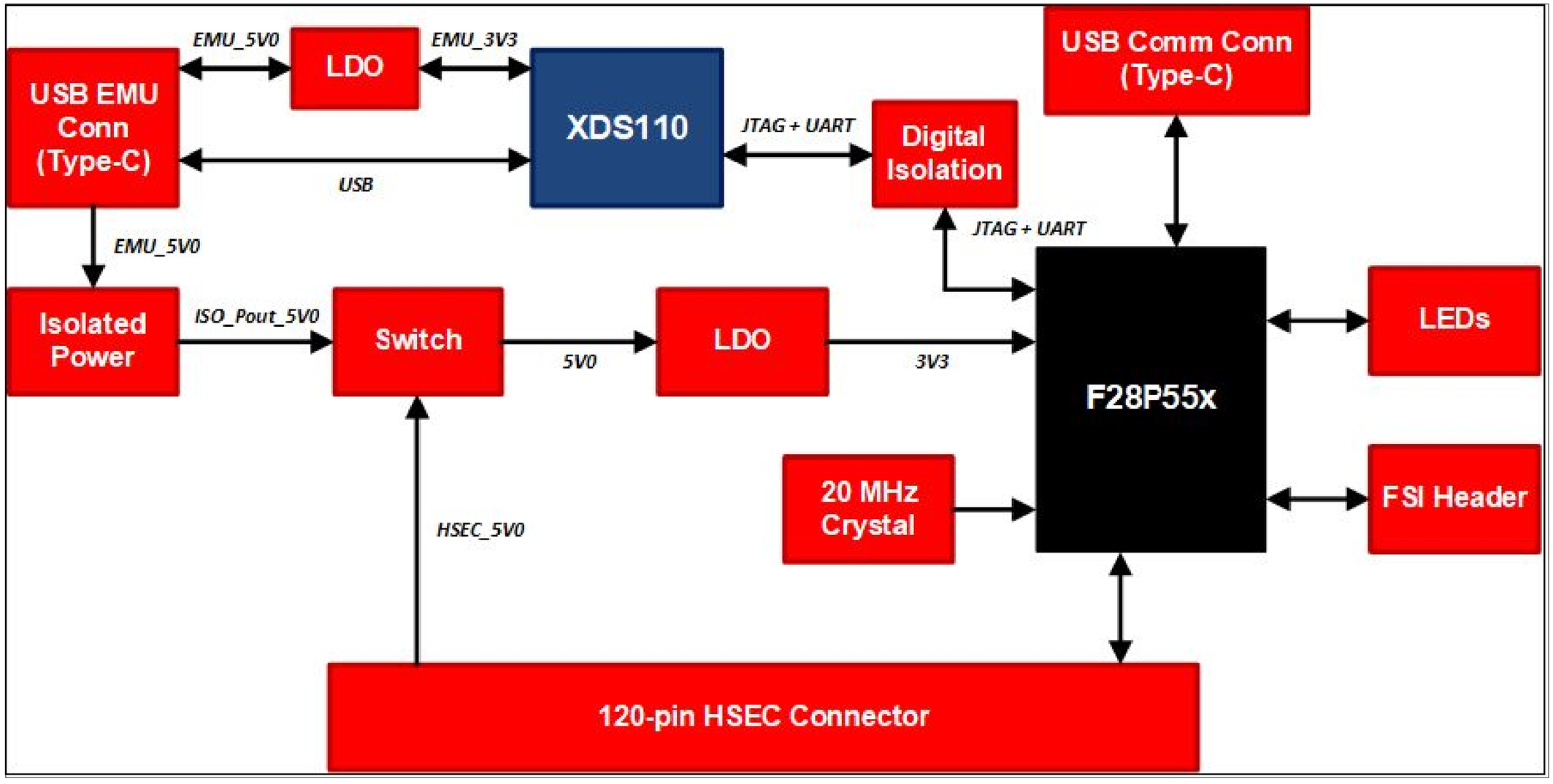
| Revision History | | | | |
|---|---|---|---|---|
| Rev | ECN # | Approved Date | Approved by | Notes |
| E1 | N/A | Sept 13, 2023 | PL | Initial Draft |

1) USB Differential Pairs - 90 Ohm
(A) XDS_D_P and XDS_D_N
(B) USB_D_P (GPIO41) and USB_D_N (GPIO23)

2) ADC PGA Differential pair Impedance Matching - 50 Ohm
(A) HSEC_PGAx_IN_P pins should match with HSEC_PGAx_IN_N, where x is between 1-3
(B) MCU_PGAx_IN_P pins should match with MCU_PGAx_IN_N, where x is between 1-3




Power to the MCU is either supported by the USB-C on the left or through the HSEC



| | | |
|---|---|---|
| Orderable: TMDSCNCD28P55X | Designed for: Public Release | Mod. Date: 10/10/2023 |
| TID #: N/A | Project Title: F28P55x controlCARD | |
| Number: MCU132 Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | Assembly Variant: 001 | Sheet: 1 of 10 |
| Drawn By: Peter Luong | File: MCU132E1_CoverSheet.SchDoc | Size: B |
| Engineer: Peter Luong | Contact: http://www.ti.com/support | |

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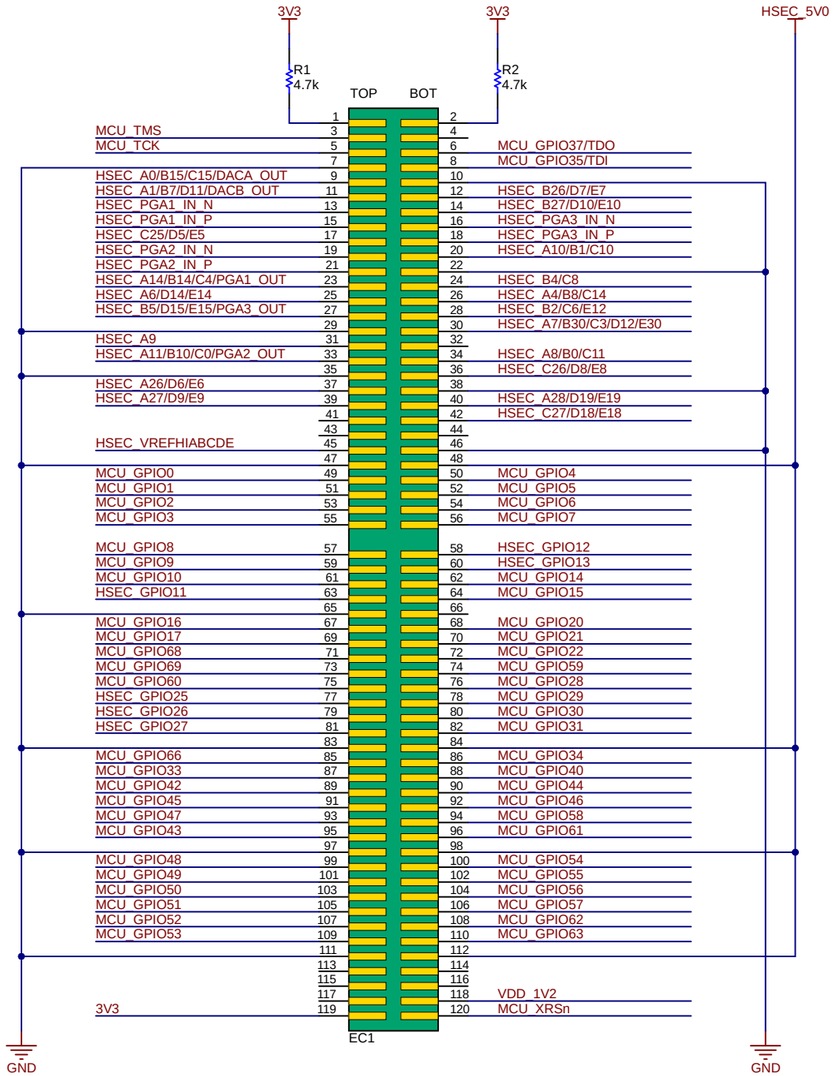
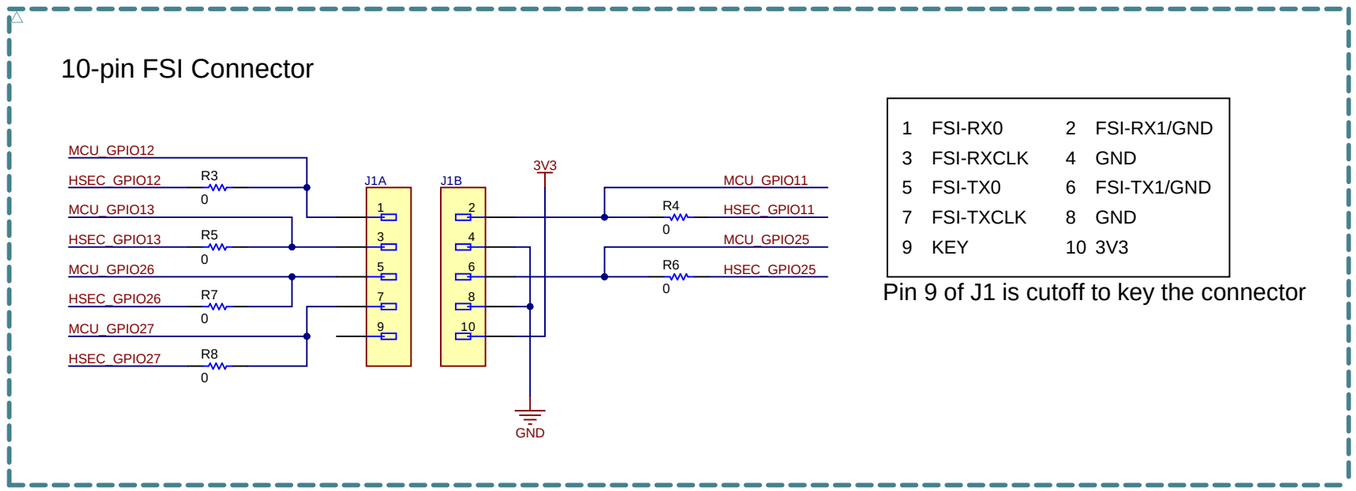
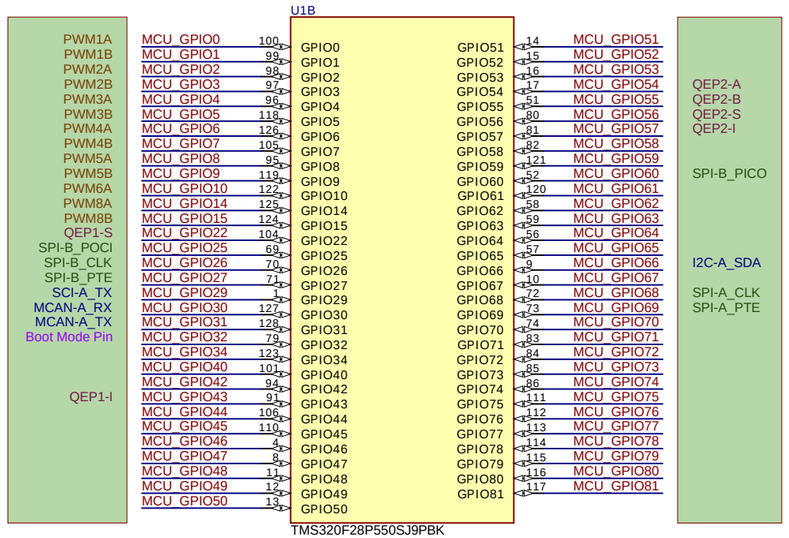
J1 has been updated over previous designs. Pins 9 and 10 were added enabling power to the connector.
Additionally Pins 2 and 6, previously GND, have been repurposed to enable the full 3 pin FSI communication.
The user can shunt HSEC GPIO11 and HSEC GPIO25 to ground if backwards compatibility is required.






| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/12/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 2 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_GPIO.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

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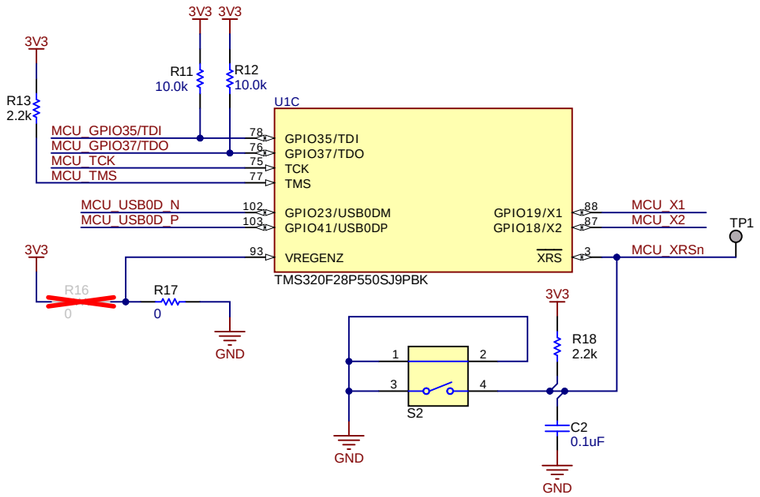
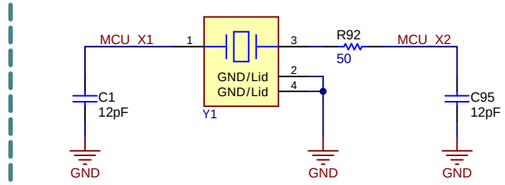
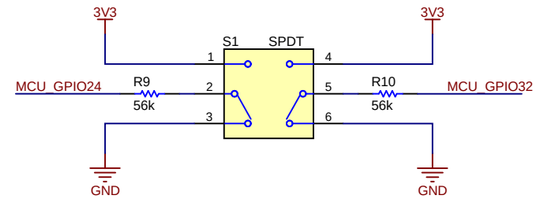
## JTAG and Reset




## 20 MHz External Crystal




## Boot Mode Switch

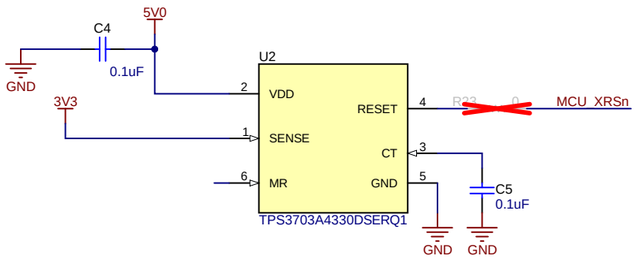



## Boot Mode Selection Chart

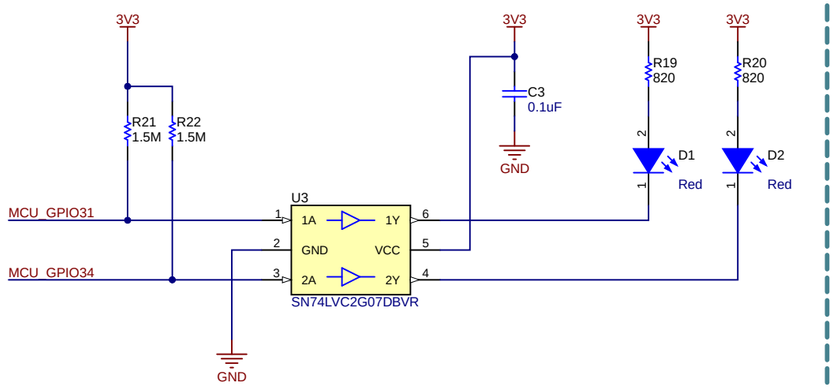
(S2: UP is '1', DOWN is '0')

| Mode # | GPIO24 | GPIO32 | Boot Mode |
|---|---|---|---|
| 00 | 0 | 0 | Boot from Parallel GPIO |
| 01 | 0 | 1 | Boot from SCI / Wait Mode |
| 02 | 1 | 0 | Boot from CAN (MCAN-NONFD) |
| 03 | 1 | 1 | Boot from Flash (USB) |

## System Supervisory Circuitry




## LEDs






| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/9/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 3 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_Support.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

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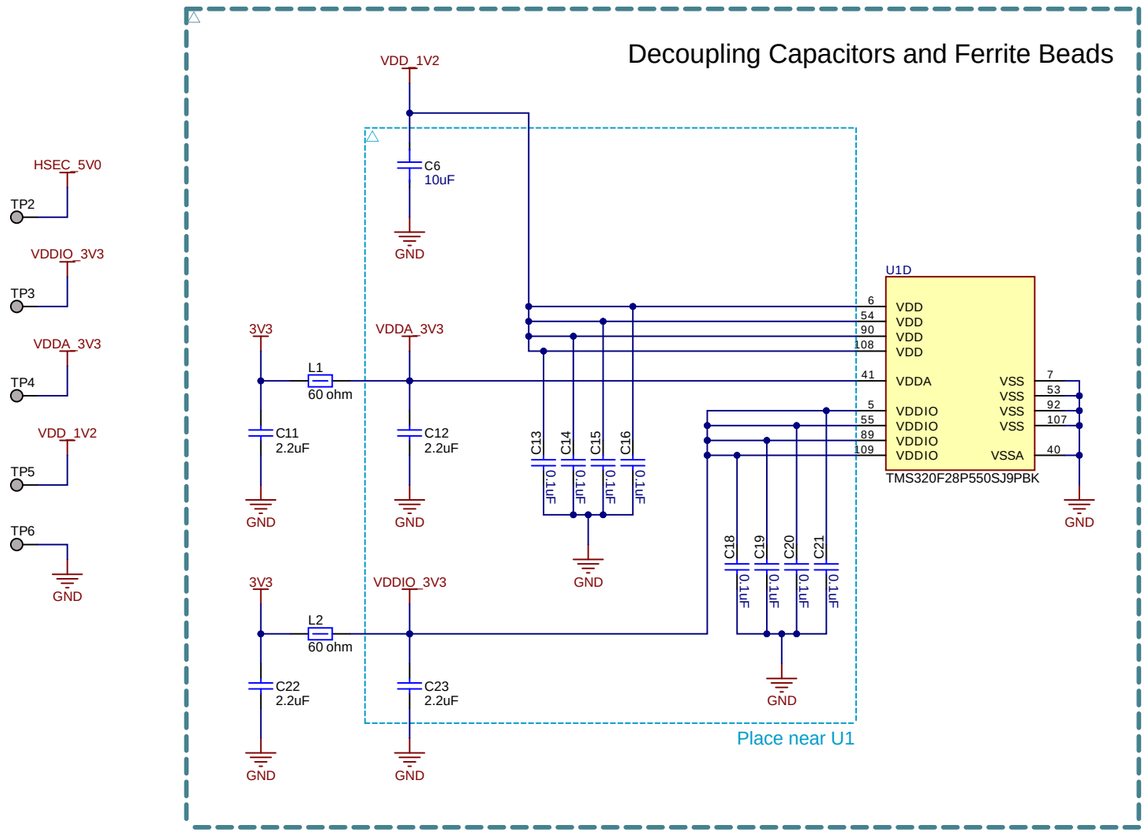


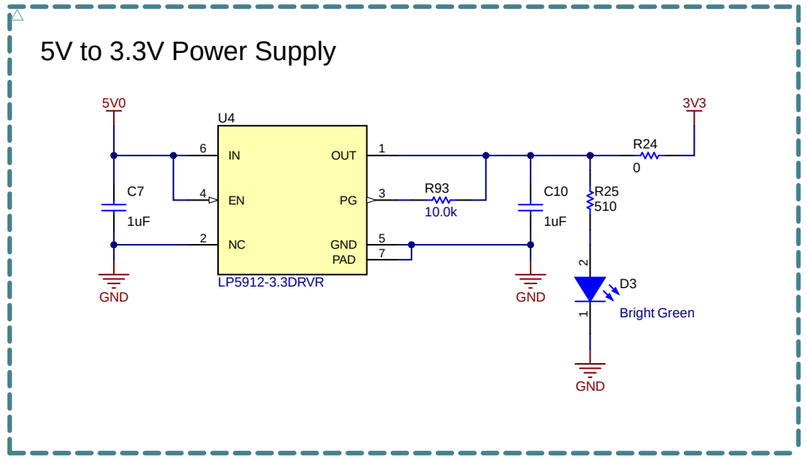


The F28P55x controlCARD uses the internal VREG to generate the 1.2V voltage rail for VDD.

For custom boards using external VREG mode, recommend to use dual-output DC-DC (e.g., TPS62441) to generate both 3.3V and 1.2V supplies.



| | | | |
|---|---|---|---|
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| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 4 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_Power.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

http://www.ti.com

## ESD Diodes for Analog Inputs

U5 — TPD6E001RSER
HSEC_A0/B15/C15/DACA_OUT → HSEC_C25/D5/E5
HSEC_PGA1_IN_N → HSEC_PGA2_IN_N
HSEC_PGA1_IN_P → HSEC_PGA2_IN_P
VDDA_3V3, C24 0.1uF, GND

U6 — TPD6E001RSER
HSEC_B27/D10/E10 → HSEC_A10/B1/C10
HSEC_B26/D7/E7 → HSEC_PGA3_IN_P
HSEC_A1/B7/D11/DACB_OUT → HSEC_PGA3_IN_N
VDDA_3V3, C25 0.1uF, GND

U7 — TPD4E001QDBVRQ1
HSEC_A4/B8/C14 → HSEC_B4/C8
HSEC_A14/B14/C4/PGA1_OUT
VDDA_3V3, C26 0.1uF, GND

U8 — TPD6E001RSER
HSEC_A6/D14/E14 → HSEC_A11/B10/C0/PGA2_OUT
HSEC_B5/D15/E15/PGA3_OUT → HSEC_A26/D6/E6
HSEC_A9 → HSEC_A27/D9/E9
VDDA_3V3, C27 0.1uF, GND

U9 — TPD6E001RSER
HSEC_A8/B0/C11 → HSEC_C27/D18/E18
HSEC_A7/B30/C3/D12/E30 → HSEC_A28/D19/E19
HSEC_B2/C6/E12 → HSEC_C26/D8/E8
VDDA_3V3, C28 0.1uF, GND

S3 Is the analog configuration switch

Position 1 - ON
- ADC uses external reference voltage supplied on pin 45 of TMDSHSECDOCK

Position 1 - OFF
- ADC uses the internal voltage reference

MCU_VREFHI — S3 CHS-01TB — HSEC_VREFHIABCDE

| | | | | | |
|---|---|---|---|---|---|
| HSEC_A0/B15/C15/DACA_OUT | R26 | 0 | MCU_A0/B15/C15/DACA_OUT | 30 | A0/B15/C15/DACA_OUT |
| HSEC_A1/B7/D11/DACB_OUT | R27 | 0 | MCU_A1/B7/D11/DACB_OUT | 29 | A1/B7/D11/DACB_OUT |
| HSEC_PGA1_IN_P | R28 | 0 | MCU_PGA1_IN_P | 21 | A2/B6/C9/GPIO224/PGA1_INP |
| HSEC_PGA2_IN_P | R29 | 0 | MCU_PGA2_IN_P | 20 | A3/B3/C5/GPIO242/PGA2_INP |
| HSEC_A4/B8/C14 | R30 | 0 | MCU_A4/B8/C14 | 42 | A4/B8/C14 |
| HSEC_PGA2_IN_N | R31 | 0 | MCU_PGA2_IN_N | 28 | A5/B12/C2/PGA2_INM |
| HSEC_A6/D14/E14 | R32 | 0 | MCU_A6/D14/E14 | 18 | A6/D14/E14/GPIO228 |
| HSEC_A7/B30/C3/D12/E30 | R33 | 0 | MCU_A7/B30/C3/D12/E30 | 37 | A7/B30/C3/D12/E30 |
| HSEC_A8/B0/C11 | R34 | 0 | MCU_A8/B0/C11 | 39 | A8/B0/C11 |
| HSEC_A9 | R35 | 0 | MCU_A9 | 48 | A9/GPIO227 |
| HSEC_A10/B1/C10 | R36 | 0 | MCU_A10/B1/C10 | 50 | A10/B1/C10/GPIO230 |
| HSEC_A11/B10/C0/PGA2_OUT | R37 | 0 | MCU_A11/B10/C0/PGA2_OUT | 27 | A11/B10/C0/PGA2_OUT |
| HSEC_PGA3_IN_P | R38 | 0 | MCU_PGA3_IN_P | 35 | A12/C1/E11/PGA3_INP |
| | | | | 33 | A13/B13/C13/D13/E13/VREFLO |
| | | | | 34 | A13/B13/C13/D13/E13/VREFLO |
| HSEC_A14/B14/C4/PGA1_OUT | R39 | 0 | MCU_A14/B14/C4/PGA1_OUT | 26 | A14/B14/C4/PGA1_OUT |
| HSEC_PGA1_IN_N | R40 | 0 | MCU_PGA1_IN_N | 22 | A15/B9/C7/PGA1_INM |
| | | | MCU_GPIO28 | 2 | A16/B16/C16/GPIO28 — SCI-A_RX |
| | | | MCU_GPIO20 | 60 | A17/B17/C17/GPIO20 — QEP1-A |
| | | | MCU_GPIO21 | 61 | A18/B18/C18/GPIO21 — QEP1-B |
| | | | MCU_GPIO13 | 62 | A19/B19/C19/GPIO13 — PWM7B |
| | | | MCU_GPIO12 | 63 | A20/B20/C20/GPIO12 — PWM7A |
| | | | MCU_GPIO11 | 64 | A24/D0/E0/GPIO11 — PWM6B |
| | | | MCU_GPIO17 | 67 | A25/D3/E3/GPIO17 — SPI-A_POCI |
| HSEC_A26/D6/E6 | R41 | 0 | MCU_A26/D6/E6 | 24 | A26/D6/E6 |
| HSEC_A27/D9/E9 | R42 | 0 | MCU_A27/D9/E9 | 44 | A27/D9/E9/GPIO212 |
| HSEC_A28/D19/E19 | R43 | 0 | MCU_A28/D19/E19 | 47 | A28/D19/E19/GPIO215 |
| HSEC_B2/C6/E12 | R44 | 0 | MCU_B2/C6/E12 | 19 | B2/C6/E12/GPIO226 |
| HSEC_B4/C8 | R45 | 0 | MCU_B4/C8 | 49 | B4/C8/GPIO236 |
| HSEC_B5/D15/E15/PGA3_OUT | R46 | 0 | MCU_B5/D15/E15/PGA3_OUT | 38 | B5/D15/E15/PGA3_OUT |
| HSEC_PGA3_IN_N | R47 | 0 | MCU_PGA3_IN_N | 36 | B11/D16/E16/PGA3_INM |
| | | | MCU_GPIO33 | 65 | B24/D1/E1/GPIO33 — I2C-A_SCL |
| | | | MCU_GPIO24 | 68 | B25/D4/E4/GPIO24 — Boot Mode Pin |
| HSEC_B26/D7/E7 | R48 | 0 | MCU_B26/D7/E7 | 25 | B26/D7/E7 |
| HSEC_B27/D10/E10 | R49 | 0 | MCU_B27/D10/E10 | 45 | B27/D10/E10/GPIO213 |
| | | | MCU_GPIO16 | 66 | C24/D2/E2/GPIO16 — SPI-A_PICO |
| HSEC_C25/D5/E5 | R50 | 0 | MCU_C25/D5/E5 | 23 | C25/D5/E5 |
| HSEC_C26/D8/E8 | R51 | 0 | MCU_C26/D8/E8 | 43 | C26/D8/E8/GPIO211 |
| HSEC_C27/D18/E18 | R52 | 0 | MCU_C27/D18/E18 | 46 | C27/D18/E18/GPIO214 |
| | | | MCU_VREFHI | 31 | D20/E20/VREFHI |
| | | | MCU_VREFHI | 32 | D20/E20/VREFHI |

U1A — TMS320F28P550SJ9PBK

C56 2.2uF, C57 2.2uF — Place near U1

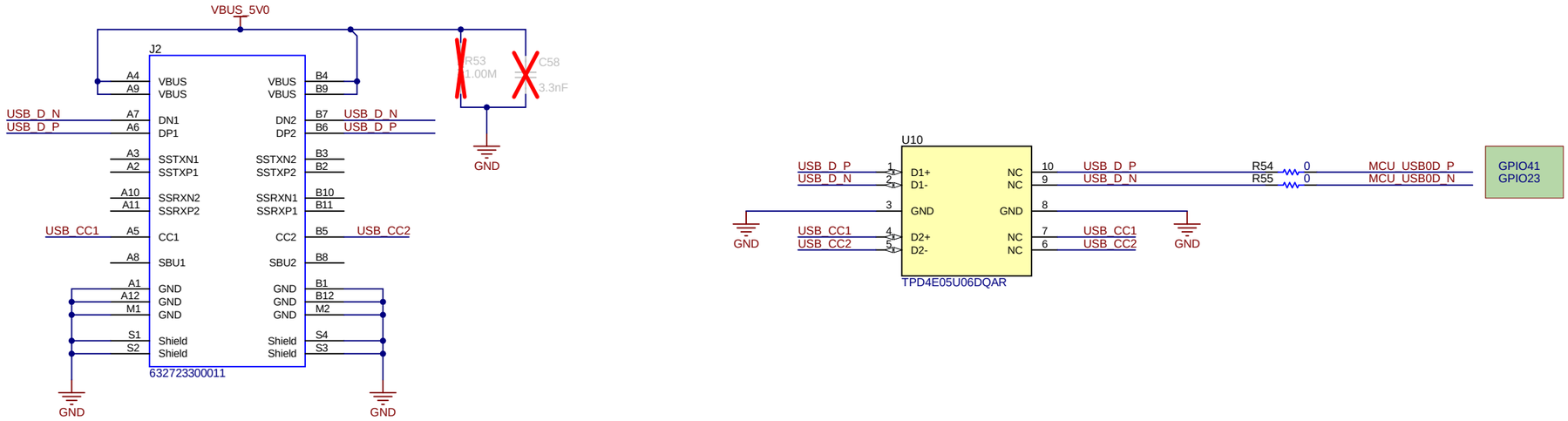
GND



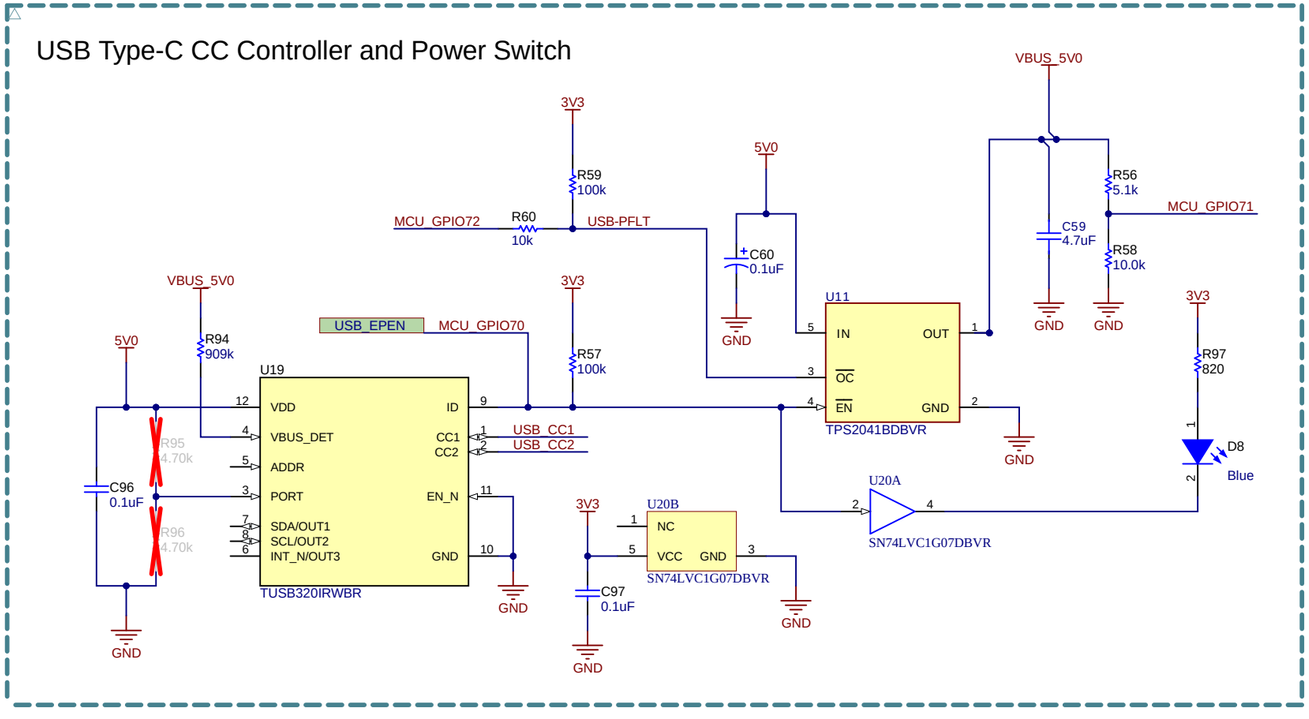
| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/10/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 5 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_ADC.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

http://www.ti.com

## USB Type-C Connector - Communication Peripheral to MCU




## USB Type-C CC Controller and Power Switch




| Switch Truth Table | | |
|---|---|---|
| MCU_GPIO70 STATUS | DESCRIPTION | USB_MODE |
| 1 (HIGH) | UB_CC1 & USB_CC2 are pulled up | Host mode (DFP) |
| 0 (LOW) | UB_CC1 & USB_CC2 are strongly pulled down | Device mode (UFP) |

LED D8 will turn on to indicate that the C2000 device is in Host Mode (DFP).

NOTE: USB VBUS_5V0, PFLT & EPEN do not have a specific mux position in this device.

In this controlCARD, a standard GPIO is used to detect changes to these signals.



| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/18/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 6 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_USB.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

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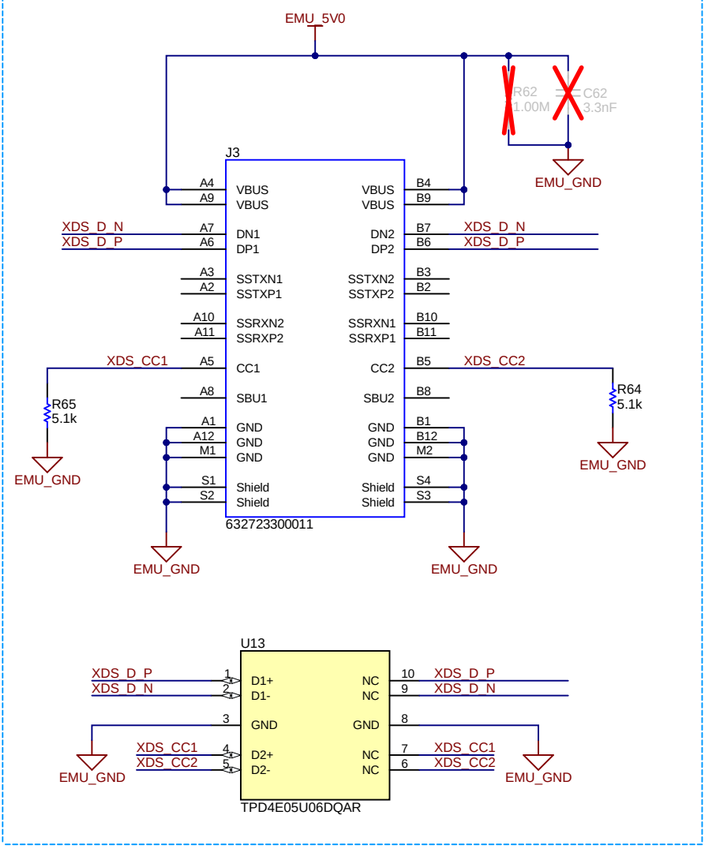
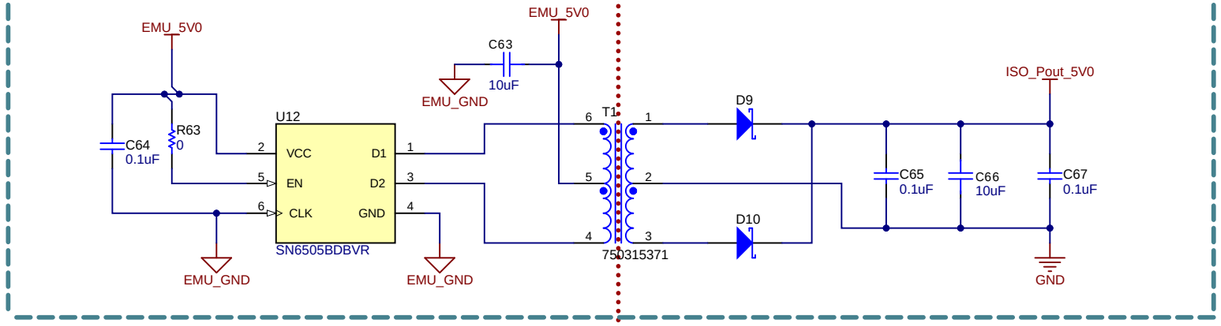
## USB Type-C Connector - XDS110 side

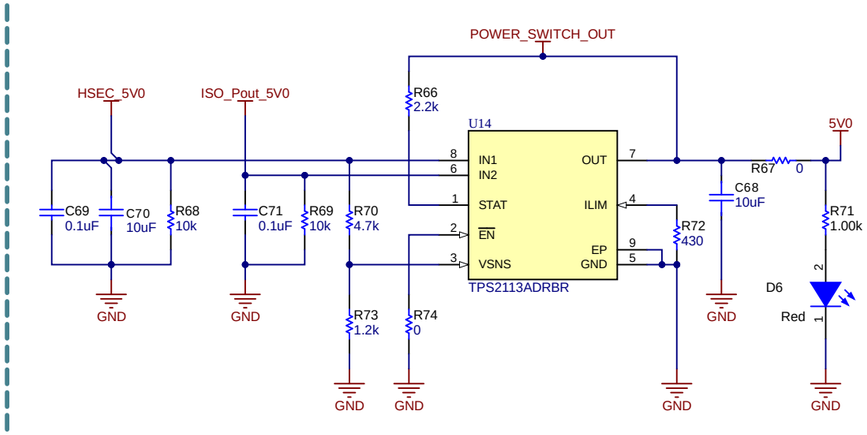



(Cold Side) (Hot Side)

## USB Isolated Power

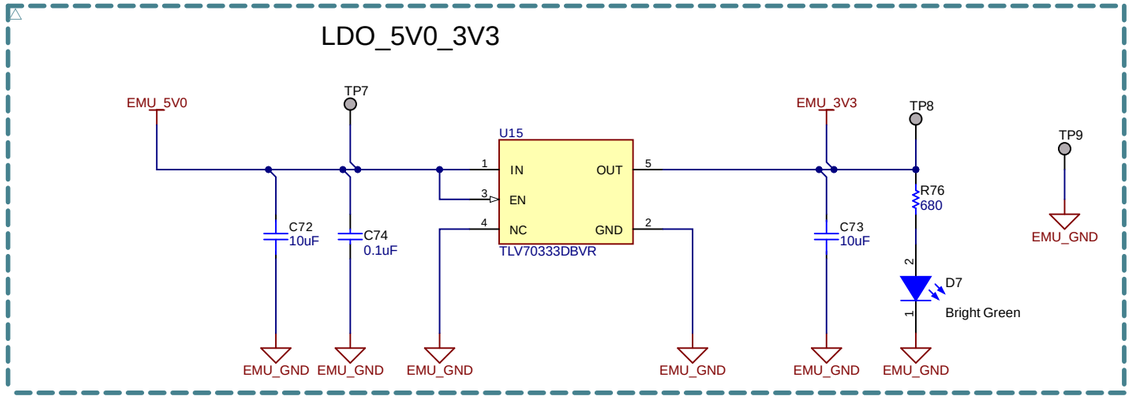



## Power Selection Switch




| Switch Truth Table | | |
|---|---|---|
| HSEC_5V0 > 4V | ISO_Pout_5V0 > HSEC_5V0 | POWER_SWITCH_OUT |
| Yes | X | HSEC_5V0 |
| No | No | HSEC_5V0 |
| No | Yes | ISO_Pout_5V0 |

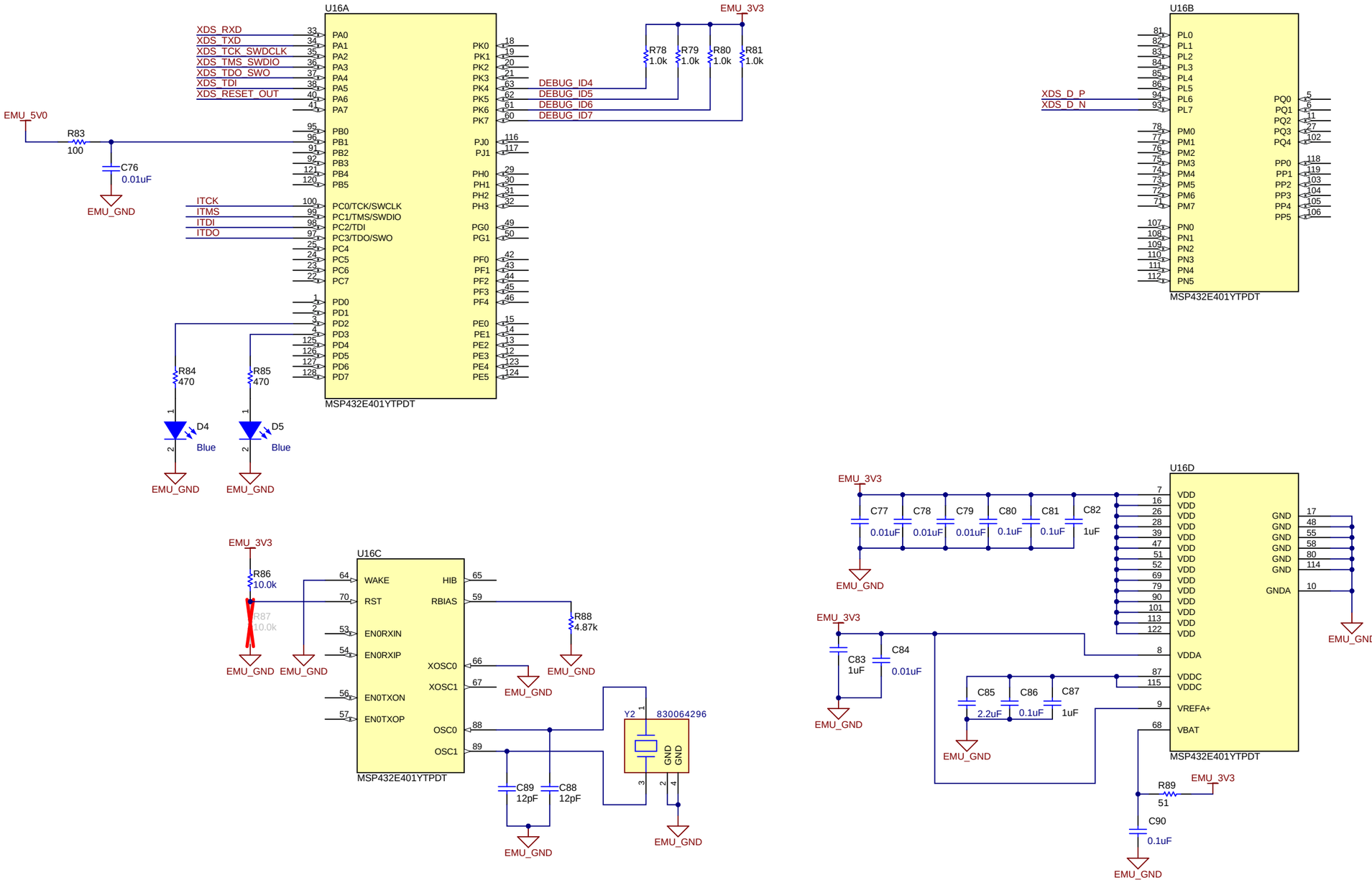
## LDO_5V0_3V3






| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/9/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 7 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_XDS110_USB_Power.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | http://www.ti.com |

# XDS110 Device






| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/9/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 8 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_XDS110_MCU.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

TEXAS INSTRUMENTS
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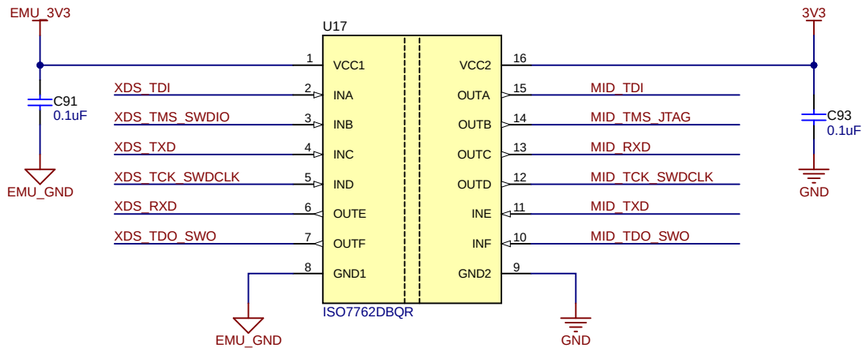
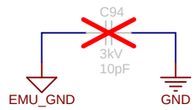
NOTE: Because the JTAG signals are isolated, cJTAG is not suppported on this controlCARD.

(Cold Side) (Hot Side)

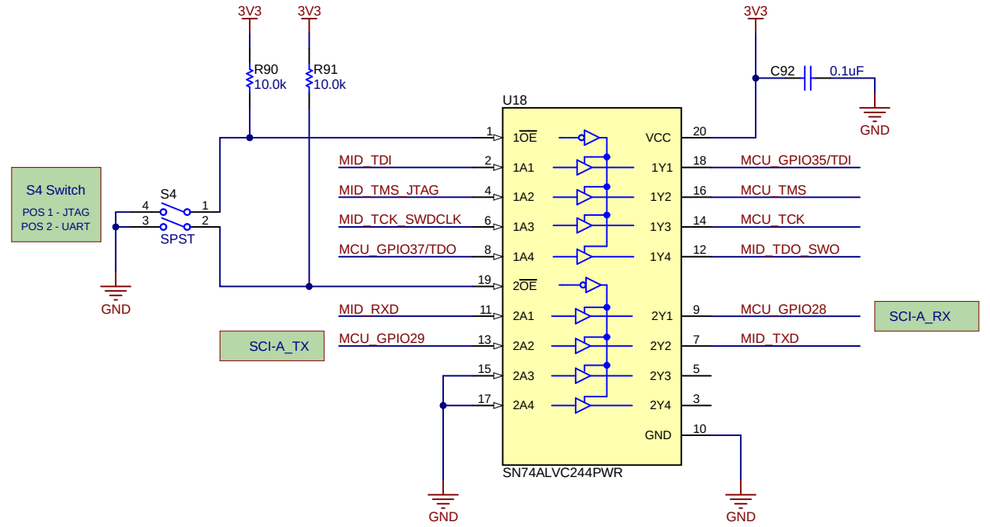



WARNING: To avoid potential shock hazard in high-voltage settings, leave the Y cap (C94) unpopulated from the EVM.

## S4 - JTAG Emulation & UART Switch

POS 1 ON: Use XDS110 emulator that is on the cCARD
POS 1 OFF: Boot from FLASH/peripheral (see boot mode switch) OR use emulator on baseboard
POS 2 ON: GPIOs 28 & 29 will be connected to the USB-to-UART adapter on the XDS110 emulator
POS 2 OFF: GPIOs 28 & 29 are disconnected from the USB-to-UART adapter on the XDS110 emulator and connected to the HSEC connector pins






| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/9/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 9 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_Emulator_Interface.SchDoc | Size: B |
| Engineer: Peter Luong | | Contact: http://www.ti.com/support | |

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FID1 FID2 FID3 FID4 FID5 FID6

PCB Number: MCU132
PCB Rev: E1

PCB
LOGO
Texas Instruments

CE Mark

PCB
LOGO
FCC disclaimer

PCB
LOGO
WEEE logo

LBL1
PCB Label
THT-14-423-10
Size: 0.65" x 0.20 "

ZZ1
Label Assembly Note
This Assembly Note is for PCB labels only

ZZ2
Assembly Note
These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ3
Assembly Note
These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ4
Assembly Note
These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

ZZ5
Assembly Note
Clip off KEY pin 9 of J1 connector header



| | | | |
|---|---|---|---|
| Orderable: TMDSCNCD28P55X | | Designed for: Public Release | Mod. Date: 10/10/2023 |
| TID #: N/A | | Project Title: F28P55x controlCARD | |
| Number: MCU132 | Rev: E1 | Sheet Title: | |
| SVN Rev: Version control disabled | | Assembly Variant: 001 | Sheet: 10 of 10 |
| Drawn By: Peter Luong | | File: MCU132E1_Hardware.SchDoc | Size: B |
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