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APLUS INTEGRATED CIRCUITS INC.

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# AVxx16K Series

## DATA SHEET

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## 1. GENERAL DESCRIPTION:

The **AVH316K** , **AV0716K** , **AV1416K** , **AV2116K** , **AV2816K** and **AV4216K** are single-chip voice synthesizing CMOS IC. They are low cost with proper functions and can synthesize voice up to 3.5, 7, 14, 21, 28 and 42 seconds, using Aplus 5-bit LOGPCM algorithm. ~~Others~~ or speech data can be programmed into ROM by changing one mask during the device fabrication. Besides, not only the very flexible and functional PowerIO pins (IO1/IO2) are available for 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 2.4V 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, 21, 28 and 42 seconds those can be partitioned up to 32 voice\_sections. Each voice\_section length is flexible. Besides, there are additional 32 mute\_sections.
- (3). Voice length can be individually up to 3.5, 7, 14, 21, 21 and 21 seconds and voice+mute length can be individually up to 21 seconds at 6kHz sample rate for each voice\_section.
- (4). Total 96 voice\_steps are available for 16 sub\_tables. The number of voice\_step for each sub\_table is flexible, but maximum is 96. For each voice\_step, it can specify one voice\_section, playback speed and IO1/IO2 output enable options if IO1/IO2 are set as output.
- (5). Built-in variable oscillator, 16 kinds of playback speed option : ( 3.9k ~ 14.0kHz)

A	B	C	D	E	F	G	H
14.0kHz	12.0kHz	10.5kHz	9.3kHz	8.3kHz	7.5kHz	7.0kHz	6.4kHz
I	J	K	L	M	N	O	P
6.0kHz	5.5kHz	5.2kHz	4.9kHz	4.6kHz	4.4kHz	4.1kHz	3.9kHz

- (6). IO1 or IO2 can be either input or output pin (Mask option).
- (7). Optional "Three Triggers Input" (all OKY, IO1 and IO1 are input), "Two Triggers Input" (OKY and IO1 are input, IO2 is output), or "One Trigger Input" (OKY is input, IO1 and IO2 are output).
  - (A). Each input pin has mask options for Edge/Level, Hold/Unhold and Retrigger/Irritrigger trigger modes.
  - (B). 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 can be chosen when other keys are triggered.
  - (C). OKY and IO1 input can choose Toggle On/Off function or not.
  - (D). OKY input can choose CDS+1M 、CDS 、1M pull-low 、10M pull low or floating input type.  
IO1 and IO2 input can choose CDS+1M 、CDS 、1M pull-low or floating input type.
  - (E). Each input can choose debounce time: Long debounce for push buttons. Short debounce for fast switches.
  - (F). Input pin priority : OKY > IO1 > IO2.

(8). IO1/IO2 have 7 kinds of output option :

- (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.
- (G). Synchronous output : arbitrary output with voice, user can edit the Sync signal by PowerIO editor.

※ 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 length in voice\_section must be the multiple of 200Hex, and the mute length in voice\_section must be the multiple of 80Hex. But when the voice length in voice\_section of “voice + mute” don't fully use the last 200Hex, the unused voice length is set as mute and combined with the followed mute time.

(11). In pure mute voice\_section of M00~M31, the mute length must be the multiple of 80Hex. The maximum mute length is up to 21 seconds at 6kHz sample rate for each mute voice\_section.

(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/IO2 input.

The input type figure is as page 2.

## 1. 一般規格:

AVH316K、AV0716K、AV1416K、AV2116K、AV2816K、AV4216K，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 5-bit LOGPCM 編碼方式，合成長達 3.5、7、14、21、28、42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 PowerIO pin 選擇 (IO1/IO2)，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 2.4 ~ 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、28、42 秒，且最多可被分割成32個語音段(voice\_section)，每段長度可不同。另外還有32個靜音段(mute\_section)可供使用。
- (3). 每一段語音的長度分別最多可達 3.5、7、14、21、21、21 秒。(在6kHz取樣頻率下)  
每一段“語音+靜音 時間”的長度，每個母體最多可達 21 秒。(在6kHz取樣頻率下)
- (4). 共有96個語音格(voice\_step)，可規劃成16個語音組(sub\_table)，每個語音組可放的語音格並沒有限制(但最多只有96個語音格)。每一語音格可指定一語音段和播放速度，並搭配 IO1/IO2 輸出致能或非致能(IO1/IO2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: 3.9k ~ 14.0kHz)：

A	B	C	D	E	F	G	H
14.0kHz	12.0kHz	10.5kHz	9.3kHz	8.3kHz	7.5kHz	7.0kHz	6.4kHz
I	J	K	L	M	N	O	P
6.0kHz	5.5kHz	5.2kHz	4.9kHz	4.6kHz	4.4kHz	4.1kHz	3.9kHz

- (6). IO1或IO2可選擇作輸入腳或是輸出腳 (光罩選擇)。
- (7). 可選擇“三鍵觸發輸入模式”(OKY, IO1和IO2都當作輸入)，“兩鍵觸發輸入模式”(OKY, IO1當作輸入，IO2當作輸出) 或“單鍵(OKY)觸發輸入模式”(只有OKY當作輸入，IO1和IO2都當作輸出)。
- (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). OKY輸入最多有16個sub\_table的 One-Key sequential 或 random 的選擇，在 One-Key sequential 時並可選擇sub-table的順序是否要Reset(當其他按鍵被觸發後)。
- (C). OKY和IO1輸入可選擇是否有 Toggle On/Off 的功能。
- (D). OKY 輸入可選擇 CDS+1M、CDS、1M pull-low、10M weak-pull low 或 floating 的輸入方式。  
IO1/IO2 輸入可選擇 CDS+1M、CDS、1M pull-low 或 floating 的輸入方式。
- (E). 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。
- (F). 按鍵優先順序：OKY>IO1>IO2。

(8). IO1/IO2可做以下 7 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。
- (G). Synchronous 輸出：可隨聲音作任意的輸出變化(需開啓PowerIO編輯器來做Sync信號編輯)。

(※ 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). 每一語音段中的語音長度為 200HEX 的整數倍，而每一語音段中的靜音長度為 80HEX 的整數倍。但是當“語音+靜音”的語音段中的語音長度不滿 200HEX，則剩餘的語音長度會當作靜音與後面的靜音合併。

(11). 純靜音段 M00~M31，每一段的靜音長度為80HEX的整數倍，最大靜音長度為21秒。

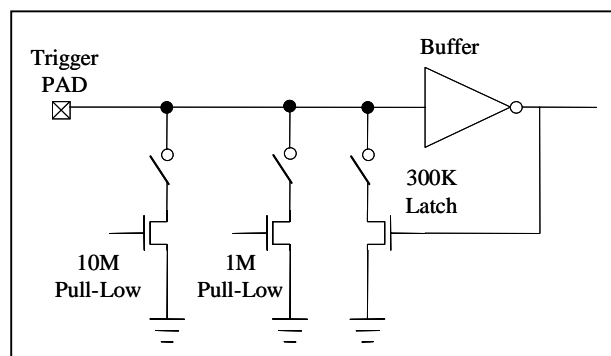
(12). 選擇頻率振盪器：

- (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)

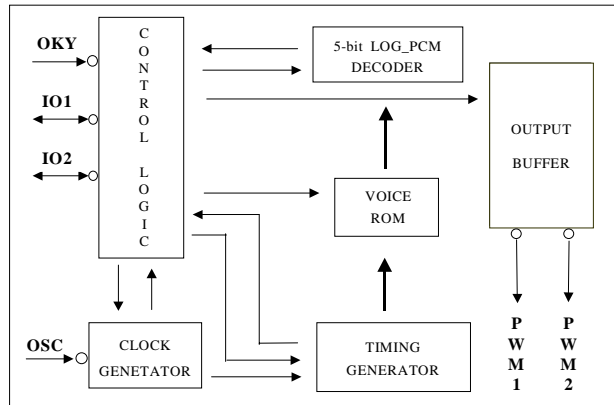
※ 輸入方式選項：

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/IO2 當輸入時，沒有 10M pull-low 的選項。



### 3. BLOCK DIAGRAM:



### 4. PAD DESCRIPTION:

Pad Name	Pad No.	ATTR.	Function
OKY	1	I/O	One-Key Input for trigger.
IO1	2	I/O	Status output or input for trigger.
IO2	3	I	Status output or input for trigger.
GND1, 2	4, 8	Power	Negative power supply.
PWM1	5	O	Audio output.
Vdd	6	Power	Positive power supply.
PWM2	7	O	Audio output.
OSC	9	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 “.bin” and “.htm”, the binary file and function check list. User can download the “.bin” file into 4EA\_DB demo board to demonstrate the AVxx16K function. The related mapping of 4EA\_DB is as below,

	AVxx16K	4EA_DB	4EA_DB Description
I/O Pin	OKY	PRA0	PRA0 performs OKY input.
	IO1/IO2 as Input	PRA1/PRA2	PRA1/PRA2 perform IO1/IO2 input mode.
	IO1/IO2 as Output	PRB0/PRB1	PRB0/PRB1 perform IO1/IO2 output mode.
	PWM1, PWM2	PWM1, PWM2	PWM output to directly drive speaker.
	OSC	OSC1	OSC1 connect 150K ohms resistor to Vdd.

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

	AVxx16K	4EA_DB	4EA_DB Description
Input Type	CDS + 1M	CDS + 1M	The same.
	CDS	CDS + 1M	Almost the same.
	1M pull-low	Floating	Need to connect 1M external resistor to GND.
	10M pull-low	Floating	Need to connect 10M external resistor to GND.
	Floating	Floating	The same.

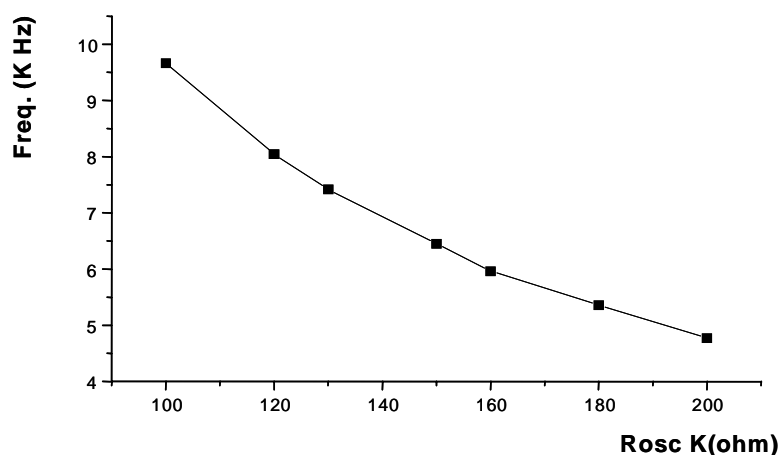
Once the function has been approved, user only need to send the “.bin” file to Aplus for code tape-out.

**6. ABSOLUTE MAXIMUM RATING:**

Symbol	Rating	Unit
Vdd~Vss	-0.5 ~ +7.0	V
Vin	$V_{ss}-0.3 < V_{in} < V_{dd}+0.3$	V
Vout	$GND < V_{out} < V_{dd}$	V
Top (operating)	0 ~ +70	°C
Tst (storage)	-25 ~ +85	°C

**7. DC CHARACTERISTICS:**

Symbol	Parameter		Min.	Typ.	Max.	Unit	Condition
Vdd	Operating voltage		2.4	3.0	6.4	V	
Isb	Supply current	Standby			1	uA	Vdd=3V, I/O open (with Rosc or OSC grounded)
Iop		Operating			200		
Iih	Input current: OKY, IO1, IO2 ( 1M pull low )				3	uA	Vdd=3V
Iil				0			
Iih	Input current: OKY ( 10M pull low )				0.3	uA	Vdd=3V
Iil				0			
Iih	Input current: OKY, IO1, IO2 (CDS)				10	uA	Vdd=3V
Iil				0			
Ioh	PWM1, PWM2 output current			-30		mA	Vdd=3V, Vop=2.4V
Iol				30			Vdd=3V, Vop=0.6V
Ioh	IO1/IO2 output current			-4.5		mA	Vdd=3V, Vop=2.55V
Iol				7.5			Vdd=3V, Vop=0.75V
dF/F	Frequency stability		-5		5	%	$\frac{F_{osc(3v)}-F_{osc(2.4v)}}{F_{osc(3v)}}$
dF/F	Fosc lot variation		-10		10	%	Vdd=3V, Rosc=160KΩ

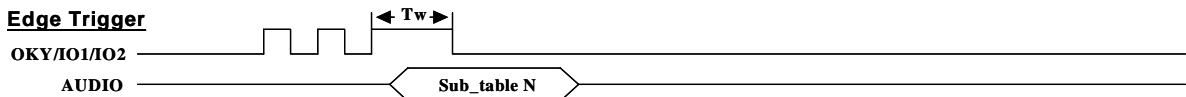
**8. Frequency vs. External Rosc : (measured at internal option of 6kHz playback speed)**


## 9. TIMING DIAGRAM:

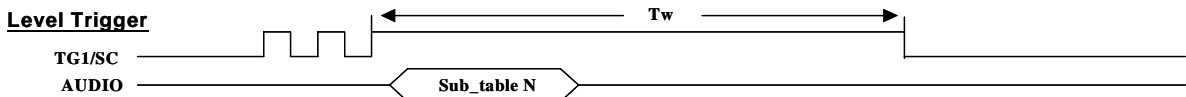
### 1.> Edge/Level

#### Edge Mode:

##### Edge Trigger

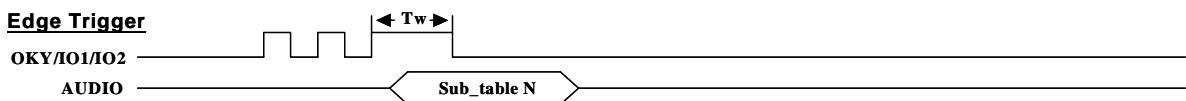


##### Level Trigger

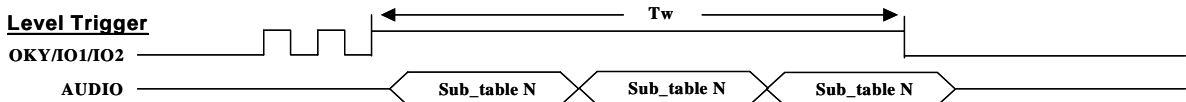


#### Level Mode:

##### Edge Trigger



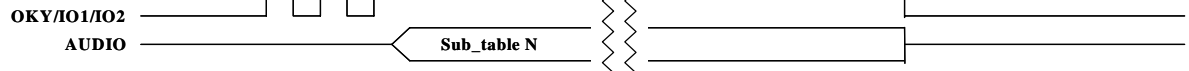
##### Level Trigger



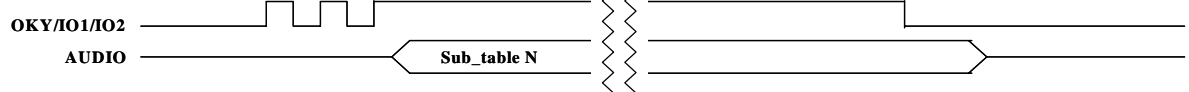
\* Note: Tw is the minimum pulse width > debounce time (5.3ms or 20.8us at 6kHz).

### 2.> Hold/Unhold

#### Hold:



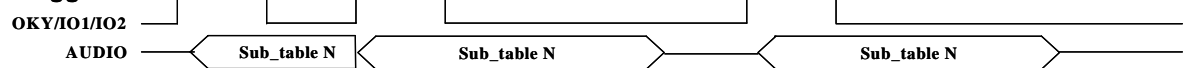
#### Unhold:



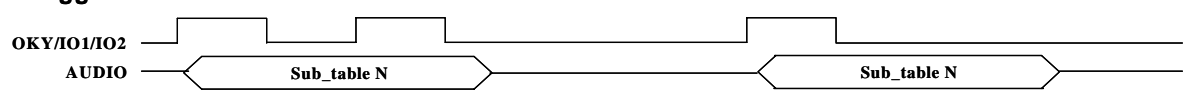
\* Note: Both Edge and Level have Hold and Unhold option.

### 3.> Retrigger/Irretrigger

#### Retrigger:



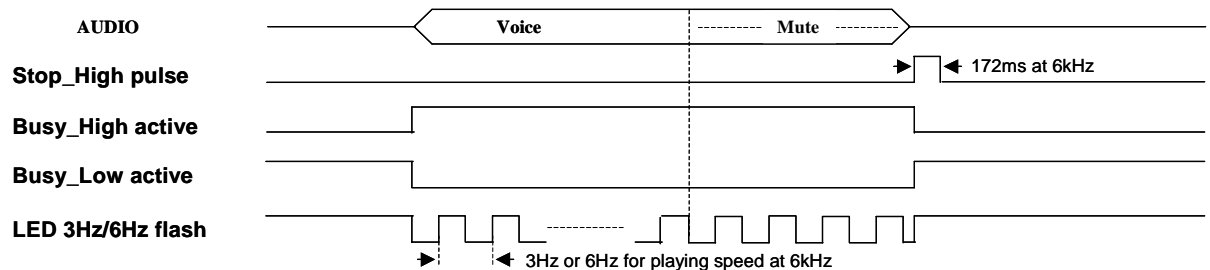
#### Irretrigger:



Play from beginning immediately.

Ignore trigger input signal during playing.

### 4.> Status Output (IO1/IO2)

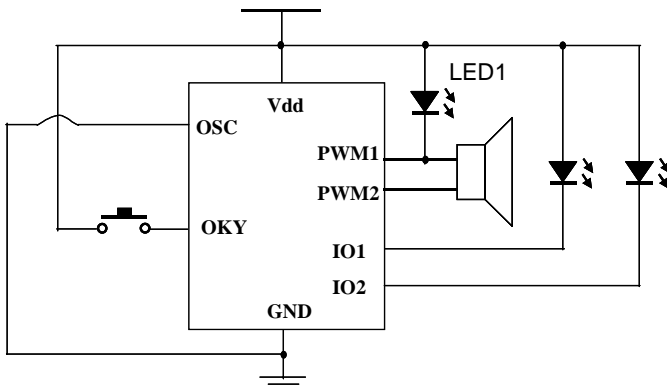


LED dynamic 2/4 : When the voice amplitude is higher than 2/4 full-scale amplitude, LED ON.  
LED ON means status output low.

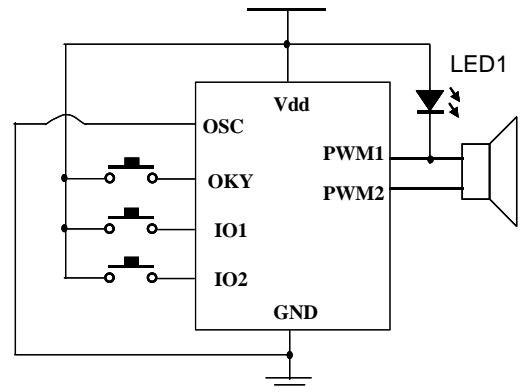


### 10. APPLICATION:

#### 1 trigger, 3 LED, using internal oscillator

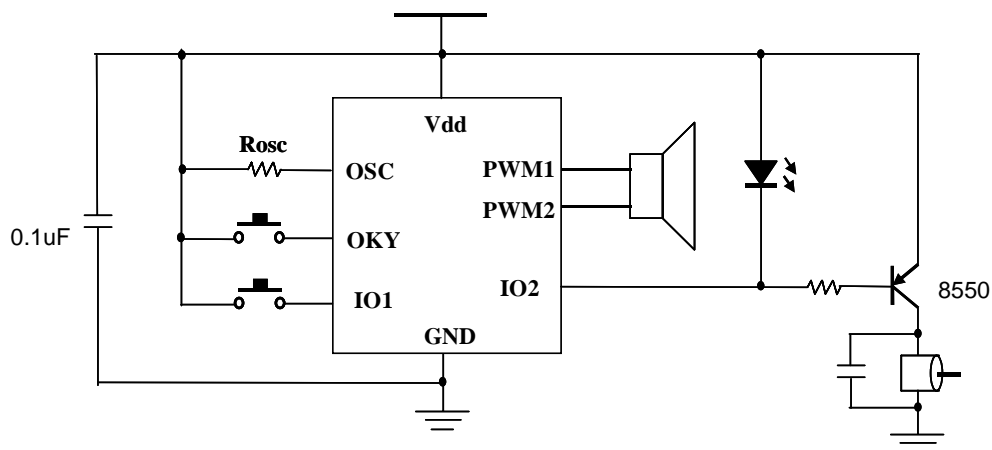


#### 3 triggers, 1 LED, using internal oscillator



LED1 is flashing when PWM output enable.

#### 2 triggers, 1 LED, 1 motor, using external oscillator

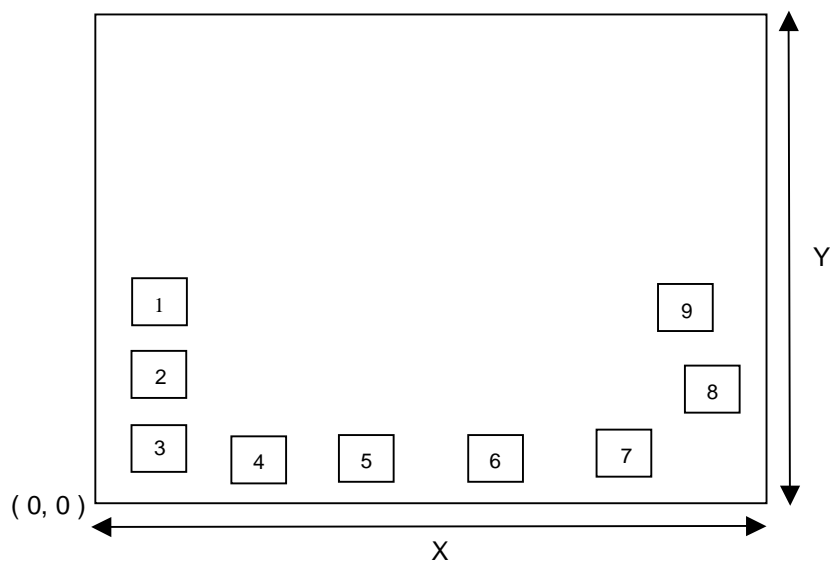


Rosc=160K $\Omega$  (at 6kHz sample rate, option: I)

IO2 is set to output mode, select "Busy\_Low active" or "Sync output" for driving motor.

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 Aplus for more information.

**11. BONDING DIAGRAM:**

**Chip size:**

 AVH316K : X=1074  $\mu$ m, Y=758  $\mu$ m

 AV0716K : X=1074  $\mu$ m, Y=884  $\mu$ m

 AV1416K : X=1080  $\mu$ m, Y=1180  $\mu$ m

 AV2116K : X=1074  $\mu$ m, Y=1462  $\mu$ m

 AV2816K : X=1080  $\mu$ m, Y=1760  $\mu$ m

 AV4216K : X=1074  $\mu$ m, Y=2328  $\mu$ m

**Pad size:** 80  $\mu$ m x 80  $\mu$ m

※ The IC substrate must be connected to GND.

**12. PAD LOCATION:**

Pad No.	Pad Name	X	Y
1	OKY	90	294
2	IO1	90	184
3	IO2	90	74
4	GND1	231	52
5	PWM1	396	52
6	Vdd	623	52
7	PWM2	849	52
8	GND2	940	161
9	OSC	906	281