Aistin Blue BTL3K3 external buses, testpoints, pinouts and configurations

Application note 14. Jun. 2016 1.02

Abstract

This application note explains Aistin Blue BTL3K3 external connectivity and nRF51822 pinout for software and add-on board development. Configuration resistor functionality and configuration combination possibilities are explained as well.

Aistin Blue BTL3K3 version

Two versions of Aistin Blue are commonly available and three other versions are available by order. This document covers only version BTL3K3. The other versions include coin battery version, sensor component variant version and sensorless version.

BTL3K3 I2C addresses for slave devices.

Table 1 below show the default and optional I2C addresses for the components installed. Three of the sensors have optional I2C address selection resistors. The optional slave addresses and corresponding resistors are marked in brackets. Remaining components do not have selection resistors. The add-on board designer must select different slave addresses for I2C devises used on the same bus than addresses configured on the BTL3K3 board. The memory module uses I2C2 (BRD_CTS/I2C2_SCL and BRD_RTS/I2C2_SDA) lines and the sensors use the I2C1 (I2C_SCL and I2C_SDA) lines. The I2C2 line can be separated from the AistinBus24 connectors by removing the R46 and R47 resistors to prevent I2C2 traffic interacting with UART flow control used by AistinBus24 connected boards. This however prevents the flow control usage with the nRF51822.

BTL3K3			
Slave	type	SAD (optional SAD)	SAD selector R (optional)
KX122-1037	Accelerometer	0x1Fh (0x1Eh)	R10 (R30)
KMX62-1031	Acc/magnetometer	0x0Eh (0x0Fh)	R14 (R13)
KXG03 / KXG07	acc/gyroscope	0x4Fh (0x4Eh)	R33 (R34)
BM1383GLV	Barometer	0x5Dh	-
M24M02-DRCS6TP/K	Memory	50h-53h(A), 58h-5Bh(IP)	-

Table 1: BTL3K3 I2C addresses

Default interrupt routing

Default setup for BTL3K3 interrupt routing can be seen in the table 2. On the nRF51822, pin19 is routed to SINT (Sensor INT) -line, Pin22 is routed to DINT (Data INT) -line and the Pin4 is routed to GENIO1/INT1 -line.

nRF51822	KX122-1037 Accelerometer	KMX62-1031 Acc/Magn	KXG03 Acc/gyroscope	BM1383(A)GLV Barometer
Pin19, p0.13, GPIO, SINT	INT2	-	INT2	-
Pin22, p0.16, GPIO, DINT	INT1	-	INT1	INT
Pin4, p0.00, GPIO, GENIO1/INT1	-	GPIO1	-	-

Table 2: BTL3K3 board default interrupt routing to nRF51822

NOTE: Interrupts are routed to the selectors via diode to prevent unwanted behaviour with some sensor combinations. This causes interrupt lines to work only in active low mode. Keep this in mind when enabling and configuring interrupt functionality.

AistinBus24

There is one AistinBus24 connectors mounted on the board, AISTIN2. The pinout for this connector can be seen on the Table 3. AISTIN2 is assembled on the TOP side of the board. Signals not used internally on the board are marked with asterisk on the table below. At the left side of the table is the pin list for the corresponding signals on the nRF51822 SOC. Signals with a "BRD_" key signature are reserved for add-on boards.

nRF51822	Pin #	AISTIN2 (TOP) PINS	AISTIN BUS	explanation
NA	1	VBAT	VBAT	Battery
VDD	2	VCC	VCC	+2.8V
Pin21, p0.15, GPIO	3	RPOW	RPOW	Radio power enable
Pin16, p0.10, GPIO	4	SEN	SEN	Sensor enable
Pin3, p0.30, GPIO	5	I2C_SDA	SDA	I2C_SDA
Pin11, p0.07, GPIO	6	I2C_SCL	SCL	I2C_SCL
Pin19, p0.13, GPIO	7	SINT	SINT	Sensor int
GND	8	GND	GND	ground
Pin41, p0.22, GPIO	9	BRD_SS	SS	Add-on brd SPI_SS
Pin8, p0.04, AIN5	10	BRD_SCLK	SCLK	Add-on brd SPI_SCLK
Pin7, p0.03, AIN4	11	BRD_MOSI	MOSI	Add-on brd SPI_MOSI
Pin6, p0.02, AIN3	12	BRD_MISO	MISO	Add-on brd SPI_MISO
VDD	13	VCC	VDD	+2.8V
VDD	14	VCC	VCC	+2.8V
Pin23, nRESET	15	SWDIO_NRESET	RST	nRESET
Pin5, p0.01, AIN2	16	1WIRE	1WIRE	1WIRE
Pin10, p0.06, AIN7	17	AD0	AD0	AD0 input
Pin14, p0.08, GPIO	18	RINT	RINT	Radio int
Pin22, p0.16, GPIO	19	DINT	DINT	data int
GND	20	GND	GND	ground
Pin27, p0.19, GPIO	21	BRD_CTS/I2C2_SCL	RTS	Add-on brd UART RTS
Pin28, p0.20, GPIO	22	BRD_CTS/I2C2_SDA	CTS	Add-on brd UART CTS
Pin26, p0.18, GPIO	23	BRD_RX	RX	Add-on brd UART RX
Pin25, p0.17, GPIO	24	BRD_TX	TX	Add-on brd UART TX

Table 3: AistinBus24 connector pinouts

The physical pinout of AistinBus24 connector can be seen on the image 1 below. The pin1 of the connectors are placed towards the center of the board.

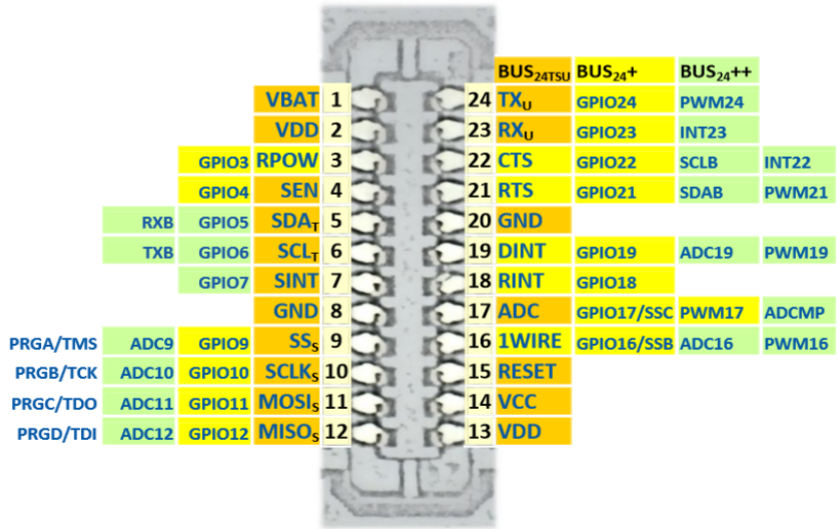


Image 1: AistinBus24

Configuration and pull-up resistors.

These resistors include I2C address selection resistors, interrupt routing resistors and I2C pull-up resistors. Address selection resistors are sharing the same mounting pads with optional resistors, as well as the interrupt routing resistors. This prevents accidental mounting of both address selection resistors, prevents interrupt routing to both interrupt lines at the same time and minimizes land pattern area on the board. The list of the resistors, their functionality and the resistor blocked physically is listed on the table 4 below

CONFIGURATION AND PULLUP RESISTORS		
RESISTOR	FUNCTION	
R10 (default)	KX122-1037 ADDRESS HIGH SELECTOR	Not to be used with R30
R30	KX122-1037 ADDRESS LOW SELECTOR	Not to be used with R10
R13	KMX62-1031 ADDRESS HIGH SELECTOR	Not to be used with R14
R14 (default)	KMX62-1031 ADDRESS LOW SELECTOR	Not to be used with R13
R33 (default)	KXG03 ADDRESS HIGH SELECTOR	Not to be used with R34
R34	KXG03 ADDRESS LOW SELECTOR	Not to be used with R33
R17	KX122-1037 INT1 TO SINT SELECTOR	Not to be used with R20
R18 (default)	KX122-1037 INT2 TO SINT SELECTOR	Not to be used with R19
R19	KX122-1037 INT2 TO DINT SELECTOR	Not to be used with R18
R20 (default)	KX122-1037 INT1 TO DINT SELECTOR	Not to be used with R17
R21	KXG03 / 07 & BM1383(A)GLV INT1 TO SINT SELECTOR	Not to be used with R24
R22 (default)	KXG03 / 07 INT2 TO SINT SELECTOR	Not to be used with R23
R23	KXG03 / 07 INT2 TO DINT SELECTOR	Not to be used with R22
R24 (default)	KXG03 / 07 & BM1383(A)GLV INT1 TO SINT SELECTOR	Not to be used with R21
R15 (10k)	I2C_SCL PULLUP	
R16 (10k)	I2C_SDA PULLUP	
R40 (10k)	BRD_CTS/I2C2_SDA PULLUP	
R41 (10k)	BRD_CTS/I2C2_SCL PULLUP	

Table 4: Configuration and pullup resistors for BTL3K3

Test points

There are several pin holes added on the board as well as small test points on selected places. Some of the testpoints are not used and they should be left floating at all times.

TEST POINTS	FUNCTION	DESCRIPTION
TEST1	GENIO1/INT1	KMX62-1031 GPIO1 INPUT/OUTPUT
TEST2	I2C_SDA	I2C_SDA LINE (SENSORS)
TEST3	I2C_SCL	I2C_SCL LINE (SENSORS)
TEST4	SINT	SENSOR INTERRUPT
TEST5	DINT	DATA/SENSOR INTERRUPT
TEST6	VSEN	SENSOR VOLTAGE SUPPLY (VCC SWITCHED ON BY SEN)
TEST7	VCC	REGULATED VOLTAGE SUPPLY (2.8V)
TEST8	GND	COMMON GROUND
TESTPAD1	KX122-1037 TRIG	EXTERNAL TRIGGER FOR KX122-1037
TESTPAD2	NOT USED	NOT USED
TESTPAD3	KXG03 / 07 AUX_CL	KXG03 / KXG07 AUXILIARY I2C CLK
TESTPAD4	KXG03 / 07 AUX_DA	KXG03 / KXG07 AUXILIARY I2C SDA
TESTPAD5	KXG03 / 07 TRIG	EXTERNAL TRIGGER FOR KXG03 INPUT BUFFER ACTIONS
TESTPAD6	KXG03 / 07 SYNC	KXG03 / KXG07 SYNC INPUT/OUTPUT
TESTPAD7	NOT USED	NOT USED
TESTPAD8	NOT USED	NOT USED
TESTPAD9	NOT USED	NOT USED
TESTPAD10	KMX62-1031 GPIO2	KMX62-1031 GPIO2 INPUT/OUTPUT
TESTPAD11	FTDI USB RESET	UART TO USB BRIDGE RESET INPUT

Table 5: Testpoints

Nordic nRF51822 pinout

The nRF51822 pins are almost all used. Only one pin (SWSTAT, pin17) is not currently used. The use for it is planned and it is routed on the board. The pinout can be seen on the table below.

Pin	Pin name	function	connection
1	VDD	VDD	
2	DCC	DCC	
3	P0.30	I2C_SDA	I2C1_SDA
4	P0.00 / AREF0	GENIO1/INT1	KMX62-1031 GPIO1
5	P0.01 / AIN2	1WIRE	AISTIN1 & AISTIN2 1WIRE
6	P0.02 / AIN3	BRD_MISO	AISTIN1 & AISTIN2 MISO
7	P0.03 / AIN4	BRD_MOSI	AISTIN1 & AISTIN2 MOSI
8	P0.04 / AIN5	BRD_SCLK	AISTIN1 & AISTIN2 SCLK
9	P0.05 / AIN6	NA	NA
10	P0.06 / AIN7	AD0	AISTIN1 & AISTIN2 AD0
11	P0.07 / AREF1	I2C_SCL	SENSOR & AISTIN1 & AISTIN2 I2C_SCL
12	VDD	VCC	
13	VSS	GND	
14	P0.08	RINT	AISTIN1 & AISTIN2 (RADIO) INT
15	P0.09	PCTRL	SOFT POWER OFF
16	P0.10	SEN	SENSOR ENABLE, AISTIN1 SEN & AISTIN2 SEN
17	P0.11	SWSTAT	NOT USED
18	P0.12	LED_GREEN	GREEN LED
19	P0.13	SINT	SENSOR INT, AISTIN1 SINT & AISTIN2 SINT
20	P0.14	BMEAS	BATTERY MEASUREMENT ENABLE
21	P0.15	RPOW	AISTIN1 (BOTTOM) RADIO POWER
22	P0.16	DINT	SENSOR INT, AISTIN1 DINT & AISTIN2 DINT
23	SWDIO / nRESET	SWDIO_NRESET	FLASH CONNECTOR NRESET, AISTIN1 & AISTIN2 NRESET
24	SWDCLK	SWDCLK	FLASH CONNECTOR SWDCLK
25	P0.17	BRD_TX	AISTIN1 & AISTIN2 BRD_TX
26	P0.18	BRD_RX	AISTIN1 & AISTIN2 BRD_RX
27	P0.19	BRD_CTS/I2C2_SCL	AISTIN1 & AISTIN2 BRD_CTS/I2C2_SCL, I2C MEMORY SCL
28	P0.20	BRT_RTS/I2C2_SDA	AISTIN1 & AISTIN2 BRD_RTS/I2C2_SDA, I2C MEMORY SDA
29	DEC2	DEC2	
30	VDD_PA	VDD_PA	
31	ANT1	ANT1	
32	ANT2	ANT2	
33	VSS	GND	
34	VSS	GND	
35	AVDD	AVDD	
36	AVDD	AVDD	
37	XC1	XC1	
38	XC2	XC2	
39	DEC1	DEC1	
40	P0.21	LED_RED	RED LED
41	P0.22	BRD_SS	AISTIN1 & AISTIN2 BRD_SS
42	P0.23	LED_BLUE/RPOW2	BLUE LED, AISTIN2 (TOP) RADIO POWER
43	P0.24	USB_CTS	USB UART CTS
44	P0.25	USB_RTS	USB UART RTS
45	P0.26 / XL2	OSC1	
46	P0.27 / XL1	OSC2	
47	P0.28	USB_RX	USB UART RX
48	P0.29	USB_TX	USB UART TX

Table 6: nRF51822 pinout

Component and testpoint placement top

Positions of configuration resistors and testpoints on the top side can be seen on the image below.

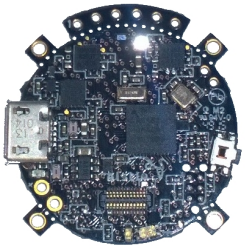
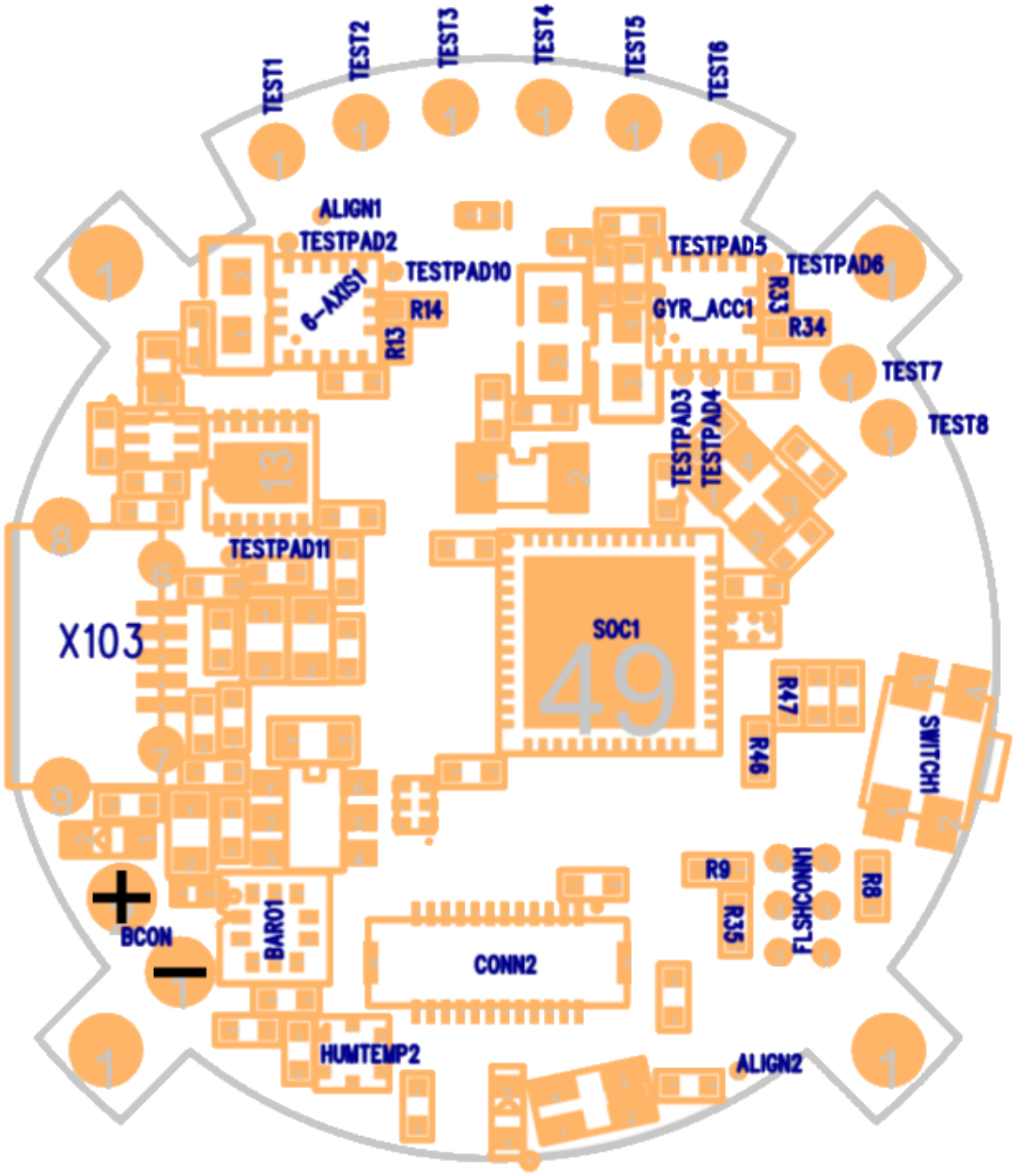


Image 2: BTL3K3 top

Reference	Component
6-AXIS1	KMX62-1031
GYR_ACC1	KXG03 / KXG07
BARO1	not assembled
HUMTEMP2	not assembled
CONN2	Aistin 2 connector
X103	USB connector
BCON	Battery connector (B2B-PH-K-S(LF)(SN))(Optional)

Table 7: Top side component references



Component placement bottom

Positions of configuration resistors, components and testpoints on the bottom side can be seen on the image below.

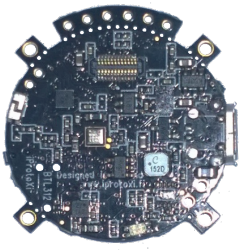
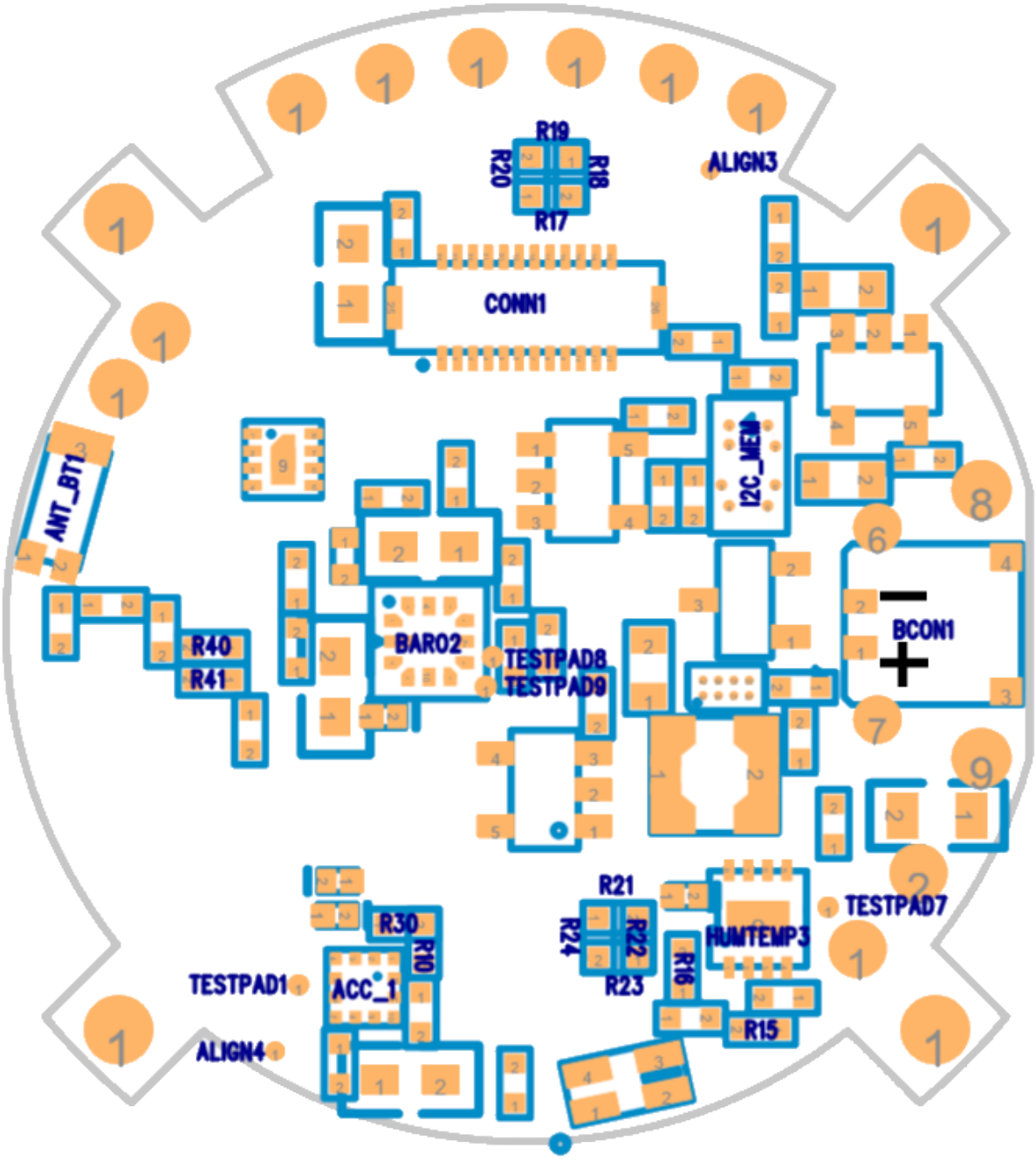


Image 3: BTL3K3 bottom

Reference	Component
CONN1	Aistin 1 connector (Not assembled)
I2C_MEM	M24M02-DRCS6TP/K
BARO2	BM1383(A)GLV
ACC1	KX122-1037
HUMTEMP3	not assembled
BCON1	Battery connector (BM02B-ACHSS-GAN-ETF)(Optional)

Table 8: Bottom side component references



Interrupt resistors

Interrupt resistors can be assembled as pairs. Pairs are color coded. Setup and functionality is explained in the table 9.

RES	Accelerometer	Acc/Magnetometer	Acc/gyroscope	Humidity/temp	Barometer	Default setup
R17	INT1 => SINT	N/A *	-	-	-	Not assembled
R18	INT2 => SINT	N/A *	-	-	-	Assembled
R19	INT2 => DINT	N/A *	-	-	-	Not assembled
R20	INT1 => DINT	N/A *	-	-	-	Assembled
R21	-	N/A *	INT1 => SINT	-	INT => SINT	Not assembled
R22	-	N/A *	INT2 => SINT	INT => SINT	-	Assembled
R23	-	N/A *	INT2 => DINT	INT => DINT	-	Not assembled
R24	-	N/A *	INT1 => DINT	-	INT => DINT	Assembled

Table 9: Interrupt resistor setup

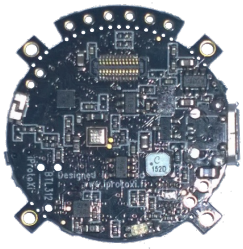
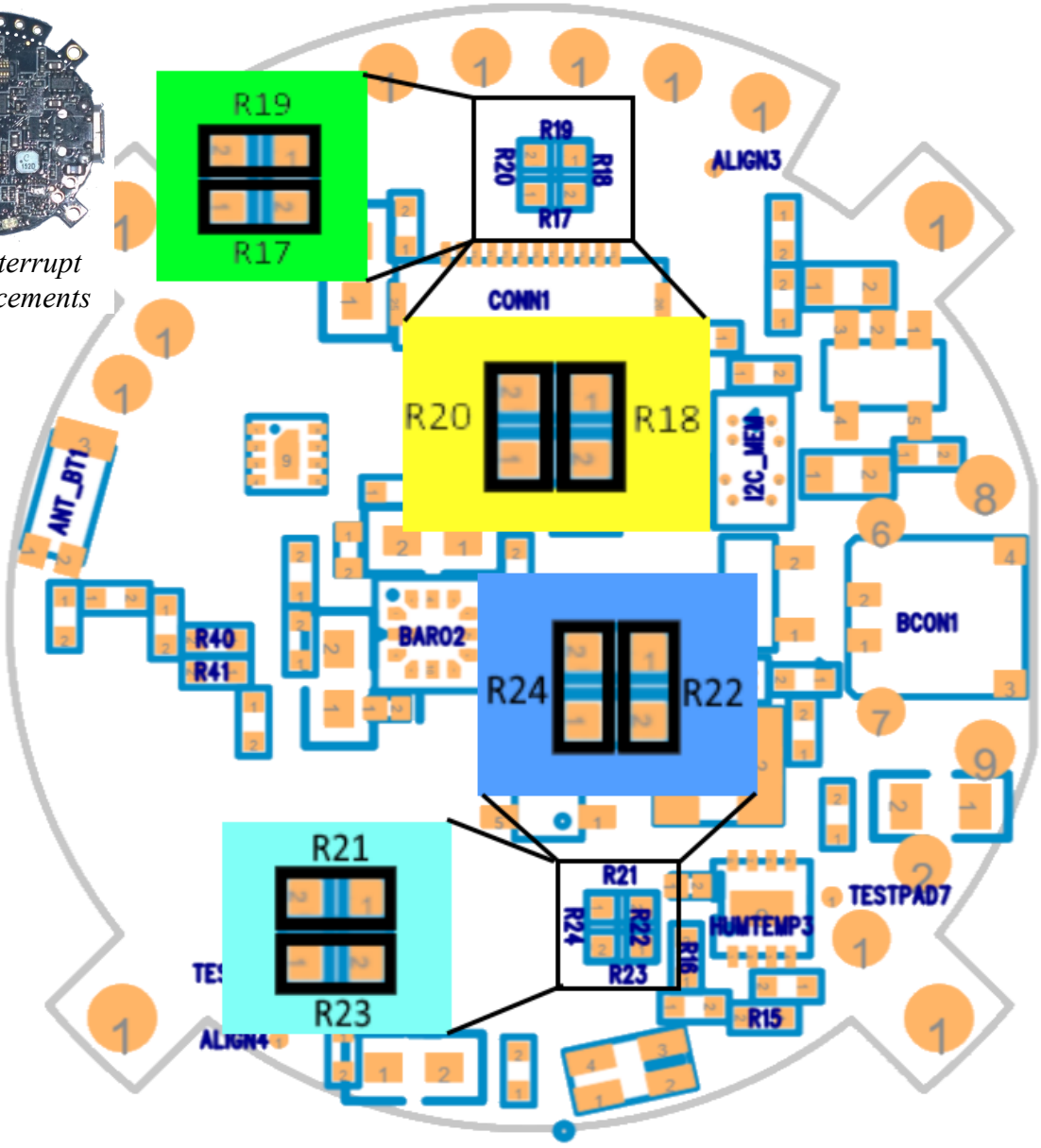


Image 4: Interrupt resistor placements



Component axis orientation

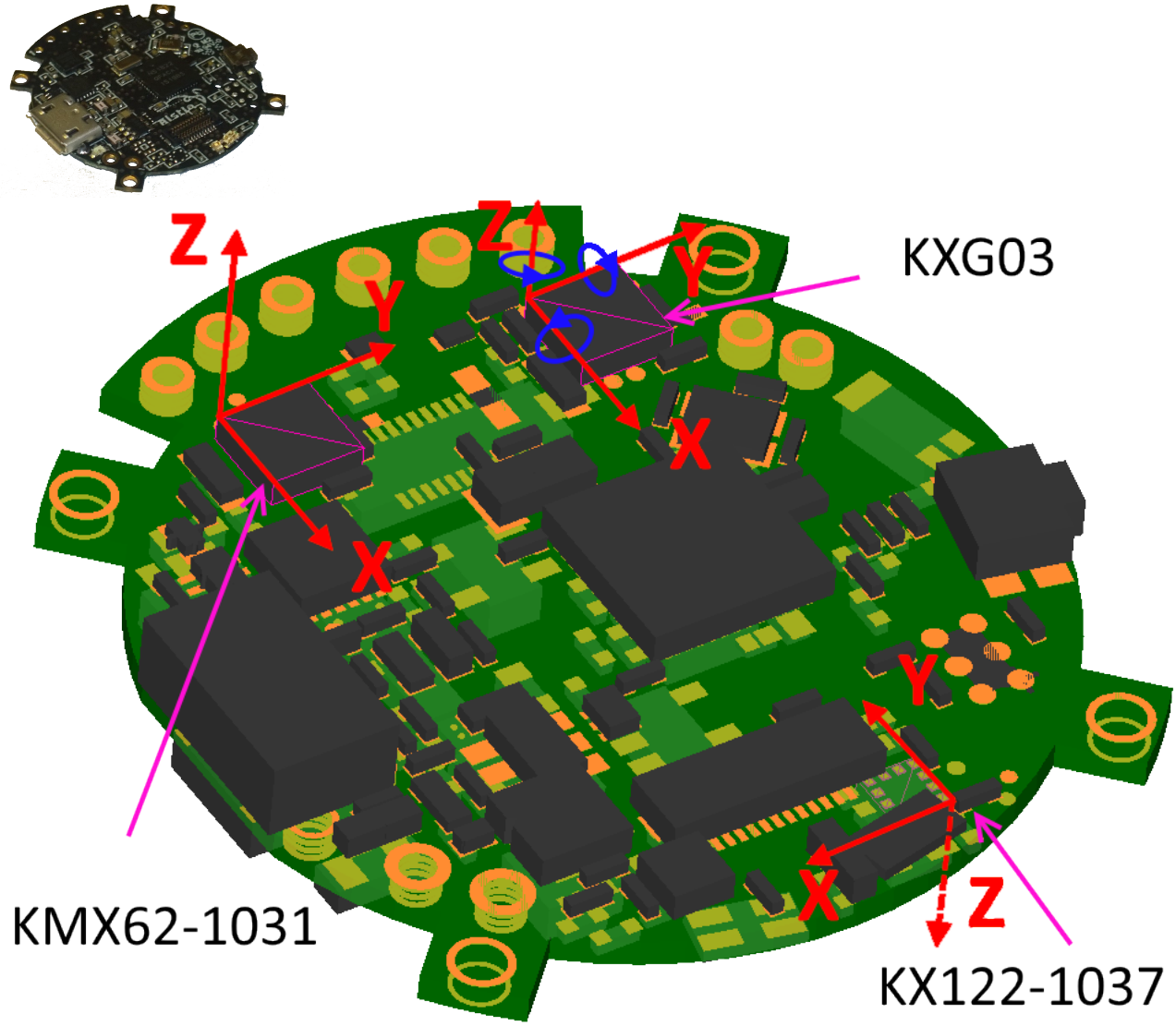
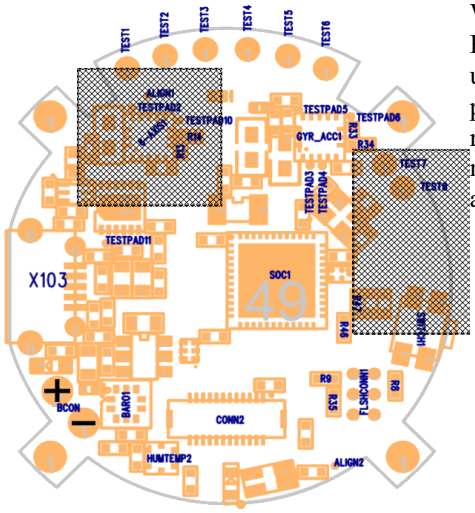


Image 5: Component Axis orientation

Enclosure considerations



When fitting the BTL3K3 board into an enclosure, please keep BT2.4GHz antenna and the KMX62-1031 accelerometer/magnetometer uncovered by metal sheets or wiring. Metal covering will affect the performance of these parts significantly. Using plastic enclosure is recommended. For best performance, assembly screws should be non-magnetic material (nylon / beryllium-copper alloy / bronze-aluminium alloy).

Powering up

Aistin Blue BTL3K3 boards are designed to be powered by rechargeable battery. External power can be used with caution. External power applied to VBAT line while USB is plugged is not recommended. If external power is applied to VSEN line only, the device will most likely be powered via nRF internal and external pull-up resistors. VCC line test point is normally regulated by 2.8V voltage regulator. If BTL3K3 power supply is removed, please wait for few seconds to allow capacitors to discharge before reconnecting any power supply.

absolute maximum	min	max
VBAT	-0.3V	6.6V
VUSB	-0.3V	7.6V
VDD	-0.3V	3.6V

Table 10: absolute maximums

Operating condition	min	typ	max
VBAT *	3.1V		5.5V
VUSB	4.75V	5V	5.25V
VDD	2.7V	2.8V	2.9V

Table 11: Operating conditions

* If external power is applied to VBAT, the minimum voltage is defined by LDO regulator voltage drop. 3.1V limit is to secure 2.8V output for the regulator. Lower voltages may cause regulated voltages to drop and some functionality may be lost.

Battery selection and charge current

BTL3X2 is optimized for batteries capable of 190mA maximum charge current. If you are using batteries with current protection circuit with lower than 190mA trip current, you may experience issues when trying to charge battery with low voltage levels. Protection circuit may prevent battery from charging. To limit charging current the R109 needs to be changed. The resistor size can be calculated with the equation:

Ireg = 1000V / Rprog, where Ireg is charging current (mA) and Rprog is R109 (kOhm). Therefore:
Rprog = 1000V / Ireg

The charging current can be calculated from battery specification. Battery continuous charge C rating and capacity is given.

Ireg = Cap x Cch

Cap is battery capacity (mAh) and Cch is the continuous charge C rating.

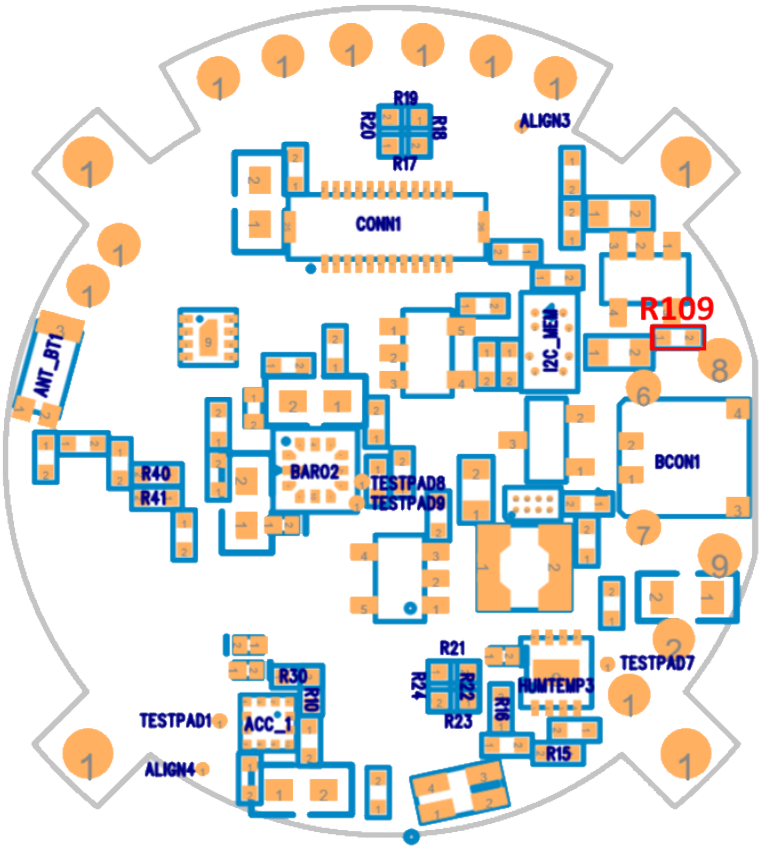
For example 128mAh with 1.2C continuous charge rating, the maximum charge current would be:

128 x 1.2 = 153.6mA

and the minimum resistor size would be

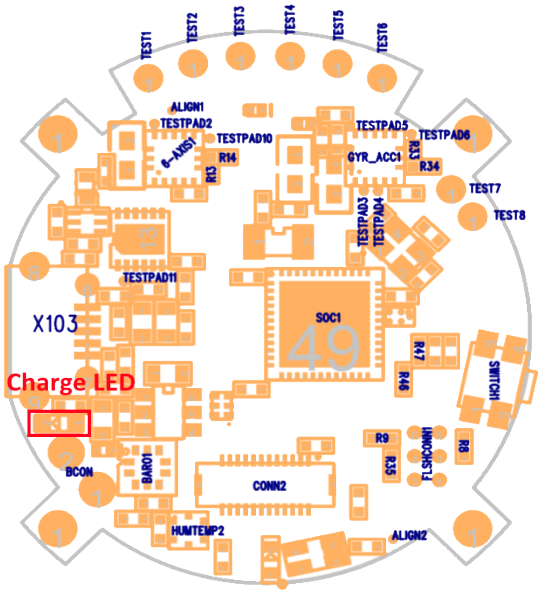
1000 / 153.6 = 6510 => 6.8kOhm

You may want to limit current a bit more to extend battery lifetime. In this case 8.2k Ohm resistor would be safe, limiting the maximum charge current to 122mA.



USB connector usage

BTL3K3 boards can be powered via USB connector without battery. When USB is connected and battery is installed, the battery starts charging. The red charging indicator led (image) is lit and stays lit if the battery is charging. If the battery is fully charged, the led turns off. Also communication via USB is possible. To use USB communication, the BTL3K3 board needs to be powered by battery before connecting the USB. BTL3K3 boards include FTDI USB to UART interface. Corresponding pins for USB connectivity on nRF51822 are listed on Table 12.



Pin	Pin name	function	connection
43	P0.24	USB_CTS	USB UART CTS
44	P0.25	USB_RTS	USB UART RTS
47	P0.28	USB_RX	USB UART RX
48	P0.29	USB_TX	USB UART TX

Table 12: nRF51822 pins for USB connectivity

The interface uses dedicated pins on nRF51822 for USB communication. More information on USB to UART interface chip can be found on datasheet http://www.ftdichip.com/Support/Documents/DataSheets/ICs/DS_FT234XD.pdf