

LEA Logo

LEA Logo

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

✗ Fiducial medium

USB-C Cable

XDS100 – Page 2

Connector Top – Page 4

Power – Page 6

Error Detection – Page 8

Status LEDs – Page 10



https://github.com/upb-lea/LEA_control_board

Isolation – Page 3

Connector Bottom – Page 5

MCU – Page 7

Analog Filter – Page 9

MCU GPIOs – Page 11

Components reference:

2XX -> Page 2
3XX -> Page 3
4XX -> Page 4
5XX -> Page 5
6XX -> Page 6
7XX -> Page 7
8XX -> Page 8
9XX -> Page 9
1XXX -> Page 10

PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /
File: LCB-CCB-01.kicad_sch

Title: LCB-CCB-01: Control Board – Debugger XDS100 / JTAG

Size: A4 Date: 2025-05-27

KiCad E.D.A. 9.0.2

Rev: 1.2.0

Id: 1/11

XDS100 USB-C Port

[illegible][illegible]

Power Status LED

+3.3V_LV ← D201 (2mA) R202 (680Ω) → GND_LV

12 MHz Clock

The diagram illustrates the 12 MHz Clock circuit. A yellow component, labeled **ECS-2033-120-AU**, is shown with the following connections:

- Pin 1 (Vdd):** Connected to **+3.3V_LV**.
- Pin 2 (Gnd):** Connected to **GND_LV**.
- Pin 3 (Output):** Labeled **CLK_12MHz**.
- Pin 4 (Y201):** Labeled **Output**.

A capacitor **C210** with a value of **100n** is connected between pins 1 and 2.

Decoupling Capacitors

MCU FT232HL

The diagrams illustrate the decoupling capacitor placement for the FT232HL MCU. The left diagram shows the 3.3V LV supply with capacitors C211 to C215. The right diagram shows the 1.8V HV supply with capacitors C216 to C220. Both diagrams show capacitors connected to GND_LV.

Debugger Selection

U204
ADG736BRMZ

U205
ADG736BRMZ

U206
ADG736BRMZ

Debug_Select
S201
CA5-120TA

PADERBORN UNIVERSITY DEPARTMENT OF	
Sheet: /XDS100 – Page 2/	File: Debugger.kicad_sch
Title: LCB-CCB-01: Control	
Size: A4	Date: 2025-05-27
KiCad E.D.A. 9.0.2	

Sheet: /XDS100 - Page 2/ File: Debugger.kicad_sch		
Title: LCB-CCB-01: Control Board - Debugger XDS100 / JTAG		
Size: A4	Date: 2025-05-27	Rev: 1.2.0
KiCad E.D.A. 9.0.2		Id: 2/11

JTAG and SCI Isolation

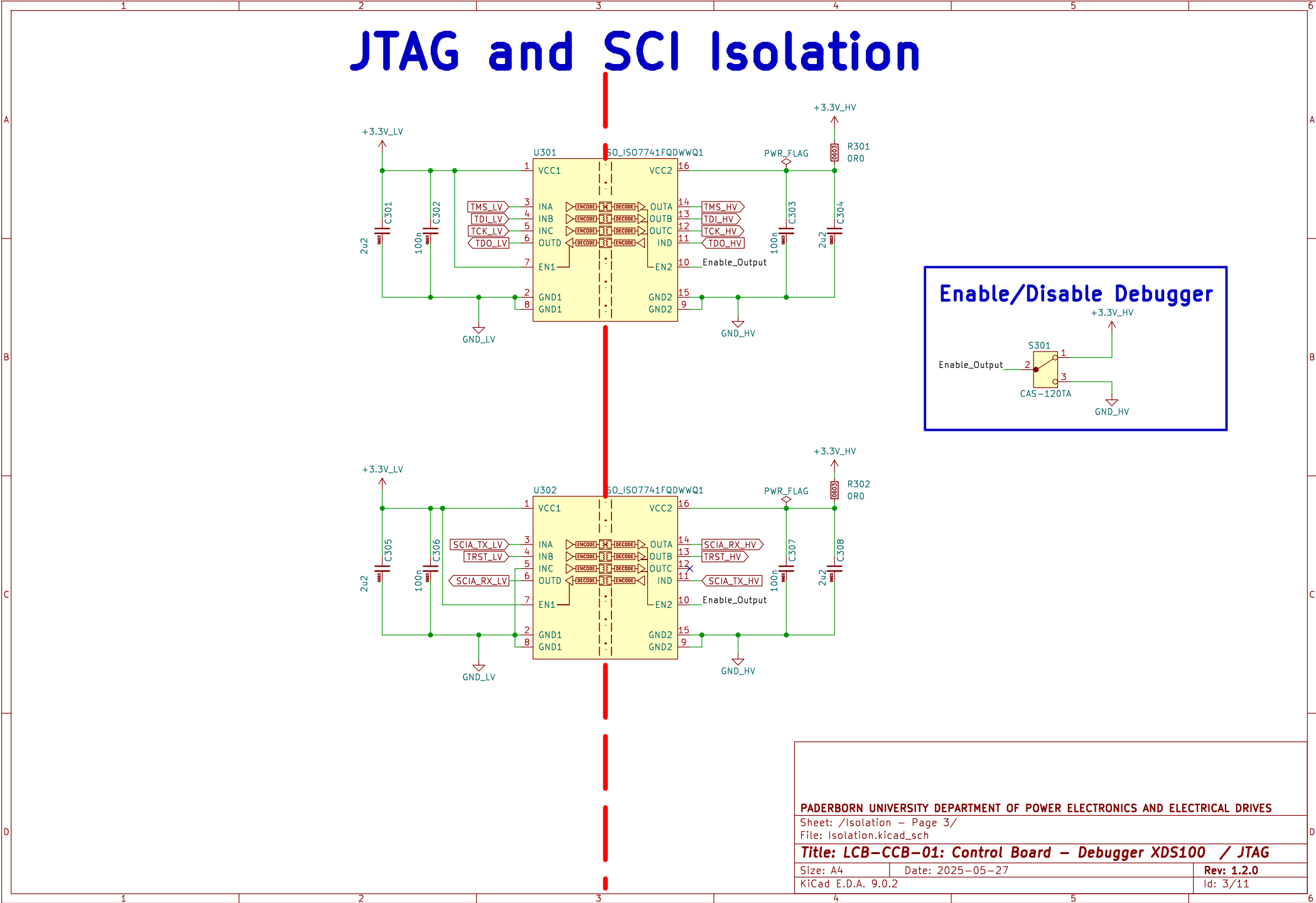
The diagram illustrates the JTAG and SCI isolation for two chips, U301 and U302, which are SO-ISO7741FQDWWQ1 components. The chips are connected to a +3.3V_LV supply and a +3.3V_HV supply. The JTAG signals (TMS, TDI, TCK, TDO) are isolated between the two chips. The SCI signals (SCIA_TX, SCIA_RX, TRST) are also isolated. The Enable_Output pin of each chip is connected to a common Enable/Disable Debugger circuit, which is controlled by a CAS-120TA component. The circuit is powered by +3.3V_HV and grounded to GND_HV.

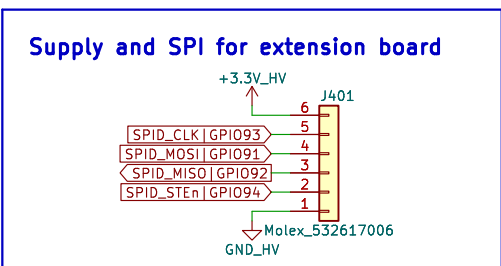
Enable/Disable Debugger

The Enable/Disable Debugger circuit is shown in a callout box. It consists of a CAS-120TA component connected to +3.3V_HV and GND_HV. The Enable_Output pin of the chips is connected to the output of the CAS-120TA component.

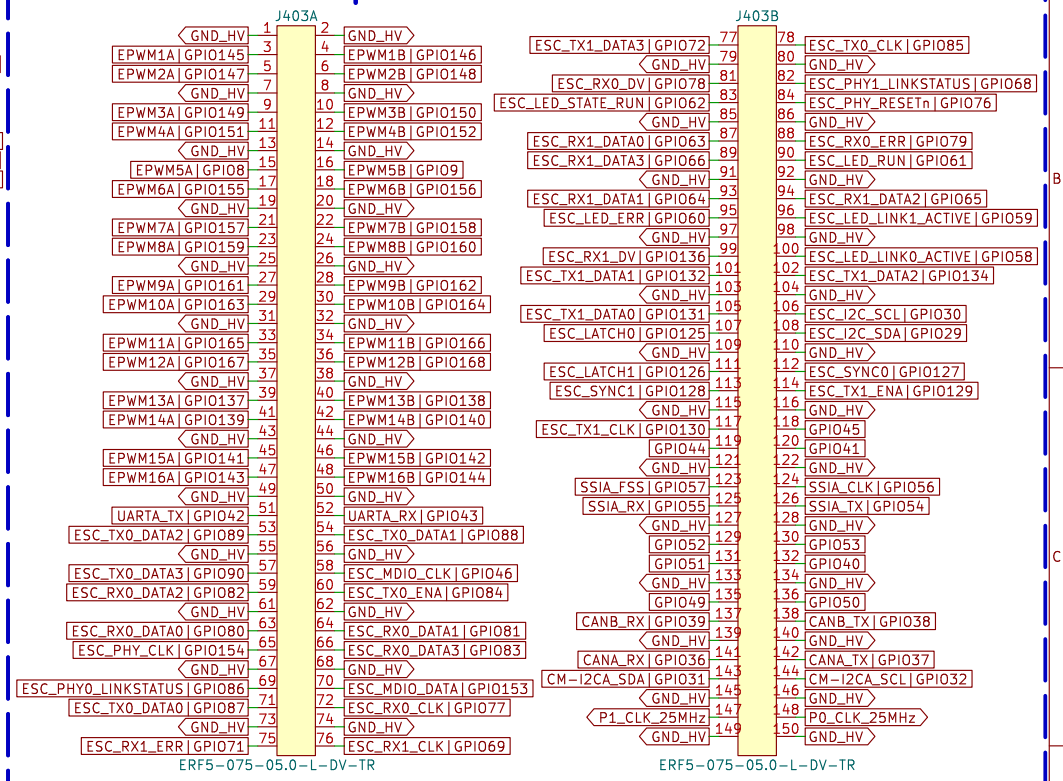
Metadata:

PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES		
Sheet: /Isolation - Page 3/		
File: Isolation.kicad_sch		
Title: LCB-CCB-01: Control Board - Debugger XDS100 / JTAG		
Size: A4	Date: 2025-05-27	Rev: 1.2.0
KiCad E.D.A. 9.0.2		Id: 3/11





Top J403 Connector



Id: 4/11

Bottom J501 Connector

J501A	J501B
+3V3_Connector_HV	GND_HV
+3V3_Connector_HV	ENET_MII_TX_ERR GPIO113
+3V3_Connector_HV	ENET_MII_TX_EN GPIO118
+3V3_Connector_HV	GND_HV
+3V3_Connector_HV	ENET_MII_TX_Data2 GPIO123
GND_HV	ENET_MII_RX_Data1 GPIO115
GND_HV	ENET_MII_TX_Data3 GPIO124
FreePin1	ENET_CLK_25MHz
MCAN_RX GPIO170	GND_HV
GND_HV	GND_HV
I2CA_SCL GPIO1	FreePin3
SCIC_TX GPIO12	FreePin5
GND_HV	FreePin7
SPIA_MOSI GPIO16	GND_HV
SPIA_STEn GPIO19	GND_HV
GND_HV	GND_HV
SPIC_MOSI GPIO100	SPIC_MISO GPIO101
SPIC_STEn GPIO103	SPIC_CLK GPIO102
GND_HV	GND_HV
SPIB_MOSI GPIO124	SPIB_MISO GPIO125
SPIB_STEn GPIO127	SPIB_CLK GPIO126
GND_HV	GND_HV
SCIB_TX GPIO22	SCIB_RX GPIO23
GPIO20_nErr1	GPIO15_Err1
GPIO21_nErr2	GPIO95_Err2
GPIO104_nErr3	GPIO99_Err3
GND_HV	GND_HV
GPIO14_nErr4	GPIO96_Err4
GPIO33	GPIO34
GND_HV	GND_HV
ENET_MDIO_CLK GPIO105	ENET_RMII_CLK GPIO107
ENET_MII_INTR GPIO108	ENET_PPSO GPIO147
GND_HV	GND_HV
ENET_MDIO_DATA GPIO106	ENET_REVMII_MDIO_RST GPIO107
ENET_MII_COL GPIO110	ENET_MII_RX_DV GPIO112
GND_HV	GND_HV
ENET_MII_CRS GPIO109	ENET_PPS1 GPIO148
ENET_MII_RX_CLK GPIO111	ENET_MII_RX_Data0 GPIO114

ERM5-075-05.0-L-DV-K-TR

ERM5-075-05.0-L-DV-K-TR

Bottom J502 Connector

J502A	J502B
GND_HV	GND_HV
EPWM1A GPIO145	EPWM1B GPIO146
EPWM2A GPIO147	EPWM2B GPIO148
GND_HV	GND_HV
EPWM3A GPIO149	EPWM3B GPIO150
EPWM4A GPIO151	EPWM4B GPIO152
GND_HV	GND_HV
EPWM5A GPIO153	EPWM5B GPIO154
EPWM6A GPIO155	EPWM6B GPIO156
GND_HV	GND_HV
EPWM7A GPIO157	EPWM7B GPIO158
EPWM8A GPIO159	EPWM8B GPIO160
GND_HV	GND_HV
EPWM9A GPIO161	EPWM9B GPIO162
EPWM10A GPIO163	EPWM10B GPIO164
GND_HV	GND_HV
EPWM11A GPIO165	EPWM11B GPIO166
EPWM12A GPIO167	EPWM12B GPIO168
GND_HV	GND_HV
EPWM13A GPIO169	EPWM13B GPIO170
EPWM14A GPIO171	EPWM14B GPIO172
GND_HV	GND_HV
EPWM15A GPIO173	EPWM15B GPIO174
EPWM16A GPIO175	EPWM16B GPIO176
GND_HV	GND_HV
UARTA_TX GPIO142	UARTA_RX GPIO143
ESC_TX0_DATA2 GPIO108	ESC_TX0_DATA1 GPIO108
GND_HV	GND_HV
ESC_TX0_DATA3 GPIO109	ESC_TX0_CLK GPIO104
ESC_RX0_DATA2 GPIO108	ESC_TX0_ENA GPIO104
GND_HV	GND_HV
ESC_RX0_DATA0 GPIO108	ESC_RX0_DATA1 GPIO108
ESC_PHY_CLK GPIO154	ESC_RX0_DATA3 GPIO108
GND_HV	GND_HV
ESC_PHY0_LINKSTATUS GPIO108	ESC_RX0_CLK GPIO107
ESC_TX0_DATA0 GPIO107	GND_HV
GND_HV	ESC_RX1_ERR GPIO107
ESC_RX1_ERR GPIO107	ESC_RX1_CLK GPIO106

ERM5-075-05.0-L-DV-K-TR

ERM5-075-05.0-L-DV-K-TR

PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /Connector Bottom - Page 5/

File: Connector_Bottom.kicad_sch

Title: LCB-CCB-01: Control Board - Debugger XDS100 / JTAG

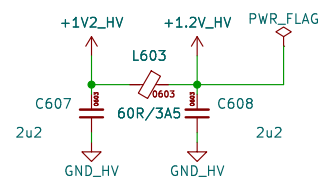
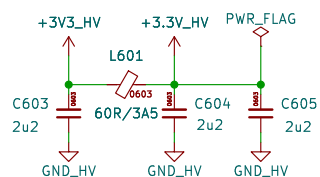
Size: A4 Date: 2025-05-27

KiCad E.D.A. 9.0.2

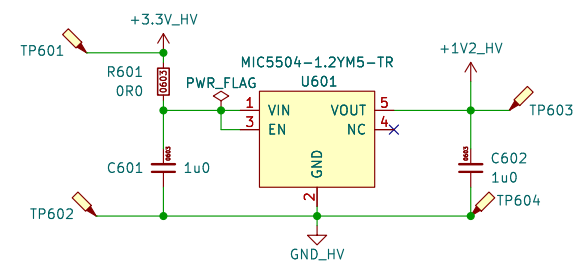
Rev: 1.2.0

Id: 5/11

Ferrit Beads



LDO 1.2V for MCU Core



PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /Power – Page 6/

File: Power.kicad_sch

Title: LCB-CCB-01: Control Board – Debugger XDS100 / JTAG

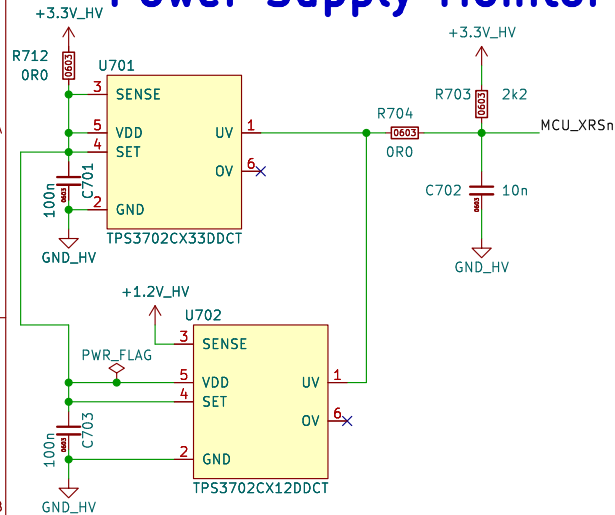
Size: A4 Date: 2025-05-27

Rev: 1.2.0

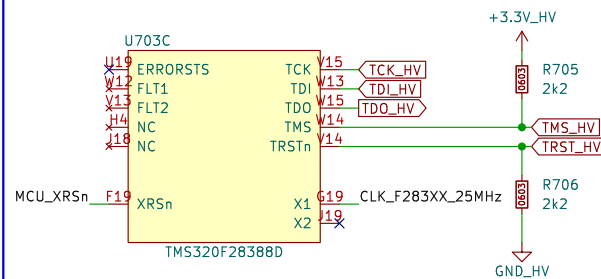
KiCad E.D.A. 9.0.2

Id: 6/11

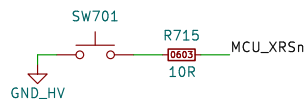
Power Supply Monitor



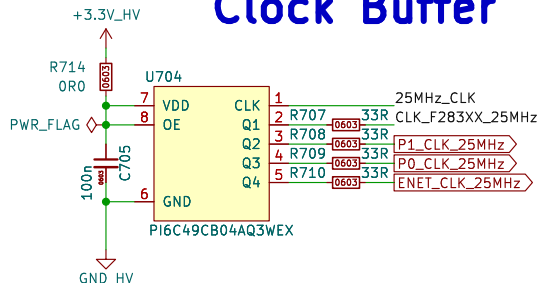
JTAG, CLK, Reset



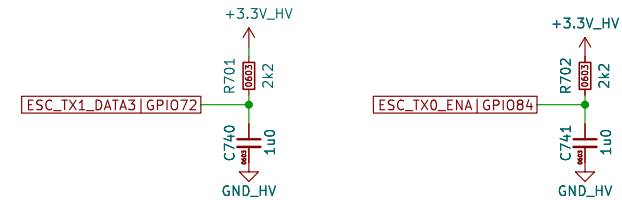
Reset Switch



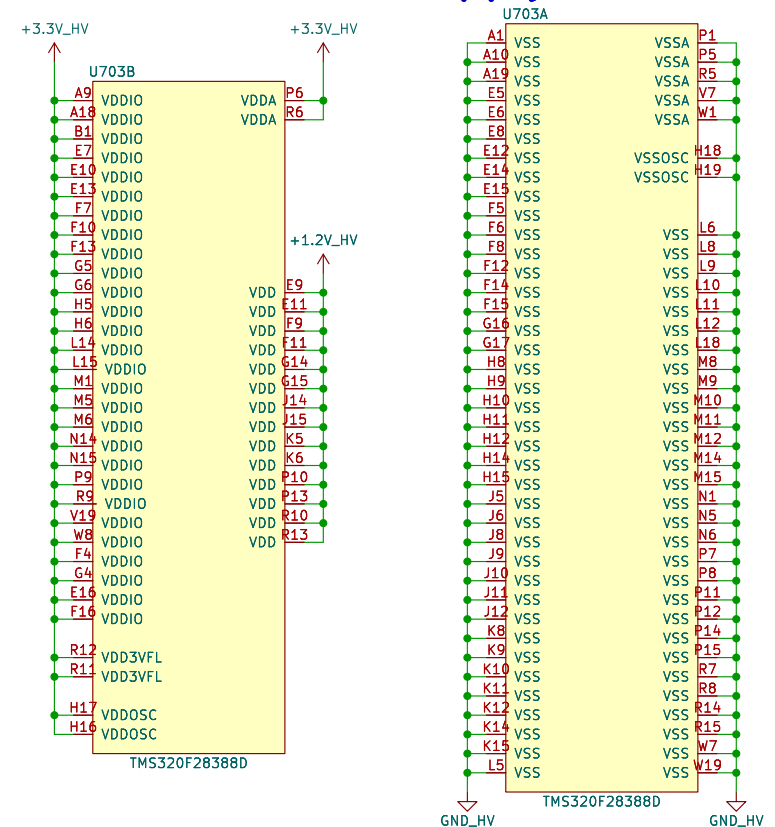
Clock Buffer



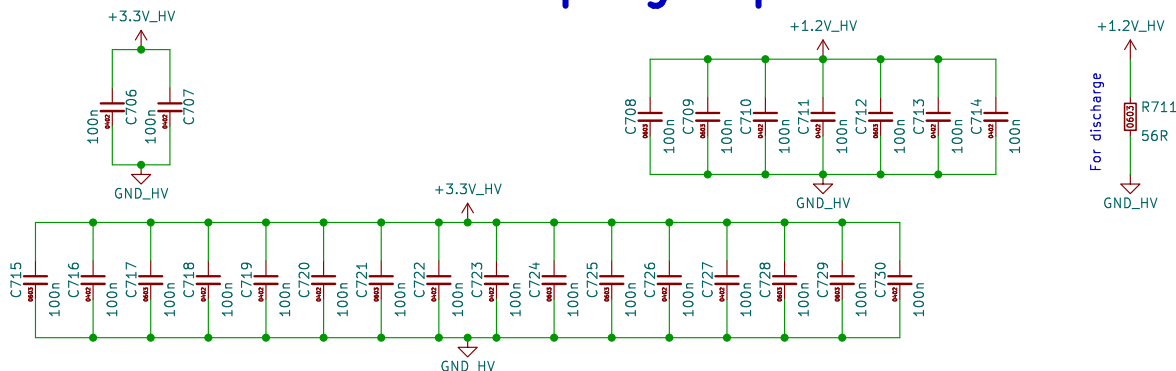
Boot Mode Pins



F2838D MCU Supply Pins



F28388D MCU Decoupling Capacitors



PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /MCU - Page 7/

File: MCU.kicad_sch

Title: LCB-CCB-01: Control Board - Debugger XDS100 / JTAG

Size: A4

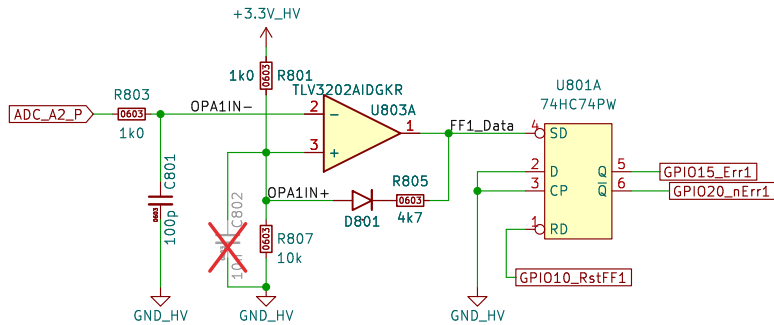
Date: 2025-05-27

Rev: 1.2.0

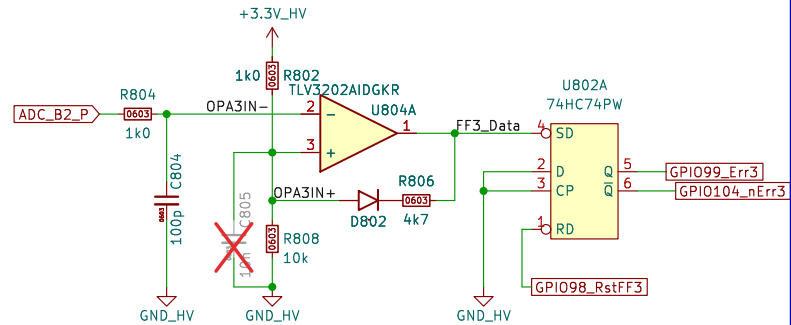
KiCad E.D.A. 9.0.2

Id: 7/11

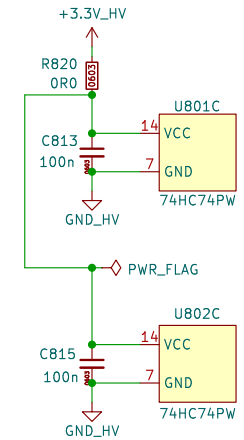
Error1 – A2



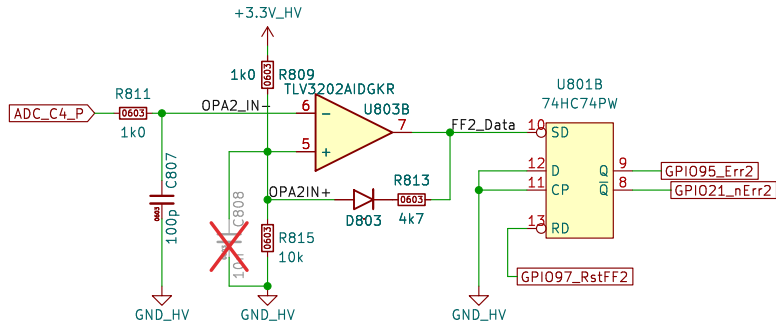
Error3 – B2



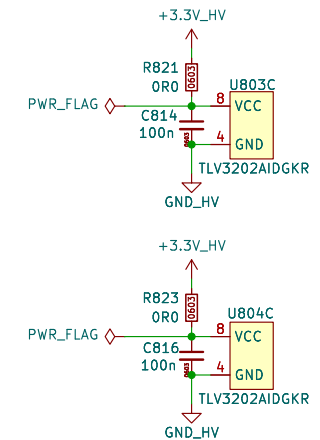
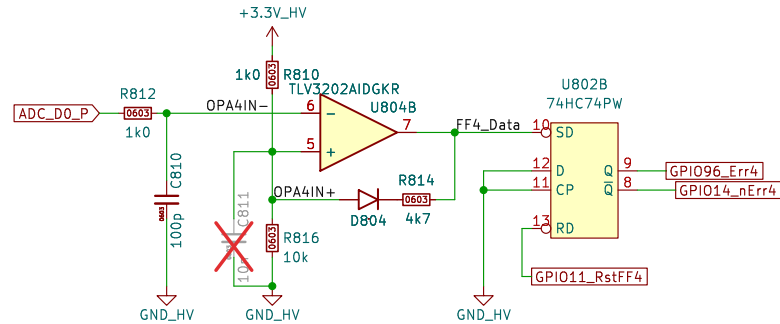
Power Supply



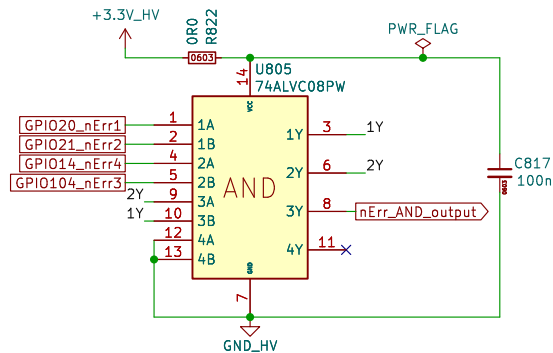
Error2 – C4



Error4 – D0



Error AND Gate



PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /Error Detection – Page 8/

File: ErrorcComparator.kicad_sch

Title: LCB-CCB-01: Control Board – Debugger XDS100 / JTAG

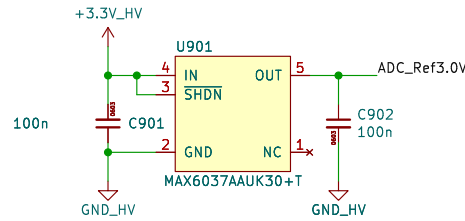
Size: A4 Date: 2025-05-27

KiCad E.D.A. 9.0.2

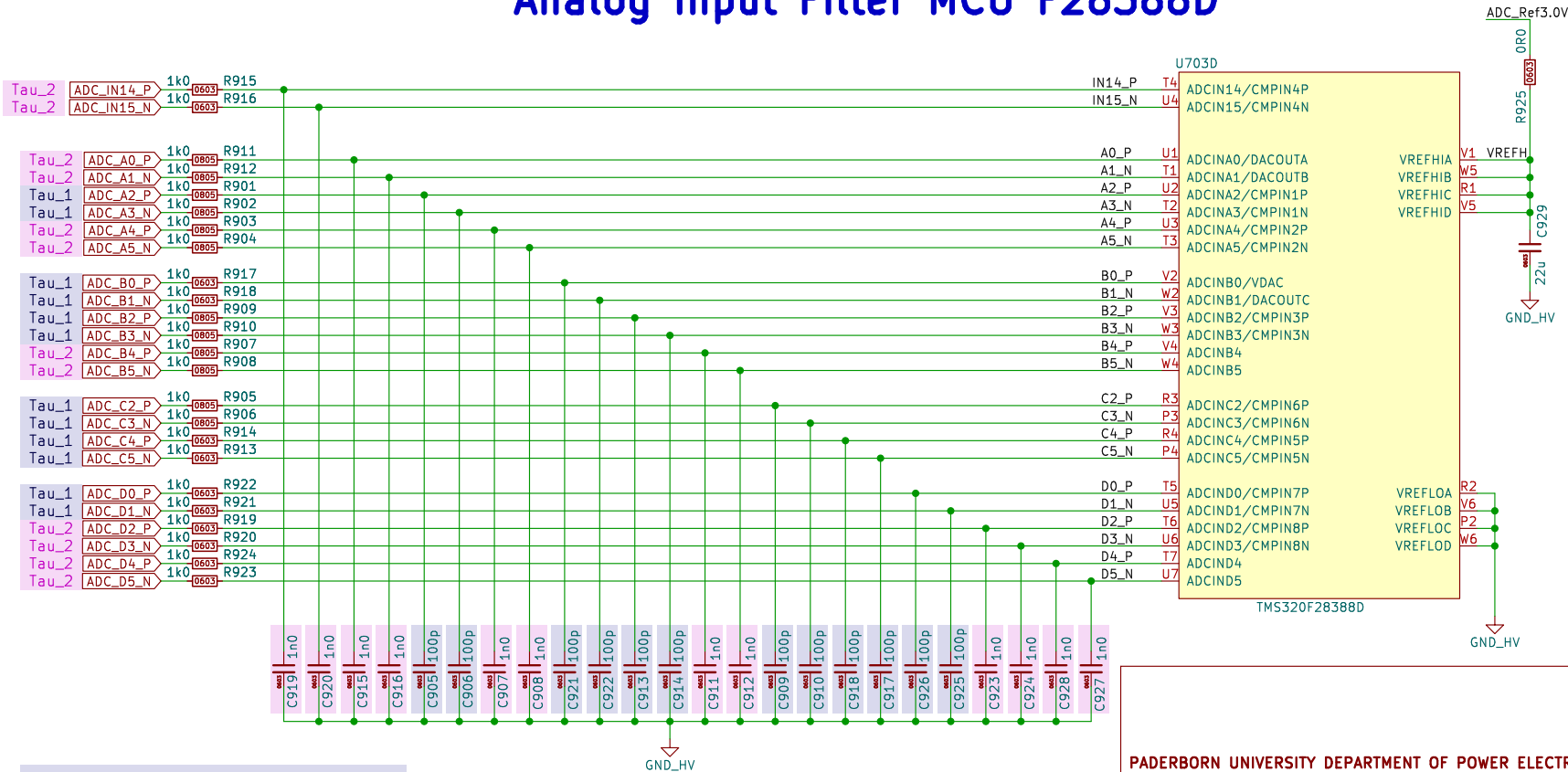
Rev: 1.2.0

Id: 8/11

3V Reference Voltage



Analog Input Filter MCU F28388D



$$\text{Tau}_1 = 100\text{ns} = 1\text{k}\Omega \cdot 100\text{pF}$$

$$\text{Tau}_2 = 1\mu\text{s} = 1\text{k}\Omega \cdot 1\text{nF}$$

PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /Analog Filter – Page 9/

File: AnalogFilter.kicad_sch

Title: LCB-CCB-01: Control Board – Debugger XDS100 / JTAG

Size: A4

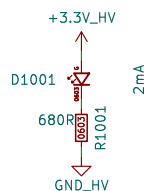
Date: 2025-05-27

Rev: 1.2.0

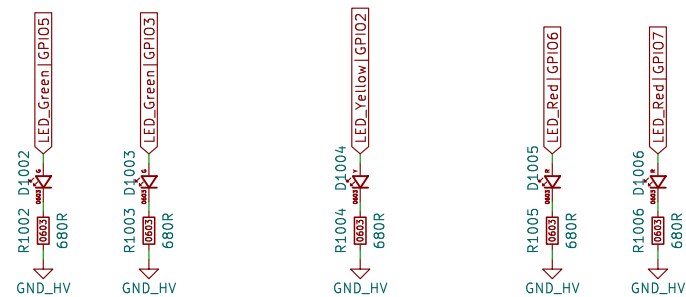
KiCad E.D.A. 9.0.2

Id: 9/11

Power LED



Status LEDs



F28388D MCU GPIO Configuration

U703E			
I2CA_SDA GPIO0	C8	GPIO_0	GPIO_61
I2CA_SCL GPIO1	D8	GPIO_1	GPIO_62
LED_Yellow GPIO2	A7	GPIO_2	GPIO_63
LED_Green GPIO3	B7	GPIO_3	GPIO_64
MCAN_TX GPIO4	C7	GPIO_4	GPIO_65
LED_Green GPIO5	D7	GPIO_5	GPIO_66
LED_Red GPIO6	A6	GPIO_6	GPIO_67
LED_Red GPIO7	B6	GPIO_7	GPIO_68
EPWM5A GPIO8	G2	GPIO_8	GPIO_69
EPWM5B GPIO9	G3	GPIO_9	GPIO_70
GPIO10_RstFF1	B2	GPIO_10	GPIO_71
GPIO11_RstFF4	C1	GPIO_11	GPIO_72
SCIC_TX GPIO12	C2	GPIO_12	GPIO_73
SCIC_RX GPIO13	D1	GPIO_13	GPIO_74
GPIO14_nErr4	D2	GPIO_14	GPIO_75
GPIO15_Err1	D3	GPIO_15	GPIO_76
SPIA_MOSI GPIO16	E1	GPIO_16	GPIO_77
SPIA_MISO GPIO17	E2	GPIO_17	GPIO_78
SPIA_CLK GPIO18	E3	GPIO_18	GPIO_79
SPIA_STEn GPIO19	E4	GPIO_19	GPIO_80
GPIO20_nErr1	F2	GPIO_20	GPIO_81
GPIO21_nErr2	F3	GPIO_21	GPIO_82
SCIB_TX GPIO22	J4	GPIO_22	GPIO_83
SCIB_RX GPIO23	K4	GPIO_23	GPIO_84
SPIB_MOSI GPIO24	K3	GPIO_24	GPIO_85
SPIB_MISO GPIO25	K2	GPIO_25	GPIO_86
SPIB_CLK GPIO26	K1	GPIO_26	GPIO_87
SPIB_STEn GPIO27	L1	GPIO_27	GPIO_88
SCIA_RX_HV	V1	GPIO_28	GPIO_89
ESC_I2C_SDA GPIO29	W1	GPIO_29	GPIO_90
ESC_I2C_SCL GPIO30	T1	GPIO_30	GPIO_91
CM-I2CA_SDA GPIO31	U1	GPIO_31	GPIO_92
CM-I2CA_SCL GPIO32	U1	GPIO_32	GPIO_93
GPIO33	T1	GPIO_33	GPIO_94
GPIO34	U1	GPIO_34	GPIO_95
CANA_RX GPIO36	V1	GPIO_36	GPIO_97
CANA_TX GPIO37	U1	GPIO_37	GPIO_98
CANB_TX GPIO38	T1	GPIO_38	GPIO_99
CANB_RX GPIO39	W1	GPIO_39	GPIO_100
UARTA_TX GPIO42	V1	GPIO_40	GPIO_101
UARTA_RX GPIO43	D1	GPIO_41	GPIO_102
GPIO44	C1	GPIO_42	GPIO_103
GPIO45	K1	GPIO_43	GPIO_104
ESC_MDIO_CLK GPIO46	K1	GPIO_44	GPIO_105
ENET_PPSS0 GPIO47	E1	GPIO_45	GPIO_106
ENET_PPSS1 GPIO48	R1	GPIO_46	GPIO_107
GPIO49	R1	GPIO_47	GPIO_108
GPIO50	R1	GPIO_48	GPIO_109
GPIO51	P1	GPIO_49	GPIO_110
GPIO52	P1	GPIO_50	GPIO_111
GPIO53	P1	GPIO_51	GPIO_112
SSIA_TX GPIO54	P1	GPIO_52	GPIO_113
SSIA_RX GPIO55	P1	GPIO_53	GPIO_114
SSIA_CLK GPIO56	N1	GPIO_54	GPIO_115
SSIA_FSS GPIO57	N1	GPIO_55	GPIO_116
ESC_LED_LINK0_ACTIVE GPIO58	M1	GPIO_56	GPIO_117
ESC_LED_LINK1_ACTIVE GPIO59	M1	GPIO_57	GPIO_118
ESC_LED_ERR GPIO60	M1	GPIO_58	GPIO_119
		GPIO_59	GPIO_120
		GPIO_60	GPIO_121

TMS320F28388D

U703F			
ENET_MII_TX_Data1 GPIO122	T8	GPIO_122	GPIO_146
ENET_MII_TX_Data2 GPIO123	U8	GPIO_123	GPIO_147
ENET_MII_TX_Data3 GPIO124	V8	GPIO_124	GPIO_148
ESC_LATCH0 GPIO125	T9	GPIO_125	GPIO_149
ESC_LATCH1 GPIO126	U9	GPIO_126	GPIO_150
ESC_SYNC0 GPIO127	V9	GPIO_127	GPIO_151
ESC_SYNC1 GPIO128	W9	GPIO_128	GPIO_152
ESC_TX1_ENA GPIO129	T10	GPIO_129	GPIO_153
ESC_TX1_CLK GPIO130	U10	GPIO_130	GPIO_154
ESC_TX1_DATA0 GPIO131	V10	GPIO_131	GPIO_155
ESC_TX1_DATA1 GPIO132	W10	GPIO_132	GPIO_156
ESC_TX1_DATA2 GPIO134	V18	GPIO_133	GPIO_157
SCIA_TX_HV	U18	GPIO_134	GPIO_158
ESC_RX1_DV GPIO136	T1	GPIO_135	GPIO_159
EPWM13A GPIO137	T18	GPIO_136	GPIO_160
EPWM13B GPIO138	N19	GPIO_137	GPIO_161
EPWM14A GPIO139	M19	GPIO_138	GPIO_162
EPWM14B GPIO140	M19	GPIO_139	GPIO_163
EPWM15A GPIO141	M18	GPIO_140	GPIO_164
EPWM15B GPIO142	L19	GPIO_141	GPIO_165
EPWM16A GPIO143	F18	GPIO_142	GPIO_166
EPWM16B GPIO144	F17	GPIO_143	GPIO_167
EPWM1A GPIO145	E1	GPIO_144	GPIO_168
		GPIO_145	

TMS320F28388D

PADERBORN UNIVERSITY DEPARTMENT OF POWER ELECTRONICS AND ELECTRICAL DRIVES

Sheet: /MCU GPIOs - Page 11/

File: MCU_GPIOs.kicad_sch

Title: LCB-CCB-01: Control Board - Debugger XDS100 / JTAG

Size: A4 Date: 2025-05-27

Rev: 1.2.0

KiCad E.D.A. 9.0.2

Id: 11/11