# BTM8640M

## Bluetooth Module Data Sheet

Document Type: Bluetooth Module Datasheet

Document Version: V1.01

Release Date: March 06, 2013

# Revision History

| Date | Version | Description | Author |
|---|---|---|---|
| 2013-01-23 | V1.0 | ■ First Release | |
| 2013-03-06 | V1.01 | ■ Update Version | |
| | | | |
| | | | |
| | | | |
| | | | |

# CONTENT

# 1. INTRODUCTION

The BTM8640M Bluetooth® module is a perfect solution for enhanced audio applications, such as stereo headphones. It can be connected with any Bluetooth® devices in an operating range. It is slim and light so the designers can have better flexibilities for the product shapes.

The BTM8640M Bluetooth® module complies with Bluetooth® specification version 4.0. It supports HSP, HFP, A2DP, AVRCP profiles. It integrates RF Baseband controller, antenna,… etc. and provide UART interface, programmable I/O, stereo speaker output, microphone input,… etc.

The detail information of BTM8640M Bluetooth® module is presented in this document below.

## 1.1 Block Diagram

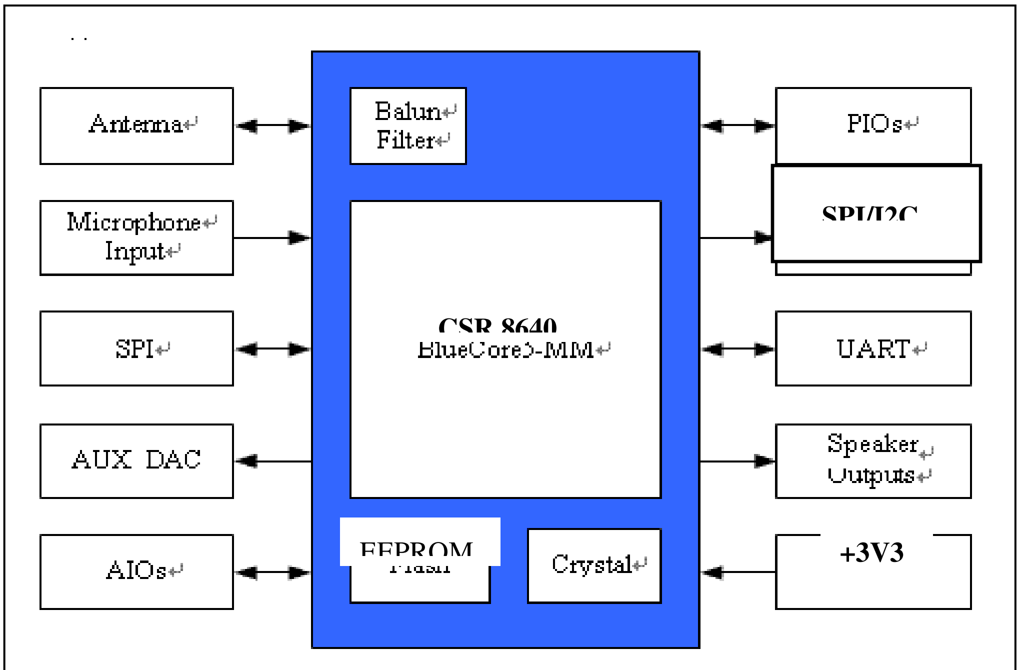



**Figure 1: Block Diagram**

## 1.2 Features

- ✓ Small overall dimension(12mm x 15.4mm x 2mm)
- ✓ Bluetooth Specification V4.0
- ✓ Class 2and Class 3 support
- ✓ Physical connection as SMD type
- ✓ DSP Co-Processor 16-bit Internal Stereo CODEC for DAC.
- ✓ High quality stereo audio: Supported sample rates of 8,11.025,16,22.05,32,44.1,48 and 96kHz(DAC only)
- ✓ Music Enhancements: SBC,MP3,AAC and Fast stream decoder
- ✓ Support HSP, HFP, A2DP, AVRCP profile
- ✓ CSR's proximity pairing and CSR's proximity connection
- ✓ Multipoint support for HFP connection to 2 handsets for voice
- ✓ Multipoint support for A2DP connection to 2 A2DP source for music playback
- ✓ Compatible with CSR cVc software echo cancellation solution.
- ✓ Built-in RF combo filter, Integrated 26M Crystal.
- ✓ No radio signal interference, support for 802.11 co-existence

※ ***Some features are optional for customization on demand.***

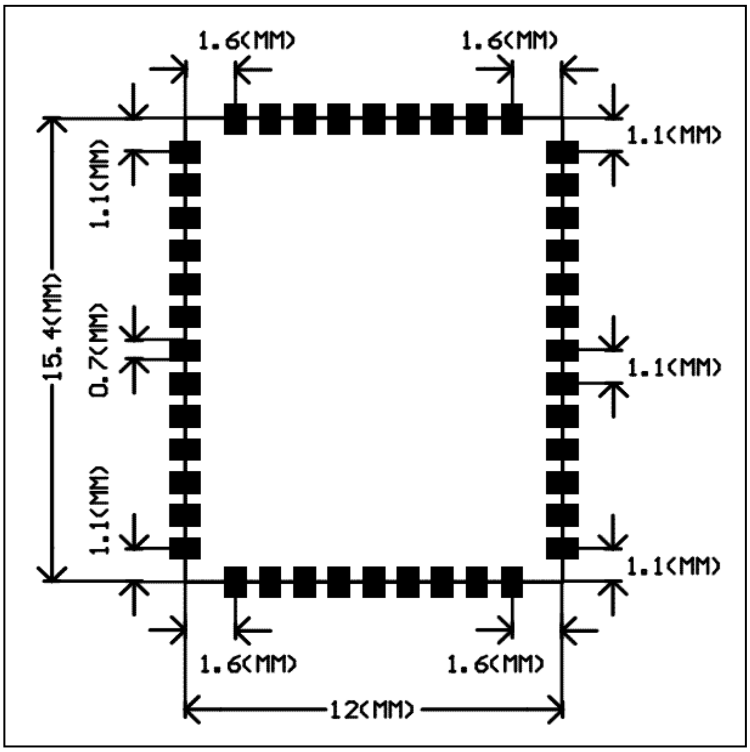
## 1.3 Application

- ✓ High Quality Stereo Bluetooth Headsets
- ✓ High Quality Wired Stereo Headset and Headphones
- ✓ Bluetooth Speakers

# 2. GENERAL SPECIFICATION

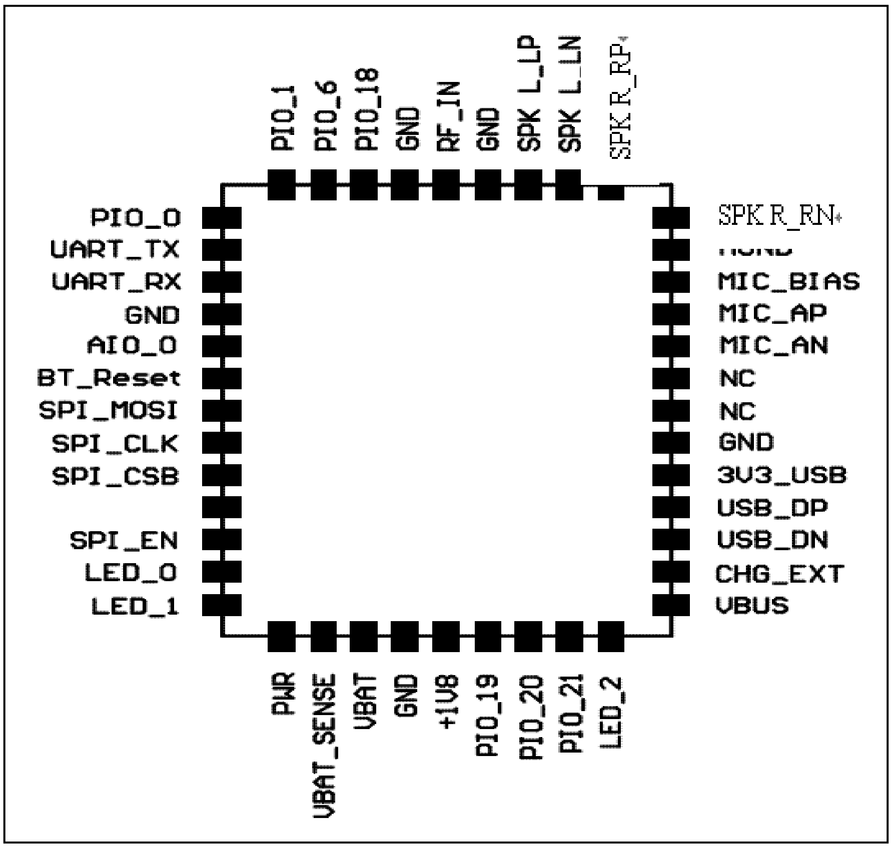
| **Bluetooth Specification** | |
|---|---|
| Chip Set | CSR8640 |
| Module ID | BTM8640M |
| BT Standard | Bluetooth® V4.0 specification |
| RF TX Output Power | 4dBm (Class II) |
| Sensitivity | -82dBm@0.1%BER |
| Frequency Band | 2.402GHz~2.480GHz ISM Band |
| Baseband Crystal OSC | 26MHz |
| Hopping | 1600hops/sec, 1MHz channel space |
| RF Input Impedance | 50 ohms |
| Major Interface | • Microphone : Input (Differential)<br>• Speaker : Output (Differential)<br>• UART : Tx/Rx<br>• PIOs<br>• Antenna |
| Profile | HSP, HFP, A2DP, AVRCP |
| Voice Processor | 80MIPS Kalimba with cVc support |
| **Power** | |
| Supply Voltage | 3.0V ~ 4.2V DC |
| Working Current | 15mA typical, Depends on profiles |
| Standby Current | <1mA |
| **Operating Environment** | |
| Temperature | -40ºC to +85ºC |
| Humidity | 10%~90% Non-Condensing |
| **Environmental** | RoHS Compliant |

# 3. PHYSICAL CHARACTERISTIC




**Dimension:**

**Figure 2**




**Pin Definition:**

**Figure 3**

## 3.1 Pin Description

| Pin# | Pin Name | Pad Type | Description |
|---|---|---|---|
| 1 | PIO_0 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |
| 2 | UART_TX | Bi-directional CMOS output, tri-state, with weak internal pull-up | UART data output |
| 3 | UART_RX | CMOS input with weak internal pull-down | UART clear to send active low |
| 4 | GND | Ground | Digital Ground |
| 5 | AIO_0 | Bi-directional VDD/Low-voltage regulator output | Analogue programmable input/ output line circuitry and 1.5V regulated output (from internal low-voltage regulator) |
| 6 | BT_Reset | CMOS input with weak internal pull-up | Active LOW reset |
| 7 | SPI_MOSI | CMOS input, with weak internal pull-down | SPI data input |
| 8 | SPI_CLK | Input with weak internal pull-down | SPI clock |
| 9 | SPI_CSB | Input with weak internal pull-up | Chip select for Serial Peripheral Interface (SPI),active low |
| 10 | SPI_MISO | CMOS output, tri-state, with weak internal pull-down | SPI data output |
| 11 | SPI_EN | Input with weak internal pull-up | Chip select for Serial Peripheral Interface (SPI),active low |
| 12 | LED_0 | Open drain output | LED driver |
| 13 | LED_1 | Open drain output | LED driver |
| 14 | PWR | Input enable | Regulator enable input.<br>Can also be sensed as an input.<br>Regulator enable and multifunction button. A high input (tolerant to VBAT) enables the on-chip regulators, which can then be latched on internally and the button used as a multifunction input. |

| | | | |
|---|---|---|---|
| 15 | VBAT_SENSE | Battery charger sense input | Connect directly to the battery positive pin |
| 16 | VBAT | Power supply | Battery positive terminal |
| 17 | GND | Ground | Digital Ground |
| 18 | +1V8 | Open drain output | LED driver |
| 19 | PIO_19 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |
| 20 | PIO_20 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |
| 21 | PIO_21 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |

| | | | |
|---|---|---|---|
| 22 | LED_2 | Open drain output | LED driver |
| 23 | VBUS | Power supply | Alternative supply via bypass regulator for 1.8V and 1.35V<br>Switch mode power supply regulator inputs.<br>Must be connected to the same potential as VOUT_3V3. |
| 24 | CHG_EXT | External battery charger control | External battery charger transistor base control |
| 25 | USB_N | Bidirectional | USB data minus |
| 26 | USB_P | Bidirectional | USB data plus with selectable internal 1.5kohm pull-up resistor |
| 27 | 3V3_USB | Power supply | Regulator enable input.<br>Can also be sensed as an input.<br>Regulator enable and multifunction button. A high input (tolerant to VBAT) enables the on-chip regulators, which can then be latched on internally and the button used as a multifunction input. |
| 28 | GND | Ground | Digital Ground |
| 29 | NC | NC | NC |
| 30 | NC | NC | NC |
| 31 | MIC_AN | Analogue | Microphone input negative, left |
| 32 | MIC_AP | Analogue | Microphone input positive, left |

| | | | |
|---|---|---|---|
| 33 | MIC_BIAS | Analogue | Microphone bias |
| 34 | AGND | Ground | Analogue Ground |
| 35 | NC | NC | NC |
| 36 | NC | NC | NC |
| 37 | SPKL_LN | Analogue out | Speaker output negative |
| 38 | SPKL_LP | Analogue out | Speaker output positive |
| 39 | GND | Ground | Digital Ground |
| 40 | RF_IN | RF | Bluetooth 50ohm transmitter output/receiver input |
| 41 | GND | Ground | Digital Ground |
| 42 | PIO_18 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |
| 43 | PIO_6 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |
| 44 | PIO_1 | Bi-directional with programmable strength internal pull-up/down | Programmable input/output line |

# 4. REFERENCE SCHEMATIC

## 4.1

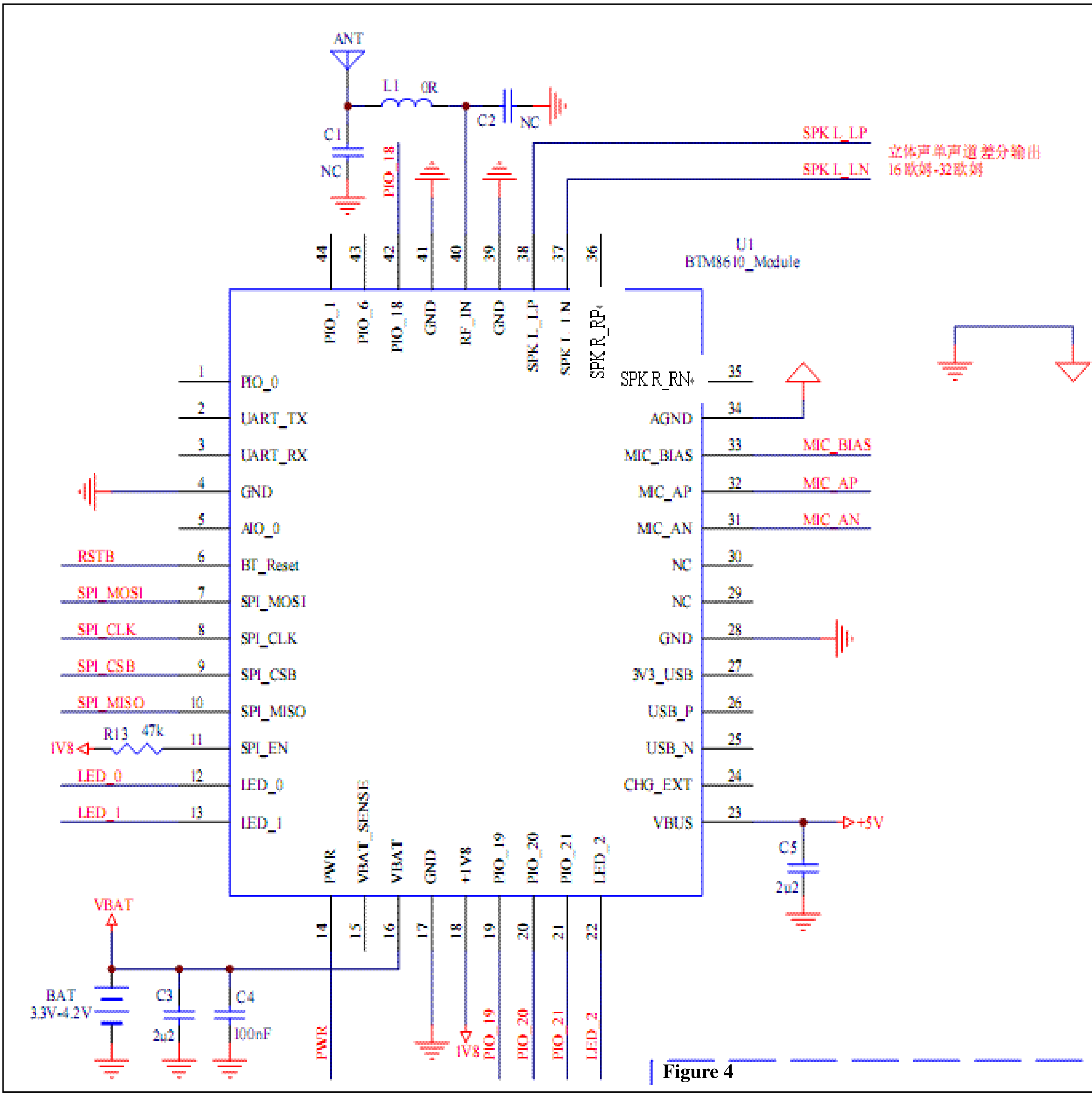
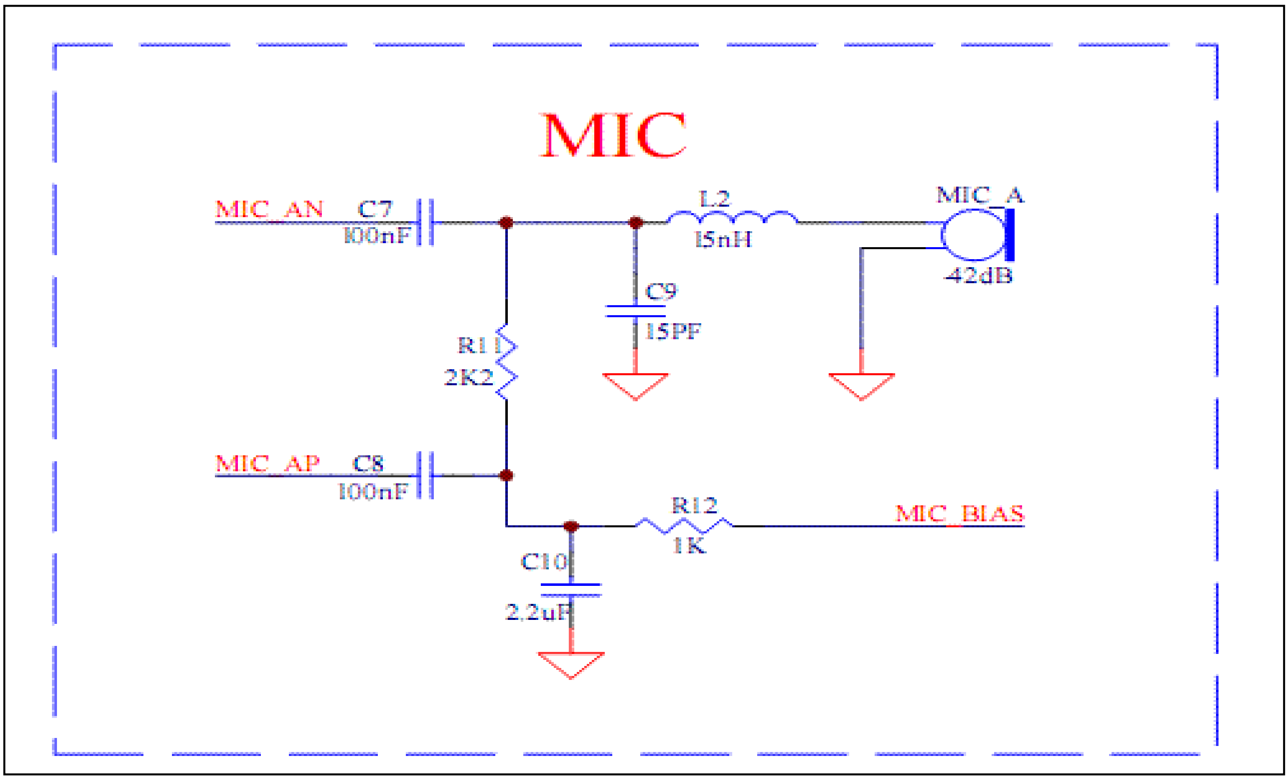



Figure 4

## 4.2


MIC
MIC_AN
C7
100nF
L2
15nH
MIC_A
-42dB
C9
15PF
R11
2K2
MIC_AP
C8
100nF
R12
1K
MIC_BIAS
C10
2.2uF

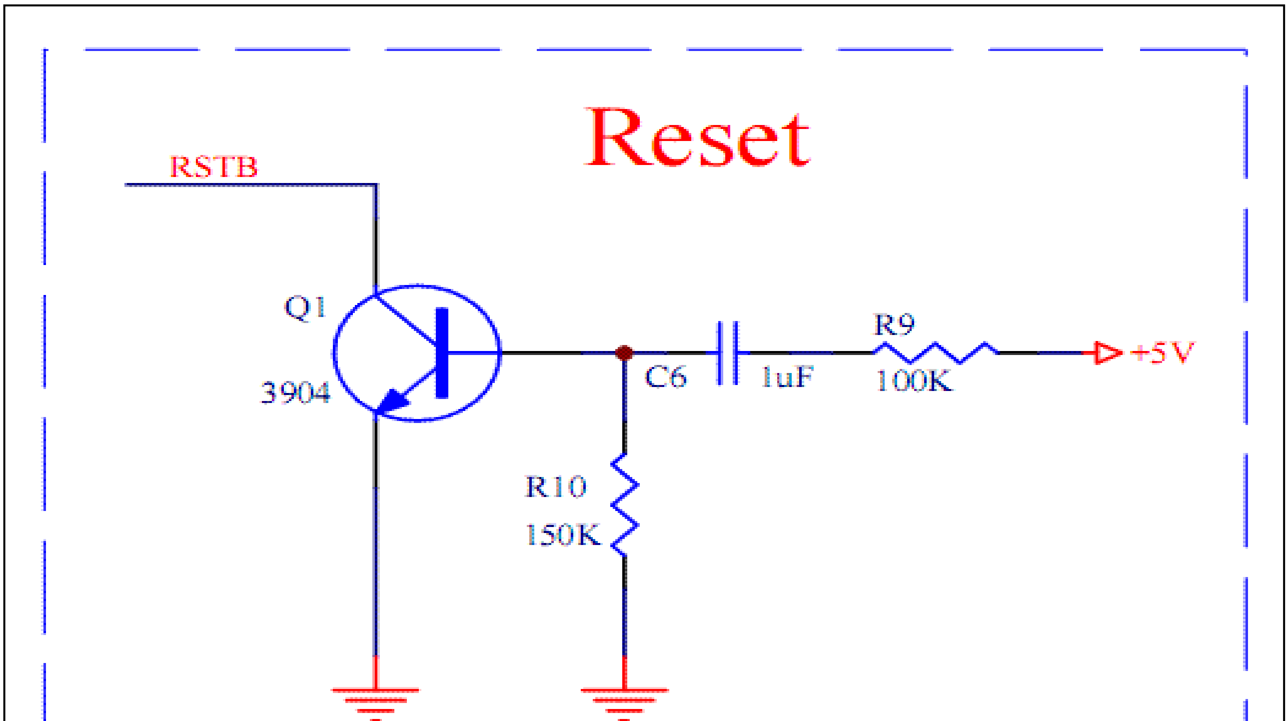

Reset
RSTB
Q1
3904
C6
1uF
R9
100K
+5V
R10
150K

Figure 5

## 4.3

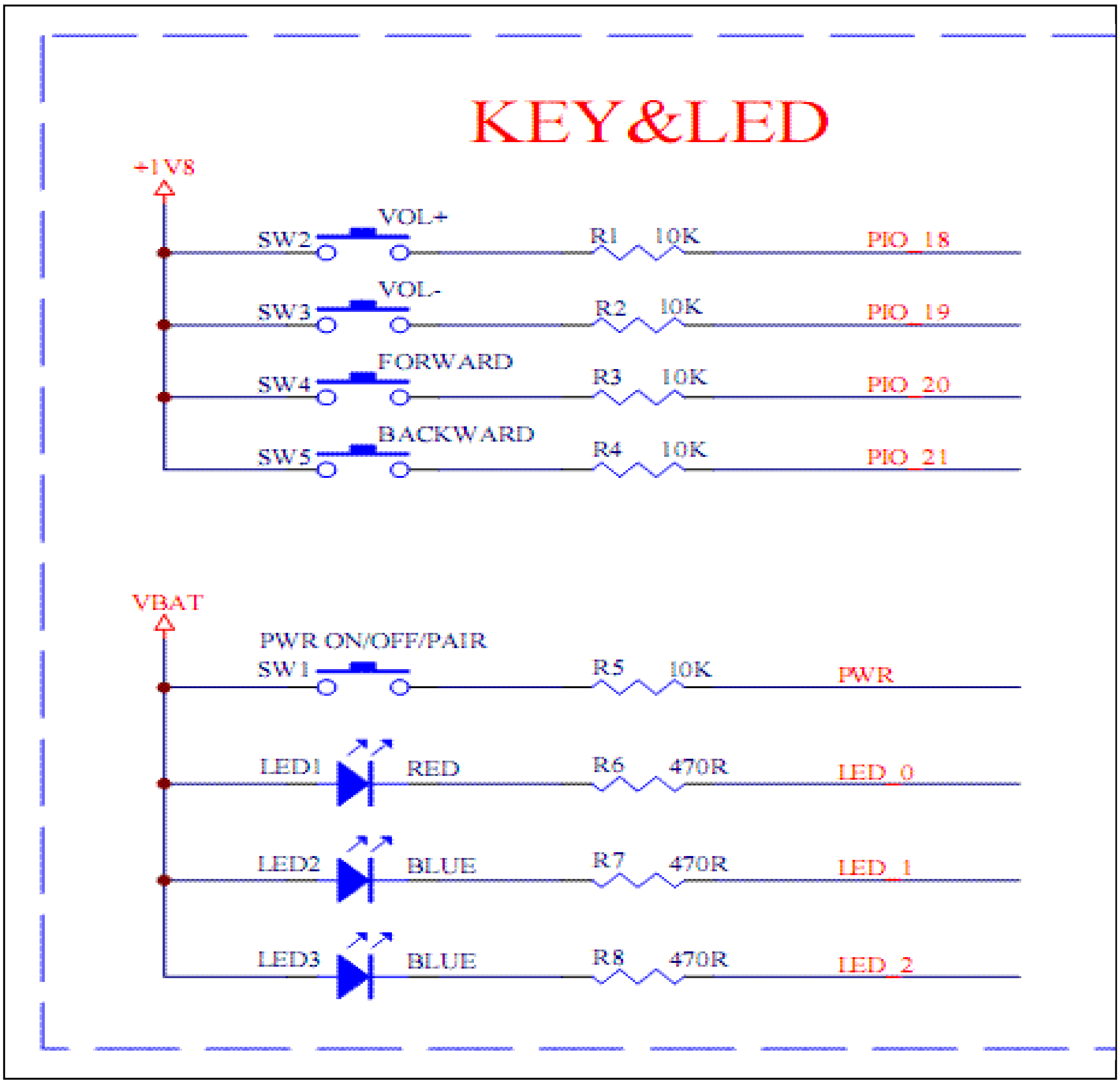



**Figure 6**


**Figure 7**

# 5. PHYSICAL INTERFACE

## 5.1 Power Supply

The transient response of the regulator is important. If the power rails of the module are supplied from an external voltage source, the transient response of any regulator used should be 20µs or less.

## 5.2 Audio Interfaces

Audio interface as following features:

- Mono analogue input for voice band and audio band
- Stereo and mono analogue output for voice band and audio band

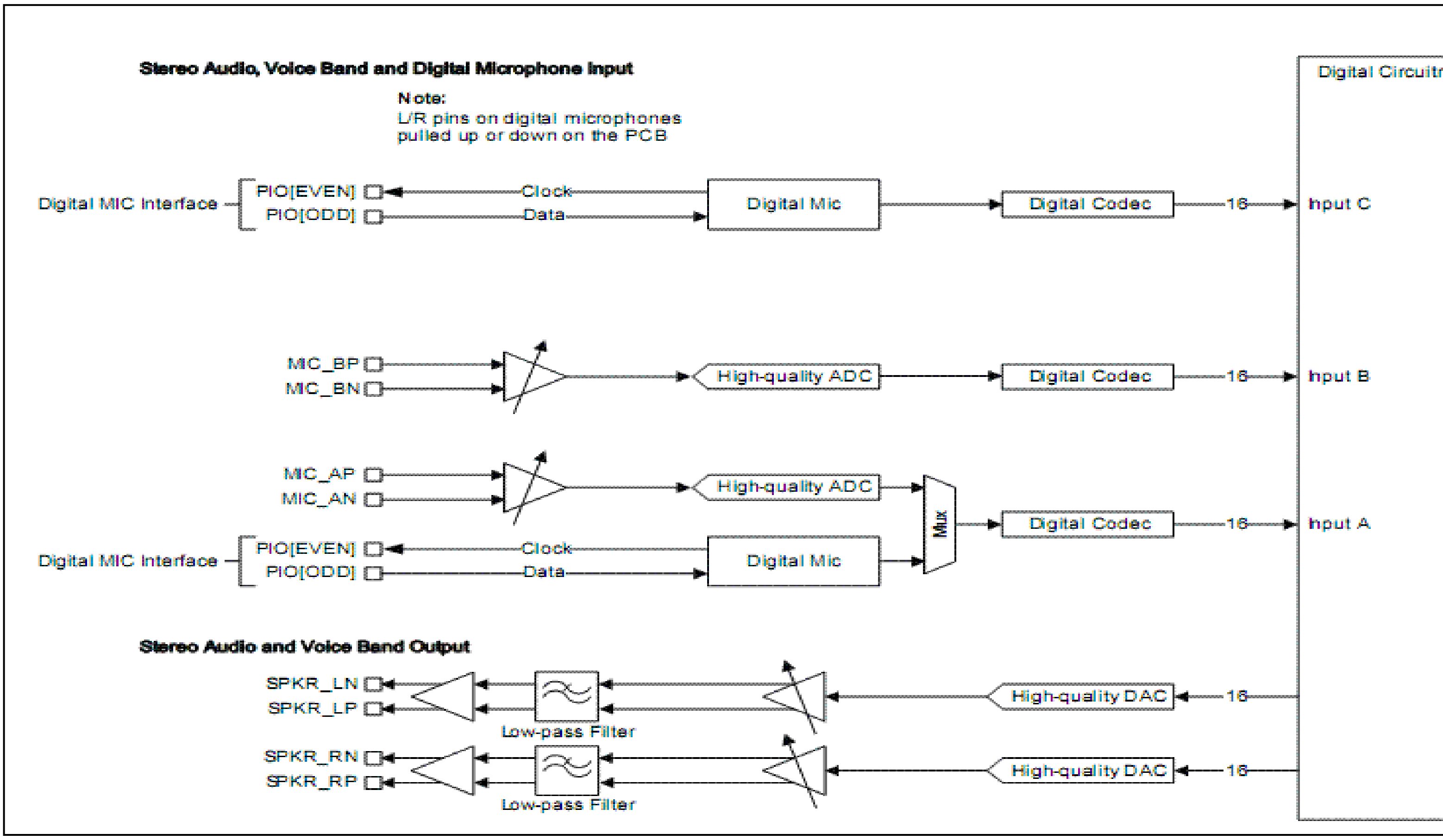



**Figure 8**

The stereo audio CODEC uses a fully differential architecture in the analogue signal path, which results in low noise sensitivity and good power supply rejection while effectively doubling the signal amplitude. It uses a minimum of external components. The module features a differential stereo audio output interfaces.

### 5.2.1 ADC

The ADC consists of a second order Digma Delta converter as show in **Figure 8.**

### 5.2.2 ADC Sample Rate Selection and Warping

ADC supports the following sample rates: 8kHz, 11.025kHz, 16kHz, 22.05kHz, 24kHz, 32kHz,44.1kHz,48kHz.

One of the main concerns for stereo wireless music applications is the ability to keep sample rates for the CODECs at both ends of the wireless link in synchronization. A VM function adjusts the sample rate using a 'warping' function to tune the sample rate to the required value. The ADC warp function allows the sample rate to be changed by +/-3%, in steps of $1/2^{17}$, or 7.6ppm. The warp function preserves the signal quality – the distortion introduced when warping the sample rate is negligible.

### 5.2.3 ADC Gain

The ADC contains two gain stages for each channel, an analogue and a digital gain stage.

### 5.2.4 DAC

The DAC contains two second order Sigma Delta converters allowing two separate channels that are identical in functionality as show in **Figure 8**.

### 5.2.5 DAC Sample Rate Selection and Warping

Each DAC supports the following sample rates: 8kHz, 11.025kHz, 16kHz, 22.05kHz, 24kHz, 32kHz,44.1kHz, 48kHz,96kHz.

One of the main concerns for the DAC used in stereo wireless music applications is the ability to keep sample rates for the CODECs at both ends of the wireless link in synchronization. A VM function adjusts the sample rate using a 'warping' function to tune the sample rate to the required value. The ADC warp function allows the sample rate to be changed by +/-3%, in steps of $1/2^{17}$, or 7.6ppm. The warp function preserves the signal quality – the distortion introduced when warping the sample rate is negligible.

### 5.2.6 DAC Gain

The DAC contains two gain stages for each channel, a digital and an analogue gain stage.

### 5.2.7 Mono Operation

Mono operation is single channel operation of the stereo CODEC. The left channel represents the single mono channel for audio in and audio out. In mono operation the right channel is auxiliary mono channel that may be used in dual mono channel operation.

### 5.2.8 Audio Input Stage

The audio input stage of the module consists of a low noise input amplifier, which receives its analogue input signal from pins MIC_AP and MIC_AN to a second–order ∑-Δ ADC that outputs a 4Mbit/sec single-bit stream into the digital circuitry. The input can be configured to be either single ended or fully differential. It can be programmed for either microphone or line input and has a 3-bit digital gain setting of the input-amplifier in 3dB steps to optimize it for the use of different microphones.

### 5.2.9 Microphone Input

Check the reference design in **Figure 8** for the microphone input design.

### 5.2.10 Audio Output Stage

The output digital circuitry converts the signal from 16-bit per sample, linear PCM of variable sampling frequency to a 2Mbits/sec multi-bit stream, which is fed into the analogue output circuitry.
The output circuit comprises a digital to analogue converter with gain setting and output amplifier. Its class-AB output-stage is capable of driving a signal on both channels of up to 2V pk-pk- differential into a load of 16Ω. The output is available as a differential signal between SPK_R_RP and SPK_R_RN for the left channel; and between SPK_L_LP and SPK_L_LN for the right channel. The output is capable of driving a speaker directly if its impedance is at least 8Ω if only one channel is connected or an external regulator is used.

The gain of the output stage is controlled by a 3-bit programmable resistive divider, which sets the gain in steps of approximately 3dB.

The multi-bit stream from the digital circuitry is low pass filtered by a second order bi-quad filter with a pole at 20kHz. The signal is then amplified in the fully differential output stage, which has a gain bandwidth of typically 1MHz.

## 5.3 RF Interface

The module integrates a balun filter. The user can connect a 50ohms antenna directly to the RF port.

## 5.4 General Purpose Analog IO

The general purpose analog IOs can be configured as ADC inputs by software. Do not connect them if not use.

## 5.5 General Purpose Digital IO

There are nine general purpose digital IOs defined in the module. All these GPIOs can be configured by software to realize various functions, such as button controls, LED displays or interrupt signals to host controller, etc. Do not connect them if not use.

## 5.6 Serial Interfaces

### 5.6.1 UART

This is a standard UART interface for communicating with other serial devices. The UART interface provides a simple mechanism for communicating with other serial devices using the RS232 protocol.

When the module is connected to another digital device, UART_RX and UART_TX transfer data between the two devices. The remaining two signals, UART_CTS and UART_RTS, can be used to implement RS232 hardware flow control where both are active low indicators.

**Note: The serial port interface(UART)can be used for system debugging. Don't support to use command set for profile function application by UART, such as HFP/A2DP/AVRCP and so on. These profiles function application can be controlled only by PIO, such as pairing/connect/answer/play/pause/next/previous function application and so on.**

### 5.6.2 SPI

The synchronous serial port interface (SPI) can be used for system debugging. It can also be used for in-system programming for the flash memory within the module. SPI interface uses the SPI_MOSI, SPI_MISO, SPI_CSB and SPI_CLK pins. Testing points for the SPI interface are reserved on board in case that the firmware shall be updated during manufacture.

The module operates as a slave and thus SPI_MISO is an output of the module. SPI_MISO is not in high-impedance state when SPI_CSB is pulled high. Instead, the module outputs 0 if the processor is running and 1 if it is stopped. Thus the module should NOT be connected in a multi-slave arrangement by simple parallel connection of slave SPI_MISO lines.

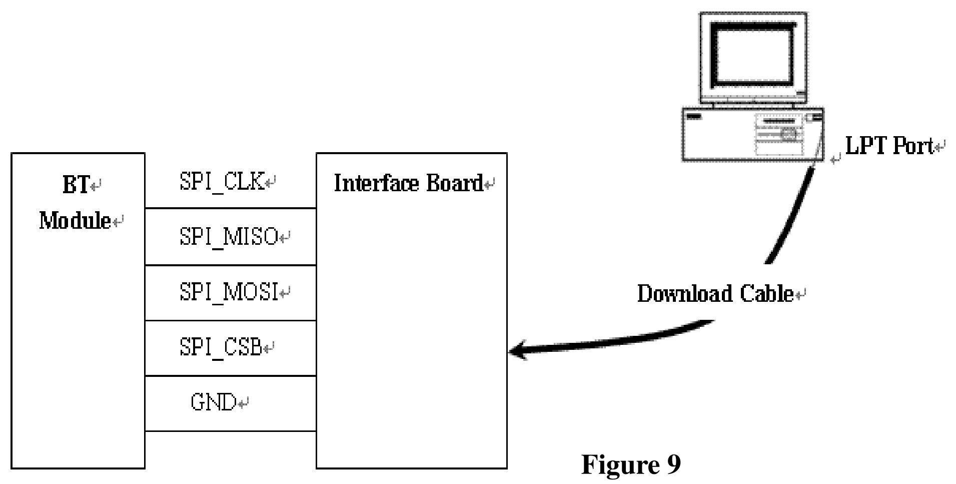



**Figure 9**

# 6. ELECTRICAL CHARACTERISTIC

## 6.1 Absolute Maximum Rating

| Rating | Min | Max | Unit |
|---|---|---|---|
| Storage Temperature | -40 | +105 | °C |
| Operating Temperature | -40 | +85 | °C |
| PIO/AIO Voltage | -0.4 | +3.6 | V |
| +3V3 Voltage | -0.4 | +3.6 | V |
| USB_DP/USB_DN Voltage | -0.4 | +3.6 | V |
| Other Terminal Voltages except RF | -0.4 | 3V3+0.4 | V |

**Table 1**

## 6.2 Recommended Operating Conditions

| Operating Condition | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Operating Temperature Range | -40 | -- | +85 | °C |
| +3V3 Voltage | +3.0 | +3.6 | +4.2 | V |

**Table 2**

## 6.3 Input/output Terminal Characteristics

### 6.3.1 Digital Terminals

| Supply Voltage Levels | Min | Typical | Max | Unit |
|---|---|---|---|---|
| **Input Voltage Levels** | | | | |
| VIL input logic level low | -0.3 | - | +0.25x3V3 | V |
| VIH input logic level high | 0.625*3V3 | - | 3V3+0.3 | V |
| **Output Voltage Levels** | | | | |
| $V_{OL}$ output logic level low, $I_{OL}$ = 4.0mA | - | - | 0.125 | V |
| $V_{OH}$ output logic level high, $I_{OH}$ = -4.0mA | 0.75x3V3 | - | 0.625x3V3 | V |
| **Input and Tri-state Current** | | | | |
| Ii input leakage current at Vin=+3V3 or 0V | -100 | 0 | 100 | nA |
| Ioz tri-state output leakage current at Vo=+3V3 or 0V | -100 | 0 | 100 | nA |
| With strong pull-up | -100 | -40 | -10 | µA |
| With strong pull-down | 10 | 40 | 100 | µA |
| With weak pull-up | -5 | -1.0 | -0.2 | µA |
| With weak pull-down | 0.2 | +1.0 | 5.0 | µA |
| I/O pad leakage current | -1 | 0 | +1 | µA |

| | | | | |
|---|---|---|---|---|
| CI Input Capacitance | 1. | - | 5.0 | pF |
| **Resistive Strength** | | | | |
| Rpuw weak pull-up strength at +3V3-0.2V | 500k | - | 2M | Ω |
| Rpdw weak pull-up strength at 0.2V | 500k | - | 2M | Ω |
| Rpus strong pull-up strength at +3V3-0.2V | 10k | - | 50k | Ω |
| Rpds strong pull-up strength at 0.2V | 10k | - | 50k | Ω |

**Table 3**

### 6.3.2 Internal CODEC - Analogue to Digital Converter

| Parameter | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Resolution | - | - | 16 | Bits |
| Input Sample Rate | 8 | - | 44.1 | kHz |
| Signal / Noise, $f_{in}$=1kHz, BW=20Hz->20kHz A-Weighted THD+N<1% 150mV Vpk-pk | | | | |
| $F_{sample}$ = 8kHz | - | 82 | - | dB |
| $F_{sample}$ = 11.025kHz | - | 81 | - | dB |
| $F_{sample}$ = 16kHz | - | 80 | - | dB |
| $F_{sample}$ = 22.05kHz | - | 79 | - | dB |
| $F_{sample}$ = 32kHz | - | 79 | - | dB |
| $F_{sample}$ = 44.1kHz | - | 78 | - | dB |
| Digital Gain | -24 | - | 21.5 | dB |

**Table 4**

### 6.3.3 Internal CODEC - Digital to Analogue Converter

| Parameter | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Resolution | - | - | 16 | Bits |
| Output Sample Rate, Fsample | 8 | - | 48 | kHz |
| Signal / Noise, $f_{in}$=1kHz, BW=20Hz->20kHz A-Weighted THD+N<0.01% 0dBFS signal Load 100kΩ | | | | |
| $F_{sample}$ = 8kHz | - | 95 | - | dB |
| $F_{sample}$ = 11.025kHz | - | 95 | - | dB |
| $F_{sample}$ = 16kHz | - | 95 | - | dB |
| $F_{sample}$ = 22.05kHz | - | 95 | - | dB |
| $F_{sample}$ = 32kHz | - | 95 | - | dB |
| $F_{sample}$ = 44kHz | - | 95 | - | dB |
| $F_{sample}$ = 48kHz | - | 95 | - | dB |
| $F_{sample}$ = 96kHz | | 95 | | dB |
| Digital Gain | -24 | - | 21.5 | dB |
| Gain Resolution | | 1/32 | | dB |

**Table 5**

### 6.3.4 Microphone Input

| Microphone Input | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Input full scale at maximum gain | - | 4 | - | mV rms |
| Input full scale at minimum gian (differential) | | 800 | - | mV rms |
| Gain | -3 | - | 42 | dB |
| Gain resolution | - | 3 | - | dB |
| Distortion at 1kHz | - | - | -74 | dB |
| 3dB Bandwidth | - | 20 | | kHz |
| Input impedance | - | 6 | | kΩ |
| THD+N(microphone input)@30mV rms input | - | 0.04 | - | % |

**Table 6**

### 6.3.5 Speaker Output

| Speaker Driver | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Output voltage full scale swing (differential) | - | 750 | - | mV rms |
| THD+N 100kΩ load | - | - | 0.01% | % |
| THD+N 16Ω load | - | - | 0.1% | % |
| SNR(Load=16Ω, 0dBFS input relative to digital silence) | - | 95 | - | dB |

**Table 7**

## 6.4 Power consumptions

| Operating Condition | Min | Typical | Max | Unit |
|---|---|---|---|---|
| Connected Idle (Sniff 1.28 secs) | | 0.19 | | mA |
| Connected with audio streaming | 10 | 15 | 20 | mA |
| Deep Sleep Idle mode | | 60 | | µA |

**Table 8**

# 7. RECOMMENDED TEMPERATURE REFLOW PROFILE

The soldering profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder reflow.

2F                                    Friday March 09, 2012    10:21:21

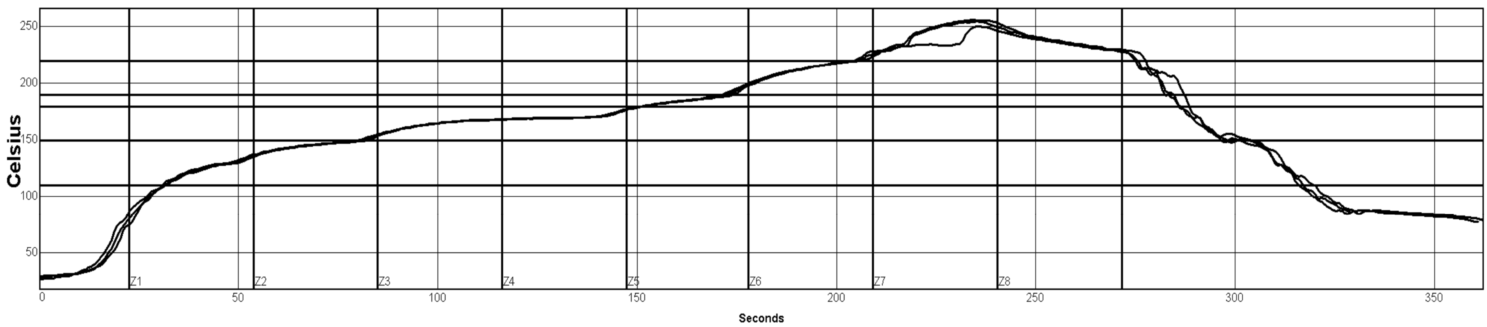
Site:

Oven Name: WQ                                    Process Window Name: 无铅

Setpoints (Celsius)

| Zone | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Top | 140 | 150 | 170 | 170 | 190 | 225 | 265 | 230 |
| Bottom | 140 | 150 | 170 | 170 | 190 | 225 | 265 | 230 |

Conveyor Speed ( cm/min ): 75.0




| PWI= 304% | Max Rising Slope | | Preheat 110-190C | | Soak Time 150-180C | | Reflow Time /220C | | Peak Temp | |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 3.9 | 189% | 141.4 | 157% | 70.4 | -296% | 71.1 | 111% | 254.8 | 97% |
| 3 | 4.0 | 197% | 139.7 | 149% | 70.6 | -294% | 70.3 | 103% | 250.6 | 11% |
| 4 | 3.9 | 192% | 142.1 | 160% | 69.6 | -304% | 71.2 | 112% | 256.5 | 130% |

**Process Window:**

Solder Paste: SYSTEM DEFAULT

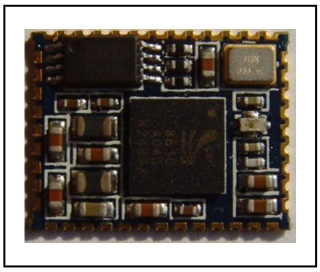
| Statistic Name | Low Limit | High Limit | Units |
|---|---|---|---|
| Max Rising Slope (Target=2.0) | 0.0 | 3.0 | Degrees/Second |
| Preheat Time 110-190C | 90 | 130 | Seconds |
| Soak Time 150-180C | 90 | 110 | Seconds |
| Time Above Reflow - 220C | 50 | 70 | Seconds |
| Peak Temperature | 245 | 255 | Degrees Celsius |

**Description:**

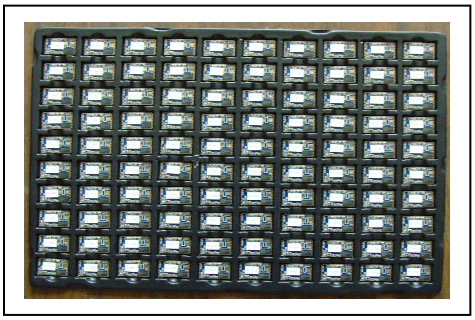
**Figure 10**

# 8. PACKAGING INFORMATION

1. BLUETOOTH® Module: BTM8640M



2. Assembly



3. Dimension