WCDMA UGxx

Audio Design Note

UMTS/HSPA Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2015-9-7	Felix YIN/ Jun WU	Initial
1.1	2015-10-23	Felix YIN	1. Updated PCM information in Chapter 2 2. Updated <data_length> value for AT+QDAC

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1 Introduction

This document mainly introduces how to use Pulse Code Modulation (PCM) digital interface with Quectel UGxx modules.

2 PCM Characteristic

Quectel UGxx modules provide one PCM digital interface for audio design, which supports the following features:

- Supports16, 32 bit mode with short frame synchronization, the PCM supports 32 bit mode by default. The default configuration of PCM codec is **AT+QDAC=1,0,0,2,0,0**. Refer to *document [3]* for more details.
- Supports master and slave mode.
- Supports audio sample rate 8 kHz.

The following table shows the pin definition of PCM and I2C interface.

Table 1: Pin Definition

Pin Name	I/O	Description
PCM_IN	DI	PCM data input
PCM_OUT	DO	PCM data output
PCM_SYNC	DO	PCM data frame sync signal
PCM_CLK	DO	PCM data bit clock
I2C_SCL	OD	I2C serial clock
I2C_SDA	OD	I2C serial data

Table 2: IO Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IL}	Low-level input voltage	-0.3	0.35	V
V_{IH}	High-level input voltage	1.3	1.85	V
V_{OL}	Low-level output voltage	0	0.25	V

| V_{OH} | High-level output voltage | 1.55 | VDD_EXT | V |

NOTE

The voltage of VDD_EXT is 1.8V, please refer to *document [1]* for details.

In PCM audio format, the MSB of the channel included in the frame (PCM_SYNC) is clocked on the second CLK falling edge after the PCM_SYNC pulse rising edge. The period of the PCM_SYNC signal (frame) lasts for Data word bit +1 clock pulses.

The firmware of module has integrated the configuration on NAU8814/ALC5616/MAX9860 application with I2C interface. **AT+QDAC** command can be used to configure the external codec chip linked with PCM interface, and refer to *document [3]* for more details. Data bit is 32 bit and the sampling rate is 8 KHz. The following figure shows the timing of the application with ALC5616 codec.
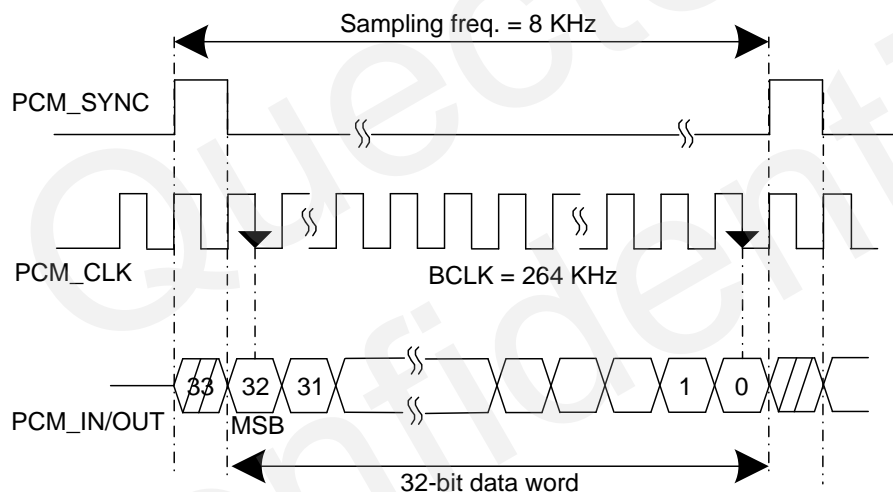
Figure 1: PCM Master Mode Timing

For the relations between peripherals, modules and PCM CODEC, please refer to the following figure.
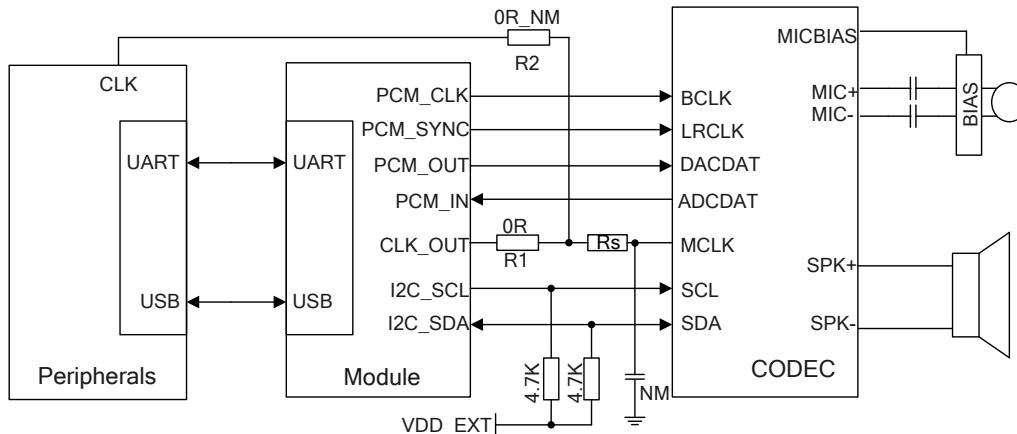
Figure 2: The Connection Diagram of Peripherals, Module and Codec

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NOTES

1. The communication between the module and peripherals can be realized by UART or USB interface.
2. The MCLK of codec can be provided by peripherals or module. When the MCLK is provided by module, R1 is mounted and R2 is not mounted. When the MCLK is provided by peripheral, R2 is mounted and R1 is not mounted.
3. It is recommended to reserve RC (R=22Ω, C=22pF) circuit on the PCM lines, especially for PCM_CLK.
4. UGxx modules provide a digital clock output (CLK_OUT) for an external audio codec, the CLK_OUT function is disabled by default. When CLK_OUT is required, AT command is used to provide the codec with a 13/26MHz clock generated from the module. A RC (e.g. R=22Ω, C=47pF) circuit is recommended to be reserved on CLK_OUT line. Refer to *document [3]* for details. If unused, keep this pin open.

AT+QPCMON is used to enable PCM_CLK (BCLK) & PCM_SYNC when there is no audio application. The output frequency depends on the settings of **AT+QDAC**: sync=**<sample_rate>**, PCM_CLK(BCLK)**=<sample_rate>** * (**<data_length>**+ 1).

AT+QDAC=1,0,0,2,0,0

OK
AT+QPCMON=1   //Enable PCM SYNC & BCLK, SYNC=8k, BCLK=264K

OK
AT+QPCMON=0   //Disable PCM SYNC & BCLK

OK

---

3 Audio Circuit Design

Codec ALC5616, NAU8814 and MAX9860 have been approved for PCM application.

Pin25 provides a clock ranges from 32k to 26M. This clock can be used to provide MCLK for codec. When ALC5616, NAU8814 or MAX9860 is using, Pin25 will output a 26M clock by default. **AT+QPCMCLK** is used to enable this clock.

AT+QCLKOUT=1, 2	//Output 26M frequency
OK	
AT+QCLKOUT=0	//Close output
OK	

The following chapters will show the audio design circuit with these codec.

3.1. PCM Codec Design Circuit with ALC5616

The following figure shows PCM application with ALC5616 from Realtek (http://www.realtek.com.tw/), and I2C interface is equipped to configure codec.
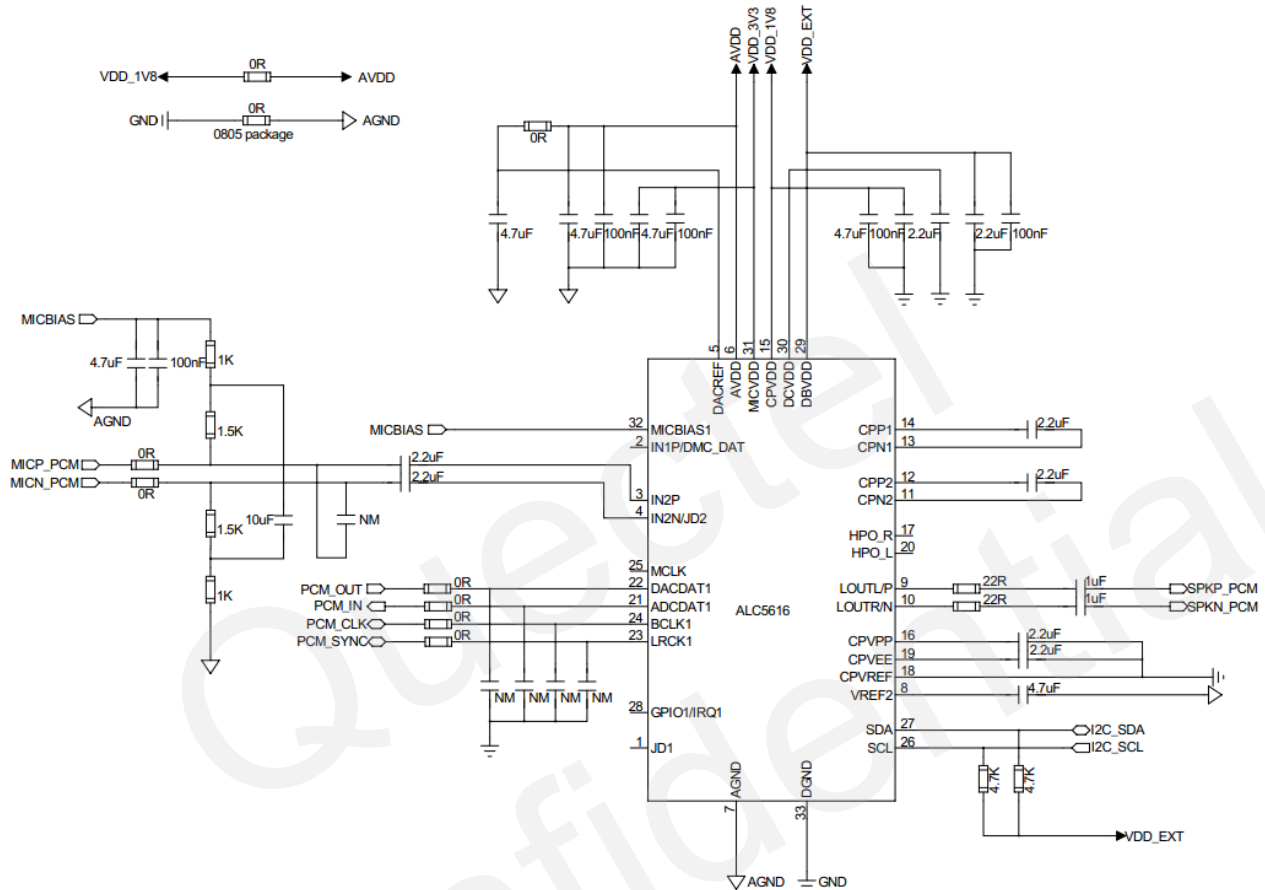
Figure 3: ALC5616 Codec Design

NOTES

1. The RC filter circuit (R=22ohm, C=22pF) needs to be installed on PCM_CLK line.
2. VDD_3V3 and VDD_1V8 are needed to be supplied externally.
3. Set **AT+QDAC=3** to choose ALC5616, MCLK is not needed, and ALC5616 uses internal PLL to generate system clock.

3.2. PCM Codec Design Circuit with NAU8814

The following figure shows PCM application with NAU8814 from Nuvoton (http://www.nuvoton.com), and I2C interface is equipped to configure codec.
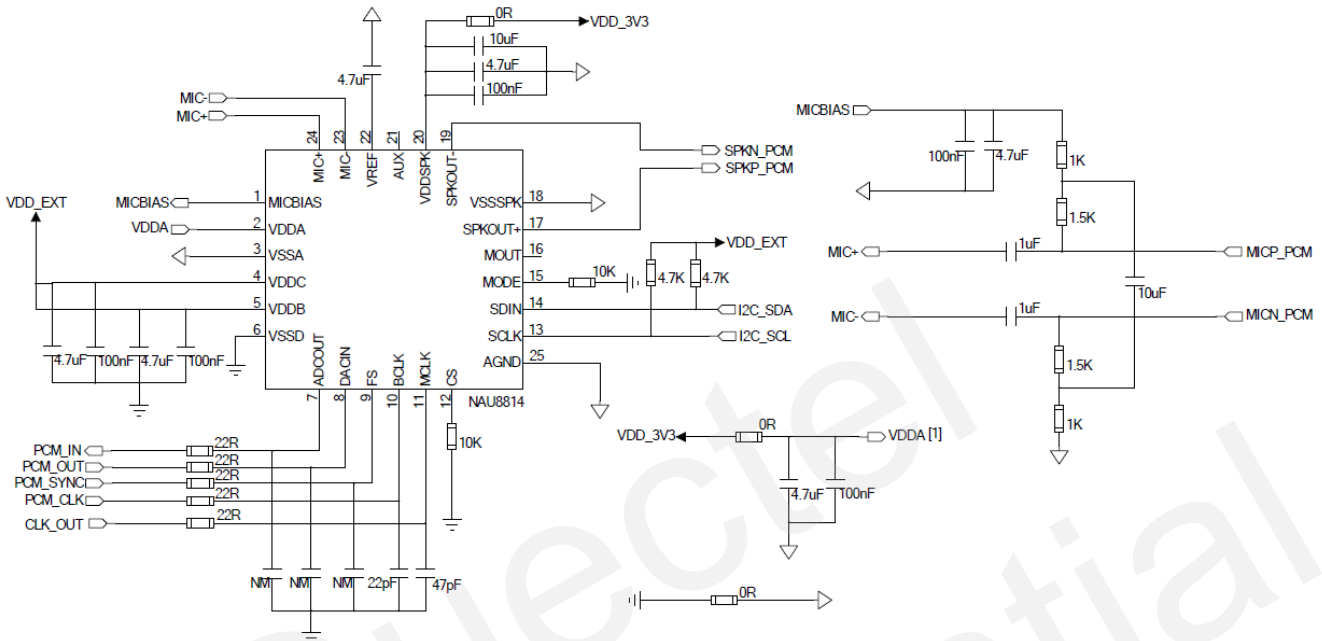
Figure 4: NAU8814 Codec Design

NOTES

1. The RC filter circuit (R=22ohm, C=22pF) needs to be installed on PCM_CLK line.
2. VDD_3V3 is needed to be supplied externally.
3. Set **AT+QDAC=2** to choose NAU8814, please provide 2M external crystal for NAU8814. The CLOCK_OUT pin can also provide 26M clock for NAU8814, but the quality of the voice is worse than 2M external crystal.

3.3. PCM Codec Design Circuit with MAX9860

The following figure shows PCM application with MAX9860 from Maxim (http://www.maxim-ic.com), and I2C interface is equipped to configure codec.
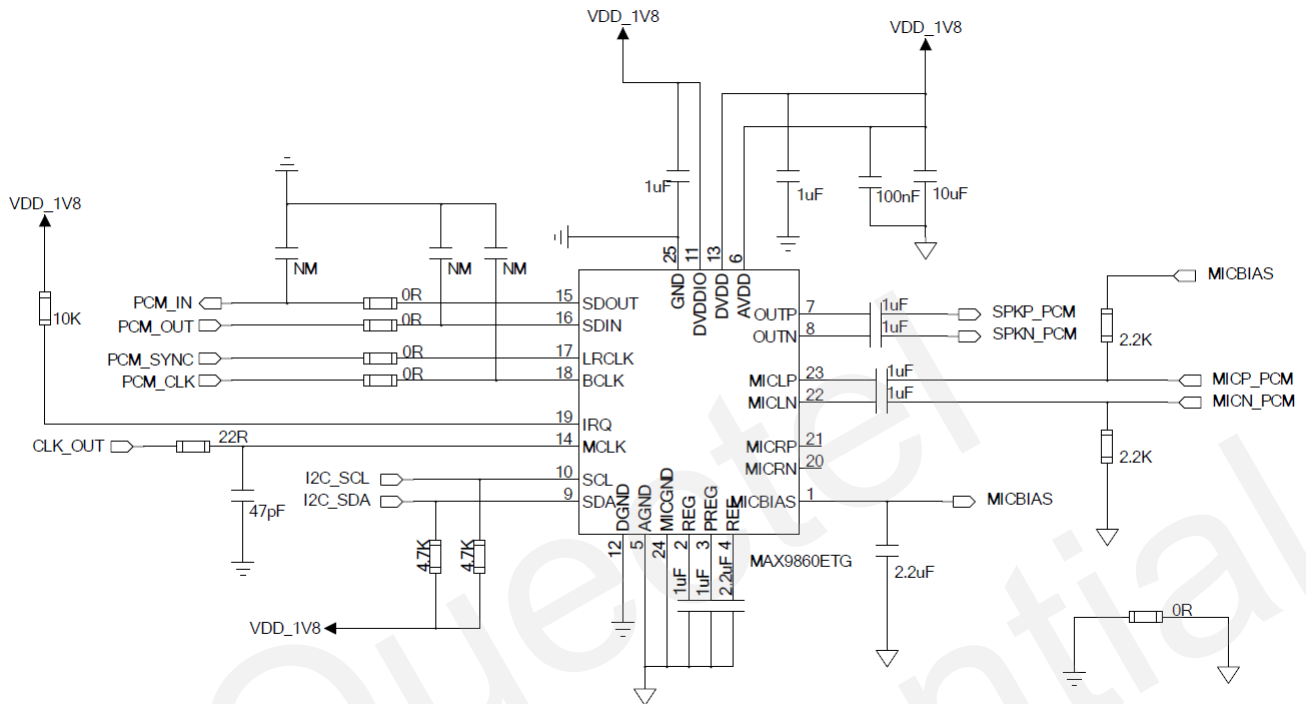
Figure 5: MAX9860 Codec Design

NOTES

1. The RC filter circuit (R=22ohm, C=22pF) needs to be installed on PCM_CLK line.
2. Set **AT+QDAC=4** to choose MAX9860, the module will provide 26M MCLK by default.

3.4. Microphone Interface Design
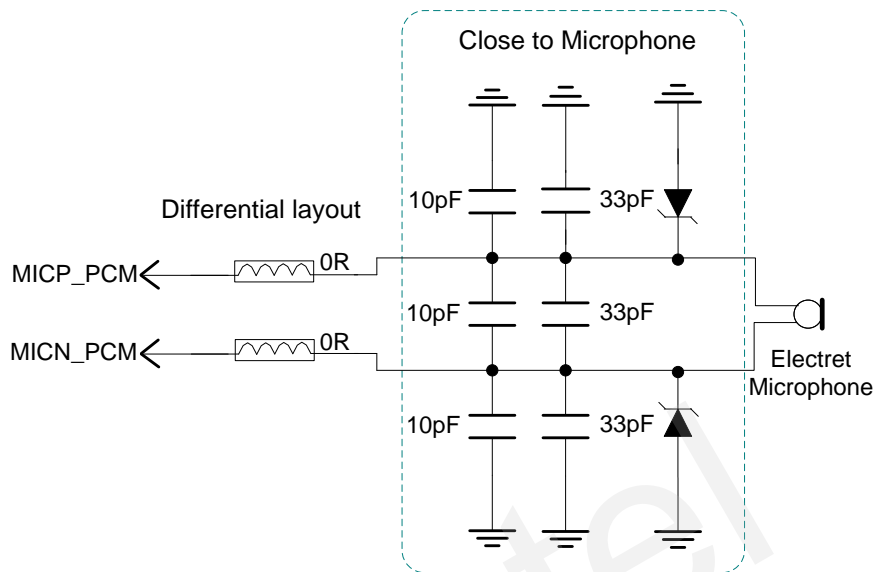
Figure 6: Microphone Design

3.5. Receiver Interface Design
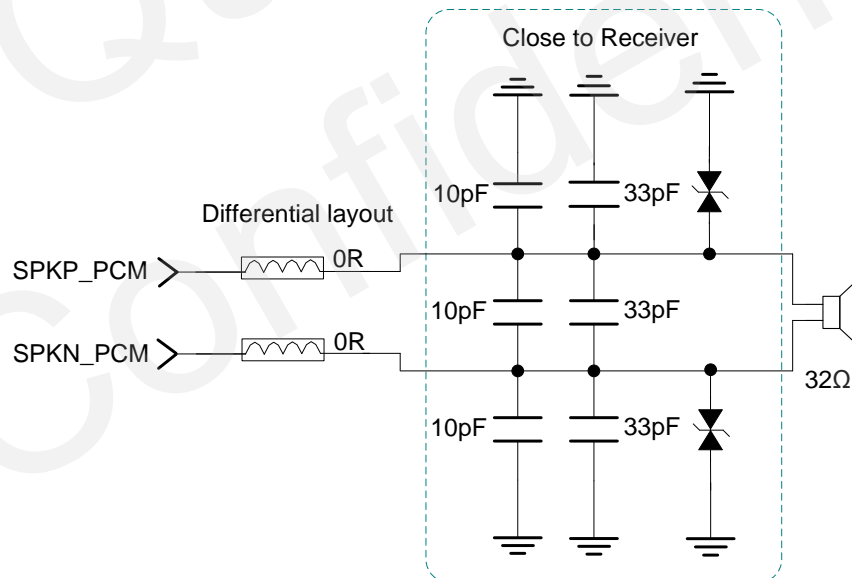
Figure 7: Receiver Design

3.6. Earphone Interface Design

The following figure shows the single-ended application for earphone design.
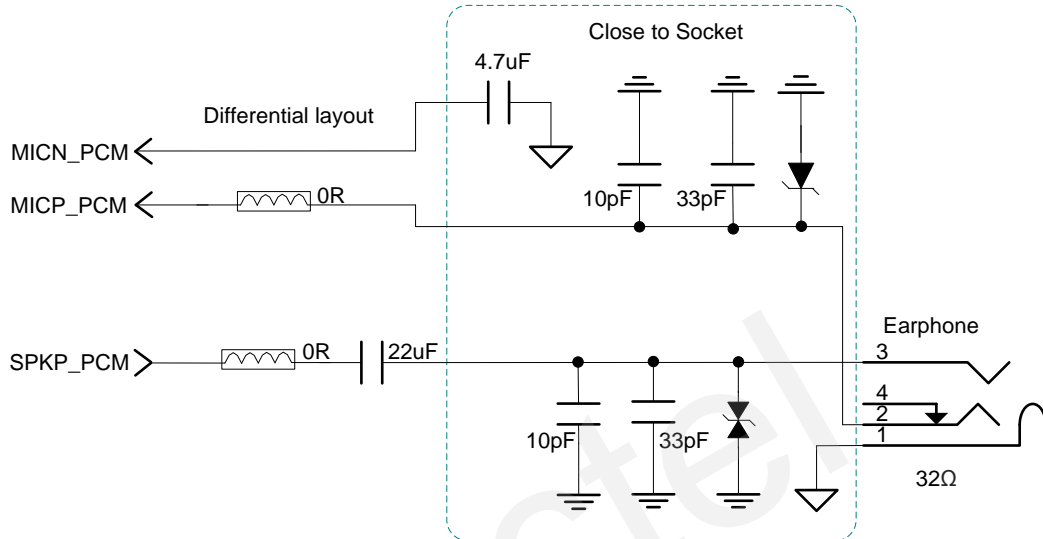
Figure 8: Earphone Design

3.7. Speaker Amplifier Design

If the 8Ω speaker is applied, it is recommended to add an audio amplifier.
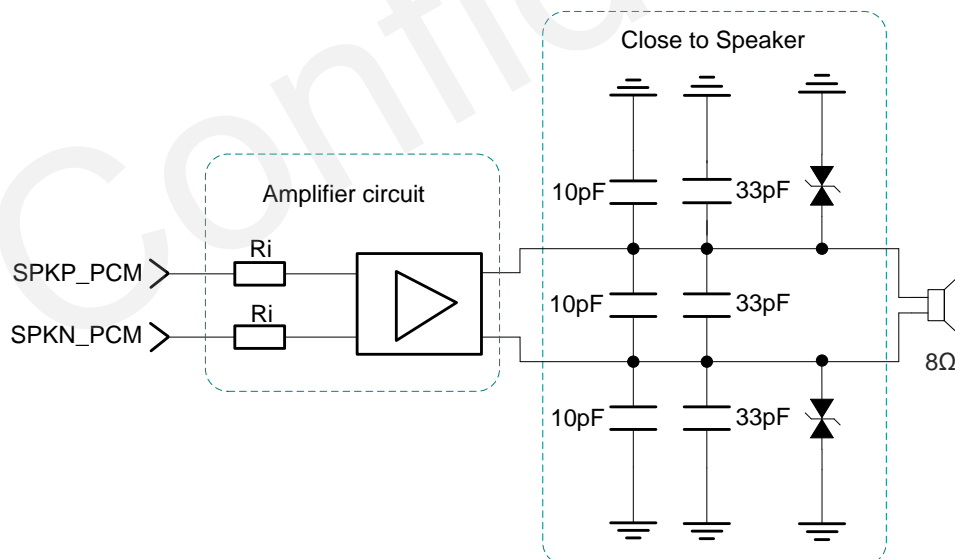
Figure 9: Speaker Amplifier Design

4 Design Consideration

4.1. Power Supply for PCM Codec

For different PCM codec, the supply voltage is different. It's better to supply power for PCM codec with dedicated LDO, and not to share this power with other circuits.

4.2. Audio Layout

Power supply ripple, unbalanced ground and RF burst radiation have negative effect on audio layout. Layout of MICP_PCM/MICN_PCM, SPKP_PCM/SPKN_PCM must meet the rule of differential signal. Moreover, these two pairs of signals should be separated from each other by flooding ground to avoid echo issue from SPK signal to MIC signal. Figure 10 shows an example.
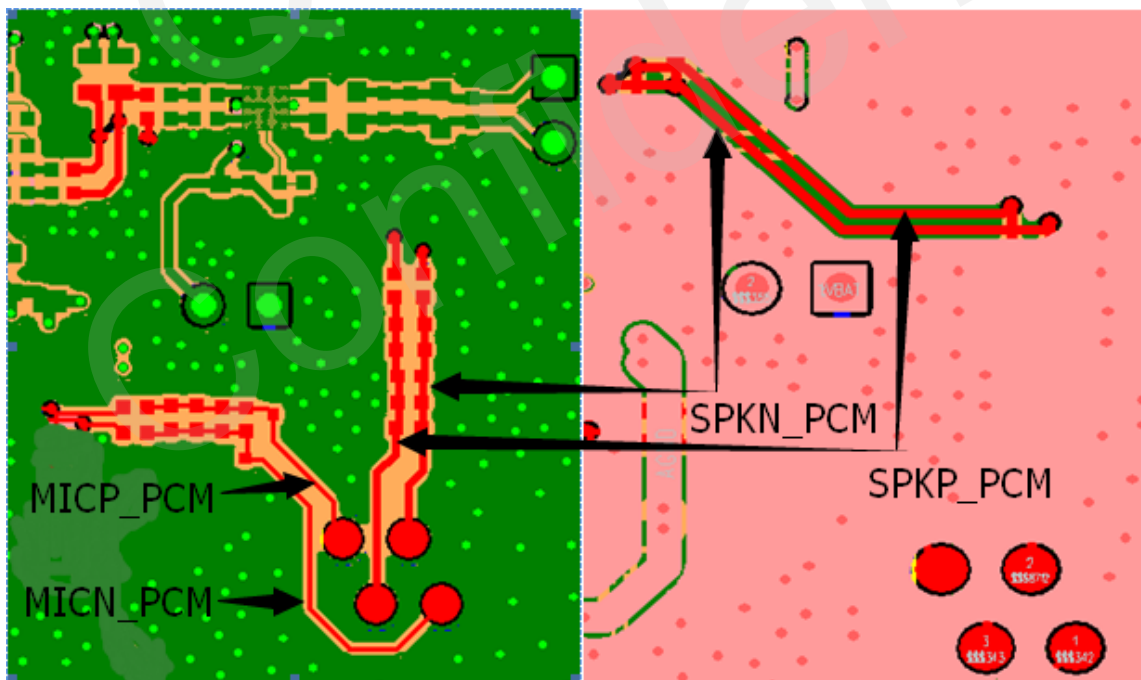
Figure 10: Audio Layout

4.3. TDD Noise

It is important to avoid or reduce TDD noise in audio circuit design and layout, some suggestions are listed below:

1. Different capacitors have their own self-resonant frequencies due to the different fabrication processes and materials. Generally, we choose 33pF capacitor (0603 package) to filter GSM900 interference and 10pF capacitor (0603 package) to filter DCS1800 interference on the power and analog audio signal lines. It is strongly recommended to add an electrets-microphone within two capacitors (10pF and 33pF) in handset and hands-free application. These two capacitors could largely suppress coupling TDD noise from RF interference.

2. Capacitors should be placed close to audio components or audio interface, and layout must be short.

3. Flood ground area should be as large as possible to reduce the ground impedance and improve ground integrality.

4. Reduce power voltage ripple, especially the power supply in audio circuits. A wide layout is used from power source (like adapter interface, battery connector, or LDO output pin) to audio power supply. Good antenna matching is also important to reduce power ripple.

5. The filtering capacitors and ESD protection devices should be connected to main digital ground. Separate analog ground and digital ground, and connect them at a single point on the PCB by one 0 ohm resistor to reduce digital interference and background noise.

6. Antenna must be stay away from audio components and layout of audio circuit. Antenna should be kept at least 5cm away from microphone.

7. Layout of power supply must be stay away from audio and cannot be parallel.

4.4. Mechanical Design

It is important to consider how to suppress echo in the equipment with hands-free function or in an application of which microphone and speaker are very close to each other.

The mechanical structure design has significant impact on echo issue. If it is not properly designed, the echo suppressing arithmetic in software could not make up for echo issue caused by bad mechanical structure, and even force to redesign.

Echo issue could be generated by several paths, as shown in Figure 11.
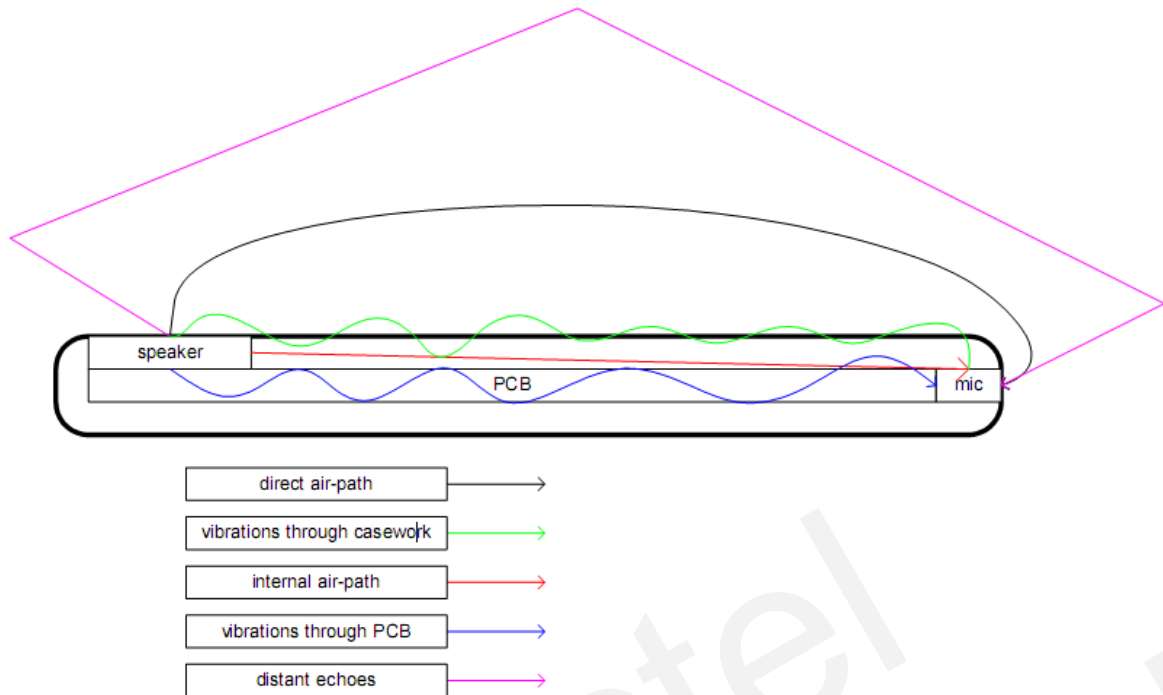
Figure 11: Five Echo Paths

In these five paths, internal air-path and direct air-path are the first influential factors. Other three factors (vibrations through casework, vibrations through PCB, distant echoes) are secondary.

To deal with echo issue from internal air-path, you can separate microphone from internal space of chassis by foam or rubber ring which can effectively suppress the inner echo interference. Figure 12 shows recommended design for microphone socket.
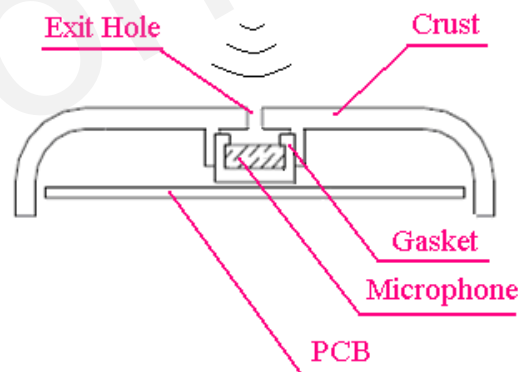
Figure 12: Microphone Socket Design

> **NOTE**
>
> The best installation way of microphone socket is to encase microphone by silicone cover except for front cavity, and design a cylindrical hole whose center is the exit hole inside the chassis, make the microphone with silicone cover just fit the cylindrical hole, so as to only let voice enter into microphone from the exit hole, and not from leak of chassis interior. Certain air space room should be reserved in the front cavity of microphone as it is necessary for good microphone performance.

Figure 13 shows recommended design for speaker socket.
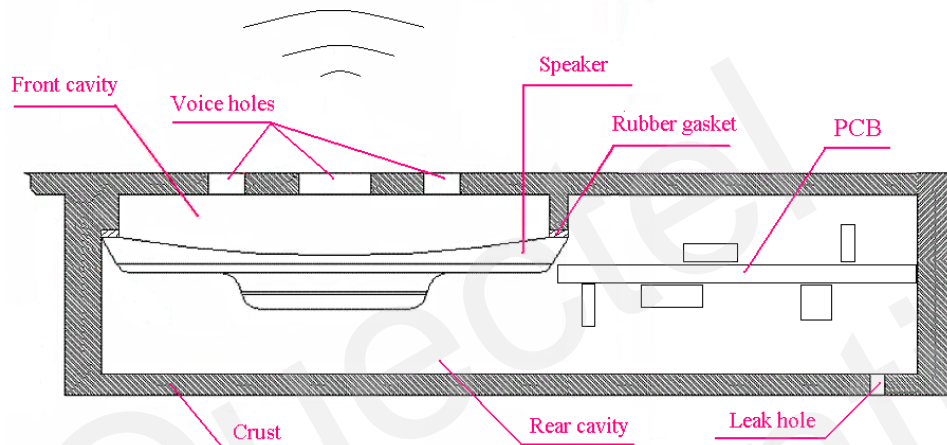
Figure 13: Speaker Socket Design

A good way to suppress the internal echo path is to seal the rear cavity of receiver, which is usually expensive. The rear cavity of receiver and speaker is important for good voice quality. A sealed rear cavity with sufficient space could produce a good voice output. An 8Ω speaker is often big and difficult to give an independently sealed rear cavity for it. However, sealing microphone socket in chassis is always useful. Furthermore, the whole chassis must be sealed as far as possible. If there is any unavoidable leak hole, keep it far away from microphone. If the leak hole is close to microphone, the voice coming from the hole could be picked up by MIC, and then leads to echo at the far end. If the leak hole is close to speaker, the output voice quality could be aggravated at certain extent.

4.5. Component of SPK

A SPK and receiver with higher sensitivity, flatter frequency response, less THD and impedance of 32Ω (receiver), 16Ω (receiver) or 8Ω (speaker) is recommended. These technical data are often shown in data sheet of SPK and receiver. For SPK, its frequency response and THD performance can be tested by speaker test system. SPK frequency and THD response are shown in Figure 14 and Figure 15.
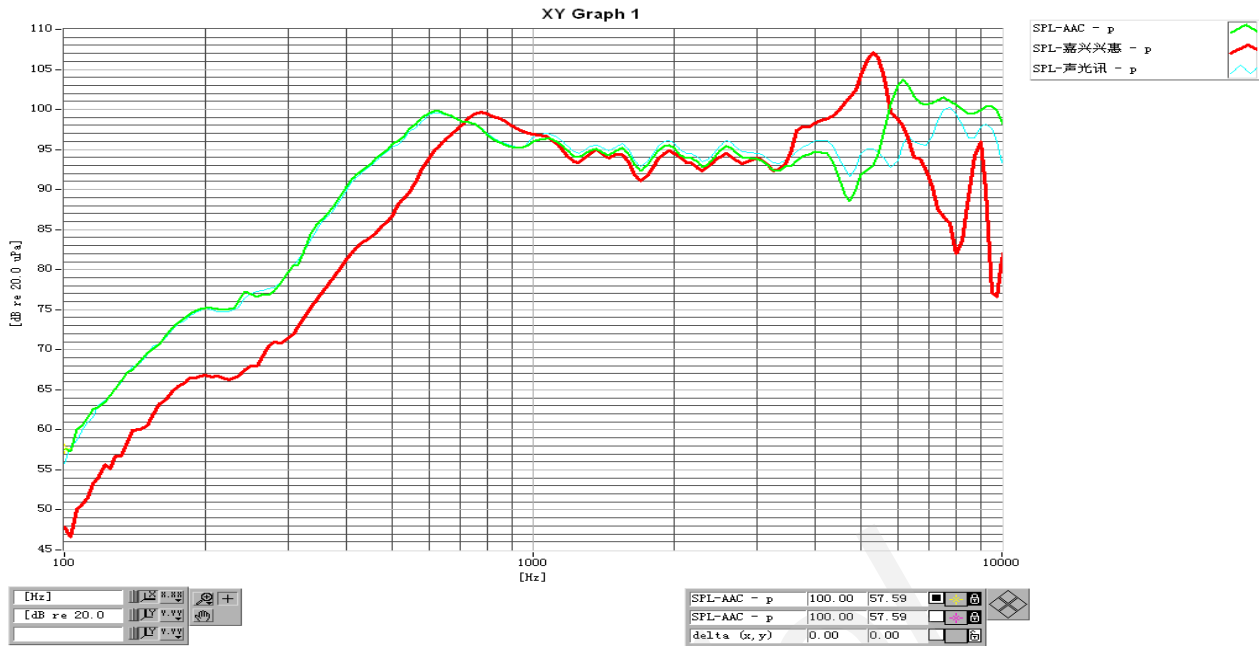
Figure 14: SPK Frequency Response

NOTE

Horizontal axis is frequency, longitudinal axis is loudness and unit is dB.
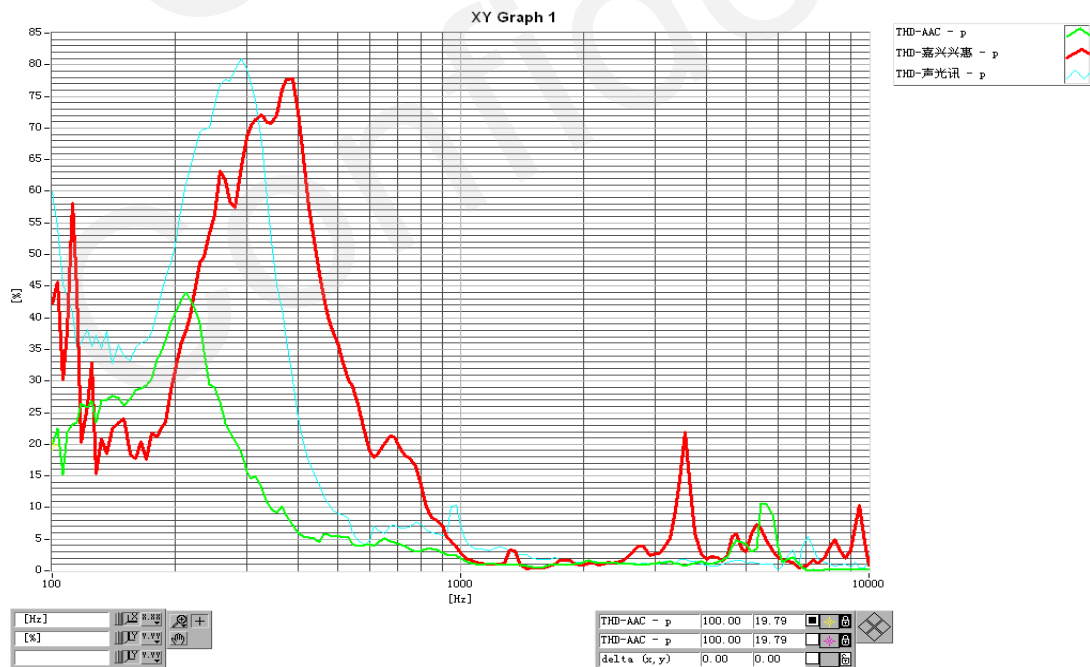
Figure 15: SPK THD

NOTE

1. Horizontal axis is frequency, longitudinal axis is distortion and unit is %.
2. In Figure 15, the three colors represent three venders' products. After comprehensive comparison, the green one performs the best, and the blue one is worse, and the red one is the worst.

4.6. Components of Microphone

It is recommended to use an electret microphone with a sensitivity of -42±3dB/Pa @ 2V (not less than -44±3dB) and impedance of 2.2Kohm. If RF TDD noise is detected at the MIC, please contact MIC vendor for product with better RF suppression capability. Furthermore, the microphone channel circuit can be optimized to decrease TDD issue at MIC side.

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5 Audio Tuning in Different Modes

There are three kinds of common modes: handset, headset, handfree. **AT+QAUDMOD** is used to choose modes. For each mode, there are some default settings, such as CLVL, CRSL, QSIDET, QMIC and QAUDGAIN.

If the audio is not good and **AT+QAUDMOD** has been executed, please follow the steps below to tune audio:

Step 1:   Execute **AT+CLVL** to tune downlink volume.
Step 2:   Execute **AT+QMIC** to tune uplink volume.
Step 3:   If the volume is a little smaller or higher and you have set QMIC & CLVL, please use **AT+QAUDGAIN** to tune it.
Step 4:   If you use the recommended codec, you can use **AT+QAUDCFG** to tune the codec volume.
Step 5:   Execute **AT+QSIDET** to tune side tone.
Step 6:   If there is echo or noise left, please use **AT+QAUDCFG** to tune EEC & NR.

NOTE

Please do not set the volume too higher, otherwise it will influence EEC & NR.

This following examples show how to tune audio in three different modes:

5.1. Speech Call in Handset Mode

The default mode is set to handset mode.

AT+QAUDMOD=0	//**<mode>**=0 is used for handset mode.
OK	
AT+CLVL=80	//Tune downlink volume.
OK	
AT+QMIC=0,12	//Tune uplink volume
OK	

```
AT+QAUDGAIN=0,-1,50          //If downlink or uplink volume is a litter lower or higher,
                                 please use AT+QAUDGAIN to tune it.

OK
AT+QSIDET=-100               //Tune side tone

OK
```

5.2. Speech Call in Headset Mode

Set **AT+QAUDMOD=1** to use Headset mode.

```
AT+QAUDMOD=1                 //<mode>=1 is used for headset mode.

OK
AT+CLVL=70                   //Tune downlink volume.

OK
AT+QMIC=1,14                 //Tune uplink volume

OK
AT+QAUDGAIN=1,60,-1          //If downlink or uplink volume is a litter lower or higher, please
                                 use AT+QAUDGAIN to tune it.
OK
AT+QSIDET=-100               //Tune side tone

OK
```

5.3. Speech Call in Handfree Mode

Set **AT+QAUDMOD=2** to use Headset mode. This mode is always used for vehicle-mounted devices.

```
AT+QAUDMOD=2                 //<mode>=2 is used for handfree mode.

OK
AT+CLVL=50                   //Tune downlink volume.

OK
AT+QMIC=2,12                 //Tune uplink volume

OK
```

AT+QAUDGAIN=2,100,60	//If downlink or uplink volume is a litter lower or higher, please use AT+QAUDGAIN to tune it.
OK	
AT+QSIDET=-450	//Tune side tone
OK	

AT+QAUDGAIN=2,100,60

6 Audio AT Command Description

This chapter will introduce the common audio related AT commands. For more details, please refer to *document [3]*.

6.1. AT+QDAC Digital Audio Interface Configuration

AT+QDAC is used to configure the digital audio interface. While **<io>**=1, you can define the PCM interface by yourself; while **<io>**=2, and the external codec chip linked with PCM interface is the NAU8814 model through the I2C, the module can be used directly and set by the default configurations. while **<io>**=3, and the external codec chip linked with PCM interface is the ALC5616 model through the I2C, the module can be used directly and set by the default configurations. while **<io>**=4, and the external codec chip linked with PCM interface is the MAX9860 model through the I2C, the module can be used directly and set by the default configurations.

AT+QDAC Digital Audio Interface Configuration	
Test Command **AT+QDAC=?**	Response **+QDAC:(1-4),(0,1),(0-8),(0-2),(0,1),(0,1)** **OK**
Read Command **AT+QDAC?**	Response **+QDAC:<io>[,<mode>,<sample_rate>,<data_length>,<channel_mode>,<data_format>]** **OK**
Write Command **AT+QDAC=<io>[,<mode>,<sample_rate>,<data_length>,<channel_mode>,<data_format>]**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<io>	1	Digital PCM output (customer defined)
	2	Analog output (for default audio codec NAU8814)
	3	Analog output (for default audio codec ALC5616)
	4	Analog output (for default audio codec MAX9860)
<mode>	0	Master mode
	1	Slave mode
<sample_rate>	0	8K
	1	11K
	2	12K
	3	16k
	4	22K
	5	24K
	6	32K
	7	44K
	8	48K
<data_length>	0	16-bit
	2	32-bit
<channel_mode>	0	Mono
	1	Stereo
<data_format>	0	PCM
	1	I2S

NOTES

1. Configuration of **<io>** will be saved to NV immediately by default.
2. The module provides clock, and clock depends on **<sample_rate>** and **<data_length>**
3. When you select ALC5616, NAU8814 or MAX9860, please do not input other parameters, the PCM interface is set by the default configurations.

Example

AT+QDAC=?	//Query the range.
+QDAC: (1-4),(0,1),(0,8),(0-2),(0,1),(0,1)	
OK	
AT+QDAC?	//Query current interface configuration.
+QDAC: 1,0,0,2,0,0	
OK	
AT+QDAC=1,0,0,2,0,0	//Set PCM interface to master mode, PCM format.
OK	
AT+QDAC=2	//Select NAU8814.

```
OK
AT+QDAC=3            //Select ALC5616.
OK
AT+QDAC=4            //Select MAX9860.
OK
```

6.2. AT+QIIC   IIC Read&Write

AT+QIIC is used to configure the codec via I2C interface.

AT+QIIC IIC Read&Write.	
Test command **AT+QIIC=?**	Response **+QIIC: (0,1),(0-FF),(0-FF),(1,2),(0-FFFF)** **OK**
Set command **AT+QIIC=<rw>,<device>,<addr>,<byt es>[,<value>]**	Response **OK** Response **+QIIC: <value>** **OK**
Maximum Response Time	300ms

Parameter

<rw>	0	Write command
	1	Read command
<device>	0-0xFF	Device address
<addr>	0-0xFF	Register address
<bytes>	1-2	Read/write bytes
<value>	0-0xFFFF	Data value

NOTE

Configuration will be not saved.

6.3. AT+CLVL   Loud Speaker Volume Level

AT+CLVL is used to select the volume of the internal loudspeaker of the module.

AT+CLVL Loud Speaker Volume Level	
Test Command **AT+CLVL=?**	Response **+CLVL:** (list of supported**<level>**s) **OK**
Read Command **AT+CLVL?**	Response **+CLVL: <level>** **OK**
Write Command **AT+CLVL=<level>**	Response **OK** If error is related to ME functionality: **+CME ERROR: <err>**
Maximum Response Time	300ms
Reference 3GPP TS 27.007	

Parameter

<level>	Integer type, value (0-100) with manufacturer specific range (Smallest value represents the lowest sound level), the default value of mode 0 is 80, the default value of mode 1 is 70 and the default value of mode 2 is 50.

NOTES

This parameter will not be saved.

6.4. AT+QAUDGAIN   Set Gain Offset

This command is to set gain offset to change uplink and downlink volume.

AT+QAUDGAIN Set Gain Offset	
Test Command	Response

AT+QAUDGAIN=?	+QAUDGAIN: (0-2),(-600~300),(-600~300)
	OK
Set Command **AT+QAUDGAIN=<mode>[,<ul_gain_offset>,<dl_gain_offset>]**	Response If configuration parameters are omitted: **+QAUDGAIN:<mode>,<ul_gain_offset>,<dl_gain_offset>** **OK** If configuration parameters are entered: **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<mode>	Numeric type, audio mode 　0　Handset 　1　Headset 　2　Handfree
<ul_gain_offset>	Numeric type, value: -600~300, indicates uplink gain offset. Default value of mode 0 is -1, the default value of mode 1 is 60, and the default value of mode 2 is 100.
<dl_gain_offset>	Numeric type, value: -600~300, indicates downlink gain offset. Default value of mode 0 is 50, the default value of mode 1 is -1, and the default value of mode 2 is 60.

NOTE

This parameter will be saved to NV by default.

6.5. AT+QMIC　Set Uplink(MIC) Volume

This command is to set MIC gains to change uplink volume.

AT+QMIC　Set Uplink(MIC) Volume	
Test Command **AT+QMIC=?**	Response **+QMIC: (0-2),(0-15)** **OK**

Read Command	Response
AT+QMIC?	**+QMIC: <handset volume>,<headset volume>,<handfreevolume>**
	OK
Set Command	Response
AT+QMIC=<mode>,<volume>	**OK**
	ERROR
Maximum Response Time	300ms

Parameter

<mode>	Numeric type, audio mode
	0 Handset
	1 Headset
	2 Handfree
<volume>	Numeric type, indicates uplink volume, range: 0-15, the default value of mode 0 is 12, the default value of mode 1 is 14, and the default value of mode 2 is 13.

NOTE

These parameters will not be saved.

6.6. AT+CMUT   Mute Control

AT+CMUT is used to enable and disable the uplink voice mute during a voice call.

AT+CMUT Mute Control	
Test Command	Response
AT+CMUT=?	**+CMUT: (0,1)**
	OK
Read Command	Response
AT+CMUT?	**+CMUT: <n>**
	OK
Write Command	Response
AT+CMUT=<n>	**OK**

	If error is related to ME functionality:
	+CME ERROR: <err>
Maximum Response Time	300ms
Reference 3GPP TS 27.007	

Parameter

| **<n>** | 0 | Mute off |
| | 1 | Mute on |

NOTE

This parameter will not be saved.

6.7. AT+QCLKOUT   Output Clock Source

AT+QCLKOUT is used to output clock source from pin25.

AT+QCLKOUT Output Clock Source	
Test Command **AT+QCLKOUT=?**	Response **+QCLKOUT: (0,1),(1-4)** **OK**
Read Command **AT+QCLKOUT?**	Response **+QCLKOUT: <enable>,<source>** **OK** **+CME ERROR: <err>**
Write Command **AT+QCLKOUT=<enable>[,<source>]**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<enable>	0	Disable to output clock source.
	1	Enable to output clock source.
<source>	1	26MHz
	2	13MHz
	3	6.5MHz
	4	32.768KHz

NOTES

1. Parameters will not be saved to NV.
2. When Pin25 is busy, it will return CME error.

6.8. AT+QSIDET   Set the Side Tone Gain in the Current Mode

AT+QSIDET is used to set the side tone gain value of the current mode.

AT+QSIDET Set the Side Tone Gain in Current Mode	
Test Command **AT+QSIDET=?**	Response **+QSIDET: (-450~200)** **OK**
Read Command **AT+QSIDET?**	Response **+QSIDET: <stgain>** **OK**
Write Command **AT+QSIDET=<stgain>**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<stgain>	Numeric type, indicates the configured side tone gain in current mode. Range: -450~200. The default value of mode 0 is -100, the default value of mode 1 is -100, and the default value of mode 2 is -450.

> **NOTE**
>
> Parameter will be saved to NV immediately by default.

6.9. AT+QAUDLOOP   Enable Audio Loop Test

This command is used to enable audio loop test.

AT+QAUDLOOP Enable Audio Loop Test	
Test Command **AT+QAUDLOOP=?**	Response **+QAUDLOOP: (0,1),(0-2)** **OK**
Read Command **AT+QAUDLOOP?**	Response **+QAUDLOOP: <enable>,<path>** **OK**
Set Command **AT+QAUDLOOP=<enable>[,<path>]**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<enable>	Numeric type; to enable or disable audio loop test
	<u>0</u> Disable audio loop test
	1 Enable audio loop test
<path>	Compatible argument, no effect

> **NOTE**
>
> These parameters will not be saved.

6.10. AT+QAUDMOD Set Audio Mode

AT+QAUDMOD sets the audio mode required for the connected device.

AT+QAUDMOD	Set Audio Mode	
Test Command **AT+QAUDMOD=?**	Response **+QAUDMOD: (0-2)** **OK**
Read command **AT+QAUDMOD?**	Response **+QAUDMOD: <mode>** **OK**
Write Command **AT+QAUDMOD=<mode>**	Response **OK** If error is related to ME functionality: **+CME ERROR: <err>**
Maximum Response Time	300ms

Parameter

<mode>	Numeric type, indicates the current configured audio mode
	<u>0</u> Echo canceller, noise suppressor, digital gain and calibration parameter for Handset
	1 Echo canceller, noise suppressor, digital gain and calibration parameter for Headset
	2 Echo canceller, noise suppressor, digital gain and calibration parameter for Speaker

---

NOTE

These parameters will not be saved.

6.11. AT+CRSL Set Ring Tone Volume

AT+CRSL can be used to set the volume of ring tone.

AT+CRSL	Set Ring Tone Volume	
Test Command **AT+CRSL=?**	Response **+CRSL:** (list of supported **<level>**s)

	OK
Read Command **AT+CRSL?**	Response **+CRSL: <level>** **OK**
Write Command **AT+CRSL=<level>**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<level>	Numeric type, indicates the configured volume of ring tone. Range: 0-100, the default value of mode 0 is 80, the default value of mode 1 is 50, and the default value of mode 2 is 80.

NOTE

This parameter will not be saved.

6.12. AT+CALM   Mute the Ring Tone

AT+CALM is used to mute the ring tone. There is no ring tone when a call is coming.

AT+CALM Mute the Ring Tone	
Test Command **AT+CALM=?**	Response **+CALM: (list of supported <n>s)** **OK**
Read Command **AT+CALM?**	Response **+CALM: <n>** **OK**
Write Command **AT+CALM=<on>**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<n>	Numeric type
	<u>0</u> Ring tone is normal
	1 Ring tone is mute

NOTE

This parameter will not be saved.

6.13. AT+QPCMON   Enable PCM Sync & BCLK

AT+QPCMON is used to enable PCM sync & BCLK.

AT+QPCMON Enable PCM Sync & BCLK	
Test Command **AT+QPCMON=?**	Response **+QPCMON:** (list of supported **<n>**s) **OK**
Read Command **AT+QPCMON?**	Response **+QPCMON: <n>** **OK**
Write Command **AT+QPCMON=<n>**	Response **OK** **ERROR**
Maximum Response Time	300ms

Parameter

<n>	Numeric type
	<u>0</u> Disable PCM sync & BCLK
	1 Enable PCM sync & BCLK

NOTE

This parameter will not be saved.

6.14. AT+QAUDCFG   Audio Tuning Process

AT+QAUDCFG is used to query and configure various audio settings of UE.

AT+QAUDCFG Audio Tuning Process	
Test Command **AT+QAUDCFG=?**	Response **+QAUDCFG: "handset/eec",** (list of supported **<eecpara>**s) **+QAUDCFG: " headset/eec",** (list of supported **<eecpara>**s) **+QAUDCFG: "handfree/eec",** (list of supported **<eecpara>**s) **+QAUDCFG: " handset /nr/ul",** (list of supported **<nrpara>**s) **+QAUDCFG: "headset /nr/ul",** (list of supported **<nrpara>**s) **+QAUDCFG: "handfree/nr/ul",** (list of supported **<nrpara>**s) **+QAUDCFG: "handset/nr/dl",** (list of supported **<nrpara>**s) **+QAUDCFG: "headset /nr/dl ",** (list of supported **<nrpara>**s) **+QAUDCFG: "handfree/nr/dl ",** (list of supported **<nrpara>**s) **+QAUDCFG: "nau8814/dlgain",** **+QAUDCFG: "nau8814/ulgain",** **+QAUDCFG: "alc5616/dlgain",** **+QAUDCFG: "alc5616/ulgain",** **+QAUDCFG: "max9860/dlgain",** **+QAUDCFG: "max9860/ulgain",** **OK**
Maximum Response Time	300ms

6.14.1.   AT+QAUDCFG="handset/eec"   Set Echo Cancellation for Handset

AT+QAUDCFG="handset/eec" is used to set echo cancellation for handset.

AT+QAUDCFG="handset/eec" Set Echo Cancellation for Handset	
Test Command **AT+QAUDCFG=?**	Response …… **+QAUDCFG: "handset/eec",<eecpara>**

	...... **OK**
Write Command **AT+QAUDCFG="handset/eec"[,<eecpara>]**	Response If configuration parameters are omitted: **+QAUDCFG: "handset/eec",<eecpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<eecpara>	List of integers, separated by dot (.)	
	Par0	Echocancollationcontrol word, 1: enable, 0: disable, default value might be different in different audio modes
	Par1	AEC (Acoustic Echo Canceller) control word, 1: enable, 0: disable, default value might be different in different audio modes
	Par2	EC_NrCoeffs_Real, Number of taps in real subband, range: 1-528. Default value might be different in different audio modes
	Par3	EC_NrCoeffs_Complex_1, Number of taps in complex subband 1, range: 1-528. Default value might be different in different audio modes
	Par4	EC_NrCoeffs_Complex_2, Number of taps in complex subband2, range: 1-528. Default value might be different in different audio modes
	Par5	EC_NrCoeffs_Complex_3, Number of taps in complex subband3, range: 1-528. Default value might be different in different audio modes
	Par6	EC_NrCoeffs_Complex_4, Number of taps in complex subband4, range: 1-528. Default value might be different in different audio modes
	Par7	EC_NrCoeffs_Complex_5, Number of taps in complex subband5, range: 1-528. Default value might be different in different audio modes
	Par8	EC_Blen, NLMS update block length range: (1,2,4,5,8). Default value might be different in different audio modes
	Par9	SER (Spectral Echo Reduction) control word, 1: enable, 0: disable, default value might be different in different audio modes
	Par10	SER_Beta, Smoothing factor of the echo reduction applied by the SER, range: 0-32767. Default value might be different in different audio modes
	Par11	SER_Overest, Overestimation factor of the echo estimation, range: 0-32767. Default value might be different in different audio modes
	Par12	SER_NoiseLevel, Overestimation factor of the noise estimation, range: 0-32767. Default value might be different in different audio modes
	Par13	SER_MultCtrl, Allowed amplitude of short-term variations of noise estimation, range: 0-32767. Default value might be different in different audio modes

Par14   AGC (Automatic Gain Control) control word, 1: enable, 0: disable, default value might be different in different audio modes

Par15   RE_LdAddGain, Additionalgain, range: -16384~16384. Default value might be different in different audio modes

Par16   RE_LdGainLoLim, Total gain lower limit, range: 0-16384. Default value might be different in different audio modes

Par17   RE_LdGainUpLim, Total gain upper limit, range: 0-16384. Default value might be different in different audio modes

Par18   RE_NrShliFilt, Shifts for gain smoothing, range: -36~36. Default value might be different in different audio modes

Par19   RE_TriggerOffset, AGC trigger offset for the decision logic to allow more double-talk, range: -16384~16384. Default value might be different in different audio modes

Par20   RE_FarPowerCenter, Threshold on far-end power (below which overestimation is Par22, above which estimationisPar23), range: 0-16384. Default value might be different in different audio modes

Par21   RE_FarPowerDistorted, Threshold on far-end overestimated power (above which overestimated by **Par24**, to compensate residual echo when strong LS distortion), range: 0-16384. Default value might be different in different audio modes

Par22   RE_FarOverEstR0, Far-end power overestimation ratio if loudspeaker power is below **Par20**, range: 0-14666. Default value might be different in different audio modes

Par23   RE_FarOverEstR1, Far-end power overestimation ratio if loudspeaker power is abovePar20, range: 0-14666. Default value might be different in different audio modes

Par24   RE_FarOverEstR2, Far-end power overestimation ratio if loudspeaker power is above **Par21**, range: 0-16384. Default value might be different in different audio modes

Par25   EDL (Echo Delay Lines) control word, 1: enable, 0: disable, default value might be different in different audio modes

Par26   Delay in milliseconds in the echo reference path, range: 0-60. Default value might be different in different audio modes

---

NOTES

1.   Auto save the configuration to NV. The setting is still valid after module restart.

2.   If you set Par1 & Par9 & Par14 & Par25 to 0, please set Par0 to 0, otherwise it will return error. When you set Par0 to 0, Par1 & Par9 & Par14 & Par25 will be set to 0 by default.

3.   Par2+2*(Par3 Par4+Par5+Par6+Par7) < 2200.

Example

**AT+QAUDCFG="handset/eec","1.1.100.100.100.1.1.1.2.1.32113.16384.2560.4096.1.0.0.5000.0.0.512
0.12288.256.282.307.1.0"**   //Set configuration to default

OK

AT+QCFG="handset/eec"   //Query

+QAUDCFG:
"handset/eec","1.1.100.100.100.1.1.1.2.1.32113.16384.2560.4096.1.0.0.5000.0.0.5120.12288.256.282.
307.1.0"

OK

6.14.2. AT+QAUDCFG="headset/eec"   Set Echo Cancellation for Headset

AT+QAUDCFG="headset/eec" is used to set echo cancellation for headset.

AT+QAUDCFG="headset/eec" Set Echo Cancellation for Headset	
Test Command **AT+QAUDCFG=?**	Response …… **+QAUDCFG: "headset/eec",<eecpara>** …… **OK**
Write Command **AT+QAUDCFG="headset/eec"[,<eecpara>]**	Response If configuration parameters are omitted" **+QAUDCFG: "headset/eec",<eecpara>** **OK** If configuration parameters are entered" **OK** **ERROR**

Parameter

<eecpara>	List of integers, separated by dot (.), for details, please refer to **<eecpara>** of AT+QAUDCFG="handset/eec"

Example

AT+QAUDCFG="headset/eec","1.1.100.100.100.1.1.1.2.1.32113.16384.2560.4096.1.0.0.5000.0.0.512
0.12288.256.282.307.1.0"   //Set configuration to default

OK
AT+QCFG="headset/eec"   //Query

+QAUDCFG:
"headset/eec","1.1.100.100.100.1.1.1.2.1.32113.16384.2560.4096.1.0.0.5000.0.0.5120.12288.256.282.
307.1.0"
OK

6.14.3. AT+QAUDCFG="handfree/eec"   Set Echo Cancellation for Handfree

AT+QAUDCFG="handfree/eec" is used to set echo cancellation for handfree.

AT+QAUDCFG="handfree/eec" Set Echo Cancellation for Headfree	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "handfree/eec",<eecpara>** **……** **OK**
Write Command **AT+QAUDCFG="handfree/eec"[,<eecpara>]**	Response If configuration parameters are omitted: **+QAUDCFG="handfree/eec",<eecpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<eecpara>   List of integers, separated by dot (.), for more details, please refer to **<eecpara>** of
AT+QAUDCFG="handset/eec".

Example

AT+QAUDCFG="handfree/eec","1.1.150.150.150.1.1.1.2.1.32113.16384.10240.16384.1.1800.80.8192
.0.0.6144.12288.256.282.307.1.0"   //Set configuration to default

OK
AT+QCFG="handfree/eec"   //Query

+QAUDCFG:
"handfree/eec","1.1.150.150.150.1.1.1.2.1.32113.16384.10240.16384.1.1800.80.8192.0.0.6144.12288.
256.282.307.1.0"
OK

6.14.4. AT+QAUDCFG="handset/nr/ul"　Set Uplink Noise Reduction for Handset

AT+QAUDCFG="handset/nr/ul" is used to set uplink noise reduction for handset.

AT+QCFG="handset/nr/ul"　Set Uplink Noise Reduction for Handset	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "handset/nr/ul",<nrpara>** **……** **OK**
Write Command **AT+QAUDCFG="handset/nr/ul"[,<nrpara>]**	Response If configuration parameters are omitted: **+QAUDCFG: "handset/nr/ul",<nrpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<nrpara>	List of integers, separated by dot (.).	
	Par0	Noise Reduction control word, 1: enable, 0: disable, Default value might be different in different audio modes
	Par1	NR_AttenFactorMinVal, Minimum value of Noise Reduction gain, range: 0-32767. Default value might be different in different audio modes
	Par2	NR_OvEstFacBandZero, Overestimation factor for Noise Reduction in band 0, range: 0-32767. Default value might be different in different audio modes
	Par3	NR_OvEstFacBandNoZero, Overestimation factor for Noise Reduction in band 1 to 7, range: 0-32767. Default value might be different in different audio modes
	Par4	NR_GainFactor, Defines how aggressive the NR is, range: 0-32767. Default value might be different in different audio modes
	Par5	NR_GainLimit, Maximum gain allow, range: 0-32767. Default value might be different in different audio modes

---

NOTE

Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="handset/nr/ul", "1.6000.9000.10000.1800.19660"	//Set configuration to default
OK	
AT+QAUDCFG="handset/nr/ul"	//Query
+QAUDCFG: "handset/nr/ul", "1.6000.9000.10000.1800.19660"	
OK	

6.14.5. AT+QAUDCFG="handset/nr/dl" Set Down Link Noise Reduction for Handset

AT+QAUDCFG="handset/nr/dl" is used to set down link noise reduction for handset.

AT+QCFG="handset/nr/dl" Set Down Link Noise Reduction for Handset	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "handset/nr/dl",<nrpara>** **……** **OK**
Write Command **AT+QAUDCFG="handset/nr/dl"[,<nrpara>]**	Response If configuration parameters are omitted: **+QAUDCFG:"handset/nr/dl",<nrpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<nrpara>	List of integers, separated by dot (.). For more details, please refer to **<nrpara>** of AT+ QAUDCFG="handset/nr/ul"

NOTE

Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="handset/nr/dl","1.12000.10000.10000.1000.19660"   //Set configuration to default

OK
AT+QAUDCFG="handset/nr/dl"   //Query

+QAUDCFG: "handset/nr/dl","1.12000.10000.10000.1000.19660"

OK

6.14.6.   AT+QAUDCFG="headset/nr/dl"   Set Down Link Noise Reduction for Headset

AT+QAUDCFG="headset/nr/dl" is used to set down link noise reduction for headset.

AT+QCFG="headset/nr/dl" Set Down Link Noise Reduction for Headset	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "headset/nr/dl",<nrpara>** **……** **OK**
Write Command **AT+QAUDCFG="headset/nr/dl"[,<nrpara>]**	Response If configuration parameters are omitted: **+QAUDCFG: "headset/nr/dl",<nrpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<nrpara>	List of integers, separated by dot (.). For details, please refer to **<nrpara>** of AT+QAUDCFG="handset/nr/ul"

NOTE

Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="headset/nr/dl","1.12000.10000.10000.1000.19660"   //Set configuration to default

OK
AT+QAUDCFG="headset/nr/dl"   //Query

+QAUDCFG: "headset/nr/dl", "1.12000.10000.10000.1000.19660"

OK

6.14.7. AT+QAUDCFG="headset/nr/ul"   Set Uplink Noise Reduction for Headset

AT+QAUDCFG="headset/nr/ul" is used to set uplink noise reduction for headset.

AT+QCFG="headset/nr/ul" Set Uplink Noise Reduction for Headset	
Test Command AT+QAUDCFG=?	Response …… +QAUDCFG: "headset/nr/ul",\<nrpara> …… OK
Write Command AT+QAUDCFG="headset/nr/ul"[,\<nrpara>]	Response If configuration parameters are omitted: +QAUDCFG: "headset/nr/ul",\<nrpara> OK If configuration parameters are entered: OK ERROR

Parameter

\<nrpara>	List of integers, separated by dot (.). For details, please refer to **\<nrpara>** of AT+QAUDCFG="handset/nr/ul"

> **NOTE**
>
> Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="headset/nr/ul","1.6000.9000.10000.1800.19660"   //Set configuration to default

OK
AT+QAUDCFG="headset/nr/ul"   //Query

+QAUDCFG: "headset/nr/ul","1.6000.9000.10000.1800.19660"

OK

6.14.8. AT+QAUDCFG="handfree/nr/dl" Set Down Link Noise Reduction for Handfree

AT+QAUDCFG="handfree/nr/dl" is used to set down link noise reduction for handfree.

AT+QCFG="handfree/nr/dl" Set Down Link Noise Reduction for Handfree	
Test Command **AT+QAUDCFG=?**	Response **......** **+QAUDCFG: "handfree/nr/dl",<nrpara>** **......** **OK**
Write Command **AT+QAUDCFG="handfree/nr/dl"[,<nrpara>]**	Response If configuration parameters are omitted: **+QAUDCFG: "handfree/nr/dl",<nrpara>** **OK** If configuration parameters are entered: **OK** **ERROR**

Parameter

<nrpara>   List of integers, separated by dot (.). For details, please refer to **<nrpara>** of AT+ QAUDCFG="handset/nr/ul"

NOTE

Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="handfree/nr/dl","1.12000.10000.10000.1000.19660"   //Set configuration to default

OK
AT+QAUDCFG="handfree/nr/dl"   //Query

+QAUDCFG: "handfree/nr/dl","1.12000.10000.10000.1000.19660"

OK

6.14.9.   AT+QAUDCFG="handfree/nr/ul"   Set Uplink Noise Reduction for Handfree

AT+QAUDCFG="handfree/nr/ul" is used to set uplink reduction for handfree.

AT+QCFG="handfree/nr/ul" Set Uplink Noise Reduction for Handfree	
Test Command AT+QAUDCFG=?	Response …… +QAUDCFG: "handfree/nr/ul",\<nrpara> …… OK
Write Command AT+QAUDCFG="handfree/nr/ul"[,\<nrpara>]	Response If configuration parameters are omitted: +QAUDCFG: "handfree/nr/ul",\<nrpara> OK If configuration parameters are entered: OK ERROR

Parameter

\<nrpara>	List of integers, separated by dot (.). For details, please refer to **\<nrpara>** of AT+ QAUDCFG="handset/nr/ul"

NOTE

Auto save the configuration to NV. The setting is still valid after module restart.

Example

AT+QAUDCFG="handfree/nr/ul","1.6000.9000.10000.1800.19660"   //Set configuration to default

OK
AT+QAUDCFG="handfree/nr/ul"   //Query

+QAUDCFG: "handfree/nr/ul","1.6000.9000.10000.1800.19660"

OK

6.14.10. AT+QAUDCFG="nau8814/dlgain" Set Down Link Gain Level for Codec nau8814

AT+QAUDCFG="nau8814/dlgain" is used to set down link gain level for codec nau8814.

AT+QAUDCFG="nau8814/dlgain" Set Down Link Gain Level for Codec nau8814	
Test Command AT+QAUDCFG=?	Response …… +QAUDCFG: "nau8814/dlgain",\<level> …… OK
Write Command AT+QAUDCFG="nau8814/dlgain"[,\<level>]	Response If configuration parameters are omitted: (+QAUDCFG="nau8814/dlgain"), Return current configuration: +QAUDCFG: "nau8814/dlgain",\<level> OK If configuration parameters are entered: OK ERROR If error is related to ME functionality: +CME ERROR: \<err>

Parameter

\<Level>   Numeric type, indicates the downlink gain of nau8814, range: 0-100, default: 100

NOTE

This parameter will not be saved.

Example

AT+QAUDCFG="nau8814/dlgain",85   //Set downlink gain to 85

OK

6.14.11. AT+QAUDCFG="nau8814/ulgain" Set Uplink Gain Level for Codec nau8814

AT+QAUDCFG="nau8814/ulgain" is used to set uplink gain level for codec nau8814.

AT+QAUDCFG="nau8814/ulgain" Set Uplink Gain Level for Codec nau8814	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "nau8814/ulgain",<level>** **……** **OK**
Write Command **AT+QAUDCFG="nau8814/ulgain"[,<level>]**	Response If configuration parameters are omitted: (**+QAUDCFG="nau8814/ulgain"**), Return current configuration: **+QAUDCFG: "nau8814/ulgain",<level>** **OK** If configuration parameters are entered: **OK** **ERROR** If error is related to ME functionality: **+CME ERROR: <err>**

Parameter

<Level>   Numeric type, indicates the uplink gain of nau8814, range: 0-100, default: 84

> **NOTE**
>
> This parameter will not be saved.

Example

AT+QAUDCFG="nau8814/ulgain",90   //Set uplink gain to 90

OK

6.14.12. AT+QAUDCFG="alc5616/dlgain"   Set Down Link Gain Level for Codec alc5616

AT+QAUDCFG="alc5616/dlgain" is used to set down link gain level for codec alc5616.

AT+QAUDCFG="alc5616/dlgain" Set Down Link Gain Level for Codec alc5616	
Test Command **AT+QAUDCFG=?**	Response **……** **+QAUDCFG: "alc5616/ dlgain",<level>** **……** **OK**
Write Command **AT+QAUDCFG="alc5616/dlgain"[,<level>]**	Response If configuration parameters are omitted: (**+QAUDCFG="alc5616/dlgain"**), Return current configuration: **+QAUDCFG: "alc5616/dlgain",<level>** **OK** If configuration parameters are entered: **OK** **ERROR** If error is related to ME functionality: **+CME ERROR: <err>**

Parameter

<Level>	Numeric type, indicates the downlink gain of alc5616, range: 0-100, default: 100

> **NOTE**
>
> This parameter will not be saved.

Example

AT+QAUDCFG="alc5616/dlgain",85   //Set downlink gain to 85

OK

6.14.13. AT+QAUDCFG="alc5616/ulgain"   Set Uplink Gain Level for Codec alc5616

AT+QAUDCFG="alc5616/ulgain" is used to set uplink gain level for codec alc5616.

AT+QAUDCFG="alc5616/ulgain" Set Uplink Gain Level for Codec alc5616	
Test Command **AT+QAUDCFG=?**	Response …… **+QAUDCFG: "alc5616/ ulgain",\<level>** …… **OK**
Write Command **AT+QAUDCFG="alc5616/ulgain"[,\<level>]**	Response If configuration parameters are omitted: (**+QAUDCFG="alc5616/ulgain"**), Return current configuration: **+QAUDCFG: "alc5616/ulgain",\<level>** **OK** If configuration parameters are entered: **OK** **ERROR** If error is related to ME functionality: **+CME ERROR: \<err>**

Parameter

\<Level>   Numeric type, indicates the uplink gain of alc5616, range: 0-100, default: 74

> **NOTE**
>
> This parameter will not be saved.

Example

AT+QAUDCFG="alc5616/ulgain",85　　　//Set uplink gain to 85

OK

6.14.14. AT+QAUDCFG="max9860/dlgain" Set Down Link Gain Level for Codec max9860

AT+QAUDCFG="max9860/dlgain" is used to set down link gain level for codec max9860.

AT+QAUDCFG="max9860/dlgain" Set Down Link Gain Level for Codec max9860	
Test Command **AT+QAUDCFG=?**	Response …… **+QAUDCFG: "max9860/dlgain",<level>** …… **OK**
Write Command **AT+QAUDCFG="max9860/dlgain"[,<level>]**	Response If configuration parameters are omitted: (**+QAUDCFG="max9860/dlgain"**), Return current configuration: **+QAUDCFG: "max9860/dlgain",<level>** **OK** If configuration parameters are entered: **OK** **ERROR** If error is related to ME functionality: **+CME ERROR: <err>**

Parameter

<Level>　　　Numeric type, indicates the down link gain of max9860, range: 0-100, default: 87

NOTE

This parameter will not be saved.

Example

AT+QAUDCFG="max9860/dlgain",85   //Set downlink gain to 85

OK

6.14.15. AT+QAUDCFG="max9860/ulgain"   Set Uplink Gain Level for Codec max9860

AT+QAUDCFG="max9860/ulgain" is used to set uplink gain level for codec max9860.

AT+QAUDCFG="max9860/ulgain" Set Uplink Gain Level for Codec max9860	
Test Command AT+QAUDCFG=?	Response …… +QAUDCFG: "max9860/ulgain",\<level> …… OK
Write Command AT+QAUDCFG="max9860/ulgain"[,\<level>]	Response If configuration parameters are omitted: (+QAUDCFG="max9860/ulgain"), Return current configuration: +QAUDCFG: "max9860/ulgain",\<level> OK If configuration parameters are entered: OK ERROR If error is related to ME functionality: +CME ERROR: \<err>

Parameter

\<Level>   Numeric type, indicates the uplink gain of max9860, range: 0-100, default: 80

NOTE

This parameter will not be saved.

Example

```
AT+QAUDCFG="max9860/ulgain",85       //Set uplink gain to 85

OK
AUDCFG="handset/nr/dl","1.12000.10000.10000.1000.19660"       //Set configuration to default

OK
AT+QAUDCFG="handset/nr/dl"                                      //Query

+QAUDCFG: "handset/nr/dl","1.12000.10000.10000.1000.19660"

OK
```

---

7 Appendix

Table 3: Related Documents

SN	Document name	Remark
[1]	Quectel_UGxx_Hardware_Design	UG95 and UG96 Hardware Design
[2]	Quectel_UGxx_Reference_Design	UG95 and UG96 Reference Design
[3]	Quectel_WCDMA_UGxx_AT_Commands_ Manual	UGxx AT Commands Manual

Table 4: Terms and Abbreviations

Abbreviation	Description
LDO	Low Dropout Regulator
ME	Mobile Equipment (UG95 and UG96 Module)
NV	Non-Volatile Memory
PCM	Pulse-code Modulation