WiBear-SF
IEEE 802.11b/g WLAN and Bluetooth 3.0+EDR Module
Data Sheet

Preliminary Version 1.03
March 2012

Introduction

The WiBear-SF industrial universal module is targeted for integration into different OEM products solution enabling them to communicate over WLAN and Bluetooth connection. Module supports IEEE 802.11b/g WLAN station (client), micro access point, Bluetooth 3.0 + HS, and Bluetooth 2.1 + EDR operation modes. It provides a complete end-to-end solution for low-power applications. It includes an integrated MAC/Baseband processor and RF front-end components and can connect to a host processor through SDIO/SPI and high-speed UART interfaces. The WiBear-SF modules are offered in two versions (see ordering information). Host drivers for common operating systems such as Linux, Android, and Windows Mobile are available. The modules for Europe (CE) and US (FCC) are radio type approved.

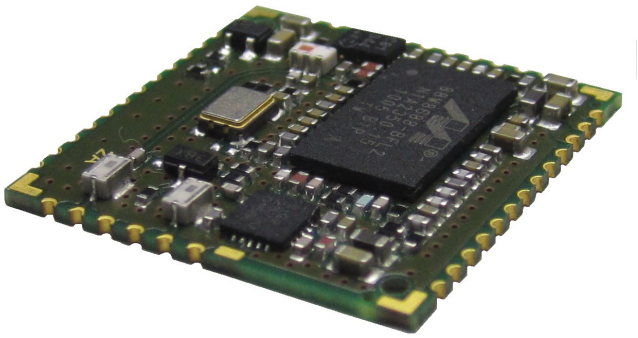


Figure 1: Physical outlook

Applications

- WLAN and Bluetooth networks
- Access to laptops, mobile phones etc.
- Automotive and industrial networking
- Home / building automation

Key Features

- Standards: IEEE 802.11b/g/e/i/h
- WLAN 802.11b/g station and micro access point operation (up to 8 clients supported)
- Bluetooth 3.0 + HS (Highspeed)
- Bluetooth 2.1 + EDR (backward compatibility)
- Background scan mode
- Wide temperature operation range -40ºC to +85ºC
- Unified 20mm x 20mm footprint, surface mounting
- SDIO/G-SPI and high speed UART interfaces
- Support for low power modes
- CE/FCC/IC compliant

Ordering Information

Table 1: Ordering information

Order Number	Part Number	Description
AN00K73534	WiBear-SF1	WiBear-SF1 Module, industrial temperature range
AN00K73535	WiBear-SF2	WiBear-SF2 Module, industrial temperature range
AN00K77232	WiBear-SF1_EK_Mini	Evaluation Kit with WiBear-SF1 Module, industrial temperature range
AN00K77233	WiBear-SF2_EK_Mini	Evaluation Kit with WiBear-SF2 Module, industrial temperature range

Product Variants

Product Variants

Table 2: Product variants

Product Name	Description
WiBear-SF1	Module has one joint antenna connector for WLAN and Bluetooth operation (see block diagram). Overall performance (throughput) in micro Access Point (µAP) mode with simultaneous Bluetooth traffic is less than WiBear-SF2. May be recommended for cost effective µAP solution, µAP without or rare Bluetooth traffic or cost effective station with one system antenna. See table below for performance comparison.
WiBear-SF2	Module has separated antenna connectors for WLAN and Bluetooth operation (see block diagram). Overall performance (throughput) is maximized for µAP mode with simultaneous Bluetooth traffic. Required two system antennas (one for WLAN and one for Bluetooth) with isolation between antennas 30 dB or better (orthogonal oriented antennas with distance between more than 50…60 mm.) May be recommended for higher performance of µAP.

Performance Comparison

Table 3: WLAN throughput in µAP mode

Module	Mode	Net Throughput
WiBear-SF1 or WiBear-SF2	TCP traffic, without Bluetooth	20 Mbps
WiBear-SF2 (Dual antenna)	TCP traffic + one Bluetooth SCO connection	18 Mbps
WiBear-SF1 (Single antenna)	TCP traffic + one Bluetooth SCO connection	13 Mbps

Note: Only one station (client) and one AP used in this test. Table shows near the maximum reached typical performance, real performance depend on host processor and system optimization level.

Note: Performance strongly depends from host controller. Recommended host controller performance corresponds to an ARM9 running with 400MHz to make available the net throughput as shown in Table 3

Note: For maximizing of WiBear-SF2 performance in µAP mode during simultaneous operation of WLAN and Bluetooth, Bluetooth Coexistence Arbiter (BCA) should be disabled by host software.

Block Diagram

WiBear-SF1

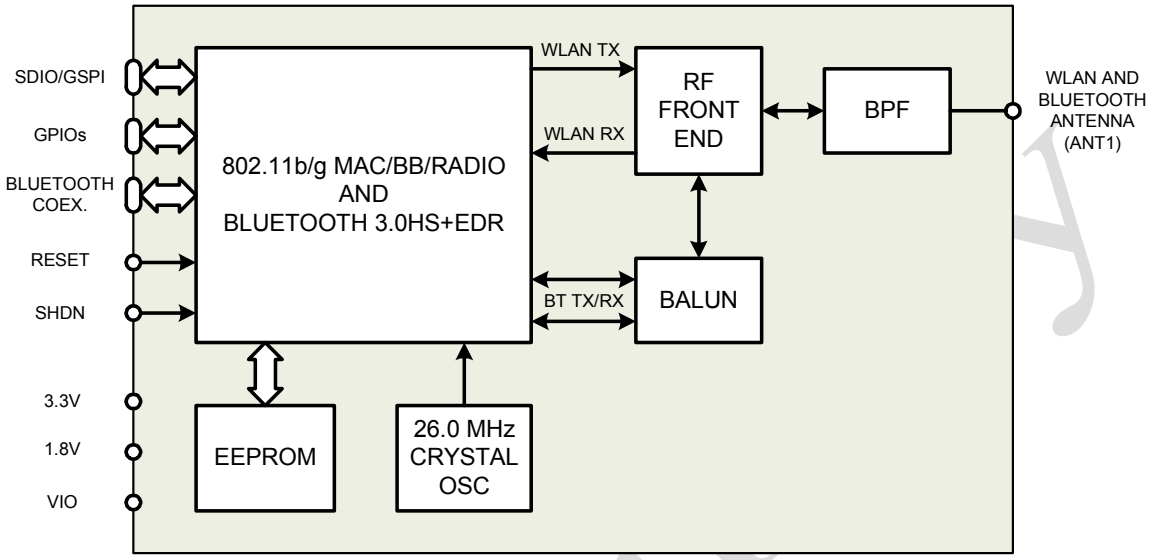


Figure 2: Block diagram of WiBear-SF1

WiBear-SF2

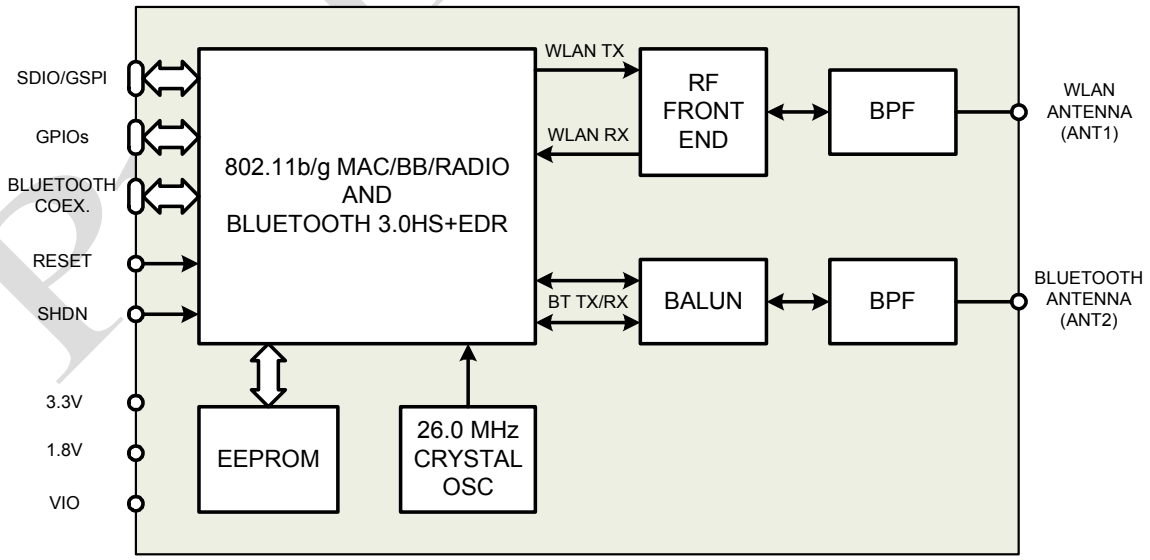


Figure3: Block diagram of WiBear-SF2

Pin Description

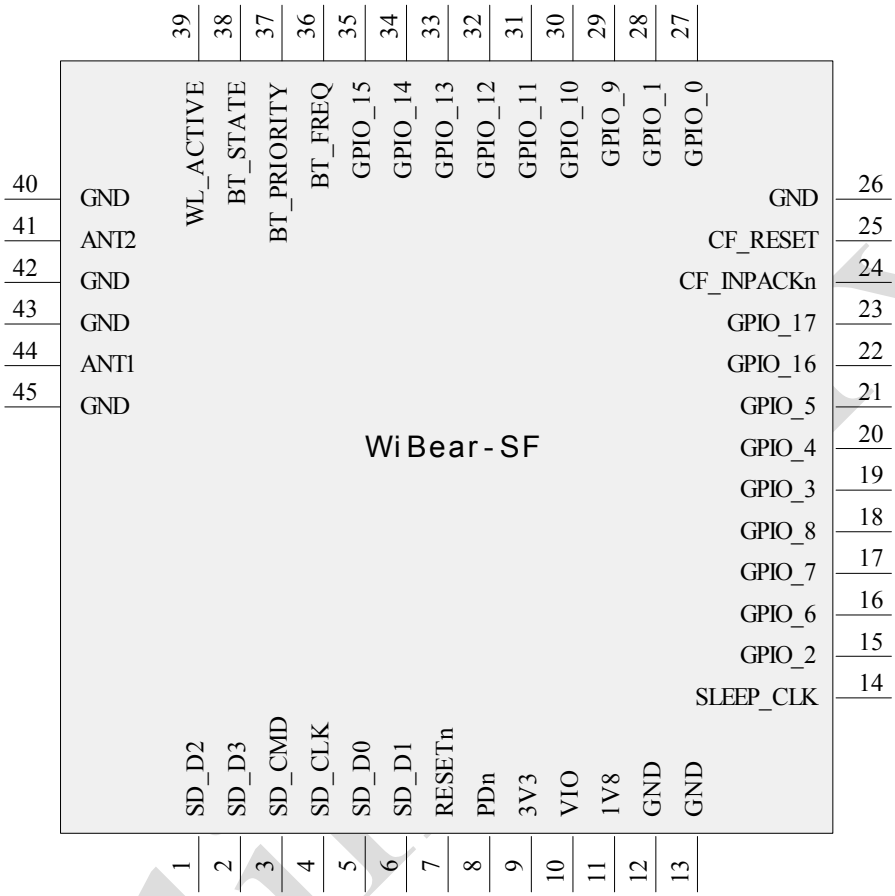


Figure 4: Module pinout

Table 4: Pin description

Pin No.	Pin Name	Pin Type	Description
1	SD_D2	I/O	SDIO 4-bit: Data line bit [2] or Read Wait (optional) SDIO 1-bit: Read Wait (optional) SDIO-SPI: Reserved G-SPI: Interrupt output (active low)
2	SD_D3	I/O	SDIO 4-bit: Data line bit [3] SDIO 1-bit: Reserved SDIO-SPI: Chip select (active low) G-SPI: Clock request
3	SD_CMD	I/O	SDIO 4-bit: Command/Response SDIO 1-bit: Command line SDIO-SPI: Data input G-SPI: Data input
4	SD_CLK	I	SDIO 4-bit: Clock input SDIO 1-bit: Clock input SDIO-SPI: Clock input G-SPI: Clock input

5	SD_D0	I/O	SDIO 4-bit: Data line bit [0] SDIO 1-bit: Data line SDIO-SPI: Data output G-SPI: Chip select input (active low)
6	SD_D1	I/O	SDIO 4-bit: Data line bit [1] SDIO 1-bit: Interrupt SDIO-SPI: Reserved G-SPI: Data output
7	RESETn	I	Reset (active low) Has weak internal pull-up
8	PDn	I	Full power down (active low), has internal pull-up to VIO pin
9	3V3	Power	3.3V Power supply
10	VIO	Power	1.8V or 3.3V host supply. Provide supply to all I/O pins.
11	1V8	Power	1.8V Power supply
12	GND	Ground	Ground
13	GND	Ground	Ground
14	SLEEP_CLK	I	Clock input for external sleep clock source (32.768kHz). The sleep clock used during power save modes and can be generated by an internal module clock source or provided from an external source. When an external sleep clock source is used, the internal sleep clock can be disabled to save power. For Bluetooth sleep mode an external sleep clock is required.
15	GPIO_2	I/O	UART RTS output
16	GPIO_6	I/O	UART SOUT output
17	GPIO_7	I/O	UART SINT input
18	GPIO_8	I/O	UART CTS input
19	GPIO_3	I/O	UART DSR input (normally not used) For UART connection use GPIO_2, GPIO_6, GPIO_7 and GPIO_8
20	GPIO_4	I/O	Host-to-Module wake-up input
21	GPIO_5	I/O	UART DTR output (normally not used) For UART connection use GPIO_2, GPIO_6, GPIO_7 and GPIO_8
22	GPIO_16	I/O	AIU_SPDIF output / Module to Host interrupt output if AIU_SPDIF is disabled
23	GPIO_17	I/O	LED output (Bluetooth activity) / Configuration Pin Note: Regardless of the I/O supply (1.8V or 3.3V), the supply to the actual board LED always need to use 3.3V supply on the other end of the LED and works as open drain circuitry.
24	CF_INPACKn	O	Module-to-Host wake-up output
25	CF_RESET	I	PC Card I/O Mode. Resets the card when active high. Do not connect if not used.
26	GND	Ground	Ground
27	GPIO_0	I/O	SLEEPn output
28	GPIO_1	I/O	LED output (WLAN TX or receive ready) / Configuration Pin Note: Regardless of the I/O supply (1.8V or 3.3V), the supply to the actual board LED always need to use 3.3V supply on the other end of the LED and works as open drain circuitry.
29	GPIO_9	I/O	AIU_TWSI_CLK input/output
30	GPIO_10	I/O	AIU_TWSI_DATA input/output
31	GPIO_11	I/O	BT_PCM_DIN input
32	GPIO_12	I/O	BT_PCM_DOUT output
33	GPIO_13	I/O	BT_PCM_CLK input/output (output if device is PCM master, input if device is PCM slave)
34	GPIO_14	I/O	BT_PCM_SYNC input/output (output if device is PCM initiator, input if device is PCM target)
35	GPIO_15	I/O	BT_PCM_MCLK output
36	BT_FREQ	I	Bluetooth frequency 0 – no frequency conflict between WLAN and the next Bluetooth hopping frequency 1 – frequency conflict between WLAN and the next Bluetooth hopping frequency

37	BT_PRIORITY	I	Bluetooth priority 2-Wire BCA: When high – Bluetooth is transmitting or receiving high priority packets. 3-Wire BCA: When high – Bluetooth is requesting to transmit or receive packets.
38	BT_STATE	I	Bluetooth state 0 – normal priority, RX 1 – high priority, TX BT_STATE is used to input the Bluetooth priority and direction of traffic following the assertion of the BT_PRIORITY input.
39	WL_ACTIVE	O	WLAN Active 2-Wire BCA: When high – WLAN is transmitting or receiving packets. 3-Wire BCA: 0 – Bluetooth device allowed to transmit 1 – Bluetooth device not allowed to transmit In 3 or 4 -wire BCA mode the signal output is programmable and can be low during both Bluetooth RX and TX timeslots. This pin drives low when in power down mode.
40	GND	Ground	Ground
41	ANT2	I/O	Bluetooth antenna for WiBear-SF2 module, for WiBear-SF1 not used
42	GND	Ground	Ground
43	GND	Ground	Ground
44	ANT1	I/O	WLAN + Bluetooth antenna for WiBear-SF1 module, WLAN only antenna for WiBear-SF2 module
45	GND	Ground	Ground

Note: Some GPIO functions may vary depend on used firmware (driver) version. Please refer to firmware description.

Note: In case of Bluetooth low power mode operation is needed connect to pin 14 32.768 kHz external clock with ±50 ppm or better accuracy over temperature and voltage and configure module for operation from external sleep clock (see section *"Module configuration"*). Typically the WLAN can use the internally generated sleep clock derived from the reference clock source in all operation modes. But in case of the Bluetooth application in where there is a requirement between master and slave relationship of the two Bluetooth devices during sniff mode to have a clock source of 50 ppm or better. The internal generated sleep clock is not accurate enough. Typically the accuracy of the internal sleep clock around 5000 ppm. In case if low power Bluetooth mode does not needed module can be configured for operation with internal sleep clock.

Note: Besides the aforesaid, connect pin 14 (SLEEP_CLK) to 32.768 kHz source if pin-to-pin compatibility with further module models (WiBear-11n) required. Operation of newest models may be not possible without this clock.

Electrical Specifications

Absolute Maximum Ratings

Table 5: Absolute maximum ratings

Name	Parameter	Min	Max	Units
3V3	Power supply voltage 3.3V	-0.3	4.2	V
1V8	Power supply voltage 1.8V	-0.3	2.3	V
VIO	I/O supply voltage 1.8V/3.3V	-0.3	4.2	V
$T_{STORAGE}$	Storage temperature	-40	+85	ºC

Operating Conditions

Table 6: Operating conditions

Name	Parameter	Min	Typ	Max	Units
3V3	Power supply voltage 3.3V	3.1	3.3	3.6	V
1V8	Power supply voltage 1.8V	1.7	1.8	1.9	V
VIO	I/O supply voltage 1.8V/3.3V	1.6	1.8	2.0	V
		3.0	3.3	3.6	V
T_A	Ambient operating temperature	-40	-	+85	ºC

Current Consumption

Table 7: Current consumption

Mode	1.8V Current		3.3V Current		Units
	AVG	Peak	AVG	Peak	
WLAN and Bluetooth RX	170	180	-	20	mA
WLAN TX +18dBm	170	180	-	210	mA
WLAN TX +15dBm	170	180	-	180	mA
WLAN TX + 6dBm	170	180	-	160	mA
WLAN RX, Bluetooth TX	200	205	-	20	mA
Typical operation at maximum power, ~ 50% RX / 50% TX time	180	205	125	210	mA
WLAN and Bluetooth in Deep Sleep mode	0.025	-	2.5	-	mA
Shutdown	0.025	-	0.025	-	mA

Note: Average consumption current strongly depend on operation mode and RX/TX time ratio

Digital Pad Ratings

Table 8: Digital pad ratings

Name	Parameter	Mode[1]	Min	Max	Units
V_{IH}	Input high voltage	1.8V	1.2	VIO+0.3	V
		3.3V	2.3	VIO+0.3	V
V_{IL}	Input low voltage	1.8V	-0.3	0.6	V
		3.3V	-0.3	1.1	V
V_{HYS}	Input hysteresis	1.8V	250	-	mV
		3.3V	400	-	mV
V_{OH}	Output high voltage	1.8V	1.2	-	V
		3.3V	2.6	-	V
V_{OH}	Output low voltage	1.8V	-	0.4	V
		3.3V	-	0.4	V

Note: [1]Typical voltage at VIO pin.

Radio Specifications

WLAN

Table 9: WLAN Radio specifications

Parameter	Specification
RF Frequency Range	2.400 – 2.500 GHz
Supported Channels	1 – 13 (IEEE 802.11b/g)
Modulation	802.11b: CCK and DSSS 802.11g: OFDM
Supported Data Rates	802.11b: 1, 2, 5.5, 11 Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54 Mbps
Transmit Power	802.11b: 18 dBm ± 1 dB 802.11g: 15 dBm ± 1 dB
Receiver Sensitivity	802.11b: 1 Mbps -98 dBm ± 1 dB 11 Mbps -90 dBm ± 1 dB 802.11g: 6 Mbps -91 dBm ± 1 dB 54 Mbps -74 dBm ± 1 dB

Table 10: 802.11b/g Channels Supported

Channel	Frequency, GHz	North America	Europe	Spain	France	Japan MKK
1	2.412	x	x	-	-	x
2	2.417	x	x	-	-	x
3	2.422	x	x	-	-	x
4	2.427	x	x	-	-	x
5	2.432	x	x	-	-	x
6	2.437	x	x	-	-	x
7	2.442	x	x	-	-	x
8	2.447	x	x	-	-	x
9	2.452	x	x	-	-	x
10	2.457	x	x	x	x	x
11	2.462	x	x	x	x	x
12	2.467	-	x	-	x	x
13	2.472	-	x	-	x	x
14	2.484	-	-	-	-	x

Note: channel 14 (Japan) operate in 802.11b mode only.

Bluetooth

Table 11: Bluetooth Radio specifications

Parameter	Specification
RF Frequency Range	2.400 – 2.4835 GHz
Supported Modes	BT 2.1, BT3.0 HS, EDR
Number of channels	79
Modulation	1 Mbps: GFSK (BDR) 2 Mbps: π/4 DQPSK (EDR) 3 Mbps: 8DQPSK (EDR)
Transmit Power	Minimum +3 dBm
Receiver Sensitivity	BDR: -90 dBm ± 1.5 dB EDR: -87 dBm ± 1.5 dB

Physical Dimensions

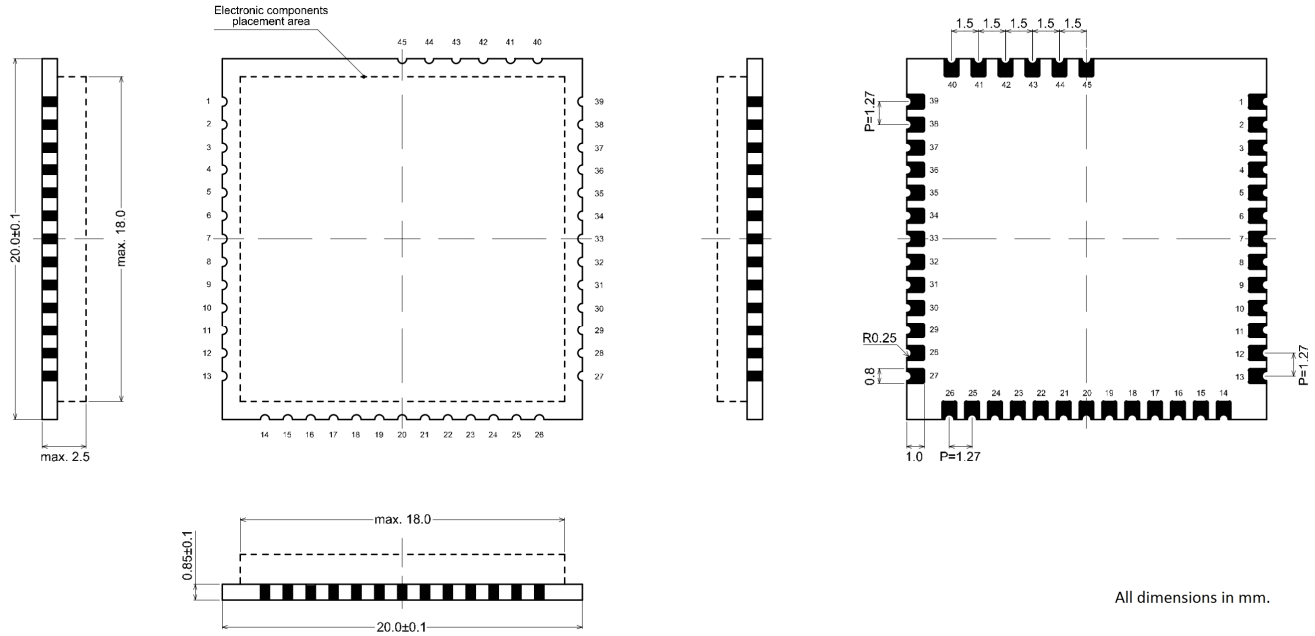


Figure 5: Physical dimensions

Recommended Footprint

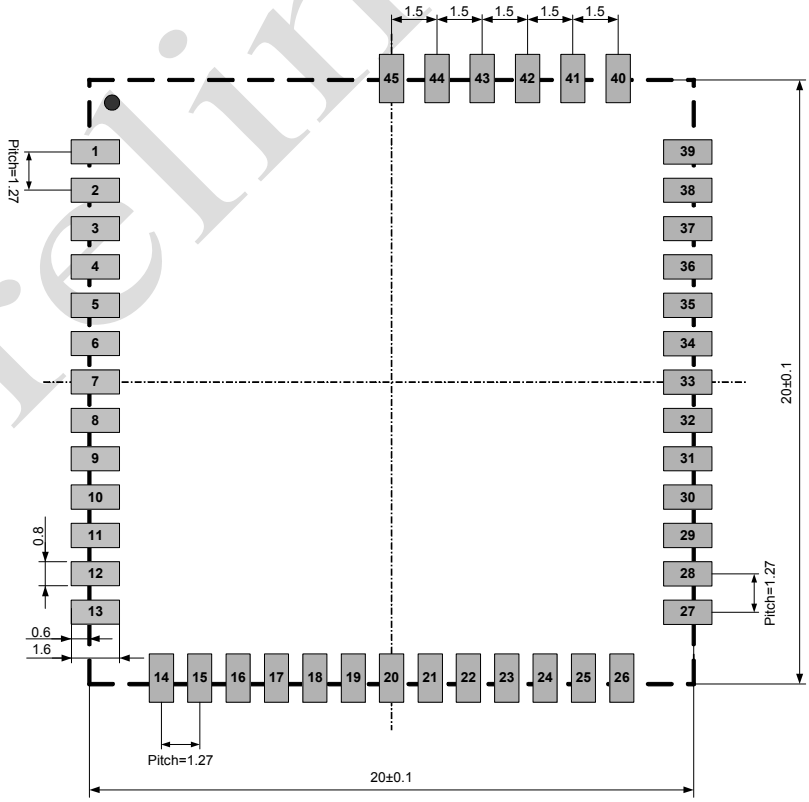


Figure 6: Recommended footprint

Module Configuration

Module uses some pins as configuration inputs to set parameters following a reset. The definition of these pins changes after reset to their usual function. When you need to configure the pins for a certain operation mode, you need to provide a 100k pull down resistor to ground. No external circuitry is required (but allowed) to set a configuration pin to high logical level. External reset is not needed for proper operation due to internal power-up reset logic but can be used by host controller in cases of abnormal module behavior.

Table 12: Configuration pins

GPIO	Function	Condition	Operation mode
GPIO_17	Host interface configuration	PD	G-SPI mode
		NC or PU	SDIO 4-bit, SDIO 1-bit and SDIO-SPI mode
GPIO_5	Sleep Clock configuration	PD	Internal sleep clock
		NC or PU	External sleep clock (32.768 kHz) should be used
GPIO_2	Internally used	NC or PD	Allowed, does not change functionality
		PU	Not allowed
GPIO_1	Internally used	PD	Not allowed
		NC or PU	Allowed, does not change functionality
GPIO_6	Internally used	PD	Not allowed
		NC or PU	Allowed, does not change functionality
GPIO_16	Internally used	PD	Not allowed
		NC or PU	Allowed, does not change functionality

Notes: GPIO_17 and GPIO_5 are end-user selectable for configuration changing
G-SPI and SDIO-SPI configurations has different pins functionality
PD – Pull-Down resistor (100k – 10k)
NC – Not Connected (floating pin) or connected to high impedance input
PU – Pull-Up resistor (100k – 10k)

Note: For all “NC or PU” in case of possible leakage to ground more than 1.2uA please apply Pull-Up resistor to VIO.

Note: simultaneous usage of LED on GPIO_17 line connected to 3.3V and Pull-Down is not allowed (LED acts as a strong Pull-Up), do not connect LED in case of Pull-Down necessity.

Host Interfaces

SDIO Interface

High speed host interface of WiBear-SF module (pins 1 – 6) can be configured as a SDIO (default) or G-SPI interface. WiBear-SF module supports a SDIO device interface that conforms to the industry standard SDIO Full-Speed specification and allows a host controller using the SDIO bus protocol to access the WLAN and/or Bluetooth devices. Module also supports High Speed mode as defined in the SDIO 1.2 specification.

The SDIO interface supports dual function operation – for WLAN and Bluetooth. Dual functionality allows the use of independent client drivers for WLAN and/or Bluetooth on the host platform. A module acts as the device on the SDIO bus. The SDIO interface supports SPI, 1-bit SDIO and 4-bit SDIO modes at the full clock range of 0 to 50 MHz. Pin description shown in table below.

Table 13: SDIO interface description

Pin No.	Pin Name	Pin Type	Description
1	SD_D2	I/O	SDIO 4-bit: Data line bit [2] or Read Wait (optional) SDIO 1-bit: Read Wait (optional) SDIO-SPI: Reserved
2	SD_D3	I/O	SDIO 4-bit: Data line bit [3] SDIO 1-bit: Reserved SDIO-SPI: Chip select (active low)
3	SD_CMD	I/O	SDIO 4-bit: Command/Response SDIO 1-bit: Command line SDIO-SPI: Data input
4	SD_CLK	I	SDIO 4-bit: Clock input SDIO 1-bit: Clock input SDIO-SPI: Clock input
5	SD_D0	I/O	SDIO 4-bit: Data line bit [0] SDIO 1-bit: Data line SDIO-SPI: Data output
6	SD_D1	I/O	SDIO 4-bit: Data line bit [1] or Interrupt (Optional) SDIO 1-bit: Interrupt SDIO-SPI: Interrupt

Note: For SDIO interface selection see “Module configuration” chapter

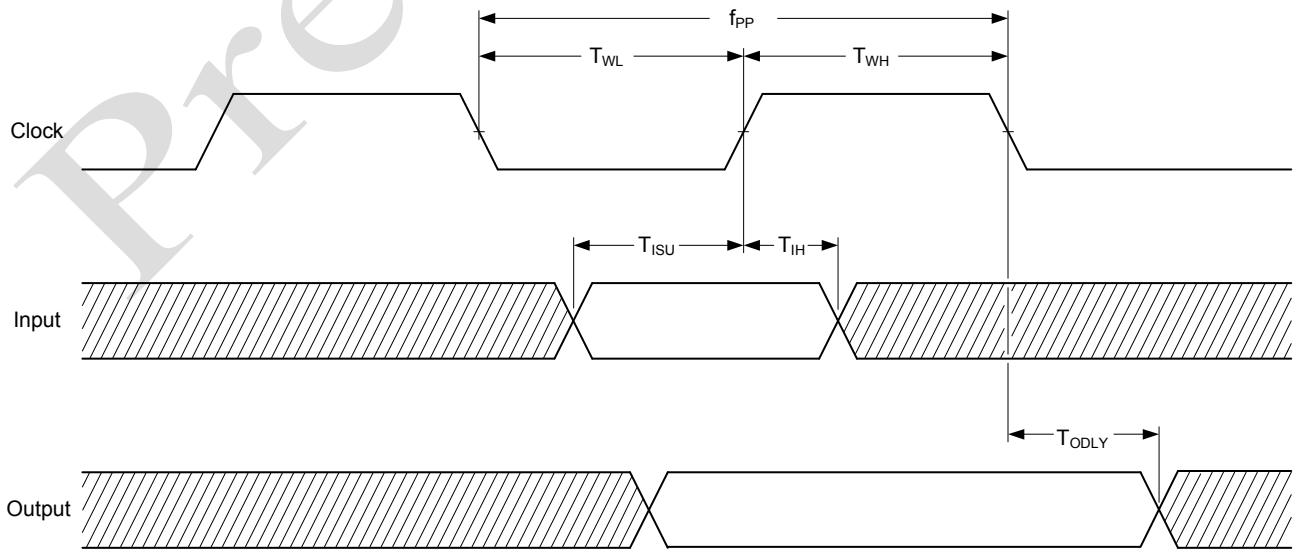


Figure 7: SDIO Protocol Timing Diagram

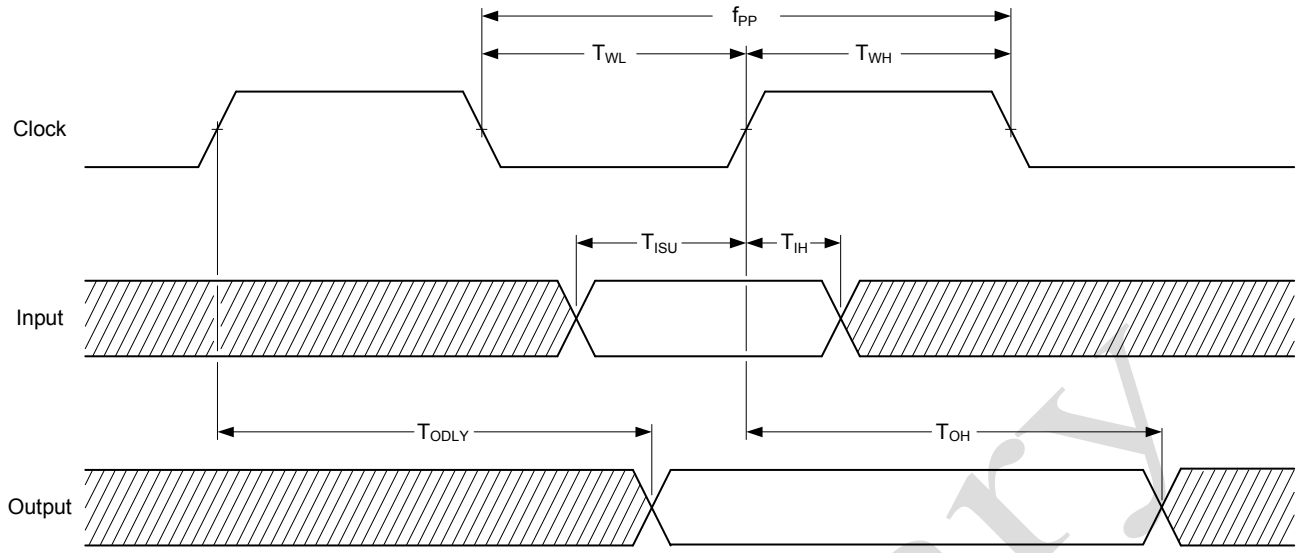


Figure 8: SDIO Protocol Timing Diagram at High Speed Mode

Table 14: SDIO Host Interface Timing Data

Symbol	Parameter	Condition	Min	Typ	Max	Units
f_{PP}	Clock Frequency	Normal	0	-	25	MHz
		High Speed	0	-	50	MHz
T_{WL}	Clock Low Time	Normal	10	-	-	ns
		High Speed	7	-	-	ns
T_{WH}	Clock High Time	Normal	10	-	-	ns
		High Speed	7	-	-	ns
T_{ISU}	Input Setup Time	Normal	5	-	-	ns
		High Speed	6	-	-	ns
T_{IH}	Input Hold Time	Normal	5	-	-	ns
		High Speed	2	-	-	ns
T_{ODLY}	Output Delay Time	-	-	-	14	ns
T_{OH}	Output Hold Time	High Speed	2.5	-	-	ns

G-SPI Interface

High speed host interface of WiBear-SF module (pins 1 – 6) can be configured as a G-SPI or SDIO (default) interface. In G-SPI mode module supports a generic, half-duplex, DMA-assisted SPI host interface (G-SPI) that allows a host controller using a generic SPI bus protocol to access the WLAN device. module acts as the slave device on the SPI bus. The design is capable of 50 MHz operation. Pin description shown in table below.

Table 15: G-SPI interface description

Pin Number	Generic SPI bus Name	Description
1	SINTn	SPI Unit active low interrupt output
2	SCLK_EN	SPI Unit clock Enable output
3	SDI	SPI Unit data input
4	SCLK	SPI Unit clock input
5	CSn	SPI Unit active low chip select input
6	SDO	SPI Unit data output
7	RSTn	Active low reset input (Module reset)

Note: For G-SPI interface selection see “Module configuration” chapter

Each transaction is initiated by assertion of the active low signal SCSn. Following the assertion of SCSn, the SDI input is latched with every positive edge of SCLK. When data is output, it is clocked out with the positive edge of SCLK. The clock input SCLK is low at the start and completion of a transaction. The interrupt output signal (SINTn) is asserted by the module to interrupt the host.

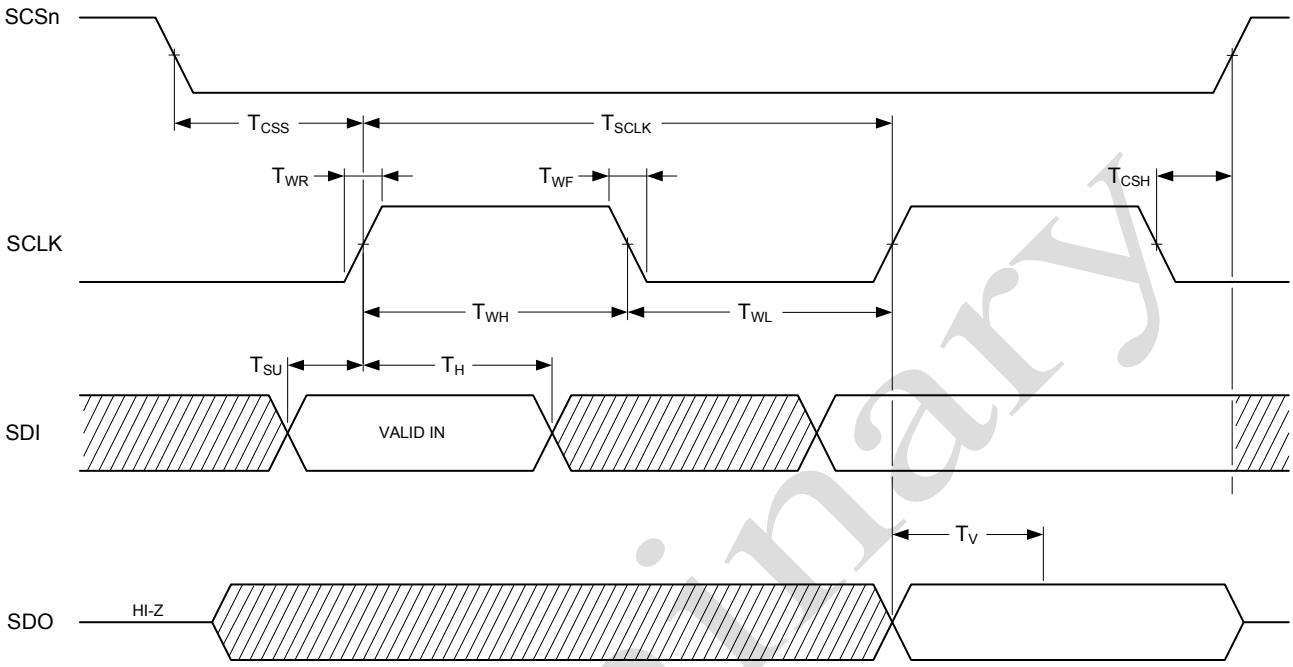


Figure 9: G-SPI Interface Transaction Timing

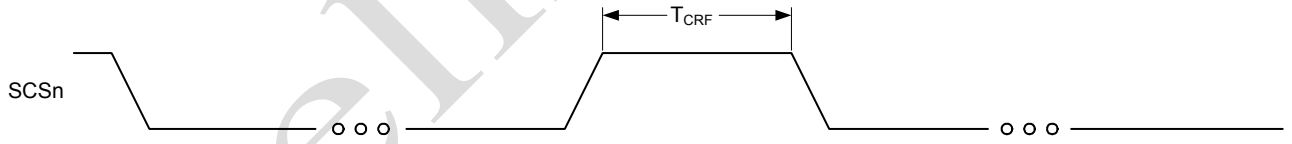


Figure 10: G-SPI Interface Inter-Transaction Timing

Table 16: G-SPI Host Interface Timing Data

Symbol	Parameter	Min	Typ	Max	Units
T_{SCLK}	Clock Period	20	-	-	ns
T_{WH}	Clock High	5	-	-	ns
T_{WL}	Clock Low	9	-	-	ns
T_{WR}	Clock Rise Time	-	-	1	ns
T_{WF}	Clock Fall Time	-	-	1	ns
T_{H}	SDI Hold Time	2.5	-	-	ns
T_{SU}	SDI Setup Time	2.5	-	-	ns
T_{V}	SDO Hold Time	5	-	-	ns
T_{CSS}	SCSn Fall to Clock	5	-	-	ns
T_{CSH}	Clock to SCSn Rise	0	-	-	ns
T_{CRF}	SCSn Rise to SCSn Fall	400	-	-	ns

Bluetooth Coexistence Interface

Module supports configurations with internal or external Bluetooth operation. Only one of the system configurations can be used at a time. The Bluetooth Coexistence Arbiter (BCA) can be configured to interface with an external Bluetooth device or with the internal Bluetooth subsystem. With the external interface mode, a choice of 2-wire (2WBCA), 3-wire (3WBCA) or 4-wire (4WBCA) signaling scheme is available. Only one of the BCA schemes can be used at a time.

The 2WBCA interface decides which device has primary access to the shared wireless medium according to the 2WBCA coexistence scheme. The 2WBCA interface makes its decision based on input signals from the Bluetooth device, 802.11 MAC device and register settings. The 2WBCA interface module compares any conflicting traffic based on a programmable table in the MAC registers. In that case arbiter needs to be configured for 2WBCA operation, the default timer values and programmable options are optimized for 3WBCA operation and may not be suitable for 2WBCA operation.

The 3WBCA and 4WBCA scheme operate the same, except that the 4WBCA includes an additional input signal to specify whether the Bluetooth device is using a channel that overlaps with the WLAN channel. The 4WBCA coexistence framework is based on the IEEE 802.15.2 recommended practice Packet Traffic Arbitration (PTA) scheme.

Table 17: Bluetooth coexistence signals

Pin No.	Pin Type	2-Wire	3-Wire	4-Wire
36	I	Not used	Not used	BT_FREQ
37	I	BT_PRIORITY	BT_RF_ACTIVE	BT_RF_ACTIVE
38	I	Not used	BT_STATE	BT_STATE
39	O	WL_ACTIVE	BT_TX_CONF	BT_TX_CONF

2WBCA

2WBCA accepts one input (BT_PRIORITY) from Bluetooth device, requesting access to the medium for a priority Bluetooth event. The BCA unit outputs a control (WL_ACTIVE) signal to the Bluetooth device to signal when the WLAN is active. The Bluetooth device should not attempt to transmit when the WL_ACTIVE signal is high. The 2WBCA determines WLAN Rx and Tx priority based on the frame type and register settings.

3WBCA

BCA uses three signals. BT_RF_ACTIVE (BT_REQ) input signal to inform Module that Bluetooth traffic is actively in Tx or Rx mode (Bluetooth device requests access to the medium). The assertion of this signal precedes the actual Bluetooth packet slot time. BT_TX_CONF – output signal from Module to the Bluetooth device to indicate permission to Tx. If this output is low, then the Bluetooth device can Tx. This signal stays low for the duration of Bluetooth transmission. BT_STATE – input to inform the Module wether Bluetooth in Tx or Rx mode and priority level of the traffic (priority of BT_RF_ACTIVE and the direction of the Bluetooth data). Priority information on the BT_STATE input pin is signaled after the BT_RF_ACTIVE signal is asserted. The Bluetooth Tx/Rx information on the BT_STATE input pin is signaled after priority information.

4WBCA

The 4WBCA based on the 3WBCA with the addition of an input signal specifying whether the Bluetooth device will be using a channel that overlaps with the WLAN channel (in band) or does not overlap with the WLAN channel (out of band) – BT_FREQ signal. The same control registers affect the 3WBCA and 4WBCA schemes.

Antennas

Antenna Connection

On-board chip antennas or external antennas may be used with WiBear-SF module. Chip antenna can be connected to the module by a 50 Ohm micro-strip or coplanar transmission line (see picture below). Transmission line dimensions should be calculated in accordance to printed board and solder mask material dielectric parameters, thickness and vertical distance to a next subject ground plane. In some cases antenna may not perform as intended and exhibit undesirable characteristics, such as low gain or poor return loss. This is mainly due to the mismatch of the antenna system to the 50 Ohm impedance feed line into the antenna or the enclosure over the antenna (distance to ground plane and its shape around antenna, printed board material dielectric constant and material thickness, housing material over the antenna, adjacent metal devices, such as batteries, LCD panels etc.) To fix an antenna mismatch problem additional matching circuit with capacitors and/or inductors should be used. Pi-network can be placed on board closed to antenna (components C4, C5, L1 on example board) as a universal solution for almost any possible cases of mismatching. Please refer to the application notes for chip antenna layout considerations which usually provided by manufacturers of antennas for chip antenna placement and matching.

For external antenna connection widely used Hirose U.FL-R-SMT receptacle may be recommended (actually as a standard solution for such or similar equipment). This connector should be connected to module by micro-strip or coplanar 50 Ohm transmission line. It is good to keep free from surrounding top layer ground plane the area under a coaxial connector and in close around the antenna terminal ANT1/ANT2 of the module (see example below). Amount of the ground plane around RF connections and components should be maximized. For reducing parasitic inductance of connection between ground planes at different levels sufficient amount of VIAs should be used.

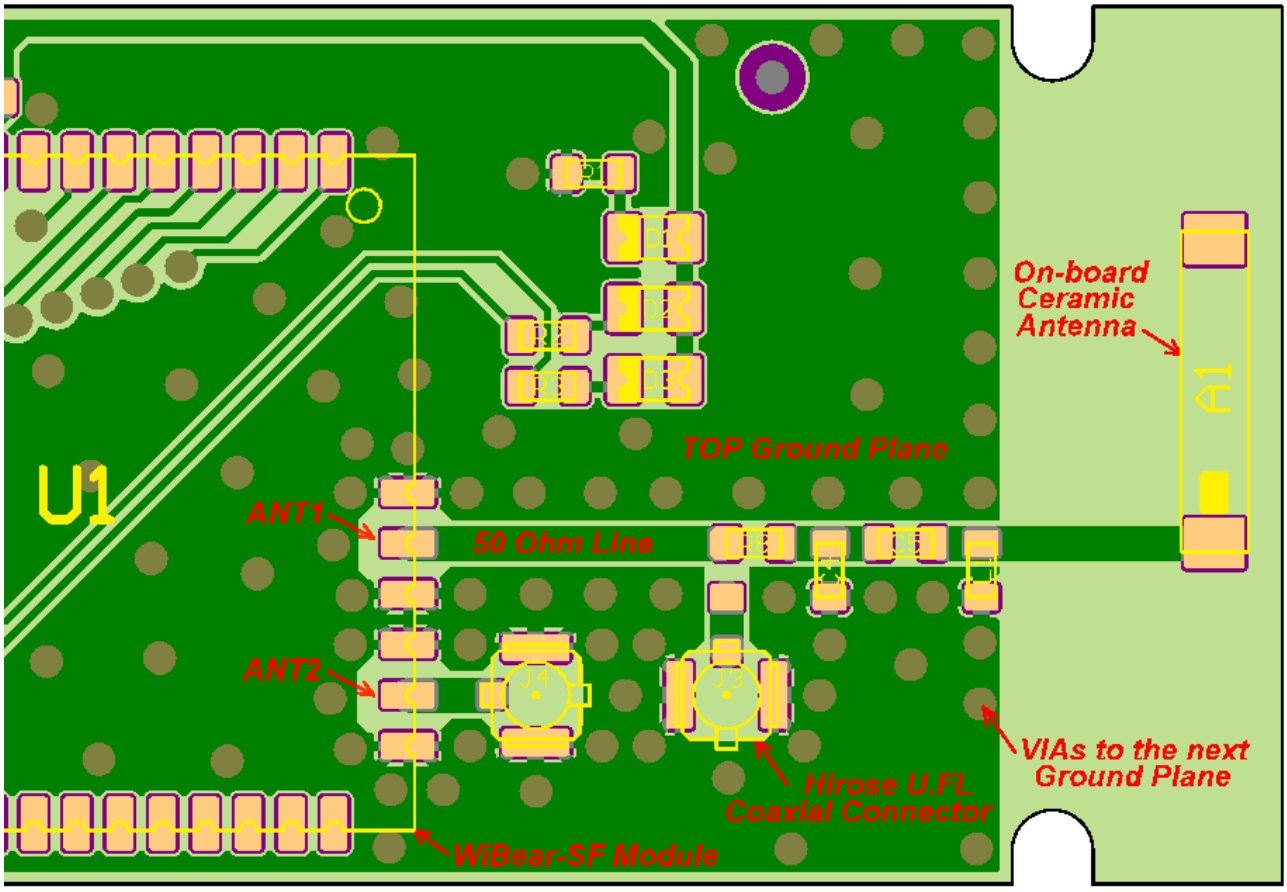


Figure 11: Example of the antenna connection to the module

Antenna Accessories

Table 18: Antenna accessories

Part name and description	Comment	Outlook
Hirose U.FL-R-SMT Surface mounted 50-Ohm miniature coaxial connector	U.FL coaxial receptacle may be mounted on main board which consist WiBear-SF module to provide RF connection between module and external components (antenna). Actually as a standard solution for such or similar equipment	
U.FL to SMA (receptacle) adapter cable	Ready-made cables of different length (from 75 to 300 mm) and diameters (0.81, 1.13 and 1.32 mm) are available on the market as well as possibility of the custom production. The SMA connector may be mounted in a panel. Not approved for use in US and Canada. Approved for EU (due to SMA connector).	
U-FL to RP-SMA (receptacle) adapter cable	Ready-made cables of different length (from 75 to 300 mm) and diameters (0.81, 1.13 and 1.32 mm) are available on the market as well as possibility of the custom production. The RP (Reverse Polarity) connector may be mounted in a panel. Approved for use in the US, Canada and EU (due to RP-SMA connector).	

Antennas

Table 19: Antennas

Part name and description	Comment	Outlook
Wuerth Elektronik 7488910245, Johanson Technology 2450AT45A100 Chip antenna, surface mounting Frequency range: 2400 – 2500 MHz Gain: 3 dBi Impedance: 50 Ohm Size: 9.5 x 2.0 x 1.2 mm	SMD Antenna	
WiMo 17010.10 / 17010.10REV Half-wave dipole antenna Frequency range: 2350 – 2500 MHz Gain: 3.14 dBi Impedance: 50 Ohm Polarization: vertical Size: 95 x 9 mm Connector: 17010.10: SMA plug 17010.10REV: RP-SMA plug	Both SMA and RP-SMA connectors approved for EU, RP-SMA version only approved for US and Canada.	
WiMo 17010.11 / 17010.11REV Half-wave dipole antenna Frequency range: 2350 – 2500 MHz Gain: 3.14 dBi Impedance: 50 Ohm Polarization: vertical Size: 95 x 16 mm Connector: 17010.11: SMA plug 17010.11REV: RP-SMA plug	Both SMA and RP-SMA connectors approved for EU, RP-SMA version only approved for US and Canada.	

Reference Design

Overview

Reference design shows how to connect a WiBear-SF module to the host controller over SDIO and UART interfaces. WLAN and Bluetooth (BT2.1 + EDR) may be connected to the host simultaneously over SDIO bus or separately over SDIO bus and UART for WLAN and Bluetooth correspondingly. For WLAN and Bluetooth HS operation (BT3.0 HS + EDR) both connections are required (SDIO + UART). Possible to use onboard ceramic antenna or external antenna connected via coaxial connector by means of setting of jumper R8 or R9. Host interface voltage can be settled by jumper R6 or R7 (3.3V or 1.8V). Ready-made reference design available as WiBear-SF Evaluation Kit (WiBear-SF1 or WiBear-SF2 EK Mini) from Lesswire AG.

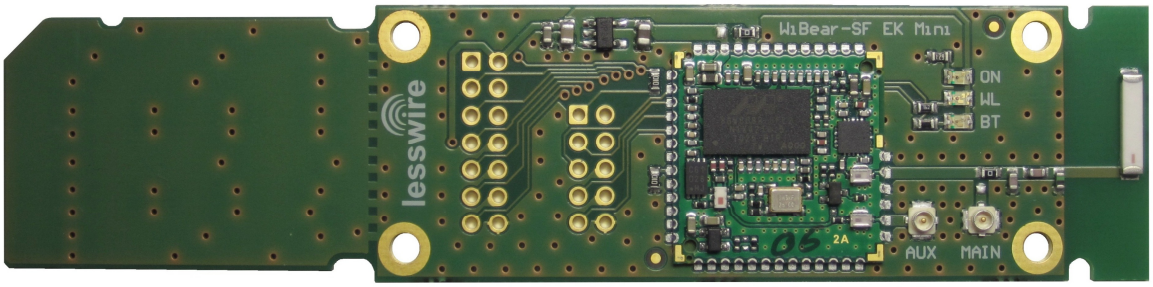
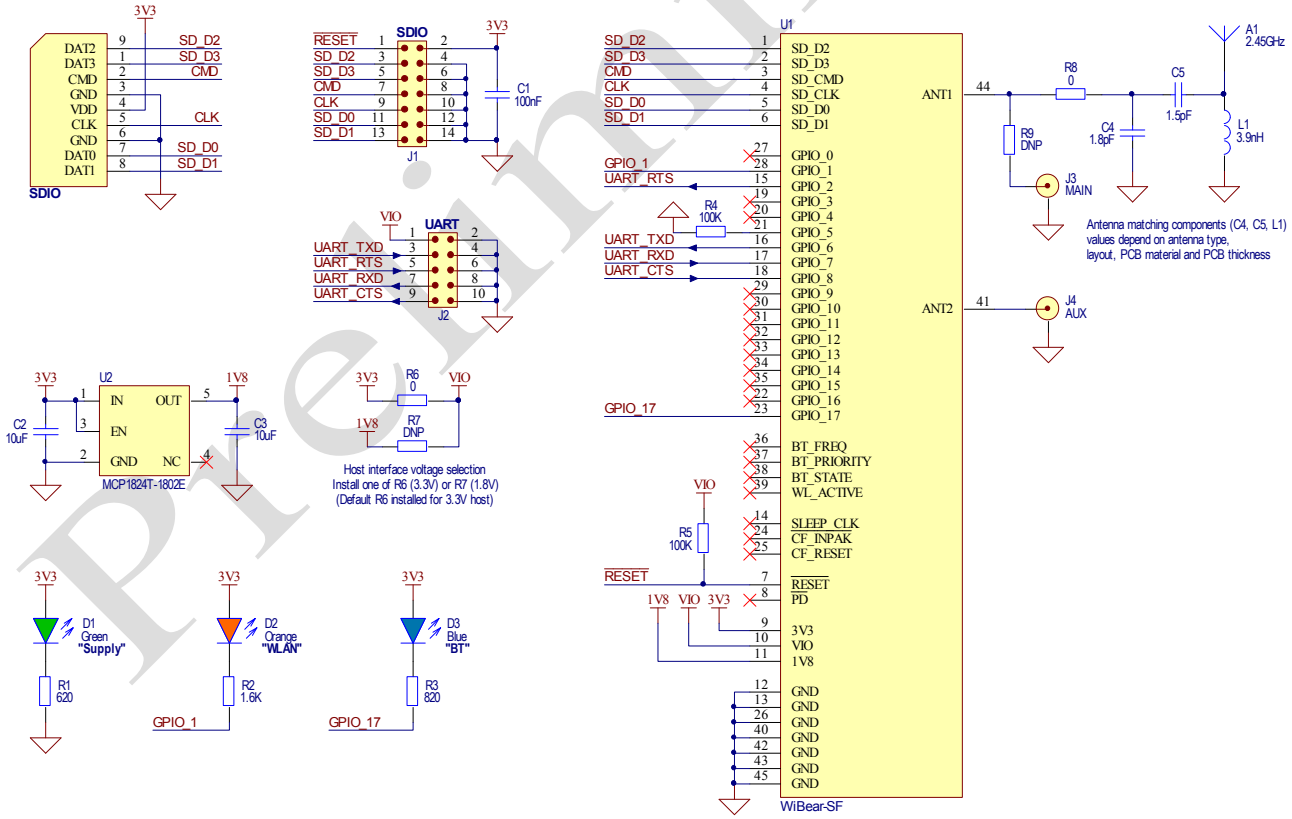


Figure 12: Evaluation Kit outlook

Schematic Diagram



Assembly option	Description	U1	J4
1	WiBear-SF1: WLAN and Bluetooth at the same antenna terminal (U1: ANT1, Pin 44)	WiBear-SF1	DNP
2	WiBear-SF2: WLAN (U1: ANT1, Pin 44) and Bluetooth (U1: ANT2, Pin 41) at the different antenna terminals	WiBear-SF2	+

* End user can select on-board antenna or coaxial connector usage for "Main" signal by means of installation of one of two resistors R8 or R9 (Default: on-board antenna)

Figure 13: Schematic diagram

Assembly Diagram

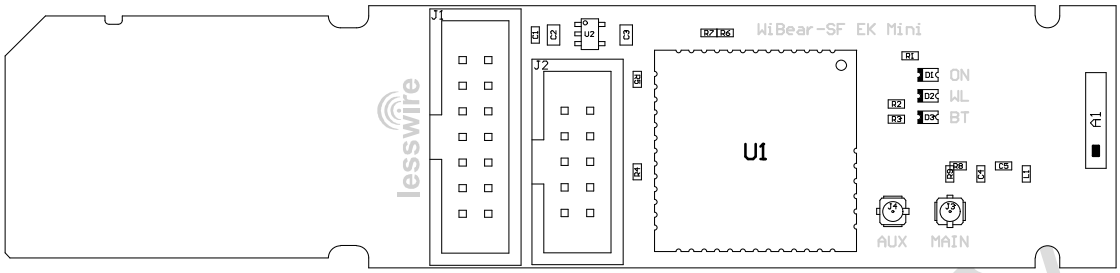


Figure 14: Assembly diagram

Bill of Materials

Table 20: Bill of materials

Qty	Des	Part Description	Manufacturer Part Number	Assembly Option	
				1	2
1	A1	Antenna CHIP 2450MHz 9.5x2.0x1.2mm	Johanson Technology: 2450AT45A100	+	+
1	C1	CAP, CER, 100nF, 20%, X7R, 16V, SMD 0603	Generic Components	+	+
2	C2, C3	CAP, CER, 10uF, 20%, X5R, 6.3V, SMD 0805	Generic Components	+	+
1	C4	CAP, CER, 1.8pF, +/-0.1pF, NP0, 50V, SMD 0603	Generic Components	+	+
1	C5	CAP, CER, 1.5pF, +/-0.1pF, NP0, 50V, SMD 0603	Generic Components	+	+
1	D1	LED, Green, SMD 0805	Kingbright: KPHCM-2012SCGCK	+	+
1	D2	LED, Orange, SMD 0805	Kingbright: KPHCM-2012SECK	+	+
1	D3	LED, Blue, SMD 0805	Kingbright: KPHCM-2012PBC-A	+	+
1	J1	Pin Header, Double Row, 2.54mm pitch, Straight, Shrouded, 2x7 Way, Through Hole	Generic Components	DNP	DNP
1	J2	Pin Header, Double Row, 2.54mm pitch, Straight, Shrouded, 2x5 Way, Through Hole	Generic Components	DNP	DNP
1	J3	Coaxial Connector, 0 - 6GHz, SMD	Hirose: U.FL-R-SMT	+	+
1	J4	Coaxial Connector, 0 - 6GHz, SMD	Hirose: U.FL-R-SMT	DNP	+
1	L1	IND, CER, 3.9nH +/-0.3nH, 600mA, 0.3 Ohm, SMD 0603	Generic Components	+	+
1	PCB	PCB, 110x26x1.5mm, FR4, 2Layers, Plated through holes	Lesswire AG: WiBear-SF EK Mini	+	+
1	R1	RES, 620 Ohm, 5%, 1/10W, SMD 0603	Generic Components	+	+
1	R2	RES, 1.6K, 5%, 1/10W, SMD 0603	Generic Components	+	+
1	R3	RES, 820 Ohm, 5%, 1/10W, SMD 0603	Generic Components	+	+
2	R4, R5	RES, 100K, 5%, 1/10W, SMD 0603	Generic Components	+	+
2	R6, R8	RES, 0 Ohm, 1/10W, SMD 0603	Generic Components	+	+
2	R7, R9	RES, 0 Ohm, 1/10W, SMD 0603	Generic Components	DNP	DNP
1	U1	WLAN 802.11b/g and Bluetooth Module, 20.0x20.0x3.0mm	Lesswire AG: WiBear-SF	WiBear -SF1	WiBear -SF2
1	U2	CMOS LDO Voltage Regulator 1.8V 300mA, SOT23-5	Microchip: MCP1824T-1802E/OT	+	+

Mounting process

The WiBear-SF is a surface mount module supplied on a 6-layer FR4-type PCB with gold plated connection pads and produced in a lead-free process with a lead-free soldering paste.

Modules rated at moisture sensitivity level 3. See moisture sensitive warning label on each shipping bag for detailed information. After opening the dry pack, modules must be mounted within 168 hours in factory conditions of maximum 30°C/60%RH or must be stored at less than 10%RH. Modules require baking if the humidity indicator card shows more than 10% when read at 23±5°C or if the conditions mentioned above are not met. Please refer to J-STD-033B standard for bake procedure.

Module is compatible with industrial reflow profile for RoHS/Pb-free solders, Sn96.5/Ag3.0/Cu0.5 solder is a right choice. Use of "No Clean" soldering paste is strongly recommended, cleaning the populated modules is strongly discouraged - residuals under the module cannot be easily removed with any cleaning process. Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads.

Only a single reflow soldering process is encouraged for host boards with WiBear-SF modules.

The reflow profile used is dependent on the thermal mass of the entire populated PCB, heat transfer efficiency of the oven and particular type of solder paste used. Since the profile used is process and layout dependent, the optimum profile should be studied case by case. Recommendations below should be taken as a starting point guide. In case of basic information necessity please refer to J-STD-020C standard.

Table 21: Recommended reflow profile

Profile feature	Sn-Pb eutectic (Sn63/Pb37)	RoHS/Pb-free (Sn96.5/Ag3.0/Cu0.5)
Ramp up rate (T_{SMAX} to T_P)	3°C/sec max	3°C/sec max
Minimum soak temperature (T_{SMIN})	100°C	150°C
Maximum soak temperature (T_{SMAX})	150°C	200°C
Soak time (ts)	60 - 120 sec	60 - 180 sec
Liquidus temperature (T_L)	183°C	217°C
Time above T_L (t_L)	60 - 150 sec	60 - 150 sec
Peak temperature (T_P)	215 - 225°C	235 - 245°C
Time within +0 / -5°C of actual T_P (tp)	10 - 30 sec	20 - 40 sec
Ramp down rate	6°C/sec max	6°C/sec max
Time from 25°C to T_P	6 min max	8 min max

Note: lowest value of T_P and slower ramp down rate (2 - 3°C/sec) is preferred.

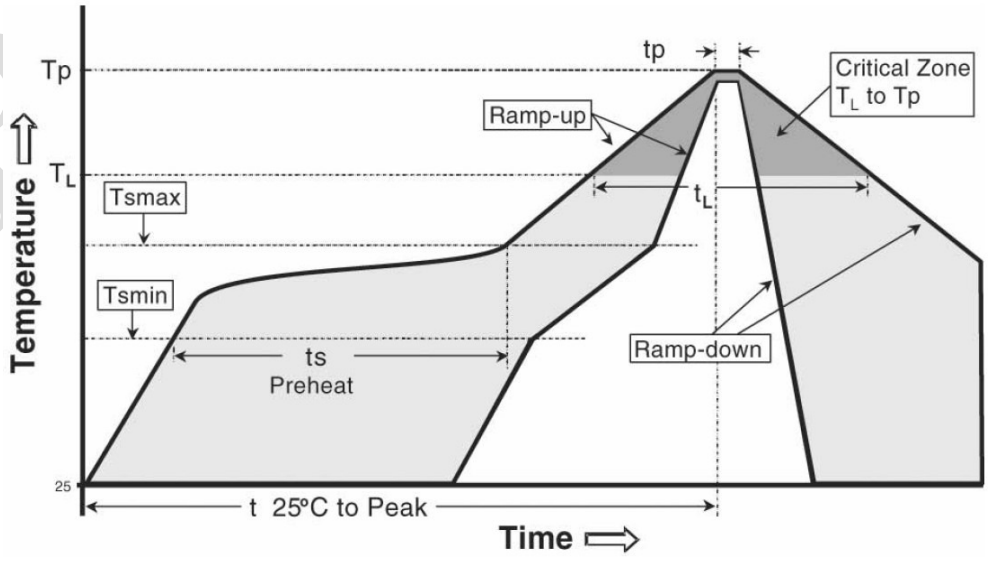


Figure 15: Reflow profile

Certifications

General

This module has to be installed and used in accordance with the technical instructions provided by the manufacturer. The module may be implemented in the configuration that was authorized. Note that any modifications of this equipment not expressly approved by the manufacturer could void the user's authority to operate the equipment.

European Union Regulatory Compliance

WiBear-SF module has been tested and complies with the regulatory standards EN 300 328 and EN 301 489 - 1/-17. We declare that the human exposure of this module is below the SAR limits specified in the EU recommendations 1999/519/EC.

IMPORTANT: The 'CE' marking must be affixed to a visible location on the OEM product, where this module is installed in, and has to be labeled in accordance to R&TTE Directive 1999/5/EC.

FCC Compliance

This device complies with Part 15 of the FCC Rules and has limited modular approval due to module shield absence. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Not authorized modification could void authority to use this equipment.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. The internal / external antenna(s) used for this module must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE: The outside of final product that contain a WiBear-SF module must display in a user accessible area a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: PV7-WIBEAR-SF-STA" or "Contains FCC ID: PV7-WIBEAR-SF-STA", for equipment which contain WiBear-SF1 Module and "Contains Transmitter Module FCC ID: PV7-WIBEAR-SF-UAP" or "Contains FCC ID: PV7-WIBEAR-SF-UAP" for equipment which contain WiBear-SF2 Module.

IC Compliance

The term "IC" before the radio certification number only signifies that Industry Canada technical specification were met. WiBear-SF1 IC ID: 7738A-WIBEARSFSTA, WiBear-SF2 IC ID: 7738A-WIBEARSFUAP.
Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada.

Approved Antenna List

Module has been tested and approved for use with the antennas listed in the table below.

Table 22: Approved Antenna List

Model Name	Manufacturer and description	Gain [dBi]
17010.10REV	WiMo, Halfwave dipole, SMA, 2350 – 2500 MHz	3.14
7488910245	Wuerth Elektronik, chip antenna, 2400 - 2500 MHz	3

Alternative antenna of the same type and which has a gain equal or less that the approved antenna can be used without recertification. Use of an antenna different type or same type but higher gain will invalidate the country approvals, in that case OEM installer must authorize usage of alternative antenna with respective regulatory agencies.

Revision History

Table 23: Revision history

Date	Version	Author	Description
17-Dec-2010	0.90	Igor Shevchenko Wilfried Lohmann	Preliminary release
08-Feb-2010	0.91	Igor Shevchenko	Current consumption table added
16-Mar-2011	0.92	Igor Shevchenko	Pin Description table changed “Module configuration” chapter and G-SPI Interface description added
17-Mar-2011	0.93	Igor Shevchenko	BT Output Power changed SDIO Interface description added
18-Apr-2011	0.94	Igor Shevchenko	Note about SLEEP_CLK and WLAN 802b/g Supported Channels added, Bluetooth output power changed. Storage temperature corrected to -40…+85C. FCC Compliance explanation expanded.
03-May-2011	0.95	Igor Shevchenko	Key features expanded (Supported standards) Supported Channels list corrected Sleep clock note added Bluetooth coexistence interface section added Module configuration notes are expanded
30-May-2011	0.96	Igor Shevchenko	Radio specifications changed.
14-Jun-2011	0.97	Igor Shevchenko	Reflow solder profile added.
15-Jun-2011	0.98	Igor Shevchenko	Reflow solder profile updated.
25 -Oct-2011	0.99	Igor Shevchenko Andras Varadi	Added note on page 3. Minor text errors fixed.
29-Nov-2011	1.00	Igor Shevchenko	Module, Evaluation Kit photos and module dimensions drawing updated (w/o shielding), recommended antennas parameters updated, Wuerth 7488910245 chip antenna to approved antenna list added. IC compliance added. SDIO timing diagrams error fixed.
01-Dec-2011	1.01	Igor Shevchenko	MSL Class 3 information added, recommended reflow profile note updated, note for channels supported list added.
28-Feb-2012	1.02	Igor Shevchenko	FCC and IC compliance expanded (FCC limited modular approval and IC IDs added)
12-Mar-2012	1.03	Igor Shevchenko	Antennas parameters in Table 19 updated