RuuviTag

Open Source Bluetooth Smart Sensor Beacon

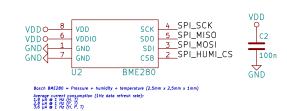http://ruuvi.com

Power Source

Q_PMOS_GSD VDD
Q1
+BATT P8
+BATT P9
Efficient reverse polarity protection circuitry.
PWR_FLAG
GND P5
PWR_FLAG
GND

Supply voltage: 1V7 – 3V6
Absolute maximum: 3V6

The default use case is to use CR2477N Lithium coin cell, but alternative power sources are also supported. Supercapacitor for example.

Bluetooth Smart SoC

nRF52 side matching
3n9
GND 100n C8 13 VDD
GND 100n C9 36 VDD
GND 4u7 C10 48 VDD
ANT 30 ANTENNA
VSS 31
C1 L3
GND 100n C11 1 DEC1
GND NA C12 32 DEC2
GND 100p C13 33 DEC3
46 DEC4
47 DCDC
0p8
GND
P0.31/AIN7 43
P0.30/AIN6 42
P0.29/AIN5 41 SPI_SCK
P0.28/AIN4 40 SPI_MISO

High frequency chip inductor ±10% ->
L1 15n
Chip Inductor, IDC,min = 50 mA, ±20% ->
L2 10u
1u C3
GND
P0.27 39
P0.26 38 I2C_SCL P17
P0.25 37 SPI_MOSI / I2C_SDA P18

XC1 34
XC2 35
GND 12p C4 32K
GND 12p C5
XTAL SMD 3215, 32.768 kHz, 9 pF, ±20 ppm
Capacitors, NP0, ±2%
Y1
ACC_INT1
SPI_HUMI_CS

P0.00/XL1
P0.01/XL2 3
P0.02/AIN0 4
P0.03/AIN1 5
P0.04/AIN2 6
P0.05/AIN3 7
P0.06 8
P0.07 9
P0.08 10
NFC1/P0.09 11
NFC2/P0.10 12

P0.24 29
P0.23 28
P0.22 27
SWDIO 26 SWDIO
SWDCLK 25 SWDCLK
P0.21/RESET 24 RESET
P0.20/TRACECLK 23
P0.19 22 LED2
P0.18/TRACEDATA[0] 21 SWO
P0.17 20 LED1
P0.16/TRACEDATA[1] 19
P0.15/TRACEDATA[2] 18
P0.14/TRACEDATA[3] 17
P0.13 16 BUTTON1
P0.12 15
P0.11 14 SPI_ACC_CS

P2 UART_TX
P3 UART_RX

NFC Antenna

GND
C6
NFC P4 NFCTUN1
C7
NFCTUN2
GND

Battery protection!
If the antenna is exposed to a strong NFC field, current may flow in the opposite direction on the supply due to parasitic diodes and ESD structures.

If the battery used does not tolerate return current, a series diode must be placed between the battery and the device in order to protect the battery.

NC 44
VSS 45
BOTPAD 49
GND
U1   nRF52832

GND 12p C14 XC1 Y2
32M xXC2
GND 12p C16
GND
XTAL SMD 2016, 32 MHz, Cl=8 pF, Total Tol: ±40 ppm
Capacitors, NP0, ±2%

LEDs & Buttons

VDD 470 R1 LED1 D1 LED1
VDD 470 R2 LED3 D2 LED2
GND SW1 SW_PUSH BUTTON1
GND SW2 SW_PUSH RESET

Accelerometer

VDD
14 VDD INT2 9
1 VDD_IO INT1 11 ACC_INT1
15 RES(VDD)/ADC2
NC 2
NC 3
VDD
10 RES(GND) CS 7 SPI_ACC_CS
5 GND SDO/SA0 6 SPI_MISO
12 GND SDA/SDI/SDO 5 SPI_MOSI
13 GND/ADC3 SCL/SPC 4 SPI_SCK
16 GND/ADC1
C18 4u7
U4   LIS3DH
GND

LIS3DH datasheet:
* The ADC1, ADC2 & ADC3 if not used can be left floating or keep connected to Vdd or GND.
* When no communication is on-going, data on CS, SPC, SDI and SDO are driven by internal pull-up resistors.

Accelerometer choices:
* H3LIS100DL: 8bit, 100u, 400Hz
* H3LIS200DL: 8bit, 10G–200, 1kHz
* H3LIS331DL: 12bit, 100–400G, 1kHz
* LIS2DH12: 2–8g, 1uA sleep, 10uA 50Hz, 250uA 1kHz max datarate, 1000pcs 1EUR (Mouser)
* LIS3DH: 22bit, 6–2*g, 2uA sleep, 10uA 10Hz, 250uA 1kHz max datarate, 1000pcs 2.6EUR (Mouser)
* LIS3DSH: 16bit, 2–16g, 2uA sleep, 11uA 3Hz, 225uA 1.6kHz max datarate, 1000pcs 1.3EUR (Mouser)
* LIS3DH: 12bit, 2–16g, 0.5uA sleep, 2uA 1Hz, 11uA 50Hz max datarate, 1000pcs 0.96EUR (Mouser)
* LIS2DE12: 8bit, 2–16g, 0.5uA sleep, 2uA 1Hz, 11uA 50Hz, 5kHz max datarate, 1000pcs 0.6EUR (Mouser, not yet in stock)

Pressure + Humidity + Temperature

VDD 8 VDD SCK 4 SPI_SCK
VDD 6 VDDIO SDO 5 SPI_MISO
GND 1 GND SDI 3 SPI_MOSI
GND 7 GND CSB 2 SPI_HUMI_CS
U2   BME280
VDD
C2 100n
GND

Bosch BME280 = Pressure + humidity + temperature (2.5mm x 2.5mm x 1mm)

Average current consumption (1Hz data refresh rate):
1.8 uA @ 1 Hz (H, P, T)
2.8 uA @ 1 Hz (P, T)
3.6 uA @ 1 Hz (H, P, T)

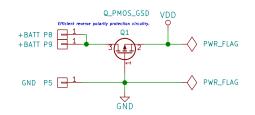Average current consumption in sleep mode 0.1 µA

Antenna

ANTENNA
C19
NA
GND

Shunt capacitor or Inductor. For convenience, a shunt capacitor is preferred. A shunt can be removed without changing the rest of the circuit and a capacitor is cheaper than an inductor.

Nordic Semiconductor's 1/4 wavelength monopole antenna design guide states:
When implementing the monopole as a trace on the PCB, the length of the trace should be extended somewhat to allow for some fine-tuning of the antenna to resonance at 2.45GHz. If the size of available ground plane is approaching the ideal size and the antenna trace is uniformly surrounded by the FR4 substrate, then the length of the trace should be extended by about 20%. If the ground plane size is considerably smaller than the ideal size and/or much of the antenna trace is routed close to the edge of the PCB, then the length of the antenna trace should be extended by about 30%.

Theoretical length L = 92mm / 4 = 23mm   -> 23mm * 1.3 = 30mm.

There are the following two methods to tune an antenna:

• If the physical dimensions of the antenna can be altered, for example, with PCB antenna, adjusting the length will be one part of the tuning. Another part is to add a component, inductor, or capacitor, to pull the antenna impedance towards the 50 ohm center point.

• If the antenna cannot be altered physically, more external components must be used to tune the antenna. These external components are called the matching network.

If it is not possible to get the impedance exactly 50 ohm by adjusting the length of the antenna, a component must be used to pull the impedance to the 50 ohm point. It is preferable to use a shunt capacitor since a capacitor is cheaper than an inductor and because a shunt capacitor can be removed without any impact.

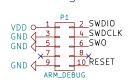For more info, check Nordic Semiconductor's White Paper about antenna tuning: Google "nWP-017_Antenna_Tuning"

Debug In

P1
VDD 1 2 SWDIO
GND 3 4 SWDCLK
GND 5 6 SWO
7 8
GND 9 10 RESET
ARM_DEBUG

Title: RuuviTag
Size: A3 | Date: 2016-01-13 | **Rev: B2**
KiCad E.D.A. kicad 4.0.1-stable | Id: 1/1

P6 FIDUCIAL
P7 FIDUCIAL