



IS200X, IS201X, IS202X, BM1X, BM2X

Application Note

Revision History

Date	Revision Content	Version
May/4'2015	Release version	1.0

Index

1. OVERVIEW.....	1
1.1 GENERAL DESCRIPTION	1
1.2 KEY FEATURE LIST:.....	1
1.3 AVAILABLE PART NUMBER:	1
1.4 APPLICATION BLOCK DIAGRAM:	3
2. IO ASSIGNMENT LIST.....	3
2.1 FOR IS2013, IS2015, IS2020, IS2023, IS2025, BM15, BM20, BM23, BM25	4
2.2 FOR IS2008, IS2010	4
2.3 FOR IS2021	4
2.4 FUNCTION DESCRIPTION	5
3. SYSTEM TURN ON/OFF APPLICATION	6
3.1 POWER SWITCH TYPE SETTING	6
3.2 AUTO POWER OFF FUNCTION.....	7
4. BATTERY CHARGER APPLICATION.....	8
4.1 BUILD IN BATTERY CHARGER	8
4.2 EXTERNAL CHARGER.....	8
4.3 BATTERY STATUS DISPLAY IN APPLE iOS	8
5. LINE-IN (AUX-IN) APPLICATION.....	10
5.1 ADVANCED LINE-IN (AUX-IN) FUNCTION	10
5.2 LINE-IN CIRCUIT	11
6. VOICE PROMPT & MULTI TONE	12
6.1 VOICE PROMPT/MULTI TONE FUNCTION	12
6.2 TONE SETTINGG	12
6.2 MULTI-TONE PROMPT	14
7. BUZZER APPLICATION.....	15
8. NFC TRIGGERS BLUETOOTH CONNECTION APPLICATION	16
8.1 GENERAL INTRODUCTION FOR NFC APPLICATION	16
8.1.1 NFC TAG FOR APPLICATION.....	16
8.1.2 NFC BEHAVIOR AFTER TRIGGERED	16
8.2 ADDITIONAL NFC TRIGGER CIRCUIT	17
8.3 NFC WRITER TOOL	18
8.4 MP TOOL FOR NFC APPLICATION.....	18

9. AUDIO WITH AMPLIFIER APPLICATION	20
9.1 BUILD-IN CLASS D AMPLIFIER	20
9.1.1 POWER TREE FOR INTERNAL CLASS-D AMP (CDA).....	20
9.2 EXTERNAL AUDIO AMPIIFIER CIRCUIT	21
9.2.1 AUDIO AMP SELECTION	21
9.2.2 AUDIO AMP CIRCUIT DESIGN	21
9.2.3 AUDIO GAIN ADJUST GUIDELINE	23
9.2.4 EXTERNAL AMP POWER ON TIMING CONTROL FOR POP NOISE FREE.....	23
9.2.5 SOFT START FOR SINGLE END OUTPUT	24
9.2.6 PCB LAYOUT GROUND PARTITION.....	25
10. SPEAKER PHONE HOUSING DESIGN.....	26
10.1 HOUSING DESIGN	26
11. EXTERNAL MCU APPLICATION	27
11.1 OPERATION WITH EXTERNAL MCU	27
12. I²S APPLICATION	5
13. ANTENNA PLACEMENT RULE.....	7
14. MISCELLANEOUS.....	8
14.1 HEADSET APPLICATION	8
14.2 OPTIONAL RESET CIRCUIT	8
14.3 EEPROM DATA PROTECTION.....	9

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:

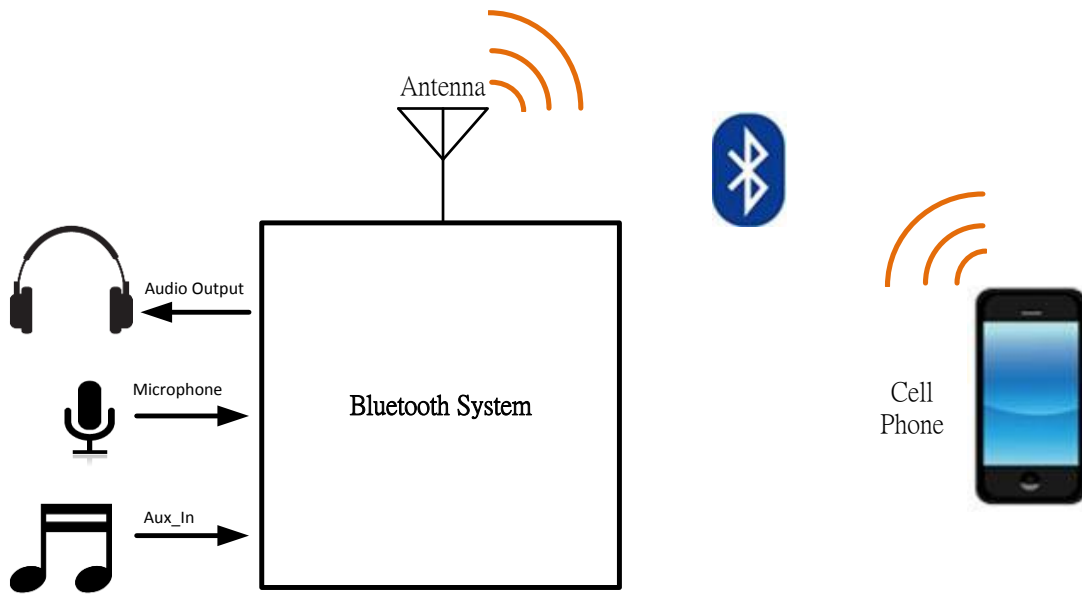
- ICs:
IS2008S(QFN48), IS2010S(QFN48), IS2013S(QFN56), IS2013S(QFN56), IS2015S(QFN56),
IS2020S(QFN56), IS2021S(QFN48), IS2023S(QFN56), IS2025S(QFN68)
- Modules:
BM15, BM20, BM23, BM25

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

Table1-1: Features list of IS20XX and BMXX

Feature	IS2008S	IS2010S	IS2013S	IS2015S	IS2020S	IS2021S	IS2023S	IS2025S	BM13	BM15	BM20	BM23	BM25
Chip													
Application	Headset	Headset	Speaker	Speaker	Headset /Speaker	Headset	i ² S Speaker	Speaker	SPEAKER	SPEAKER	Headset SPEAKER	i ² S SPEAKER	SPEAKER
Stereo/Mono	Mono	Mono	Mono	Mono	Stereo	Stereo	Stereo	Stereo	Mono	Mono	Stereo	Stereo	Stereo
Pin count	48	48	56	56	56	48	56	68	40	40	37	40	40
Dimension (mm ²)	6x6	6x6	7x7	7x7	7x7	5X6.5	7X7	8X8	15x29	15x29	15x29	15x29	15x29
Audio DAC output	1-ch	1-ch	1-ch	1-ch	2-ch	2-ch	X	2-ch	1-ch	1-ch	2-ch	X	X
DAC (single-end) SNR@2.8V (dB)	-98	-98	-98	-98	-98	-98	-98	-98	-98	-98	-98	-98	-98
DAC (cap-less) SNR@2.8V (dB)	-96	-96	-96	-96	-96	-96	-96	-96	-96	-96	-96	-96	-96
ADC SNR @2.8V (dB)	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90	-90
i ² S digital interface	X	X	X	X	X	X	✓	X	X	X	X	✓	X
Analog Aux- in	X	X	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓
Mono MIC	2	2	1	1	2	1	1	2	1	1	1	1	1
Support external audio AMP	X	X	✓	✓	✓	X	X	✓	✓	✓	✓	X	✓
Build-in Class-D amplifier	X	X	1-ch	1-ch	X	X	X	2-ch	1-ch	1-ch	X	X	2-ch
UART	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LED Driver	2	2	2	2	2	2	2	2	2	2	2	2	2
Internal DC-DC step-down regulator	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DC 5V Adaptor Input	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Battery Charger (350mA max)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GPIO for Application	6	6	9	9	9	8	X	10	9	9	9	X	10
Button support	6	6	6	6	6	6	6	6	6	6	6	6	6
Support NFC application	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Voice prompt	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multi-tone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DSP sound effect	X	X	✓	✓	✓	✓	X	✓	✓	✓	✓	X	✓
Profile													
HFP	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
AVRCP	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
A2DP	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
PBAP	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
HSP	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
SPP	X	1.0	X	1.0	1.0	1.0	1.0	1.0	NA	1.0	1.0	1.0	1.0
Build-in EEPROM	X	X	X	X	X	✓(128k)	X	X	X	X	X	X	X

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.

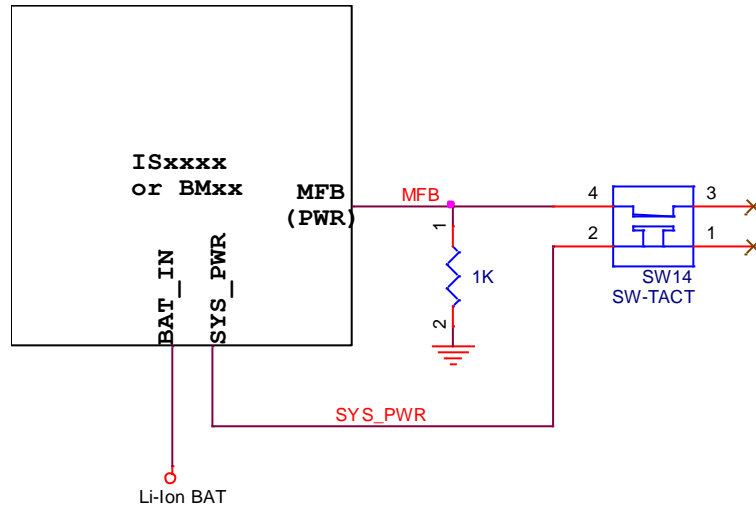
3. SYSTEM TURN ON/OFF APPLICATION

3.1 POWER SWITCH TYPE SETTING

- MFB Power On/Off:

Power on/off by a push button “MFB”

Figure 3-1 MFB Power Switch

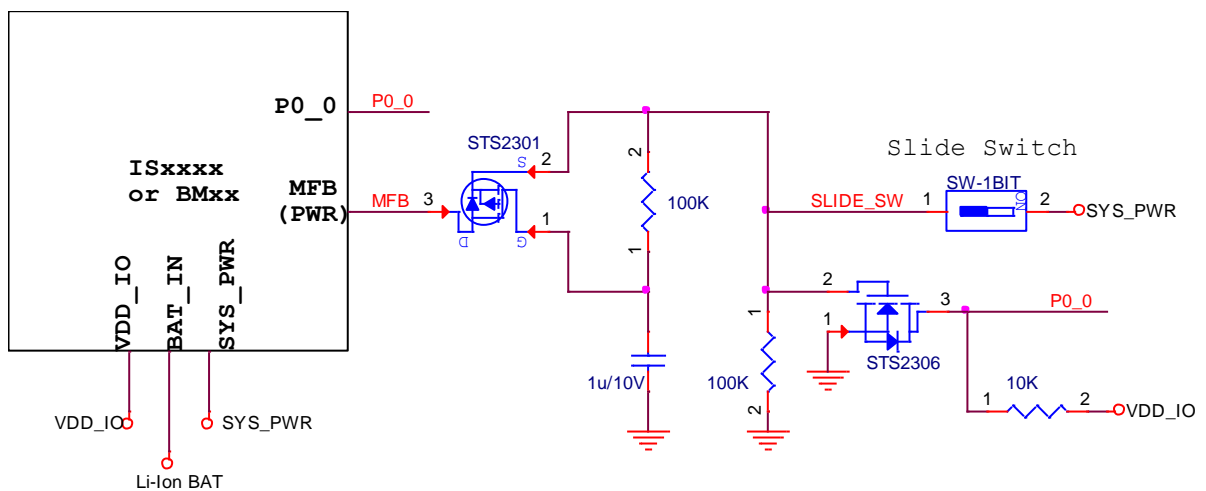


- Slide Switch Type:

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



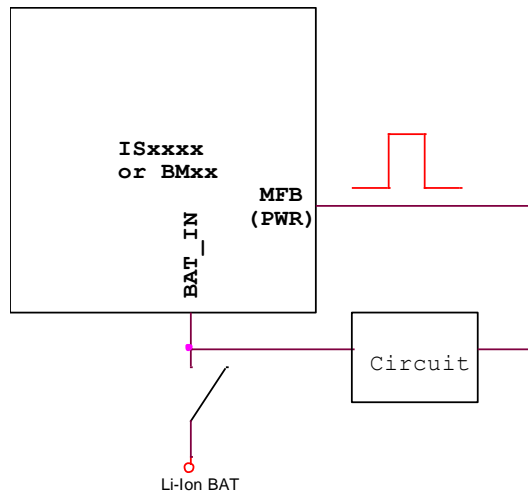
- Power On Directly

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)

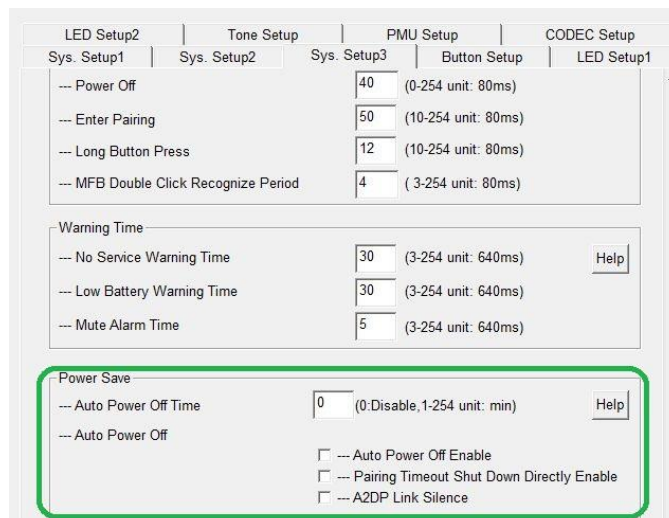
3.2 AUTO POWER OFF FUNCTION

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:



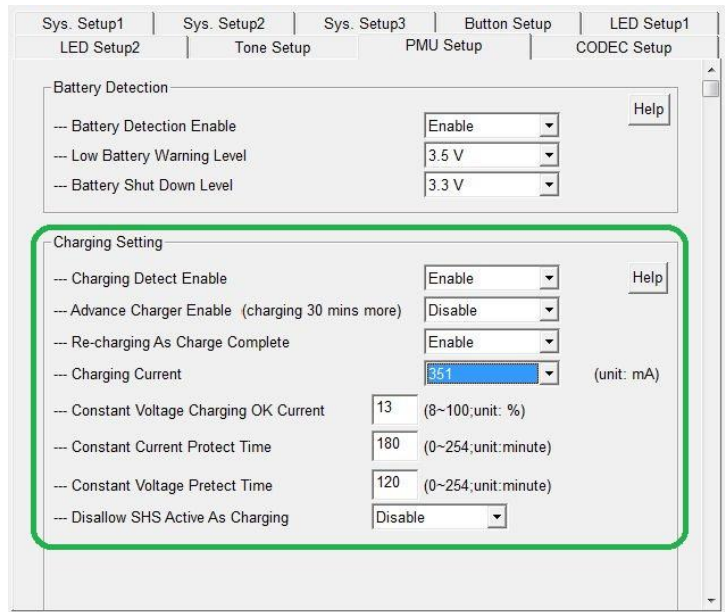
4. BATTERY CHARGER APPLICATION

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:



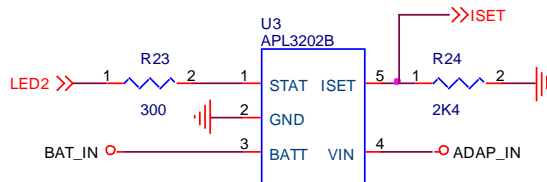
4.2 EXTERNAL CHARGER

- 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

*Charge Current Formula:
 $I_{chg} = K_{set} \times V_{set} / R_{set}$
 $K_{set} = 1000, V_{set} = 1V,$
 $R_{set} = 2.4K \Rightarrow I_{chg} = 417mA$



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($\leq 3.3V^*$)	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 ($\geq 3.9V$)	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

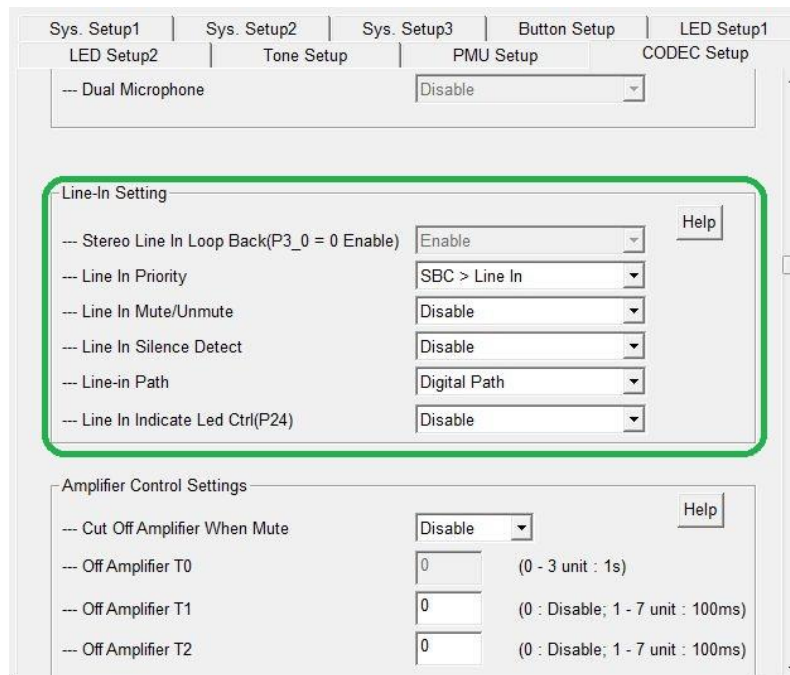
5. LINE-IN (AUX-IN) APPLICATION

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:

- Analogy loopback: Line-in signal loopback to output stage directly.
- 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).

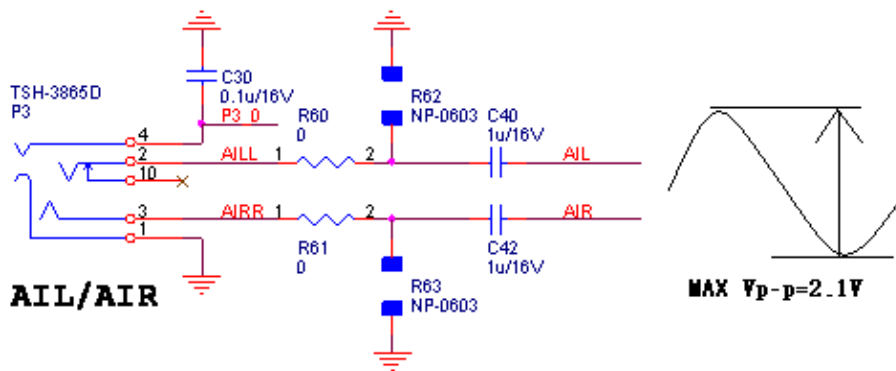
P3_0 connected to dedicated line-in jack Pin 4 as below. Pin1 & 4 of the jack will be shorted together when jack be plug-in and force P3_0 pull low to indicate line in jack inserted.

-Line-in signal V_{p-p} control

External resistor divider is necessary to make the maximum input V_{p-p} under 2.1V. Please adjust resistor (R60~R63) to fit the max V_{p-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.

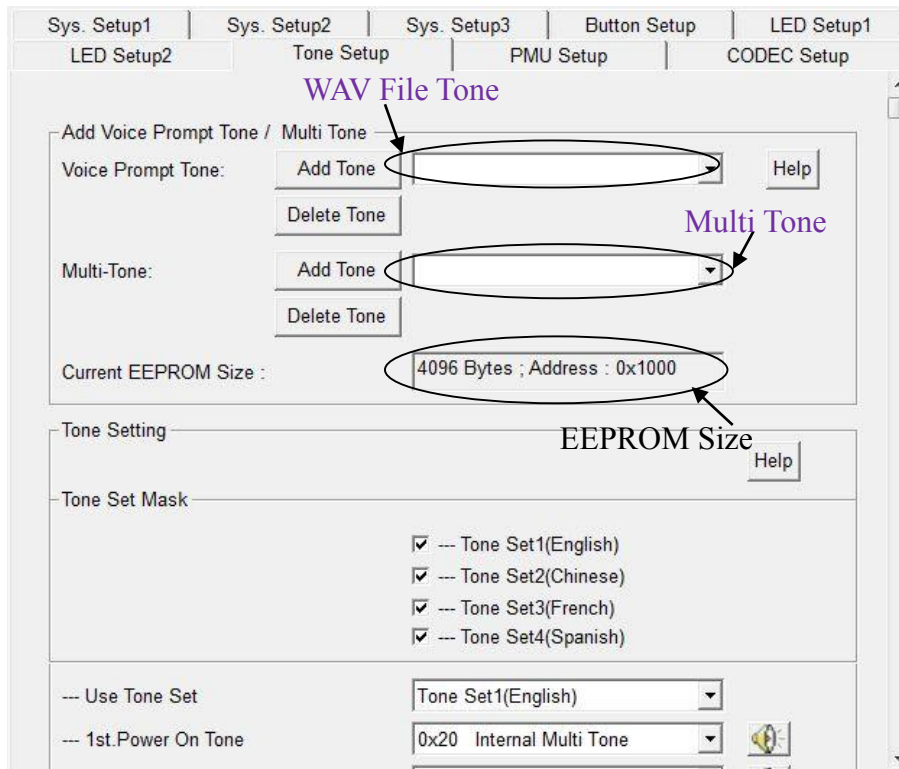
External wave format voice prompt and multi-tone can be selected at the “Add voice prompt tone/multi tone” section as Figure 6.1.

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



The voice prompt status of 4 languages is listed below:

Table 6-1 Voice Prompt Status

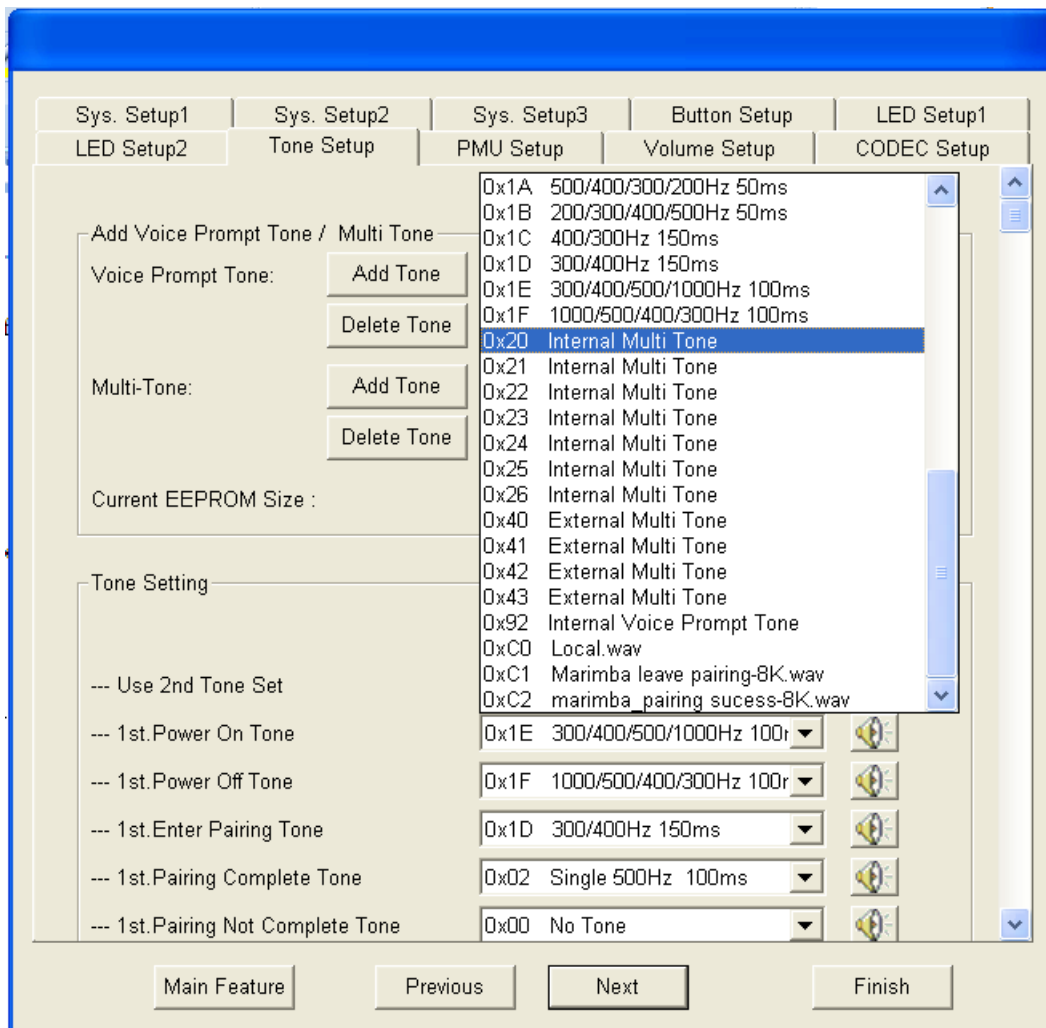
	English	Chinese	Spanish	French
1	Power On	開機	Encendido	Allumer
2	Ready to Pair	進入配接狀態	listo para asociar	Prêt à appairer
3	Pairing Completed	完成配對	asociación completada	Pairage réussi
4	Pairing Not Completed	配對失敗	asociación fallida	Pairage échoué
5	Device Connected	藍牙已連接	Dispositivo conectado	Bluetooth 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

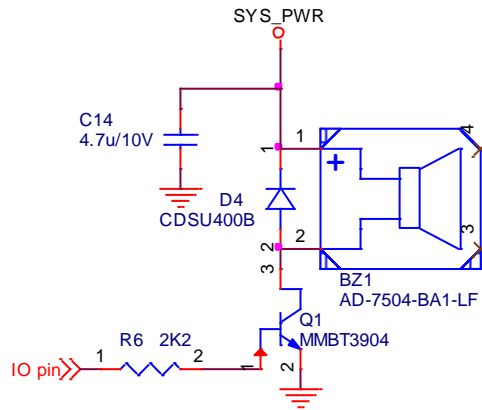
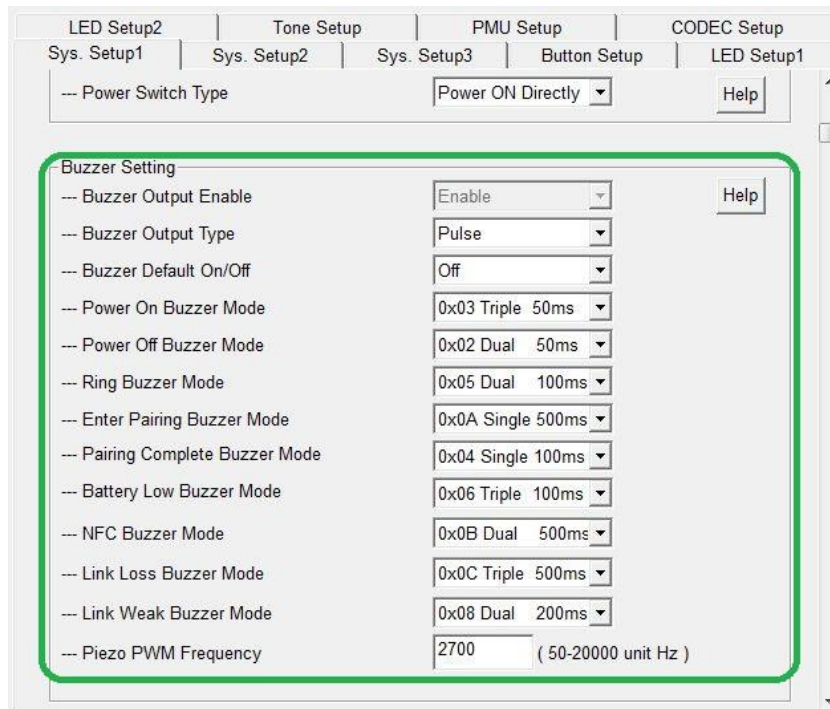


Figure 7-2 UI Setting of Buzzer part:



8. NFC TRIGGERS BLUETOOTH CONNECTION APPLICATION

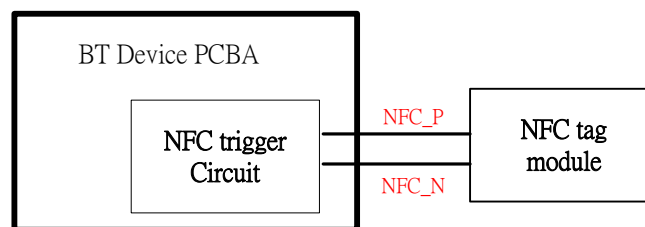
System provides NFC (Near Field Communication) triggered connection application with NFC Forum Type 2 tag. It can be easier to finish Bluetooth pairing and connection process by use NFC.

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.

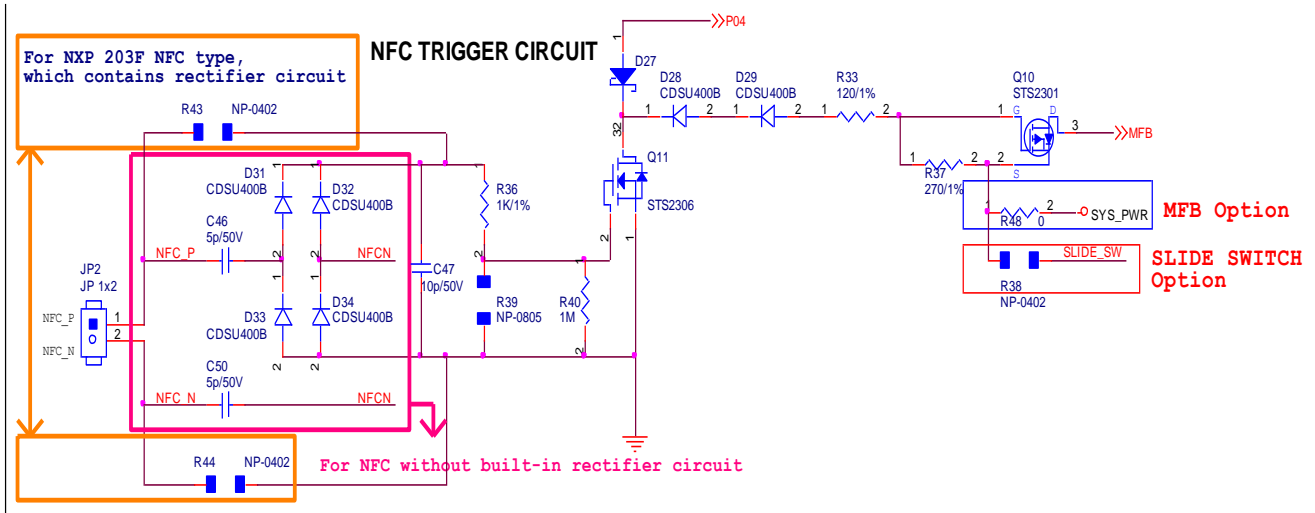
- System in connection mode

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

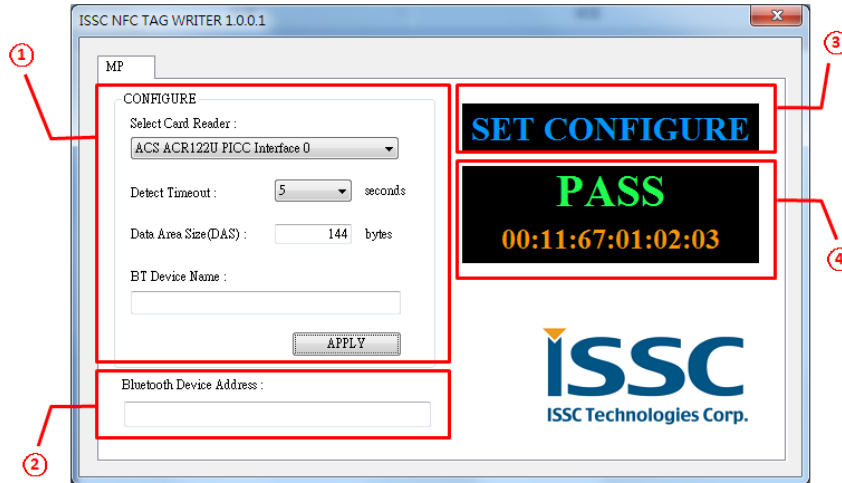


- NFC function trigger I/O: P04 (or P15), it can be set up by UI tool.
- System can be turned on by MFB button/ Slide Switch or triggered by Mobile Phone NFC function and turn off system by MFB button/Slide Switch.
- For NFC + Slide Switch application:
Slide switch must be turned on to enable NFC function, 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



- ① CONFIGURE
- ② Bluetooth Device Address
- ③ State
- ④ Result

*The supported NFC reader module is ACS ACR122, Website: 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

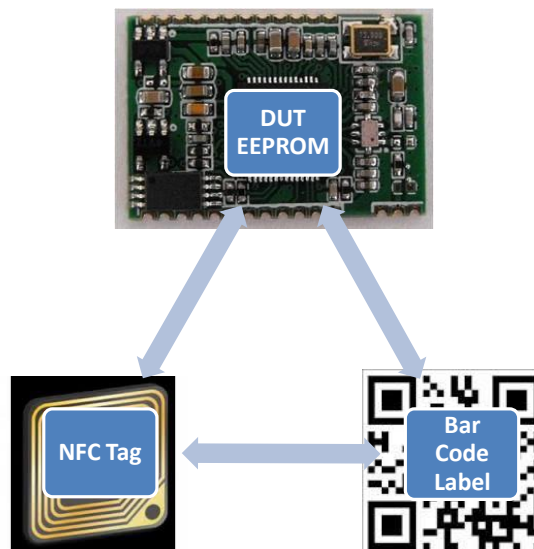


Table 8-1 Scenarios of Read or Write NFC Information

Scenarios		EEPROM	Tag	Label	Tools	RemarksQuick 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	For label adhesive BM module with new Tag.... Use the NFC Tag Writer to write NFC tag.
3	NOT suggest 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/>

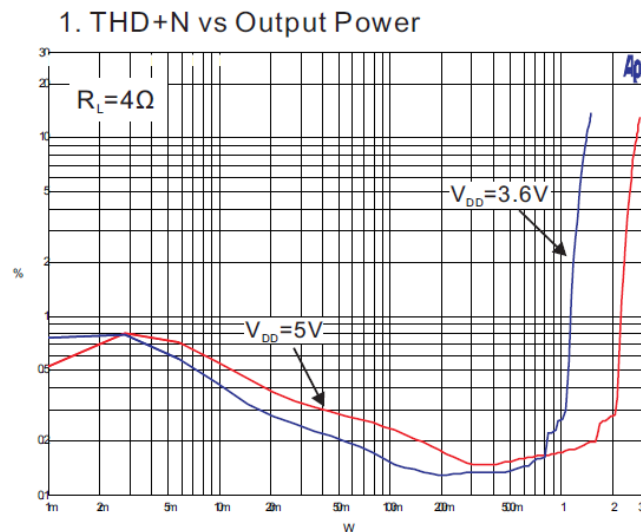
NFC Data Exchange Format (NDEF) ◦ http://www.nfc-forum.org/specs/spec_list/

9.2 EXTERNAL AUDIO AMPIIFIER 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 V_{p-p} of amplifier output should be $3.7 \times 2 = 7.4V$
- 2) The signal come from BT audio output assume 2V (V_{p-p}), then max. gain of AMP should: $7.4/2=3.7$
- 3) For this AMP (PAM8004), the gain of AMP should be: $2 \times (142k \text{ ohm} / R_{input}) \leq 3.7$, so we select $R_{input} = 82 \text{ k ohm}$.

Figure 9-4 Audio AMP Circuit Design

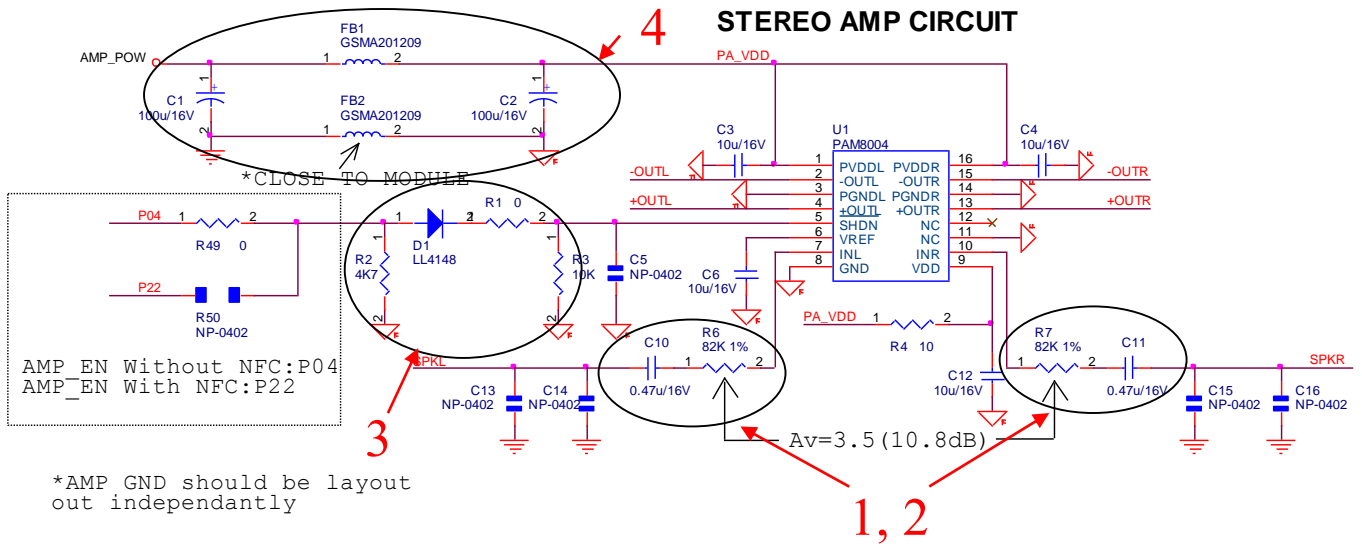


Figure 9-5 Mono AMP Circuit Design

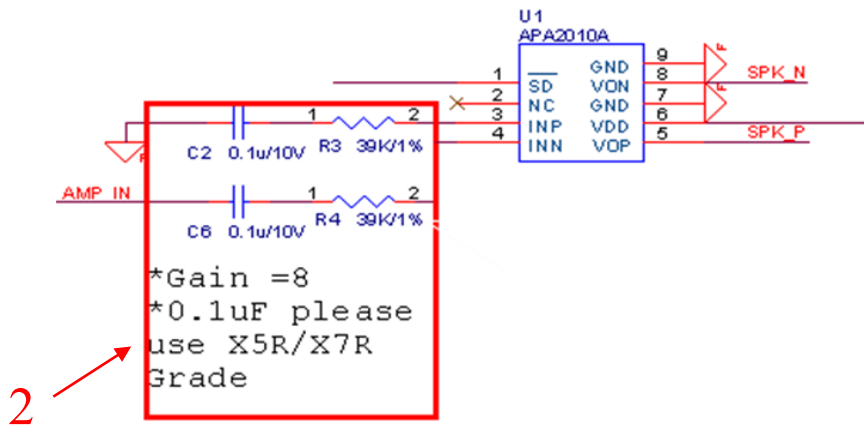
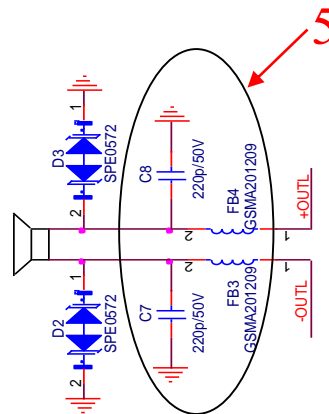


Figure 9-6 Speaker Output Circuit

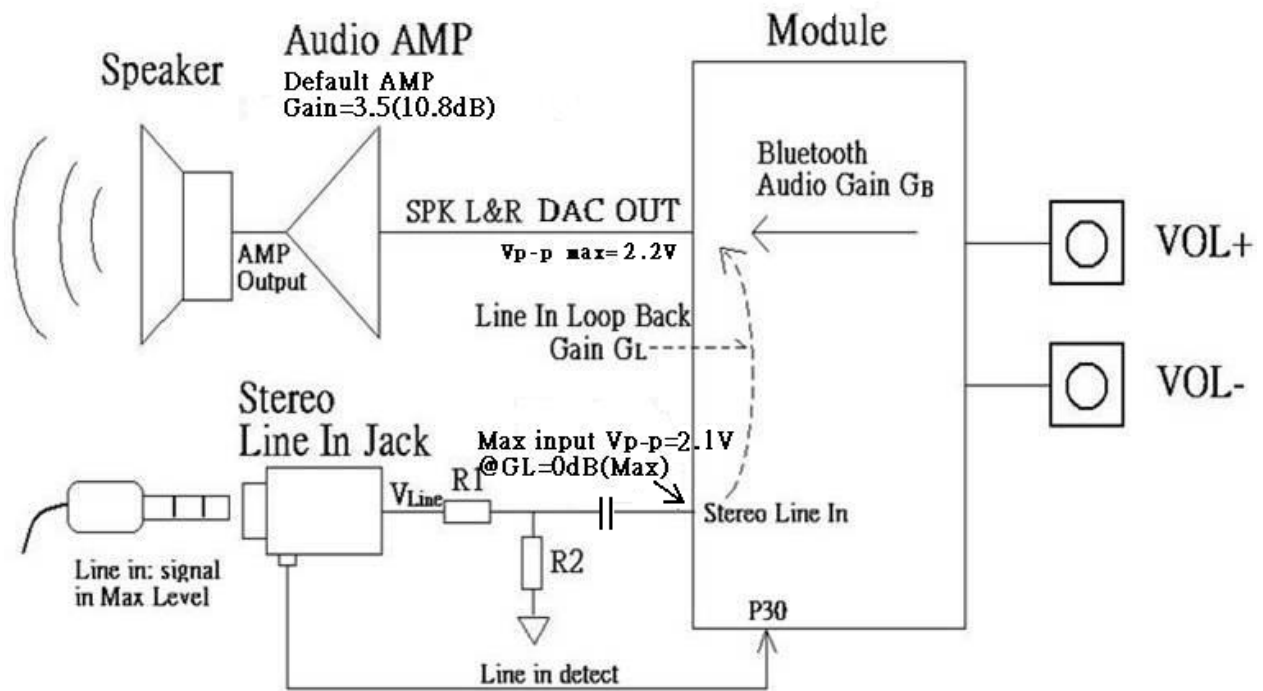


9.2.3 AUDIO GAIN ADJUST GUIDELINE

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= G_L , Bluetooth output gain= G_B
2. Line in loop gain adjusts: R1/R2 is selected to meet the max line in V_{p-p} limit = 2.1V @ $G_L=0dB$.
Default R1/R2 is to accommodate the maximum volume of music source to fit the maximum input V_{p-p} . If your selected music source's max output V_{p-p} is higher, please reduce R1/R2 to meet the line in limit.
3. Bluetooth audio path: the maximum speaker output ($V_{p-p \max}$) 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

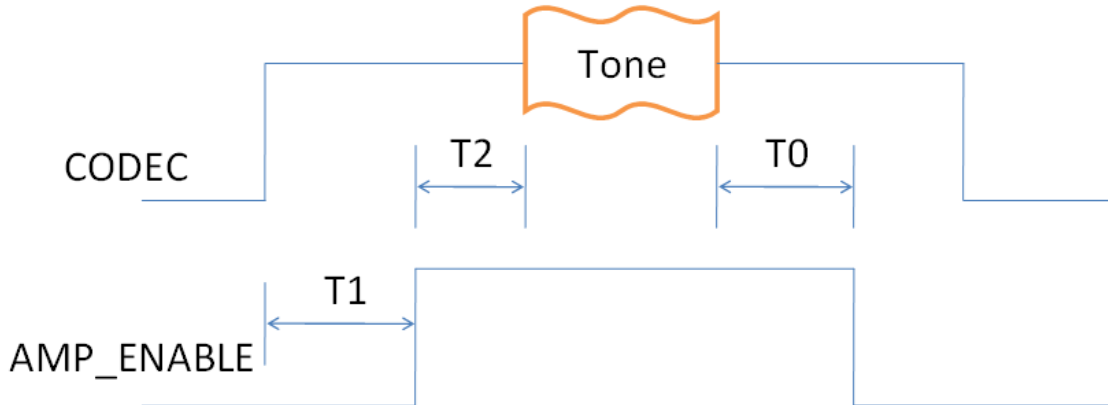
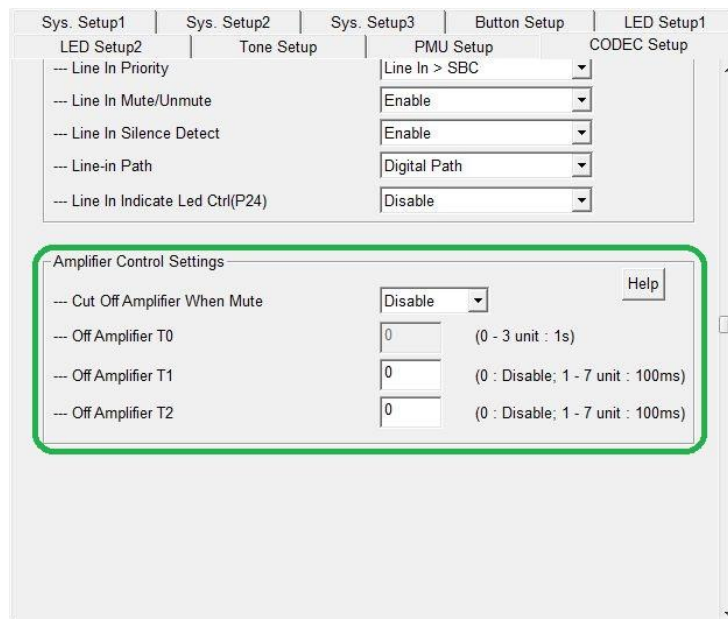


Figure 9-9 UI Setting of EXT AMP timing:

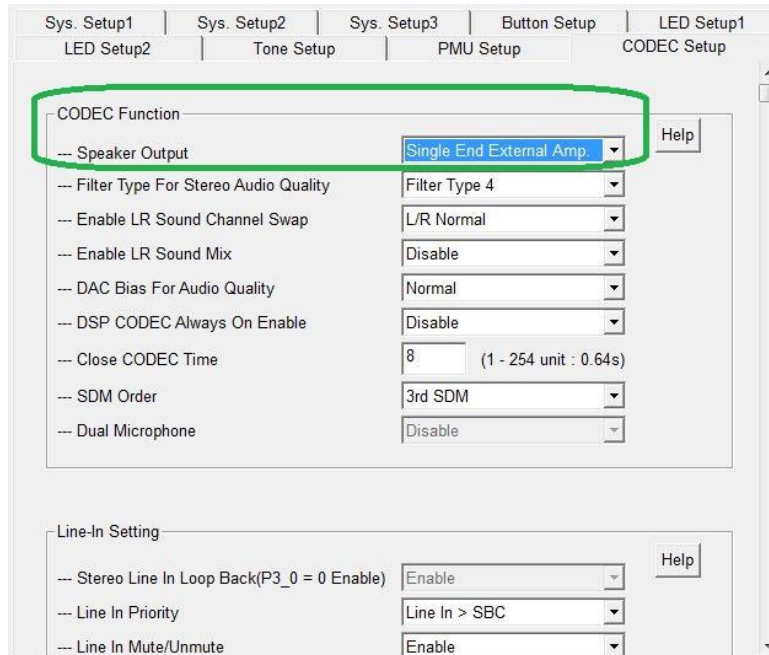


9.2.5 SOFT START FOR SINGLE END OUTPUT

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

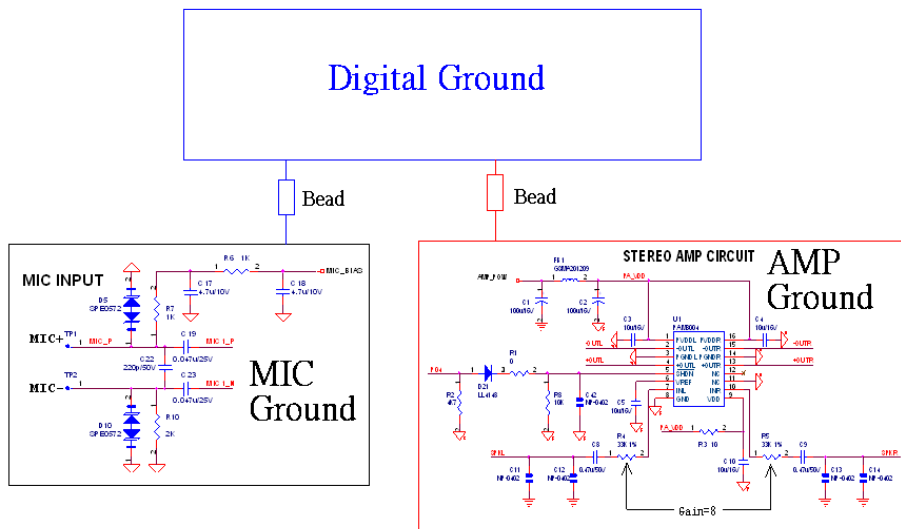
Figure 9-10 UI setting of single end EXT AMP part:



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

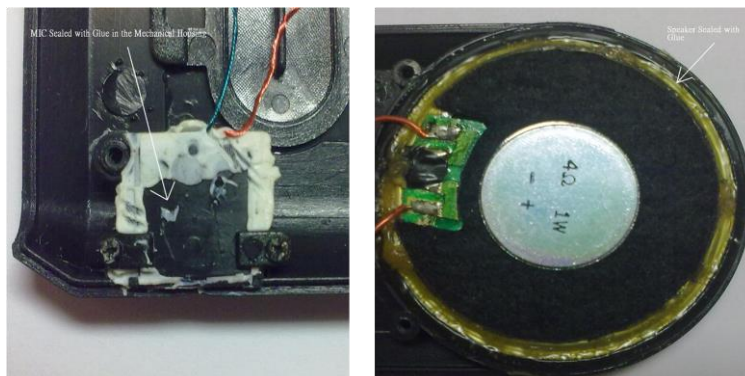
For better speaker phone acoustic echo cancellation quality, some key point of speaker housing design shall be notified as follows:

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

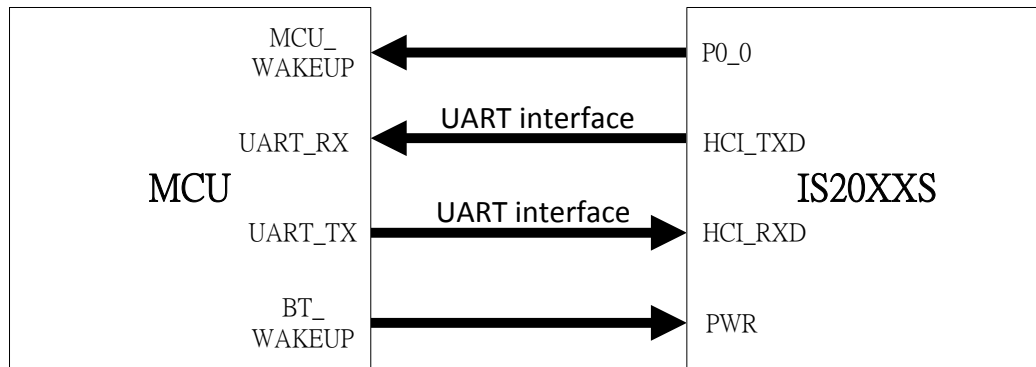


11. EXTERNAL MCU APPLICATION

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

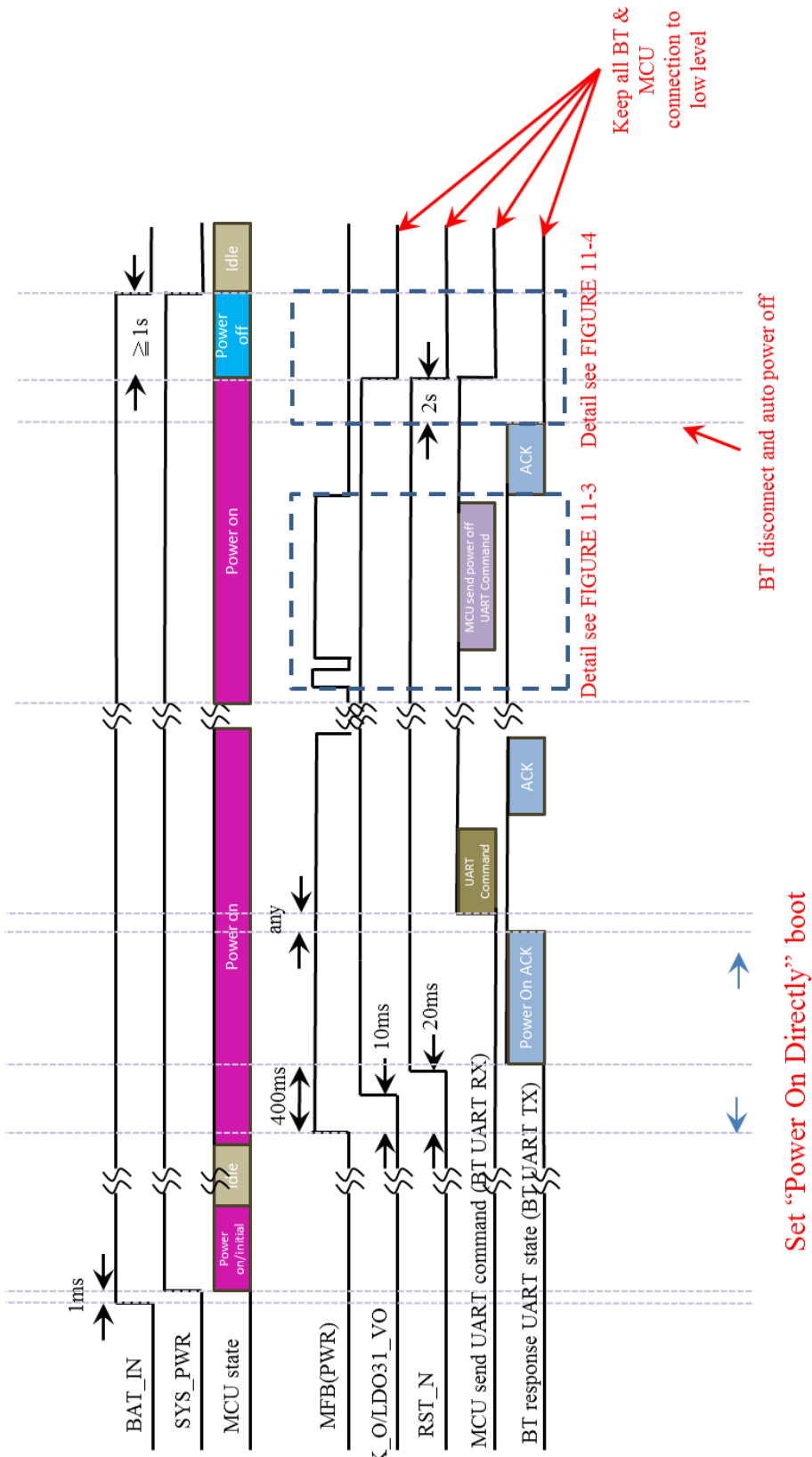


FIGURE 11-3: TIMING SEQUENCE OF RX INDICATION AFTER POWER ON

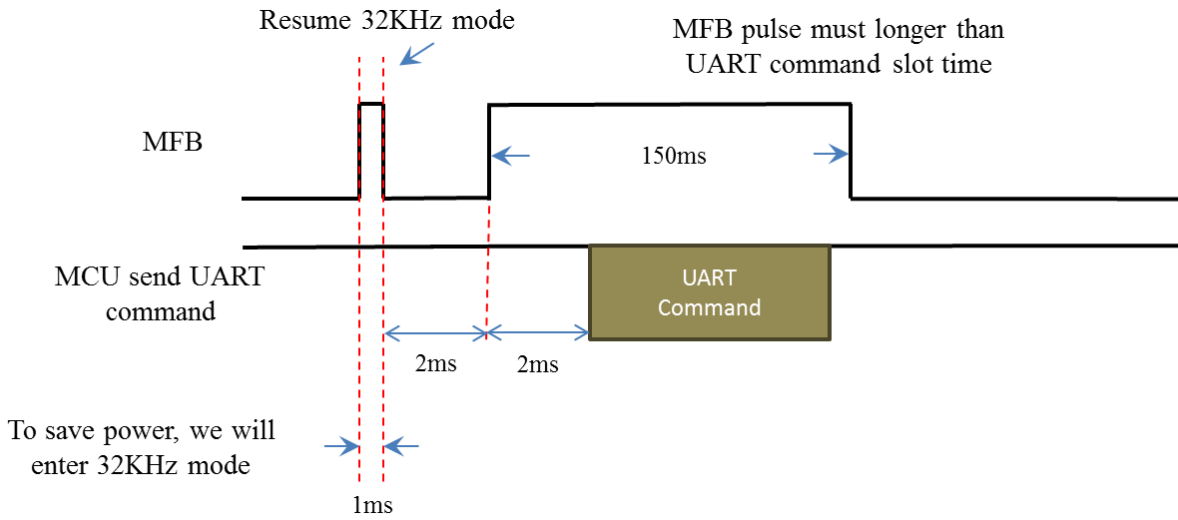
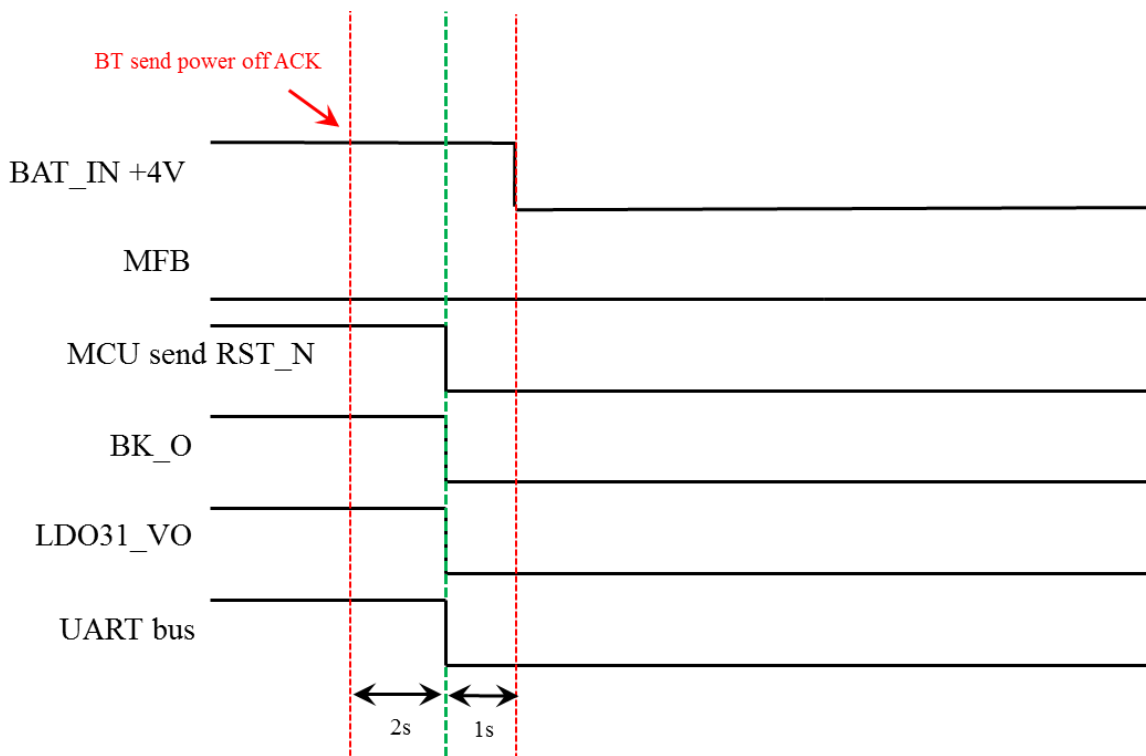


FIGURE 11-4: TIMING SEQUENCE OF POWER OFF

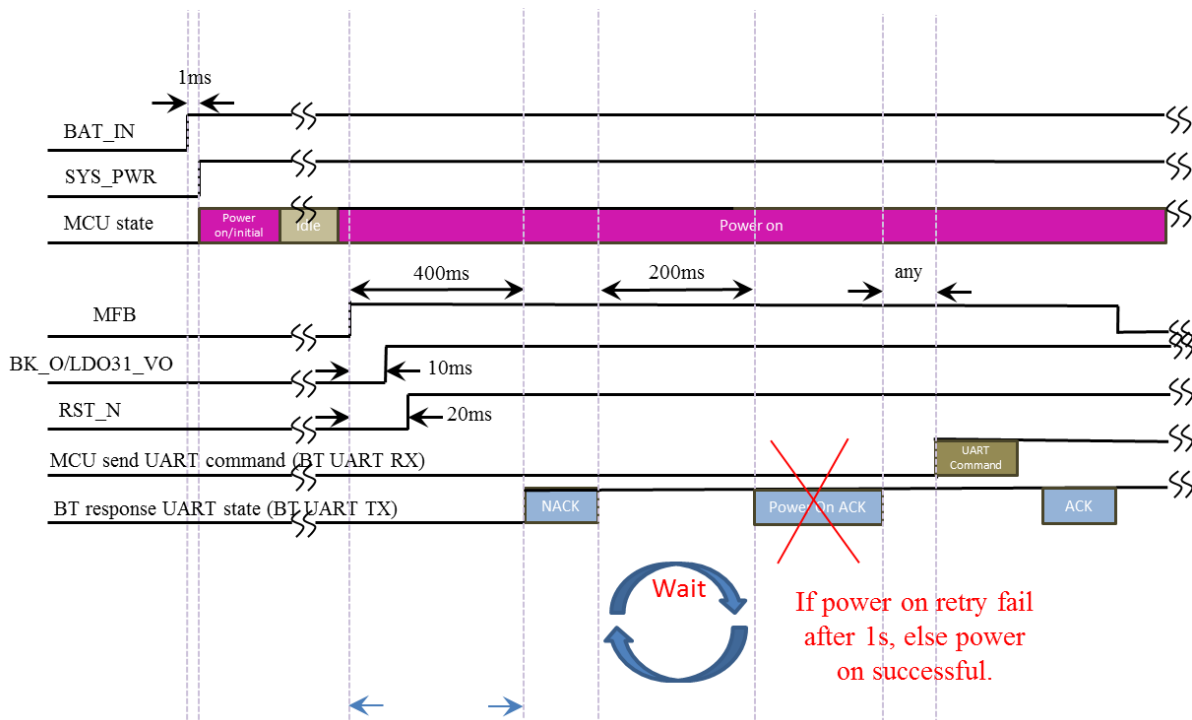


EEPROM clock= 100KHz

For a byte write, $0.01ms * 32clock * 2 = 640us$

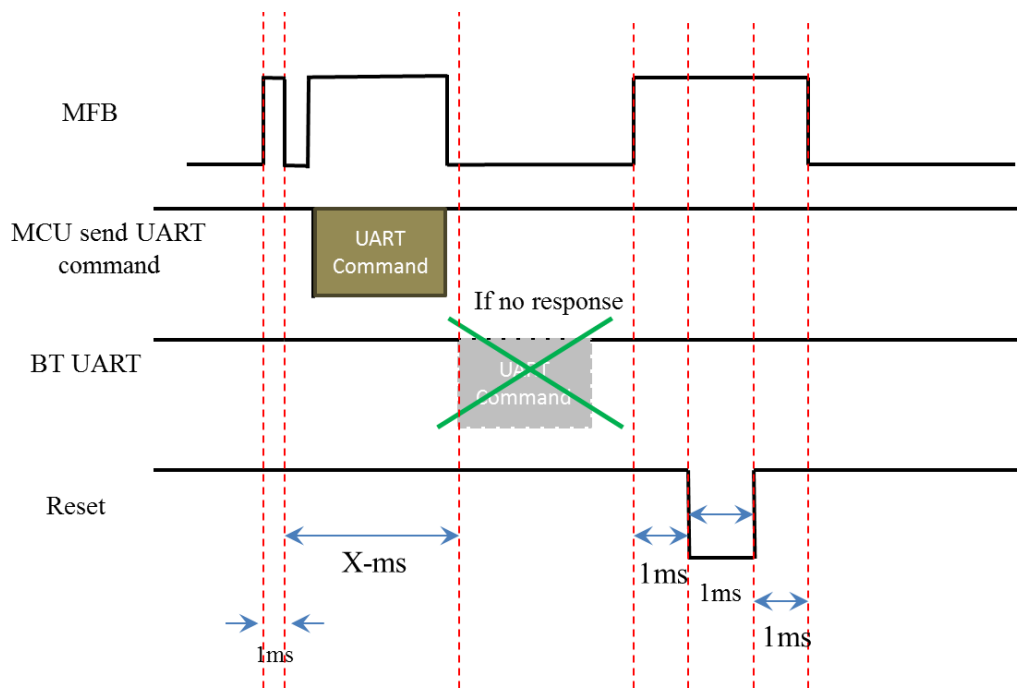
If power drop faster than 640us, some issue may occurs, but the possibility is low

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



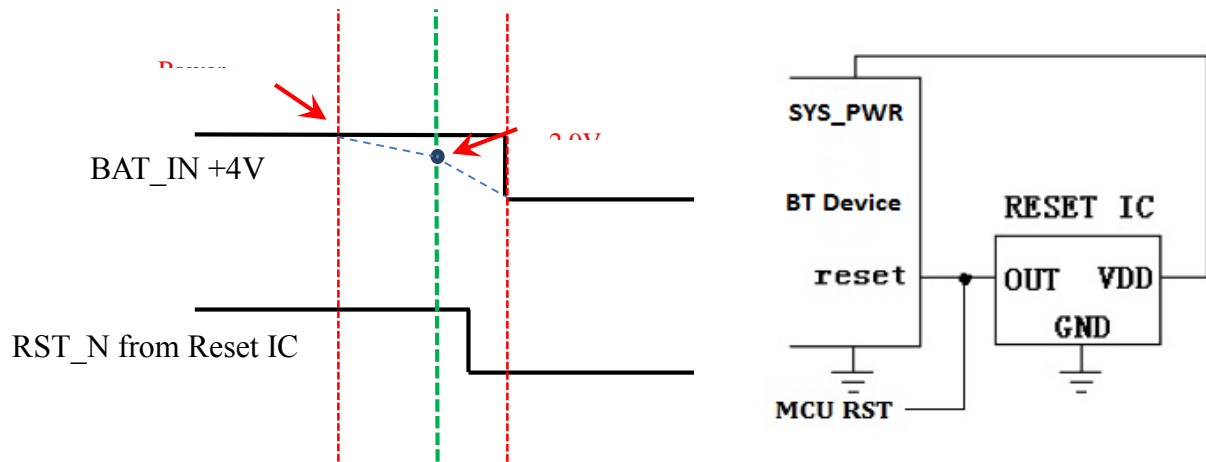
Set "Power On Directly" boot Maximum: 5 times (1s)

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



If MCU send UART command, but BT does not response within X-ms, MCU will send a reset signal to BT to do hardware reset

FIGURE 11-7: TIMING SEQUENCE OF POWER DROP PROTECTION



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 $\leq 10\text{ms}$

Recommend part: TCM809SVNB713 or G691L263T73

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

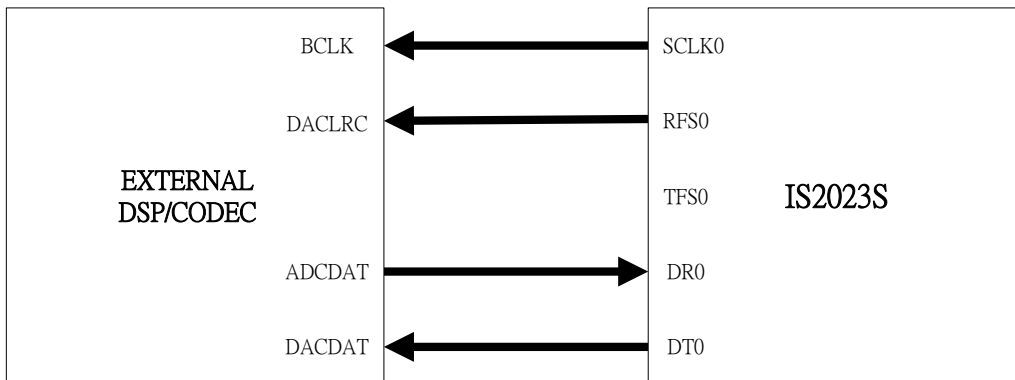
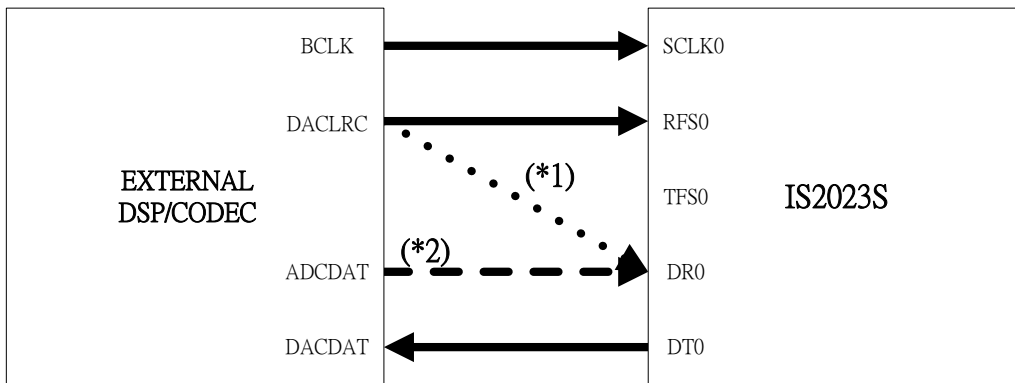


FIGURE 12-2: SLAVE MODE REFERENCE CONNECTION



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)

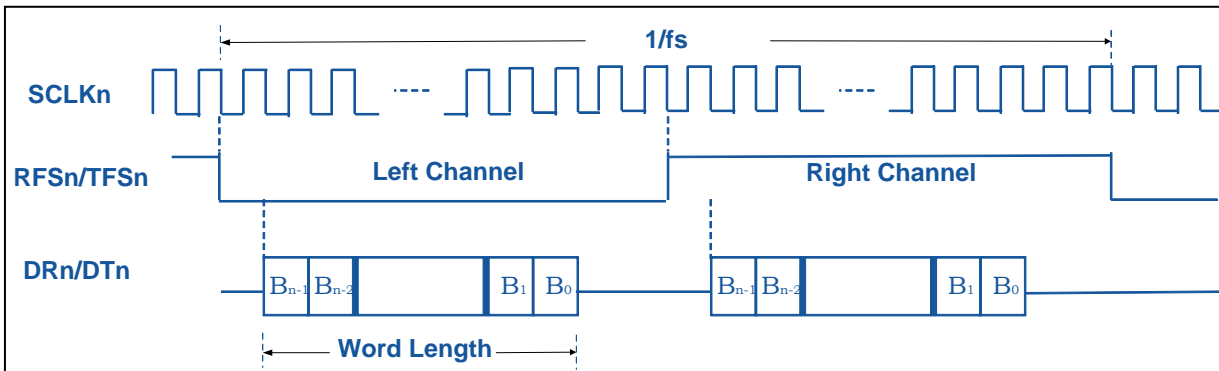
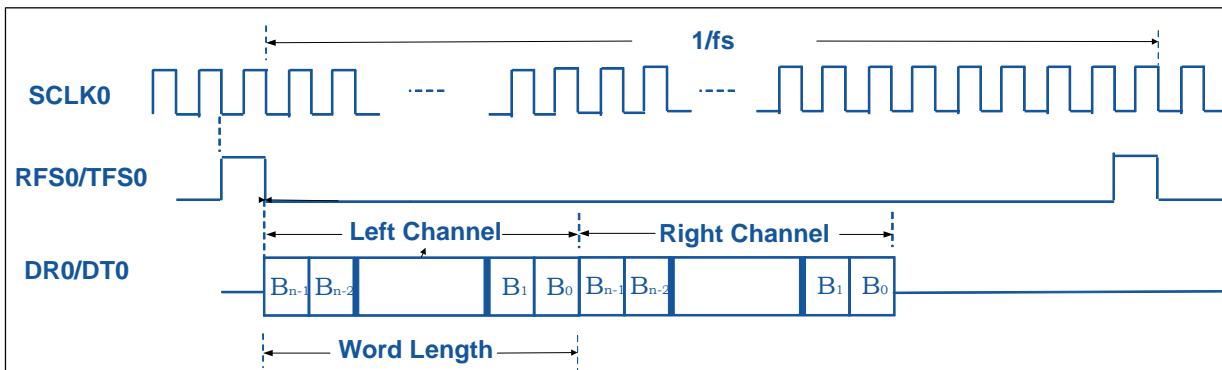


FIGURE 12-4: TIMING FOR PCM MODES (both master and slave)



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

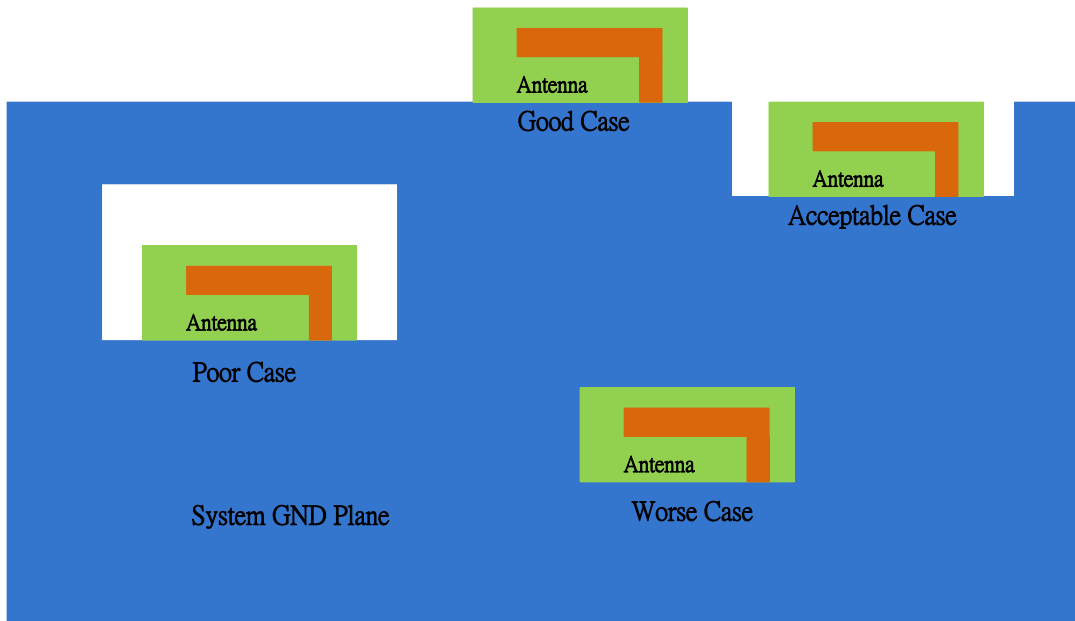
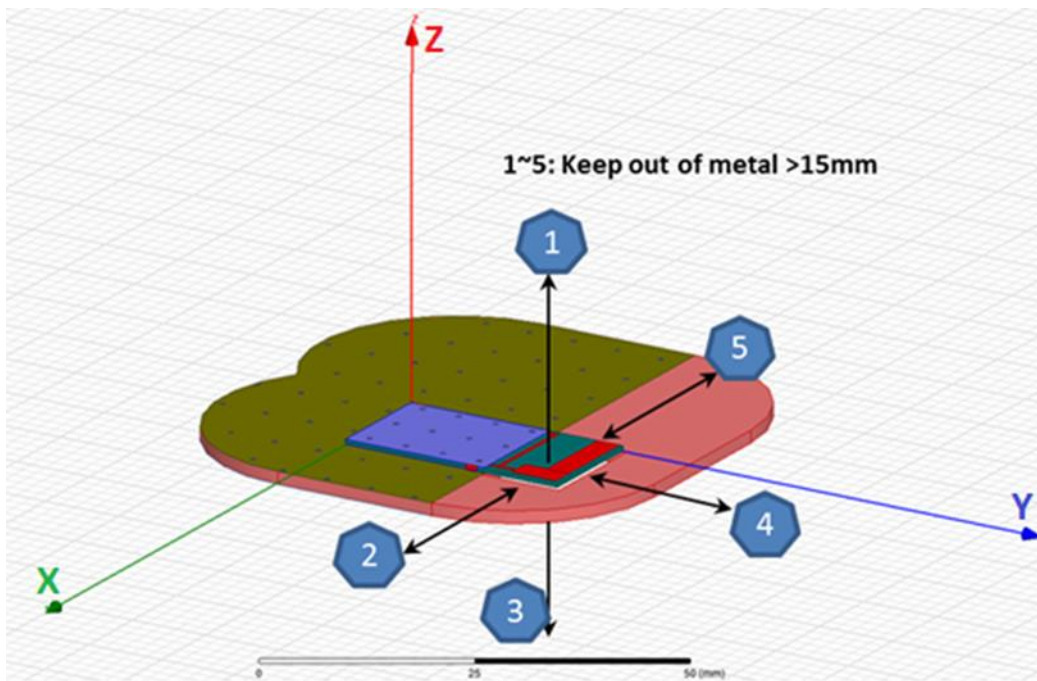


FIGURE 13-2: KEEP OUT AREA SUGGESTION FOR ANTENNA



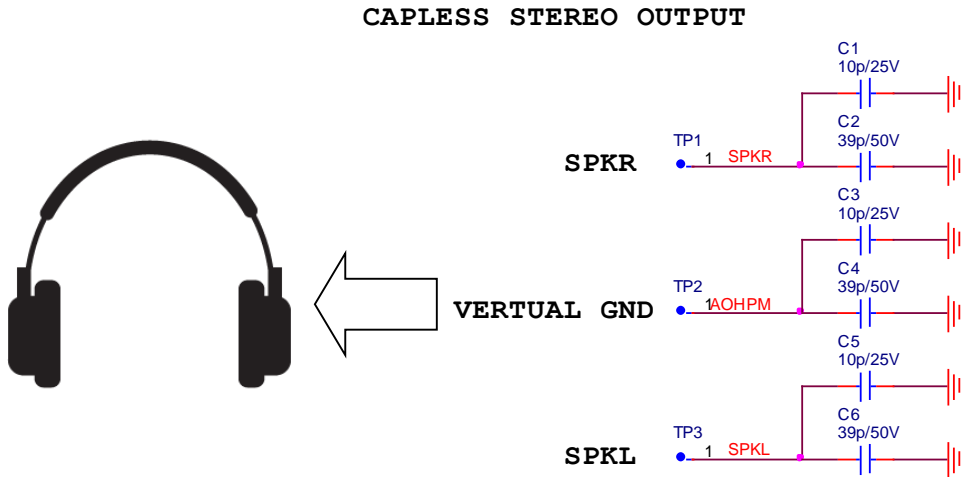
For more detail free space of antenna placement design, you can reference the design rule of antenna produce vendor.

14. MISCELLANEOUS

14.1 HEADSET APPLICATION

For headphone application, cap-less output connection is suggested to skip DC block capacitor.

Figure 14-1 CAP LESS STEREO OUTPUT



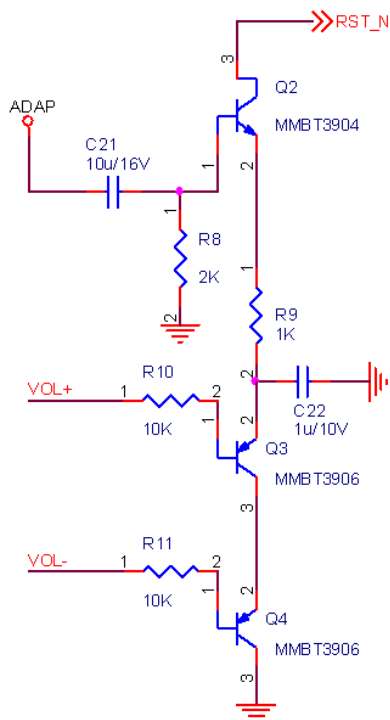
(Note: The shunt capacitor of each channel should less than 500pF.)

14.2 OPTIONAL RESET CIRCUIT

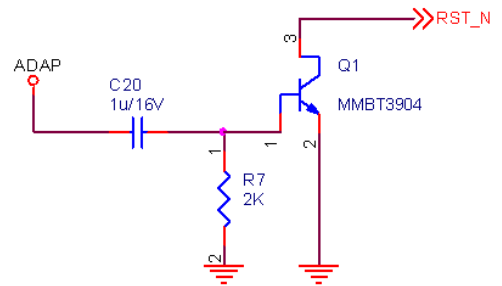
- Plug-in Reset: When adapter inserted, reset circuit will make a reset pulse to RST_N
- Conditional Reset: Press VOL+/VOL- simultaneously and then insert adapter will make a reset pulse to RST_N

Figure 14-2 RESET CIRCUIT

CONDITONAL RESET CIRCUIT (PRESS VOL+ & VOL-, THEN INSERT)



UNCONDITIONAL 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 $<3.0 \pm 0.1V$, stop the startup process.