佑 華 微 電 子 股 份 有 限 公 司

AM9AF Series
Data Sheet

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Rev 1.1 2005/12/15

Revision History

Revision#	Date	Description	Page
1.0	2004/10/25	Original.	-
1.1	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. Add IO1 status output.	3, 5, 8 7 7 9

1. 一般規格:

AM9AF003x、AM9AF007x 皆爲單晶片 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 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2個很彈性的I/O選擇(IO1, OKY)，來配合不同的應用，並可用佑華所提供的 EzSpeech 工具軟體來進行開發。

2. 特性

(1). 單一工作電壓範圍爲 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，且最多可被分割成32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 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 5、10 秒。(在6kHz取樣頻率下)

(4). 共有256個語音格(voice_step)，可規劃成16對語音組(sub_table)，每個語音組可放的語音格並沒有限制(但最多只有256個語音格)。每一語音格可指定一語音段搭配 IO1 的輸出致能或非致能(IO1當作輸出時)。

(5). 內建變頻振盪器，共有16種不同播放速度的選擇(playback speed: 4.6k ~ 13.3kHz)：

A	B	C	D	E	F	G	H
13.3kHz	11.8kHz	10.3kHz	9.7kHz	8.8kHz	8.2kHz	7.7kHz	7.1kHz
I	J	K	L	M	N	O	P
6.7kHz	6.3kHz	6kHz	5.7kHz	5.3kHz	5.2kHz	4.9kHz	4.6kHz

<如果選擇內建的頻率振盪器，請將 OSC 腳接地或空接。>

(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”(OKY, IO1當作輸入)，或 “單鍵(OKY)觸發輸入模式”(只有OKY當作輸入，IO1當作輸出)。

(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). 每一種輸入可選擇 CDS+1M、CDS、1M pull-low 或 floating 的輸入方式。

(c). OKY 輸入最多有16個sub_table的 One-Key sequential 或 random 的選擇，在 One-Key sequential 時 sub-table 的順序是不可 Reset (當IO1按鍵被觸發後)。

(d). 每一種輸入可選擇不同防止誤動作(Debounce)時間：Long - 提供一般手動操作；Short - 提供跳動開關使用。

(e). 優先順序：OKY>IO1

(8). IO1可做以下 5 種輸出選擇：

(a). Busy_High active : 播放時送出高位準位訊號。

(b). Busy_Low active : 播放時送出低準位訊號。

(c). LED 3Hz flash : 播放時 LED 3Hz 閃爍。(當播放速度爲 6kHz 時)

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

(e). LED 12Hz flash : 播放時 LED 12Hz 閃爍。(當播放速度爲 6kHz 時)

(※ LED 3Hz / 6Hz/12Hz 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，假如是Sink的輸出接法，則每段語音開始是先亮再滅。)

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

(10). 每一語音段中的語音或靜音長度爲 8 HEX 的整數倍。

(11). OSC Auto_Detect 功能：

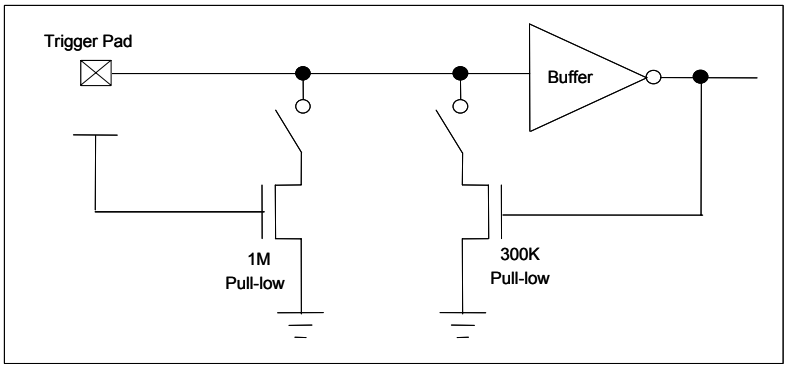
此功能在Power_On時，即會自動偵測系統工作頻率爲內部振盪或是外部電阻振盪。

(a). 選擇內部振盪：將OSC pad 空接或接地時，在Power_On後，系統會自動偵測爲內部振盪頻率，因此在系統工作時OSC Pad 外接任何電阻或是雜訊，皆不會影響內部振盪頻率。

(b). 選擇外阻振盪：將OSC pad 外接適當振盪電阻(Rosc)到Vdd時，在Power_on後，系統會自動偵測爲外部電阻振盪頻率，因此在系統工作時若將Rosc值改變，會影響原工作頻率，若在系統工作時將Rosc移除，則系統頻率將停止或不隱定。

※ 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內部爲 1M 的下拉電阻；而當按鍵放開時，IC內部爲 1M+300K (並聯) 的下拉電阻。
CDS	IC內部爲 300K 的下拉電阻，通常與光敏電阻一起使用。
1M pull-low	IC內部爲 1M 的下拉電阻，保留給一些特殊應用使用。
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。



1. GENERAL DESCRIPTION

The AM9AF003x and AM9AF007x are single-chip voice synthesizing CMOS IC. They are low cost with proper functions and can synthesize voice up to 3.5 and 7 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 two very flexible functions I/O pins (OKY/IO1) are 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.

(2). The total voice duration is about 3.5 or 7 seconds those can be partitioned up to 32 voice_sections. Each voice_section length is flexible.

(3). Voice length can be individually up to 3.5 or 7 seconds at 6kHz S.R. for each voice_section.
Voice+mute length can be individually up to 5 or 10 seconds at 6kHz sample rate for each voice_section.

(4). Total 256 voice_steps are available for 16 sub_tables. Each sub_table can only use maximum 256 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, 16 kinds of playback speed option for internal oscillation used : (4.6k ~ 13.3kHz)

A	B	C	D	E	F	G	H
13.3kHz	11.8kHz	10.3kHz	9.7kHz	8.8kHz	8.2kHz	7.7kHz	7.1kHz
I	J	K	L	M	N	O	P
6.7kHz	6.3kHz	6kHz	5.7kHz	5.3kHz	5.2kHz	4.9kHz	4.6kHz

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

(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). Each input can choose CDS+1M, CDS, 1M pull-low or floating input type.
(c). OKY input can choose One-Key Sequential or Random for maximum 16 sub_tables. At One-Key Sequential, the Reset function of sub_table sequence cannot be reset when IO1 key is triggered.
(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：OKY > IO1.

(8). IO1 has the following 5 output options:
(a). Busy_High active : high active signal output during playing.
(b). Busy_Low active : low active signal output during playing.
(c). LED 3Hz flash : 3Hz sink signal output for driving LED during playing at 6kHz sample rate.

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

(e). LED 12Hz flash : 12Hz sink signal output for driving LED during playing at 6kHz sample rate.

※ *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. In Sink mode, the initial output signal is high.*

(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 8 Hex.

(11). OSC Auto-Detect function:

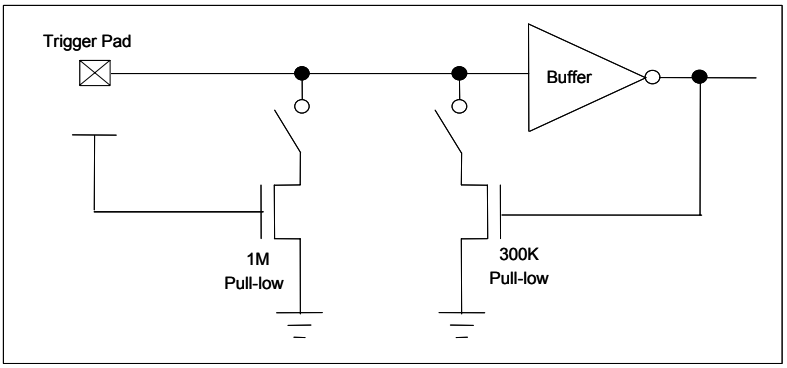
This function will automatically detect the clock source from internal or external oscillator after Power-On.

(a). Internal oscillator: Connect OSC pad to GND or floating. After Power_On, system will be detected to be internal oscillation. Thus, while system is working, connecting a resistor to OSC pad or outside noise from OSC pad will not affect the internal oscillator.

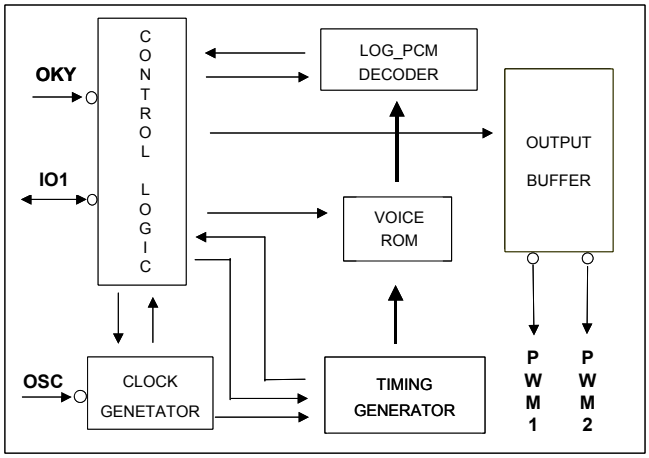
(b). External oscillator: Connect OSC pad to Vdd with a resistor, Rosc. After Power_On, system will be detected to be external oscillation. Thus, changing the Rosc value will change the system clock, or removing the Rosc will affect the system stability.

※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.
Floating	No internal resistor connection, usually connected to other output pin or connected to GND by an external resistor.



3. BLOCK DIAGRAM



4. PAD DESCRIPTION

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

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 binary file and function check list. User can download the "**.eva**" file into AM9AA_DB demo board to demonstrate the AM9AF function. The related mapping of AM9AA_DB is as following,

	AM9AF	AM9AA_DB	AM9AA_DB Description
I/O Pin	OKY	OKY	The same.
	IO1	IO1	The same.
	PWM1, PWM2	PWM1, PWM2	PWM output to directly drive speaker.
	OSC	Rosc	Rosc is connected with 160K ohms resistor at 6kHz.

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

	AM9AF	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.
	Floating	Floating	The same.

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

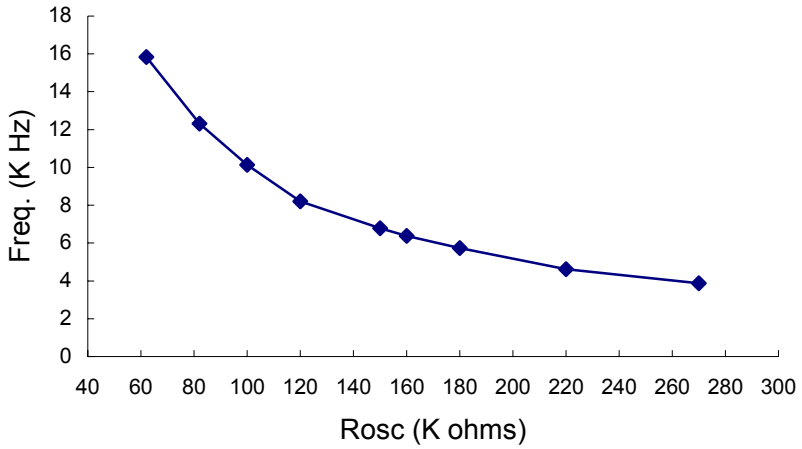
6. ABSOLUTE MAXIMUM RATING

Symbol	Rating	Unit
Vdd~Vss	-0.5 ~ +7.0	V
Vin	Vss-0.3 < Vin < Vdd+0.3	V
Vout	GND < Vout < Vdd	V
Top (operating)	0 ~ +70	ºC
Tst (storage)	-25 ~ +85	ºC

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	Vdd=3V, I/O open 6kHz S.R.
I_{op}		Operating		600			
I_{ih}	Input current: OKY, IO1 (1M pull low)				3	uA	Vdd=3V
I_{il}				0			
I_{ih}	Input current: OKY, IO1 (CDS)				10	uA	Vdd=3V
I_{il}				0			
I_{oh}	PWM1, PWM2 output current			-30		mA	Vdd=3V, V_{oh}=2.4V
I_{ol}				30			Vdd=3V, V_{ol}=0.6V
I_{oh}	IO1 output current			-4.2		mA	Vdd=3V, V_{oh}=0.42V
I_{ol}				9.8			Vdd=3V, V_{ol}=2V
dF/F	Frequency stability		-5		5	%	$\frac{Fosc(3v)-Fosc(2.4v)}{Fosc(3v)}$
dF/F	Fosc lot variation		-10		10	%	Vdd=3V, Rosc=160KΩ

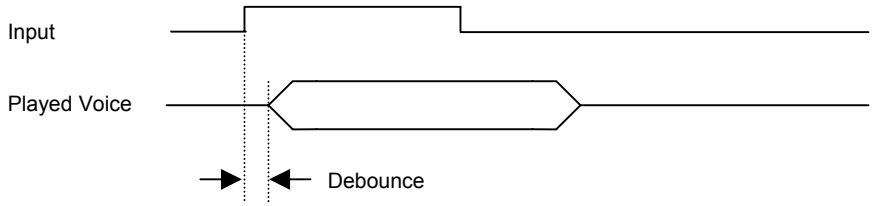
8. Frequency vs. External Rosc



9. TIMING DIAGRAM

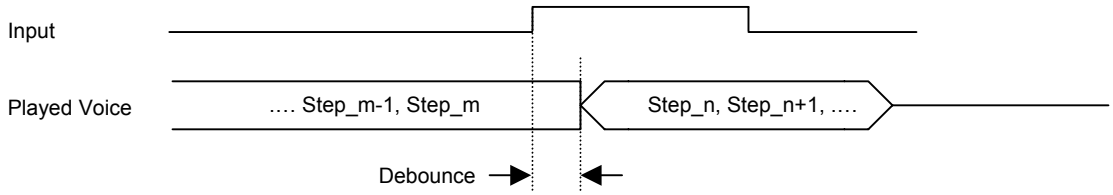
(1) Debounce Time

(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

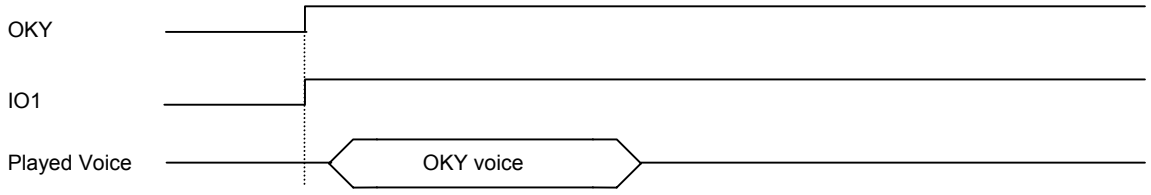
(b). Trigger While playing voice



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

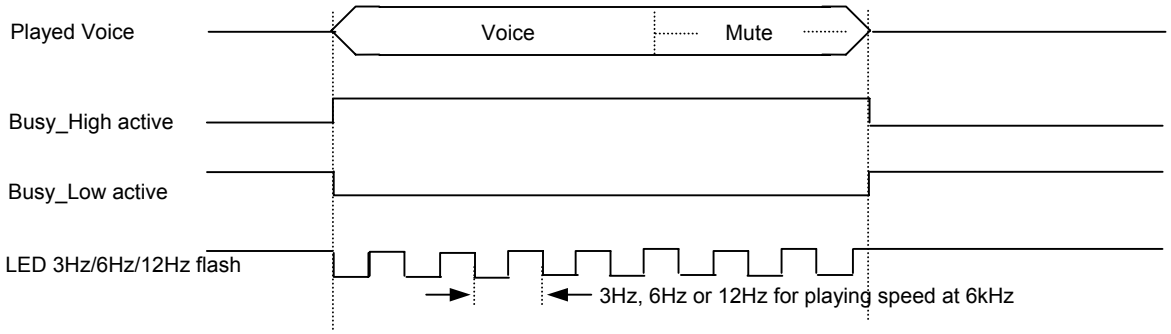
For example, if Step_m S.R. = 8kHz, Slow debounce = 5.3*(6k/8k) ms = 3.9ms, Fast debounce < 50*(6k/8k) us =37.5us

(2) Input Priority



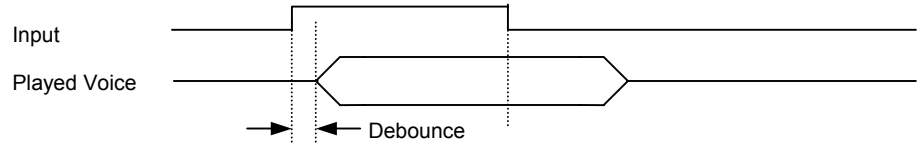
※ Priority: OKY > IO1

(3) Status Output (IO1)

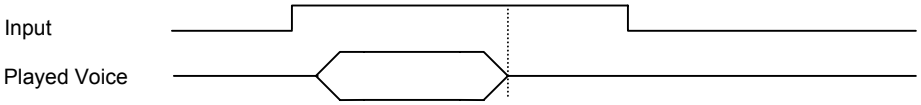


(4) General Timing Diagram

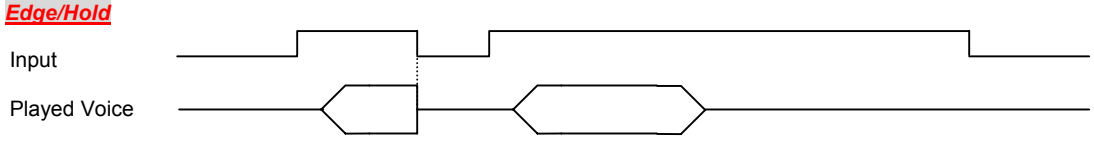
(a). Edge mode, Edge trigger



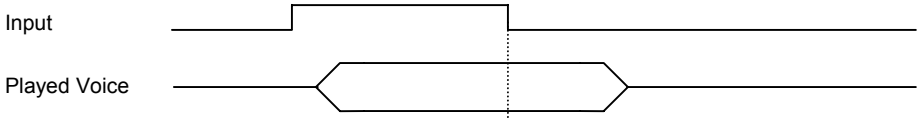
(b). Edge mode, Level trigger



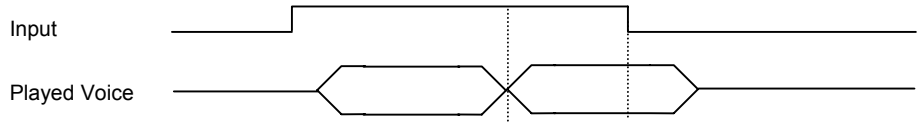
Edge/Hold



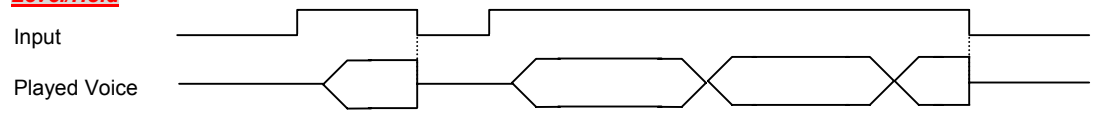
(c). Level mode, Edge trigger



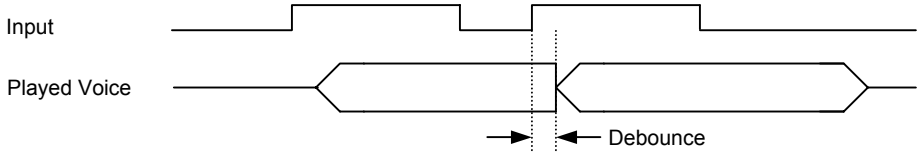
(d). Level mode, Level trigger



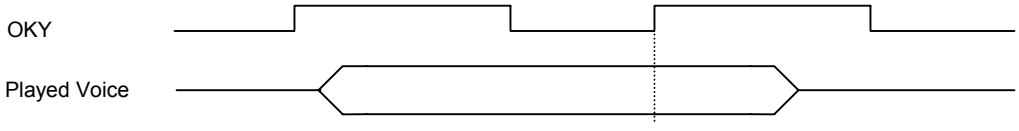
Level/Hold



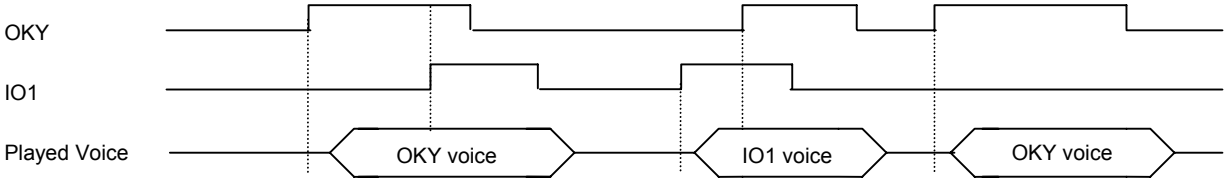
(e). Retrigger mode



(f). Irretrigger mode



(g). Retrigger mode, first key priority

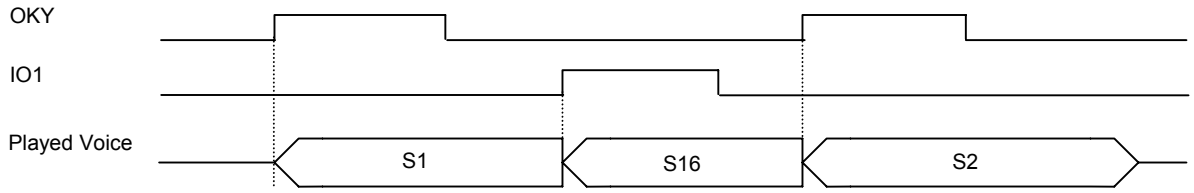


(5) Special Timing Diagram

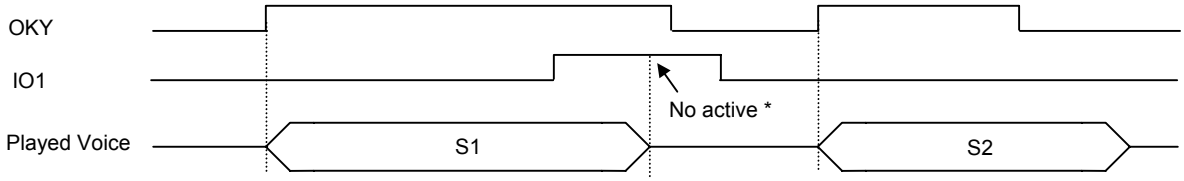
Henceforth, the debounce time is ignored for the following diagrams.

(a). Different Input Reload

(a-1) OKY (E/U/R)=S1 S2 S3 S4, IO1(E/U/R)=S16 (S1 means sub_table 1)

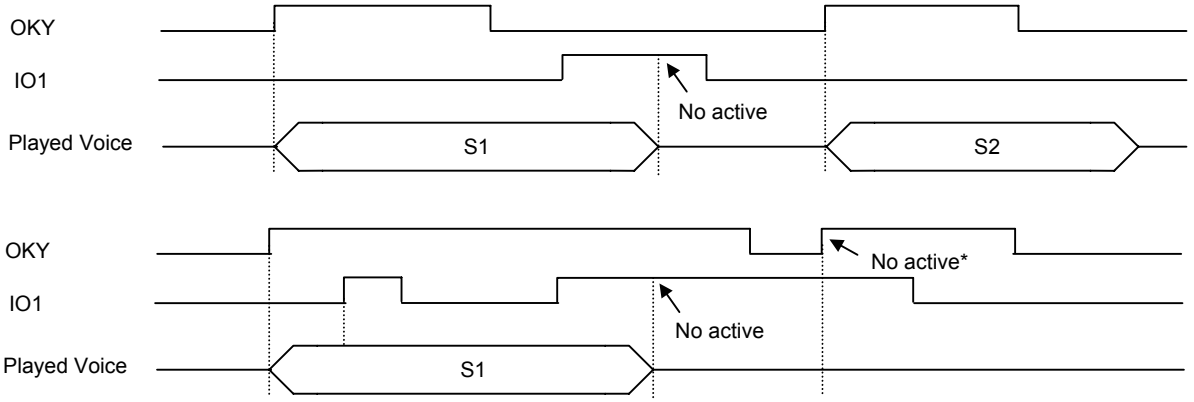


(a-2) OKY (E/U/R) =S1 S2 S3 S4, IO1 (L/x/x) =S16



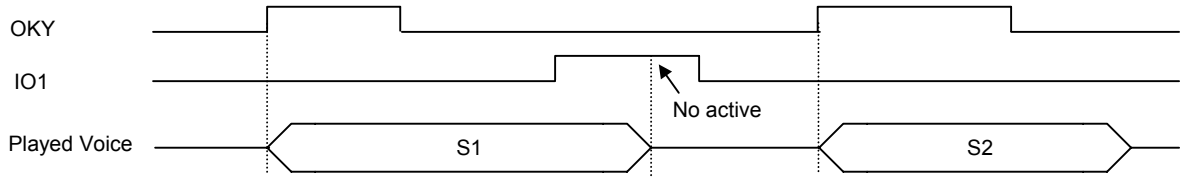
* If you press IO1 during OKY voice playing, in the time of S1 end, the trigger mode follows OKY (E/U/R).

(a-3) OKY (E/U/l) =S1 S2 S3 S4, IO1 (E/x/x) =S16

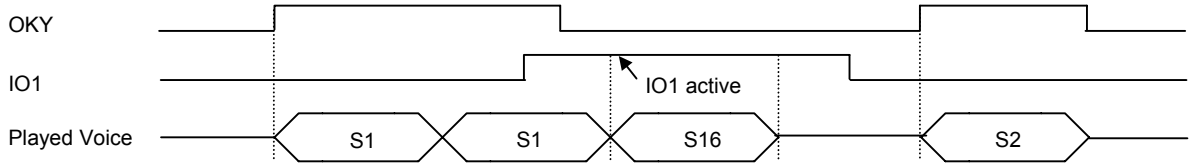


* Because IO1 signal is still high, the OKY Edge signal is not active.

(a-4) OKY (E/U/l) =S1 S2 S3 S4, IO1 (L/x/x) =S16



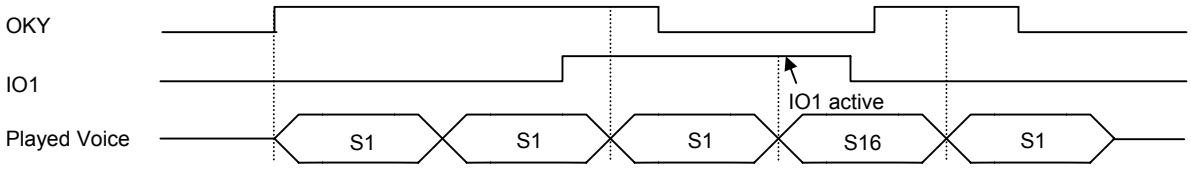
(a-5) OKY (L/U/x) =S1 S2 S3 S4, IO1 (E/x/x) =S16



※ In the time of sub_table end: When S1 end, the trigger mode follows OKY (L/U/x). When S16 end, it follows IO1 (E/x/x).

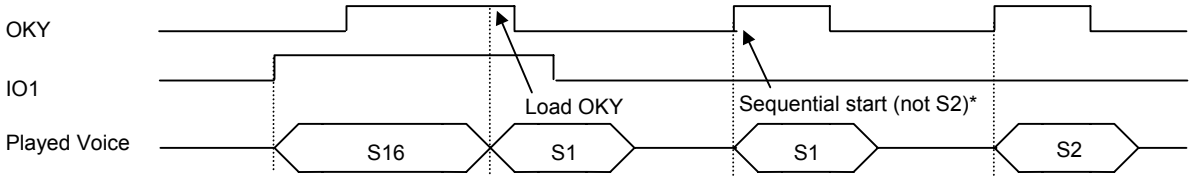
※ Once S16 is played (just leave S1 ending), the trigger mode follows IO1 (E/x/x) immediately.

(a-6) OKY (L/U/x) =S1 S2 S3 S4, IO1 (L/U/l) =S16



※ Reload key priority: OKY > IO1

(a-7) OKY (L/U/x) =S1 S2 S3 S4, IO1 (L/U/x) =S16

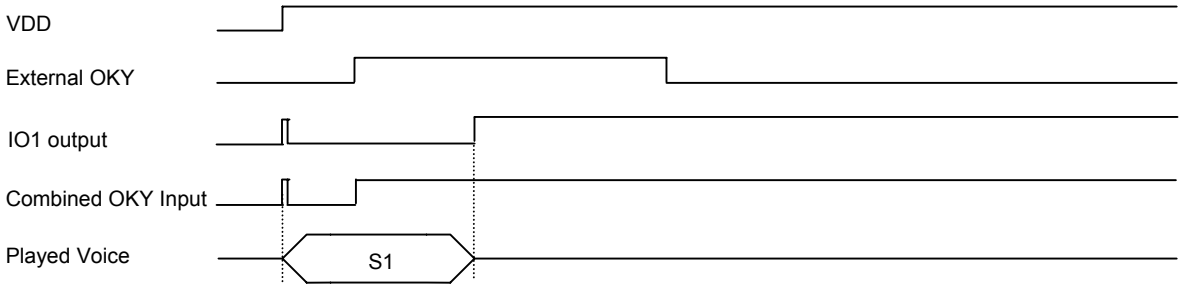


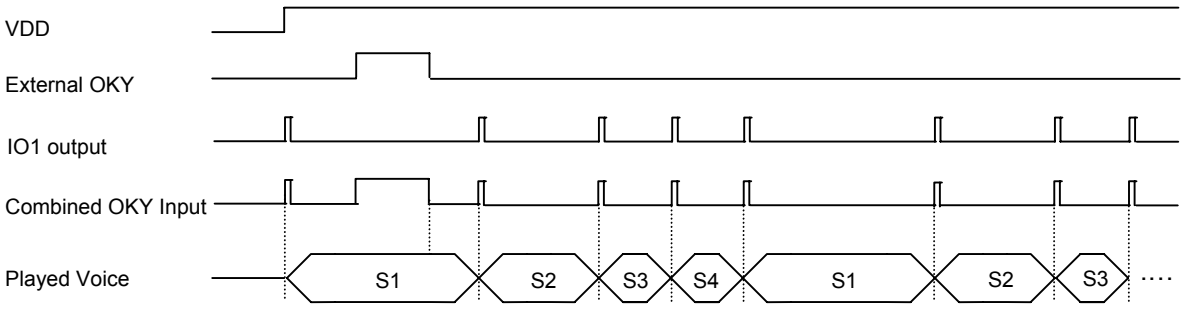
※ When IO1 is triggered first and its voice play, to trigger OKY don't follow sequential trigger because no debounce happen.

* In OKY, 1st debounce happen, so to play S1. OKY Sequential number is counted only if there is debounce happened.

(b). External Feedback function *(IO1 is output and connected to OKY input)*

OKY (E/U/l) =S1 S2 S3 S4, IO1= Busy_low (When not playing voice, IO1 is high.)



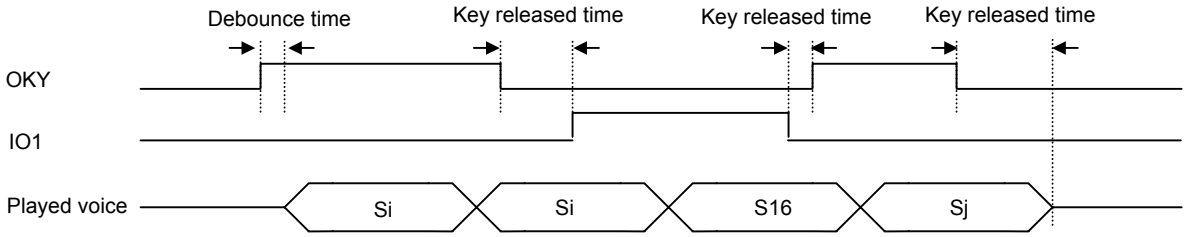


※ When power is on, IO1 will generate a high pulse at Busy_low status, but the duration equal debounce time.

(c). Random Function

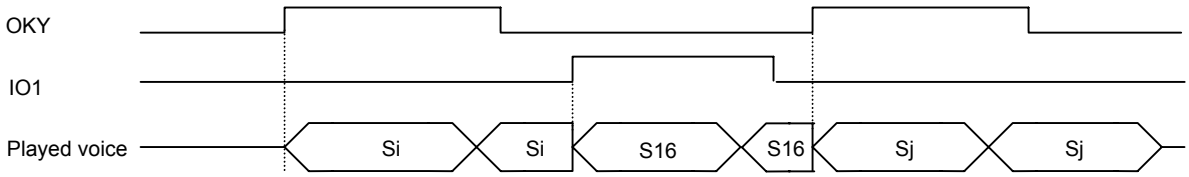
(c-1) OKY (L/U/I) =S1 S2 S3 S4, IO1 (L/U/I) =S16

Random is counting at “debounce time” and “voice playing but input key is released”. But the first trigger only counts “debounce time” due to no “key release time”.



i=1 or 2 or 3 or 4; j=1 or 2 or 3 or 4 (i and j are random number)

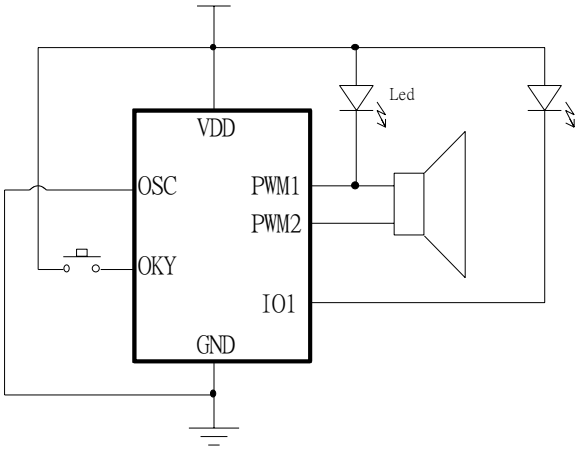
(c-2) OKY (L/U/R) =S1 S2 S3 S4, IO1 (L/U/R) =S16



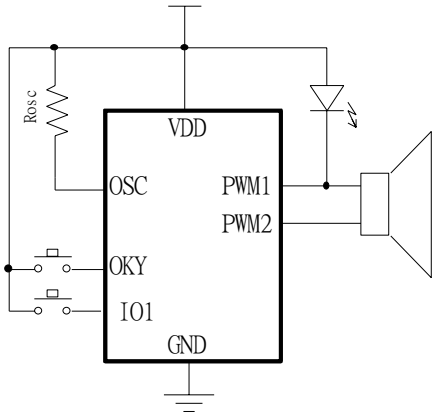
i=1 or 2 or 3 or 4; j=1 or 2 or 3 or 4 (i and j are random number)

10. APPLICATION

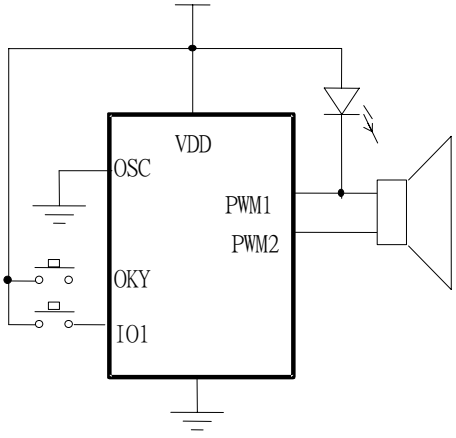
(1) 1 trigger, 2 LEDs, using internal oscillator
OKY is input, IO1 is output



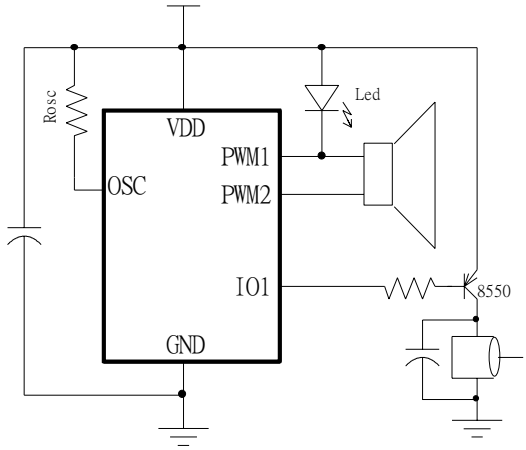
(2) 2 triggers, 1 LED, using external oscillator



(3) 2 triggers, 1 LED, using internal oscillator



(4) 1 trigger, 1 LED, using external oscillator, with one motor OKY is input, IO1 is output

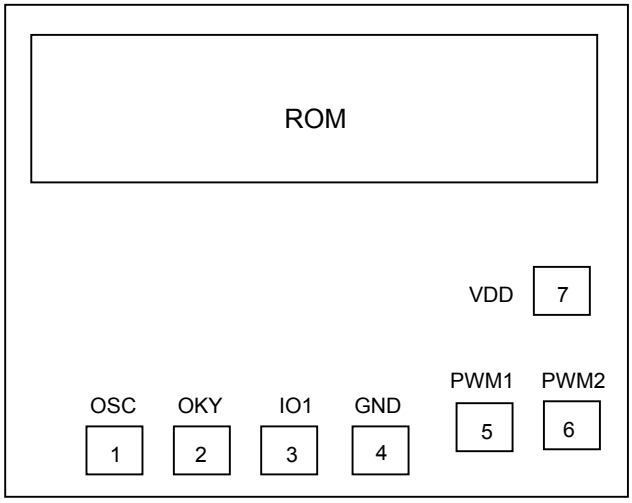


* Rosc=160KΩ, or SR option: "K" with internal oscillator. (at 6kHz sample rate)

* While driving motor, one capacitor is suggested to put between VDD and GND.

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

11. BONDING DIAGRAM



* The IC substrate must be connected to GND.