a module solution provider

WB9770-00

Ultra-low Power 2.4GHz BLE Wireless Audio Module

NXP NXH3670 + KL27 MCU Solution

Datasheet

Draft 0.1

Prepared By	Reviewed By	Approved By

Index

1. OVERVIEW

The WB9770-00 module from JORJIN is a wireless audio module targeting at wireless audio streaming for hearables, wireless headsets and headphones applications. This module is based on NXP NXH3670 and KL27.

The NXH3670UK constitutes a highly integrated, single chip ultra-low power 2.4 GHz wireless transceiver with embedded MCU. The NxH3670 runs a proprietary wireless audio streaming protocol which has been optimized for wireless gaming headset applications, providing high-quality forward audio streaming at low latency (<20ms) combined with a simultaneous voice microphone backchannel. Additionally, a wireless bidirectional data channel is available. While primarily designed for headsets, this solution can also enable wireless audio streaming for household and office devices like soundbars, wireless speakers, wireless Subwoofers and more.

The module is using a MKL27Z256VMP4 as host controller for the NXH3670. To communicate with the NXH3670 SPI slave interface, it has an SPI master interface. In addition, the host controller has an I2C master interface which can be connected to the codec or any external I2C device.

1.1. General Features

- NXP NXH3670UK & MKL27Z256VMP4, 24.576MHz & 16MHz crystals, and chip antenna on a single module.
- LGA 90pins package.
- Dimension 19.5mm(L) x 12mm(W)
- The height of module without antenna is 2.2mm, with antenna is 2.6mm.
- Powerful ARM® Cortex®-M0+ Microcontroller up to 48MHz
- 256 KB program flash memory, 32 KB SRAM in host controller.
- USB full-speed 2.0 device controller supporting crystal-less operation
- USB x 1, I2C x 2, SPI x 1, UART x 2, I2S x 1
- More than 40 GPIOs
- 2.4-GHz RF Transceiver and Integrated Antenna.
- Supporting BLE GFSK modulation 1 Mbps and 2 Mbps
- Audio interfaces and audio processing accelerators
- RoHS Compliance
- Operating temperature -20 °C to +85 °C

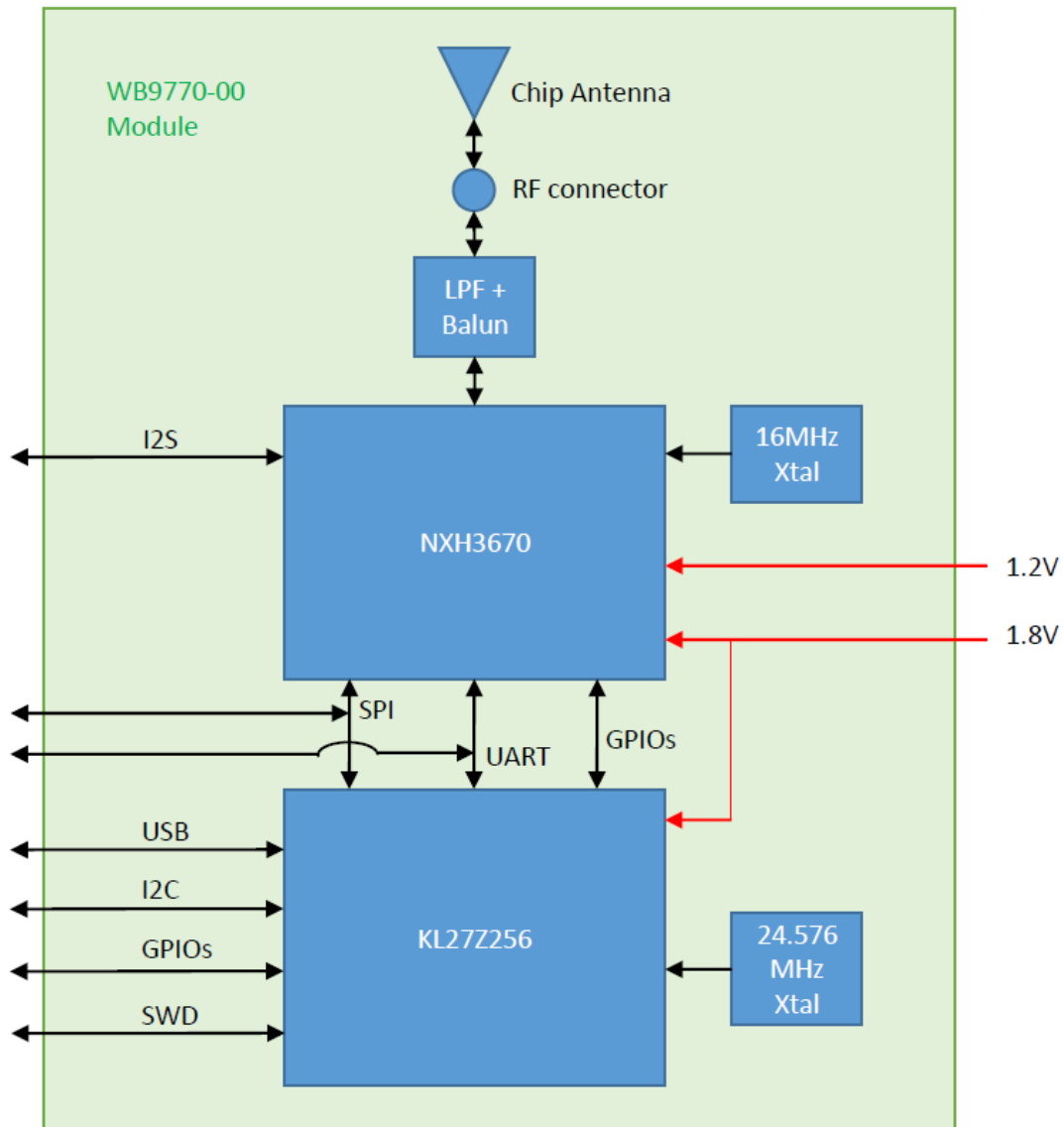## 2. FUNCTIONAL FEATURES

2.1. Module Block Diagram

Figure 2-1. WB9770-00 Block Diagram

2.2. Block Functional Feature

NXH3670

- A 2.4 GHz RF transceiver and digital modem supporting up to 2 Mbits/s
- Supporting BLE GFSK modulation 1 Mbps and 2 Mbps
- A low-power 16 MHz crystal oscillator and on-chip oscillators
- An RF MAC for supporting the lower protocol layers
- A Cortex-M0 subsystem for system control and higher protocol layers
- An AES-128 security coprocessor
- Audio interfaces and audio processing accelerators
- A CoolFlux DSP for audio processing
- Multiple user interfaces for control, data, debug and test
- Sensitivity −90 dBm in BLE 2 Mbps modulation mode
- Sensitivity −94 dBm in BLE 1 Mbps modulation mode
- Programmable TX output power of −10 dBm to +4 dBm in 2 dB steps
- Low current consumption:
  - Sleep current < 63 µA
  - Continuous RX current < 3.7 mA
  - Continuous TX current < 7.3 mA (0 dBm output power)
- Control/Data interfaces:
  - SPI slave
  - UART
  - GPIOs
- Audio interfaces and processing
  - I2S interface
  - G.722/ADPCM codec accelerator
  - CoolFlux DSP up to 16 MHz in low-power mode and 84 MHz in high-performance mode
  - Asynchronous sample rate converter (ASRC)
  - Latency control
- Bluetooth specification version 5.0

_____

KL27Z256

- Core Processor : ARM® Cortex®-M0+ core up to 48 MHz
- Memories
  - 256 KB program flash memory
  - 32 KB SRAM
  - 16 KB ROM with build-in bootloader
  - 32-byte backup register
- System
  - 4-channel asynchronous DMA controller
  - Watchdog
  - Low-leakage wakeup unit
  - Two-pin Serial Wire Debug (SWD) programming and debug interface
  - Micro Trace Buffer
  - Bit manipulation engine
  - Interrupt controller
- Peripherals
  - USB full-speed 2.0 device controller supporting crystal-less operation
  - One UART module supporting ISO7816, operating up to 1.5 Mbit/s
  - Two low-power UART modules supporting asynchronous operation in low-power modes
  - Two I2C modules and I2C0 supporting up to 1 Mbit/s
  - Two 16-bit SPI modules supporting up to 24 Mbit/s
  - One FlexIO module supporting emulation of additional UART, IrDA, SPI, I2C, I2S, PWM and other serial modules, etc.
  - One serial audio interface I2S
  - One 16-bit 818 ksps ADC module with high accuracy internal voltage reference (Vref) and up to 16 channels
  - High-speed analog comparator containing a 6-bit DAC for programmable reference input
  - One 12-bit DAC
  - 1.2 V internal voltage reference
- Timers

- One 6-channel Timer/PWM module

- Two 2-channel Timer/PWM modules

- One low-power timer

- Periodic interrupt timer

● Up to 50 general-purpose input/output pins (GPIO)
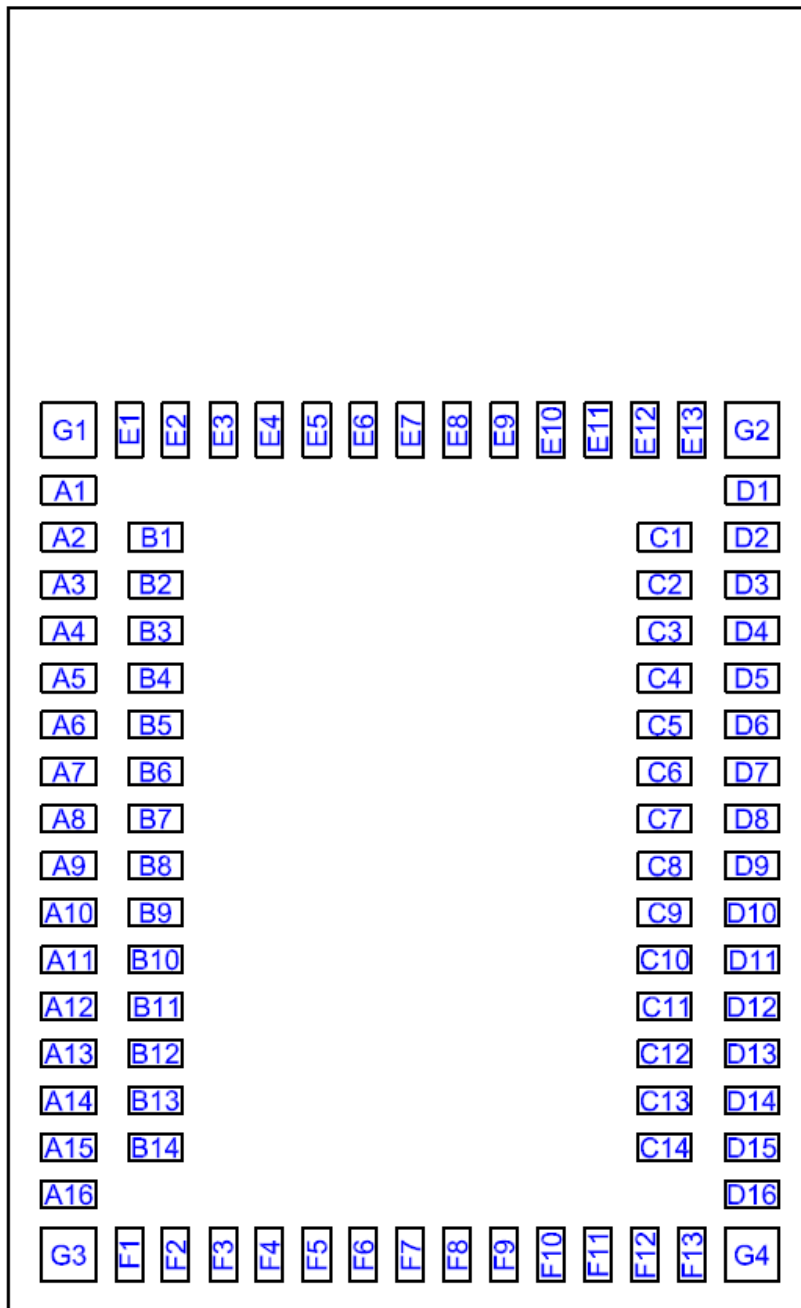
3. MODULE OUTLINE

3.1. Signal Layout (Top View)

Figure 3-1. WB9770-00 Signals layout

3.2. Pin Description

Table 3-1. Pin Description

Pin No.	Pin Name	Type	Description
A1	GND	GND	GND
A2	GND	GND	GND
A3	GND	GND	GND
A4	GND	GND	GND
A5	VDD_RF	POWER	NXH3670 main power input
A6	GND	GND	GND
A7	I2C_SDA	Digital I/O	I2C data pin / PTC11 pin of KL27Z256
A8	I2C_SCL	Digital I/O	I2C clock pin / PTC10 pin of KL27Z256
A9	PTD3	Digital I/O	PTD3 pin of KL27Z256
A10	GND	GND	GND
A11	VREGIN	POWER	USB regulator power input of KL27Z256
A12	USB0_D-	Analog I/O	USB_DM pin of KL27Z256
A13	USB0_D+	Analog I/O	USB_DP pin of KL27Z256
A14	GND	POWER	GND
A15	PTE23	Digital I/O	PTE23 pin of KL27Z256
A16	PTE29	Digital I/O	PTE29 pin of KL27Z256
B1	GND	GND	GND
B2	GND	GND	GND
B3	GND	GND	GND
B4	GND	GND	GND
B5	GND	GND	GND
B6	SWD_DIO	Digital I/O	Serial Wire Debug I/O pin / PTA3 pin of KL27Z256
B7	PTD1	Digital I/O	PTD1 pin of KL27Z256
B8	NIRQ	Digital I/O	PMIC IC interrupt signal input / PTD0 pin of KL27Z256
B9	GND	GND	GND
B10	PTD2	Digital I/O	PTD2 pin of KL27Z256
B11	SWD_CLK	Digital I/O	Serial Wire Debug clock pin / PTA0 pin of KL27Z256
B12	SPK_VOLUMEUP	Digital I/O	Audio out volume up switch input signal / PTA1 pin of

			KL27Z256
B13	PTE21	Digital I/O	PTE21 pin of KL27Z256
B14	WIRELESS/ POR_STATUS	Digital I/O	Status LED indicator signal output / PTE20 pin of KL27Z256
C1	LPUART_RX	Digital I/O	Low power UART1 RX pin / PTE1 pin of KL27Z256
C2	GND	GND	GND
C3	SPI_INT	Digital I/O	SPI interrupt signal from NXH3670 to KL27Z256. This pin is already used inside the module, do not use this pin in external circuit / PTC4 pin of KL27Z256
C4	SPI_CLK	Digital I/O	SPI clock signal from KL27Z256 to NXH3670. / PTD5 pin of KL27Z256
C5	SPI_CSN	Digital I/O	SPI chip select signal from KL27Z256 to NXH3670. This pin is already used inside the module, do not use this pin in external circuit / PTD4 pin of KL27Z256
C6	SPI_MOSI	Digital I/O	SPI MOSI signal from KL27Z256 to NXH3670. / PTD7 pin of KL27Z256
C7	SPI_MISO	Digital I/O	SPI MISO signal from KL27Z256 to NXH3670. / PTD6 pin of KL27Z256
C8	GND	GND	GND
C9	PTC5	Digital I/O	PTC5 pin of KL27Z256
C10	BAT_STATUS	Digital I/O	Battery LED indicator signal output / PTC2 pin of KL27Z256
C11	RESET	Digital I	RESET signal input of KL27Z256, active low. Built-in 10K pullup resistor and 0.1uF capacitor to GND.
C12	PTB3	Digital I/O	PTB3 pin of KL27Z256
C13	PTB2	Digital I/O	PTB2 pin of KL27Z256
C14	GND	GND	GND
D1	LPUART_TX	Digital I/O	Low power UART1 TX pin / PTE0 pin of KL27Z256
D2	GND	GND	GND
D3	I2S_SO	Digital O	I2S output data line from NXH3670 / SWM7 pin of NXH3670
D4	I2S_WS	Digital I	I2S word select line to NXH3670 / SWM11 pin of NXH3670
D5	I2S_SI	Digital I	I2S input data line to NXH3670 / SWM6 pin of

			NXH3670
D6	I2S_CLK	Digital I	I2S clock line to NXH3670 / SWM10 pin of NXH3670
D7	GND	GND	GND
D8	MIC_MUTE	Digital I/O	Microphone mute control switch input signal pin / PTC8 pin of KL27Z256
D9	SPEAKER_MUTE	Digital I/O	Audio out mute control switch input signal pin / PTC9 pin of KL27Z256
D10	MIC_VOLUMUP	Digital I/O	Microphone volume up switch input signal / PTC7 pin of KL27Z256
D11	PTB19	Digital I/O	PTB19 pin of KL27Z256
D12	SPK_ VOLUMEDOWN	Digital I/O	Audio out volume down switch input signal / PTC3 pin of KL27Z256
D13	MIC_ON/OFF_ LIGHT	Digital I/O	Microphone ON/OFF LED indicator signal output / PTC1 pin of KL27Z256
D14	PTB18	Digital I/O	PTB18 pin of KL27Z256
D15	PTB17	Digital I/O	PTB17 pin of KL27Z256
D16	PTC0	Digital I/O	PTC0 pin of KL27Z256
E1	GND	GND	GND
E2	GND	GND	GND
E3	GND	GND	GND
E4	GND	GND	GND
E5	GND	GND	GND
E6	GND	GND	GND
E7	GND	GND	GND
E8	GND	GND	GND
E9	GND	GND	GND
E10	GND	GND	GND
E11	GND	GND	GND
E12	GND	GND	GND
E13	GND	GND	GND
F1	PTE22	Digital I/O	PTE22 pin of KL27Z256
F2	PTE30	Digital I/O	PTE30 pin of KL27Z256
F3	PTE31	Digital I/O	PTE31 pin of KL27Z256

F4	PTE24	Digital I/O	PTE24 pin of KL27Z256
F5	PTE25	Digital I/O	PTE25 pin of KL27Z256
F6	PTA5	Digital I/O	PTA5 pin of KL27Z256
F7	MIC_ VOLUMEDOWN	Digital I/O	Microphone volume down switch input signal / PTA4 pin of KL27Z256
F8	VDD_MCU	POWER	Power input for KL27Z256 Power for NXH3670 I/O voltage
F9	GND	GND	GND
F10	PTB1	Digital I/O	PTB1 pin of KL27Z256
F11	PTB0	Digital I/O	PTB0 pin of KL27Z256
F12	PTB16	Digital I/O	PTB16 pin of KL27Z256
F13	PTA2	Digital I/O	PTA2 pin of KL27Z256
G1	GND	GND	Ground
G2	GND	GND	Ground
G3	GND	GND	Ground
G4	GND	GND	Ground

4. MODULE SPECIFICATIONS

We reserve the right to amend the design and/or specifications of our products without notice.

4.1. Absolute Maximum Ratings[1][2]

over operating free-air temperature range (unless otherwise noted)

Parameter	Conditions	MIN	MAX	Unit
Supply voltage, VDD_RF		-0.5	+1.55	V
Supply voltage, VDD_MCU		-0.3	+2.7	V
Voltage on any digital pin		-0.3	VDD_MCU+0.3	V
USB_DP/DM input voltage		-0.3	3.63	V
USB regulator input (V_{REGIN})		-0.3	6.0	V
Input RF level			-10	dBm
Storage temperature range		-40	+85	°C

(1) All voltage values are with respect to ground, unless otherwise noted.

(2) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

4.2. ESD Ratings

Parameter			Value	Unit
Electrostatic discharge performance (V_{ESD})	Electrostatic discharge voltage, human body model[1]	All pins	±2000	V
	Electrostatic discharge voltage, charged-device model[2]	All pins	±500	V

(1) Determined according to JEDEC Standard JESD22-A114, Electrostatic Discharge (ESD) Sensitivity Testing Human Body Model (HBM).

(2) Determined according to JEDEC Standard JESD22-C101, Field-Induced Charged-Device Model Test Method for Electrostatic-Discharge-Withstand Thresholds of Microelectronic Components.

4.3. Recommended Operating Conditions

Parameter	Conditions	MIN	Typ	MAX	Unit
Ambient temperature range		-20	+25	+85	°C
Operating supply voltage (VDD_RF)		1.14	1.2	1.26	V
Operating supply voltage (VDD_MCU)		1.71	1.8	2.6	V
I/O pin Input high voltage (V_{IH})		0.75 x VDD_MCU	-	-	V
I/O pin Input low voltage (V_{IL})		-	-	0.3 x VDD_MCU	V
I/O pin Output high voltage (V_{OH})	normal drive pad, I_{OH} = -1.5mA high drive pad, I_{OH} = -6mA	VDD_MCU − 0.5	-	-	V
I/O pin Output low voltage (V_{OL})	normal drive pad, I_{OH} = 1.5mA high drive pad, I_{OH} = 6mA	-	-	0.5	V

4.4. Power Consumption Summary

Parameter	Conditions	VDD_RF@1.2V	VDD_MCU@1.8V	Unit
Sleep		0.092	0.025	mA
CONNECTING - Advertise		0.7	0.025	mA
CONNECTED		0.4	0.025	mA
STREAMING - Low Latency		7.14	0.025	mA

4.5. Receiver specification

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDD_RF=1.2V, f_{RF} = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Receiver sensitivity	2Mbps Mode, BER = 10^{-3}	-	-90	-	dBm
Receiver sensitivity	1Mbps Mode, BER = 10^{-3}	-	-94	-	dBm
Receiver saturation	BER = 10^{-3}	-	-10	-	dBm
RSSI dynamic range		-90		-10	dBm
RSSI tolerance		-3		+3	dB

4.6. Transmitter specification

RF performance is specified in a single ended 50 ohm reference plane at the antenna feeding point with Tc = 25°C, VDD_RF= 1.2V, f_{RF} = 2440 MHz, unless otherwise noted.

Parameter	Test Conditions	Min	Typ	Max	Units
Output power, highest setting	Delivered to a single-ended 50-Ω load	-	+4	-	dBm
Output power, lowest setting	Delivered to a single-ended 50-Ω load	-	-10	-	dBm
programming step size			2		dB
output power tolerance	At 0 dBm		±1.5		dB

4.7. Internal 16-MHz Crystal Oscillator (RF OSC)

over operating free-air temperature range (unless otherwise noted)

Parameter	Test Conditions	Min	Typ	Max	Units
Crystal frequency			16		MHz
Calibrated crystal frequency tolerance	including temperature and aging	-40		+40	ppm

4.8. Internal 24.576MHz Crystal Oscillator (MCU OSC)

over operating free-air temperature range (unless otherwise noted)

Parameter	Test Conditions	Min	Typ	Max	Units
Crystal frequency			24.576		MHz

4.9. More Characteristics

For a complete device documents of the NXH3670 & KL27Z256, visit the NXP website at http://www.nxp.com

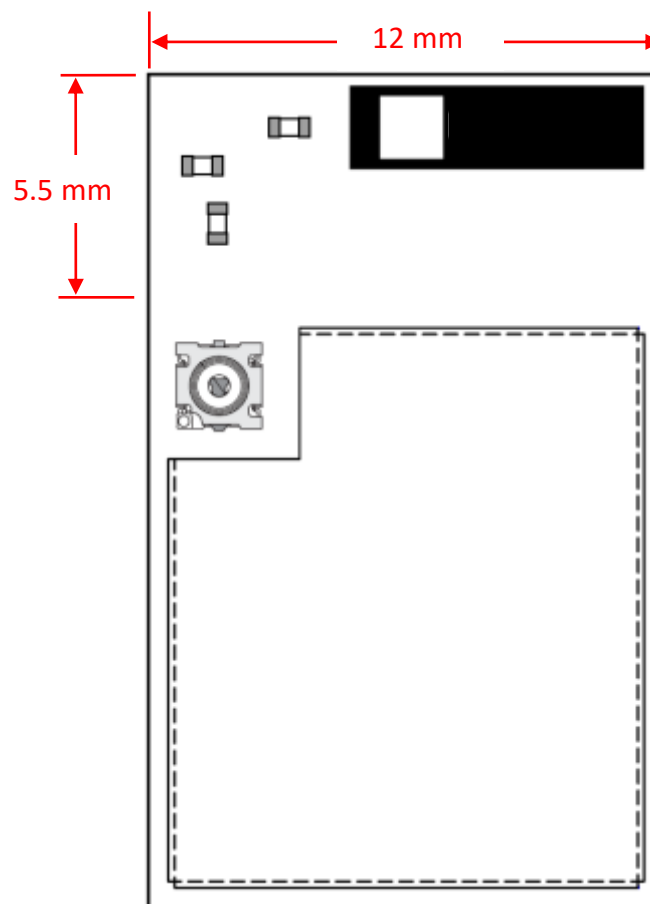## 4.10. Chip Antenna Characteristics

TBD

5. DESIGN RECOMMENDATIONS
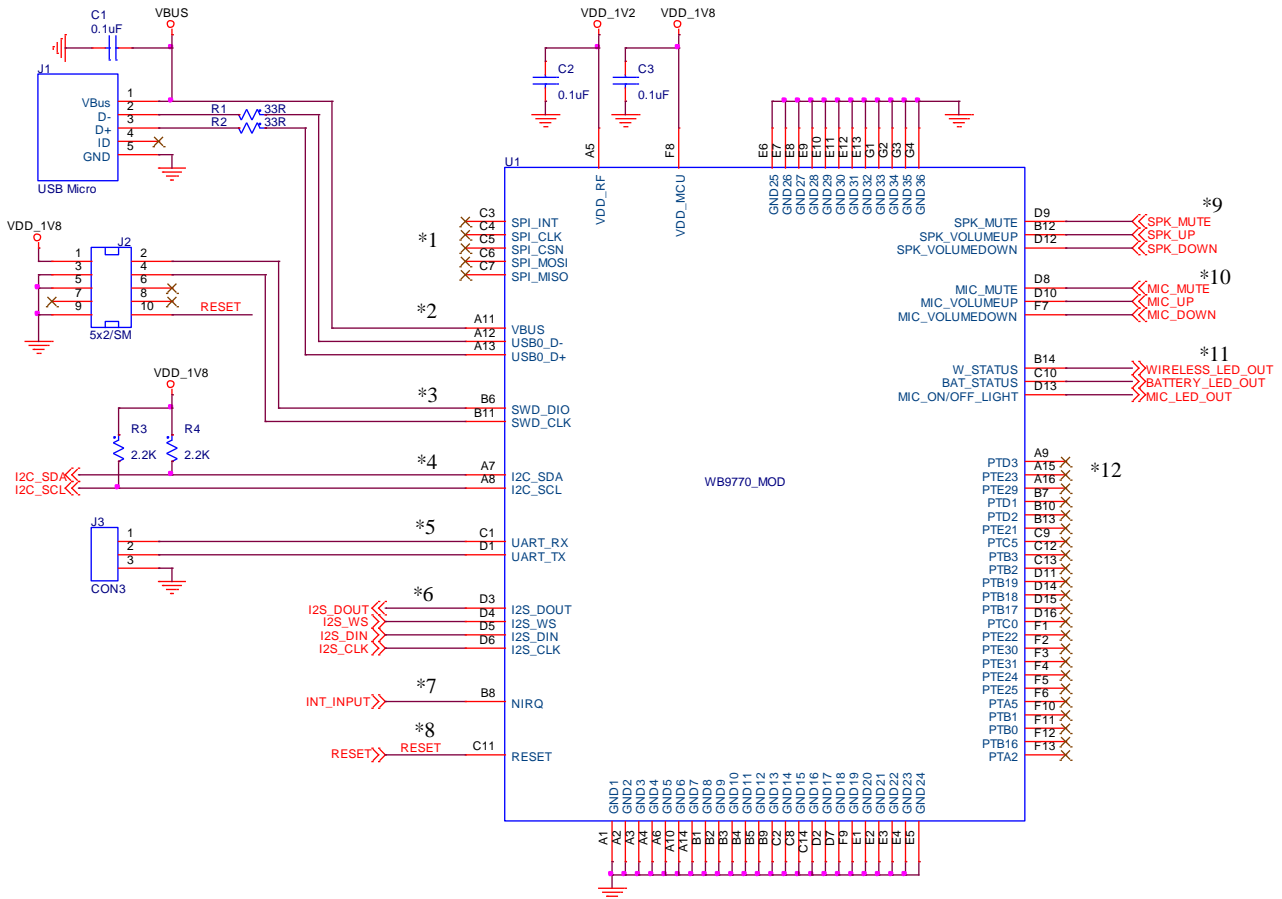
5.1. Module Layout Recommendations

Follow these module layout recommendations:

- Antenna

  For a module with on board chip antenna, to eliminate the influence from other components or ground, recommended that the module is placed in the corner of main PCB, and define a clearance area around the antenna, where no grounding or signal trace are contained. The clearance area applies to all layers of the main PCB. The recommended dimensions of the main PCB keep out area are shown in bellow.
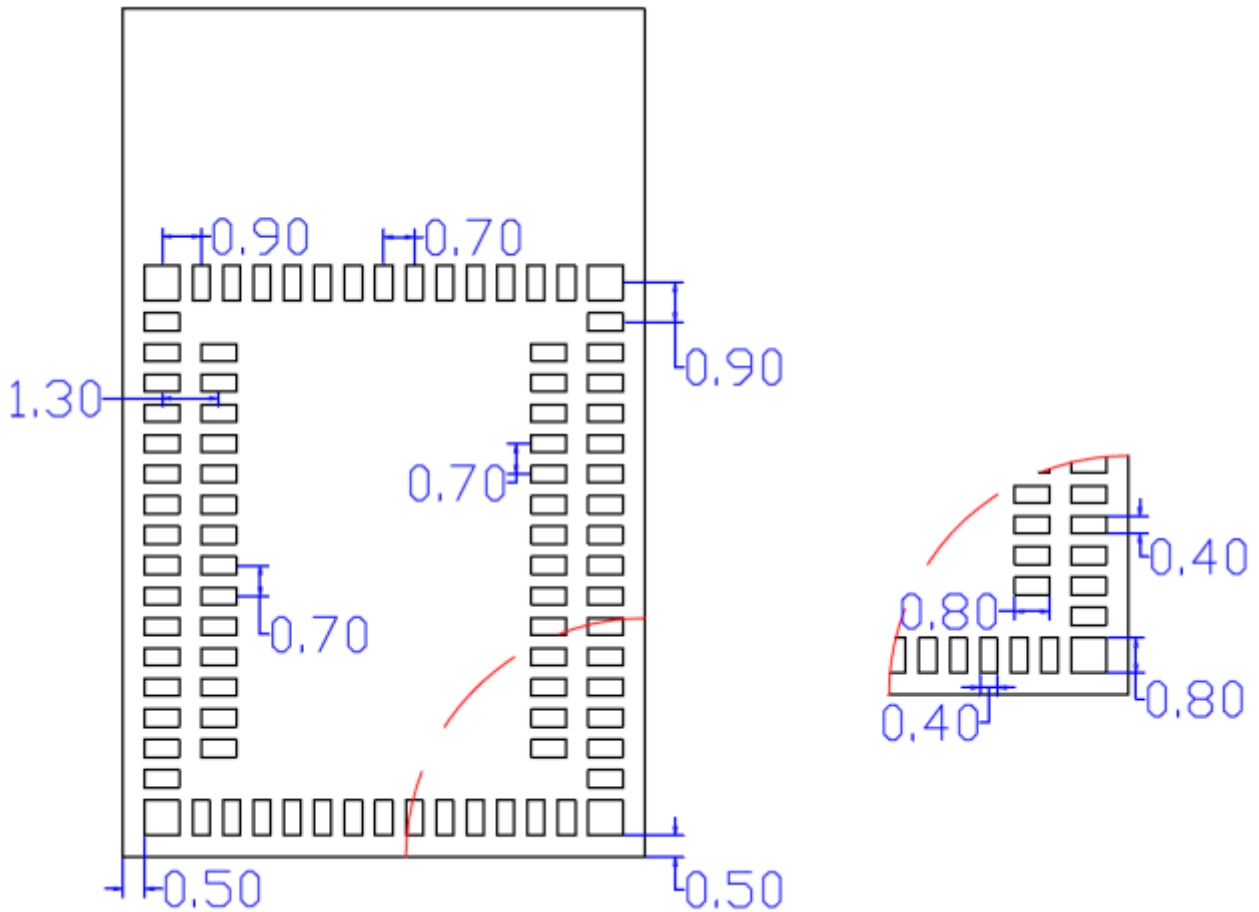
5.2. Reference Schematic

Note:

1) The SPI interface is already used inside the module, leave floating or connect to test points for debugging.

2) The USB port can be programmed the firmware.

3) The SWD (Serial Wire Debug) port is the programming the firmware and debug interface.

4) The master mode I2C interface can control the audio codec and other devices.

5) The UART interface is available on the KL27 and NXH3670 for debug purpose.

6) The I2S audio interface is from the NXH3670, and should be connected to the codec. The codec acts as I2S master.

7) The interrupt signal from peripheral devices, such as PMIC.

8) Reset input signal, it can be floating or connected to a reset circuit.

9) The switch control input signals for audio out. The function can be modify by firmware.

10) The switch control input signals for microphone input. The function can be modify by firmware.

11) The status indicator output signals for LED. The function can be modify by firmware.

12) Reserved GPIO pins. They can be floating or connected to other circuit.
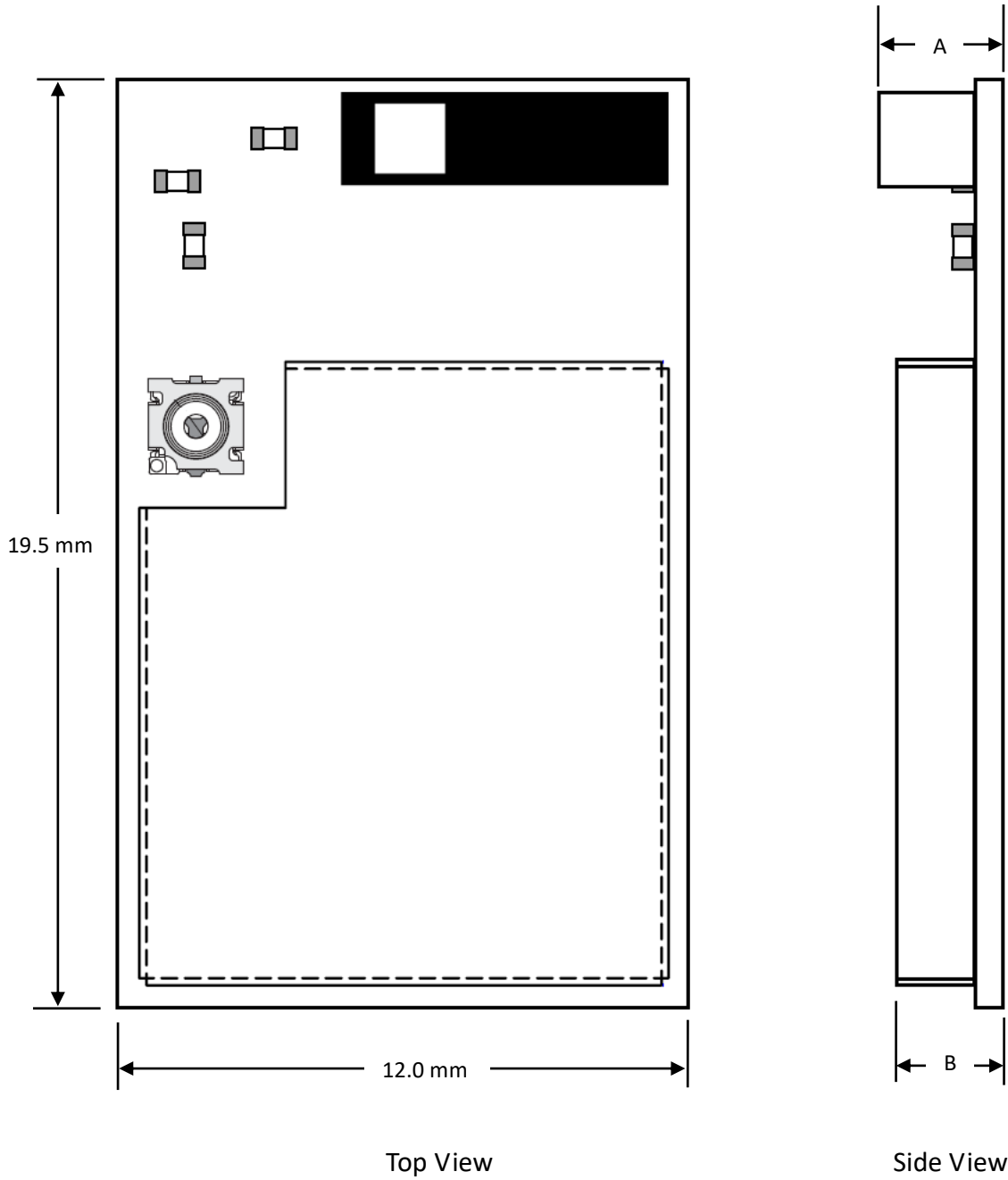
6. PACKAGE INFORMATION

6.1. Pad Dimension

Note:

1> Pad tolerance as ±30um

2> Unit: mm

6.2. Module Mechanical Outline

Top View

Side View

Note:

A: Typical: 2.6mm, Maximum: 2.9mm

B: Typical: 2.2mm, Maximum: 2.4mm

6.3. Ordering Information

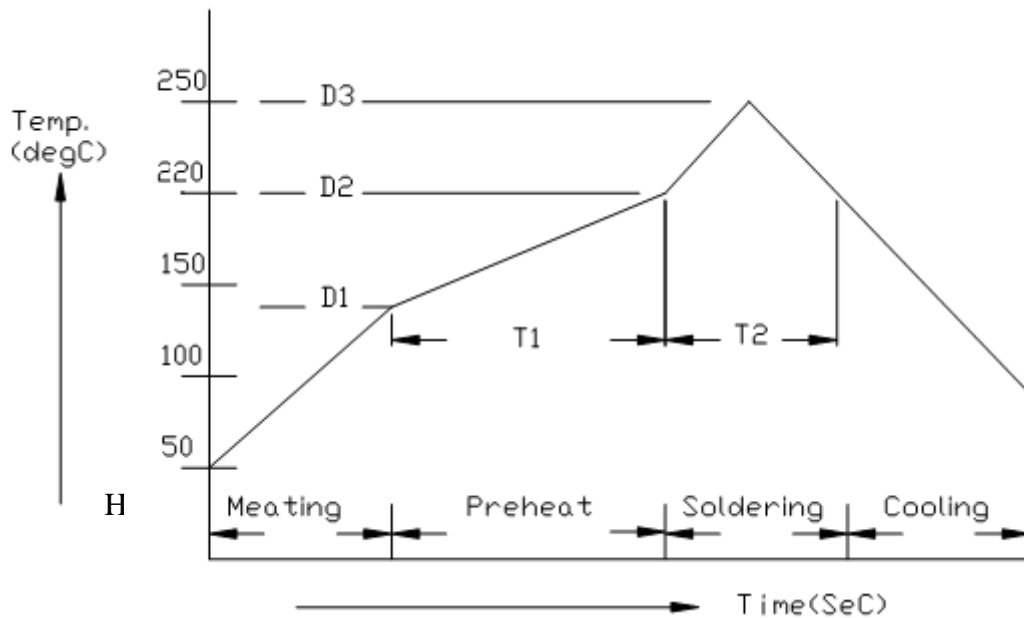| Order Number	Package
WB9770-00	LGA-90

7. SMT AND BAKING RECOMMENDATION

7.1. Baking Recommendation

● Baking condition：

   - Follow MSL Level 4 to do baking process.

   - After bag is opened, devices that will be subjected to reflow solder or other high temperature process must be

    a) Mounted within 72 hours of factory conditions <30°C/60% RH, or

    b) Stored at <10% RH.

   - Devices require bake, before mounting, if Humidity Indicator Card reads >10%

  - If baking is required, Devices may be baked for 8 hrs. at 125 °C.

7.2. SMT Recommendation

● Recommended Reflow profile：

No.	Item	Temperature (°C)	Time (sec)
1	Pre-heat	D1: 140 ~ D2: 200	T1: 80 ~ 120
2	Soldering	D2: = 220	T2: 60 +/- 10
3	Peak-Temp.	D3: 250 °C max	

Note: (1) Reflow soldering is recommended two times maximum.

(2) Add Nitrogen while Reflow process： SMT solder ability will be better.

- **Stencil thickness**： 0.1~ 0.13 mm (Recommended)
- **Soldering paste (without Pb)**： Recommended SENJU N705-GRN3360-K2-V can get better soldering effects.

8. HISTORY CHANGE

Revision	Date	Description
D 0.1	2020/02/20	1. Draft version