

**IS200X, IS201X, IS202X, BM1X, BM2X**

**Application Note**

Revision History

|  |  |  |
| --- | --- | --- |
| Date | Revision Content | Version |
| May/4’2015 | Release version | 1.0 |
|  |  |  |
|  |  |  |

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**Abbreviations List:**

**HFP:** Hands-free Profile

**AVRCP:** Audio Video Remote Control Profile

**A2DP:** Advanced Audio Distribution Profile

**PBAP:** Phone Book Access Profile

**HSP:** Headset Profile

**SPP:** Serial Port Profile

**NFC:** Near Field Communication

# 1. OVERVIEW

## 1.1 GENERAL DESCRIPTION

IS20XX/BMXX series is upgraded new chips and modules solution which support Bluetooth Stereo/Mono Headset, Speaker and Speaker Phone. New features such as build-in class-D amplifier and DSP audio/voice processing functions are added for more compact, cost effective and power saving usages.

## 1.2 KEY FEATURE LIST:

* + - Bluetooth 4.1 supported.
* Bluetooth profiles

- HFP v1.6

- HSP v1.1

- A2DP v1.2

- AVRCP v1.5

- SPP v1.0

- PBAP v1.0

* + - Built-in Lithium-ion battery charger (up to 350mA)
    - Build-in Class-D Amplifier (CDA) for mono/stereo speaker application.
    - Low power consumption
    - DSP audio sound effect features: DRC (Dynamic Range compression) and Widening (surrounding effect).
    - Analog/Digital (I2S) output interface for audio application
    - 4 languages voice prompts supported.( English/Chinese/Spanish/French)
    - UART command set upgrade to v1.45
    - Max. 8 paired device records

## 1.3 AVAILABLE PART NUMBER:

* ICs:

IS2008S(QFN48), IS2010S(QFN48), IS2013S(QFN56), IS2013S(QFN56), IS2015S(QFN56), IS2020S(QFN56), IS2021S(QFN48), IS2023S(QFN56), IS2025S(QFN68)

* Modules:

BM15, BM20, BM23, BM25

The key feature of each IC and module are listed below:

Table1-1: Features list of IS20XX and BMXX



## 1.4 APPLICATION BLOCK DIAGRAM:

# 2. IO ASSIGNMENT LIST



## 2.1 FOR IS2013, IS2015, IS2020, IS2023, IS2025, BM15, BM20, BM23, BM25

**Table2-1: IO assignment list of IS2013, IS2015, IS2020, IS2023, IS2025, BM20, BM23, BM25**

|  |  |
| --- | --- |
| **Pin name** | **Function** |
| PWR | MFB ; RX\_Ind |
| P0\_2 | Play / Pause |
| P2\_7 | Vol+ |
| P0\_5 | Vol- |
| P0\_1 | FWD ; CLS1 TX |
| P0\_3 | REV ; Buzzer ; Out\_Ind 1 ; CLS1 RX |
| P1\_5 | Out\_ind 0 ; NFC ; Slide Switch ; Buzzer (default pull down) |
| P2\_0 | System Config ; |
| P2\_4 | System Config ; |
| P0\_4 | NFC ; Out\_ind 0 |
| P0\_0 | TX\_Ind ; Slide Switch |
| P3\_0 | Line\_IN detect |

## 2.2 FOR IS2008, IS2010

**Table2-2: IO assignment list of IS2008, IS2010**

|  |  |
| --- | --- |
| **Pin name** | **Function** |
| PWR | MFB ; RX\_Ind |
| P0\_2 | Play / Pause |
| P2\_7 | Vol+ |
| P0\_5 | Vol- |
| P0\_1 | FWD ; CLS1 TX |
| P0\_3 | REV ; Buzzer ; Out\_Ind 1 ; CLS1 RX |
| P1\_5 | Out\_ind 0 ; NFC ; Slide Switch (default pull down) |
| P2\_0 | System Config |

## 2.3 FOR IS2021

**Table2-3: IO assignment list of IS2021**

|  |  |
| --- | --- |
| **Pin name** | **Function** |
| PWR | MFB ; RX\_Ind |
| P0\_2 | Play / Pause |
| P2\_7 | Vol+ |
| P0\_5 | Vol- |
| P0\_1 | FWD ; CLS1 TX |
| P0\_3 | REV ; Buzzer ; Out\_Ind 1 ; CLS1 RX |
| P1\_5 | Out\_ind 0 ; NFC ; Slide Switch ; Buzzer (default pull down) |
| P2\_0 | System Config ; |
| P0\_4 | NFC ; Out\_ind 0 |
| P0\_0 | TX\_Ind ; Slide Switch |

## 2.4 FUNCTION DESCRIPTION

**Table2-4: The description of function:**

|  |  |
| --- | --- |
| **Function** | **Description** |
| MFB | Multi-Function Button input |
| RX\_Ind | UART RX indicator from MCU |
| TX\_Ind | UART TX indicator from Bluetooth |
| Play/Pause | Play or pause the audio playback control input |
| Vol+ | Increase volume control input |
| Vol- | Decrease volume control input |
| FWD | Skip track forwards control input |
| REV | Skip track backwards control signal input. |
| CLS1 TX | Class 1 TX control signal output |
| CLS1 RX | Class 1 RX control signal output |
| Buzzer | Buzzer control signal output. |
| Out\_Ind 0 / 1 | Output indication for specific application. |
| Line\_IN detect | Aux\_In jack insert control signal input. |
| Slide switch | Slide switch control signal input. |
| NFC | NFC tag contact signal input. |
| System Config | System configuration control signal input. |

# 3. SYSTEM TURN ON/OFF APPLICATION

## 3.1 POWER SWITCH TYPE SETTING

**- MFB Power On/Off:**

Power on/off by a push button “MFB”

**Figure 3-1 MFB Power Switch**

****

**- Slide Switch Type:**

Turn on system by the slide switch, it will generate around 60mS pulse to MFB pin as power on signal.   
 Turn off the switch will pull high P0\_0 and firmware will turn off the module completely.

**Figure 3-2 Slide Switch Circuit**



**- Power On Directly**

Connect Li-ion battery to BAT\_IN to turn on Bluetooth system directly

Note: It has risk that maybe causes “error EEPROM writing” when system is power off directly.

Mobile phone also cannot detect Bluetooth disappear immediately.

**Figure 4-5 Power On Directly**

****(MFB pulse timing >200ms)

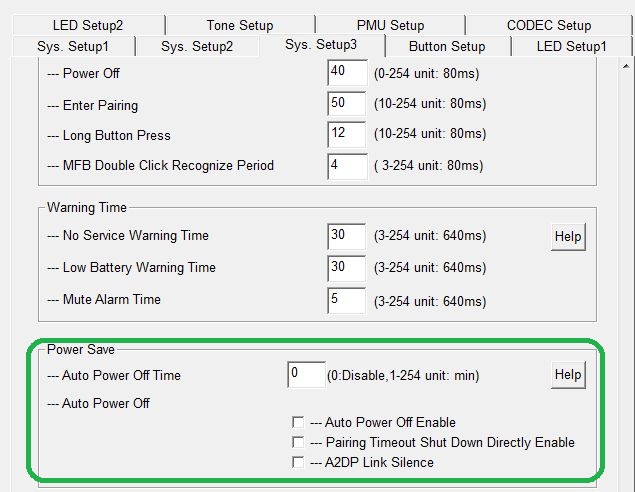
## 3.2 AUTO POWER OFF FUNCTION

When auto power off is enabled by UI tool and timeout occur, the procedure will be executed while below conditions is satisfied.

* Battery low
* BT state is in standby mode (No HF and A2DP link).
* Line-in is silence.
* No keys were pressed.
* No power adaptor is plugged in.

Note: For slide switch design or CODEC is set as always on, auto power off function is not provided.

**FIGURE 3-2: UI Setting of Power Save part:**



# 4. BATTERY CHARGER APPLICATION

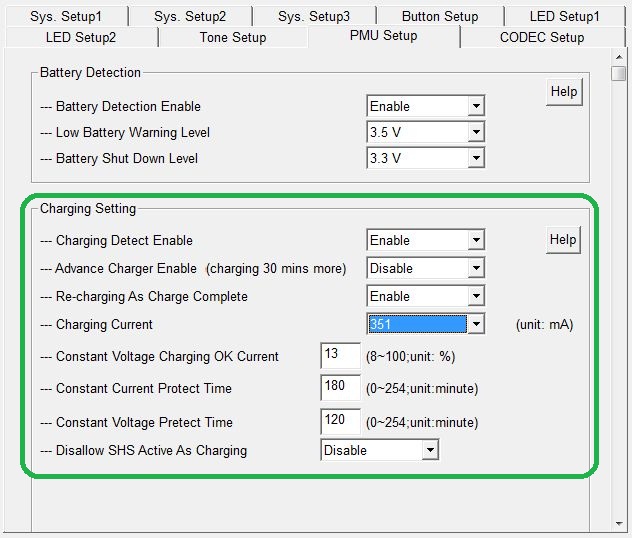
## 4.1 BUILD IN BATTERY CHARGER

- IS20XX and BMXX provide an internal Li-ion battery charger (max. 350mA charge current).

- Max. 350 mA charging current can be set up by UI tool.

If an external charger is needed for system, disable internal charger by UI tool.

**FIGURE 4-1: UI Setting of charging part:**



## 4.2 EXTERNAL CHARGER

- If an external charger is needed (for example, external charger APL3202B which can provide 417mA charge current), internal charger should be turn off in UI tool.   
\*Note: The ISET pin of APL3202B is used to disable the charger while in mass production test.

**Figure 4-2 Example of External Charger**



## 4.3 BATTERY STATUS DISPLAY IN APPLE iOS

For Apple iOS iPad and iPhone battery level display, battery status report is available during charge and discharge status.

The battery status vs. iOS battery level on discharging / charge mode is shown below:

**Discharge Mode**

Table 3-1: Discharge Battery Status vs. iOS Battery Level

|  |  |  |
| --- | --- | --- |
| **BAT Status** | **iOS BAT Level Notification** | **iPhone BAT icon display** |
| Dangerous(≤ 3.3V\*) | 0 | Bar is empty with red warning color |
| Low (3.3~3.5V\*) | 0 | Bar is empty with red warning color |
| Normal (3.50~3.7V) | 3 | Bar is lower level with green color |
| High (3.7~3.9V) | 6 | Bar is higher level with green color |
| Full (≥ 3.9V) | 9 | Bar is full level with green color |

**Charging Mode**

Table 3-2: Charging Battery Status vs. iOS Battery Level

|  |  |  |
| --- | --- | --- |
| **SPK Charging Status** | **BAT Level Notification** | **iPhone BAT icon display** |
| REVIVING | 0 | Bar is empty with red warning color |
| PRE\_CHARGING | 0 | Bar is empty with red warning color |
| CC | 3 | Bar is lower level with green color |
| CV | 6 | Bar is higher level with green color |
| Complete/IDLE/Error | 9 | Bar is full level with green color |

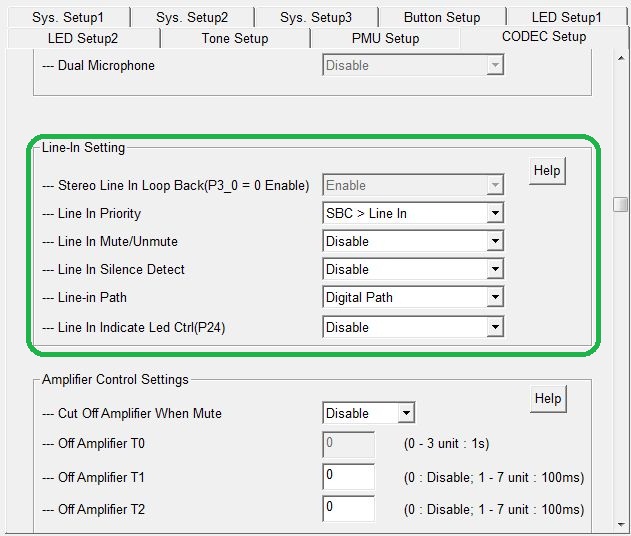
# 5. LINE-IN (AUX-IN) APPLICATION

## 5.1 ADVANCED LINE-IN (AUX-IN) FUNCTION

**-Priority of A2DP and Line-in for speaker output:**

SCO always plays the first priority to make/receive a phone call. Priority of A2DP and Line-in audio is selectable by UI tool.

**FIGURE 5-1: UI Setting of Line-in part:**



The behavior of Line-in audio and Bluetooth A2DP/SCO is listed below:  
1. Line-in loop back to DAC output stage scheme:  
 a. Analogy loopback: Line-in signal loopback to output stage directly.   
 b. Digital loopback: Line-in signal connect to internal DSP block for audio process (e.g. EQ), then pass to

output stage.

2. Line-in audio control:

Volume up/down and mute is controllable. The control buttons are the same as Bluetooth audio.

3. Mute function defines:

-Line-in priority is higher than A2DP:

* + - * Under A2DP mode: Press Play/Pause button set AVRCP Play/Pause command.
      * Under Line-in mode: Press Play/Pause button set Mute/Un-Mute Line-in music
      * Always back to Line-in Un-Mute mode when AUX is plugged in.

-A2DP priority is higher than Line-in setting:

* + - * No Line-in mute/un-mute feature.

4. When Line-in priority is higher than A2DP, A2DP music will be stopped when Line-in jack is plugged and all AVRCP events will be ignored.

## 5.2 LINE-IN CIRCUIT

-**Line-in jack plug-in detect (P3\_0)**

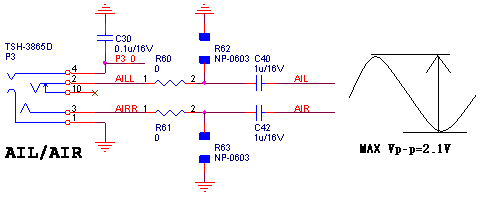
P3\_0 can be set as line-in detector by UI tool (active low).   
P3\_0 connected to dedicated line-in jack Pin 4 as below. Pin1 &4 of the jack will be shorted together when jack be plug-in and force P3\_0 pull low to indicate line in jack inserted.

**-Line-in signal Vp-p control**

External resistor divider is necessary to make the maximum input Vp-p under 2.1V. Please adjust resistor (R60~R63) to fit the max Vp-p to 2.1V base on your audio source.

Detail line in gain setting, please refer to “DSP Application Note” document.

**Figure 5-2 Line in circuit**



**-Line-in Silence Detection**

Line-in silence detection design has been built-in system. It can be used to save power when auto power off function is turned on by UI tool and Line-in signal silence.

# 6. VOICE PROMPT & MULTI TONE

## 6.1 VOICE PROMPT/MULTI TONE FUNCTION

Build in voice prompt and multi tone functions are available. It can be customizing by provide “Wave file format” voice prompt and “midi file format” multi tone and set up by UI tool.

## 6.2 TONE SETTINGG

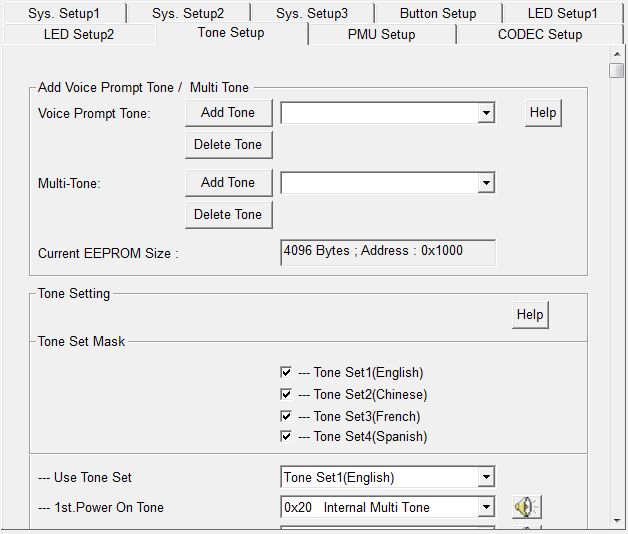
There are 4 tone set and the default languages voice prompt which include:

Tone Set 1(English) / Tone Set 2(Chinese) / Tone Set 3 (Spanish) / Tone Set 4 (French) are supported and can be switched by button event.   
External wave format voice prompt and multi-tone can be selected at the “Add voice prompt tone/multi tone” section as Figure 6.1.

Users can build up the \*.wav format voice prompt and add the file in the desired tone condition.

Note1: The wav file should be in 8K, 16bit mono type  
Note2: The wave file is stored in EEPROM, extra space is required if the wav file added. The size is supported up to 512K bit. Total size of the EEPROM will show on “Current EEPROM Size” window in UI tool.

**Figure 6.1 Tone Setting**



WAV File Tone

EEPROM Size

Multi Tone

The voice prompt status of 4 languages is listed below:

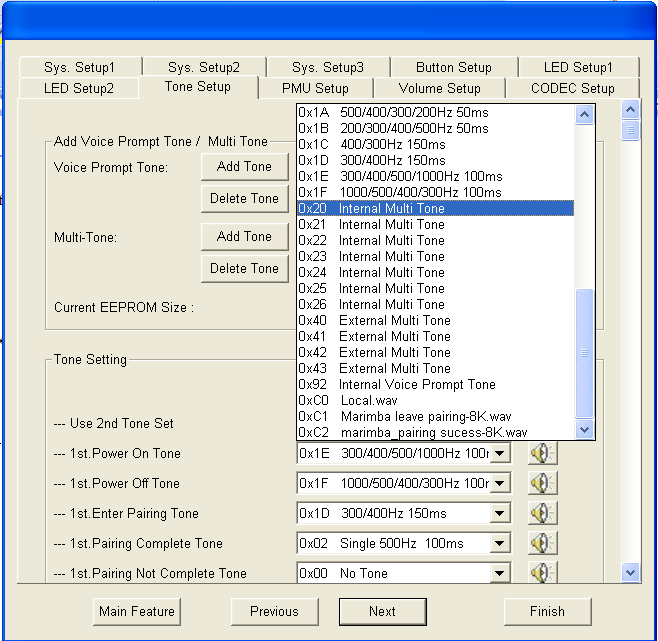
**Table 6-1 Voice Prompt Status**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | English | Chinese | Spanish | French |
| 1 | Power On | 開機 | Encendido | Allumer |
| 2 | Ready to Pair | 進入配接狀態 | listo para asociar | Prêt à appairer |
| 3 | Pairing Completed | 完成配對 | asociación completada | Pairage réussi |
| 4 | Pairing Not Completed | 配對失敗 | asociación fallida | Pairage échoué |
| 5 | Device Connected | 藍牙已連接 | Dispositivo conectado | Bluetooth active |
| 6 | Device Disconnected | 藍牙已斷開 | Dispositivo desconectado | Bluetooth désactivé |
| 7 | Incoming Call | 遠方來電 | Llamada entrante | Appel Entrant |
| 8 | Call Rejected | 拒接電話 | Llamada rechazada | Appel Refusé |
| 9 | Power Off | 關機 | Apagado | Eteindre |
| 10 | Battery Low | 電量不足 | Batería baja | Batterie faible |
| 11 | Battery Medium | 電量適中 | Batería media | Batterie moyenne |
| 12 | Battery High | 電量充足 | Batería llena | Batterie haute |
| 13 | Maximum Volume | 最大音量 | volumen máximo | Volume maximum |
| 14 | Minimum Volume | 最小音量 | volumen mínimo | Volume minimum |
| 15 | Charging Initiated | 充電開始 | Cargando | Charge activée |
| 16 | Charging Completed | 充電完成 | Carga completada | Charge terminée |
| 17 | Call ended | 電話結束 | Llamada finalizada | Appel terminé |
| 18 | English Mode | 中文模式 | Modo Español | Mode en français |
| 19 | Last number re-dial | 末碼重撥 | Re-llamar último número | Rappel du dernier numéro |
| 20 | Voice Dial | 語音撥號 | Marcación por voz | Numérotation vocale |

## 6.2 MULTI-TONE PROMPT

Multi-tone type prompt sound is provided by setting the “Tone Setting” page in UI tool. There are 7 types of internal Multi-tone are provided, which are built in ROM code.

Customizing multi-tones are provided, which need extra space of EEPROM to store them. (as Figure 6.1)

**Figure 6.2 Multi-tone Prompt in UI**

\*\*Suggested max playing time of Multi Tone and Voice Prompt tone:

* + - * Power on tone: 4.5 second.
      * Others: 3 second.

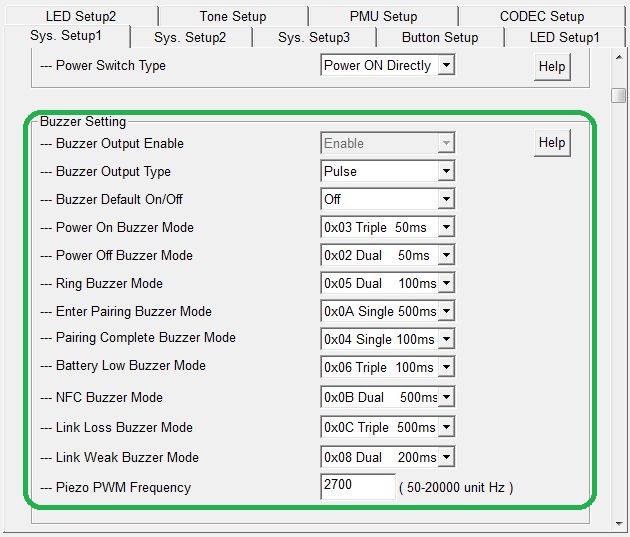
# 7. BUZZER APPLICATION

System provides buzzer application for both PWM and pulse mode. It can be set up by UI tool.

**Figure 7-1 Reference Circuit of Buzzer**



**Figure 7-2 UI Setting of Buzzer part:**



# 8. NFC TRIGGERS BLUETOOTH CONNECTION APPLICATION

System provides NFC (Near Field Communication) triggered connection application with NFC Forum Type 2 tag. It can be easier to finish Bluetooth pairing and connection process by use NFC.

## 8.1 GENERAL INTRODUCTION FOR NFC APPLICATION

### 8.1.1 NFC TAG FOR APPLICATION

-NFC Forum Type 2 compatible, not support FELICA

-Requirement Size (User Data Size)

Containing BT address & Device Name=> 66Bytes

-Antenna (Coil) pin-out available

**Figure 8-1 NFC Tag Pin Out**



### 8.1.2 NFC BEHAVIOR AFTER TRIGGERED

Trigger NFC of BT system has different reaction according to different state:

-**System in power off state**  
NFC touch will triggers the MFB and then power on the system. Firmware detects NFC signal (by IO pin) and system will get into standby mode then waiting for the Bluetooth connection from mobile phone.

- **System in pairing mode**  
NFC touch will make system leave pairing mode and get into standby mode then wait for the Bluetooth connection from mobile phone.

- **System in link back mode**

NFC touch will cancel the link back action and get into standby mode then wait for the Bluetooth connection from mobile phone.

- **System in connection mode**  
System will not have any action but Mobile phone should disconnect the link. It depends on the APP design criteria.

## 8.2 ADDITIONAL NFC TRIGGER CIRCUIT

It needs addition trigger circuit when use NFC application. NFC\_P & NFC\_N connects to NFC tag module, for NFC tag with/without rectifier circuit, there are circuit option which has described in the circuit below.

**Figure 8-2 NFC TRIGGER CIRCUIT**

****

- NFC function trigger I/O: P04 (or P15), it can be set up by UI tool.

- System can be turned on by MFB button/ Slide Switch or triggered by Mobile Phone NFC function and turn off

system by MFB button/Slide Switch.

- For NFC + Slide Switch application:

Slide switch must be turned on to enable NFC function, reference circuit please check slide switch option in

NFC trigger circuit.

- Two UI setting are suggested:

Enable “power on link back setting” and make system “into pairing mode as system in standby mode” in UI

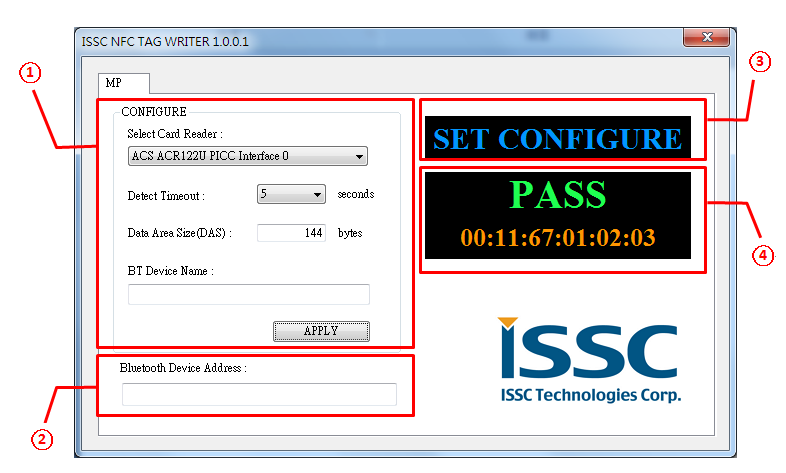
tool for non-NFC mobile phone.

- If mobile phone with NFC touch speaker after power on, system will get into standby mode and wait for page.

## 8.3 NFC WRITER TOOL

IS20XX provide a NFC writer which can easily write NFC tag by bar code scanner or manually typing. Please refer to document “NFC Tag Writer\_User\_Manual” document for more detail

**Figure 8-3 NFC Writer Tool**



CONFIGURE Bluetooth Device Address State Result

\*The supported NFC reader module is ACS ACR122, Website: [www.acs.com.hk](http://www.acs.com.hk)

## 8.4 MP TOOL FOR NFC APPLICATION

MP Tool is supported for NFC tag read/write scenario between DUT and Bar Code Label.

By reading the information in Bar Code or DUT EEPROM, users can write BT Info. (e.g. Device Name, BT Address) to NFC tag by NFC reader. Or read the existed BT Information in NFC tag by NFC reader and write to DUT EEPROM.

**Figure 8-4: BT info between 3 storages: EEPROM, Barcode Label, and NFC Tag**



**Table 8-1 Scenarios of Read or Write NFC Information**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Scenarios | | EEPROM | Tag | Label | Tools | Remarks ….Quick Start Guide |
| 1 | Typical MP | Empty | Empty | Yes/No | MPBT(WTT) | For new non-tested DUT/Tag.…Edit all wanted test items and #9800 in MPSE, then runs MPBT. |
| 2 | MP with module | Full | Empty | Yes | NFC Tag Writer (WTT)[[1]](#footnote-1) | For label adhesive BM module with new Tag…. Use the NFC Tag Writer to write NFC tag. |
| 3 | NOT suggest[[2]](#footnote-2) | Full | Empty | No | MPBT(WTT) | For tested DUT with new Tag….Select #9800 only in MPSE, and select the 『No Write』 as Address input, then run MPBT. |
| 4 | Empty | Full | No | MPBT(RFT) | For pre-burn Tag or replacing DUT….Select the 『NFC』Tag as Address input in configure/MPBT. |
| 5a | For QC | Full | Full | Yes | MPBT(RFT) | New: Barcode to verify Tag and EEPROM,  For the data consistence verification between Tag/EEPROM/Label (most likely used by QC purpose)…  #9800 verify only 🡪barcode configure/MPBT, and barcode verify |
| 5b | Full | Full | No | MPBT(RFT) | New: Tag to verify EEPROM…  #9800 verify only 🡪 no write configure/MPBT |
| 5c | Full | No | Yes | MPBT | Existing function: barcode configure/MPBT, and barcode verify |

To cover the above usage scenarios, there are two operation modes:

***Write To Tag mode*** (***WTT***) and ***Read From Tag mode*** (***RFT***), according to the data alignment flow provided for MP NFC function. In WTT, the content written into Tag is referred from that of DUT EEPROM, and vice versa In RFT.

\*For more information of NFC MP Tool, please contact FAE.

\* Near Field Communication(NFC)。<http://nearfieldcommunication.com/>

NFC Data Exchange Format (NDEF)。<http://www.nfc-forum.org/specs/spec_list/>

# 9. AUDIO WITH AMPLIFIER APPLICATION

## 9.1 BUILD-IN CLASS D AMPLIFIER

In IS2025 and BM25, it provides dual channels (Max. 1.9W for each channel) class D amplifier output. In IS2013, IS2015 and BM15, it provides single channel (Max. 1.9W) class D amplifier output. User can use UI tool to turn on the internal class D amplifier for speaker application.

### 9.1.1 POWER TREE FOR INTERNAL CLASS-D AMP (CDA)

Max. DC power level for internal class-D amplifier is 4.5V, so for

- Use Li-ion Battery as power source

Connect Li-ion battery to CDA\_PWR pin directly.

- When Li-ion Battery & Adapter both exist:

As the reference circuit below:

**Figure 9-1 Power Switch Circuit for Li-ion Battery and Adapter**

****

1. The power switch circuit will turn off the trace from BAT\_IN to CDA\_PWR when adapter is inserted.
2. The circuit uses a LDO and diode to make sure CDA\_PWR power lower than 4.5V.
3. If system want keep speaker volume even low battery, it need a boost circuit to keep power of amplifier.

(as Figure 9-2)

**Figure 9-2 Provide 4.5V for Internal CDA**

## 9.2 EXTERNAL AUDIO AMPIFIER CIRCUIT

### 9.2.1 AUDIO AMP SELECTION

* + 1. High enable active audio amplifier is supported.
    2. “Active Mode” Pop noise free of the amp is required

3. It would be better to choose AMP’s SNR spec as high as possible. DAC SNR = 96dB, if amplifier SNR spec is lower than IS20XX, poor AMP’s SNR will be dominated by noise

4. Select the suitable speaker driver (Max Watt) to meet the AMP’s THD+N vs Output Power requirement.

**Figure 9-3 Audio AMP THD+N vs. Output Power  
**

### 9.2.2 AUDIO AMP CIRCUIT DESIGN

1. Gain of Audio AMP set to 3.5(10.8dB)\* and the max speaker gain set to 0 dB in DSP tool.

2. Input resistor must select 1% /0805 grade & Capacitor please select X5R or X7R type.

3. For PAM8004 AMP example, to prevent power on pop noise and AMP leakage current, please follow the reference circuit of amp enable path.

4. Power trace π type filter (100uF-Bead-100uF) is required to filter out the digital & switching noise for EMI. The max current limit of bead >1.5 A is suggested.

5. D-type AMP speaker output L (Ferrite Bead)/ C high frequency filter for EMI immunity depend on the switching frequency. Please follow the selected AMP’s suggestion.

\*Note:

About gain setting of AMP:

1) We assume amplifier power come from Li-ion battery, so Vp-p of amplifier output should be 3.7x2= 7.4V

2) The signal come from BT audio output assume 2V (Vp-p), then max. gain of AMP should: 7.4/2=3.7

3) For this AMP (PAM8004), the gain of AMP should be: 2 x (142k ohm / Rinput) ≤ 3.7, so we select Rinput = 82 k ohm.

**Figure 9-4 Audio AMP Circuit Design**

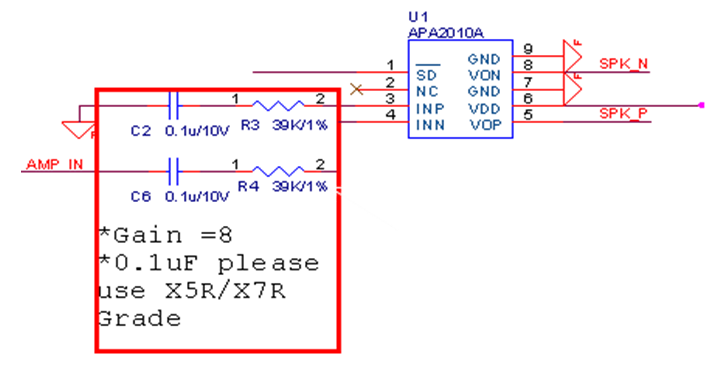
****

1, 2

4

3

**Figure 9-5 Mono AMP Circuit Design**

****

2

**Figure 9-6 Speaker Output Circuit**

5

****

### 9.2.3 AUDIO GAIN ADJUST GUIDELINE

For well fine tune the audio gain from Bluetooth or line in to external audio AMP output , some test criteria are need to be concerned:

1. Definition: Line in loopback gain= GL, Bluetooth output gain=GB

2. Line in loop gain adjusts: R1/R2 is selected to meet the max line in Vp-p limit = 2.1V @ GL=0dB.   
Default R1/R2 is to accommodate the maximum volume of music source to fit the maximum input Vp-p. If your selected music source’s max output Vp-p is higher, please reduce R1/R2 to meet the line in limit.

3. Bluetooth audio path: the maximum speaker output (Vp-p max) should be 2.2V.

4. Adjust audio amp’s gain to meet the max watt value of the amp and speaker driver. Please reference to the AMP’s THD+N vs. power spec.

**Figure 9-7 Line in & BT Audio Gain Block Diagram**

****

### 9.2.4 EXTERNAL AMP POWER ON TIMING CONTROL FOR POP NOISE FREE

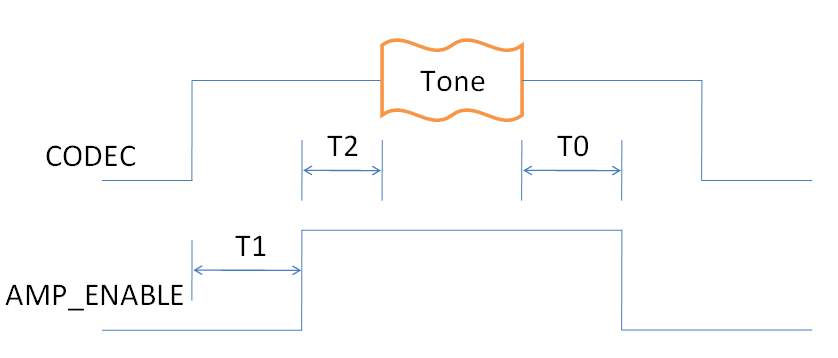
To prevent the AMP power on pop noise, the timing of Speaker output (Left &Right output of chip), Amplifier Enable pin (AMP\_EN) should be well controlled.

As shown in the following figure, T1 is defined as the time period between “SPK OUT starting time” and “AMP\_EN”. Speaker output should be always starting up earlier than AMP\_EN to prevent the pop noise induced on the rising edge of the SPK\_OUT.

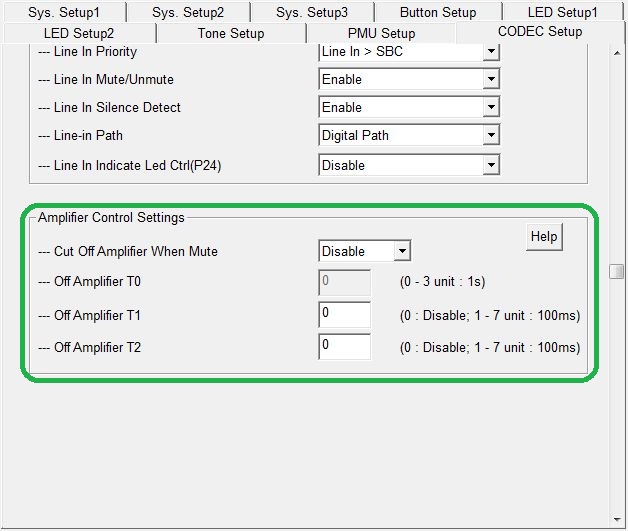
T2 is defined as the time period between “AMP\_EN” and “ First prompt sound start time”. It is designed to be adjustable to prevent the issue of some AMP has long soft start time after power n and cover the first prompt sound.

To prevent frequent switch on off pop noise during music stop, delayed AMP\_EN off timing after music stop is required.When codec mute, set T0 timer to turn off amplifier, if this value set to 0, then turn off amplifier directly, unit is 1s

**Figure 9-8 Audio AMP Power on Timing Control**



**Figure 9-9 UI Setting of EXT AMP timing:**

****

### 9.2.5 SOFT START FOR SINGLE END OUTPUT

For CODEC single end output connect to the amplifier without AMP\_EN control, the default setting of single end output has soft start/off function to minimize the pop noise. Please set single end output in UI codec setup page.  
Note: The referenced output dc cap is 1uF

**Figure 9-10 UI setting of single end EXT AMP part:**

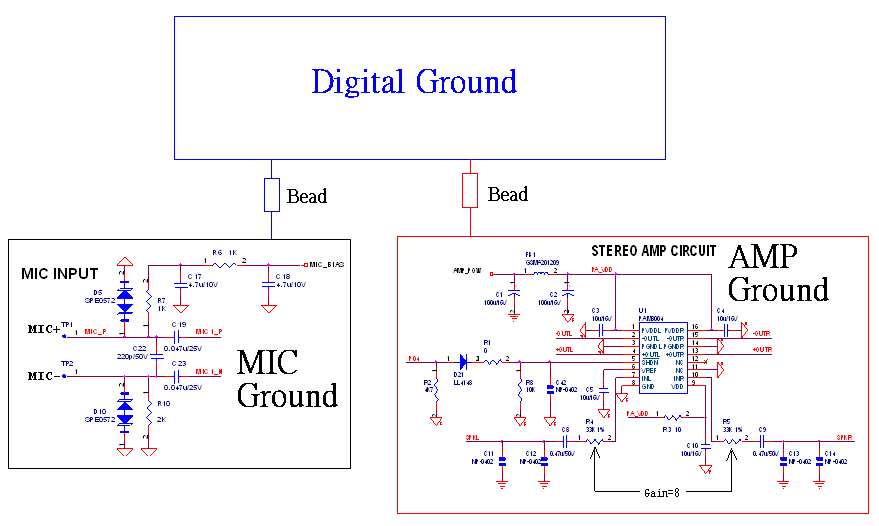
****

### 9.2.6 PCB LAYOUT GROUND PARTITION

**-**To prevent the noise interference between MIC, Audio AMP and Digital portion of the chip, ground partition as Figure 9-11 by ferrite bead is required.

-The MIC ground area should cover the MIC circuit and so does the AMP ground.

**Figure 9-11 Layout Ground Partition**

****

# 10. SPEAKER PHONE HOUSING DESIGN

## 10.1 HOUSING DESIGN

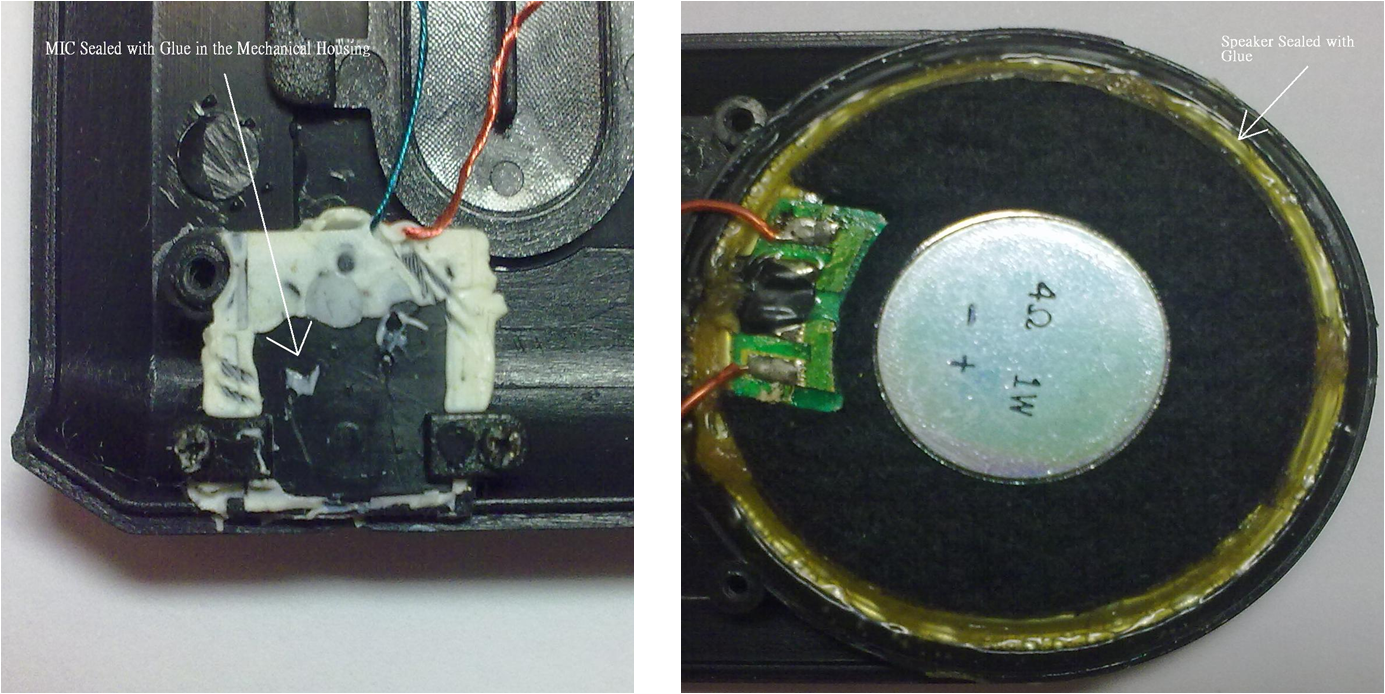
For better speaker phone acoustic echo cancellation quality, some key point of speaker hosing design shell be notified as follows:

* 1. Microphone need to have an independent and sealed room.
  2. Microphone room needs to be filled by glue to reduce the echo and speaker vibration.
  3. Distance between microphone and speaker should be as long as possible, generally greater than 4 cm is preferred.
  4. Microphone face to speaker front side.
  5. When microphone place to the housing, it must close to the microphone hole
  6. Speaker driver should be installed tightly to the housing to avoid vibration during talk.

**Figure 10-1 Distance of speaker and MIC**

****

**Figure 10-2: MIC & Speaker Housing**

****

# 11. EXTERNAL MCU APPLICATION

## 11.1 OPERATION WITH EXTERNAL MCU

IS20XXS and BMXX support UART command set to make an external MCU to control IS20XX or BMXX.

Here is the connection interface between system and MCU.

**FIGURE 11-1: INTERFACE BETWEEN MCU AND IS20XX CHIP**



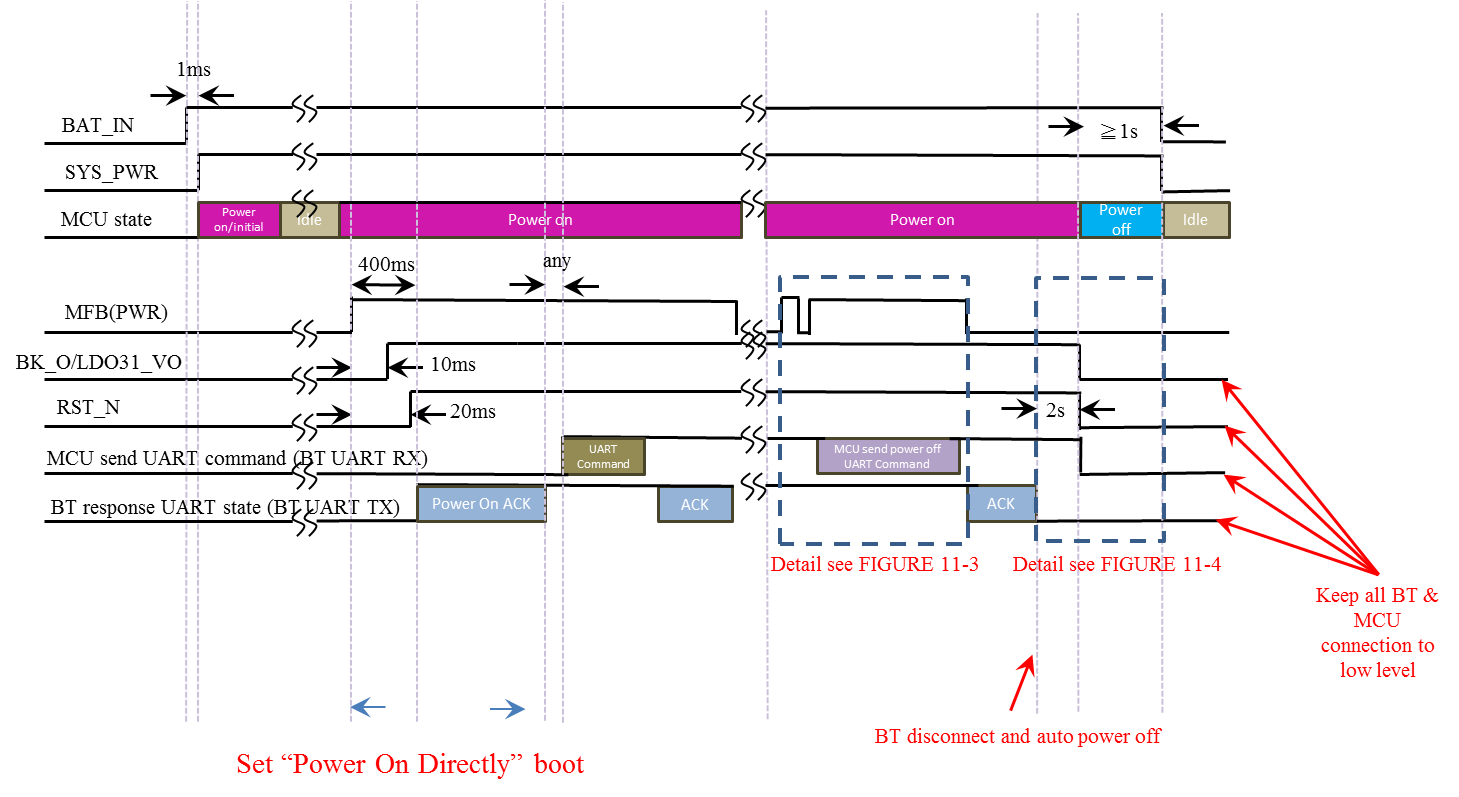
MCU can control IS20XXS chip by UART interface and wakeup IS20XXS by PWR pin. IS20XXS provide wakeup MCU function by connect to P0\_0 pin of IS20XX.

“UART\_CommandSet\_v154” document provide all UART command which IS20XX support and “IS20XXS\_UI” tool will help you to set up your system support UART command.

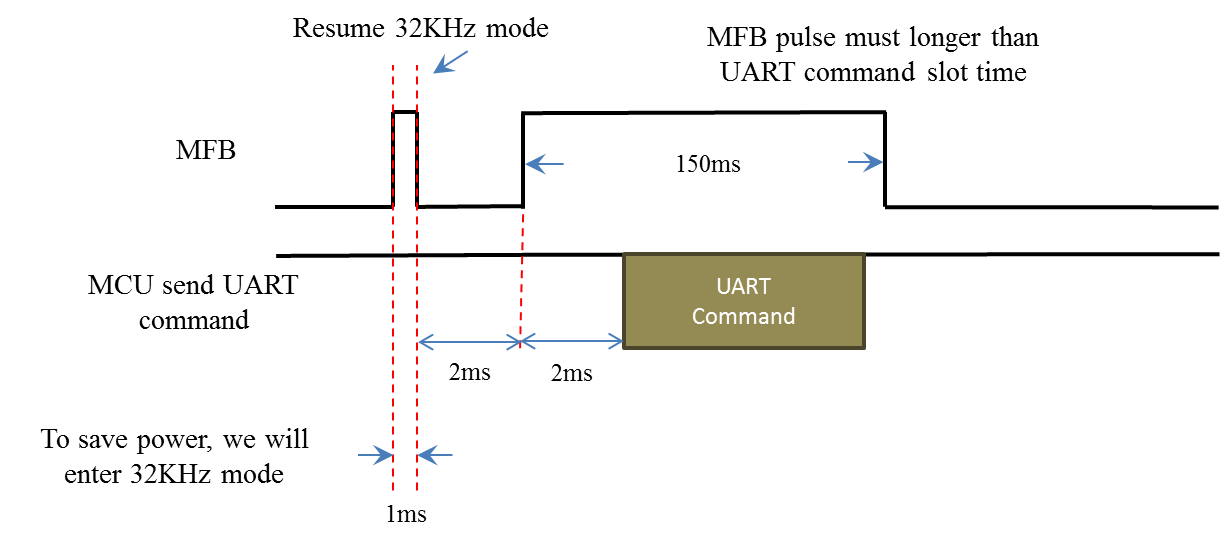
For more detail description, please reference “UART\_CommandSet\_v154” document and “IS20XXS\_UI” tool.

Here are some suggestions of UART control signal timing sequence:

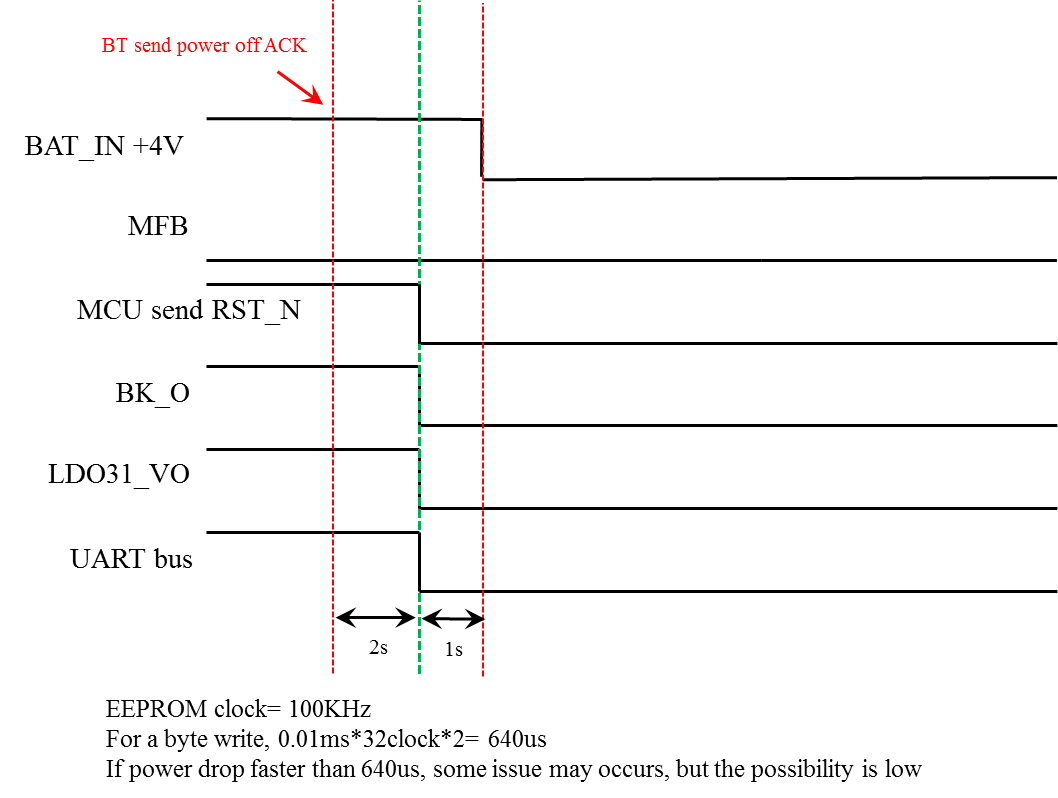
**FIGURE 11-2: POWER ON/OFF SEQUENCE**



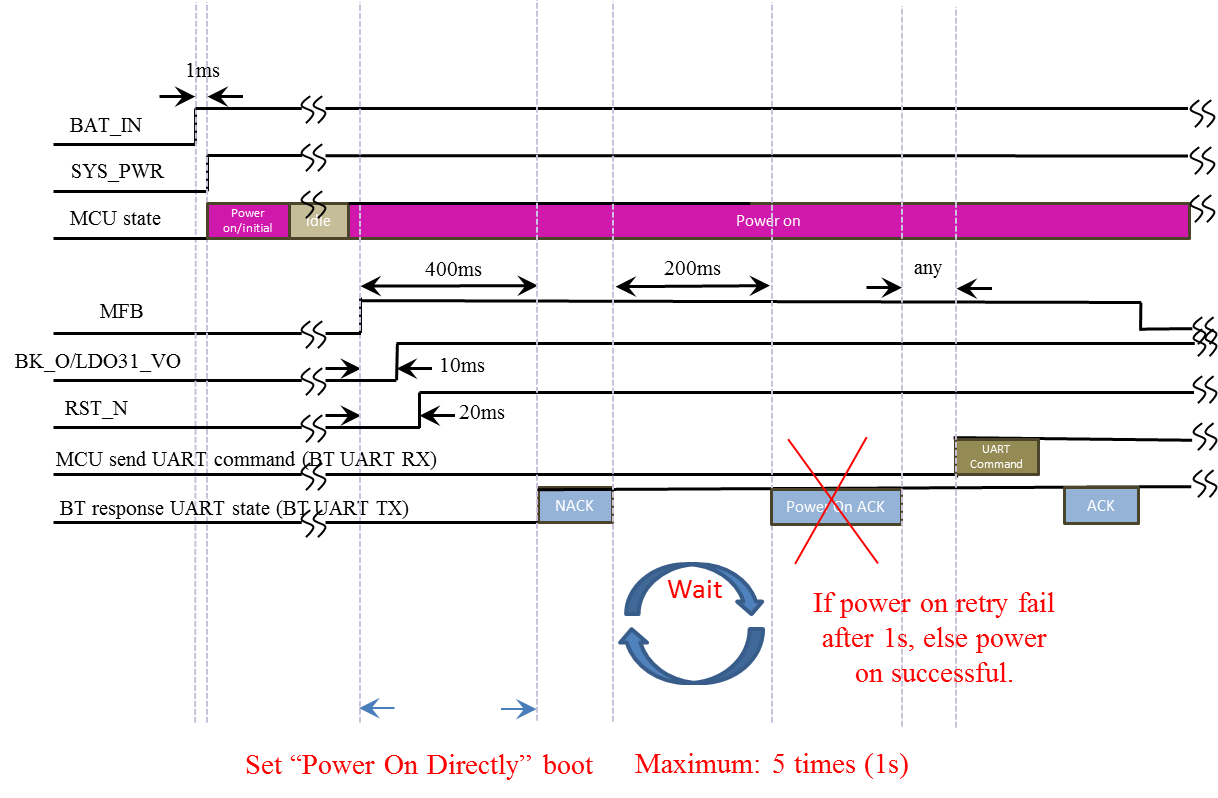
**FIGURE 11-3: TIMING SEQUENCE OF RX INDICATION AFTER POWER ON**



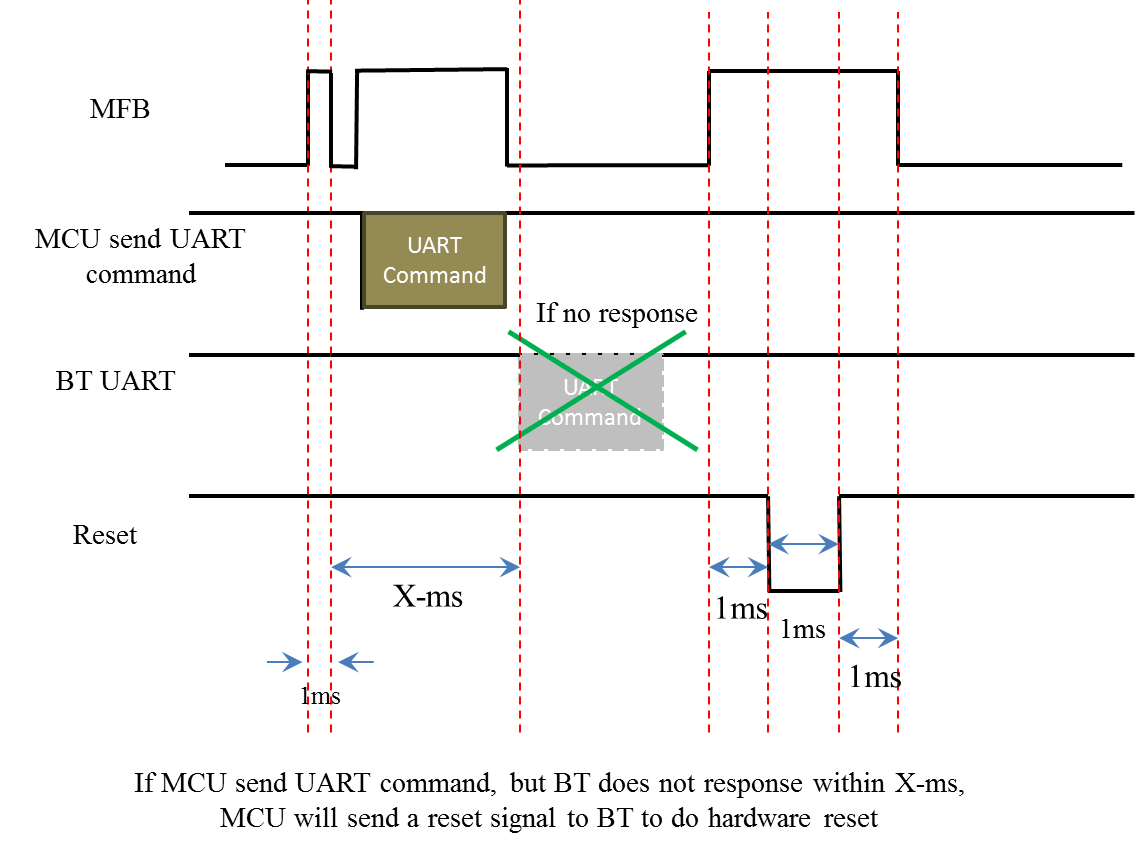
**FIGURE 11-4: TIMING SEQUENCE OF POWER OFF**



**FIGURE 11-5: TIMING SEQUENCE OF POWER ON (NACK)**



**FIGURE 11-6: RESET TIMING SEQUENCE IF MODULE HANGS UP**



**FIGURE 11-7: TIMING SEQUENCE OF POWER DROP PROTECTION**

BAT\_IN +4V

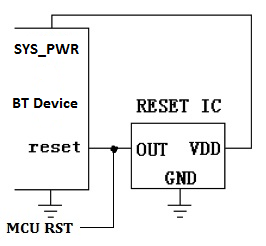
RST\_N from Reset IC

If BT’s BAT use adaptor translates voltage by LDO, we recommend use “Reset IC” to avoid power off suddenly. Rest IC spec output pin must be “Open Drain”、delay time ≦ 10ms

**Recommend part: TCM809SVNB713 or G691L263T73**

Power Off

2.9V ~ 3V



# 12. I2S APPLICATION

IS2023S and BM23 support I2S digital audio signal output. It provide 8k Hz, 44.1k Hz and 48k Hz sampling rate; it also support 16 bits and 24bits data format. The I2S setting can be set up by “IS20XXS\_UI” tool and DSP tool.

.

The I2S signal connection between IS2023S/BM23 and external DSP as below:

**FIGURE 12-1: MASTER MODE REFERENCE CONNECTION**



**FIGURE 12-2: SLAVE MODE REFERENCE CONNECTION**



Note 1: For 002 version chip or module, system should connect line 1 in slave mode figure.

And, system not support ADC signal from external DSP/CODEC.

Note 2: For other version chip or module, system should connect line 2 in slave mode figure.

About “Mast” or “Slave” mode setting, you can use “DSP Configuration Tool” to set up system.

**12.1 CLOCK AND DATA TIMING SEQUENCE**

**FIGURE 12-3: TIMING FOR I2S MODES (both master and slave)**



**FIGURE 12-4: TIMING FOR PCM MODES (both master and slave)**



# 13. ANTENNA PLACEMENT RULE

For Bluetooth product, antenna placement will affect whole system performance.

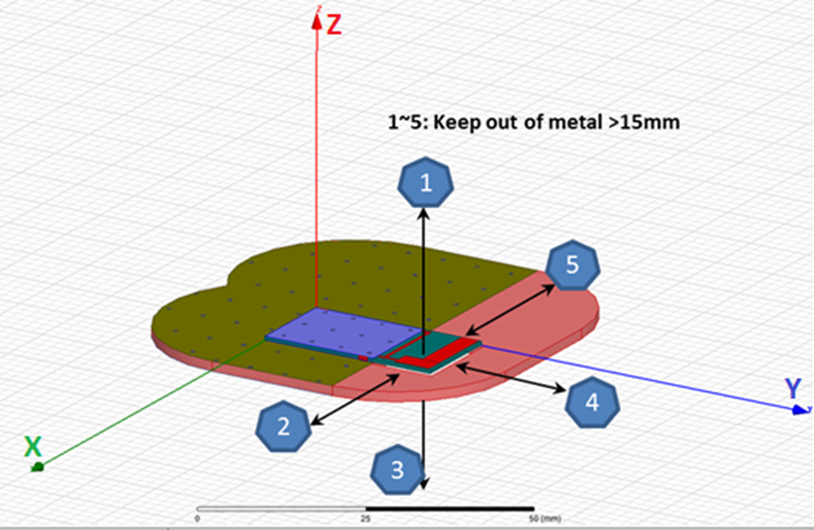
Antenna need free space to transmit RF signal, it can’t be surround by GND plane.

Here are some examples of good and poor placement on a Main Application board with GND plane.

**FIGURE 13-1: ANTENNA PLACEMENT EXAMPLES**



**FIGURE 13-2: KEEP OUT AREA SUGGESTION FOR ANTENNA**



For more detail free space of antenna placement design, you can reference the design rule of antenna produce

vendor.

# 14. MISCELLANEOUS

## 14.1 HEADSET APPLICATION

For headphone application, cap-less output connection is suggested to skip DC block capacitor. Please set capless output in UI codec setup page.

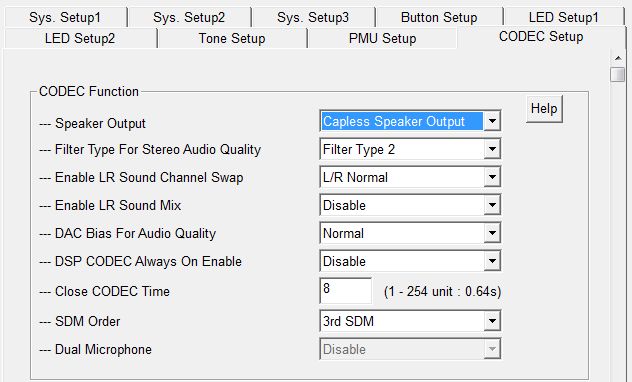
**Figure 14-1 CAP LESS STEREO OUTPUT**

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****

(Note: The shunt capacitor of each channel should less than 500pF.)

**Figure 14-2 CAP LESS SETTING IN UI**

****

For single-end headphone application, it needs serial a DC block capacitor on the circuit and set single-end output in UI codec setup page.

User can use the formula 1/(2\*RC)= Fcutoff to calculate the capacitor for your headset loading and cutoff frequency.

(R= headset resistance; C= serial capacitor; Fcutoff= Cutoff frequency)

**Figure 14-3 SINGLE-END STEREO OUTPUT**

****



**Figure 14-4 SINGLE-END SETTING IN UI**

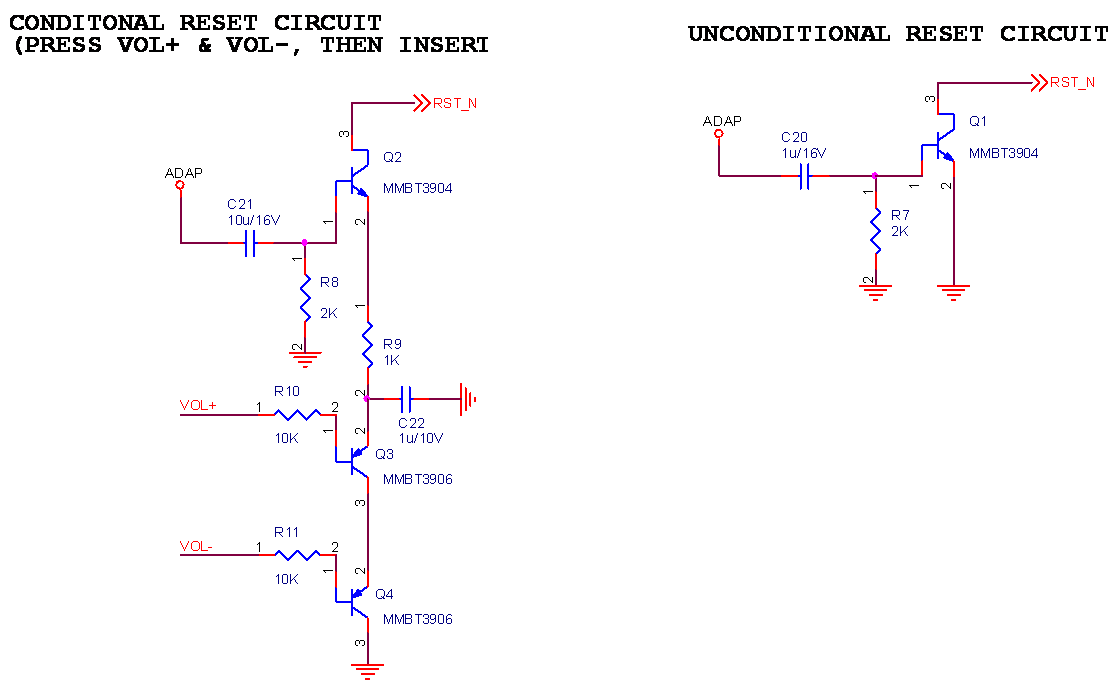
****

## 14.2 OPTIONAL RESET CIRCUIT

-Plug-in Reset: When adapter inserted, reset circuit will make a reset pulse to RST\_N

-Conditional Reset: Press VOL+/VOL- simultaneously and then insert adapter will make a reset pulse to RST\_N

**Figure 14-5 RESET CIRCUIT**

****

## 14.3 EEPROM DATA PROTECTION

During system is powering off, check the battery voltage before read/write EEPROM. If the voltage is lower than defined battery low value, stop the process of EEPROM read/write.

(e.g. If your battery is 3.2V and your low battery warning level set in 3.3V, you can’t write any new data to EEPROM!)

When system start up, check the battery voltage. If the voltage <3.0±0.1V, stop the startup process.

## 14.4 MULTI-LINK APPLICATION

System support multi-link feature, it means system build link to two different devices in same time.

a) For SCO link

There are some link status, system decide which device link active by the priority list as below:

CALL\_ACTIVE\_WITH\_CALL\_HOLD = CALL\_ACTIVE\_WITH\_CALL\_WAITING = CALL\_ACTIVE

> INCOMING\_CALL\_ONGOING

> OUTGOING\_CALL\_ONGOING = VOICE\_ACTIVATION\_ONGOING

> NO\_CALL\_ACTIVE

If device in same status, then system will active the link when

i) The first one in the status.

ii) The first one build SCO link to system.

b) For A2DP link

i) If no device in “A2DP Streaming Status”, then the last one link to system is the active device with the system.

ii) If one device in “A2DP Streaming Status”, then the device is the active device of the system.

iii) If both devices in “A2DP Streaming Status”, the last one into “A2DP Streaming Status” will be the active device of system.

1. [↑](#footnote-ref-1)
2. [↑](#footnote-ref-2)