AM9AC Series
Data Sheet

佑華微電子股份有限公司
新竹市光復路二段295號9樓之1號
電話: 03-573 6660
傳真: 03-573 6661
www..ealpha.com.tw

Alpha Microelectronics Corp.
9F-1, 295, Sec. 2, Kuang Fu Rd., Hsinchu, Taiwan
Tel : +886-3-573 6660
Fax: +886-3-573 6661
www.ealpha.com.tw

Rev 1.5   2005/12/15

Revision History

Revision#	Date	Description	Page
1.4	2004/4/25	Original.	-
1.5	2005/12/15	1. Amend voltage range. 2. Amend the binary file name to "eva" from "bin". 3. Change demo system to AM9AA_DB demo board. 4. Amend I_{oh} & I_{ol} DC characteristics of IO1. 5. Amend timing diagram. 6. Delete chip size.	3, 5, 8 7 7 8 9~12 14

1. 一般規格**:**

AM9AC0036、AM9AC0076、AM9AC0146、AM9AC021D，皆為單晶片 CMOS 語音合成 IC，他們都是非常低成本，同時具有相當實用功能的語音 IC 產品。他們以 4-bit LOGPCM 編碼方式，合成長達 3.5、7、14、21 秒之語音。藉由製造過程中更換光罩，將客戶需要之語音資料編寫入ROM中。另外使用者可以有一個很彈性的 IO pin 選擇 (IO1)，來配合不同之應用，並可用佑華所提供的 EzSpeech 工具軟體來進行開發。

2. 特性**:**

(1). 單一工作電壓範圍為 2.0 ~ 6.4 伏特(在此範圍內，可採用單一 Rosc 電阻值)。

(2). 語音總長度可達 3.5、7、14、21 秒，且可被分割成8個語音段(voice_section)，每段長度可不同。

(3). 每一段語音的長度分別最多可達 3.5、7、14、21 秒。(在6kHz取樣頻率下)
每一段 "語音+靜音時間" 的長度，分別最多可達 11、21、21、21 秒。(在6kHz取樣頻率下)

(4). 共有16個語音格(voice_step)，可規劃成2個語音組(sub_table)，每個語音組最多可放8個語音格。每一語音格可指定一語音段並搭配 IO1 輸出致能或非致能(IO1當作輸出時)。

(5). 內建頻率振盪器，共有15種不同播放速度的選擇(playback speed: 4.0k ~ 18.1kHz)：

A	B	C	D	E	F	G	H
18.1kHz	14.4kHz	12.0kHz	10.3kHz	9.0kHz	8.0kHz	7.2kHz	6.6kHz
I	J	K	L	M	N	O	-
6.0kHz	5.6kHz	5.2kHz	4.8kHz	4.5kHz	4.3kHz	4.0kHz	-

<如果選擇內建的頻率振盪器，請將 OSC 腳接地。>

(6). IO1可選擇作輸入腳或是輸出腳 (光罩選擇)。

(7). 可選擇 "兩鍵觸發輸入模式"(TG和IO1) 或 "單鍵TG觸發輸入模式"(IO1當作輸出時)。
　(A). *每一種輸入可選擇不同觸發方式 (光罩選擇)：*
　　邊緣觸發 / 位準觸發(Edge/Level) ； 保持 / 非保持(Hold/Unhold) ；
　　後段蓋前段 / 非後段蓋前段(Retrigger/Irretrigger)。
　(B). TG 輸入可選擇 CDS+1M、CDS、1M pull-low、10M weak-pull low 或 floating 的輸入方式。
　(C). IO1 輸入可選擇 CDS+1M、CDS、1M pull-low 或 floating 的輸入方式。
　(D). 防止誤動作(Debounce)時間：Long - 提供一般手動操作；Short - 提供跳動開關使用。
　　(※ 在"兩鍵觸發輸入模式" 只能選用一種 Debounce 時間。)
　(E). 優先順序：TG>IO1。

(8). IO1可做以下 6 種輸出選擇：
　(A). Stop_High pulse：停止播放時送出高位準脈衝。
　(B). Busy_High active：播放時送出高位準訊號。
　(C). Busy_Low active：播放時送出低位準訊號。
　(D). LED 3Hz flash：播放時 LED 3Hz 閃爍。(當播放速度為 6kHz 時)

(E). LED 6Hz flash：播放時 LED 6Hz 閃爍。(當播放速度為 6kHz 時)

(F). LED dynamic 2/4：播放時 LED動態 2/4位準訊號。

(※ LED 3Hz / 6Hz flash 是指以 6kHz 的播放速度 時，LED閃爍的頻率；不同的播放速度，

LED閃爍的頻率也會不同。)

(9). PWM1，PWM2 可直接驅動 buzzer 或 8、16、32、64Ω speaker。

(10). 每一段語音加上靜音的語音段長度會是 80 HEX (AM9AC0036)、或 100 HEX (AM9AC0076,
AM9AC0146, AM9AC021D) 的整數倍。

(11). 在語音段的排列順序上(00~07)，如果遇到有純粹靜音的語音段(不佔 ROM 空間)，一定要把它放在有語音
的語音段之後，也不可以將它放在兩個有語音的語音段之間 或 放在第一段(00)。

(12). 選擇頻率振盪器：

(A). 選擇外部電阻可調式頻率振盪器：將 OSC 外接電阻到正電源。

(B). 選擇內建頻率振盪器：將 OSC 接地。*(因為頻飄及系統穩定問題，不建議使用)*

※ 輸入方式選項：

選 項	功 能 描 述
CDS + 1M	一般選項，大多用在按鍵觸發。 當按鍵按下時，IC內部為 1M 的下拉電阻；而當按鍵放開時，IC內部為 1M+300K (並聯) 的下拉電阻。
CDS	IC內部為 300K 的下拉電阻，通常與光敏電阻一起使用。
1M pull-low	IC內部為 1M 的下拉電阻，保留給一些特殊應用使用。
10M pull-low	IC內部為 10M 的下拉電阻，通常使用在觸控的應用。
Floating	IC內部無下拉電阻，通常連接到其他輸出腳來做控制使用；如果沒連接其他輸出腳，一定要將此腳位外拉電阻到地。

*IO1 當輸入時，沒有 10M pull-low 的選項。
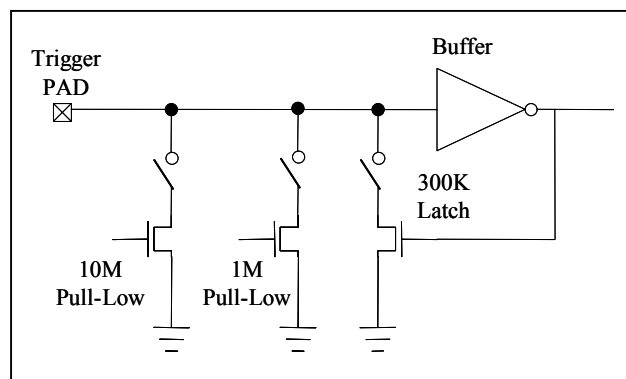
1. GENERAL DESCRIPTION:

The AM9AC0036, AM9AC0076, AM9AC0146 and AM9AC021D are single-chip voice synthesizing CMOS IC. They are low cost with proper functions and can synthesize voice up to 3.5, 7, 14 and 21 seconds, using Alpha 4-bit LOGPCM algorithm. Customer speech data can be programmed into ROM by changing one mask during the device fabrication. Besides, not only a very flexible functions I/O pin is available for the user to apply in various applications, but also an interactive development tool "EzSpeech" is ready for user-friendly programming.

2. FEATURES:

(1). Single power supply can operate from 2.0V to 6.4V (in this range, user can set Rosc as a fixed value).

(2). The total voice duration is about 3.5, 7, 14 or 21 seconds those can be partitioned up to 8 voice_sections. Each voice_section length is flexible.

(3). Voice length can be individually up to 3.5, 7, 14 or 21 seconds at 6kHz S.R. for each voice_section. Voice+mute length can be individually up to 11, 21, 21 or 21 seconds at 6kHz sample rate for each voice_section.

(4). Total 16 voice_steps are available for 2 sub_tables. Each sub_table can only use maximum 8 voice_steps. For each voice_step, it can specify one voice_section and IO1 output enable options if IO1 is set as an output.

(5). Build in oscillator, 15 kinds of playback speed option for internal resistor used : (4.0k ~ 18.1kHz)

A	B	C	D	E	F	G	H
18.1kHz	14.4kHz	12.0kHz	10.3kHz	9.0kHz	8.0kHz	7.2kHz	6.6kHz
I	J	K	L	M	N	O	-
6.0kHz	5.6kHz	5.2kHz	4.8kHz	4.5kHz	4.3kHz	4.0kHz	-

<Internal oscillator: OSC pad must be bonded to GND>

(6). IO1 can be either input or output pin (Mask option).

(7). Optional "Two Triggers Input" (TG and IO1), or "One Trigger Input" (TG pin only).

  (A). Each input pin has mask options for Edge/Level, Hold/Unhold and Retrigger/Irritrigger trigger modes.

  (B). TG input can choose CDS+1M、CDS、1M pull-low、10M pull low or floating input type.

  (C). IO1 input can choose CDS+1M、CDS、1M pull-low or floating input type.

  (D). Debounce time: Long debounce for push buttons. Short debounce for switches. (※ *In Two Triggers Input Mode, only one kind of debounce time is available.*)

  (E). Priority：TG > IO1.

(8). IO1 has the following output option A~F :

  (A). Stop_High pulse : high active stop pulse output whenever device stop playing.

  (B). Busy_High active : high active signal output during playing.

(C). Busy_Low active : low active signal output during playing.

(D). LED 3Hz flash : 3Hz sink signal output for driving LED during playing at 6kHz sample rate.

(E). LED 6Hz flash : 6Hz sink signal output for driving LED during playing at 6kHz sample rate.

(F). LED dynamic 2/4 : dynamic sink signal output for driving LED during playing.

※ *Where (D) and (E) is the LED flash rate at 6kHz sample rate. For different sample rate, the LED flash rate is different from original 3Hz or 6Hz.*

(9). PWM1 and PWM2 can directly drive buzzer or 8, 16, 32 or 64 ohms speaker.

(10). The voice_section length of "voice length + mute length" must be the multiple of 80Hex (AM9AC0036) or 100Hex (AM9AC0076, AM9AC0146, AM9AC021D).

(11). In voice_section sequence arrangement (00~07), If there are some voice_sections with only mute and without voice, they should be put next to the last voice_section with voice. Besides, that is not allowed to put a pure mute voice_section between 2 voice_sections with voice, or put the pure mute voice_section on first place (00).

(12). Oscillator selection:

(A). External oscillator: Connect OSC pin to Vdd with a resistor, Rosc.

(B). Internal oscillator: Connect OSC pin to GND. *(Not suggested because of frequency shift and system stability)*

※**Input Type Description:**

Option	Description
CDS + 1M	Normal selection for button trigger. Only 1M pull-low resistance when key-pressed, and 1M+300K(parallel) pull-low resistance when key-released.
CDS	Internal 300K ohms pull-low resistance, usually for photo-resistor trigger.
1M pull-low	Internal 1M ohms pull-low resistance, reserve for some special applications.
10M pull-low	Internal 10M ohms weak pull-low, usually for touching trigger.
Floating	No internal resistor connection, usually connected to other output pin or connected to GND by an external resistor.

* 10M pull-low option is not available for IO1 input.
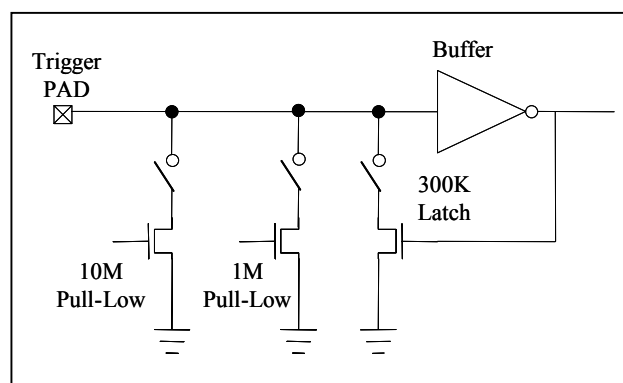
3. BLOCK DIAGRAM:
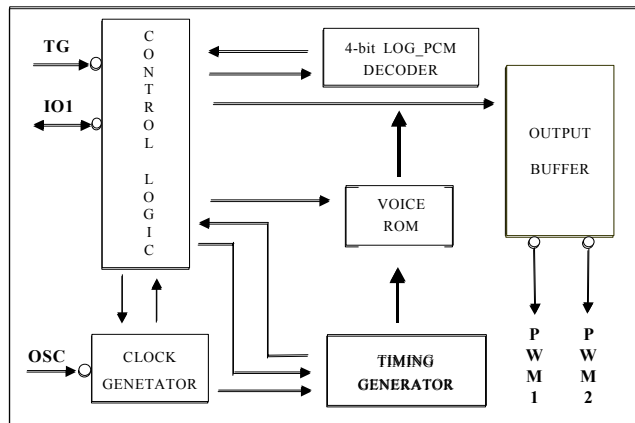
4. PAD DESCRIPTION:

Pad Name	Pad No.	ATTR.	Function
IO1	1	I/O	Status output or input for trigger.
TG	2	I	Input for trigger.
GND1, 2	3, 7	Power	Negative power supply.
PWM1	4	O	Audio output.
Vdd	5	Power	Positive power supply.
PWM2	6	O	Audio output.
OSC	8	I	Oscillator input. For using internal oscillator, connect OSC to GND.

5. CODE DEVELOPMENT & DEMO SYSTEM:

User can use "EzSpeech" software tool to develop the desired functions. For details, please see EzSpeech user manual. After finishing the code programming, user will get 2 files of "**.eva**" and "**.htm**", the evaary file and function check list. User can download the "**.eva**" file into AM9AA_DB demo board to demonstrate the AM9AC function. The related mapping of AM9AA_DB is as following,

	AM9AC	AM9AA_DB	AM9AA_DB Description
I/O Pin	TG	OKY	OKY performs TG input.
	IO1	IO1	The same.
	PWM1, PWM2	PWM1, PWM2	PWM output to directly drive speaker.
	OSC	Rosc	Rosc is connected with 220K ohms resistor at 6kHz.

For some input type option, user may need to connect an external resistor. Please refer to the table below,

	AM9AC	AM9AA_DB	AM9AA_DB Description
Input Type	CDS + 1M	CDS + 1M	The same.
	CDS	CDS	The same.
	1M pull-low	1M pull-low	The same.
	10M pull-low	10M pull-low	The same.
	Floating	Floating	The same.

Once the function has been approved, user only need to send the "**.eva**" file to Alpha for code tape-out.

## 6. ABSOLUTE MAXIMUM RATING:

Symbol	Rating	Unit
$V_{dd} \sim V_{ss}$	-0.5 ~ +7.0	V
V_{in}	V_{ss}-0.3 < V_{in} < V_{dd}+0.3	V
V_{out}	GND < V_{out} < V_{dd}	V
T_{op} (operating)	0 ~ +70	℃
T_{st} (storage)	-25 ~ +85	℃

7. DC CHARACTERISTICS:

Symbol	Parameter		Min.	Typ.	Max.	Unit	Condition
V_{dd}	Operating voltage		2.0	3.0	6.4	V	
I_{sb}	Supply current	Standby			1	uA	V_{dd}=3V, 6kHz S.R., no load
I_{op}		Operating		700			
I_{ih}	Input current: TG, IO1 (1M pull low)				3	uA	V_{dd}=3V
I_{il}				0			
I_{ih}	Input current: TG (10M pull low)				0.3	uA	V_{dd}=3V
I_{il}				0			
I_{ih}	Input current: TG & IO1 (CDS)				10	uA	V_{dd}=3V
I_{il}				0			
I_{oh}	PWM output current			-30		mA	V_{dd}=3V, V_{oh}=2.4V
I_{ol}				30			V_{dd}=3V, V_{ol}=0.6V
I_{oh}	IO1 output current			-5		mA	V_{dd}=3V, V_{oh}=0.5V
I_{ol}				7			V_{dd}=3V, V_{ol}=2.3V
dF/F	Frequency stability		-5		5	%	$\frac{F_{osc}(3v)-F_{osc}(2.4v)}{F_{osc}(3v)}$
dF/F	F_{osc} lot variation		-10		10	%	V_{dd}=3V, R_{osc}=220KΩ

8. Frequency vs. External Rosc :
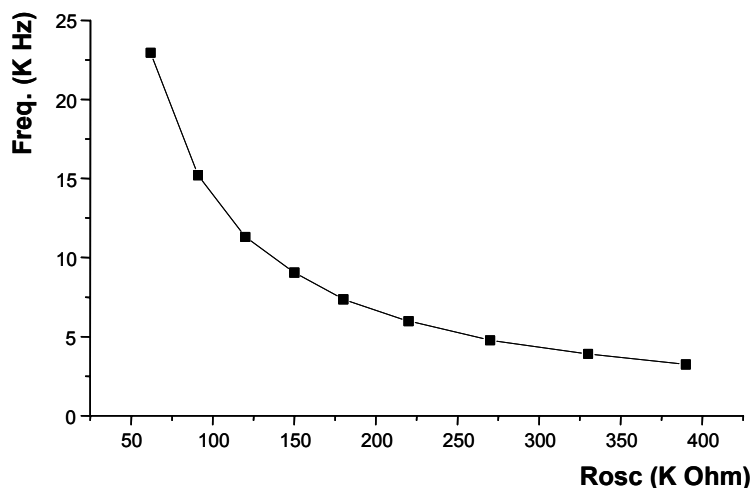
9. TIMING DIAGRAM:

(1) Debounce Time

(a). Trigger while no playing voice
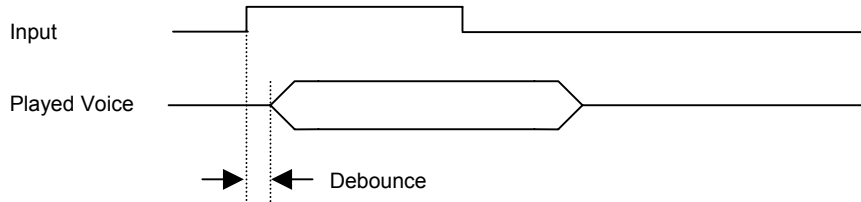
※ Debounce time is configured by 6 kHz S.R and the value is fixed. That is, Slow debounce=5.3ms, Fast debounce < 50us
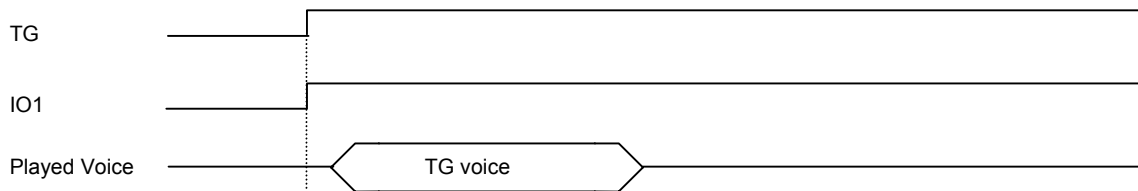
(b). Trigger While playing voice
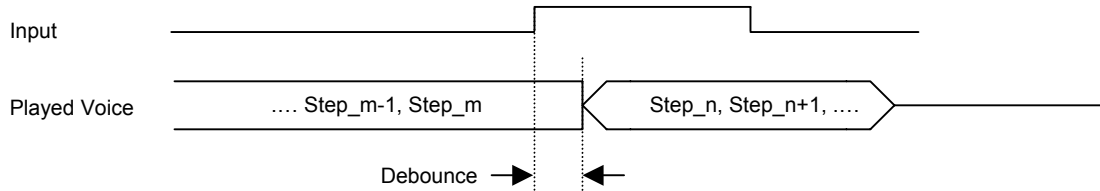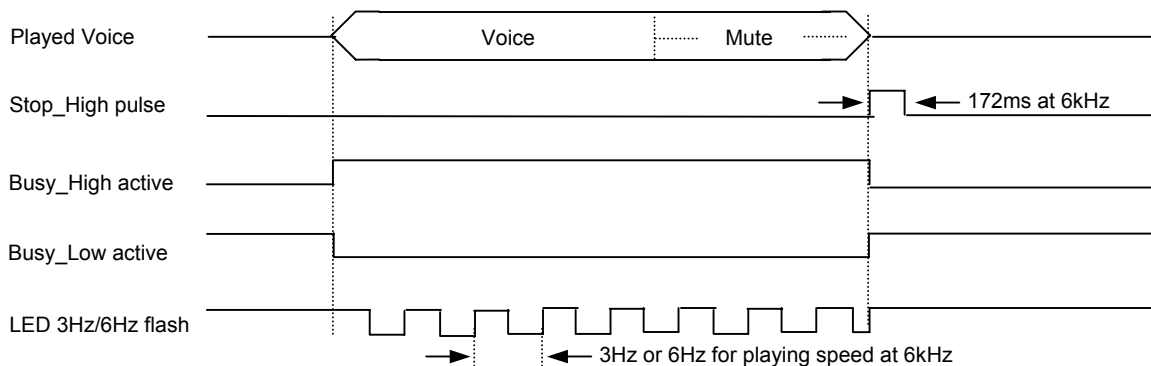

※ Debounce Time is configured by the S.R. of Step_m.

For example, if Step_m S.R. = 8kHz, Slow debounce = 5.3*(6k/8k) ms = 3.9ms, Fast debounce < 50*(6k/8k) us =37.5us
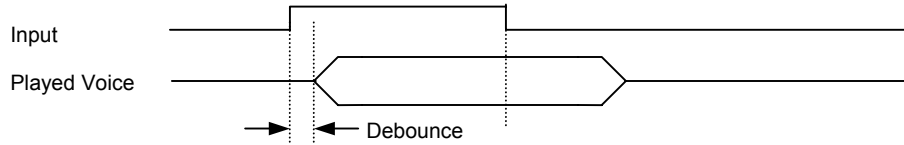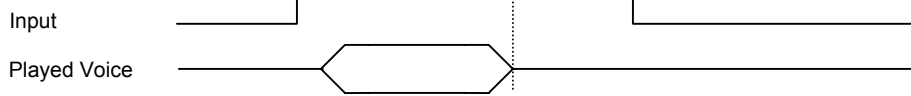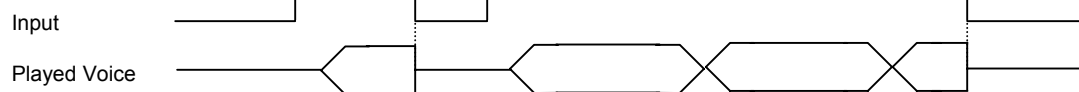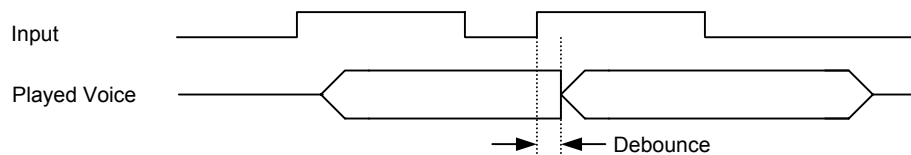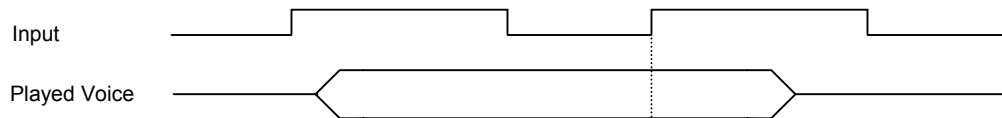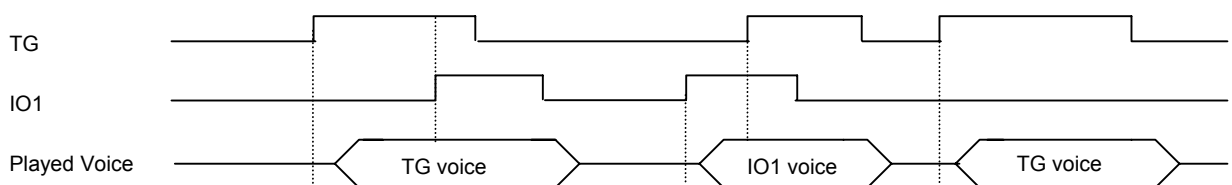
(2) Input Priority

※ Priority: TG > IO1

(3) Status Output (IO1)

LED dynamic 2/4: When the voice amplitude is higher than 2/4 full-scale amplitude, LED will be ON, i.e. status output is low.

(4) General Timing Diagram

(a). Edge mode, Edge trigger

Input

Played Voice

Debounce

(b). Edge mode, Level trigger

Input

Played Voice

Edge/Hold

Input

Played Voice
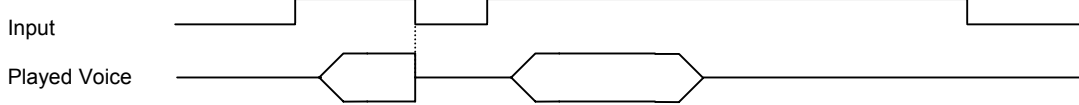
(c). Level mode, Edge trigger

Input

Played Voice
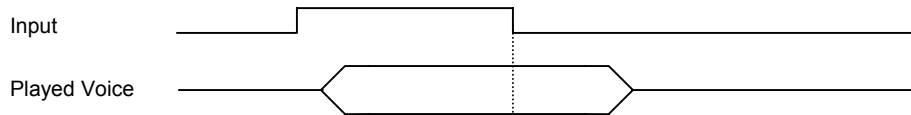
(d). Level mode, Level trigger

Input

Played Voice

Level/Hold

Input

Played Voice

(e). Retrigger mode

Input

Played Voice

Debounce

(f). Irretrigger mode

Input

Played Voice
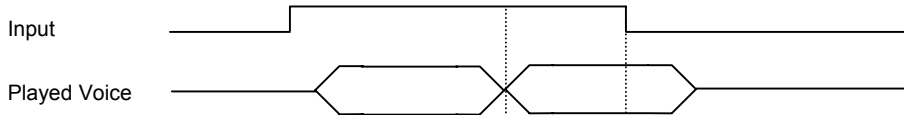
(g). Retrigger mode, first key priority

TG

IO1

Played Voice

TG voice

IO1 voice

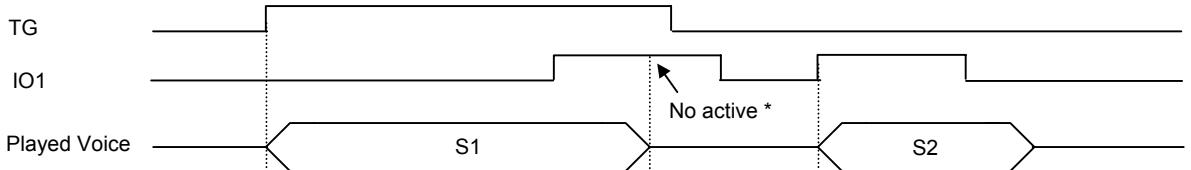TG voice

(5) Special Timing Diagram

Henceforth, the debounce time is ignored for the following diagrams.

(a). Different Input *(There is no "Different Input Reload" function for this series)*

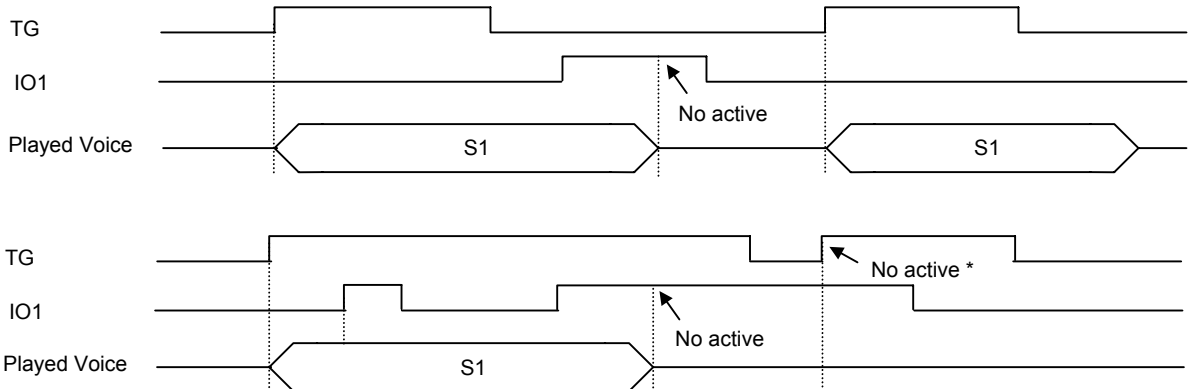*(a-1) TG (E/U/R)=S1, IO1(E/U/R)=S2 (S1 means sub_table 1, S2 means sub_table 2)*

TG

IO1

Played Voice — S1 — S2 — S1

(a-2) TG (E/U/R) =S1, IO1 (L/U/x) =S2

TG

IO1 — No active *
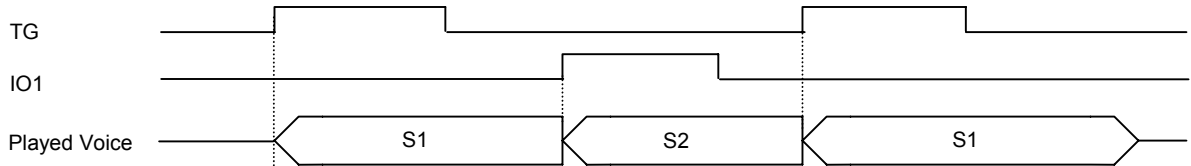
Played Voice — S1 — S2

* While playing TG's voice, to trigger IO1 is recognized as to trigger TG and the trigger mode follows TG (E/U/R).

(a-3) TG (E/U/I) =S1, IO1 (E/x/x) =S2

TG

IO1 — No active

Played Voice — S1 — S1

TG — No active *
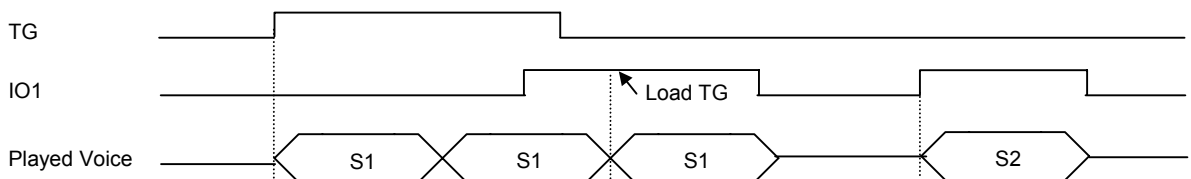
IO1 — No active

Played Voice — S1

* Because IO1 signal is still high, it is continuously recognized as to trigger TG and the TG Edge signal is not active.

(a-4) TG (E/U/I) =S1, IO1 (L/x/x) =S2
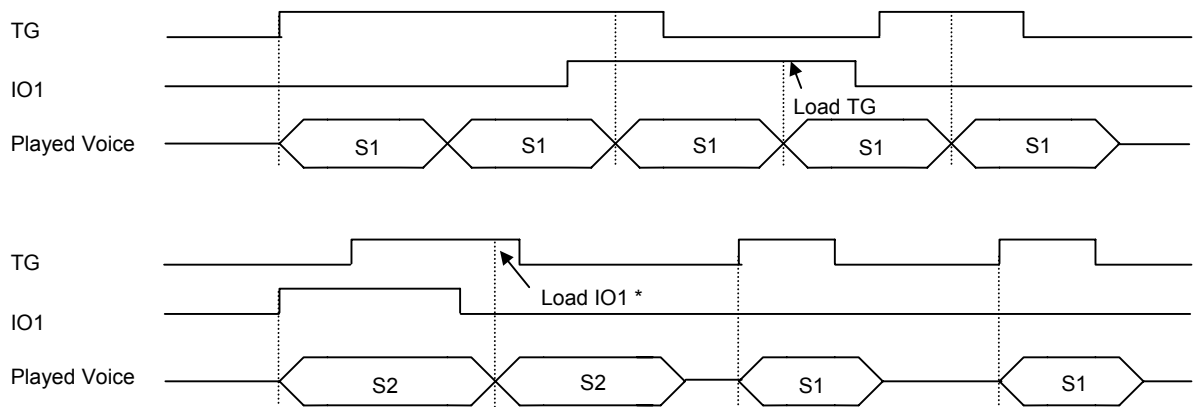
TG

IO1 — No active *

Played Voice — S1 — S1
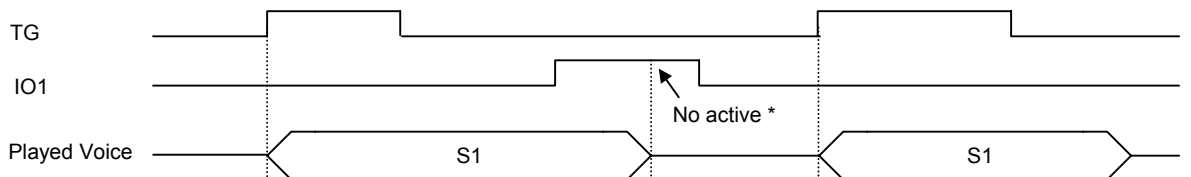
* If you press IO1 during TG voice playing, in the time of S1 end, the trigger mode follows TG (E/U/I).

(a-5) TG (L/U/x) =S1, IO1 (E/x/x) =S2

TG

IO1 — Load TG

Played Voice — S1 — S1 — S1 — S2

※ In the time of sub_table end: When S1 end, the trigger mode follows TG (L/U/x). When S2 end, it follows IO1 (E/x/x).

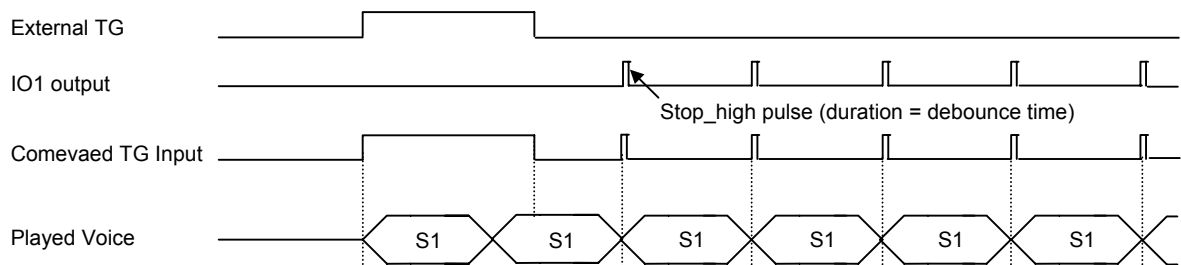*(a-6) TG (L/U/x) =S1, IO1 (L/U/x) =S2*

```
TG           _____|‾‾‾‾‾‾‾‾‾‾|_____|‾‾‾‾‾‾‾|____

IO1          _____|‾‾‾‾‾‾‾|_____
                                     ↖ Load TG

Played Voice ___< S1 >< S1 >< S1 >< S1 >< S1 >___
```

```
TG           _____|‾‾‾|_____|‾‾‾‾|_____|‾‾‾‾|___
                         ↖ Load IO1 *
IO1          ___|‾‾‾‾‾|_____

Played Voice ___< S2 >< S2 >< S1 >< S1 >___
```

* While playing IO1's voice, to trigger TG is recognized as to trigger IO1 and the trigger mode follows IO1 (L/U/x).
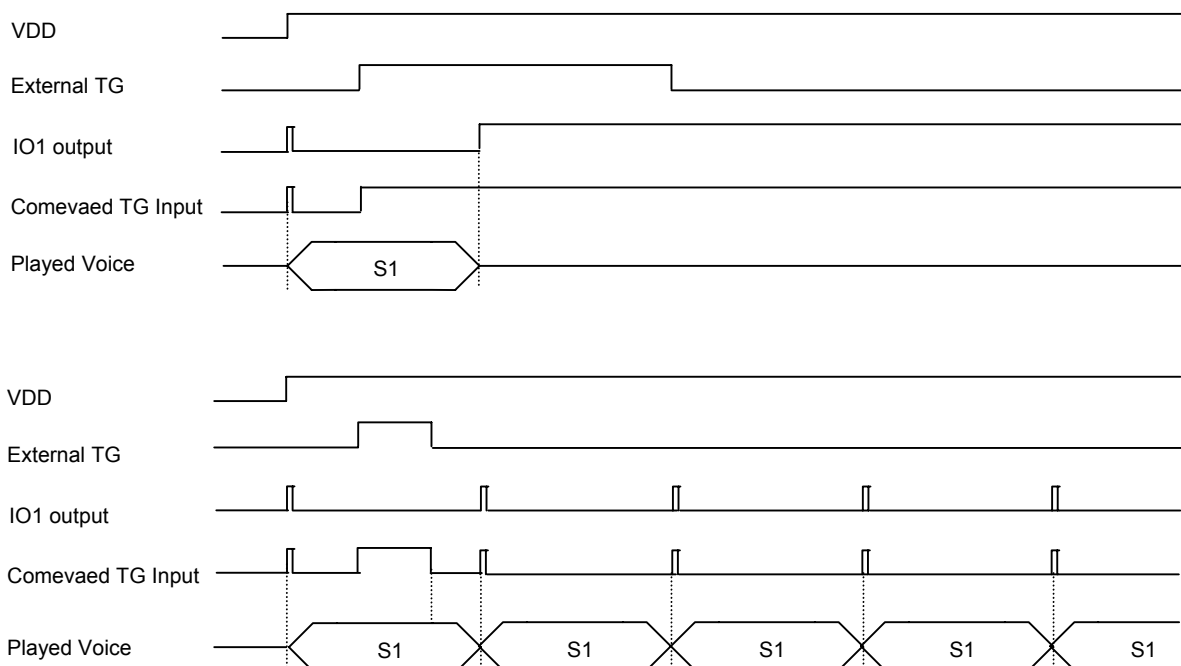
(b). External Feedback function (IO1 is output and connected to TG input)

(b-1) TG (L/U/I) =S1, IO1=Stop_high pulse (When voice end, IO1 shows a high pulse)

```
External TG       ____|‾‾‾‾|_____

IO1 output        _____|‾|__|‾|___|‾|__|‾|___
                             ↖ Stop_high pulse (duration = debounce time)

Comevaed TG Input ___|‾‾‾‾|___|‾|__|‾|___|‾|__|‾|___

Played Voice      ___< S1 >< S1 >< S1 >< S1 >< S1 >< S1 >___
```

※ The duration of Stop_high pulse is 170ms at 6kHz SR, but the high signal will trigger voice and turn low after debounce.

*(b-2) TG (E/U/I) =S1, IO1= Busy_low (When not playing voice, IO1 is high.)*

```
VDD               ___|‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾

External TG       _____|‾‾‾‾‾‾‾‾‾‾‾‾|_____

IO1 output        __|‾|_____|‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾

Comevaed TG Input __|‾|__|‾‾‾‾‾‾‾‾‾‾‾|_____

Played Voice      ___< S1 >_____
```

```
VDD               ___|‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾‾

External TG       _____|‾‾‾|_____

IO1 output        __|‾|____|‾|___|‾|____|‾|____|‾|__

Comevaed TG Input __|‾|_|‾‾|_|‾|__|‾|___|‾|____|‾|__

Played Voice      ___< S1 >< S1 >< S1 >< S1 >< S1 >___
```

※ When power is on, IO1 will generate a high pulse at Busy_low status, but the duration equal debounce time.

10. APPLICATION:

2 triggers, using internal oscillator
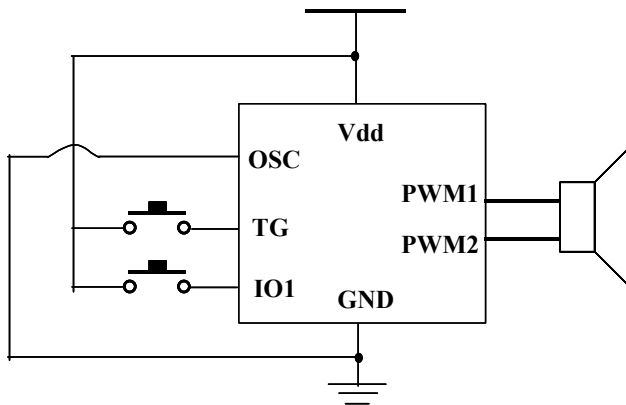
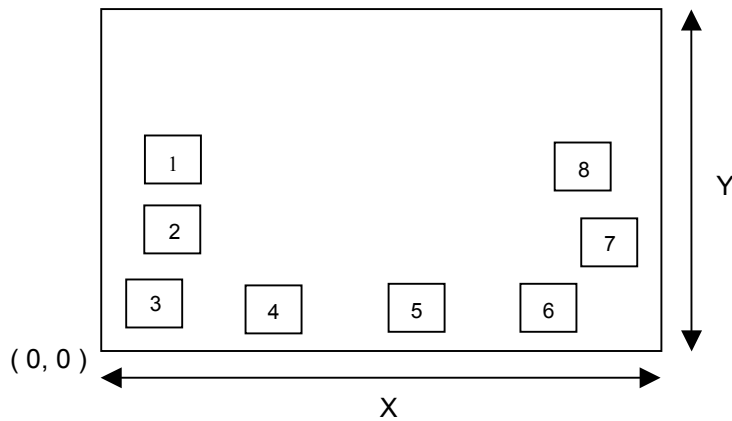**2 triggers, 1 LED, using internal oscillator**
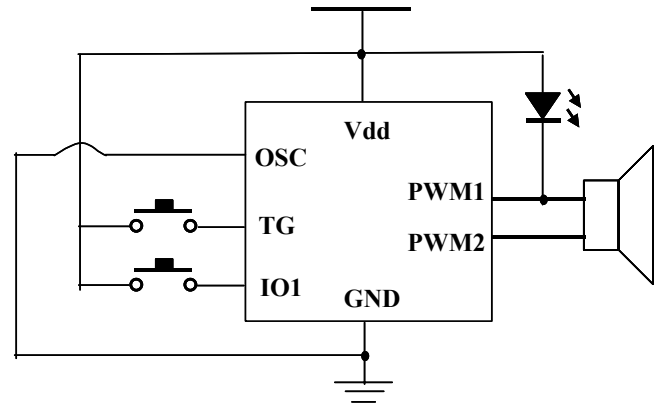
LED is flashing when PWM output enable.

1 trigger, 1 LED, 1 motor, using external oscillator
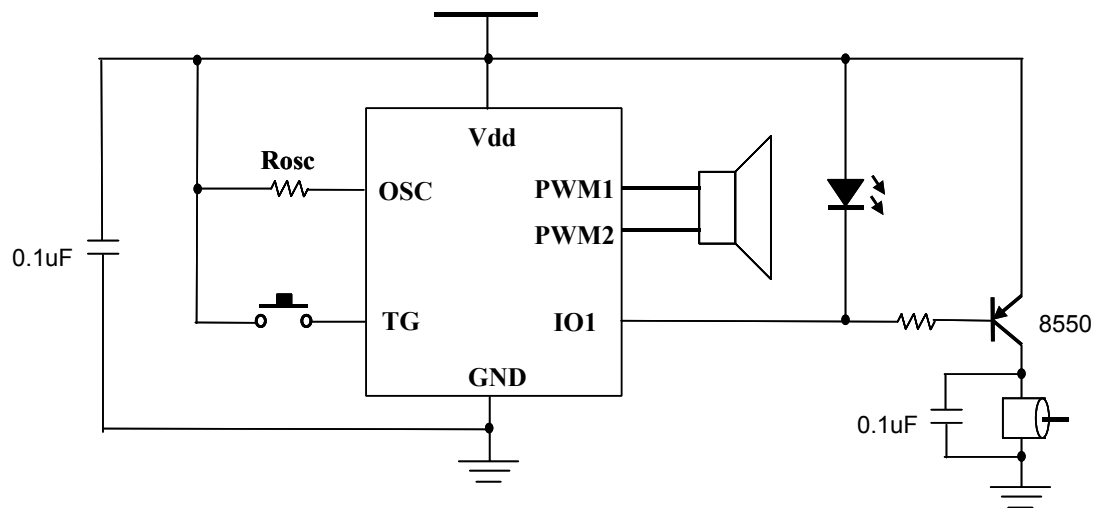
Rosc=220KΩ (at 6kHz sample rate)

IO1 is set to output mode, "Busy_Low Active" option for driving Motor.

* Notices: The above application circuits are for reference only, user can contact Alpha for more information.

11. BONDING DIAGRAM:

Pad size: 80 um x 80 um

※ The IC substrate must be connected to GND.

12. PAD LOCATION:

Pad No.	Pad Name	X	Y
1	IO1	87	307
2	TG1	87	197
3	GND1	53	69
4	PWM1	218	57
5	Vdd	445	57
6	PWM2	671	57
7	GND2	753	166
8	OSC	719	286