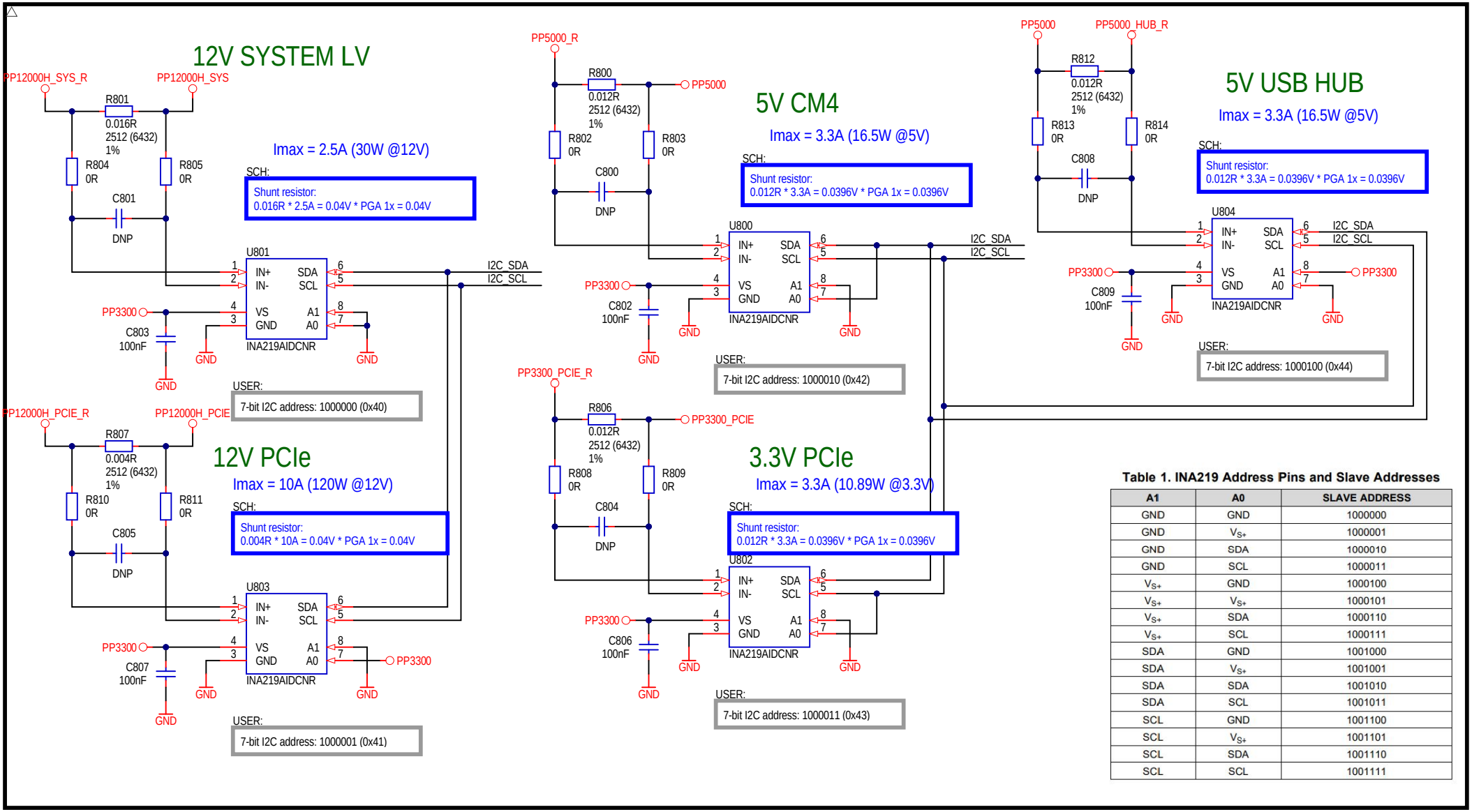
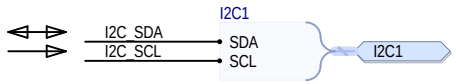
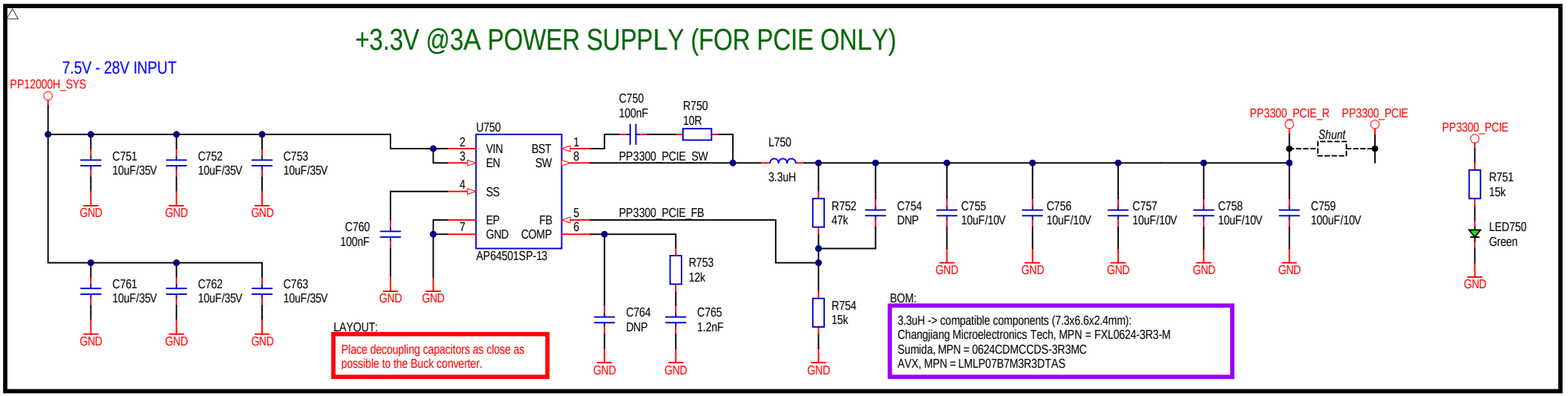


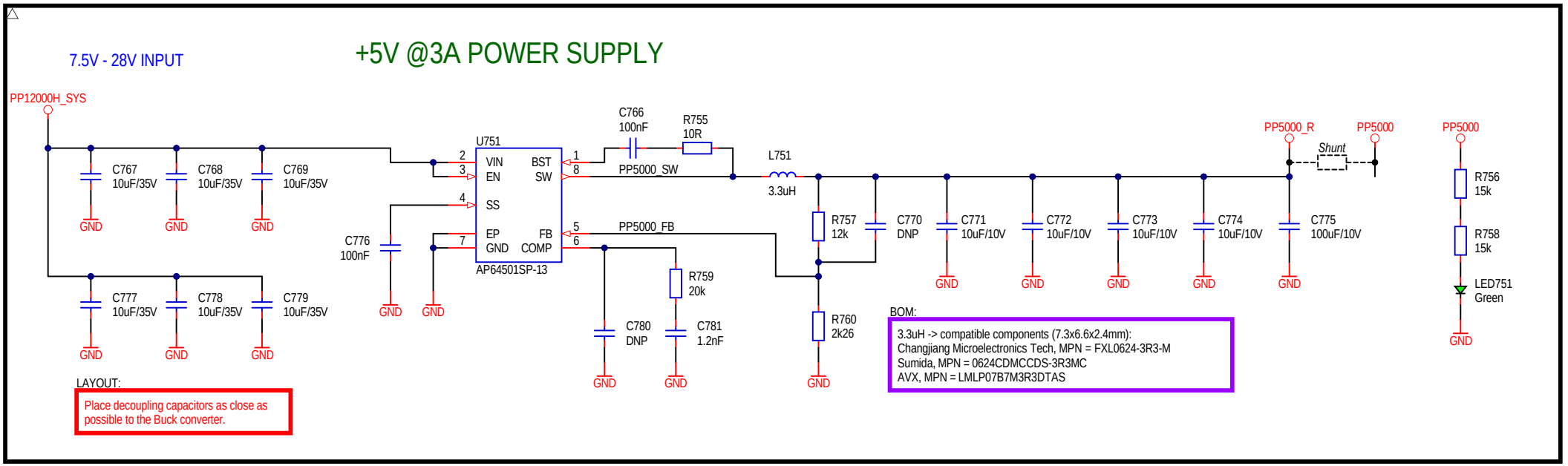
Table 1. INA219 Address Pins and Slave Addresses

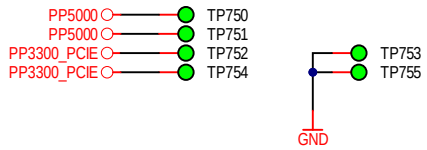
A1	A0	SLAVE ADDRESS
GND	GND	1000000
GND	V_{S+}	1000001
GND	SDA	1000010
GND	SCL	1000011
V_{S+}	GND	1000100
V_{S+}	V_{S+}	1000101
V_{S+}	SDA	1000110
V_{S+}	SCL	1000111
SDA	GND	1001000
SDA	V_{S+}	1001001
SDA	SDA	1001010
SDA	SCL	1001011
SCL	GND	1001100
SCL	V_{S+}	1001101
SCL	SDA	1001110
SCL	SCL	1001111



mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland	Size	A4
Title: Measurement sensors		Version	V1
Project: CM4 Module -> GPU card		Revision	R1
Variant: [No Variations]	RefDes: 900-949		
Designer: M. Folejewski	Sheet: 13 / 15		
File Name: [15] Sensors.SchDoc	Printed: 29.11.2022		







mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title Power supply			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: 900-949	
Designer: M. Folejewski		Sheet: 13 / 15	
File Name: [14] PWR2.SchDoc		Printed: 29.11.2022	

7.5V - 12V INPUT
12V NOMINAL

PP12000H_IN1

J700
1
2
SH
8A, 2.0mm

GND

PP12000H_IN2

J701
4 1
5 2
6 3
039-30-1060

GND
SENSE0
GND
+12V
+12V
+12V

GND

IDEAL DIODE

SCH:
Ideal diode to prevent reverse polarity at the input

PP12000H_IN1

FUS700
10A/125VDC

Q700
PMOS
SI7149ADP-T1-GE3

D701
SMAJ12A

D700
12V

R702
100k

C700
100nF/50V

R703
15k

R704
5k1

Q701
DTC143ZE

R705
0R
DNP

Q702
DTC143ZE

R708
5k1

PP12000H_SYS_R

Shunt

PP12000H_SYS

C701
220uF/25V

GND

LEDs

PP12000H_SYS
R700
100k
LED700
Green
GND

PP12000H_PCIE
R701
100k
LED701
Green
GND

PP12000H_IN1
R706
100k
LED702
Green
GND

PP12000H_IN2
R707
100k
LED703
Green
GND

TESTPOINTS

TP700
TP701
TP702
TP703

PP12000H_IN1 TP704
PP12000H_IN1 TP705
PP12000H_IN2 TP706
PP12000H_IN2 TP707
PP12000H_SYS TP708
PP12000H_SYS TP709
PP12000H_PCIE TP710
PP12000H_PCIE TP711

7.5V - 12V INPUT
12V NOMINAL

BOM:
Fuse: 10A/125V
Bel Fuse, MPN = 0679L9100-01
KOA Speer, MPN = CCF1F10TTE
Bourns, MPN = SF-2410FP1000T-2
Littelfuse, MPN = 0453010.NR

IDEAL DIODE

PP12000H_IN2

FUS701
10A/125VDC

Q703
PMOS
SI7149ADP-T1-GE3

D703
SMAJ12A

D702
12V

C702
100nF/50V

R709
15k

C704
220uF/25V

C703
10uF/35V

FUS702
10A/125VDC

PP12000H_PCIE_R

Shunt

PP12000H_PCIE

C705
220uF/25V

GND

12V PCIe POWER RAIL: ±8% (75W)
12V ±8% = 11.04V - 12.96V

PCIe Gen3 power requirement: 75W
12V -> 5.5A (66W)
3.3V -> 3A (9.9W)

mirko electronics	Mirko Electronics Smoka Wawelskiego 1 30-535 Kraków, Poland		Size A4
Title Power supply			Version V1
Project: CM4 Module -> GPU card			Revision R1
Variant: [No Variations]		RefDes: 900-949	
Designer: M. Folejewski		Sheet: 13 / 15	
File Name: [13] PWR1.SchDoc		Printed: 29.11.2022	

CM4 MOUNTING HOLES

MH900 H270_C600
MH901 H270_C600
MH902 H270_C600
MH903 H270_C600

PCB MOUNTING HOLES

MH904 H320_C700 GND
MH905 H320_C700 GND
MH906 H320_C700 GND
MH907 H320_C700 GND

M2.5 STEEL SPACERS

MECH900 M2.5, L = 3.0mm
MECH901 M2.5, L = 3.0mm
MECH902 M2.5, L = 3.0mm
MECH903 M2.5, L = 3.0mm

SCR900 M2.5
SCR901 M2.5
SCR902 M2.5
SCR903 M2.5

BOM:

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

PCB MARKING

FID900 Fiducial
FID901 Fiducial
FID902 Fiducial
FID903 Fiducial
FID904 Fiducial
FID905 Fiducial

PCB900 LAYER INDICATOR PCB_LAYER_STACKUP

ASSEMBLY VARIANT INDICATOR

R900 0R LITE VARIANT
R901 0R STD/PRO VARIANT

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: [No Variations]		RefDes: 950-999	
Designer: M. Folejewski		Sheet: 14 / 15	
File Name: [16] PCB_Mech.SchDoc		Printed: 29.11.2022	

Hardware changelog

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

2022.10.29:
- schematic update, minor changes;

2022.10.31:
- PCB shape according to PCIe standard;
- initial component placement of the front connectors;
- minor changes;

2022.11.02:
- added DC barrel jack;
- schematic: power supply update;

2022.11.03:
- component placement of the front connectors;
- microsd card: updated PCB edge;
- RefDes updated;

2022.11.09:
- power supply circuit created;
- added EC schematic page;
- minor changes;

2022.11.10:
- minor changes;
- RefDes updated;
- power supply circuit updated;

2022.11.14:
- Sensors: schematic circuit designed;

2022.11.15:
- PCB layout and component placement;

2022.11.16:
- PCB layout and component placement;

2022.11.17:
- PCB layout and component placement;

2022.11.18:
- PCB layout and component placement;

2022.11.21:
- PCB layout;

2022.11.22:
- PCB layout;

2022.11.23:
- PCB layout;

2022.11.24:
- PCB layout;

2022.11.25:
- PCB layout;

2022.11.26:
- PCB layout;

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: [No Variations]		RefDes: -	
Designer: M. Folejewski		Sheet: 15 / 15	
File Name: [17] Changelog.SchDoc		Printed: 29.11.2022	