pixhawk®

Pixhawk Autopilot Reference Standard

Revision: 0.2.0
Revision date: Feb 23, 2020

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

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.

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

License and Disclaimer

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, redund. sensors)
- FMUv6: Pixhawk 6 (2019, 400-600 MHz H7)
- FMUv6X: Pixhawk 6X (2020, 400-600 MHz H7, calibrated, redund. sensors)

Interface Standards

- OBSOLETE: Pixhawk connector standards v1 (2011-2015)
  - Connector: Hirose DF13
  - Pinout: Obsolete
- 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

Common External Interfaces

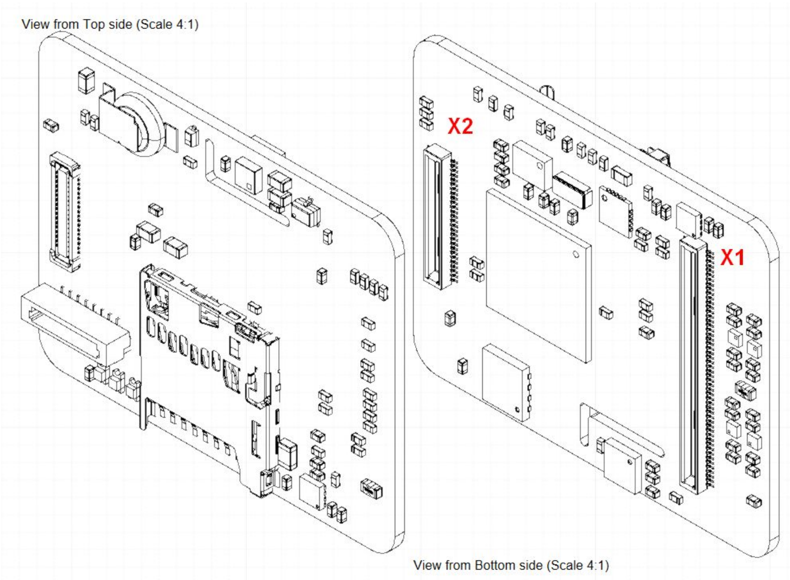
This list describes the mandatory external interfaces.

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

Pixhawk Autopilot Bus (PAB) and Module Standard

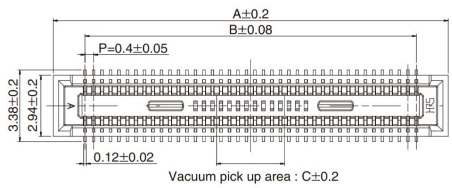
The usage of this bus is mandatory for all System-on-Module designs (SOM). However, if autopilot and baseboard are integrated into one unit, this connector pair (PAB X1 and PAB X2) can be omitted. See the mechanical section for dimensions.

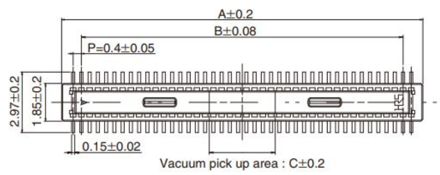
TIP: Leverage the Altium footprint available in the support files folder



Connector X1 (PAB X1)

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

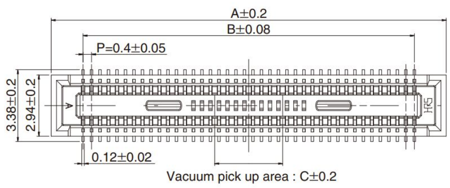
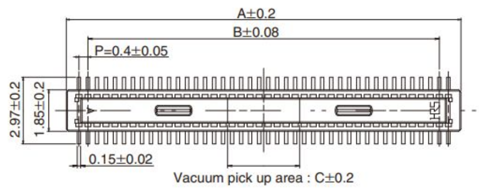
<table>
<tr><th>Side</th><th>Baseboard side (bottom)</th><th>Autopilot side (top)</th></tr>
<tr><td>Part Number</td><td>Hirose DF40HC(3.0)-100DS-0.4V(58)</td><td>Hirose DF40C-100DP-0.4V(51)</td></tr>
<tr><td>Distributors</td><td>DigiKey</td><td>DigiKey</td></tr>
<tr><td>Dimensions</td><td>

A = 22.6mm
B = 19.6mm</td><td>

A = 21.52mm
B = 19.6mm</td></tr>
</table>

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	[Digikey]()	[Digikey]()
Dimensions	 A = 12.6mm B = 9.6mm	 A = 11.52mm B = 9.6mm

X1 Pinout

Mandatory main bus with the critical Pixhawk interfaces.

2	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

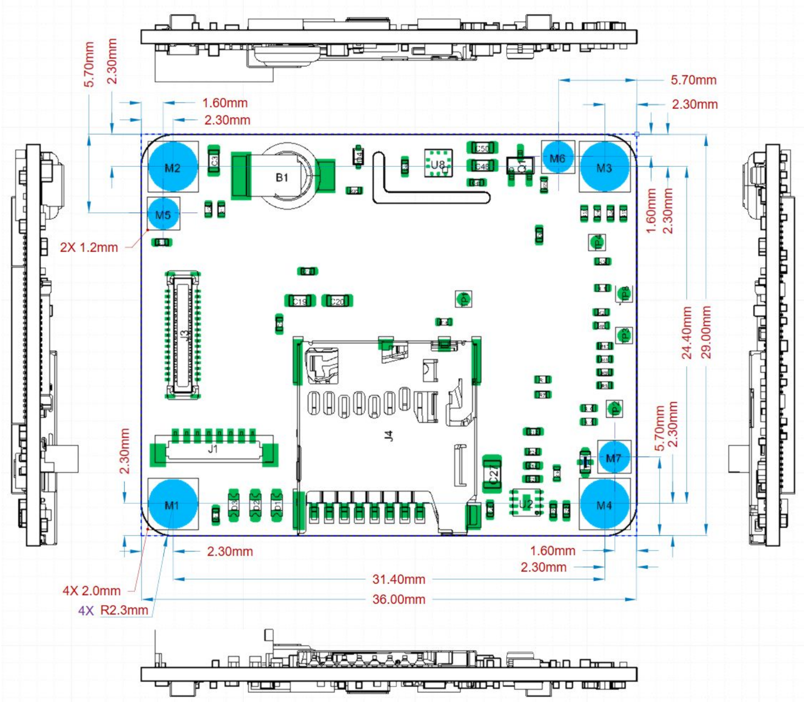
X2 Pinout

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

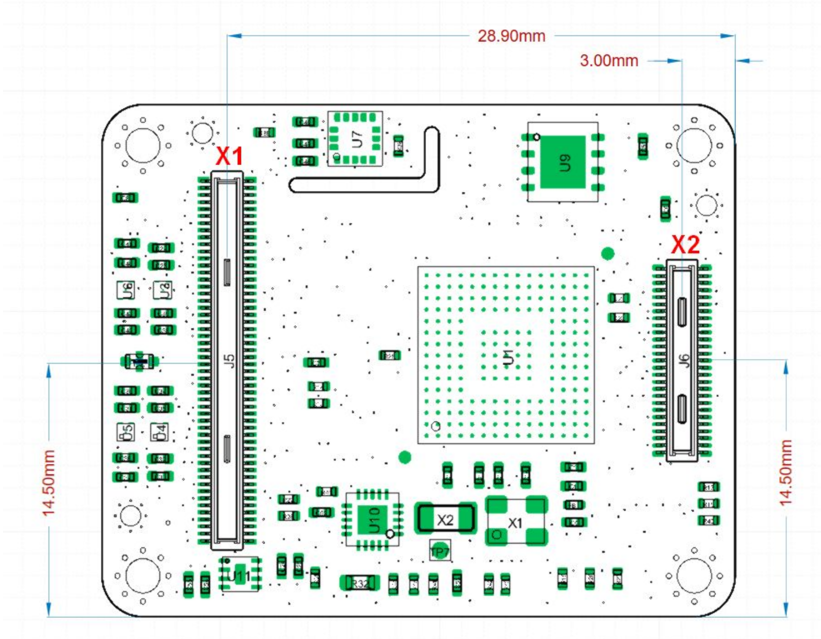
GND (Pin 1)	1	2	ETH_MDIO
ETH_REF_CLK	3	4	ETH_MDC
GND	5	6	ETH_POWER_EN
ETH_CRS_DV	7	8	GND
GND	9	10	SPARE01
ETH_RXD0	11	12	SPARE02
GND	13	14	SPARE03
ETH_RXD1	15	16	SPARE04
GND	17	18	SPARE05
ETH_TXD0	19	20	SPARE06
GND	21	22	SPARE07
ETH_TXD1	23	24	SPARE08
GND	25	26	SPARE09
ETH_TX_EN	27	28	SPARE10
GND	29	30	SPARE11
SPI6_MISO_EXTERNAL1	31	32	SPARE12
SPI6_MOSI_EXTERNAL1	33	34	SPARE13
SPI6_SCK_EXTERNAL1 (SWO)	35	36	SPARE14
GND	37	38	SPARE15
SPI6_nRESET_EXTERNAL1	39	40	SPARE16
SPI6_nCS1_EXTERNAL1	41	42	SPARE17
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

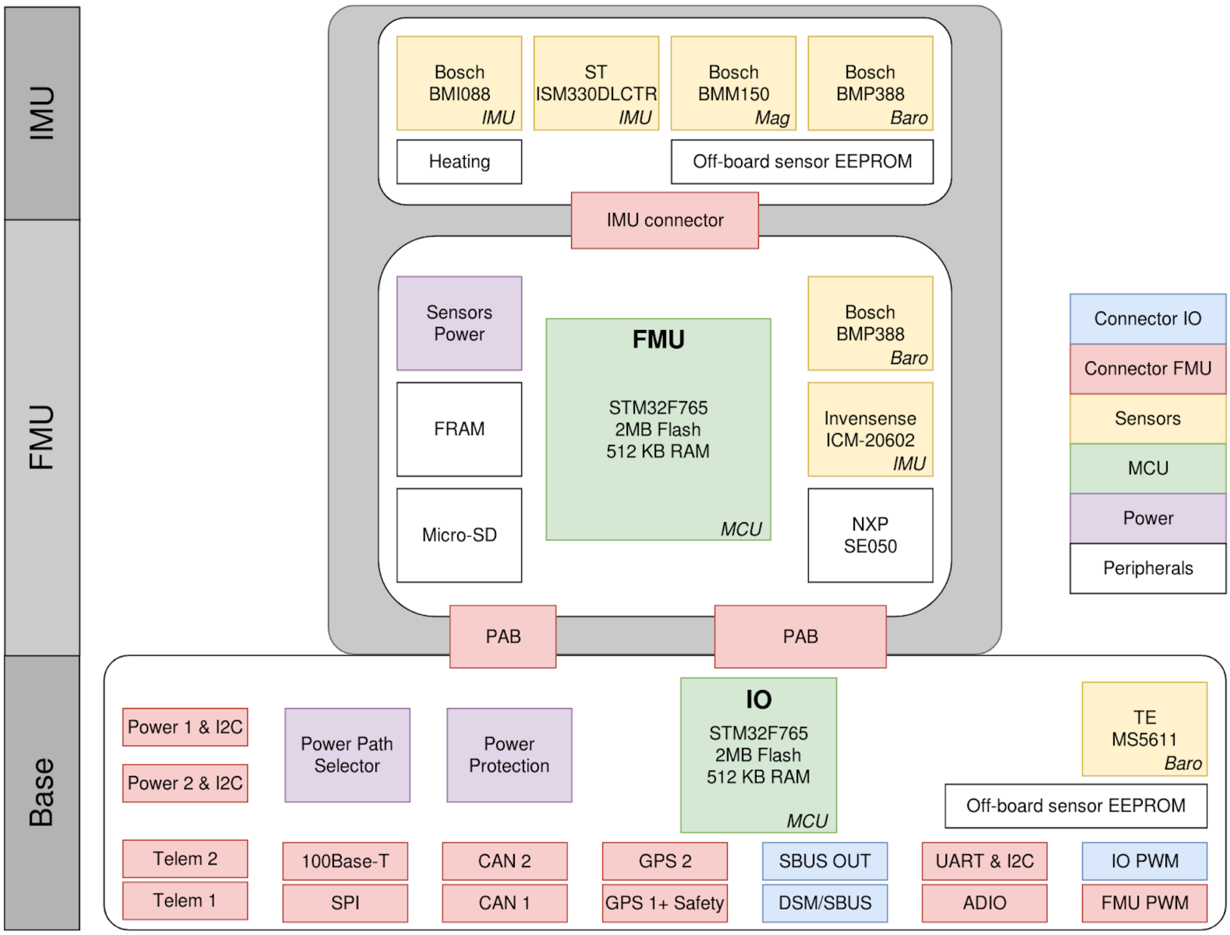


PCB Layout Guidelines

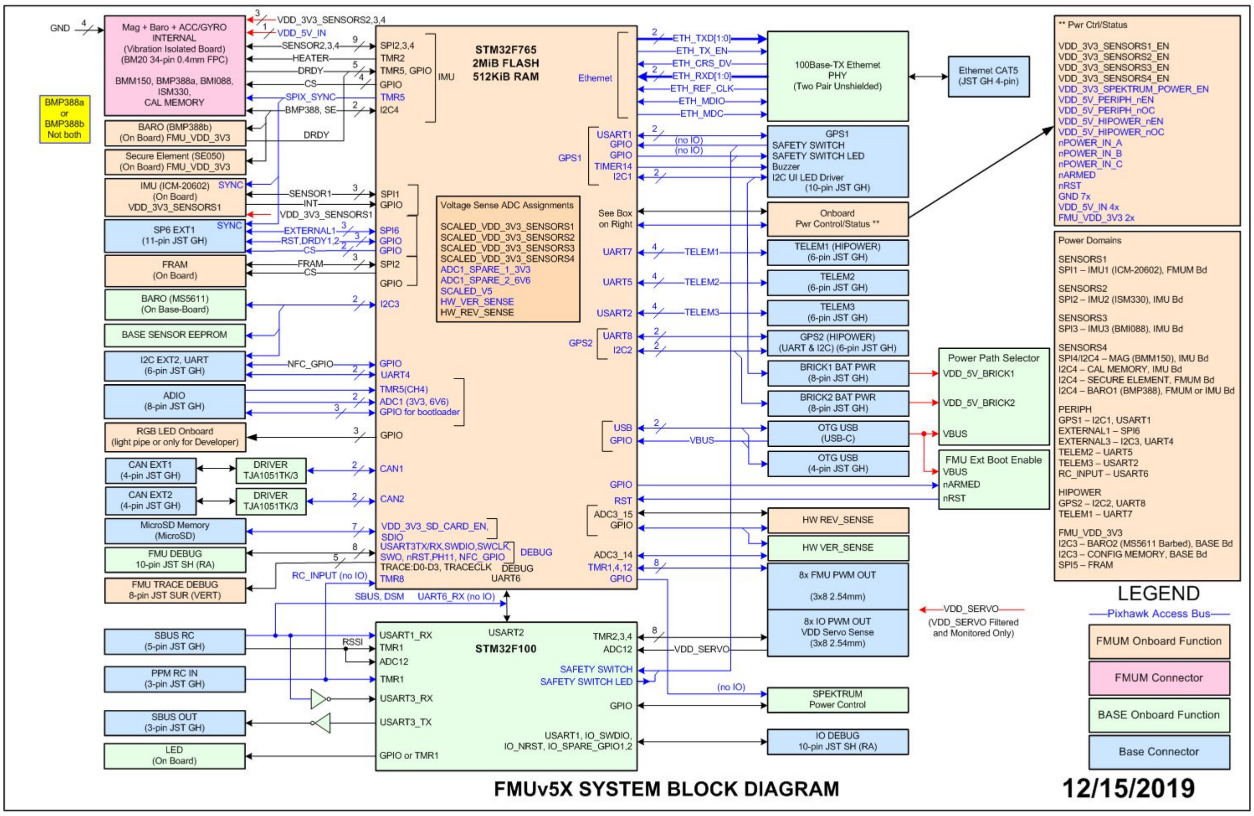
- The base board should be impedance controlled with 50 ohms single ended, 90 ohms differential for USB, and 100 ohms differential for Ethernet.
- Impedance controlled signal traces should not be routed such that they cross a split in their respective reference planes. A signal crossing a plane split 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_CRS_DV, 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 with 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

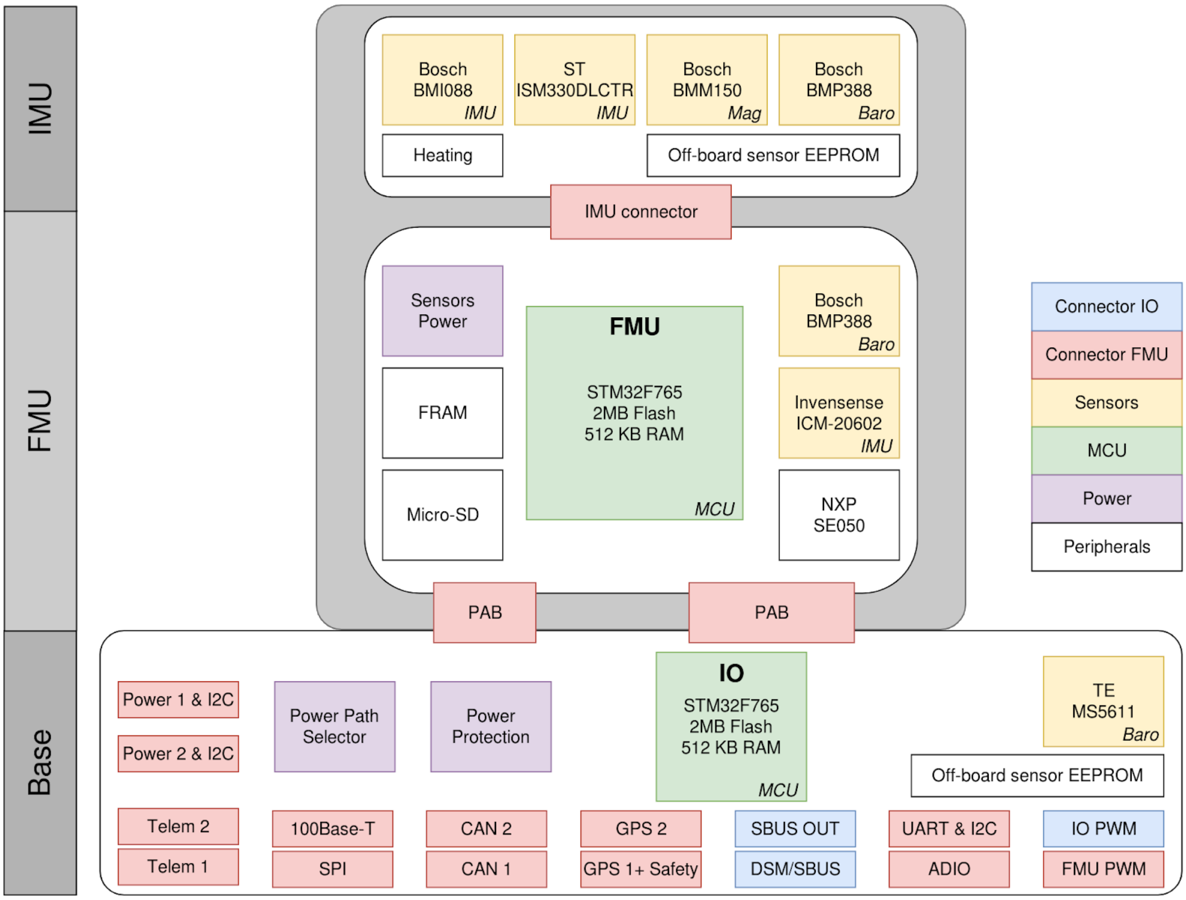
25	PB	9	UART5_TX	V	UART5_TX_TELEM2
26	PB	10	TIM2_CH3	T	HEATER
27	PB	11	ETH_TX_EN	E	ETH_TX_EN
28	PB	12	CAN2_RX	C	CAN2_RX
29	PB	13	ETH_TXD1	E	ETH_TXD1
30	PB	14	USART1_TX	U	USART1_TX_GPS1
31	PB	15	USART1_RX	U	USART1_RX_GPS1
32	PC	0	ADC1_IN10	A	ADC1_6V6
33	PC	1	ETH_MDC	E	ETH_MDC
34	PC	2	ADC1_IN12	A	SCALED_VDD_3V3_SENSORS4
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_nOC
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_nOC
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.

Detailed Block Diagram

UNDER DRAFT

The FMUv6X generation brings the proven features from FMUv6 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.
    - IMU1 (XXXXXXXX, TBD) (SPI4, redundancy domain #1, vibration isolated)
    - Invensense ICM-XXXXX (TBD) (SPI1, redundancy domain #2)
    - IMU3 (XXXXXXXX, TBD) (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 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

Autopilot Design (FMUv5X, FMUv6X)

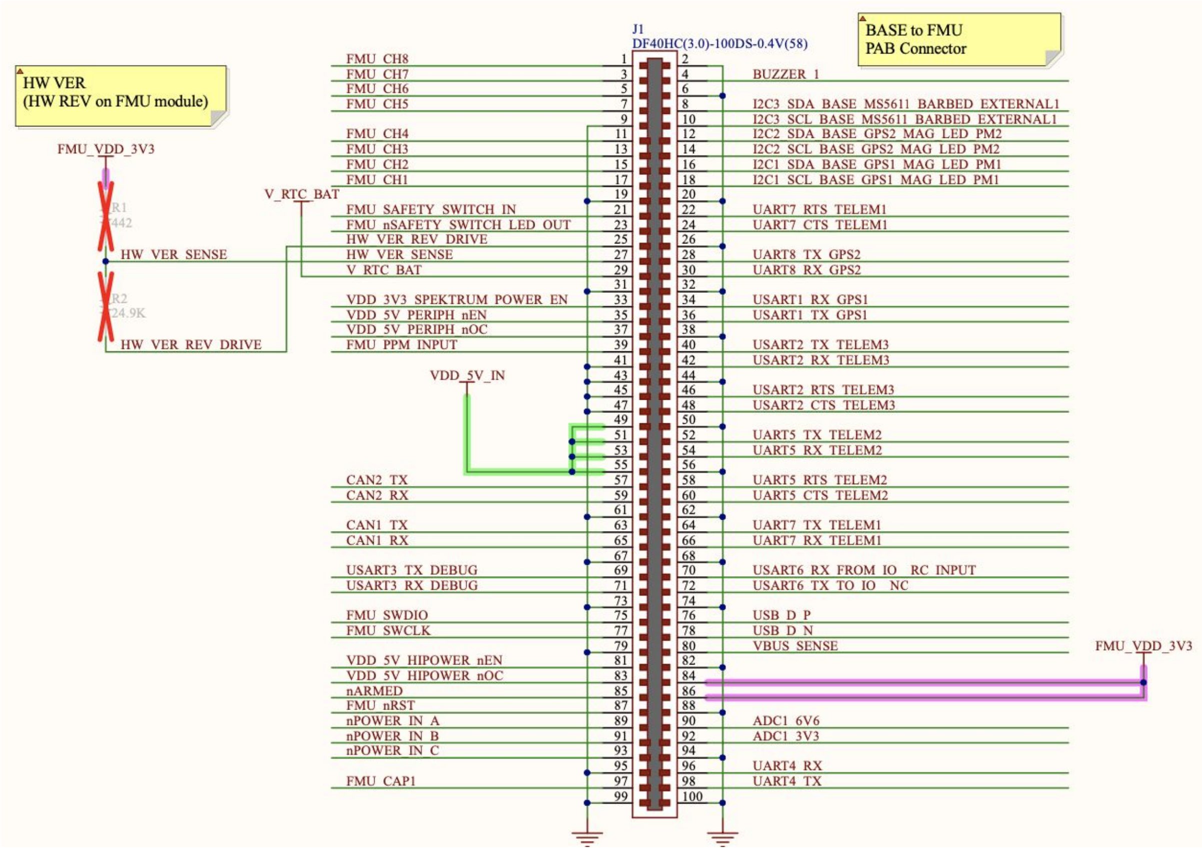
This section explains the core autopilot schematic.

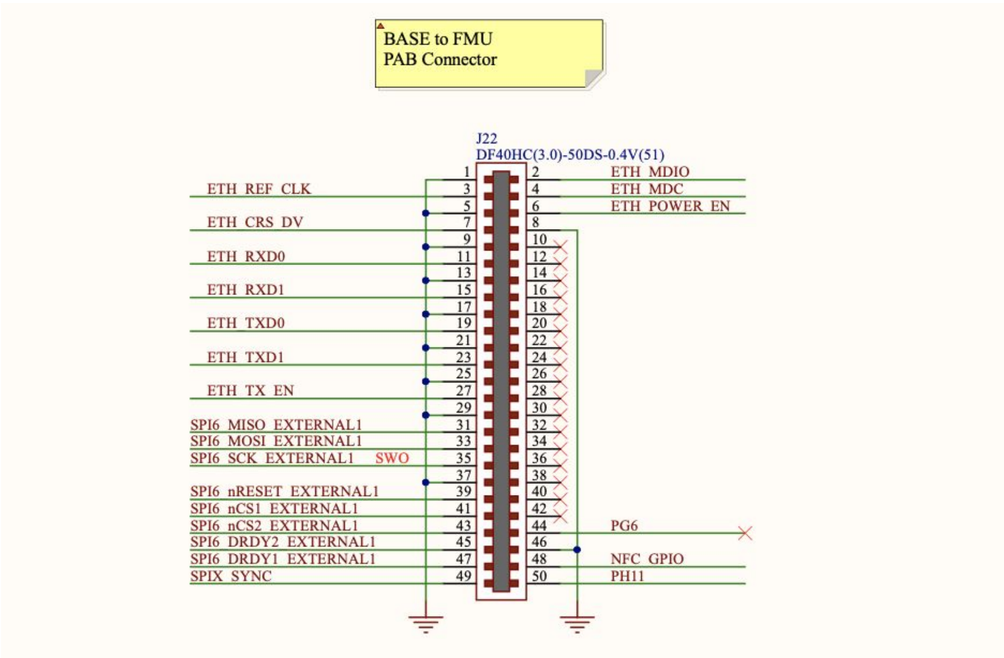
Baseboard Design Examples (FMUv5X, FMUv6X)

The design examples in this section have been proven as part of a reference design and are offered for convenience.

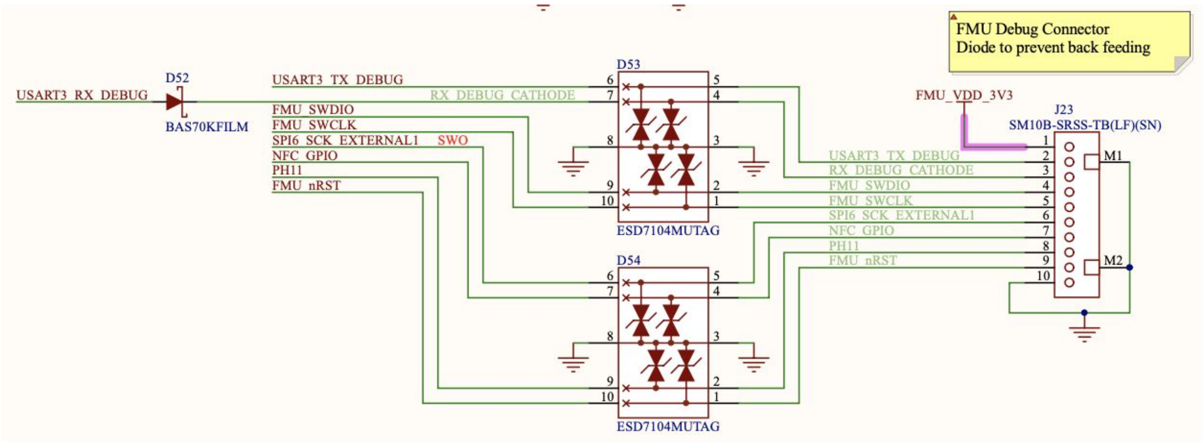
The design examples are not part of the formal specification and implementing the board differently is permitted. They serve as a baseline to ensure successful adoption of the standard.

Base to FMU Connectors (X1, X2)

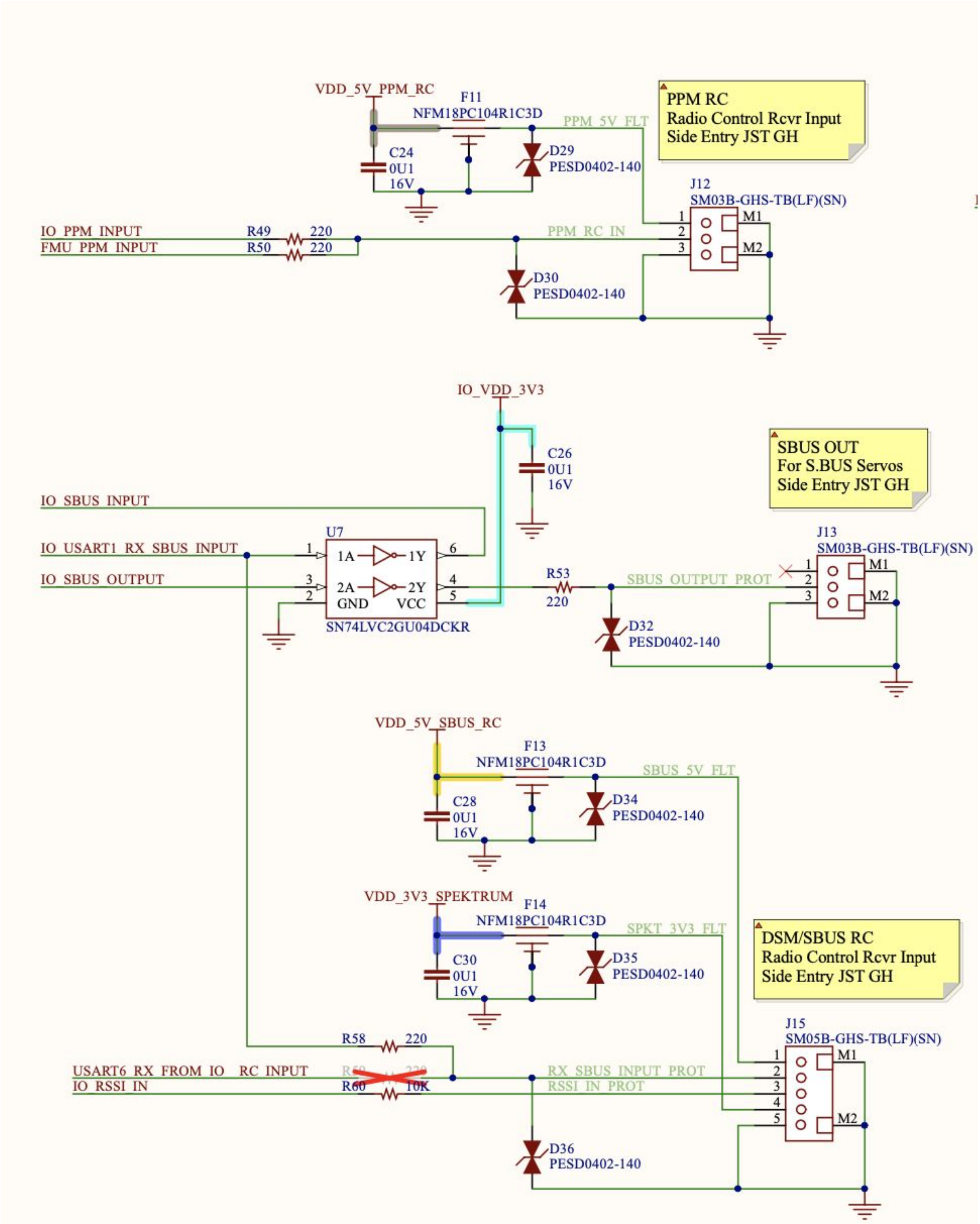




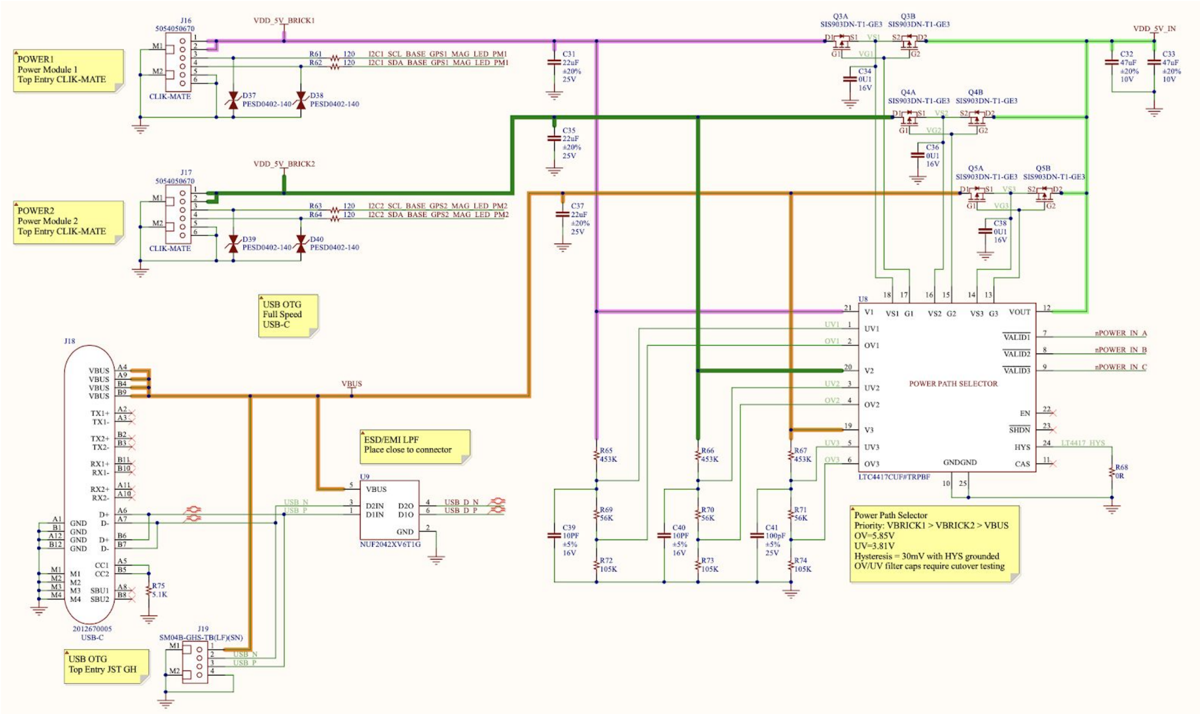
FMU Debug Connector



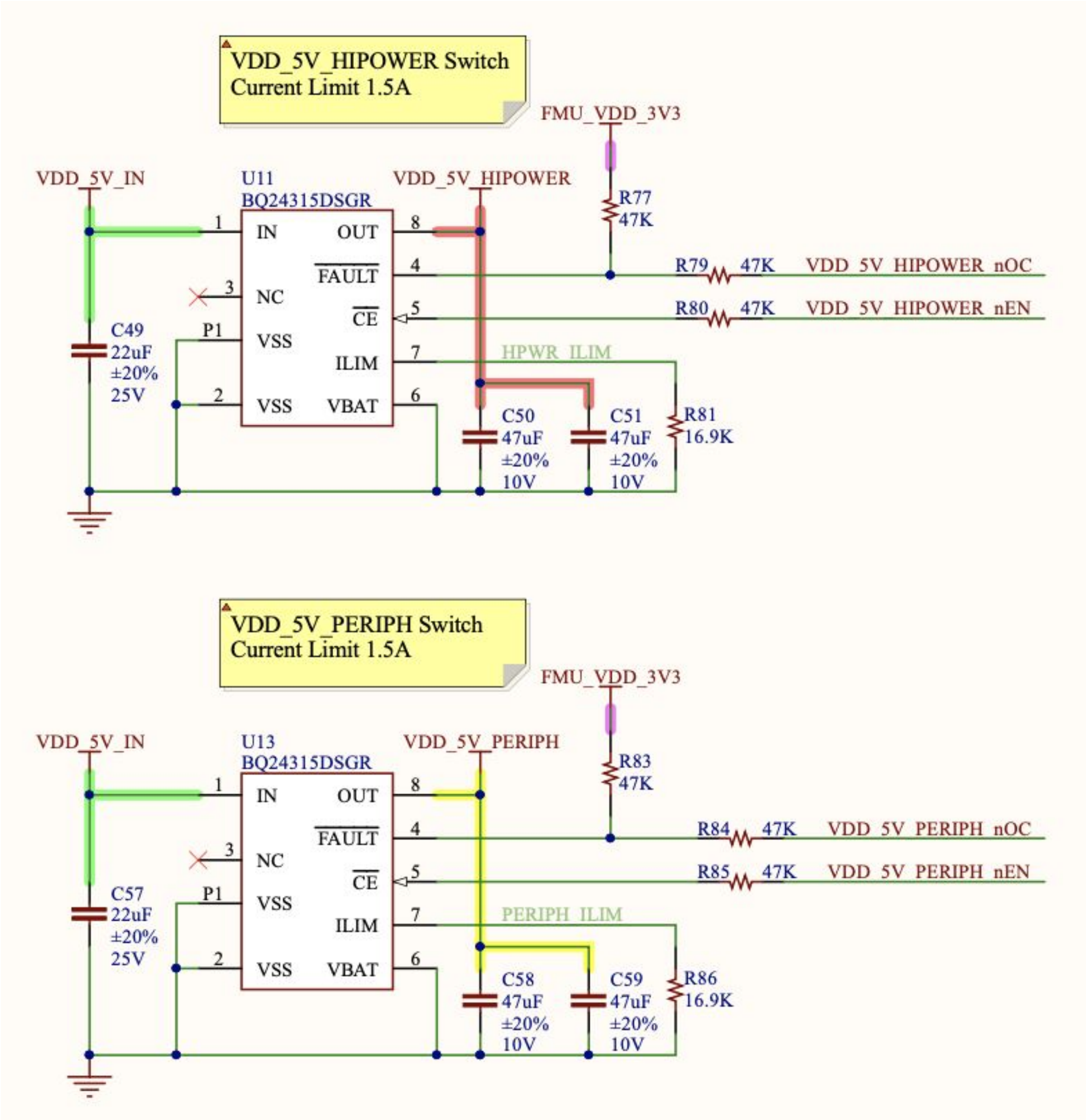
RC Inputs


VDD_5V_PPM_RC
F11
NFM18PC104R1C3D
PPM_5V_FLT
PPM RC
Radio Control Rcvr Input
Side Entry JST GH
C24
0U1
16V
D29
PESD0402-140
J12
SM03B-GHS-TB(LF)(SN)
IO_PPM_INPUT
FMU_PPM_INPUT
R49 220
R50 220
PPM_RC_IN
D30
PESD0402-140
IO_VDD_3V3
C26
0U1
16V
SBUS OUT
For S.BUS Servos
Side Entry JST GH
IO_SBUS_INPUT
U7
IO_USART1_RX_SBUS_INPUT
IO_SBUS_OUTPUT
1A
1Y
2A
2Y
GND
VCC
SN74LVC2GU04DCKR
R53
220
SBUS_OUTPUT_PROT
J13
SM03B-GHS-TB(LF)(SN)
D32
PESD0402-140
VDD_5V_SBUS_RC
F13
NFM18PC104R1C3D
SBUS_5V_FLT
C28
0U1
16V
D34
PESD0402-140
VDD_3V3_SPEKTRUM
F14
NFM18PC104R1C3D
SPKT_3V3_FLT
C30
0U1
16V
D35
PESD0402-140
DSM/SBUS RC
Radio Control Rcvr Input
Side Entry JST GH
J15
SM05B-GHS-TB(LF)(SN)
R58 220
USART6_RX_FROM_IO__RC_INPUT
IO_RSSI_IN
R60 10K
RX_SBUS_INPUT_PROT
RSSI_IN_PROT
D36
PESD0402-140

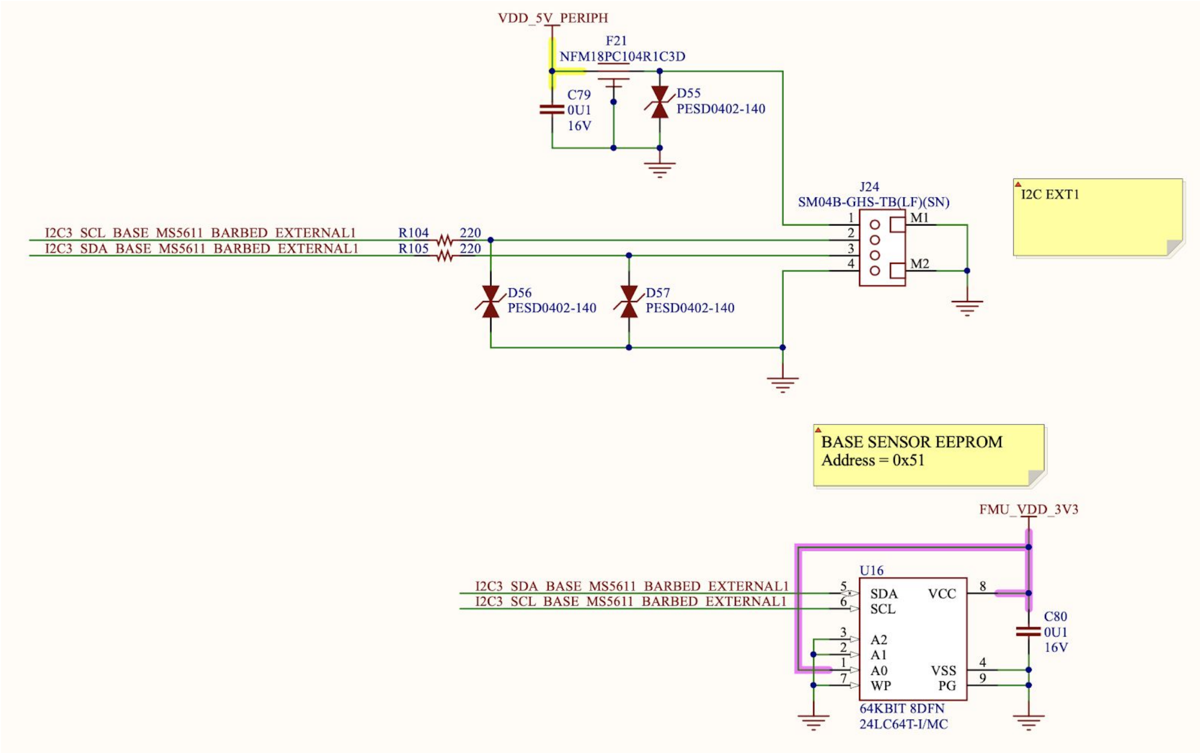
Powerpath Selector



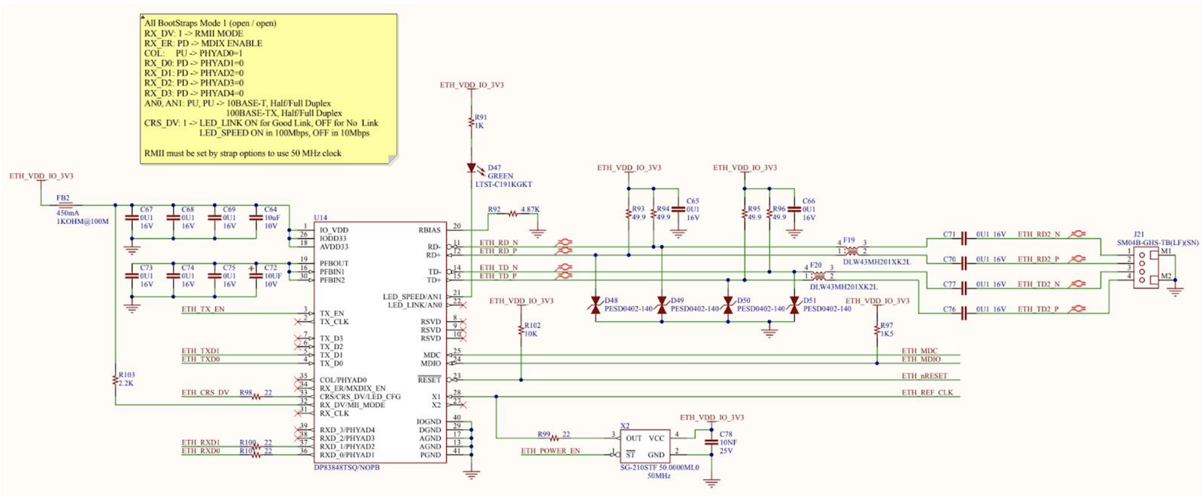
Peripheral Power Protection



Baseboard EEPROM and Sensor Connections



Ethernet Transceiver



GPS / Audio Interface