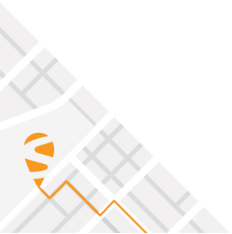




# **AsteRx-i3 Product Group Hardware Manual**

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Version 1.0.0



AsteRx-i3 Product Group Hardware Manual

Version 1.0.0

April 9, 2021

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Septentrio  
Greenhill Campus, Interleuvenlaan 15i  
3001 Leuven, Belgium

<http://www.septentrio.com>

Phone: +32 16 300 800

Fax: +32 16 221 640



@septentrio

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## ROHS/WEEE NOTICE

Septentrio receivers are compliant with the latest WEEE, RoHS and REACH directives. For more info see [www.septentrio.com/en/environmental-compliance](http://www.septentrio.com/en/environmental-compliance).



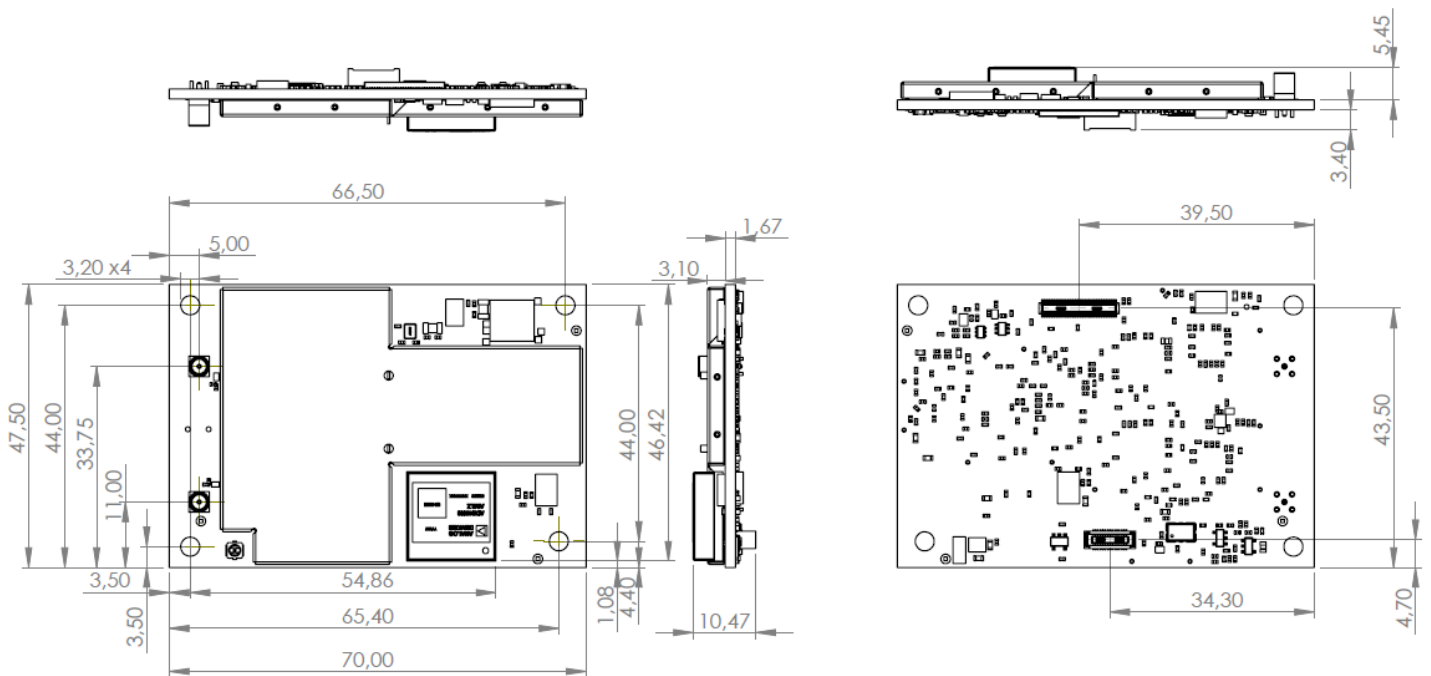
## ESD PRECAUTIONS

The OEM module is sensitive to electrostatic discharge (ESD). Although it has a limited protection, it should only be manipulated in an ESD-safe environment and using ESD-safe tools and equipment. These tools are typically marked with the following symbol:



## 2 AsteRx-i3 D OEM & AsteRx-i3 S OEM

### 2.1 AsteRx-i3 D OEM

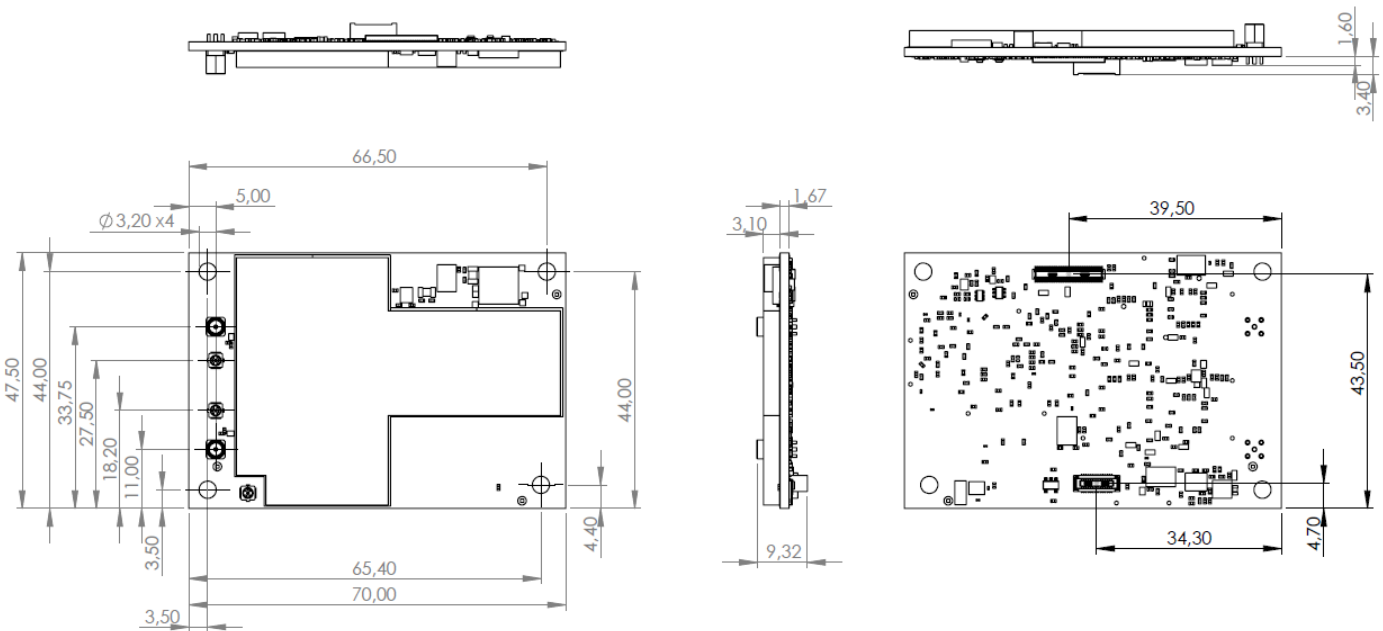
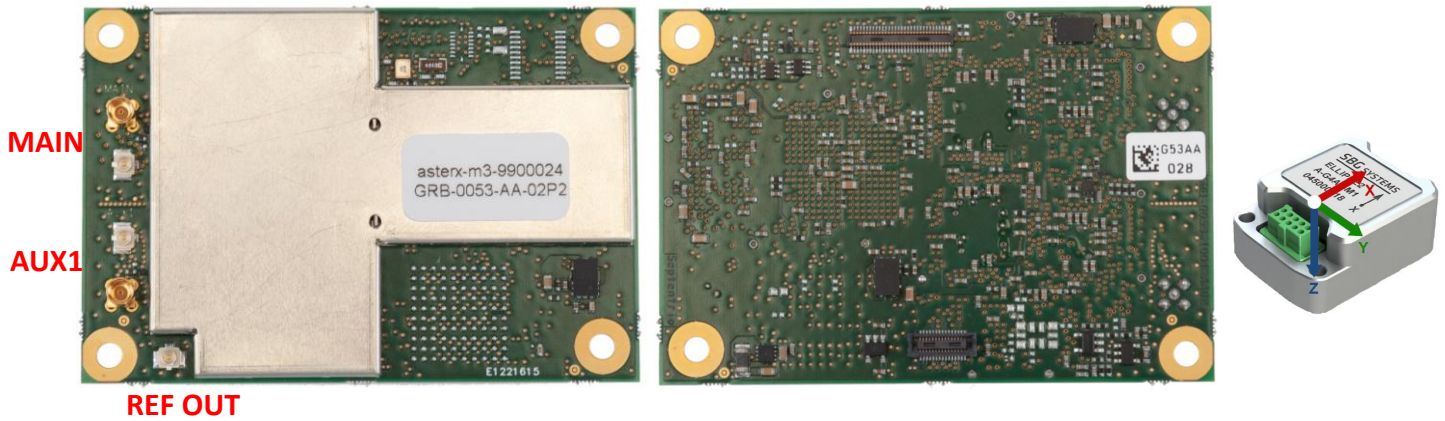


All dimensions in millimeters.

Weight = 29 g

## 2.2 AsteRx-i3 S OEM

The AsteRx-i3 S OEM board has the same dimensions and connectors as the AsteRx-i3 D OEM board, but it does not incorporate the ADIS IMU. It is designed to operate with an external SBG Ellipse IMU (see chapter 3).



All dimensions in millimeters.

Weight = 27 g

Note: the above pictures and mechanical diagrams show both u.FL and MMCX antenna connectors. In reality, only one type of connector is available depending on the board variant.

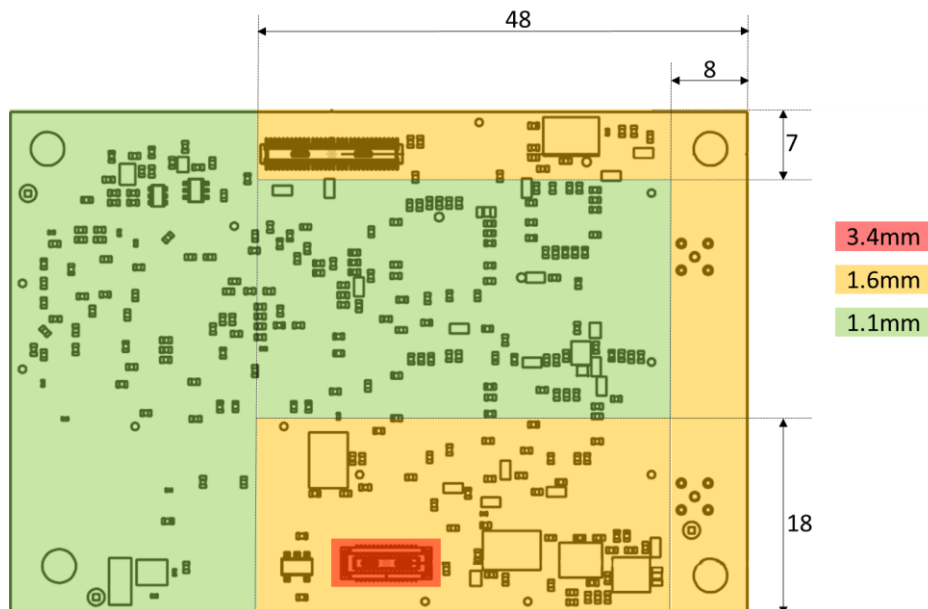
## 2.3 Mounting

RF connectors (u.FL or MMCX type) are mounted on top side of the PCB. The 30- and 60-pin Hirose I/O connectors are mounted on the bottom side.

The four mounting holes are compatible with M3 screws. Use M3 3.5mm spacers. An example of applicable SMD spacer is THF-1.6-3.5-M3 from MAC8.

All mounting holes are grounded, and should preferably be connected to ground on the host PCB. Note however that the mounting holes should not be relied on as only ground return connection: a proper ground should be supplied to the GND pins of the I/O connector(s) as well.

The maximum height of the components at the bottom side of the AsteRx-i3 OEM board is within the mask shown below (applicable to both AsteRx-i3 D OEM and AsteRx-i3 S OEM). The maximum component height is 1.1mm in the green area and 1.6mm in the yellow area.



## 2.4 Environmental

Operational:

AsteRx-i3 D OEM : -40 to +85 °C

AsteRx-i3 S OEM + Ellipse2 : -20 to +85 °C

Storage: -55 to +85 °C



## 2.5 Power and Power Consumption

The board is powered through pin#1 and pin#2 of the 30-pin connector. Power supply voltage must be 3.3V +/-5%.

The power consumption depends on the set of GNSS signals enabled with the **setSignalTracking** command.

The following table shows the typical power consumption for selected sets of signals. The dual antenna configuration corresponds to a receiver where the option to track from the AUX1 antenna is enabled.

### AsteRx-i3 D OEM:

Signals enabled with <b>setSignalTracking</b>	Power consumption	
	Dual antenna	Single antenna
GPS L1+L2, GLO L1+L2	1.35 W	1.00 W
All GNSS signals from all GNSS constellations	1.80 W	1.20 W

### AsteRx-i3 S OEM excluding SBG IMU (add 400mW to include it):

Signals enabled with <b>setSignalTracking</b>	Power consumption	
	Dual antenna	Single antenna
GPS L1+L2, GLO L1+L2	1.15 W	0.80 W
All GNSS signals from all GNSS constellations	1.60 W	1.00 W

Enabling the built-in L-Band demodulator with the **setLBandSelectMode** command adds 100 mW.

Enabling wideband interference mitigation with the **setWBIMitigation** command adds 160 mW (dual antenna) or 80mW (single antenna).

Consumption in standby mode:                      3 mW

Note that the power consumption in the above table are average values. To account for peak currents, the minimum power supply drive capability should be 1 Ampere.

## 2.6 RF Interface



For illustration purposes, the above picture shows both u.FL and MMCX connectors. In reality, only one type of connector is available depending on the board variant.

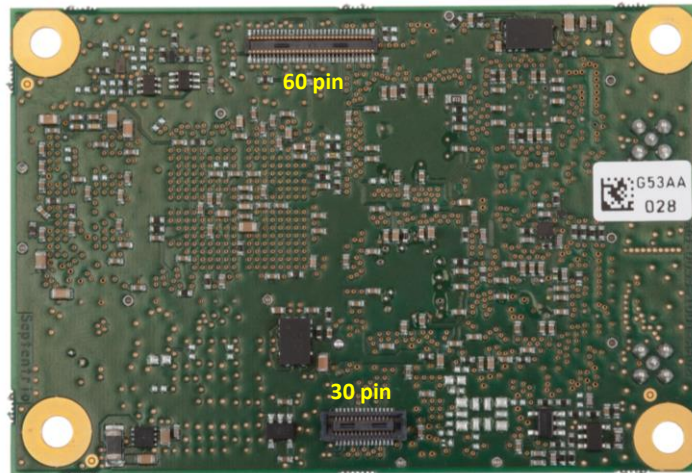
The main antenna must be connected to the u.FL or MMCX connector marked “MAIN” on the PCB and the auxiliary antenna must be connected to the AUX1 connector.

## 2.6.1 Electrical Specifications

Antenna supply voltage	3-5.5V DC, set via pin#18 of the 30-pin connector. The same voltage is applied to both antennas. If pin#18 is not connected, there is no DC voltage to the antennas.
DC series impedance	2.7 Ohms
Antenna current limit	150 mA per antenna
Antenna net gain range <sup>1</sup>	15-50 dB For optimal performances, the net gain on MAIN and AUX1 must not differ by more than 10dB.
Receiver noise figure	10 dB (with 15-dB net gain) The receiver noise figure increases as the net gain increases, but its contribution to the system noise figure decreases. The worse case is for a net gain of 15dB.
RF nominal input impedance	50 Ohms
VSWR	< 2.5:1 in 1200-1251 MHz and 1560-1610 MHz range

<sup>1</sup> The net gain is the total pre-amplification of the distribution network in front of the receiver. Typically, this equals antenna active LNA gain minus coax losses in the applicable GNSS bands.

## 2.7 I/O Connectors



The main connector is the 30-pin connector. That connector must always be connected.

The 60-pin connector provides additional signals (IO enable, serial CTS/RTS lines, GPIOs, Ethernet, 10-MHz reference input, etc). That connector can be ignored and left unconnected if these signals are not needed.

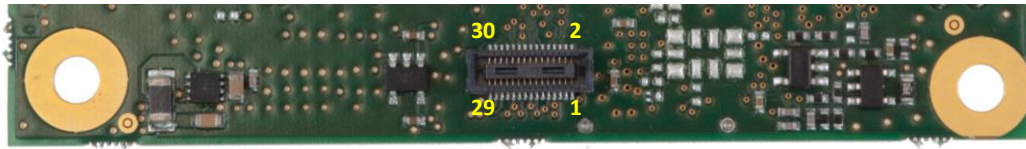
### Warnings

- All ground pins must be connected (not applicable to the 60-pin connector if that connector is not used).
- Do not drive a non-zero voltage into input pins (pins type “I” in the tables below) when the receiver is not powered. In addition, if standby mode is applicable, input pins must remain in high-Z when the IO\_EN signal is not set. See section 2.11 for details.
- When pull-up/down resistors are needed, use 10 k $\Omega$ .
- Unused or reserved pins should be left unconnected unless explicitly mentioned otherwise.

### Conventions

- Pin Type: I=Input, O=Output, P=Power, Ctrl=Control, Clk=Reference clock
- LVTTL=3V3 Low Voltage TTL:  $V_L \leq 0.8V$ ,  $V_H \geq 2.0V$ ,  $VO_L \leq 0.4V$ ,  $VO_H \geq 2.4V$ .
- PU: internally pulled up
- PD: internally pulled down
- K: keeper input type

## 2.7.1 30-pin Connector



Connector type: Hirose 30 pins DF40HC (3.5)-30DS-0.4V(51)

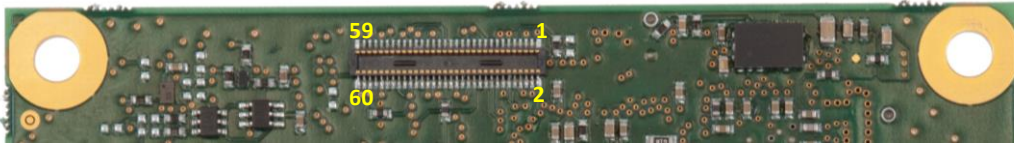
Mating connector: Hirose DF40C-30DP-0.4V(51)

See the pin numbering convention in the above picture.

Pin#	Name	Type	Level	Description	Comment
1	Vin	P	3.3V +/-5%	Main power supply input	Both Vin pins (pin#1 and pin#2) must be tied together.
3	GND	Gnd	0	Ground.	
5	USB_D+	I/O	USB	USB data signal positive D+.	
7	USB_Vbus	Ctrl	4.40V $\leq V \leq$ 5.25V	USB VBUS.  ⚠️ This pin cannot be used to power the receiver! ⚠️ Mandatory if USB is used.	See section 2.13
9	TX1	O	LVTTTL	Serial COM 1 transmit line (inactive state is high)	
11	GND	Gnd	0	Ground.	
13	TX2	O	LVTTTL	Serial COM 2 transmit line (inactive state is high)	
15	TX3	O	LVTTTL	Serial COM 3 transmit line (inactive state is high)	
17	GND	Gnd	0	Ground.	
19	EventA	I, PD	LVTTTL	Event A input.	See section 2.9
21	Reserved			Reserved	
23	GND	Gnd	0	Ground.	
25	Button	I, K	LVTTTL	Input can be connected to a push button used to control SD card logging. Low state is interpreted as "button pressed".	Debouncing must be done externally (no debouncing circuit on board). See also section 2.12.
27	LOGLED	O	LVTTTL	Internal logging status indicator. Max output current: 10 mA; output impedance: 20 Ohms	See Appendix A
29	GND	Gnd	0	Ground.	

Pin#	Name	Type	Level	Description	Comment
2	Vin	P	3.3V +/-5%	Main power supply input	Both Vin pins (pin#1 and pin#2) must be tied together.
4	GND	Gnd	0	Ground.	
6	USB_D-	I/O	USB	USB data signal negative D-.	
8	nRST	Ctrl,PU	LVTTTL	Reset input, active negative. Receiver resets when driven low.	
10	RX1	I, K	LVTTTL	Serial COM 1 receive line (inactive state is high).	
12	PPSout	O	LVTTTL	PPS output. Output impedance: 50 ohms. Output current: 24 mA. Polarity and rate user selectable. During start up, this pin is pulled low with a 100-kOhm resistor. See Reference Guide for operating instructions. Pulse duration controllable with the <b>setPPSParameters</b> command (default: 5ms).	
14	RX2	I, K	LVTTTL	Serial COM 2 receive line (inactive state is high).	
16	RX3	I, K	LVTTTL	Serial COM 3 receive line (inactive state is high).	
18	VANT	P	3< VANT < 5.5V	Antenna supply.	See section 2.6.1
20	nPDN	Ctrl,PU	LVTTTL	Receiver is put in standby mode (low power mode) when driven low. Normal operation resumes when the pin level is high.	
22	GPLED	O	LVTTTL	General purpose LED. Max output current: 10 mA; output impedance: 20 Ohms	See Appendix A
24	Reserved				
26	SD_CLK	O	LVTTTL	SD card CLK line	See section 2.12
28	SD_CMD	O	LVTTTL	SD card CMD line	See section 2.12
30	SD_DAT0	I/O	LVTTTL	SD card DAT0 line	See section 2.12

## 2.7.2 60-pin connector



Connector type: Hirose DF40C-60DP-04V(51)

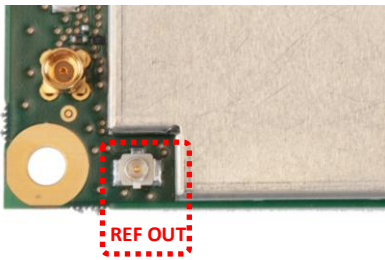
Mating connector: Hirose DF40HC(3.5)-60DS-0.4V(51)

See the pin numbering convention in the above picture.

Pin#	Name	Type	Level	Description	Comment
1	Reserved				
3	Reserved				
5	Reserved				
7	Reserved				
9	GP1	O	LVTTTL	General purpose output. GP1 in <b>setGPIOFunctionality</b> command.	See section 2.10
11	RTS2	O	LVTTTL	Serial COM2 RTS line. The AsteRx-i3 OEM drives this pin low when ready to receive data.	
13	RTS3	O	LVTTTL	Serial COM3 RTS line. The AsteRx-i3 OEM drives this pin low when ready to receive data.	
15	TX4	O	LVTTTL	Serial COM 4 transmit line (inactive state is high)	
17	Reserved				
19	Reserved				
21	Reserved				
23	Reserved				
25	Reserved				
27	Reserved				
29	GND	Gnd		Ground	
31	RMII_TXEN	O	LVTTTL	LAN PHY transmit enable	See section 2.14
33	RMII_TXD1	O	LVTTTL	LAN PHY transmit data 1	See section 2.14
35	RMII_CRSDV	I	LVTTTL	LAN PHY CRS	See section 2.14
37	RMII_RXER	I	LVTTTL	LAN PHY RX error	See section 2.14
39	Reserved				
41	Reserved				
43	Reserved				
45	Reserved				
47	Reserved				
49	Reserved				
51	Reserved				
53	Reserved				
55	Reserved				
57	EventB	I,PD	LVTTTL	Event B input.	See section 2.9
59	IO_EN	O	LVTTTL	Level is high when board is in normal operating conditions and it is safe to drive the input pins (see also warnings in section 2.11). This pin becomes high no later than 300 ms after power up or wake up from standby.	

Pin#	Name	Type	Level	Description	Comment
2	Reserved				
4	GND	Gnd		Ground	
6	Reserved				
8	GND	Gnd		Ground	
10	Reserved				
12	CTS2	I, K	LVTTTL	Serial COM 2 CTS line. Must be driven low when ready to receive data from the AsteRx-i3 OEM.	
14	CTS3	I, K	LVTTTL	Serial COM 3 CTS line. Must be driven low when ready to receive data from the AsteRx-i3 OEM.	
16	RX4	I, K	LVTTTL	Serial COM 4 receive line (inactive state is high).	
18	GND	Gnd		Ground	
20	Reserved				
22	Reserved				
24	Reserved				
26	Reserved				
28	Reserved				
30	GND	Gnd		Ground	
32	RMII_CLK	O	LVTTTL	LAN PHY Clock	See section 2.14
34	RMII_TXD0	O	LVTTTL	LAN PHY transmit data 0	See section 2.14
36	GND	Gnd		Ground	
38	RMII_RXD0	I	LVTTTL	LAN PHY receive data 0	See section 2.14
40	RMII_RXD1	I	LVTTTL	LAN PHY receive data 1	See section 2.14
42	GND	Gnd		Ground	
44	GP2	O	LVTTTL	General purpose output. GP2 in <b>setGPIOFunctionality</b> command.	See section 2.10
46	Reserved				
48	Reserved				
50	GND	Gnd		Ground	
52	Reserved				
54	MDIO	I/O	LVTTTL	LAN PHY control data	See section 2.14
56	MDC	O	LVTTTL	LAN PHY control clock	See section 2.14
58	GND	Gnd		Ground	
60	Reserved				

## 2.8 Frequency Reference Output (REF OUT)



The frequency reference used by the receiver is available at the REFOUT u.FL connector. This is a 10MHz square wave, 0 - 2.8V, output impedance 50Ohms.

## 2.9 Event/TimeSync Inputs

The receiver features two event inputs (EventA on the 30-pin connector, and EventB on the 60-pin connector), which can be used to time tag external events with a time resolution of 20ns. Use the **setEventParameters** command to configure these pins (e.g. to set the polarity). Note that this feature requires the TimedEvent permission to be enabled in the receiver.

## 2.10 General Purpose Output (GPx)

The GP1 and GP2 pins of the 60-pin connector are general purpose LVTTTL digital outputs, of which the level can be programmed with the **setGPIOFunctionality** command.

During the first seconds after powering up the board, these pins are in tristate. Use an external pull-down or pull-up resistor to have the desired level during boot.

The GPx pins can drive a maximum current of 10mA.

## 2.11 Standby Mode

In standby mode, all receiver functions are turned off and the power consumption is significantly reduced (see section 2.5). There are two ways to enter standby mode:

1. By driving the nPDN pin low (pin#20 of the 30-pin connector). The receiver wakes up when the nPDN pin level is high again (there is an internal pull-up).
2. By entering the "**exePowerMode, StandBy**" user command. To wake up, the nPDN pin should be shortly driven low (at least for 50ms).

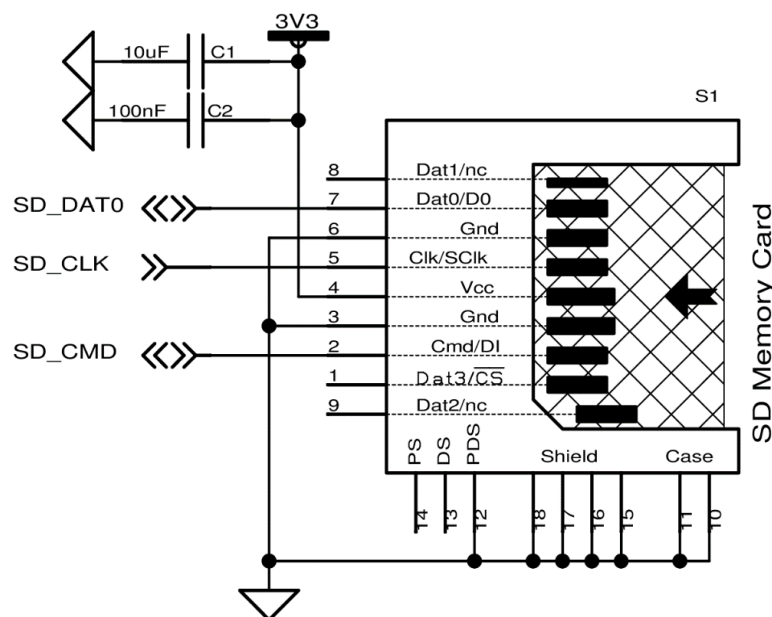
It is also possible to schedule automatic standby/wakeup periods using the **setWakeUpInterval** command.

Note that entering standby mode takes a few seconds during which all running processes are shutdown.

**Warning:** Do not drive a non-zero voltage into input pins (pins type "I") when the receiver is in standby. To be safe during standby, it is recommended to use the IO\_EN signal of the 60-pin connector as enable for the drivers driving the input pins. The IO\_EN signal is low during standby.

## 2.12 SD Memory Card Usage

The receiver can interface to an external SD memory card through the SD-card pins of the 30-pin connector. The receiver supports the 1-bit SD transfer mode with 3V3 signaling. An example circuit to a 9-pin SD memory card socket is shown below. The maximum clock frequency (SD\_CLK) is 33.000 MHz.



See instructions in the Reference Guide for details on how to configure SD card logging. The receiver is compatible with SD cards of up to 32GB. The file system is FAT32.

Shortly driving the button pin (pin#25 of 30-pin connector) low toggles logging on and off. Driving the button pin low for at least 5 seconds unmounts the SD card if it was mounted, or mounts it if it was unmounted. The SD card mount status can be checked with the LOGLED pin (see Appendix A).

When powering off the receiver while logging is ongoing, it can be that the last seconds of data are lost. To avoid data losses, it is advised to first unmount the SD card. This can be done in two ways:



1. By entering the command “**exeManageDisk, DSK1, Unmount**” before turning off the receiver.
2. By driving the button pin (pin#25) low for at least 5 seconds before turning off the receiver.

## 2.13 USB Interface

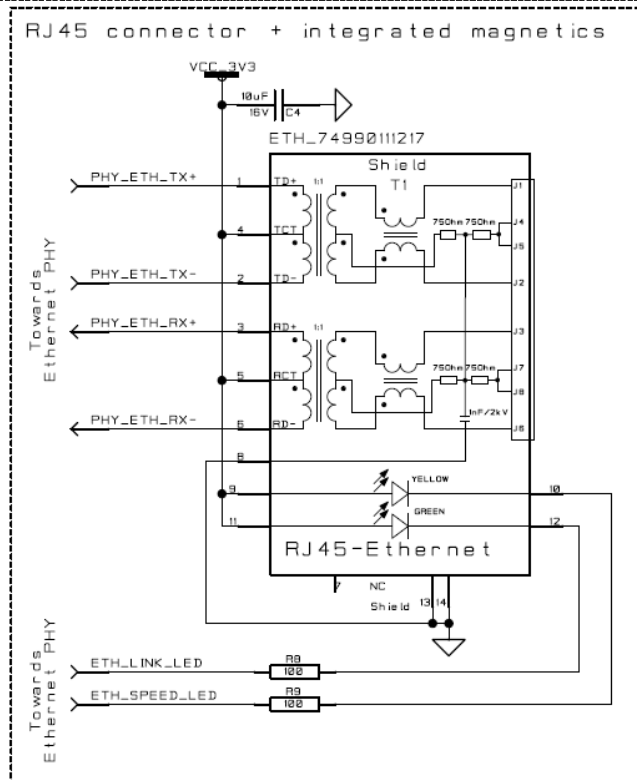
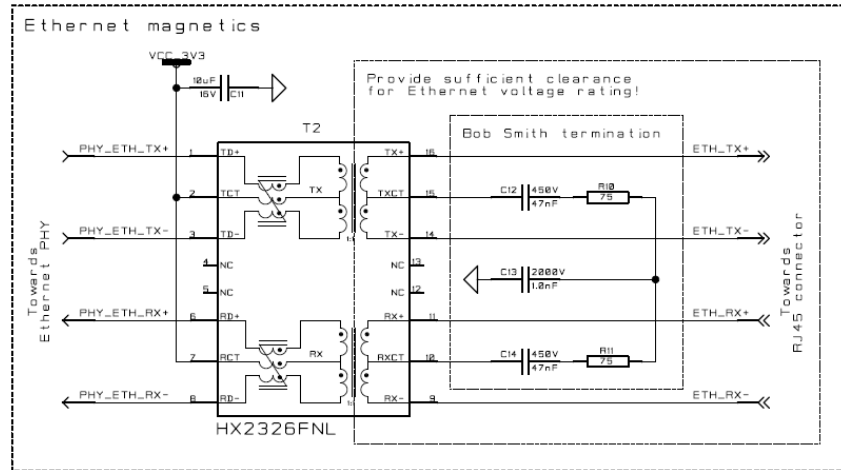
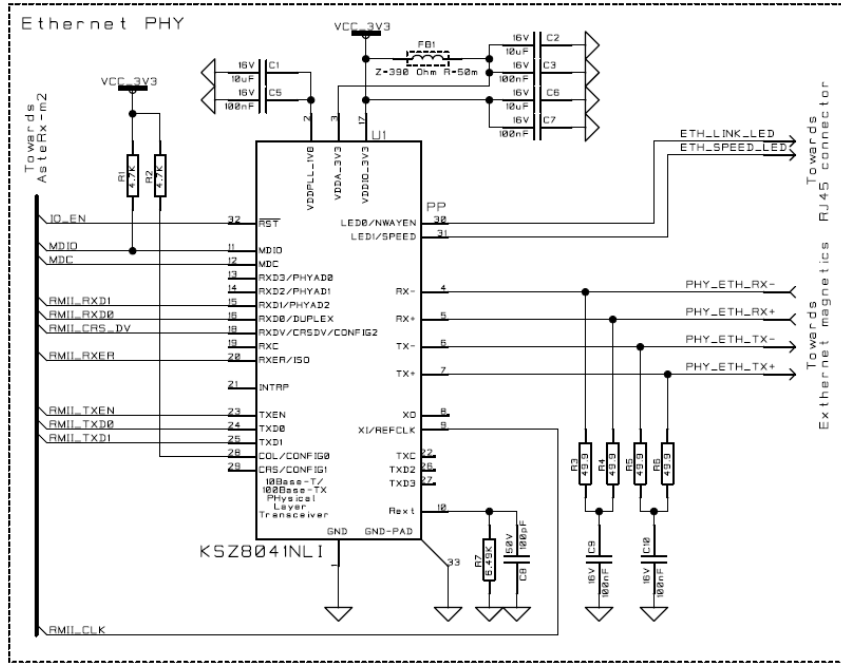
The user can configure the USB device interface in either USB 1.1 (full speed) mode, or in USB 2.0 (high speed) mode. USB 2.0 allows higher bandwidth (480 Mbps vs 12 Mbps), but may not be supported by older hardware.

By default, USB is configured in USB 2.0 mode. The update files “AsteRx-i3\_USB\_1\_1.suf” and “AsteRx-i3\_USB\_2\_0.suf” located in the `USB/` folder of the firmware package can be used to change this. The current USB mode can be checked with the command “**lif, Identification**”.

## 2.14 Ethernet

The receiver supports full duplex 10/100 Base-T Ethernet communication. The Ethernet PHY and magnetics are to be implemented on the host board. Connection with the PHY is through the RMII interface available on the 60-pin connector.

An example of application circuit using the ksz8041 PHY is given in the next page. Two options are shown: stand-alone magnetics or magnetics integrated in a RJ45 connector. Note that other PHYs can be used. Please contact Septentrio Support to check compatibility.

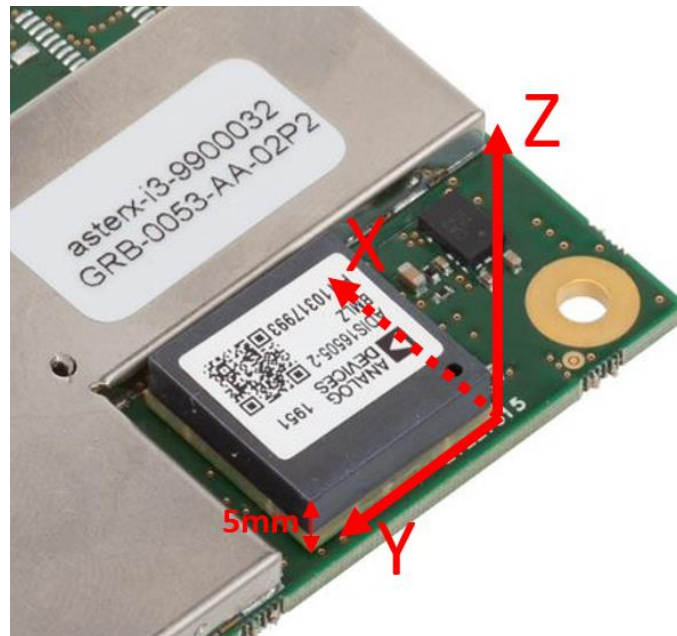


## 2.15 ADIS IMU (AsteRx-i3 D OEM only)

The AsteRx-i3 D OEM board incorporates an ADIS16505 IMU.

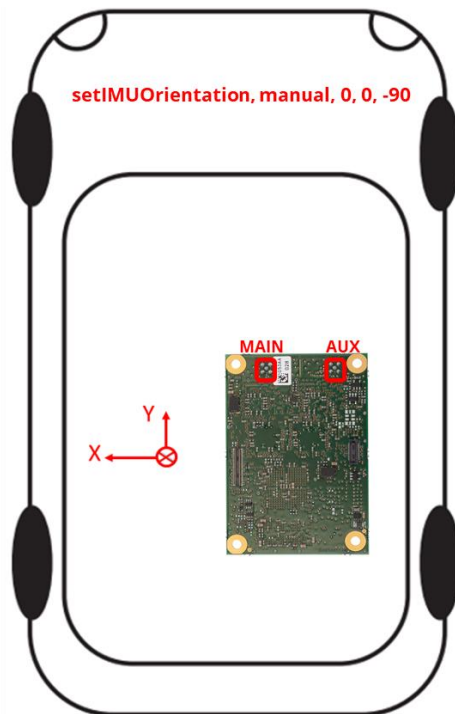
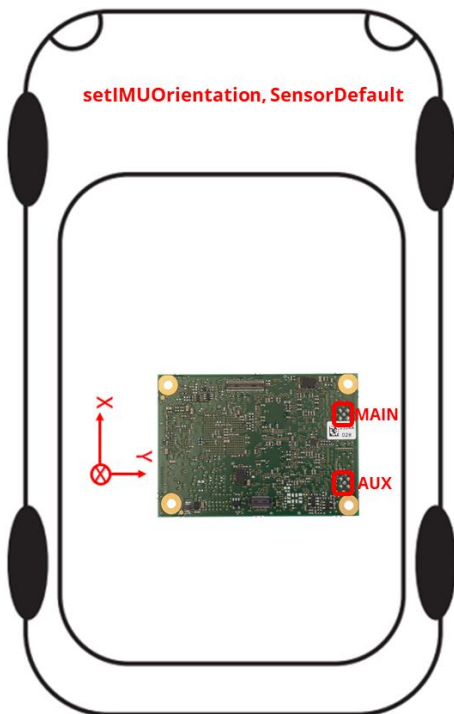
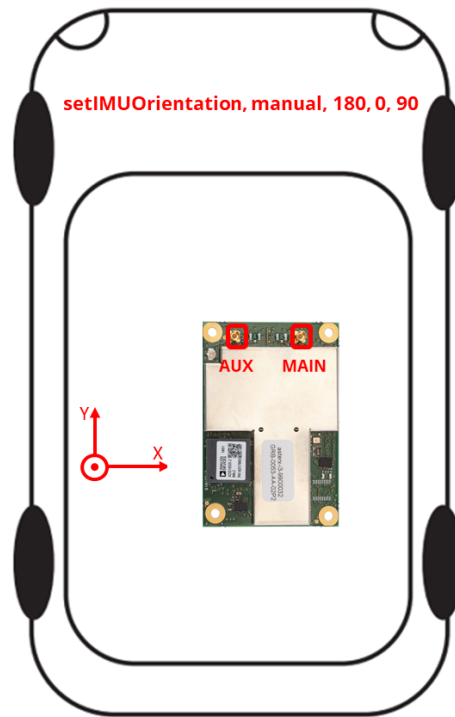
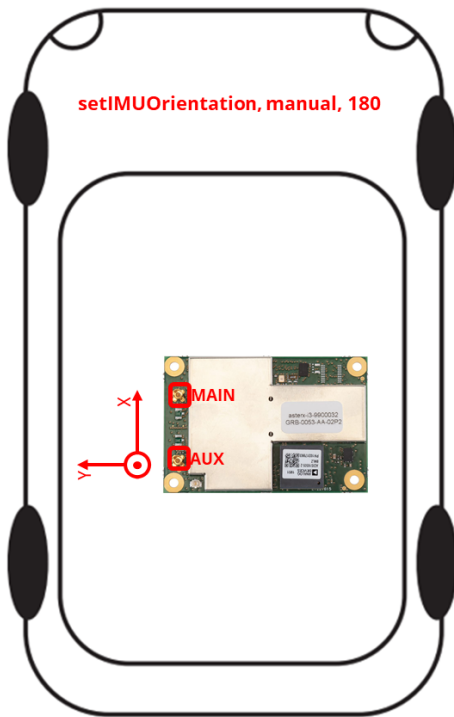
### 2.15.1 IMU Frame and Reference Point

The IMU reference point is the bottom corner of the ADIS16505 package, at the edge marked by the hole in the top of the lid, as illustrated below.



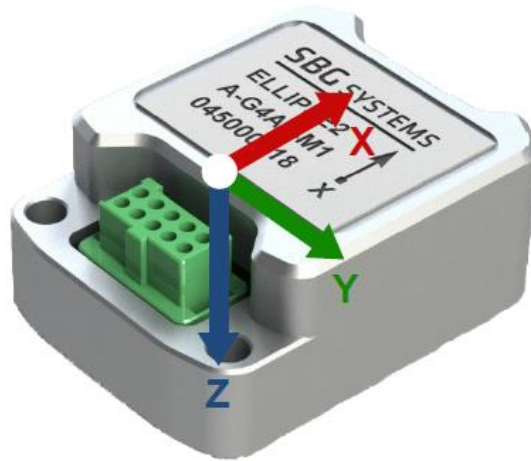
### 2.15.2 IMU Orientation in Vehicle

The orientation of the AsteRx-i3 D OEM in your vehicle must be provided to the receiver using the **setIMUOrientation** command. Selected examples are shown below.



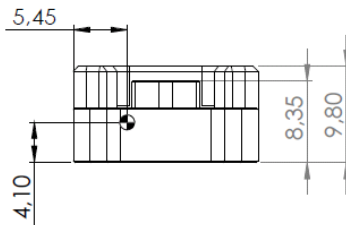
Refer to the Reference Guide to configure the INS/GNSS integration.

### 3 Ellipse2 Micro from SBG Systems

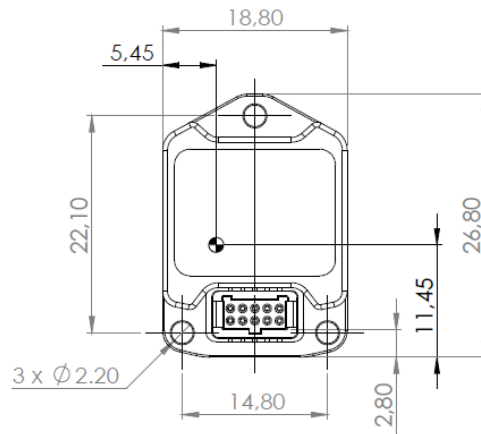


#### 3.1 Dimensions

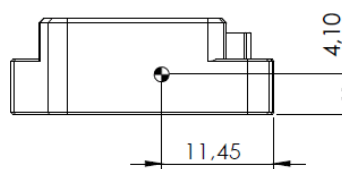
Front view




Top view



Right view

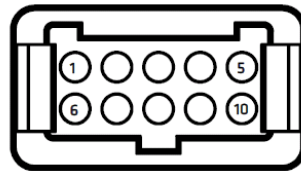


All dimensions in mm. The IMU reference point is marked by the  symbol.

## 3.2 Power Consumption

The Ellipse2 IMU consumes 400mW.

## 3.3 Connector



The IMU connector is a 10 ways Harwin Gecko. The exact receptacle reference is G125-FS11005L0P. The mating connector is Harwin G125-3041096L4 (plus contacts).

Pin #	Name	Description
1	GND	Ground return signal
2	PORT A Rx	Port A RS-232 Rx line
3	PORT E Tx	Port E RS-232 Tx line
4	SYNC A	Synchronization signal A. May be used as SYNC IN A or SYNC OUT A
5	CAN H	CAN High

Pin #	Name	Description
6	VIN	Power supply Input
7	PORT E RX	Port E RS-232 Rx line
8	PORT A TX	Port A RS-232 Tx line
9	SYNC B	Synchronization signal B. May be used as SYNC IN B or SYNC OUT B or ODO input
10	CAN L	CAN Low

The input voltage range (VIN pin) is from 4 to 15V. Communication with the AsteRx-i3 S OEM module is through Port A.

## 3.4 Open-Ended Cable

Septentrio's CBL\_AxiS\_OEM\_IMU cable (part# 215684) can be used to connect the SBG IMU to the AsteRx-i3 S OEM. Twisted pairs are used when applicable to prevent cross-talk between digital signals. The wiring diagram and the wire colors are indicated below.



It is recommended to connect PORT A of the IMU to COM3 of the AsteRx-i3 S OEM module (pin#15 and pin#16 of the 30-pin connector). Conversion from RS-232 to TTL level is needed. COM3 is the default IMU port. If using another port than COM3, it must be specified to the firmware with the **setIMUInput** command.

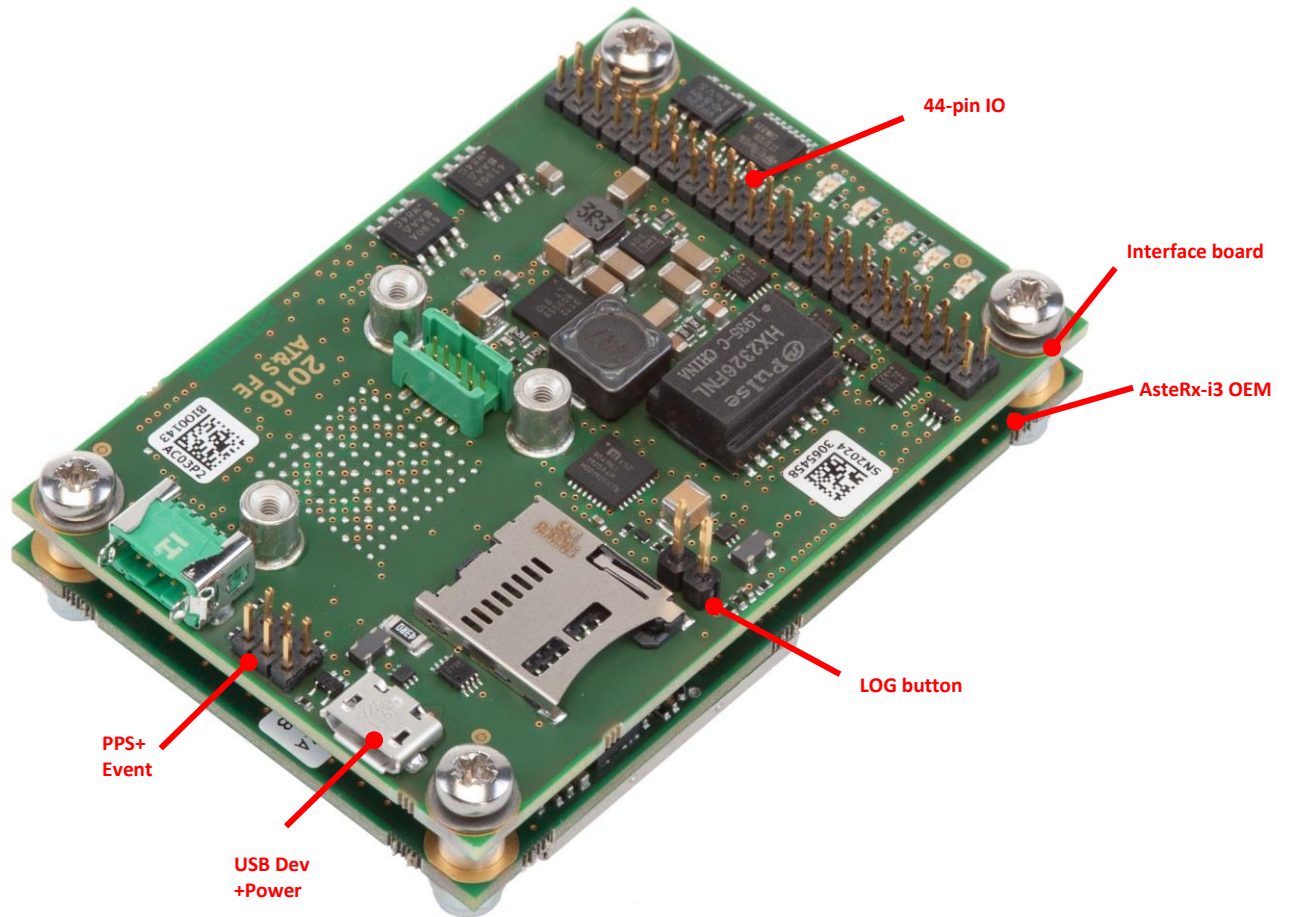
The SYNC A pin of the IMU must be connected to the PPSout pin of the AsteRx-i3 S OEM (pin#12 of the 30-pin connector). The PPSout rate must be left at its default value (1Hz).



## 4 Robotics Interface Board

The Robotics Interface Board is an interface card designed to ease integration and test.

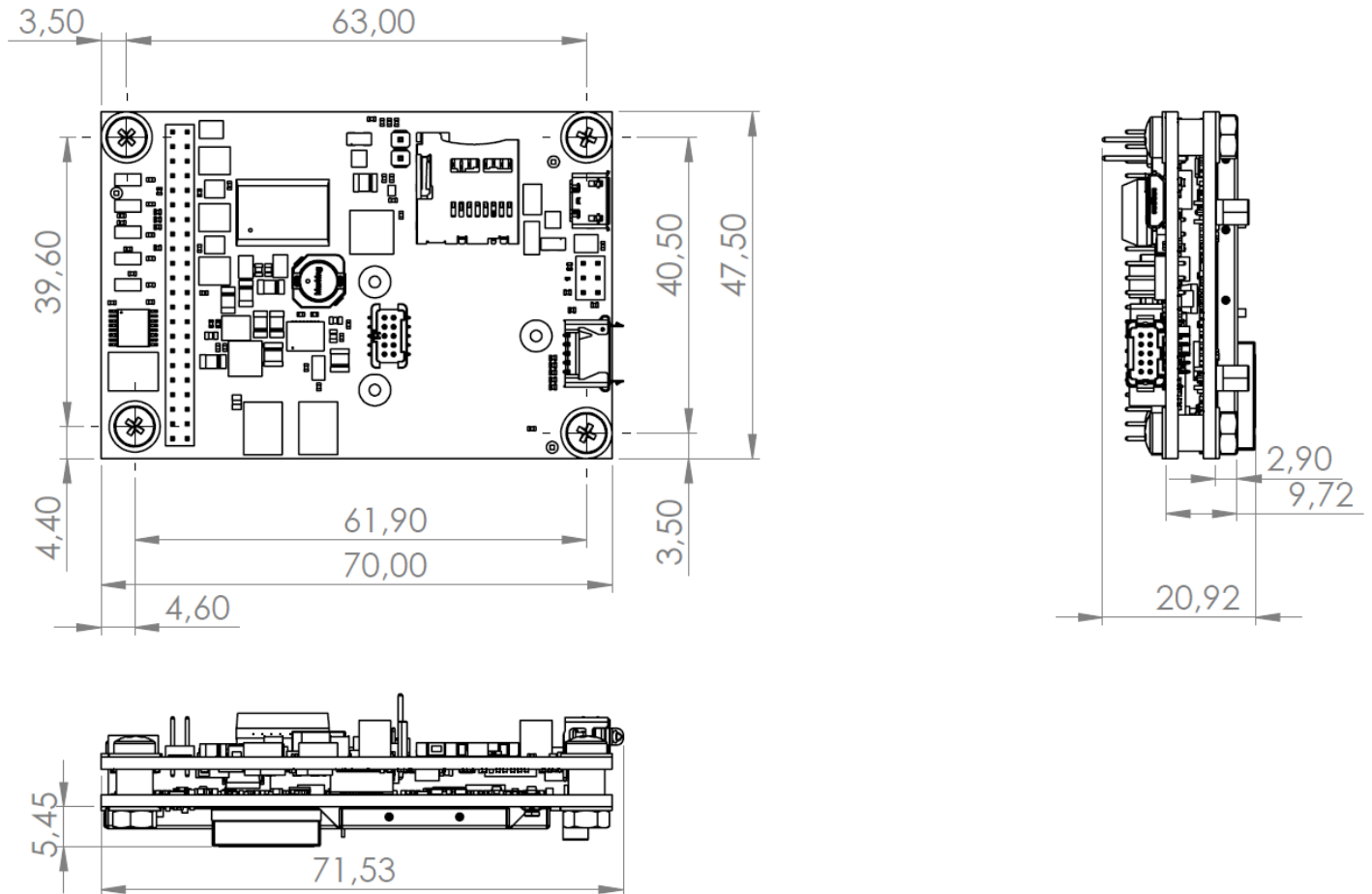
This chapter provides information on the interface card only. Refer to chapter 2 for the specifications of the AsteRx-i3 OEM board.





## 4.1 Mechanical Drawings

The drawing below shows the dimension of the Interface Board attached to the AsteRx-i3 D OEM.



Weight: 52g

## 4.2 USB Dev

Connector type: micro USB type B.



That connector can be attached to a PC to power the receiver and to communicate with it over its USB port.

## 4.3 44-pin Header

Connector type: SAMTEC TMM-122-03-S-D, 2-mm pitch.

### Conventions

- Pin Type: I=Input, O=Output, P=Power, Gnd=ground
- LVTTTL=3V3 Low Voltage TTL:  $V_{L} \leq 0.8V$ ,  $V_{H} \geq 2.0V$ ,  $VO_{L} \leq 0.4V$ ,  $VO_{H} \geq 2.4V$ .
- PU: internally pulled up
- PD: internally pulled down
- K: keeper input type

Pin numbering convention:



Pin#	Name	Type	Level	Description	Comment
1	GND	Gnd	0	Ground connection	
2	LOGLED	O	LVTTTL	Logging LED output, 10mA max current	See Appendix A
3	Reserved				
4	GPLED	O	LVTTTL	GPLED output, 10mA max current	See Appendix A
5	Reserved				
6	GP2	O	LVTTTL	General purpose output. GP2 in <b>setGPIOFunctionality</b> command.	
7	5V	P,O	5V	Output of on-board 5V supply to power external devices, max 500mA	
8	EVENTB	I,PD	LVTTTL	EventB input, 5V tolerant	See note 1 below
9	Reserved				
10	GND	Gnd	0	Ground connection	
11	Reserved				
12	GND	Gnd	0	Ground connection	
13	1PPS_OUT	O	LVTTTL	Pulse-per-second output of the OEM receiver, also used as synchronization signal for the IMU.	Also available on the 6-pin header, see 4.6
14	Reserved				
15	EVENTA1	I,PD		EventA input, 5V tolerant. The logical level on EVENTA1 and EVENTA2 pins are ORed before being transferred to the EVENTA pin of the AsterX-i3 OEM.	EVENTA2 available on the 6-pin header, see 4.6
16	Reserved				
17	COM2_CTS	I,PU	LVTTTL	COM2 cleared-to-send input. Must be driven low when ready to receive data from the interface board.	
18	COM2_RTS	O	LVTTTL	COM2 ready-to-send output. Driven low when interface board is ready to receive data.	
19	COM1_RX	I	RS232	COM1 Receive, RS232	
20	COM1_TX	O	RS232	COM1 Transmit, RS232	
21	COM2_RX	I,PU	LVTTTL	COM2 Receive (inactive state is high)	
22	COM2_TX	O	LVTTTL	COM2 Transmit (inactive state is high)	
23	GND	Gnd	0	Ground connection	
24	Reserved				
25	GND	Gnd	0	Ground connection	
26	GND	Gnd	0	Ground connection	
27	ET_RD+		Ethernet	Ethernet receive data + input	See note 2 below
28	GND	Gnd	0	Ground connection	
29	ET_RD-		Ethernet	Ethernet receive data - input	See note 2 below

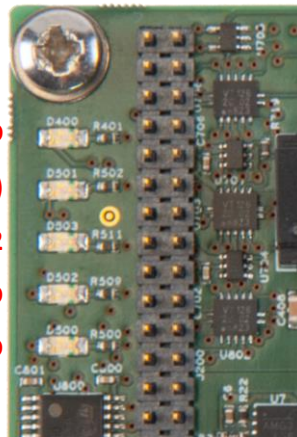
30	GND	Gnd	0	Ground connection	
31	ET_TD+		Ethernet	Ethernet transmit data + output	See note 2 below
32	GND	Gnd	0	Ground connection	
33	ET_TD-		Ethernet	Ethernet transmit data - output	See note 2 below
34	GND	Gnd	0	Ground connection	
35	Reserved				
36	GND	Gnd	0	Ground connection	
37	GND	Gnd	0	Ground connection	
38	Reserved				
39	Reserved				
40	Reserved				
41	GND	Gnd	0	Ground connection	
42	GND	Gnd	0	Ground connection	
43	PWR_IN	P	4.5 - 30V	Power input	See section 4.7
44	PWR_IN	P	4.5 - 30V	Power input	See section 4.7

**Note 1:** The level of the GP1 pin of the AsteRx-i3 OEM (pin#9 of the 60-pin connector, see 2.7.2) must be low for the EVENT pins to be functional.

**Note 2:** On-board magnetics. The Ethernet pins can directly be routed to an Ethernet connector.

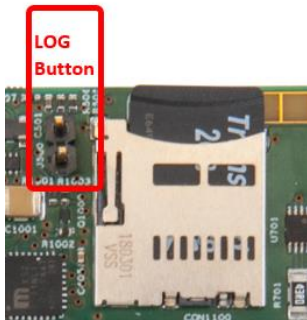
## 4.4 LEDs

**LAN activity LED**  
**Not Used (always OFF)**  
**GP2**  
**GPLED**  
**LOGLED**



The GP2 LED reflects the status of the GP2 pin (pin#44 of the 60-pin connector of the AsteRx-i3 OEM, see section 2.7.2). The LED lights when GP2 is high. The behavior of the GPLED and of the LOGLED is described in Appendix A.

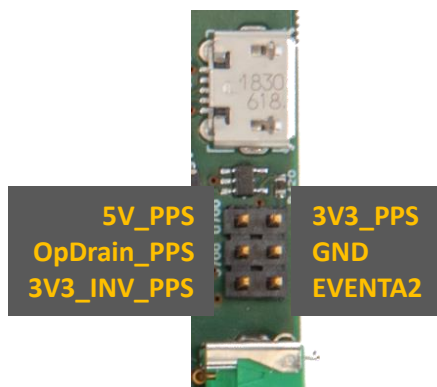
## 4.5 Log Button Header



Putting a jumper on the LOG Button header (.100" vertical header) is equivalent to pressing a "log button". The effect of the log button is described in section 2.12. The interface board takes care of debouncing.

## 4.6 PPS/Event Header

Connector type: SAMTEC TMM-103-03-G-D, 2-mm pitch.



The 6-pin 2mm header next to the micro USB connector exposes the PPS signal at different electrical levels:

Pin name	Level during pulse	Level outside pulse
5V_PPS	5V	0V
3V3_PPS	3.3V	0V
OpDrain_PPS	0V	floating
3V3_INV_PPS	0V	3.3V

The EVENTA2 pin is a second input for the EVENTA of the AsteRx-i3 OEM (see section 2.9). The first input pin (EVENTA1) is available on the 44-pin connector. The EVENTA input of the OEM receiver is the logical OR of EVENTA1 and EVENTA2.

## 4.7 Power Supply Options

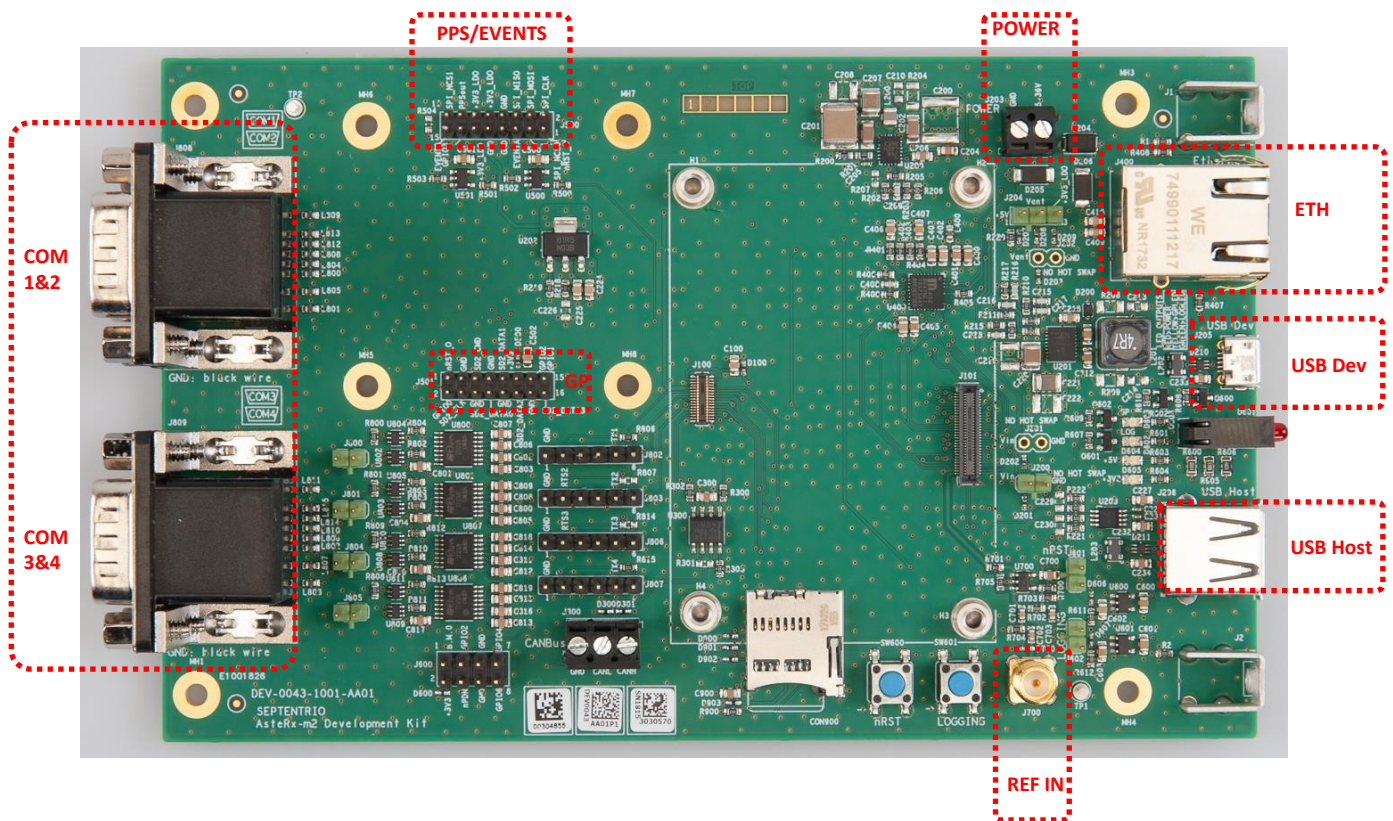
When an USB cable is connected to the micro USB connector, the interface board is powered from the computer through the USB connector.

Alternatively, the power can be applied from the PWR\_IN pins of the 44-pin connector (see section 4.3). The voltage range when powering from the PWR\_IN pins is 4.5V to 30V.

Power can be applied from both sources at the same time. On-board diodes prevent short circuits.

The interface board provides the 3V3 supply to the AsteRx-i3 OEM receiver and a 5V DC voltage to the VANT pin of the AsteRx-i3 OEM.

## 5 Development Kit



The AsteRx-i3 OEM Development Kit is specifically designed to simplify the development process for new integrations.

### 5.1 Header Types

All headers have a pitch of 2.54mm, with the exception of J500 (PPS/EVENTS) and J501 (GP). Those headers have a 2mm pitch.

### 5.2 Powering the DevKit

There are two ways to power the DevKit:

1. From the USB Dev connector (J205). This allows powering the board from a PC or from a standard phone-charger adapter. The supported USB voltage range is 4.5V-5.5V.
2. Using the POWER connector (J203). The supported voltage range is 5-36V.

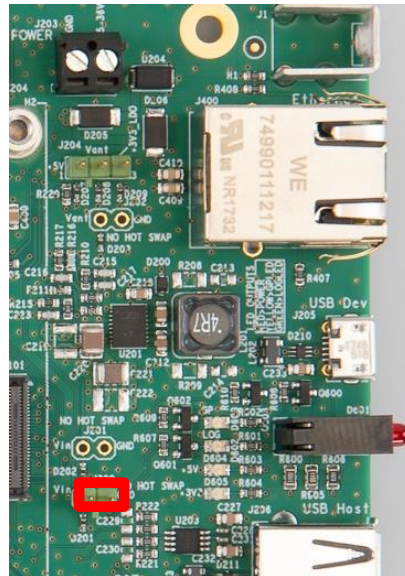


When powering from the USB Dev connector, it is recommended to use the USB cable provided with the DevKit. Low-quality USB cables often suffer from excessive voltage drop, preventing correct operation. Also, make sure that your USB port can deliver at least 1A.



It is safe to provide power to both connectors in parallel. The DevKit will use the source with the highest voltage.

Make sure that a jumper is placed on header J200, as shown below. Otherwise the DevKit will be powered, but not the OEM board.



To measure the power consumption of the AsteRx-i3 OEM board (excluding the contribution from the DevKit and the antenna), remove the jumper on J200 and connect the two pins to the probes of a multimeter in current-sensing mode. Measure the current flowing between the two pins and multiply it by 3.3V to obtain the power consumption. It is recommended to set the multimeter in high ampere setting to keep the voltage drop as low as possible.

### 5.3 Antenna Connectors

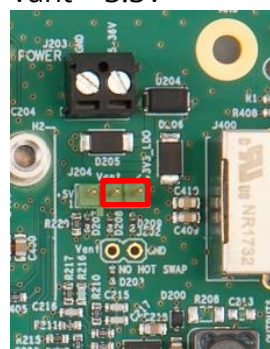
There is no antenna connector on the DevKit. The antennas must be connected directly to the u.FL or MMCX connectors on the OEM board. See section 2.6 for details.

The DC voltage (5V or 3.3V) at the antenna connectors is determined by the position of the jumper on header J204, as shown below.

Vant = 5V

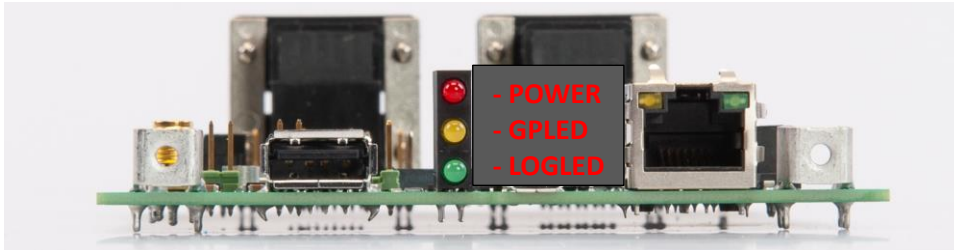


Vant = 3.3V



The jumper can be removed if the antenna does not need to be powered by the receiver. In that case, there is no DC voltage at the antenna connector.

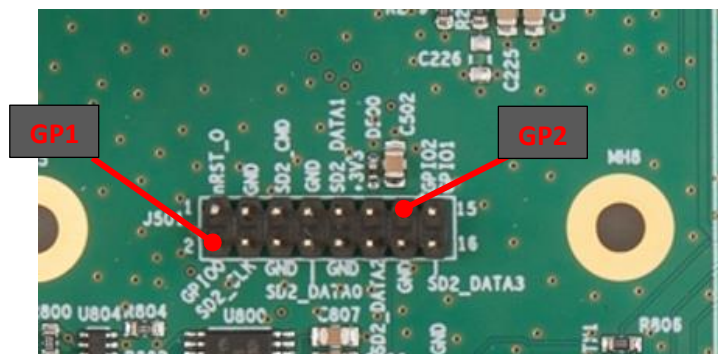
## 5.4 LEDs and General Purpose Output Pins



The POWER LED lights when the DevKit is powered.

The GPLED and LOGLED are connected to the homonymous pins of the 30-pin connector of the AsterRx-i3 OEM board. See section 2.7.1 for the pinout, and Appendix A for a description of the LED behavior.

The 3.3V GP1 and GP2 outputs are available on the J501 header.



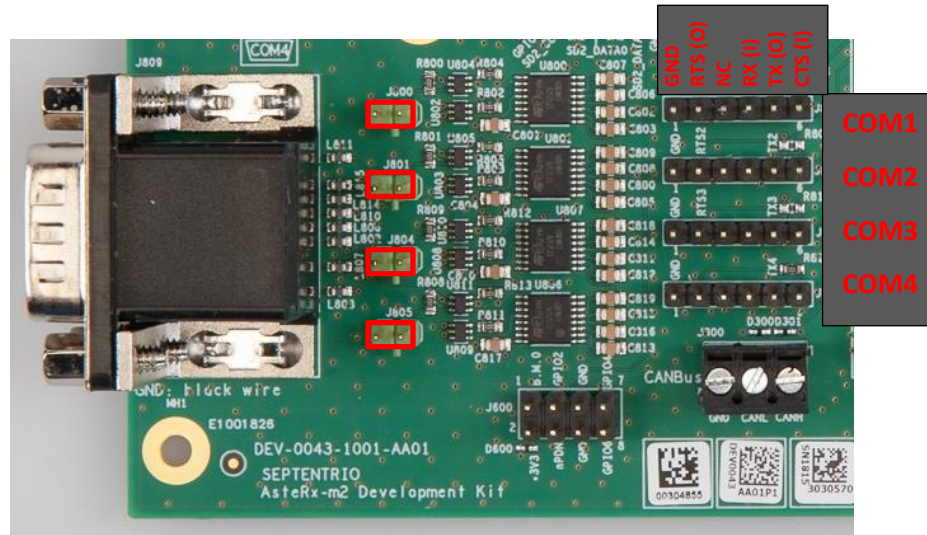
## 5.5 COM Ports



By default, the four COM ports of the AsterRx-i3 OEM are routed to the four DB9 connectors. Electrical levels on the BD9 conform to the RS232 standard. RTS/CTS lines are supported only on COM2 and COM3. Connection to a PC is done through a null-modem cable.

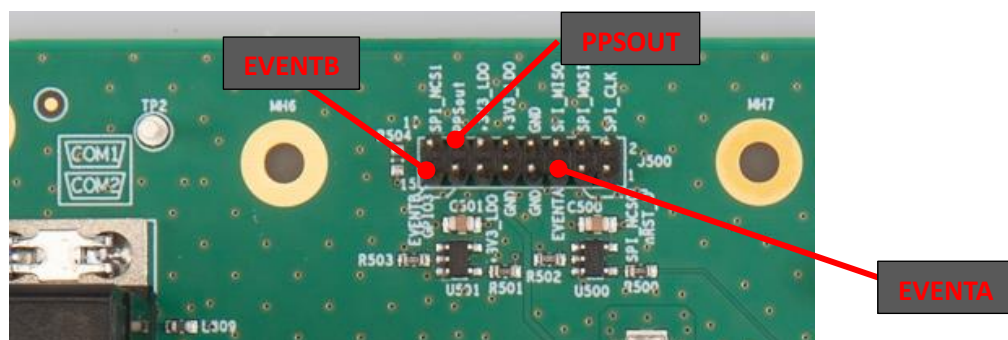


Alternatively, 3.3V TTL signals are available through four 6-pin headers, as shown below. The pinout is compatible with standard FTDI 6-pin SIL connectors. To route a COM port to the 6-pin header instead of the DB9 connector, a jumper must be placed on J800 (COM1), J801 (COM2), J804 (COM3) and/or J805 (COM4). Only those COM ports for which the jumper is placed are routed to the 6-pin header. The other COM ports are still routed to the DB9 connectors, using the RS232 levels.



Note that, when using the DB9 connectors, the baud rate must not be larger than 230400baud. This limitation does not apply to the TTL signals.

## 5.6 PPS Out and Event Inputs



The PPSout pin of header J500 is directly connected to the PPSOut pin of the AsterRx-i3 OEM (see section 2.7.1). The PPS level is 3.3V.

The EVENTA and EVENTB pins of J500 are connected to the EventA and EventB pins of the AsterRx-i3 OEM through a buffer. The voltage level at the header pins must be between -0.5V and +6V. These pins are pulled-down by a 100kOhm resistor. See section 2.9 for more details.

## 5.7 Ethernet

The DevKit supports 10/100 Base-T Ethernet. It is not possible to power the DevKit through the Ethernet connector.

## 5.8 USB Dev

That connector can be attached to a PC to power the DevKit and to communicate with the receiver over its USB port.

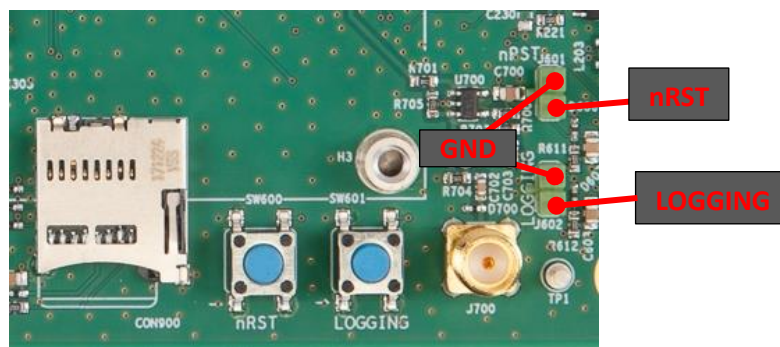
## 5.9 USB Host

Reserved.

## 5.10 REF IN

Reserved.

## 5.11 Buttons



Pressing the nRST button drives the nRST pin of the AsteRx-i3 OEM low, which resets the receiver.

Pressing the LOGGING button drives the Button pin of the AsteRx-i3 OEM low. This can be used to enable and disable logging, as described in section 2.12.

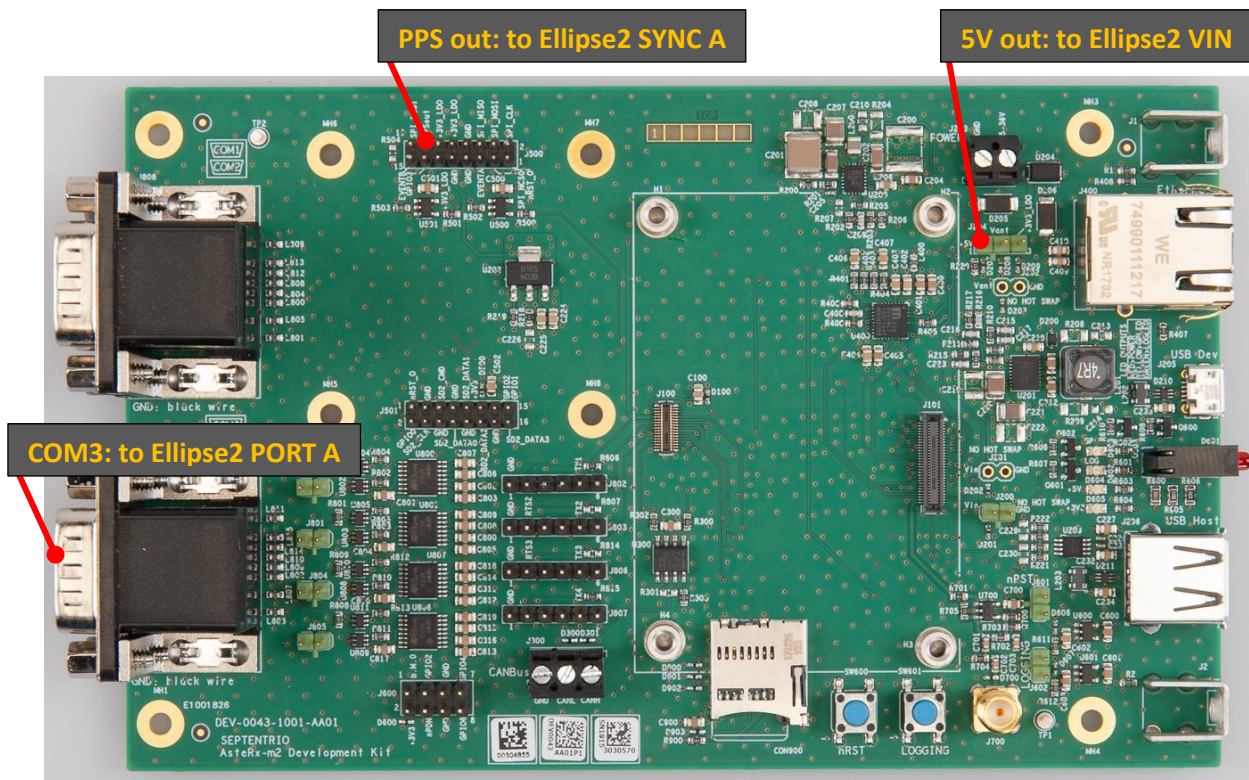
The buttons are also connected to J601 and J602 2-pin headers (see above picture). Tying the nRST or LOGGING pins of these headers to ground is the same as pressing the respective button.

## 5.12 SD Card Socket

The receiver can log files on the micro SD Card in this socket. See section 2.12 for a description of the SD Card logging.

## 5.13 Connection with the Ellipse2 IMU

Septentrio's open ended SBG IMU cable (see sections 3.4) can be used to connect the DevKit to the Ellipse2 IMU. The following connections are recommended:



## Appendix A LED Status Indicators

The LED pins can be used to monitor the receiver status. They can be used to drive external LEDs (max drive current 10mA). It is assumed that the LED lights when the electrical level of the corresponding pin is high.

The general-purpose LED (GPLED pin) is configured with the **setLEDMode** command. The following modes are supported. The default mode is "PVTLED".

GPLED mode	LED Behaviour																
PVTLED	LED lights when a PVT solution is available.																
DIFFCORLED	<p>Differential correction indicator. In rover PVT mode, this LED reports the number of satellites for which differential corrections have been provided in the last received differential correction message (RTCM or CMR).</p> <table border="1"> <thead> <tr> <th>LED behaviour</th> <th>Number of satellites with corrections</th> </tr> </thead> <tbody> <tr> <td>LED is off</td> <td>No differential correction message received</td> </tr> <tr> <td>blinks fast and continuously (10 times per second)</td> <td>0</td> </tr> <tr> <td>blinks once, then pauses</td> <td>1, 2</td> </tr> <tr> <td>blinks twice, then pauses</td> <td>3, 4</td> </tr> <tr> <td>blinks 3 times, then pauses</td> <td>5, 6</td> </tr> <tr> <td>blinks 4 times, then pauses</td> <td>7, 8</td> </tr> <tr> <td>blinks 5 times, then pauses</td> <td>9 or more</td> </tr> </tbody> </table> <p>The LED is solid 'ON' when the receiver is outputting differential corrections as a static base station.</p>	LED behaviour	Number of satellites with corrections	LED is off	No differential correction message received	blinks fast and continuously (10 times per second)	0	blinks once, then pauses	1, 2	blinks twice, then pauses	3, 4	blinks 3 times, then pauses	5, 6	blinks 4 times, then pauses	7, 8	blinks 5 times, then pauses	9 or more
LED behaviour	Number of satellites with corrections																
LED is off	No differential correction message received																
blinks fast and continuously (10 times per second)	0																
blinks once, then pauses	1, 2																
blinks twice, then pauses	3, 4																
blinks 3 times, then pauses	5, 6																
blinks 4 times, then pauses	7, 8																
blinks 5 times, then pauses	9 or more																
TRACKLED	<table border="1"> <thead> <tr> <th>LED behaviour</th> <th>Number of satellites in tracking</th> </tr> </thead> <tbody> <tr> <td>blinks fast and continuously (10 times per second)</td> <td>0</td> </tr> <tr> <td>blinks once, then pauses</td> <td>1, 2</td> </tr> <tr> <td>blinks twice, then pauses</td> <td>3, 4</td> </tr> <tr> <td>blinks 3 times, then pauses</td> <td>5, 6</td> </tr> <tr> <td>blinks 4 times, then pauses</td> <td>7, 8</td> </tr> <tr> <td>blinks 5 times, then pauses</td> <td>9 or more</td> </tr> </tbody> </table>	LED behaviour	Number of satellites in tracking	blinks fast and continuously (10 times per second)	0	blinks once, then pauses	1, 2	blinks twice, then pauses	3, 4	blinks 3 times, then pauses	5, 6	blinks 4 times, then pauses	7, 8	blinks 5 times, then pauses	9 or more		
LED behaviour	Number of satellites in tracking																
blinks fast and continuously (10 times per second)	0																
blinks once, then pauses	1, 2																
blinks twice, then pauses	3, 4																
blinks 3 times, then pauses	5, 6																
blinks 4 times, then pauses	7, 8																
blinks 5 times, then pauses	9 or more																

The LOGLED reports the SD card mount status and logging activity.

LED	LED Behaviour
LOGLED	LED is off when the SD card is not present or not mounted. LED is on when the SD card is present and mounted. Short blinks indicate logging activity.

During boot, i.e. during the first seconds after powering the receiver, the state of the LEDs is not defined.



## Appendix B System Noise Figure and C/N0

The system noise figure, in dB, can be calculated as:

$$NF_{sys} = 10 \cdot \log_{10}(10^{NF_{ant}/10} + (10^{NF_{rx}/10} - 1) / 10^{G_{preamp}/10})$$

where

- $NF_{ant}$  is the antenna LNA noise figure, in dB;
- $NF_{rx}$  is the module noise figure, in dB.  $NF_{rx}$  depends on the net gain, but a good approximation (<0.5dB) of  $NF_{sys}$  can be obtained by setting  $NF_{rx} = 10$ dB. See also section 2.6;
- $G_{preamp}$  is the net pre-amplification in front of the module, in dB.

For example, with a 2.5-dB antenna LNA noise figure, 30-dB antenna LNA gain and 15-dB cable loss,  $G_{preamp} = 30$ dB-15dB = 15dB. In this case, the system noise figure is:

$$NF_{sys} = 10 \cdot \log_{10}(10^{2.5/10} + (10^{10/10} - 1) / 10^{15/10}) = 3.14 \text{ dB.}$$

The C/N0, in dB-Hz, of a GNSS signal received at a power P can be computed by:

$$C/N0 = P - 10 \cdot \log_{10}(T_{ant} + 290 \cdot (10^{NF_{sys}/10} - 1)) + 228.6 \text{ dB}$$

where

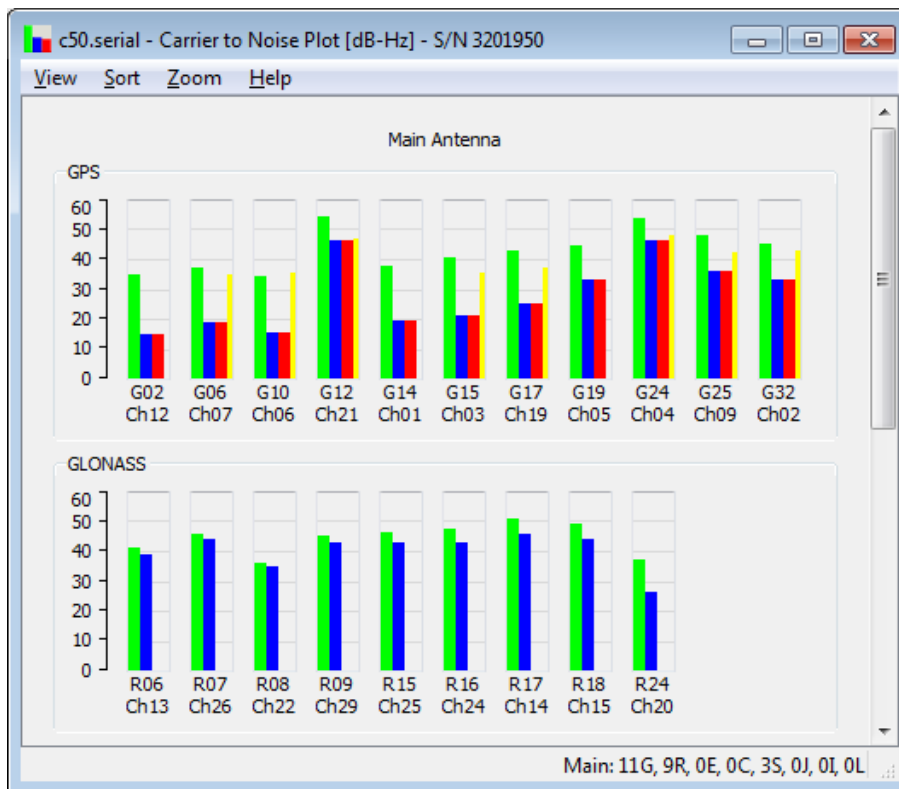
- P is the received GNSS signal power including the gain of the antenna passive radiating element, in dBW (e.g. -155dBW)
- $T_{ant}$  is the antenna noise temperature, in Kelvin. Typically  $T_{ant} = 130$ K for an open-sky antenna.
- 228.6 is  $-10 \cdot \log_{10}(k_B)$  with  $k_B = 1.38 \cdot 10^{-23}$  J/K the Boltzmann constant.

Note that, when connecting the module directly to a GNSS simulator, the applicable value for  $NF_{sys}$  is equal to  $NF_{rx}$  and  $T_{ant} = 290$ K.

## Appendix C EMC Considerations

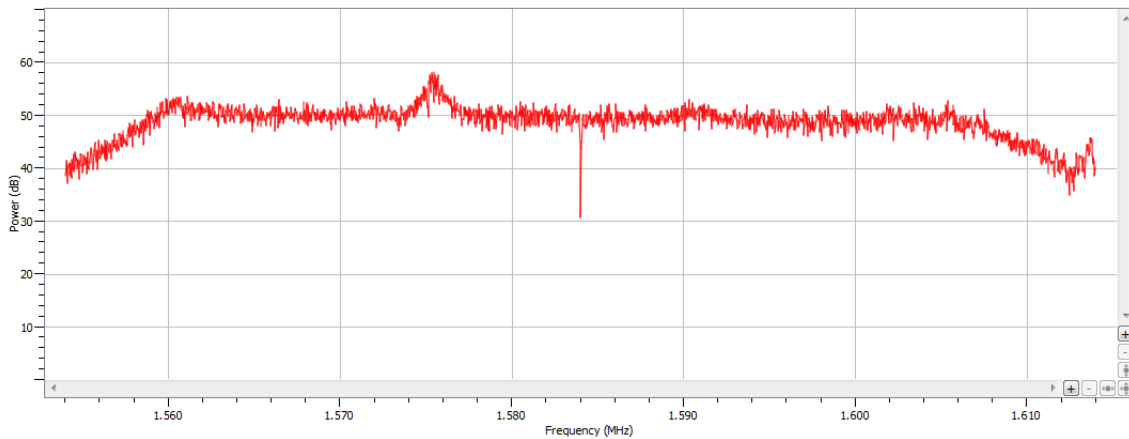
In applications in which the electronics are collocated with the GNSS antenna, cross-talk could be a major concern. GNSS signals are very weak and easily interfered by radiated harmonics of digital signals.

The most useful indicator of the signal reception quality is the C/N0 of the satellites in view. The C/N0 can be viewed in the RxControl graphical interface by clicking *View / Carrier to Noise Plot*. In open-sky conditions, the C/N0 values should reach up to 50 dB-Hz for the strong signals on L1, and up to 45 dB-Hz on L2, as illustrated below.

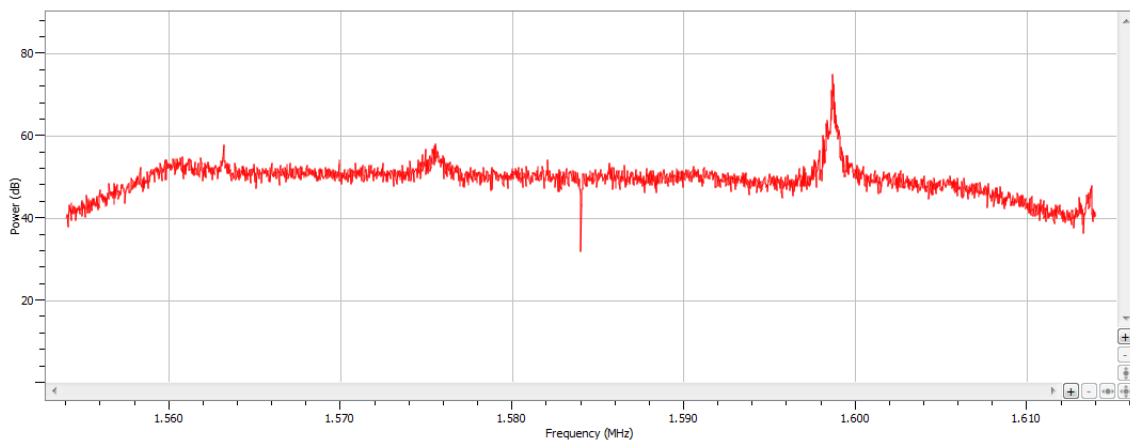


If the maximum C/N0 is lower than expected, interference and cross-talk from nearby electronics is likely, and the source of the problem needs to be identified. This is where the RF spectrum monitor built in the receiver comes in handy. The spectrum monitor can be accessed in RxControl under the *View / Spectrum View* menu. The spectrum can also be monitored offline if the `BBSamples` SBF blocks are logged.

The figure below shows a clean open-sky L1-band spectrum. The bump at 1575MHz corresponds to the GNSS signals at the L1/E1 frequency, and is normal.

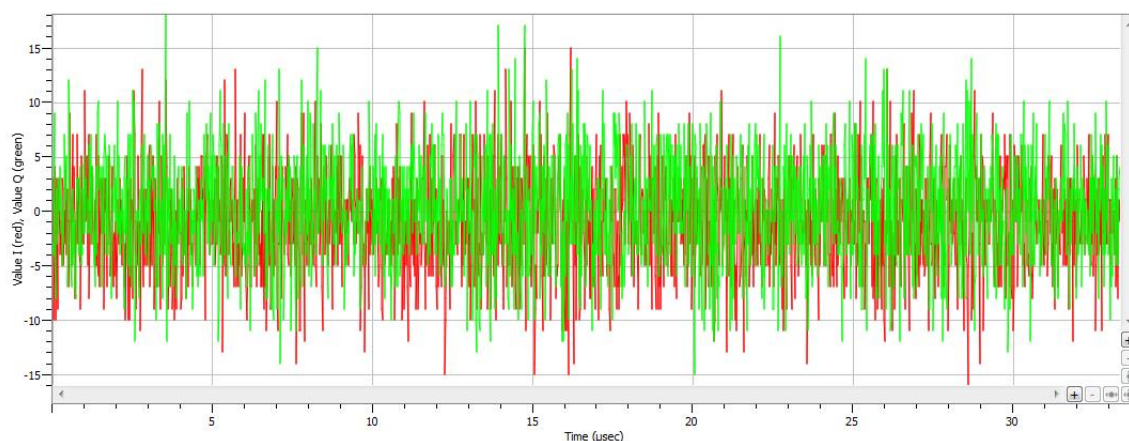


An example of interference is shown below. This particular interference at about 1598 MHz falls in the GLONASS L1 band and slightly degrades the L1 C/N0 of some GLONASS satellites.



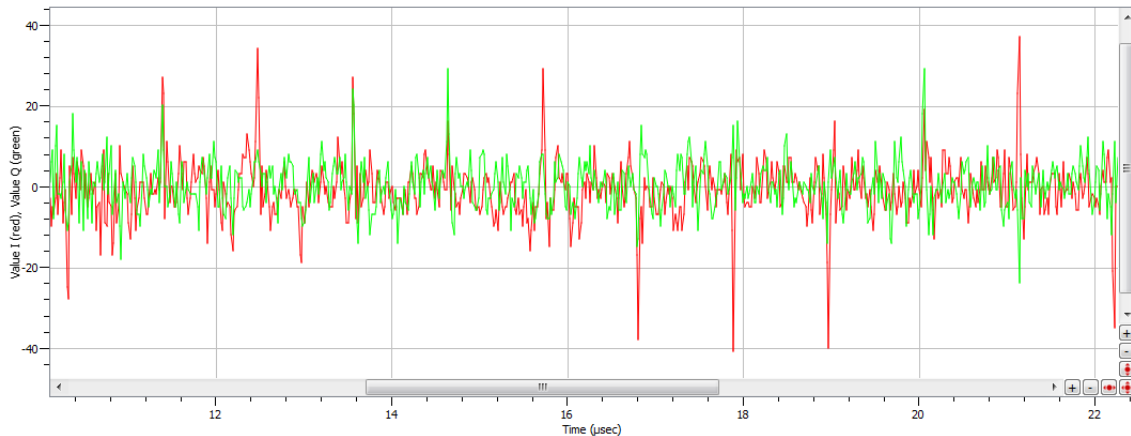
Try to keep personal computers and other equipment more than 2 meters away from the antenna while assessing electromagnetic compatibility of the integration.

RxControl also allows to observe the time domain signal. This should look like white Gaussian noise as illustrated below.





Intermittent interference ( $\mu\text{s}$ -scale) has little impact if its duty cycle is below 10%. For example, these short pulses from a digital circuit close to the antenna are essentially harmless.



If interference is detected, look for the root cause by switching off devices. Typical sources of interference are:

- Unshielded flat cables carrying digital signals or power signals towards digital circuits. Particularly, cable joints tend to radiate.
- High-speed digital devices, such as application processors, modems and cameras.
- Digital signals on the application board (e.g. clock signals, SDIO signals).

If spectral peaks are observed in the spectrum, this usually relates to radiated harmonics. The source can be identified by looking for an integer relation between the observed spectral peaks and the system frequencies. For example, peaks at 1200 and 1248 MHz are an indication of an interfering source at 48 MHz as this maps to the 25<sup>th</sup> and 26<sup>th</sup> harmonic of a 48 MHz signal. This may correspond to the frequency of a microcontroller in the application.

Integration cross-talk can be solved in a number of ways:

- Shift the clock frequency of the interfering signal to avoid the GNSS bands.
- Use shielding tape with conductive adhesive.
- Shield radiating circuits, preferably all around.
- Put digital signals in inner layers of the application board.
- Change the antenna location by experimentation.
- Enable the interference mitigation feature of the AsteRx-i3 OEM. Narrow spectral peaks can be eliminated with the notch filters (see the **setNotchFiltering** command). Intermittent wide-band cross-talk can often be eliminated with the wide band interference canceller (see the **setWBIMitigation** command).

AsteRx-i3 OEM has been designed to minimize radiation and can be used close to an antenna without additional shielding.