



# Pixhawk Reference Standard

Revision: 0.2.0

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## Abstract

This document is the formal version of the Pixhawk industry standard that includes all aspects of the hardware standard required to build compatible autopilots.

# Table of contents

|  |           |
|--|-----------|
| <b>Table of contents</b>                               | <b>2</b>  |
| <b>Document Revisions</b>                              | <b>3</b>  |
| <b>Contact and Public Developer Call</b>               | <b>3</b>  |
| <b>Trademark Guideline</b>                             | <b>3</b>  |
| <b>Flight Management Unit Standards</b>                | <b>4</b>  |
| <b>Interface Standards</b>                             | <b>4</b>  |
| <b>Common External Interfaces</b>                      | <b>5</b>  |
| <b>Pixhawk Autopilot Bus (PAB) and Module Standard</b> | <b>6</b>  |
| Connector X1 (PAB X1)                                  | 6         |
| Connector X2 (PAB X2)                                  | 7         |
| X1 Pinout  | 7         |
| X2 Pinout  | 9         |
| Mechanical Design                                      | 10        |
| PCB Layout Guidelines                                  | 11        |
| <b>FMUv5X Summary</b>                                  | <b>12</b> |
| Overview   | 12        |
| Detailed Block Diagram                                 | 13        |
| Full FMUv5X Pinout                                     | 14        |
| <b>FMUv6X Summary</b>                                  | <b>18</b> |
| Overview   | 18        |
| Detailed Block Diagram                                 | 19        |
| Full FMUv6X Pinout                                     | 20        |
| <b>Baseboard Design Guidelines (FMUv5X, FMUv6X)</b>    | <b>24</b> |
| Base to FMU Connectors (X1, X2)                        | 24        |
| FMU Debug Connector                                    | 25        |
| RC Inputs  | 26        |
| Powerpath Selector                                     | 27        |
| Peripheral Power Protection                            | 28        |
| Baseboard EEPROM and Sensor Connections                | 29        |
| Ethernet Transceiver                                   | 29        |
| GPS / Audio Interface                                  | 30        |

## Document Revisions

| Revision | Editor       | Reviewer      | Comments                 |
|----------|--------------|---------------|--------------------------|
| 0.1.0    | Lorenz Meier | David Sidrane | Initial specification    |
| 0.2.0    | Lorenz Meier | David Sidrane | Addition of FMUv6X draft |

## Contact and Public Developer Call

This standard is being developed on a [public developer call](#).

For further questions, please contact the maintainer of the standard, [lorenz@px4.io](mailto:lorenz@px4.io).

## Trademark Guideline

Pixhawk is a registered trademark and is used to mark and protect the consistent use of this standard. The requirements for this are covered in this document: [Trademark Guideline](#)

## Flight Management Unit Standards

- FMUv1: No product name (2012, 168 MHz M4)
- FMUv2: Pixhawk 1 (2013, 168 MHz M4)
- FMUv3: Pixhawk 2 (2015, 168 MHz M4, redundant sensors)
- FMUv4: Pixracer (2015, 168 MHz M4)
- FMUv4X: Pixhawk 3 Pro (2017, 168 MHz M4, redundant sensors)
- FMUv5: Pixhawk 4 (2018, 200 MHz M7)
- FMUv5X: Pixhawk 5X (2019, 200 MHz M7, temp-calibrated, redundant sensors)
- FMUv6: Pixhawk 6 (2019, 400-600 MHz H7)
- FMUv6X: Pixhawk 6X (2020, 400-600 MHz H7, temp-calibrated, redundant sensors)

## Interface Standards

- **OBSOLETE:** Pixhawk connector standards v1 (2011-2015)
  - Connector: Hirose DF13
  - Pinout:
- Pixhawk connector standards v2 (2015-)
  - Connector: JST GH
  - Pinout: [Pixhawk connector pinout](#)
- Pixhawk Autopilot Bus (PAB)
  - Connector: 100-pos Hirose DF40
  - Connector: 50-pos Hirose DF40
- Pixhawk Payload Bus (PPB)
  - Connector: KEL KY

## Common External Interfaces

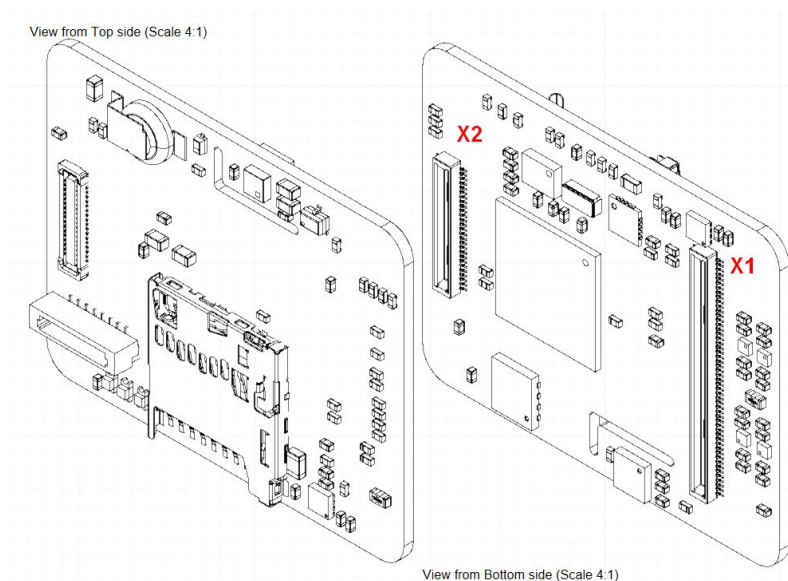
This list describes the mandatory external interfaces.

| Standard       | FMUv5      | FMUv5X     | FMUv6   | FMUv6X   |
|----------------|------------|------------|---------|----------|
| Stable         | 06/2018    | 06/2019    | 12/2019 | 02/2020  |
| Clock          | 200 MHz    | 200 MHz    | 480 MHz | 480 MHz  |
| RAM            | 512 KB     | 512 KB     | 1 MB    | 1 MB     |
| PAB / SoM      |            | ✓          | x       | ✓        |
| UART (RTS/CTS) | 2          | 3          | 3       | 3        |
| UART           | 2          | 4          | 2       | 4        |
| Debug          | 6-pos      | 10-pos     | 10-pos  | 10-pos   |
| Ethernet       | x          | ✓          | ✓       | ✓        |
| CAN            | 2          | 2          | 3       | 3        |
| I2C            | 2          | 3 (+NFC)   | 2       | 3 (+NFC) |
| Power input    | analog     | digital    | digital | digital  |
| PWM out        | 6 + 8 (IO) | 8 + 8 (IO) | 8       | 8        |
| GPIO Exposed   | [tbd]      |            |         |          |

## Pixhawk Autopilot Bus (PAB) and Module Standard

The usage of this bus is mandatory for all System-on-Module designs (SOM). However, if autopilot and baseboard are integrated into one unit, this connector pair (PAB X1 and PAB X2) can be omitted. See mechanical section for dimensions.

**TIP: Leverage the Altium footprint [available in the support files folder](#)**

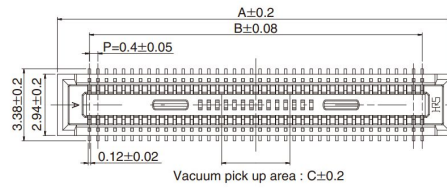


### Connector X1 (PAB X1)

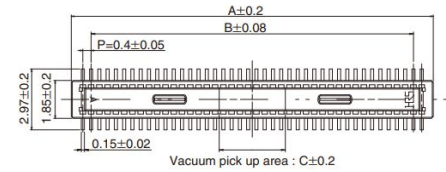
The 100-pin connector is automotive grade, low-cost, vibration resilient and allows very high density assemblies.

| Side         | Baseboard side (bottom)           | Autopilot side (top)        |
|--------------|-----------------------------------|-----------------------------|
| Part Number  | Hirose DF40HC(3.0)-100DS-0.4V(58) | Hirose DF40C-100DP-0.4V(51) |
| Distributors | <a href="#">DigiKey</a>           | <a href="#">DigiKey</a>     |

## Dimensions



A = 22.6mm  
B = 19.6mm



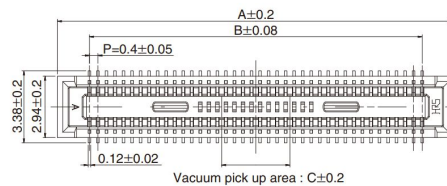
A = 21.52mm  
B = 19.6mm

## Connector X2 (PAB X2)

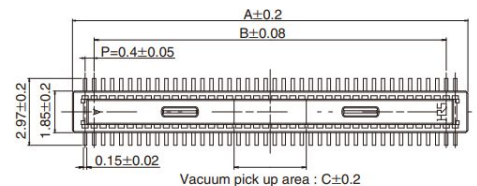
The 50-pin connector is automotive grade, low-cost, vibration resilient and allows very high density assemblies.

| Side         | Baseboard side (bottom)          | Autopilot side (top)       |
|--------------|----------------------------------|----------------------------|
| Part Number  | Hirose DF40HC(3.0)-50DS-0.4V(51) | Hirose DF40C-50DP-0.4V(51) |
| Distributors | <a href="#">Digikey</a>          | <a href="#">Digikey</a>    |

## Dimensions



A = 12.6mm  
B = 9.6mm



A = 11.52mm  
B = 9.6mm

## X1 Pinout

Mandatory main bus with the critical Pixhawk interfaces.

|                            |    |    |                                       |
|----------------------------|----|----|---------------------------------------|
| FMU_CH8                    | 1  | 2  | GND (Pin 2)                           |
| FMU_CH7                    | 3  | 4  | BUZZER_1                              |
| FMU_CH6                    | 5  | 6  | GND                                   |
| FMU_CH5                    | 7  | 8  | I2C3_SDA_BASE_MS5611_BARBED_EXTERNAL1 |
| GND                        | 9  | 10 | I2C3_SCL_BASE_MS5611_BARBED_EXTERNAL1 |
| FMU_CH4                    | 11 | 12 | I2C2_SDA_BASE_GPS2_MAG_LED_PM2        |
| FMU_CH3                    | 13 | 14 | I2C2_SCL_BASE_GPS2_MAG_LED_PM2        |
| FMU_CH2                    | 15 | 16 | I2C1_SDA_BASE_GPS1_MAG_LED_PM1        |
| FMU_CH1                    | 17 | 18 | I2C1_SCL_BASE_GPS1_MAG_LED_PM1        |
| GND                        | 19 | 20 | GND                                   |
| FMU_SAFETY_SWITCH_IN       | 21 | 22 | UART7_RTS_TELEM1                      |
| FMU_nSAFETY_SWITCH_LED_OUT | 23 | 24 | UART7_CTS_TELEM1                      |

|                           |    |     |                             |
|---------------------------|----|-----|-----------------------------|
| HW_VER_REV_DRIVE          | 25 | 26  | GND                         |
| HW_VER_SENSE              | 27 | 28  | UART8_TX_GPS2               |
| V_RTC_BAT                 | 29 | 30  | UART8_RX_GPS2               |
| GND                       | 31 | 32  | GND                         |
| VDD_3V3_SPEKTRUM_POWER_EN | 33 | 34  | USART1_RX_GPS1              |
| VDD_5V_PERIPH_nEN         | 35 | 36  | USART1_TX_GPS1              |
| VDD_5V_PERIPH_nOC         | 37 | 38  | GND                         |
| FMU_PPM_INPUT             | 39 | 40  | USART2_TX_TELEM3            |
| GND                       | 41 | 42  | USART2_RX_TELEM3            |
| GND                       | 43 | 44  | GND                         |
| GND                       | 45 | 46  | USART2_RTS_TELEM3           |
| GND                       | 47 | 48  | USART2_CTS_TELEM3           |
| VDD_5V_IN                 | 49 | 50  | GND                         |
| VDD_5V_IN                 | 51 | 52  | UART5_TX_TELEM2             |
| VDD_5V_IN                 | 53 | 54  | UART5_RX_TELEM2             |
| VDD_5V_IN                 | 55 | 56  | GND                         |
| CAN2_TX                   | 57 | 58  | UART5_RTS_TELEM2            |
| CAN2_RX                   | 59 | 60  | UART5_CTS_TELEM2            |
| GND                       | 61 | 62  | GND                         |
| CAN1_TX                   | 63 | 64  | UART7_TX_TELEM1             |
| CAN1_RX                   | 65 | 66  | UART7_RX_TELEM1             |
| GND                       | 67 | 68  | GND                         |
| USART3_TX_DEBUG           | 69 | 70  | USART6_RX_FROM_IO__RC_INPUT |
| USART3_RX_DEBUG           | 71 | 72  | USART6_TX_TO_IO__NC         |
| GND                       | 73 | 74  | GND                         |
| FMU_SWDIO                 | 75 | 76  | USB_D_P                     |
| FMU_SWCLK                 | 77 | 78  | USB_D_N                     |
| GND                       | 79 | 80  | VBUS_SENSE                  |
| VDD_5V_HIPOWER_nEN        | 81 | 82  | GND                         |
| VDD_5V_HIPOWER_nOC        | 83 | 84  | FMU_VDD_3V3                 |
| nARMED                    | 85 | 86  | FMU_VDD_3V3                 |
| FMU_nRST                  | 87 | 88  | GND                         |
| nPOWER_IN_A               | 89 | 90  | ADC1_6V6                    |
| nPOWER_IN_B               | 91 | 92  | ADC1_3V3                    |
| nPOWER_IN_C               | 93 | 94  | GND                         |
| GND                       | 95 | 96  | UART4_RX                    |
| FMU_CAP1                  | 97 | 98  | UART4_TX                    |
| GND                       | 99 | 100 | GND                         |



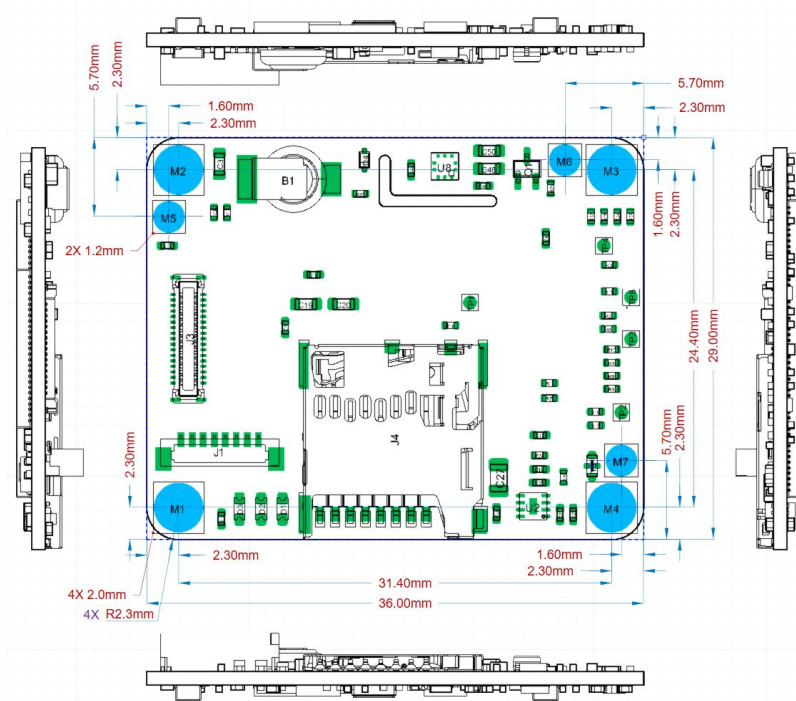
## X2 Pinout

Advanced bus (optional) containing ethernet and external SPI port.

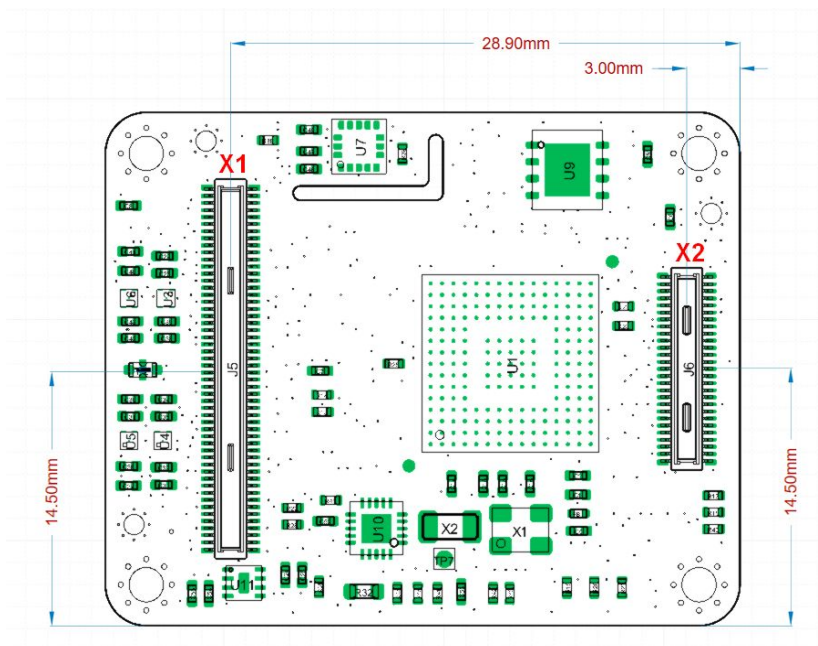
|                          |    |    |              |
|--------------------------|----|----|--------------|
| GND (Pin 1)              | 1  | 2  | ETH_MDIO     |
| ETH_REF_CLK              | 3  | 4  | ETH_MDC      |
| GND                      | 5  | 6  | ETH_POWER_EN |
| ETH_CRS_DV               | 7  | 8  | GND          |
| GND                      | 9  | 10 |              |
| ETH_RXD0                 | 11 | 12 |              |
| GND                      | 13 | 14 |              |
| ETH_RXD1                 | 15 | 16 |              |
| GND                      | 17 | 18 |              |
| ETH_TXD0                 | 19 | 20 |              |
| GND                      | 21 | 22 |              |
| ETH_TXD1                 | 23 | 24 |              |
| GND                      | 25 | 26 |              |
| ETH_TX_EN                | 27 | 28 |              |
| GND                      | 29 | 30 |              |
| SPI6_MISO_EXTERNAL1      | 31 | 32 |              |
| SPI6_MOSI_EXTERNAL1      | 33 | 34 |              |
| SPI6_SCK_EXTERNAL1 (SW0) | 35 | 36 |              |
| GND                      | 37 | 38 |              |
| SPI6_nRESET_EXTERNAL1    | 39 | 40 |              |
| SPI6_nCS1_EXTERNAL1      | 41 | 42 |              |
| SPI6_nCS2_EXTERNAL1      | 43 | 44 | PG6          |
| SPI6_DRDY2_EXTERNAL1     | 45 | 46 | GND          |
| SPI6_DRDY1_EXTERNAL1     | 47 | 48 | NFC_GPIO     |
| SPIX_SYNC                | 49 | 50 | PH11         |

## Mechanical Design

Top view of FMU SOM



Bottom view of FMU SOM

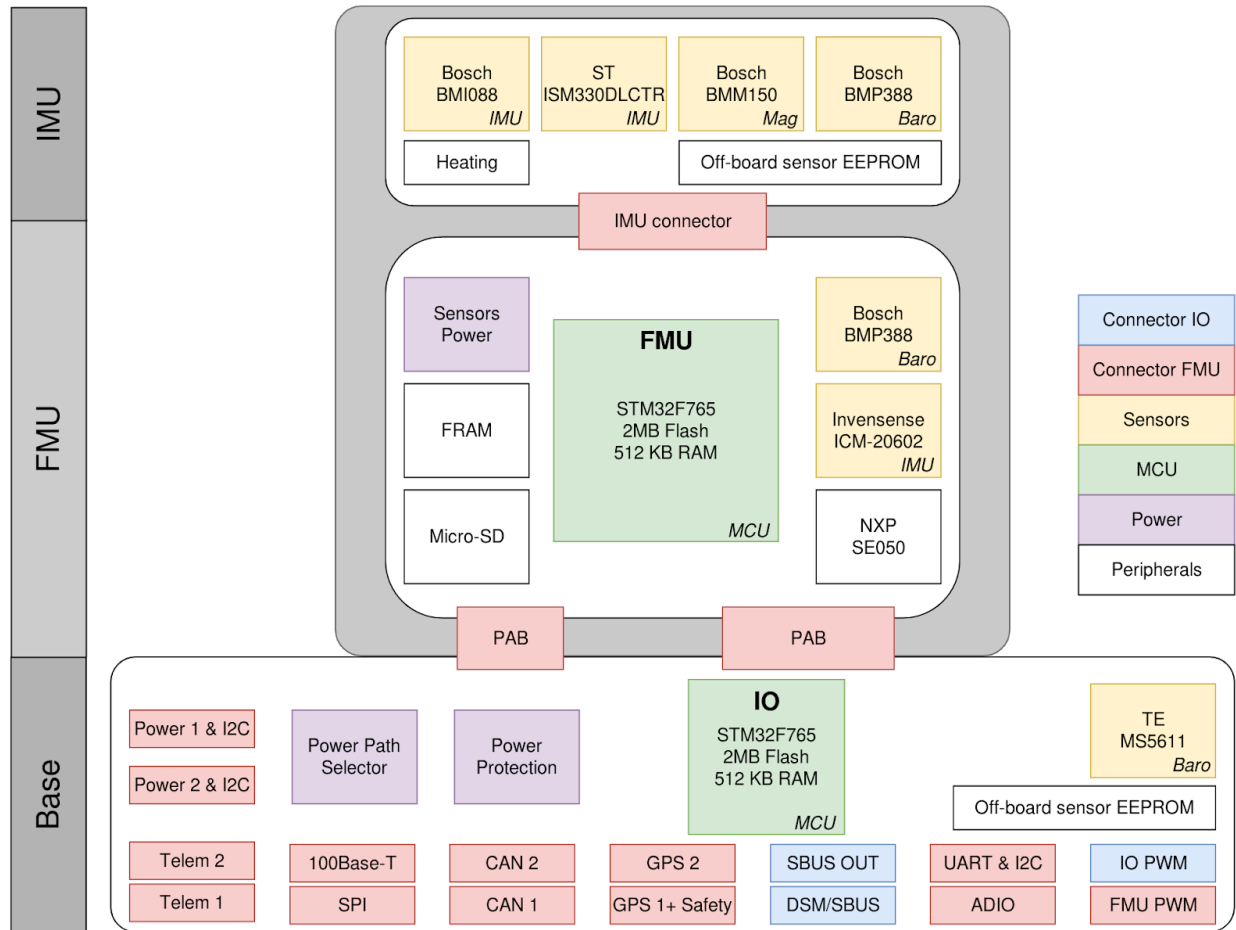


## PCB Layout Guidelines

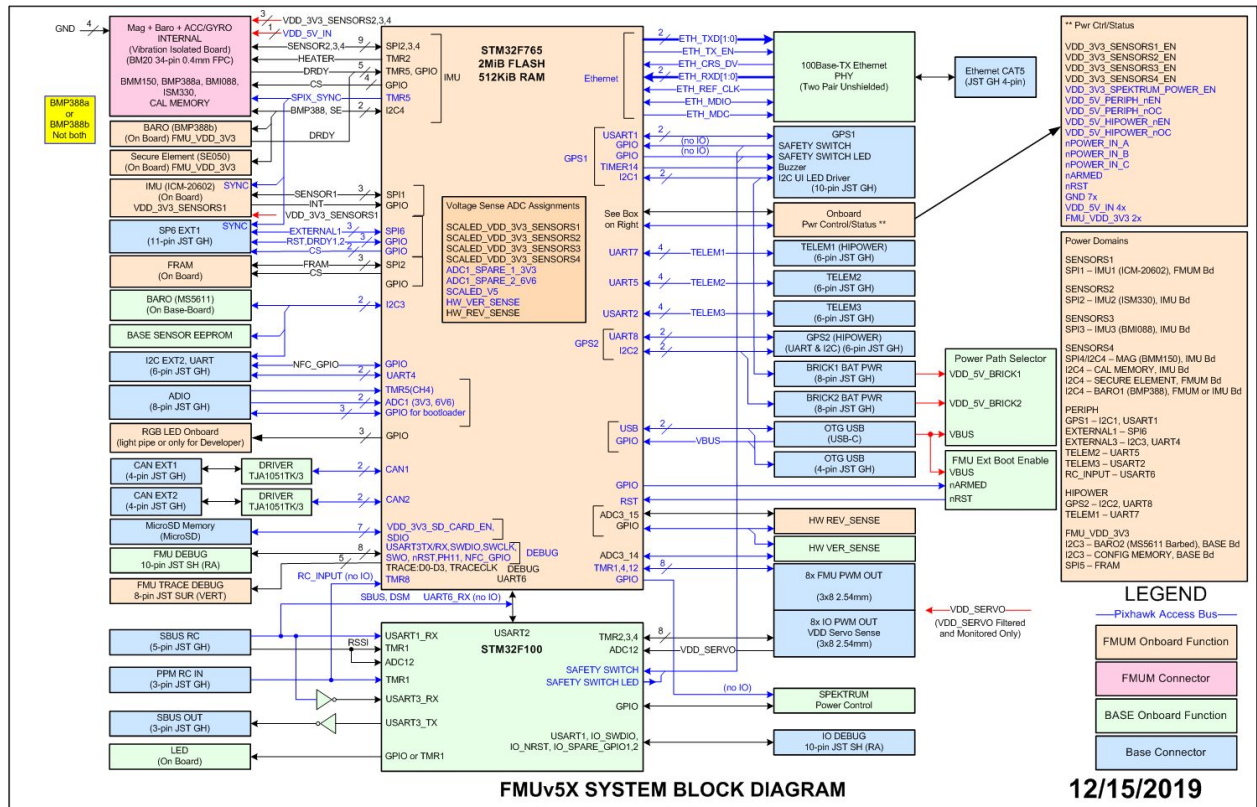
- The base board should be impedance controlled with 50 ohms single ended, 90 ohms differential for USB, and 100 ohms differential for Ethernet.
- Impedance controlled signal traces should not be routed such that they cross a split in their respective reference planes. A signal crossing a plane split may cause unpredictable return path currents impacting signal quality and potentially creating EMI problems.
- Provide 3x the gap separation between adjacent ground fill copper and both USB and Ethernet differential signal traces.
- Ethernet RMII interface signals ETH\_TX\_EN, ETH\_TXD1, ETH\_TXD0, ETH\_CRSDV, ETH\_RXD1, ETH\_RXD0 should each be kept under 6" in length with length matching to each other within 2". ETH\_TXD0 is ~1" on the FMUM board and ~0.5" longer than the rest of the RMII interface signals. Therefore on the base board ETH\_TXD0 should be less than 5" in length and the remainder of RMII signals should match (ETH\_TXD0 - 0.5") to within 2".
- While it is possible to mount low profile components under the FMU SOM, it is recommended that some form of heatsinking provision be employed to remove heat from bottom side M7 processor U1, such as a metal housing that is thermally connected to U1. Use of such a metal housing may require a keepout area under the SOM.
- The four 2.0 mm mounting holes with 3.6 mm pads are connected to ground and are intended to provide electrical grounding to the base board through metal standoffs.
- The DF40 connectors establish a 3mm board to board spacing between the SOM and base board.
- Port protection diodes and series resistors should be placed close to the connectors they are providing protection for.
- Ethernet common mode chokes specify removing copper planes and traces from beneath the parts for best performance.
- The impedance from input connector, through power path selector, to VDD\_5V\_IN should be given special attention to reduce voltage drops. Keep traces wide (at least 1mm) and use multiple vias when changing layers (at least 2).

# FMUv5X Summary

## Overview



## Detailed Block Diagram



The FMUv5X generation brings the proven features from FMUv5 to a hardened form factor.

- Secure element for secure authentication of the drone (SE050, I2C4)
- Ethernet interface for high-speed mission computer integration
- Three redundancy domains: Completely isolated sensor domains with separate buses and separate power control.
- Redundant sensors on separate buses, allowing continuous operation while losing a complete redundancy domain.
  - Bosch BMI088 accelerometer (SPI4, redundancy domain #1, vibration isolated)
  - Invensense ICM-20602 (SPI1, redundancy domain #2)
  - ST Micro ISM330 (SPI5, redundancy domain #3, vibration isolated)
  - Bosch BMM150 compass (I2C4, redundancy domain #1, vibration isolated)
  - Bosch BMP388 pressure sensor (I2C4, redundancy domain #1)
  - GPS external mag + baro #1 (I2C1, redundancy domain #2)
  - GPS external mag + baro #2 (I2C2, redundancy domain #3)
  - High accuracy barbed baro (I2C1, redundancy domain #2)
  - Calibration EEPROM for baseboard sensors (I2C1)
  - On-IMU calibration EEPROM memory for high-accuracy sensors (I2C4)
- Automated sensor calibration eliminating varying signals and temperature
- Operating temperature -40 to +85°C
- FRAM memory for configuration data (SPI2)

- Extensive power monitoring
  - Two smart batteries on SMBus or more on UAVCAN
  - 5V rail monitoring
  - 3.3V rail monitoring for CPU
  - 3.3V rail monitoring for each sensor domain
- External sensor bus (SPI5)
- Temperature calibration: Every board is calibrated for temperature from -25 to +85 degrees
- Redundant power supply: The autopilot can be powered from up to three power sources and every sensor set is powered by an independent LDO with independent power control
- Battery-backed real time clock for running security applications without GPS coverage
- For NFC one external I2C port needs to have an additional GPIO line and 5V to supply the external NFC reader.

## Full FMUv5X Pinout

The official pinout is covered in this [pinout sheet](#).

|    |    |    |                 |   |                                |
|----|----|----|-----------------|---|--------------------------------|
| 0  | PA | 0  | ADC1_IN0        | A | SCALED_VDD_3V3_SENSORS1        |
| 1  | PA | 1  | ETH_REF_CLK     | E | ETH_REF_CLK                    |
| 2  | PA | 2  | ETH_MDIO        | E | ETH_MDIO                       |
| 3  | PA | 3  | USART2_RX       | U | USART2_RX_TELEM3               |
| 4  | PA | 4  | ADC1_IN4        | A | SCALED_VDD_3V3_SENSORS2        |
| 5  | PA | 5  | SPI1_SCK        | S | SPI1_SCK_SENSOR1_ICM20602      |
| 6  | PA | 6  | SPI6_MISO       | S | SPI6_MISO_EXTERNAL1            |
| 7  | PA | 7  | ETH_CRS_DV      | E | ETH_CRS_DV                     |
| 8  | PA | 8  | TIM1_CH1        | T | FMU_CH4                        |
| 9  | PA | 9  | USB_OTG_FS_VBUS | B | VBUS                           |
| 10 | PA | 10 | TIM1_CH3        | T | FMU_CH2                        |
| 11 | PA | 11 | USB_OTG_FS_DM   | B | USB_D_N                        |
| 12 | PA | 12 | USB_OTG_FS_DP   | B | USB_D_P                        |
| 13 | PA | 13 | SWDIO           | D | FMU_SWDIO                      |
| 14 | PA | 14 | SWCLK           | D | FMU_SWCLK                      |
| 15 | PA | 15 | PA15            | G | SPI6_nCS2_EXTERNAL1            |
| 16 | PB | 0  | ADC1_IN8        | A | SCALED_VDD_3V3_SENSORS3        |
| 17 | PB | 1  | ADC1_IN9        | A | SCALED_V5                      |
| 18 | PB | 2  | SPI3_MOSI       | S | SPI3_MOSI_SENSOR3_BMI088       |
| 19 | PB | 3  | SPI6_SCK        | S | SPI6_SCK_EXTERNAL1             |
| 20 | PB | 4  | SPI1_MISO       | S | SPI1_MISO_SENSOR1_ICM20602     |
| 21 | PB | 5  | SPI1_MOSI       | S | SPI1_MOSI_SENSOR1_ICM20602     |
| 22 | PB | 6  | CAN2_TX         | C | CAN2_TX                        |
| 23 | PB | 7  | I2C1_SDA        | I | I2C1_SDA_BASE_GPS1_MAG_LED_PM1 |
| 24 | PB | 8  | I2C1_SCL        | I | I2C1_SCL_BASE_GPS1_MAG_LED_PM1 |

|    |    |    |            |    |                             |
|----|----|----|------------|----|-----------------------------|
| 25 | PB | 9  | UART5_TX   | V  | UART5_TX_TELEM2             |
| 26 | PB | 10 | TIM2_CH3   | T  | HEATER                      |
| 27 | PB | 11 | ETH_TX_EN  | E  | ETH_TX_EN                   |
| 28 | PB | 12 | CAN2_RX    | C  | CAN2_RX                     |
| 29 | PB | 13 | ETH_TXD1   | E  | ETH_TXD1                    |
| 30 | PB | 14 | USART1_TX  | U  | USART1_TX_GPS1              |
| 31 | PB | 15 | USART1_RX  | U  | USART1_RX_GPS1              |
| 32 | PC | 0  | ADC1_IN10  | A  | ADC1_6V6                    |
| 33 | PC | 1  | ETH_MDC    | E  | ETH_MDC                     |
| 34 | PC | 2  | ADC1_IN12  | A  | SCALED_VDD_3V3_SENSORS4     |
| 35 | PC | 3  | ADC1_IN13  | A  | ADC1_3V3                    |
| 36 | PC | 4  | ETH_RXD0   | E  | ETH_RXD0                    |
| 37 | PC | 5  | ETH_RXD1   | E  | ETH_RXD1                    |
| 38 | PC | 6  | USART6_TX  | U  | USART6_TX_TO_IO__NC         |
| 39 | PC | 7  | USART6_RX  | U  | USART6_RX_FROM_IO__RC_INPUT |
| 40 | PC | 8  | UART5_RTS  | V  | UART5_RTS_TELEM2            |
| 41 | PC | 9  | UART5_CTS  | V  | UART5_CTS_TELEM2            |
| 42 | PC | 10 | SPI3_SCK   | S  | SPI3_SCK_SENSOR3_BMI088     |
| 43 | PC | 11 | SPI3_MISO  | S  | SPI3_MISO_SENSOR3_BMI088    |
| 44 | PC | 12 | PC12       | G  | nARMED                      |
| 45 | PC | 13 | PC13       | G  | VDD_3V3_SD_CARD_EN          |
| 46 | PC | 14 | OSC32_IN   | X  | 32KHZ_IN                    |
| 47 | PC | 15 | OSC32_OUT  | X  | 32KHZ_OUT                   |
| 48 | PD | 0  | CAN1_RX    | C  | CAN1_RX                     |
| 49 | PD | 1  | CAN1_TX    | C  | CAN1_TX                     |
| 50 | PD | 2  | UART5_RX   | V  | UART5_RX_TELEM2             |
| 51 | PD | 3  | USART2_CTS | U  | USART2_CTS_TELEM3           |
| 52 | PD | 4  | USART2_RTS | U  | USART2_RTS_TELEM3           |
| 53 | PD | 5  | USART2_TX  | U  | USART2_TX_TELEM3            |
| 54 | PD | 6  | SDMMC2_CLK | SD | SDMMC2_CLK                  |
| 55 | PD | 7  | SDMMC2_CMD | SD | SDMMC2_CMD                  |
| 56 | PD | 8  | USART3_TX  | U  | USART3_TX_DEBUG             |
| 57 | PD | 9  | USART3_RX  | U  | USART3_RX_DEBUG             |
| 58 | PD | 10 | PD10       | G  | FMU_nSAFETY_SWITCH_LED_OUT  |
| 59 | PD | 11 | PD11       | G  | SPI6_DRDY1_EXTERNAL1        |
| 60 | PD | 12 | PD12       | G  | SPI6_DRDY2_EXTERNAL1        |
| 61 | PD | 13 | TIM4_CH2   | T  | FMU_CH5                     |
| 62 | PD | 14 | TIM4_CH3   | T  | FMU_CH6                     |
| 63 | PD | 15 | PD15       | G  | VDD_3V3_SENSORS2_EN         |
| 64 | PE | 0  | UART8_RX   | V  | UART8_RX_GPS2               |
| 65 | PE | 1  | UART8_TX   | V  | UART8_TX_GPS2               |
| 66 | PE | 2  | PE2        | D  | TRACECLK                    |
| 67 | PE | 3  | PE3        | G  | nLED_RED                    |
| 68 | PE | 4  | PE4        | G  | nLED_GREEN                  |

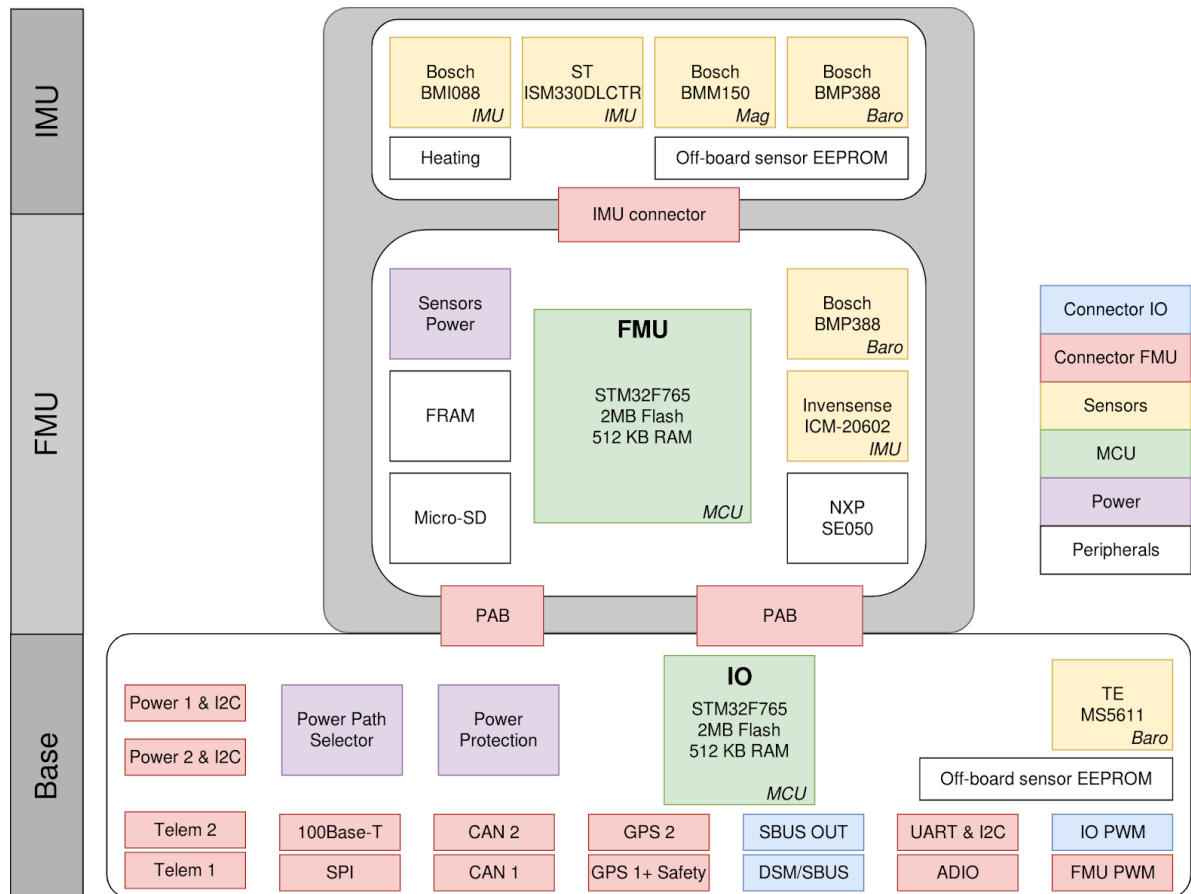
|     |    |    |           |    |                                |
|-----|----|----|-----------|----|--------------------------------|
| 69  | PE | 5  | PE5       | G  | nLED_BLUE                      |
| 70  | PE | 6  | SPI4_MOSI | S  | SPI4_MOSI_SENSOR4_BMM150       |
| 71  | PE | 7  | PE7       | G  | VDD_3V3_SENSORS3_EN            |
| 72  | PE | 8  | UART7_TX  | V  | UART7_TX_TELEM1                |
| 73  | PE | 9  | UART7_RTS | V  | UART7_RTS_TELEM1               |
| 74  | PE | 10 | UART7_CTS | V  | UART7_CTS_TELEM1               |
| 75  | PE | 11 | TIM1_CH2  | T  | FMU_CH3                        |
| 76  | PE | 12 | SPI4_SCK  | S  | SPI4_SCK_SENSOR4_BMM150        |
| 77  | PE | 13 | SPI4_MISO | S  | SPI4_MISO_SENSOR4_BMM150       |
| 78  | PE | 14 | TIM1_CH4  | T  | FMU_CH1                        |
| 79  | PE | 15 | PE15      | G  | VDD_5V_PERIPH_n0C              |
| 80  | PF | 0  | I2C2_SDA  | I  | I2C2_SDA_BASE_GPS2_MAG_LED_PM2 |
| 81  | PF | 1  | I2C2_SCL  | I  | I2C2_SCL_BASE_GPS2_MAG_LED_PM2 |
| 82  | PF | 2  | PF2       | G  | SPI1_DRDY1_ICM20602            |
| 83  | PF | 3  | PF3       | G  | SPI4_DRDY1_BMM150_DRDY         |
| 84  | PF | 4  | ADC3_IN14 | A  | HW_VER_SENSE                   |
| 85  | PF | 5  | ADC3_IN15 | A  | HW_REV_SENSE                   |
| 86  | PF | 6  | UART7_RX  | V  | UART7_RX_TELEM1                |
| 87  | PF | 7  | SPI5_SCK  | S  | SPI5_SCK_FRAM                  |
| 88  | PF | 8  | SPI5_MISO | S  | SPI5_MISO_FRAM                 |
| 89  | PF | 9  | TIM14_CH1 | T  | BUZZER_1                       |
| 90  | PF | 10 | PF10      | G  | SPI6_nRESET_EXTERNAL1          |
| 91  | PF | 11 | SPI5_MOSI | S  | SPI5_MOSI_FRAM                 |
| 92  | PF | 12 | PF12      | G  | VDD_5V_HIPOWER_nEN             |
| 93  | PF | 13 | PF13      | G  | VDD_5V_HIPOWER_n0C             |
| 94  | PF | 14 | I2C4_SCL  | I  | I2C4_SCL_FMU                   |
| 95  | PF | 15 | I2C4_SDA  | I  | I2C4_SDA_FMU                   |
| 96  | PG | 0  | PG0       | G  | HW_VER_REV_DRIVE               |
| 97  | PG | 1  | PG1       | G  | nPOWER_IN_A                    |
| 98  | PG | 2  | PG2       | G  | nPOWER_IN_B                    |
| 99  | PG | 3  | PG3       | G  | nPOWER_IN_C                    |
| 100 | PG | 4  | PG4       | G  | VDD_5V_PERIPH_nEN              |
| 101 | PG | 5  | PG5       | G  | I2C4_DRDY1_BMP388              |
| 102 | PG | 6  | PG6       | G  | PG6                            |
| 103 | PG | 7  | PG7       | G  | SPI5_nCS1_FRAM                 |
| 104 | PG | 8  | PG8       | G  | VDD_3V3_SENSORS4_EN            |
| 105 | PG | 9  | SDMMC2_D0 | SD | SDMMC2_D0                      |
| 106 | PG | 10 | SDMMC2_D1 | SD | SDMMC2_D1                      |
| 107 | PG | 11 | SDMMC2_D2 | SD | SDMMC2_D2                      |
| 108 | PG | 12 | SDMMC2_D3 | SD | SDMMC2_D3                      |
| 109 | PG | 13 | ETH_TXD0  | E  | ETH_TXD0                       |
| 110 | PG | 14 | SPI6_MOSI | S  | SPI6_MOSI_EXTERNAL1            |
| 111 | PG | 15 | PG15      | G  | ETH_POWER_EN                   |
| 112 | PH | 0  | OSC_IN    | X  | 16_MHZ_IN                      |



|     |    |    |             |   |                                       |
|-----|----|----|-------------|---|---------------------------------------|
| 113 | PH | 1  | OSC_OUT     | X | 16_MHZ_OUT                            |
| 114 | PH | 2  | PH2         | G | VDD_3V3_SPEKTRUM_POWER_EN             |
| 115 | PH | 3  | PH3         | G | NFC_GPIO                              |
| 116 | PH | 4  | PH4         | G | FMU_SAFETY_SWITCH_IN                  |
| 117 | PH | 5  | PH5         | G | SPI2_nCS1_ISM330                      |
| 118 | PH | 6  | TIM12_CH1   | T | FMU_CH7                               |
| 119 | PH | 7  | I2C3_SCL    | I | I2C3_SCL_BASE_MS5611_BARBED_EXTERNAL1 |
| 120 | PH | 8  | I2C3_SDA    | I | I2C3_SDA_BASE_MS5611_BARBED_EXTERNAL1 |
| 121 | PH | 9  | TIM12_CH2   | T | FMU_CH8                               |
| 122 | PH | 10 | TIM5_CH1    | T | SPIX_SYNC                             |
| 123 | PH | 11 | PH11        | G | PH11                                  |
| 124 | PH | 12 | TIM5_CH3    | T | SPI2_DRDY2_ISM330_INT2                |
| 125 | PH | 13 | UART4_TX    | V | UART4_TX                              |
| 126 | PH | 14 | UART4_RX    | V | UART4_RX                              |
| 127 | PH | 15 | PH15        | G | SPI4_nCS1_BMM150                      |
| 128 | PI | 0  | TIM5_CH4    | T | FMU_CAP1                              |
| 129 | PI | 1  | SPI2_SCK    | S | SPI2_SCK_SENSOR2_ISM330               |
| 130 | PI | 2  | SPI2_MISO   | S | SPI2_MISO_SENSOR2_ISM330              |
| 131 | PI | 3  | SPI2_MOSI   | S | SPI2_MOSI_SENSOR2_ISM330              |
| 132 | PI | 4  | PI4         | G | SPI3_nCS1_BMI088_ACCEL                |
| 133 | PI | 5  | TIM8_CH1_IN | T | FMU_PPM_INPUT                         |
| 134 | PI | 6  | PI6         | G | SPI3_DRDY1_BMI088_INT1_ACCEL          |
| 135 | PI | 7  | PI7         | G | SPI3_DRDY2_BMI088_INT3_GYRO           |
| 136 | PI | 8  | PI8         | G | SPI3_nCS2_BMI088_GYRO                 |
| 137 | PI | 9  | PI9         | G | SPI1_nCS1_ICM20602                    |
| 138 | PI | 10 | PI10        | G | SPI6_nCS1_EXTERNAL1                   |
| 139 | PI | 11 | PI11        | G | VDD_3V3_SENSORS1_EN                   |

## FMUv6X Summary

### Overview



NOTE: FMUv6X has the same architecture as v5X, but is based on STM32H7



- FRAM memory for configuration data (SPI2)
- Extensive power monitoring
  - Two smart batteries on SMBus or more on UAVCAN
  - 5V rail monitoring
  - 3.3V rail monitoring for CPU
  - 3.3V rail monitoring for each sensor domain
- External sensor bus (SPI5)
- Temperature calibration: Every board is calibrated for temperature from -25 to +85 degrees
- Redundant power supply: The autopilot can be powered from up to three power sources and every sensor set is powered by an independent LDO with independent power control
- Battery-backed real time clock for running security applications without GPS coverage
- For NFC one external I2C port needs to have an additional GPIO line and 5V to supply the external NFC reader.

## Full FMUv6X Pinout

The official pinout is covered in this [pinout sheet](#).

|    |    |                 |    |                                       |
|----|----|-----------------|----|---------------------------------------|
| PA | 0  | ADC1_IN16       | A  | SCALED_VDD_3V3_SENSORS1               |
| PA | 1  | ETH_REF_CLK     | E  | ETH_REF_CLK                           |
| PA | 2  | ETH_MDIO        | E  | ETH_MDIO                              |
| PA | 3  | USART2_RX       | U  | USART2_RX_TELEM3                      |
| PA | 4  | ADC1_INP18      | A  | SCALED_VDD_3V3_SENSORS2               |
| PA | 5  | SPI1_SCK        | S  | SPI1_SCK_SENSOR1_ICM20602             |
| PA | 6  | SPI6_MISO       | S  | SPI6_MISO_EXTERNAL1                   |
| PA | 7  | ETH_CRS_DV      | E  | ETH_CRS_DV                            |
| PA | 8  | I2C3_SCL        | I  | I2C3_SCL_BASE_MS5611_BARBED_EXTERNAL1 |
| PA | 9  | USB_OTG_FS_VBUS | B  | VBUS                                  |
| PA | 10 | TIM1_CH3        | T  | SPI2_DRDY2_ISM330_INT2                |
| PA | 11 | USB_OTG_FS_DM   | B  | USB_D_N                               |
| PA | 12 | USB_OTG_FS_DP   | B  | USB_D_P                               |
| PA | 13 | SWDIO           | D  | FMU_SWDIO                             |
| PA | 14 | SWCLK           | D  | FMU_SWCLK                             |
| PA | 15 | PA15            | G  | SPI6_nCS2_EXTERNAL1                   |
| PB | 0  | ADC1_INP9       | A  | SCALED_VDD_3V3_SENSORS3               |
| PB | 1  | ADC1_INP5       | A  | SCALED_V5                             |
| PB | 2  | SPI3_MOSI       | S  | SPI3_MOSI_SENSOR3_BMI088              |
| PB | 3  | SPI6_SCK        | S  | SPI6_SCK_EXTERNAL1                    |
| PB | 4  | SDMMC2_D3       | SD | SDMMC2_D3                             |
| PB | 5  | SPI1_MOSI       | S  | SPI1_MOSI_SENSOR1_ICM20602            |
| PB | 6  | USART1_TX       | U  | USART1_TX_GPS1                        |
| PB | 7  | USART1_RX       | U  | USART1_RX_GPS1                        |

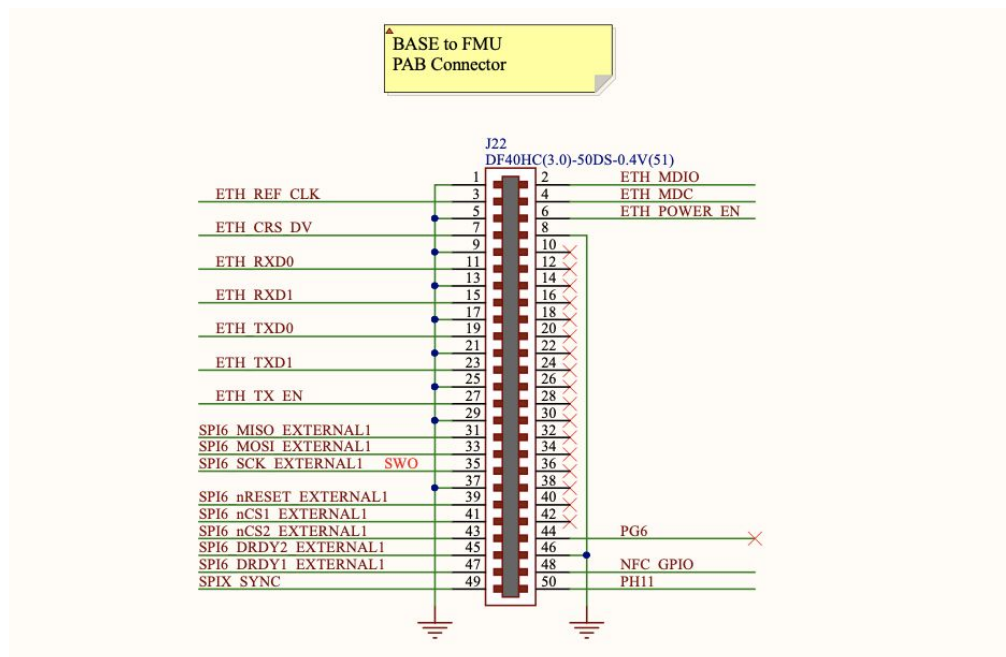
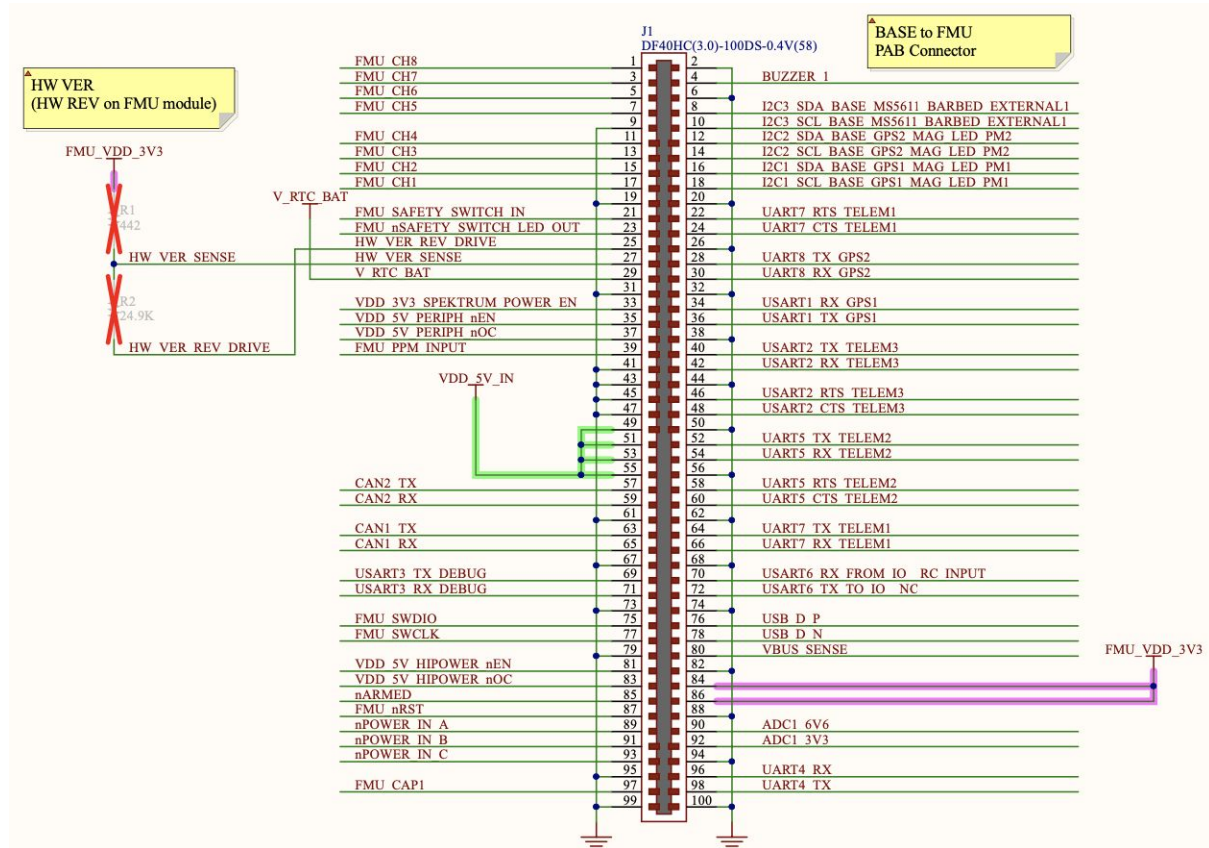
|    |    |            |    |                                |
|----|----|------------|----|--------------------------------|
| PB | 8  | I2C1_SCL   | I  | I2C1_SCL_BASE_GPS1_MAG_LED_PM1 |
| PB | 9  | I2C1_SDA   | I  | I2C1_SDA_BASE_GPS1_MAG_LED_PM1 |
| PB | 10 | TIM2_CH3   | T  | HEATER                         |
| PB | 11 | ETH_TX_EN  | E  | ETH_TX_EN                      |
| PB | 12 | FDCAN2_RX  | C  | CAN2_RX                        |
| PB | 13 | FDCAN2_TX  | C  | CAN2_TX                        |
| PB | 14 | SDMMC2_D0  | SD | SDMMC2_D0                      |
| PB | 15 | SDMMC2_D1  | SD | SDMMC2_D1                      |
| PC | 0  | PC0        | G  | NFC_GPIO                       |
| PC | 1  | ETH_MDC    | E  | ETH_MDC                        |
| PC | 2  | ADC3_INP0  | A  | ADC3_6V6                       |
| PC | 3  | ADC3_INP1  | A  | ADC3_3V3                       |
| PC | 4  | ETH_RXD0   | E  | ETH_RXD0                       |
| PC | 5  | ETH_RXD1   | E  | ETH_RXD1                       |
| PC | 6  | USART6_TX  | U  | USART6_TX_TO_IO__NC            |
| PC | 7  | USART6_RX  | U  | USART6_RX_FROM_IO__RC_INPUT    |
| PC | 8  | UART5_RTS  | V  | UART5_RTS_TELEM2               |
| PC | 9  | UART5_CTS  | V  | UART5_CTS_TELEM2               |
| PC | 10 | SPI3_SCK   | S  | SPI3_SCK_SENSOR3_BMI088        |
| PC | 11 | SPI3_MISO  | S  | SPI3_MISO_SENSOR3_BMI088       |
| PC | 12 | UART5_TX   | V  | UART5_TX_TELEM2                |
| PC | 13 | PC13       | G  | VDD_3V3_SD_CARD_EN             |
| PC | 14 | OSC32_IN   | X  | 32KHZ_IN                       |
| PC | 15 | OSC32_OUT  | X  | 32KHZ_OUT                      |
| PD | 0  | FDCAN1_RX  | C  | CAN1_RX                        |
| PD | 1  | FDCAN1_TX  | C  | CAN1_TX                        |
| PD | 2  | UART5_RX   | V  | UART5_RX_TELEM2                |
| PD | 3  | USART2_CTS | U  | USART2_CTS_TELEM3              |
| PD | 4  | USART2_RTS | U  | USART2_RTS_TELEM3              |
| PD | 5  | USART2_TX  | U  | USART2_TX_TELEM3               |
| PD | 6  | SDMMC2_CLK | SD | SDMMC2_CLK                     |
| PD | 7  | SDMMC2_CMD | SD | SDMMC2_CMD                     |
| PD | 8  | USART3_TX  | U  | USART3_TX_DEBUG                |
| PD | 9  | USART3_RX  | U  | USART3_RX_DEBUG                |
| PD | 10 | PD10       | G  | FMU_nSAFETY_SWITCH_LED_OUT     |
| PD | 11 | PD11       | G  | SPI6_DRDY1_EXTERNAL1           |
| PD | 12 | PD12       | G  | SPI6_DRDY2_EXTERNAL1           |
| PD | 13 | TIM4_CH2   | T  | FMU_CH5                        |
| PD | 14 | TIM4_CH3   | T  | FMU_CH6                        |
| PD | 15 | PD15       | G  | PD15(PH11)                     |
| PE | 0  | UART8_RX   | V  | UART8_RX_GPS2                  |
| PE | 1  | UART8_TX   | V  | UART8_TX_GPS2                  |
| PE | 2  | PE2        | D  | TRACECLK                       |
| PE | 3  | PE3        | G  | nLED_RED                       |

|    |    |           |    |                                |
|----|----|-----------|----|--------------------------------|
| PE | 4  | PE4       | G  | nLED_GREEN                     |
| PE | 5  | PE5       | G  | nLED_BLUE                      |
| PE | 6  | PE6       | G  | nARMED                         |
| PE | 7  | PE7       | G  | VDD_3V3_SENSORS3_EN            |
| PE | 8  | UART7_TX  | V  | UART7_TX_TELEM1                |
| PE | 9  | TIM1_CH1  | V  | SPIX_SYNC                      |
| PE | 10 | UART7_CTS | V  | UART7_CTS_TELEM1               |
| PE | 11 | TIM1_CH2  | T  | FMU_CAP1                       |
| PE | 12 | SPI4_SCK  | S  | SPI4_SCK_SENSOR4_BMM150        |
| PE | 13 | SPI4_MISO | S  | SPI4_MISO_SENSOR4_BMM150       |
| PE | 14 | SPI4_MOSI | S  | SPI4_MOSI_SENSOR4_BMM150       |
| PE | 15 | PE15      | G  | VDD_5V_PERIPH_nOC              |
| PF | 0  | I2C2_SDA  | I  | I2C2_SDA_BASE_GPS2_MAG_LED_PM2 |
| PF | 1  | I2C2_SCL  | I  | I2C2_SCL_BASE_GPS2_MAG_LED_PM2 |
| PF | 2  | PF2       | G  | SPI1_DRDY1_ICM20602            |
| PF | 3  | PF3       | G  | SPI4_DRDY1_BMM150_DRDY         |
| PF | 4  | PF4       | G  | VDD_3V3_SENSORS2_EN            |
| PF | 5  | PF5       | G  | FMU_SAFETY_SWITCH_IN           |
| PF | 6  | UART7_RX  | V  | UART7_RX_TELEM1                |
| PF | 7  | SPI5_SCK  | S  | SPI5_SCK_FRAM                  |
| PF | 8  | UART7_RTS | V  | UART7_RTS_TELEM1               |
| PF | 9  | TIM14_CH1 | T  | BUZZER_1                       |
| PF | 10 | PF10      | G  | SPI6_nRESET_EXTERNAL1          |
| PF | 11 | SPI5_MOSI | S  | SPI5_MOSI_FRAM                 |
| PF | 12 | ADC1_INP6 | A  | SCALED_VDD_3V3_SENSORS4        |
| PF | 13 | PF13      | G  | VDD_5V_HIPOWER_nOC             |
| PF | 14 | I2C4_SCL  | I  | I2C4_SCL_FMU                   |
| PF | 15 | I2C4_SDA  | I  | I2C4_SDA_FMU                   |
| PG | 0  | PG0       | G  | HW_VER_REV_DRIVE               |
| PG | 1  | PG1       | G  | nPOWER_IN_A                    |
| PG | 2  | PG2       | G  | nPOWER_IN_B                    |
| PG | 3  | PG3       | G  | nPOWER_IN_C                    |
| PG | 4  | PG4       | G  | VDD_5V_PERIPH_nEN              |
| PG | 5  | PG5       | G  | I2C4_DRDY1_BMP388              |
| PG | 6  | PG6       | G  | PG6                            |
| PG | 7  | PG7       | G  | SPI5_nCS1_FRAM                 |
| PG | 8  | PG8       | G  | VDD_3V3_SENSORS4_EN            |
| PG | 9  | SPI1_MISO | S  | SPI1_MISO_SENSOR1_ICM20602     |
| PG | 10 | PG10      | G  | VDD_5V_HIPOWER_nEN             |
| PG | 11 | SDMMC2_D2 | SD | SDMMC2_D2                      |
| PG | 12 | ETH_TXD1  | E  | ETH_TXD1                       |
| PG | 13 | ETH_TXD0  | E  | ETH_TXD0                       |
| PG | 14 | SPI6_MOSI | S  | SPI6_MOSI_EXTERNAL1            |
| PG | 15 | PG15      | G  | ETH_POWER_EN                   |

|    |    |             |   |                                       |
|----|----|-------------|---|---------------------------------------|
| PH | 0  | OSC_IN      | X | 16_MHZ_IN                             |
| PH | 1  | OSC_OUT     | X | 16_MHZ_OUT                            |
| PH | 2  | PH2         | G | VDD_3V3_SPEKTRUM_POWER_EN             |
| PH | 3  | ADC3_INP14  | A | HW_VER_SENSE                          |
| PH | 4  | ADC3_INP15  | A | HW_REV_SENSE                          |
| PH | 5  | PH5         | G | SPI2_nCS1_ISM330                      |
| PH | 6  | TIM12_CH1   | T | FMU_CH7                               |
| PH | 7  | SPI5_MISO   | S | SPI5_MISO_FRAM                        |
| PH | 8  | I2C3_SDA    | I | I2C3_SDA_BASE_MS5611_BARBED_EXTERNAL1 |
| PH | 9  | TIM12_CH2   | T | FMU_CH8                               |
| PH | 10 | TIM5_CH1    | T | FMU_CH4                               |
| PH | 11 | TIM5_CH2    | T | FMU_CH3                               |
| PH | 12 | TIM5_CH3    | T | FMU_CH2                               |
| PH | 13 | UART4_TX    | V | UART4_TX                              |
| PH | 14 | UART4_RX    | V | UART4_RX                              |
| PH | 15 | PH15        | G | SPI4_nCS1_BMM150                      |
| PI | 0  | TIM5_CH4    | T | FMU_CH1                               |
| PI | 1  | SPI2_SCK    | S | SPI2_SCK_SENSOR2_ISM330               |
| PI | 2  | SPI2_MISO   | S | SPI2_MISO_SENSOR2_ISM330              |
| PI | 3  | SPI2_MOSI   | S | SPI2_MOSI_SENSOR2_ISM330              |
| PI | 4  | PI4         | G | SPI3_nCS1_BMI088_ACCEL                |
| PI | 5  | TIM8_CH1_IN | T | FMU_PPM_INPUT                         |
| PI | 6  | PI6         | G | SPI3_DRDY1_BMI088_INT1_ACCEL          |
| PI | 7  | PI7         | G | SPI3_DRDY2_BMI088_INT3_GYRO           |
| PI | 8  | PI8         | G | SPI3_nCS2_BMI088_GYRO                 |
| PI | 9  | PI9         | G | SPI1_nCS1_ICM20602                    |
| PI | 10 | PI10        | G | SPI6_nCS1_EXTERNAL1                   |
| PI | 11 | PI11        | G | VDD_3V3_SENSORS1_EN                   |

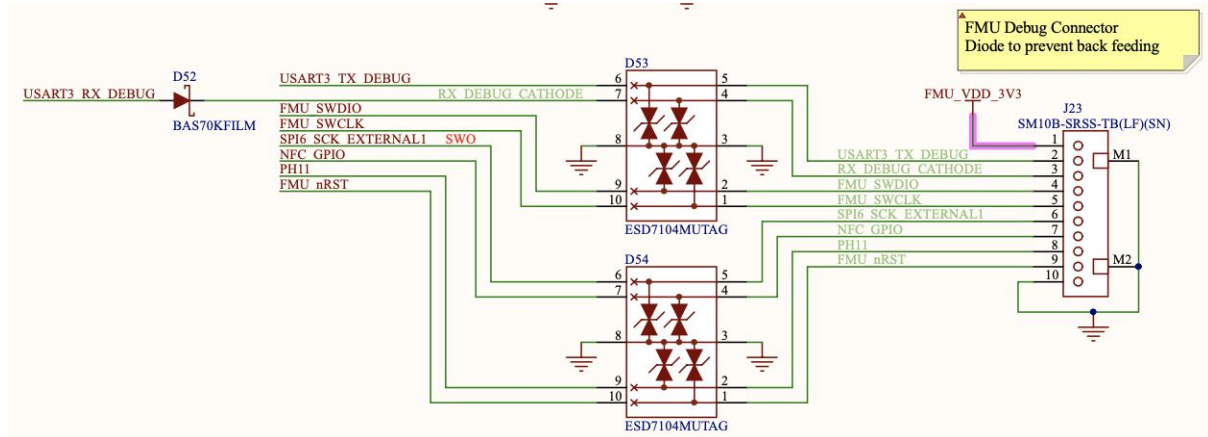
# Baseboard Design Guidelines (FMUv5X, FMUv6X)

## Base to FMU Connectors (X1, X2)

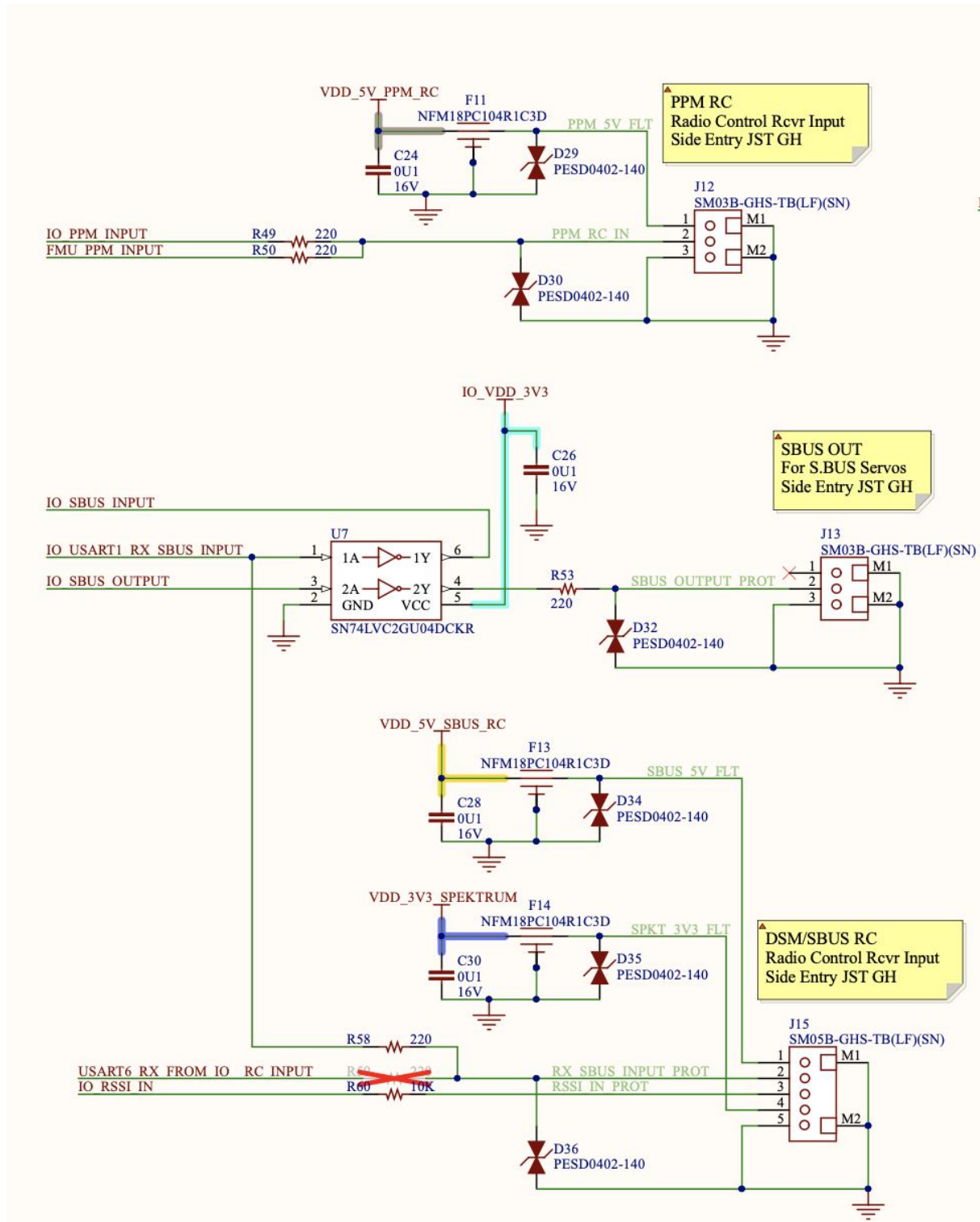




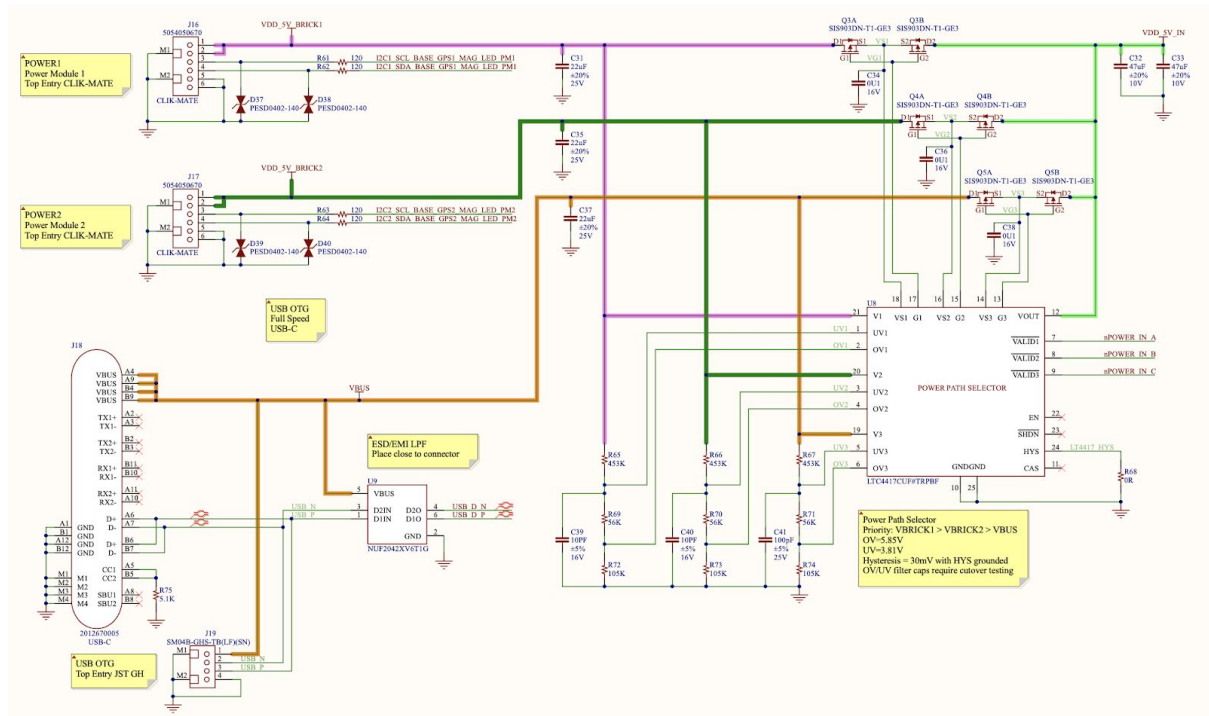
## FMU Debug Connector



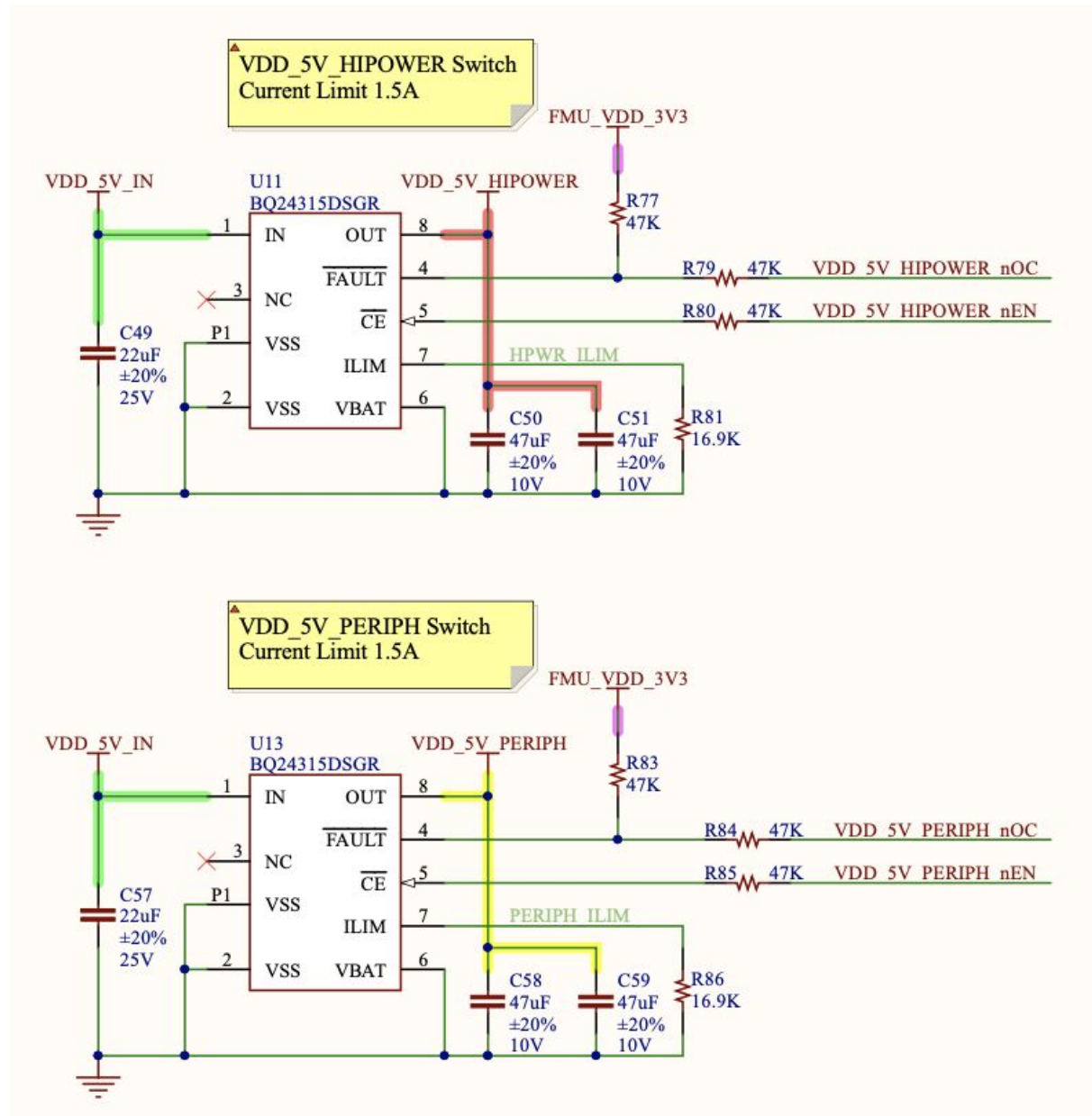
## RC Inputs



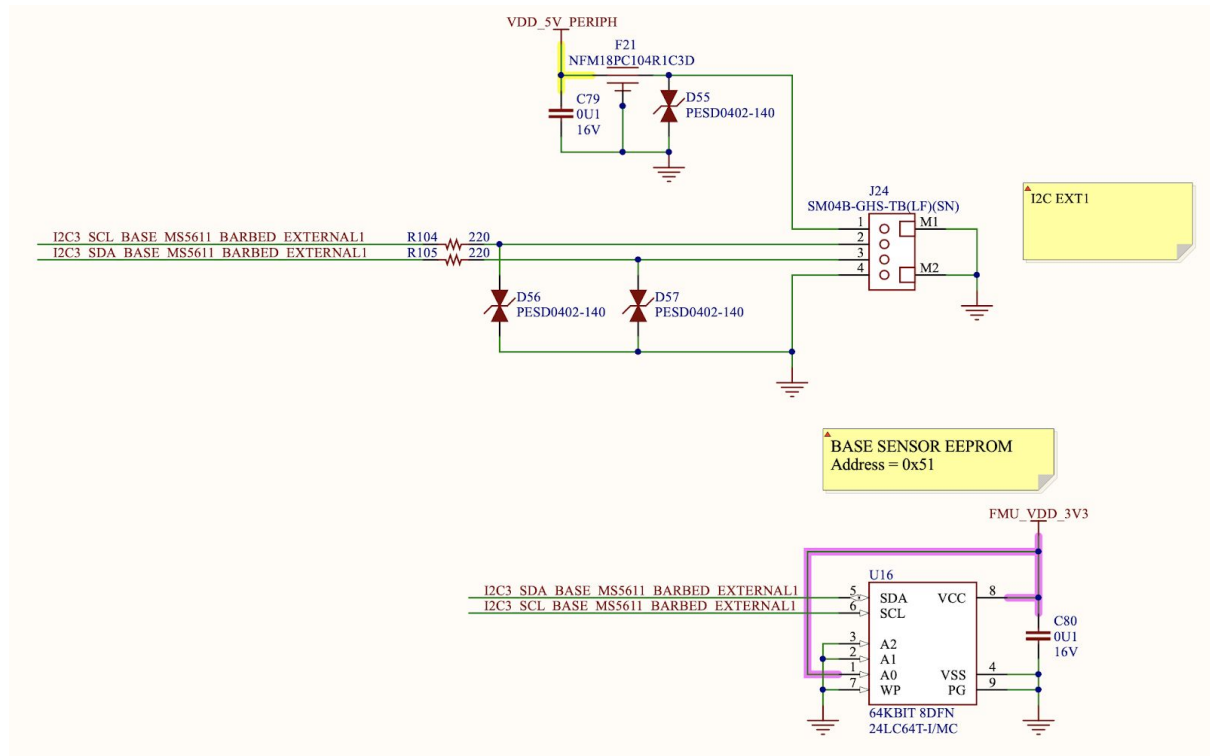
# Powerpath Selector



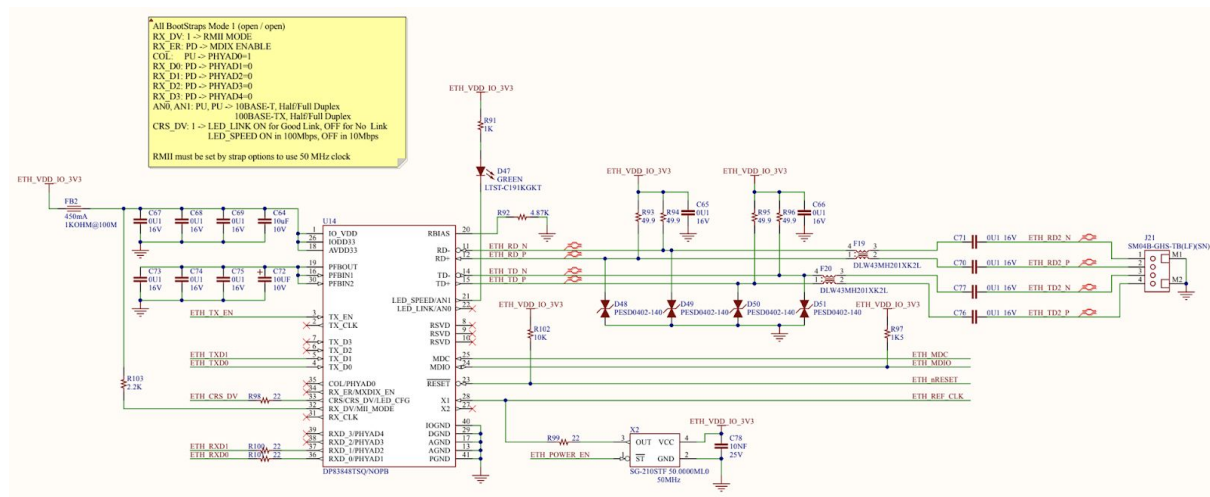
## Peripheral Power Protection



## Baseboard EEPROM and Sensor Connections



## Ethernet Transceiver



## GPS / Audio Interface

