<table>
<thead>
<tr>
<th>Document Title:</th>
<th>SIM7X00 Audio Application Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version:</td>
<td>1.00</td>
</tr>
<tr>
<td>Date:</td>
<td>2016-09-08</td>
</tr>
<tr>
<td>Status:</td>
<td>Release</td>
</tr>
<tr>
<td>Document Control ID:</td>
<td>SIM7X00 Audio Application Note_V1.00</td>
</tr>
</tbody>
</table>

**General Notes**
SIMCom offers this information as a service to its customers, to support application and engineering efforts that use the products designed by SIMCom. The information provided is based upon requirements specifically provided to SIMCom by the customers. SIMCom has not undertaken any independent search for additional relevant information, including any information that may be in the customer’s possession. Furthermore, system validation of this product designed by SIMCom within a larger electronic system remains the responsibility of the customer or the customer’s system integrator. All specifications supplied herein are subject to change.

**Copyright**
This document contains proprietary technical information which is the property of SIMCom Limited., copying of this document and giving it to others and the using or communication of the contents thereof, are forbidden without express authority. Offenders are liable to the payment of damages. All rights reserved in the event of grant of a patent or the registration of a utility model or design. All specification supplied herein are subject to change without notice at any time.

*Copyright © Shanghai SIMCom Wireless Solutions Ltd. 2016*
Contents

Contents ............................................................................................................................................... 3
Version history ..................................................................................................................................... 6
1 Introduction ....................................................................................................................................... 7
2 Scope of the document ...................................................................................................................... 8
3. Audio application ............................................................................................................................. 9
   3.1 PCM interface ......................................................................................................................... 9
   3.2 Block diagram of audio circuit .............................................................................................. 10
   3.3 External audio codec application .......................................................................................... 10
   3.4 Audio channel overview ........................................................................................................ 11
4 Hardware design ............................................................................................................................. 12
   4.1 Speaker interface configuration ............................................................................................. 12
   4.2 Receiver interface configuration ........................................................................................... 13
   4.3 Microphone interfaces configuration .................................................................................... 13
   4.4 Referenced electronic characteristic ...................................................................................... 14
5 Audio tuning ................................................................................................................................... 15
   5.1 Volume and sidetone ............................................................................................................. 15
      5.1.1 AT+CTXVOL set TX volume ..................................................................................... 16
      5.1.2 AT+CRXVOL set RX volume ..................................................................................... 17
      5.1.3 AT+SIDET set digital attenuation of sidetone ............................................................. 17
   5.2 Echo canceller ...................................................................................................................... 19
      5.2.1 AT+CECM set echo mode ............................................................................................. 19
      5.2.2 Set echo parameters of RX path .................................................................................. 19
         5.2.2.1 AT+CECRX .............................................................................................................. 20
         5.2.2.2 AT+CNLPPG ............................................................................................................ 20
         5.2.2.3 AT+CNLPPL ............................................................................................................ 21
      5.2.3 Set echo parameters of TX path .................................................................................. 22
         5.2.3.1 AT+CECH ................................................................................................................ 22
         5.2.3.2 AT+CECDT .............................................................................................................. 23
         5.2.3.3 AT+CECWB ............................................................................................................. 24
   5.3 Noise suppression .................................................................................................................. 26
      5.3.1 Near-end noise suppression ......................................................................................... 26
         5.3.1.1 AT+CNSN ................................ ................................................................................ 26
         5.3.1.2 AT+CNSLIM ............................................................................................................ 27
      5.3.2 Far-end noise suppression ........................................................................................... 29
         5.3.2.1 AT+CFNSMOD ........................................................................................................ 30
         5.3.2.2 AT+CFNSIN .............................................................................................................. 31
         5.3.2.3 AT+CFNSLVL .......................................................................................................... 31
   5.4 TDD noise ............................................................................................................................ 33
6 Codec operation (Only applied to SIM7600 and SIM7500) ........................................................... 34
   6.1 Tuning the MIC gain of codec............................................................................................... 34
6. 2 Tuning the speaker and MOUT gain of codec ................................................................. 35
7 Layout guide .......................................................................................................................... 37
8 Appendix .................................................................................................................................. 38
   I. SIM7600 external audio code schematic ........................................................................ 38
Figure Index

FIGURE 1: BLOCK DIAGRAM .............................................................................................................. 10
FIGURE 2: REFERENCE CIRCUIT OF PCM APPLICATION WITH AUDIO CODEC ....................... 10
FIGURE 3: SPEAKER INTERFACE CONFIGURATION ........................................................................... 12
FIGURE 4: RECEIVER INTERFACE CONFIGURATION ...................................................................... 13
FIGURE 5: MICROPHONE INTERFACE CONFIGURATION ............................................................... 13
FIGURE 6: AUDIO PROGRAMMING MODEL ...................................................................................... 15
FIGURE 7: CONVERSATION WITHOUT FENS ................................................................................ 29
FIGURE 8: CONVERSATION WITH FENS ....................................................................................... 29
FIGURE 9: MIC GAIN REGISTER OF CODEC ...................................................................................... 34
FIGURE 10: BIT CONFIG OF 0X2D .................................................................................................. 34
FIGURE 11: PROGRAMMABLE AMPLIFIER GAIN ........................................................................... 35
FIGURE 12: SPEAKER GAIN REGISTER OF CODEC ......................................................................... 35
FIGURE 13: 0X36 REGISTER CONFIGURATION ............................................................................... 36
FIGURE 14: GAIN VALUE OF SPEAKER ......................................................................................... 36
FIGURE 15: 0X31 REGISTER CONFIGURATION ............................................................................... 36
Version history

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Description of change</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-09-08</td>
<td>1.00</td>
<td>Origin</td>
<td>Ma Honggang</td>
</tr>
</tbody>
</table>
1 Introduction

The SIM7X00 stands for SIM7600, SIM7500 and SIM7100, this document will take SIM7600 as the example. SIM7600 provides some AT commands for audio tuning. This document describes how to design and tune the audio part for best performance of SIM7600 module.
2 Scope of the document

This document is intended for the following versions of the SIMCom modules
• SIM7600
• SIM7500
• SIM7100
3. Audio application

SIM7100 supports WM8960 and NAU8810 codec, but SIM7600 and SIM7500 only support NAU8810 codec.
When customer select SIM7100 module, customer should use AT+CODECSEL EL command to set the codec, AT+CODECSEL=1 set the codec to WM8960, and AT+CODECSEL=2 set the codec to NAU8810 codec.
If customer selects SIM7600 and SIM7500, there’s no need to set the codec kind.

3.1 PCM interface

SIM7600C provides a PCM interface for external codec, which can be used in master mode with short sync and 16 bits linear format.

Table 1: PCM specification

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line Interface Format</td>
<td>Linear(Fixed)</td>
</tr>
<tr>
<td>Data length</td>
<td>16bits(Fixed)</td>
</tr>
<tr>
<td>PCM Clock/Sync Source</td>
<td>Master Mode(Fixed)</td>
</tr>
<tr>
<td>PCM Clock Rate</td>
<td>2048 KHz (Fixed)</td>
</tr>
<tr>
<td>PCM Sync Format</td>
<td>Short sync(Fixed)</td>
</tr>
<tr>
<td>Data Ordering</td>
<td>MSB</td>
</tr>
</tbody>
</table>

PCM Interface can be operated in Master mode only. When the PCM interface is configured, PCM Tx data will be routed from the external codec Mic through the DSP encode path in the Module. PCM Rx data will be routed through the DSP decode path to the external codec speaker.
In Master Mode, the Module drives the clock and sync signals that are sent out to the external codec via the PCM Interface.
3.2 Block diagram of audio circuit

The block diagram of the SIM7600 and external audio codec is described in the figure below.

![Block diagram of audio circuit](image)

**Figure 1: Block diagram**

3.3 External audio codec application

The following figure is the reference design of SIM7600 PCM interface and external codec IC.

![Reference circuit of PCM application with audio codec](image)

**Figure 2: Reference circuit of PCM application with audio codec**
### 3.4 Audio channel overview

The table below shows the audio channels of SIM7600 wireless module.

<table>
<thead>
<tr>
<th>Module</th>
<th>Audio Channel</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIM7600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handset:</td>
<td>AT+CSDVC=1</td>
<td>Input: MIC+, MIC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output: MOUT</td>
</tr>
<tr>
<td>Handfree:</td>
<td>AT+CSDVC=3</td>
<td>Input: MIC+, MIC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Output: SPKOUT+, SPKOUT-</td>
</tr>
</tbody>
</table>

*Note: NAU8810 codec does not support AT+CSDVC=2.*
4 Hardware design

4.1 Speaker interface configuration

Because SPKOUT+ and SPKOUT- are outputs of audio amplifier, optional EMI filtering is shown at Figure 3; these components (two ferrite beads and two capacitors) can be added to reduce electromagnetic interference. If used, they should be located near the SPKOUT+ and SPKOUT-. Considerable current flows between the audio output pins and the speaker, so wide PCB traces are recommended (~ 20 mils). 8Ohm speaker is suggested. And the SPKOUT+ and SPKOUT- should layout differential, and they should be far away from VBAT, RF signals, clock and other high power or high frequency signals.
4.2 Receiver interface configuration

33p and 10p are suggested to be added beside the 32 Ohm receiver to reduce RF interfere. The width of MOUT line is typical 6 mils to reduce impedance. They should be far away from VBAT, RF signals, clock and other high power or high frequency signals. MOUT and it’s return path lines should be layout pseudo-differential.

4.3 Microphone interfaces configuration

NAU8810 codec has integrated internal MIC bias circuit. MIC_P and MIC_N should be pulled up to the external power. MIC_P and MIC_N should be layout differential.
4.4 Referenced electronic characteristic

Table 3: MIC input characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working Voltage</td>
<td>0.9*VDDA</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Working Current</td>
<td>3</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>External Microphone Load Resistance</td>
<td>1.2</td>
<td>2.2</td>
<td></td>
<td>k Ohm</td>
</tr>
</tbody>
</table>

Table 4: Audio output characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Output (MOUT) VDDSPK=3.3 V</td>
<td>-84dB</td>
<td>Po=20mW</td>
<td>RL=16Ω</td>
<td>20 mW</td>
</tr>
<tr>
<td></td>
<td>-85dB</td>
<td>Po=20mW</td>
<td>RL=32Ω</td>
<td>20 mW</td>
</tr>
</tbody>
</table>

Table 5: Speaker output characteristics

<table>
<thead>
<tr>
<th>Speaker Output (SPKOUT+, SPKOUT- with 8Ω bridge tied load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARAMETER</td>
</tr>
<tr>
<td>Signal to Noise Ratio</td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Power Supply Rejection Ratio (50Hz - 22kHz)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
5 Audio tuning

The audio programming model shows how the signal path can be influenced by varying AT command parameters. Parameters can be adjusted with corresponding AT commands. For more information on the AT commands and parameters please refer to SIMCOM_SIM7600_ATC_EN_V1.xx.doc

All commands mentioned in figure 6 only work in the phone call status, when customer hung up the phone, the parameter would set back to the default value.

![Figure 6: Audio programming model](image)

Main audio parameters can be changed to satisfy users’ requirement. Here primary register parameters and related description are listed. User can adjust them through AT command. For more detail please refers to Audio Application Document.

### 5.1 Volume and sidetone

In figure 6, customer can turn adjust codec part or DSP part parameters to get desired MIC volume, SPK volume and sidetone.

**DSP part**

- `<TXVOL>`: AT+CTXVOL (Detail description refer to table 6)
- `<RXVOL>`: AT+CRXVOL (Detail description refer to table 6)
- `<SIDET>`: AT+SIDET (Detail description refer to table 6)

**Table 7: Audio parameter for volume and sidetone**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence to</th>
<th>Range</th>
<th>Gain range</th>
<th>Calculation</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTXVOL*</td>
<td>Digital gain of input signal after ADC</td>
<td>0, 1...0xFFFF</td>
<td>Mute, -78...+18dB</td>
<td>0x333=-20db 0xA1F=-10db</td>
<td>AT+CTXVOL</td>
</tr>
</tbody>
</table>
5.1.1 AT+CTXVOL set TX volume

Description

This command is used to set audio path parameter – TX volume, and refer to related hardware design document to get more information.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CTXVOL=?</td>
<td>+CTXVOL: (list of supported &lt;tx_vol&gt;s) OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CTXVOL?</td>
<td>+CTXVOL: &lt;tx_vol&gt; OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CTXVOL=&lt;tx_vol&gt;</td>
<td>OK</td>
</tr>
</tbody>
</table>

Defined values

<tx_vol>

TX volume level which is from 0 to 0xFFFF.

Examples

AT+CTXVOL=0x1234

OK

Note: SIM7100 should use AT+CTXVOLEX to set the digital gain of input signal; the “sidet” command only apply to SIM7600 and SIM7500;
5.1.2 AT+CRXVOL set RX volume

In figure 6, customer can turn adjust DSP part parameters to get desired receiver or speaker volume.

DSP part

<RXVOL>:     AT+CRXVOL  (Detail description refer to table)

Description

This command is used to set audio path parameter – RX volume, and refer to related hardware design document to get more information.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CRXVOL=?</td>
<td>+CRXVOL: (list of supported &lt;rx_vol&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CRXVOL?</td>
<td>+CRXVOL: &lt;rx_vol&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CRXVOL=&lt;rx_vol&gt;</td>
<td>OK</td>
</tr>
</tbody>
</table>

Defined values

<rx_vol>
RX volume level which is from 0 to 0xFFFF.

Examples

AT+CRXVOL=0x1234
OK

5.1.3 AT+SIDET set digital attenuation of sidetone

Description

The command is used to set digital attenuation of sidetone. For more detailed information, please refer to relevant HD document.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SIDET=?</td>
<td>+SIDET: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SIDET?</td>
<td>+SIDET:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SIDET= &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

Defined values

<st>

Sidetone value is 0 or 1.

Examples

```
AT+SIDET =1
OK

AT+SIDET?
+SIDET: 2304
OK
```
5. 2 Echo canceller

5.2.1 AT+CECM set echo mode

SIM7600 has AT command “AT+CECM” to adjust echo canceller. This AT command is used to select the echo cancellation mode.

- at+cecm=0 : disable EC mode
- at+cecm=1 : EC mode recommended for Speaker phone aggressive
- at+cecm=2 : EC mode recommended for Speaker phone medium
- at+cecm=3 : EC mode recommended for Speaker least aggressive
- at+cecm=4 : EC mode recommended for Bluetooth
- at+cecm=5 : EC mode recommended for Bluetooth (less aggressive)
- at+cecm=6 : EC mode recommended for Bluetooth (least aggressive)
- at+cecm=7 : EC mode recommended for HANDSFREE
- at+cecm=8 : EC mode recommended for Headset
- at+cecm=9 : EC mode recommended for Handset

5.2.2 Set echo parameters of RX path

Usually, AT+CECM command would solve most of echo issues, but when the issue can’t be solved, customer could use the following AT commands to tuning the echo parameters to get better voice quality.

Table 8: Audio parameter for echo RX path

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence to</th>
<th>Range</th>
<th>Gain range</th>
<th>Calculation</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CECRX</td>
<td>Echo canceler Rx module</td>
<td>0,1</td>
<td>-</td>
<td>0---Enable feature 1---disable feature</td>
<td>AT+CECRX</td>
</tr>
<tr>
<td>CNLPPG*</td>
<td>Rx In gain factor for NLPP</td>
<td>0...0x7FFF</td>
<td>-</td>
<td>-</td>
<td>AT+CNLPPG</td>
</tr>
<tr>
<td>CNLPL*</td>
<td>Clipping limit value for NLPP</td>
<td>0...0x7FFF</td>
<td>-</td>
<td>-</td>
<td>AT+CNLPL</td>
</tr>
</tbody>
</table>

*NLPP means Non-linear pre-processing; NLPPG and NLPL would work after the CECRX was enabled.
5.2.2.1 AT+CECRX

Description
The command is used to enable or disable the echo function of RX path.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECRX=?</td>
<td>+ CECRX: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECRX?</td>
<td>+ CECRX:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECRX = &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

Defined values

<st>
Valid value 0 or 1;

Examples

AT+CECRX?
+ CECRX: 1
OK

5.2.2.2 AT+CNLPPG

Description
The command is used to set the NLPP gain.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax
Test Command Responses
AT+CNLPPG=? + CNLPPG: (list of supported <st>s)
OK

Read Command Responses
AT+ CNLPPG? + CNLPPG:<st>
OK

Write Command Responses
AT+ CNLPPG = <st> OK
ERROR

Defined values

<st>
Valid value 0….0x7FFF;

Examples

AT+ CNLPPG?
+ CNLPPG: 0x0800
OK

5.2.2.3 AT+CNLPPL

Description
The command is used to set the NLPP limit.

SIM PIN References
NO Vendor

Syntax

Test Command Responses
AT+CNLPPL=? + CNLPPL: (list of supported <st>s)
OK

Read Command Responses
AT+ CNLPPL? + CNLPPL:<st>
OK

Write Command Responses
AT+ CNLPPL = <st> OK
ERROR
Defined values

| Valid value 0….0xFFFF; |

Examples

AT+ CNLPPG?
+ CNLPPL: 0x7FFF
OK

5.2.3 Set echo parameters of TX path

Table 9: Audio parameter for echo TX path

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence to</th>
<th>Range</th>
<th>Gain range</th>
<th>Tuning direction</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CECH</td>
<td>Additional muting gain applied in DES during far-end only.</td>
<td>0…0x7FFF</td>
<td>-</td>
<td>Higher value is more muting.</td>
<td>AT+CECH</td>
</tr>
<tr>
<td>CECDT</td>
<td>Additional muting gain applied in DES during doubletalk.</td>
<td>0…0x7FFF</td>
<td>-</td>
<td>Higher value is more muting.</td>
<td>AT+CECDT</td>
</tr>
<tr>
<td>CECWB</td>
<td>This parameter adjusts the aggressiveness of EC in the high band (4 ~ 8 kHz). A higher value is more aggressive and suppresses more high-band echo.</td>
<td>0…0x7FFF</td>
<td>-</td>
<td>Higher value is more muting.</td>
<td>AT+CECWB</td>
</tr>
</tbody>
</table>

5.2.3.1 AT+CECH

Description

The command is used to set mute gain of far-end echo. For more detailed information, please refer to relevant HD document.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax
<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
</table>
| AT+CECH=?    | +CECH: (list of supported <st>s)  
OK|

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
</table>
| AT+CECH?     | + CECH:<st>  
OK|

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
</table>
| AT+CECH = <st> | OK  
ERROR|

**Defined values**

<st>
mute gain of far-end echo, integer type in decimal format and nonvolatile.  
Range: from 0 to 0x7FFF.

**Examples**

```
AT+CECH?
+CECH: 0x0200
OK
```

---

### 5.2.3.2 AT+CECDT

**Description**

The command is used to set mute gain of echo during doubletalk. For more detailed information, please refer to relevant HD document.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

**Syntax**

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
</table>
| AT+CECDT=?   | +CECDT: (list of supported <st>s)  
OK|

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
</table>
| AT+CECDT?    | + CECDT:<st>  
OK|

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECDT = &lt;st&gt;</td>
<td>OK</td>
</tr>
</tbody>
</table>
Defined values

<st>
mute gain of echo during doubletalk, integer type in decimal format and nonvolatile.
Range: from 0 to 0x7FFF.

Examples

<table>
<thead>
<tr>
<th>Command</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECDT?</td>
<td>+CECDT: 0x0100</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

5.2.3.3 AT+CECWB

Description
The command is used to set mute gain of echo during doubletalk. For more detailed information, please refer to relevant HD document.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CECWB=?</td>
<td>+CECWB: (list of supported &lt;st&gt;s) OK</td>
</tr>
<tr>
<td>AT+CECWB=?</td>
<td>+CECWB:&lt;st&gt; OK</td>
</tr>
<tr>
<td>AT+CECWB = &lt;st&gt;</td>
<td>OK</td>
</tr>
</tbody>
</table>

Defined values

<st>
mute gain of echo during doubletalk, integer type in decimal format and nonvolatile.
Range: from 0 to 0x7FFF.
Examples

`AT+CECWB?`

`+CECWB: 0x0300`

`OK`
5.3 Noise suppression

SIM7600 supports noise suppression function, includes far-end noise and near-end noise.

5.3.1 Near-end noise suppression

Customer could use AT+CNSN and AT+CNSLIM to tune the voice noise of TX path, so the listener would have a better voice call.

Table 10: Audio parameter for Near-end noise suppression

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence to</th>
<th>Range</th>
<th>Gain range</th>
<th>Calculation</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNSN</td>
<td>Oversubtraction factor and bias compensation for noise estimation</td>
<td>0...0x7FFF</td>
<td>-</td>
<td>0x286D = -10db 0x1CA8 = -13db 0x16C3 = -15db</td>
<td>AT+CNSN</td>
</tr>
<tr>
<td>CNSLIM</td>
<td>Controls the maximum amount of noise suppression.</td>
<td>0...0x7FFF</td>
<td>-</td>
<td>-</td>
<td>AT+CNSLIM</td>
</tr>
</tbody>
</table>

5.3.1.1 AT+CNSN

Description

The command is used to set Over subtraction factor and bias compensation for noise estimation.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CNSN=?</td>
<td>+ CNSN: (list of supported &lt;st&gt;s) OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CNSN?</td>
<td>+ CNSN:&lt;st&gt; OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CNSN = &lt;st&gt;</td>
<td>OK ERROR</td>
</tr>
</tbody>
</table>
Defined values

<table>
<thead>
<tr>
<th>&lt;st&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range: from 0 to 0x7FFF.</td>
</tr>
<tr>
<td>0x286D = -10db</td>
</tr>
<tr>
<td>0x1CA8 = -13db</td>
</tr>
<tr>
<td>0x16C3 = -15db</td>
</tr>
</tbody>
</table>

Examples

AT+ CNSN?
+ CNSN: 0x0258
OK

5.3.1.2 AT+CNSLIM

Description
The command is used to set maximum amount of noise suppression.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+CNSLIM=?</td>
<td>+ CNSLIM: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CNSLIM?</td>
<td>+ CNSLIM:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CNSLIM = &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

Defined values

<table>
<thead>
<tr>
<th>&lt;st&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range: from 0 to 0x7FFF.</td>
</tr>
</tbody>
</table>

Examples
AT+ CNSN?
+CNSN: 0x 16C4

OK
5.3.2 Far-end noise suppression

An example use-case is illustrated in following figure. The far-end is making a call from a public phone in a noisy environment. This public phone does not have any NS capability implemented on its Tx path. The near-end mobile phone user answers the call but has difficulty understanding the far-end due to noise contamination with the speech signal.

![Figure 7: Conversation without FENS](image)

However, with the FENS feature, the near-end mobile device is able to perform nonstationary NS on the far-end signal to improve on the SNR and voice clarity so the conversation can be maintained in an efficient manner, as illustrated in Figure 2-2.

![Figure 8: Conversation with FENS](image)

### Table 11: Audio parameter for Far-end noise suppression

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Influence to</th>
<th>Range</th>
<th>Gain range</th>
<th>Calculation</th>
<th>AT command</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFNSMOD</td>
<td>Mode for enabling/disabling submodules</td>
<td>0x00FF 0x0073 0x00F3 0x01FF</td>
<td>-</td>
<td>0x00FF – Maximum NS 0x0073 – Basic stationary NS 0x00F3 – Enhanced stationary NS 0x01FF – Aggressive NS</td>
<td>AT+CFNSMOD</td>
</tr>
</tbody>
</table>
### 5.3.2.1 AT+CFNSMOD

**Description**

The command is used to set the mode of Far-end noise suppression.

**Table: AT+CFNSMOD**

<table>
<thead>
<tr>
<th>CFNSIN</th>
<th>Input gain to FENS module</th>
<th>0x2000...0x7FFF</th>
<th>-</th>
<th>-</th>
<th>AT+CFNSIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFNSLVL</td>
<td>Target noise suppression level in dB</td>
<td>0...0x7FF FF</td>
<td>-</td>
<td>-</td>
<td>AT+CFNSL VL</td>
</tr>
</tbody>
</table>

**Syntax**

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSMOD =?</td>
<td>+ CFNSMOD: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSMOD?</td>
<td>+ CNSN:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSMOD = &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

**Defined values**

<table>
<thead>
<tr>
<th>&lt;st&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00FF – Maximum NS</td>
</tr>
<tr>
<td>0x0073 – Basic stationary NS</td>
</tr>
<tr>
<td>0x00F3 – Enhanced stationary NS</td>
</tr>
<tr>
<td>0x01FF – Aggressive NS</td>
</tr>
</tbody>
</table>

**Examples**

```plaintext
AT+ CFNSMOD?
+ CFNSMOD: 0x0073
OK
```
5.3.2.2 AT+CFNSIN

Description
The command is used to set the Input gain to FENS module.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

Syntax

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSIN =?</td>
<td>+ CFNSIN: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSIN?</td>
<td>+ CFNSIN:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSIN = &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

Defined values

<table>
<thead>
<tr>
<th>&lt;st&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range:</td>
</tr>
<tr>
<td>0...0x7FFF</td>
</tr>
</tbody>
</table>

Examples

AT+ CFNSIN?
+ CFNSIN: 0x1234
OK

5.3.2.3 AT+CFSLVL

Description
The command is used to set the target noise suppression of noise suppression.

<table>
<thead>
<tr>
<th>SIM PIN</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>Vendor</td>
</tr>
</tbody>
</table>

**Syntax**

<table>
<thead>
<tr>
<th>Test Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSLVL =?</td>
<td>+ CFNSLVL: (list of supported &lt;st&gt;s)</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Read Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSLVL?=</td>
<td>+ CFNSLVL:&lt;st&gt;</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Write Command</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+ CFNSLVL = &lt;st&gt;</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>ERROR</td>
</tr>
</tbody>
</table>

**Defined values**

<nst>
Range:
0...0x7FFF

**Examples**

```
AT+ CFNSLVL?
+CFNSIN: 0x1234

OK
```
5. 4 TDD noise

Making sure the module connect to ground well can help to reduce the TDD noise and improve ESD.
Filtering capacitors and beads are suggested to be added in the audio lines, 33p and 10p can help reduce the 850 Mhz/900Mhz and 1800 Mhz/1900Mhz RF interfere. If it is signal, the filtering capacitors and beads are suggested to add beside the module pins. If it is output trace, the filtering capacitors and beads are suggested to add beside the handset/ headset/speaker connector.
6 Codec operation (Only applied to SIM7600 and SIM7500)

SIM7600 only support NAU8810 codec by default, customer could set the parameters of codec directly by 12C interface via AT commands. The module provides AT+CWIIC and AT+CRIIC to write and read the register value of codec, this chapter would introduce the methods of tuning MIC gain, speaker gain, and MOUT gain of codec. These commands only work when the module is making a call.

6.1 Tuning the MIC gain of codec

Customer could change the PGAGAIN[5:0] 0x2D register value to change the MIC gain of codec, as the following figure shows.

Figure 9: MIC gain register of codec

The default register value of 0x2D is 0x010, PGAGAIN[5: 0] is 10000, it is equal to 0db.

Figure 10: Bit config of 0x2D
Figure 11: programmable amplifier gain

Customer could tuning the PGAGAIN[5:0] from 0x0 to 0x3F.
AT+CWIIC=0x34,0x5A,0x[0~3F],1

6.2 Tuning the speaker and MOUT gain of codec

NAU8810 provides a SPKOUT audio channel, customer could tune the SPKGAIN [5:0] and SPKBST [2] to change the speaker volume. The register address is 0x36 and 0x31.

Figure 12: Speaker gain register of codec
The default value of 0x36 is 0x039, it is equal to 000111001, from the figure 14, customer would found that the default speaker gain is 0db, the value could be tuned from 000000000 to 000111111, so the corresponding AT commands is AT+CWIIC=0x34,0x6C,0x[0~3F],1

| SPKBST[2] | 0x31 | Speaker output Boost | 0 – (1.0x VREF) Boost  
1- (1.5 x VREF) Boost |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPKAIN[5:0]</td>
<td>0x36</td>
<td>Speaker output Volume</td>
<td>Range: -57dB to +6dB @ 6dB increment</td>
</tr>
</tbody>
</table>
| SPKMUT[6] | 0x36 | Speaker output Mute | 0 – Speaker Enabled  
1 – Speaker Muted |

**Figure 13: 0x36 register configuration**

Customer could set MOUTBST from 0 to 1 to set the MOUTBST to 1.5*vref, so the output gain would increase. The AT Command AT+CWIIC=0x34,0x62,0xA,1 Use “ AT+CWIIC=0x34,0x62,0x6,1 ”, customer could set the SPKOUT output power to 1.5 times.

<table>
<thead>
<tr>
<th>Speaker Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPKAIN[5:0]</td>
</tr>
<tr>
<td>B5</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>...</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

**Speaker Gain Range -57 dB to +6 dB @ +1 increment**

| B5 | B4 | B3 | B2 | B1 | B0 | Gain (dB) |
| ...| ...| ...| ...| ...| ...| ...      |
| 1  | 1  | 1  | 1  | 1  | 1  | +4.0     |
| 1  | 1  | 1  | 1  | 0  | +5.0     |
| 1  | 1  | 1  | 1  | 1  | +6.0     |

**Figure 14: gain value of Speaker**

**Figure 15: 0x31 register configuration**
7 Layout guide

The audio signals are sensitive to RF signals and power sources (for example Vbat). Please make sure that the audio signals are far away from the RF signals and Vbat. And the output signals and input signals should be kept away from each other by ground. The differential lines should be layout together. And HPL and HPR are not differential signals, so they should be layout separately. Filtering capacitors and beads are suggested to be added in the audio lines, 33p and 10p can help reduce the 850 Mhz/900Mhz and 1800 Mhz/1900Mhz RF interfere. If it is signal, the filtering capacitors and beads are suggested to add beside the module pins. If it is output trace, the filtering capacitors and beads are suggested to add beside the handset/ headset/speaker connector. One can send design to us for checking.
8 Appendix

I. SIM7600 external audio code schematic
Contact us:
Shanghai SIMCom Wireless Solutions Ltd.
Add: SIM Technology Building, No.633, Jinzhong Road, Changning District, Shanghai P.R. China
200335
Tel: +86 21 3235 3300
Fax: +86 21 3235 3020
URL: www.simcomm2m.com