

GSM DTMF

Application Note

GSM/GPRS Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2010-04-29	Roy CHEN	Initial
1.1	2011-12-21	Roy CHEN	1. Modified AT commands description 2. Added AT+QULDLSPH command in Chapter 2.4
1.2	2015-04-08	Roy CHEN	Added applicable modules

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1 Introduction

The DTMF tones and sine tone special frequency are used widely in the applications of security monitor, wireless communication, vehicle remote control, etc.

It is an economical solution to embed the encoding/decoding DTMF and sine tone special frequency in GSM/GPRS module.

This document gives a detailed description on the circuit diagram, parameters configuration, and AT commands of Quectel GSM/GPRS modules in DTMF application. The document provides various modes of receiving and transmitting DTMF. Customers can select a suitable scheme according to their product features.

This document is applicable to all Quectel GSM modules.

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2 Generate and Transmit DTMF

Quectel module offers 4 ways to send DTMF tones to remote peer.

DTMF tones can be transmitted after a voice call is established. It is recommended not to operate DTMF transmitting and voice-talking at the same time since the quality of DTMF signal tones will be influenced by the voice. Customers should mute microphone during sending DTMF tones or talk when DTMF tones are not being sent.

Several DTMF tones transmit modes are described in the following chapters.

2.1. Send DTMF Directly with AT+VTS

When DTMF messages are sent to GSM network using **AT+VTS**, the network will generate DTMF tone to remote peer. The speed of DTMF messages exchanging and handling varies a lot depending on different network configuration and capability, which severely affects the duration of DTMF tone. Therefore, it's very difficult to precisely control the duration of DTMF tone in this mode.

Under the GSM network of China Mobile in Shanghai, we tested that the minimum period of DTMF tones was about 170ms and the mute period was about 200ms.

Table 1: AT+VTS Commands Description

AT+VTS= "<dtmf_string>"	
<dtmf_string>	String type. DTMF characters (single ASCII chars in the set 0-9, #,*,A-D) separated by commas.

Recommendation for AT+VTS parameters configuration is below:

AT+QSFR=7	//Set priority for Enhanced Full Rate encoding.
//Available for calling.	
AT+VTS= "1,2,3,4,5,6,7,8,9,0,A,B,C,D,*,#"	//Send DTMF (Under the network of China Mobile Shanghai, each 50ms/50ms*)

NOTE

'50ms/50ms' means the duration of DTMF tone is 50ms and the duration of mute is 50ms. The format appeared in the following chapters has the same meaning just as the example mentioned above.

2.2. External DTMF Generator to Microphone

An external DTMF generator is widely adopted in many security monitor systems.

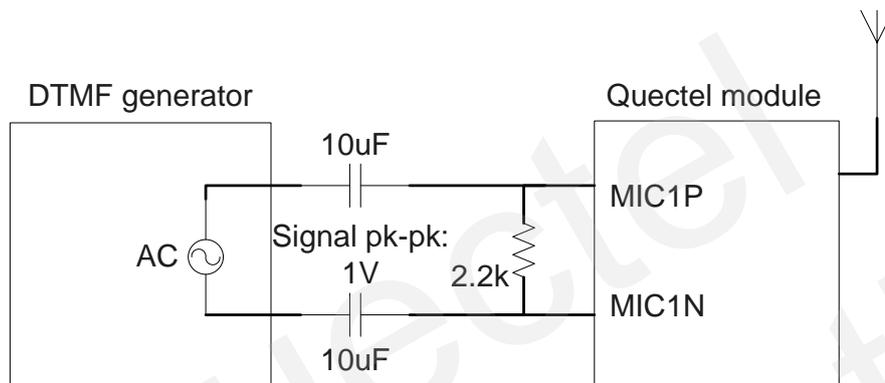


Figure 1: Recommended Circuit for External DTMF Generator

Although precise DTMF tones and mute duration can be controlled in this configuration, a certain level of distortion which is carried by audio noise; echo or network transmission also needs to be solved. The recommend parameters are shown as below.

Recommendation for parameters configuration is below:

```

AT+QAUDCH=0           //Select MIC1P as talk channel for sending DTMF.
AT+QSIDET=0           //Close side tone.
AT+QSFR=7             //Set priority for Enhanced Full Rate encoding.
AT+QMIC=0,0           //Reduce MIC1 analog gain.
AT+CAGC=0,0           //Disable analog Auto Gain Control.

```

//Available for calling, send DTMF.

2.3. Generate and Send DTMF with AT+QLDTMF

DTMF tones are generated by using **AT+QLDTMF**, and then are sent from speaker channel (SPK1 or SPK2) to MIC channel (MIC1 or MIC2). An external circuit is required to loop back the tones into microphone. The recommended peripheral circuit is below.

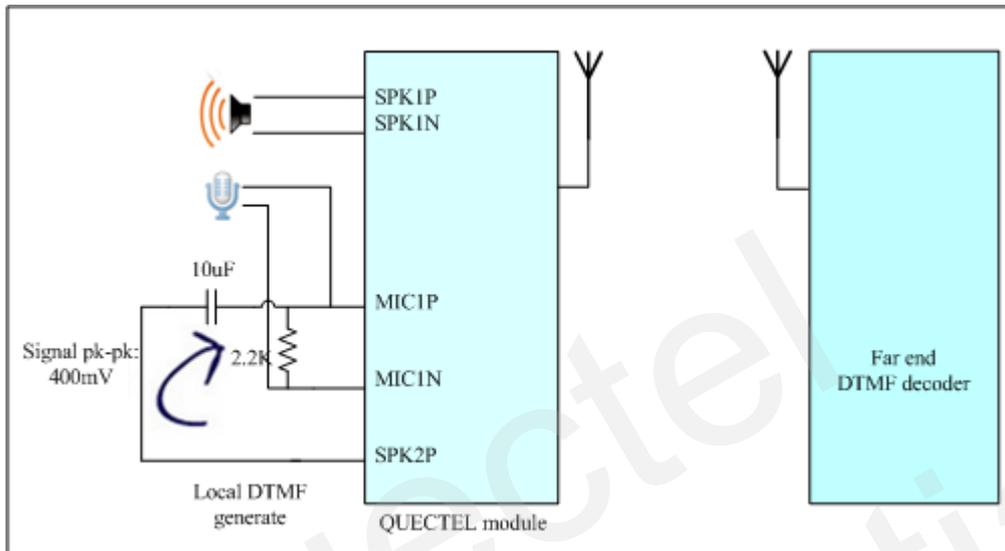


Figure 2: Recommended Peripheral Circuit

It is recommended that DTMF tones are sent from SPK2P to MIC1P since loop-back from SPK1 to MIC1 or from SPK2 to MIC2 will cause echo noise. As shown in Figure 2, voice call and DTMF tones are transmitted in the different physical channels, using **AT+QAUDCH** can switch the particular voice channel to satisfying different occasion, and **AT+QTONEP** for DTMF generates path.

Table 2: AT+QLDTMF/AT+QTONEP Command Description

AT+QLDTMF=<n>,"< dtmf-string>", [<y>]

<n> A numeric parameter (1-1000) indicates the duration of all DTMF tones in **<DTMF -string>**. The unit is 1/100 second when <y> is set to 1; or 1/10 second when <y> is not set.

<dtmf_string> A string parameter has a maximum length of 20 DTMF characters. (Single ASCII chars 0-9, #, *, A-D separated by commas.)

AT+QTONEP=<n>

Set DTMF output path

<n>

- 0 Output DTMF from Normal speaker
- 1 Output DTMF from Headset speaker
- 2 Output DTMF from Loud speaker

3 Auto (*Output DTMF from default speak path, consult AT+QAUDCH.*)

Example

```
AT+QLDTMF=5, "1,2,3,4,5,6,7,8,9,0",1 //DTMF tones 1,2,3...8,9,0. Play for 50ms, mute 50ms.
```

```
AT+QLDTMF=5, "1,2,3,4,5,6,7,8,9,0" //DTMF tones 1,2,3...8,9,0. Play for 500ms, mute 500ms.
```

NOTE

The actual minimum period of playing DTMF tone is 44ms and the minimum period of mute is 76ms though it can be set to 50ms with AT command.

Recommendation for parameters configuration is below:

```
AT+QAUDCH=0 //Select MIC1P as talk channel for sending DTMF
```

```
AT+QTONEP=1 //Select SPK2P as DTMF generating channel
```

```
AT+QMIC=0,4 //Set volume of MIC1
```

```
AT+CLVL=10 //Set volume of local DTMF tone
```

```
AT+QSIDET=0 //Close side tone
```

```
AT+QSFR=7 //Set priority for Enhanced Full Rate encoding
```

```
AT+CAGC=0,0 //Disable analog Auto Gain Control
```

```
//Available for calling.
```

```
AT+QLDTMF=5, "1,2,3,4,5,6,7,8,9,0,A,B,C,D,*,#",1 //DTMF tones 1,2,3...B,C,D, play for 500ms, mute 500ms
```

2.4. Send DTMF Directly with AT+QWDTMF

DTMF tones can be generated by **AT+QWDTMF** and directly coupled to voice uplink channel, which doesn't need any additional circuits.

In order to achieve high performance of DTMF tones sending, **AT+QULDLSPH=0,0** is used to mute the MIC uplink voice during DTMF tone playing, so the peer terminal can just receive DTMF tone only.

Table 3: AT+QWDTMF Commands Description

AT+QWDTMF=<ul_volume>,<dl_volume>,"<dtmfcode1>,<continuancetime1>,<mutetime1>[,<dtmfcode>,<continuancetime2>,<mutetime2>[,...]]"

<ul_volume>	Uplink channel of the volume, 0 is mute, 7 is the maximum.
<dl_volume>	Downlink channel of the volume, 0 is mute, 7 is the maximum.
<dtmfcode>	Play DTMF tone strings 0-9,*,#, A-D, and sine tone E(1400Hz),F(2300Hz), G(1000Hz).
<continuancetime>	DTMF tones duration, unit is ms.
<mutetime>	Mute duration, unit is ms.

AT+QULDLSPH=<ULSPH>(0-1),<DLSPH>(0-1)

ULSPH	0: Peer terminal can just receive DTMF tone only during DTMF sending. 1: Peer terminal can receive DTMF tone and Voice during DTMF sending.
DLSPH	0: Local terminal can just receive DTMF tone only during DTMF sending. 1: Local terminal can receive DTMF tone and Voice during DTMF sending.

NOTES

1. The **AT+QULDLSPH** command is available for the version M10R06R07 and M20R05A04 and their later versions.
2. The default value restores to 1,1 when module re-powers on.

For more details, please contact with Quectel Technical support.

Example

AT+QWDTMF=7, 0, "G, 30, 20, 123456789ABCD, 50, 50, E, 100, 50"
 //First send 1000Hz sine tone for 30ms and mute 20ms, then send DTMF '1' '2' '3'... 'A' 'B' 'C' 'D' 50ms/50ms in order, and send 1400Hz sine tone for 100ms and mute 50ms.

Recommendation for parameters configuration is below:

AT+QAUDCH=0 //Select MIC1 channel to send DTMF to remote peer.
AT+QSFR=7 //Set priority for Enhanced Full Rate encoding.
AT+QULDLSPH=0,0 //Mute MIC voice uplink during DTMF playing.

//Available for calling.

AT+QWDTMF=7,0, "G,30,20,123456789ABCD*#,50,50" //Send DTMF tone at 50ms/50ms.

+QWDTMF: 5

//Receive a response of '+QWDTMF: 5'
means sending DTMF tones successfully.

AT+QWDTMF=7,0, "E,100,100,F,100,50"

//Send 1400Hz for 100ms and mute 100ms;
send 2300Hz for 100ms and mute 50ms.

Table 4: Performance Comparison

	VTS	External Generator	QLDTMF	QWDTMF
Period of DTMF tone	170ms~1.08s*	Depends on generator	44ms~10s	10ms~80ms
Period of mute	200ms~25.5s*	Depends on generator	76ms~10s	10ms~80ms
Manufacture Cost	Low	High	Low	Low
Switch back to voice mode	Switch easily. Don't talk while sending DTMF or don't send DTMF while talking.	Set back to the default parameters before talking.	Set back to the default parameters before talking.	Switch easily. Improve the DTMF performance by using AT command AT+QULDLSPH=0,0

NOTE

This value is only for reference, actual value depends on network status.

3 Decode DTMF

Two decoding methods are fully detailed in the following chapters. One is decoding DTMF with an external DTMF decoding chip. The other is decoding DTMF in the module, which is useful to reduce design cost.

3.1. Speaker to External DTMF Decoder

Connecting a DTMF decoder to speaker interface is used in traditional DTMF decoding applications. DTMF decoding chip will output interrupt signal and DTMF code after detecting a DTMF tones. Recommended periphery circuit is shown below.

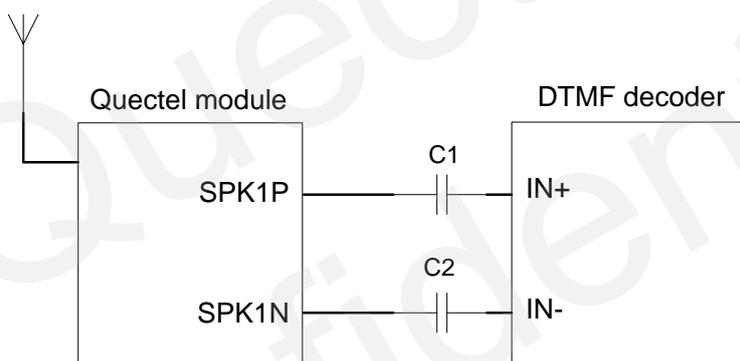


Figure 3: Recommended Circuit for External DTMF Decoder

Recommendation for parameters configuration is below:

```
AT+QAUDCH=0 //Select SPK1 as talk channel for receiving DTMF.
AT+QSFR=7 //Set priority for Enhanced Full Rate encoding.
AT+CLVL=80 //Set speaker volume, 60~100.
```

//Available for calling, receive DTMF and send to decoder.

3.2. Embed DTMF Decoding with AT+QTONEDET

The module will detect DTMF automatically and output the corresponding ASCII code through UART port when **AT+QTONEDET=1**.

Table 5: AT+QTONEDET Commands Description

AT+QTONEDET=<on/off >	
<on/off>	0: close; 1: open

NOTE

The duration of DTMF tones is recommended to be set more than 60ms. Then the successful rate of decoding will be above 99 percent.

Recommendation for parameters configuration is below:

```

AT+QTONEDET=1           //Enable DTMF detection
AT+QTONEDET=4,1,3,3,65536 //Reduce code detection sensitivity *
AT+QSFR=7               //Set priority for Enhanced Full Rate encoding

//Established a call, receive DTMF tones from remote peer.

+QTONEDET: 49           //Detected '1' and reported its ASCII code
+QTONEDET: 50           //Detected '2' and reported its ASCII code
+QTONEDET: 69,100       //Detected 1400Hz, duration is 100ms
+QTONEDET: 70,400       //Detected 2300Hz, duration is 400ms
    
```

NOTES

1. In order to minimize losing rate or repeating rate of different periods of source tones, these parameters in **AT+QTONEDET** are specially used to adjust code detection sensitivity.
2. In security alarm system, most source tones always appear at 50ms/50ms, then these parameters in **AT+QTONEDET** should not be changed. Default values can satisfy this application.
3. In voice application, DTMF tones are generated by key pressing and the duration is always more than 100ms/100ms. Set **AT+QTONEDET=4,1,3,3,65536** to reduce the ratio of code repeating.

4 Audio DTMF AT Commands

4.1. AT+QWDTMF Send DTMF Tones to Remote Peer

AT+QWDTMF Send DTMF Tones to Remote Peer

Test Command AT+QWDTMF=?	Response +QWDTMF: <ul_volume>(0-7),<dl_volume>(0-7),(" <dtmfcode>,<continuancetime>,<mutetime>") OK
Write Command AT+QWDTMF=<ul_volume>,<dl_volume>,(" <dtmfcode>,<continuancetime>,<mutetime>")	Response If emulating fails in an ME error, return: +CME ERROR: <err> If emulating succeeds in an ME: +QWDTMF: 5 OK

Parameter

<ul_volume>	0~7, uplink channel of the volume
<dl_volume>	0~7, downlink channel of the volume, recommend to set 0
<dtmfcode>	The DTMF tone strings
'0'	DTMF 0
'1'	DTMF 1
'2'	DTMF 2
'3'	DTMF 3
'4'	DTMF 4
'5'	DTMF 5
'6'	DTMF 6
'7'	DTMF 7
'8'	DTMF 8
'9'	DTMF 9
'A'	DTMF A
'B'	DTMF B

'C'	DTMF C
'D'	DTMF D
'*'	DTMF *
'#'	DTMF #
'E'	Frequency of 1400Hz
'F'	Frequency of 2300Hz
'G'	Frequency of 1KHz
<continuancetime>	Duration of each DTMF tone, unit is ms
<mutetime>	Mute time, units is ms
<playcode>	Indicate status of sending DTMF
	If <playcode> is not 5, it means DTMF sending unsuccessfully.

Example

Example 1:

AT+QWDTMF=7,0, "0,50,50,A,55,50,E,100,50" //Send DTMF '0' for 50ms and mute 50ms; send DTMF 'A' for 55ms and mute 50ms; send 1400HZ for 100ms and mute 50ms.

Example 2:

AT+QWDTMF=7, 0, "G, 100, 50, 123456789ABCD, 50, 50, E, 100, 50" //Send 1400Hz for 100ms and mute 50ms; send '1' '2' '3' ... 'B' 'C' 'D' for 50ms and mute 50ms in order; send 1400 Hz for 100ms and mute 50ms.

4.2. AT+QTDMOD Set DTMF Detection Mode

AT+QTDMOD Set DTMF Detection Mode

Test Command AT+QTDMOD=?	Response +QTDMOD: (1,2),(0,1) OK
Read Command AT+QTDMOD?	Response +QTDMOD: <operatefunction>,<funtionstatus> OK
Write Command AT+QTDMOD=<operatefuntion>,<funtionstatus>	Response OK If emulating fails in an ME error, return: +CME ERROR: <err>

Parameter

<operatefunction>	Operate function 1 Set detection range 2 Set detection mode
<functionstatus>	Function status 0 When <operatefunction>=1 , detect all DTMF, including 1400 and 2300 handshake signal. When <operatefunction>=2 , detect DTMF tone by using normal arithmetic. 1 When <operatefunction>=1 , only detect 1400 and 2300 handshake signal by using optimal arithmetic. When <operatefunction>=2 , detect long continuous DTMF tone by using optimal arithmetic.

Example

```
AT+QTDMOD =1,0 //Detect all DTMF, including 1400 and 2300 handshake signal.
AT+QTDMOD =1,1 //Only detect 1400 and 2300 handshake signal by using optimal detect.
AT+QTDMOD =2,0 //Detect DTMF tones by using normal arithmetic.
AT+QTDMOD =2,1 //Detect long continuous DTMF tones by using optimal arithmetic.
```

4.3. AT+QTONEDET Enable DTMF Decoding and Set Threshold

AT+QTONEDET Enable DTMF Decoding and Set Threshold

Test Command AT+QTONEDET=?	Response +QTONEDET: (0,1) OK
Write Command AT+QTONEDET=<mode >[,<operate >][, <prefixpause>][, <lowthreshold>][, <highthreshold>]	Response OK If emulating fails in an ME error, return: +CME ERROR: <err> After successful DTMF tones are detected, Open will be reported: +QTONEDET: <dtmfcode>[, <persistencetime>]

Parameter

< mode>	0 Disable DTMF decoding 1 Enable DTMF decoding
----------------------	---

- 2 Configure decoding threshold of 1400Hz or 2300Hz, of which duration is 100ms
- 3 Configure decoding threshold of 1400Hz or 2300Hz, of which duration is 400ms
- 4 Configure DTMF decoding threshold

<operate>	Operation value
<prefix pause>	Prefix pause number
<low threshold>	Low threshold value
<high threshold>	High threshold value

NOTES

1. Available for calling.
2. When in debug mode, report:
+QTONEDTD:<dtmfcode>,<weak>,,<pause_f7>,<pause_dtmf>,<pause_unkown>,<framecnt>
3. When reports as follow:
+QTONEDET: 50 Detected DTMF 2
+QTONEDET: 69,100 Detected 100ms of 1400Hz
+QTONEDET: 70,100 Detected 100ms of 2300Hz
+QTONEDET: 69,400 Detected 400ms of 1400Hz
+QTONEDET: 70,400 Detected 400ms of 2300Hz
4. Consult **AT+QTDMOD**

5 Appendix A DTMF Tones Definition

Quectel wireless module adopts the DTMF tones definition conforming to telephone system standard. Please refer to the table below for details:

Table 6: DTMF Tones Definition

Low (Hz)	High (Hz)			
	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	*	0	#	D

6 Appendix B Reference

Table 7: Related Documents

SN	Document Name	Remark
[1]	Quectel_Mxx _ATC	AT commands set
[2]	Quectel_GSM_AUDIO_UGD	GSM Module Audio Design User Guide

Table 8: Terms and Abbreviations

Abbreviation	Description
DTMF	Dual Tone Multi Frequency
EFR*	Enhanced Full Rate
FR*	Full Rate

NOTES

1. Full Rate or FR or GSM-FR or GSM 06.10 is the first digital speech coding standard used in the GSM digital mobile phone system. The bit rate of the codec is 13kbit/s, or 1.625 bits/audio sample (often padded out to 33 bytes/20ms or 13.2kbit/s).
2. Enhanced Full Rate or EFR or GSM-EFR or GSM 06.60 is a speech coding standard that was developed to improve the quality of GSM-Full Rate (FR) codec. Working at 12.2kbit/s, the EFR provides wire-like quality in any noise free and background noise conditions.