FEATURES

- Stand CMOS process.
- Embedded 1M bit EPROM.
- 40 Sec Voice Length at 6 KHz sampling and 4-bit ADPCM compression.
- Built-in oscillator to control sampling frequency without an external resistor .
- Maximum 64 voice groups.
- One groups contain several steps(voice section) ;Maximum 700 steps for all the groups.
- User selectable 8bit / 5bit / 4bit data compression.
- 2 input pin(TG1&TG2) and 6 user selectable input or output pin (TG5 & TG6 & TG7 & TG8 & TG11 & TG12).
- Two triggering modes are available by whole chip option during voice compilation

  - Key Trigger Mode – Up 64 Voice Groups are trigger by TG1 & TG2 & TG5~TG8 & TG11 & TG12

  - Serial Trigger Mode-Combinations of TG1 and TG5 to trigger maximum 32 Voice Groups.

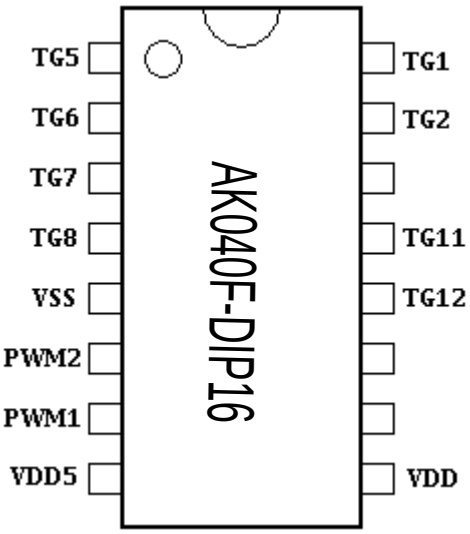
  - CPU Serial Trigger Mode – user commands are clocked serially into the chip to control the playback of chip.
- Voice Group Trigger Options: Edge/LEVEL; Hold/Un-hold; Retrigger/Non-retrigger.
- User selectable 50us (@8KHz sampling rate) or 10ms (@8KHz sampling rate) Debounce Time in all of three trigger Modes.
- Two user programmable outputs for FLASH(0.75Hz/1.5Hz/3Hz/6Hz) or BUSY(High/Low).
- Support Power-on play.
- 2.6 ~ 5.0V;Wide range single power supply and <1uA low stand-by current.
- PWM pwm1 and pwm2 drive speaker directly.
- D/A PWM2 to drive speaker through an external BJT or OP.
- Development System support voice compilation and options selection.

DESCRIPTION

AK040FDIP16

high performance Voice OTP is fabricated with Standard C MOS process with embedded 1M bit EPROM. It can srore up 40sec voice message with 4bit data compression at 6KHz sampling rate.5bit and 8bit data compression are also available as user selectable option.Three trigger modes,simple Key trigger mode and Serial trigger mode and CPU Command mode facilitate different user interface。Internal oscillator to control smpling during the voice playback,8bit current mode D/A output and PWM direct speaker driving output minimize the number of external components. PC controlled programmer and developing software are available.

PIN CONFIGURATIONS



300mil DIP / 150mil SOP

PIN NAMES

PIN	Playback Mode	OTP Program Mode	Description
1	TG5	DI	Programmable input or output(I/O pin)
2	TG6	-	Programmable input or output(I/O pin)
3	TG7	-	Programmable input or output(I/O pin)
4	TG8	-	Programmable input or output(I/O pin)
5	VSS	VSS	Power Ground
6	PWM2/DAC	DI	PWM output to drive speaker directly or D/A current output
7	PWM1	DI	PWM output to drive speaker directly
8	VDD5	VDD	2.6~5.0V Positive Power Supply
9	VDD	-	2.6~5.0V Positive Power Supply
10	-	-	NC
11	-	-	NC
12	TG12	-	Programmable input or output(I/O pin)
13	TG11	-	Programmable input or output(I/O pin)
14	-	-	NC
15	TG2	DI	Programmable input(I pin)
16	TG1	DI	Programmable input(I pin)

PIN DESCRIPTIONS

TG1
Input Trigger Pins: -In Key Trigger Mode ,TG1 is used to trigger the maximum 32 Voice Groups one by one sequentially. - In Serial Trigger Mode, TG1 is used to trigger the maximum 64 Voice Groups. - In CPU Command Mode,TG1 is used as one of the Data In pins (DIO1). -During OTP programming, TG1 serves as data IO.
TG2
Input Trigger Pins: -In Key Mode,TG2 is used to trigger the maximum 21 Voice Groups one by one sequentially. -In CPU Command Mode ,the clock signals (CLK) is transformed by TG2. -During OTP programming, TG2 serves as data IO.
TG5~TG8 & TG11~TG12
Programmable Input or Output Pins(I/O Pins) -As Input pins,these pins are used to trigger the only one group in Key Trigger Mode. -As output pins,these pins are user programmable pins for the BUSY,FLASH signals. -In CPU Command Mode , TG6 is used as chip select pin(CS),while TG5 is used as one of the Data In pins (DIO2). -During OTP programming, TG5 serves as data IO.
VSS
-Power Ground Pin during voice playback and OTP programming.
PWM2
-PWM ,one of the Digital PWM output pins which can drive speaker and buzzer directly for voice. -DAC,analog 8bit current mode D/A output for voice playback. -During OTP programming, PWM2 serves as data IO.
VDD5
- Power Supply Pin during voice playback and OTP programming.
VDD
-Power Supply Pin during voice playback in 2.6~3.6V circuit. -Connect a 0.1uF capacitance to GND in 3.6~5.0V circuit.
PWM1
-PWM, one of the Digital PWM output pins which can drive speaker and buzzer directly for voice. -During OTP programming, PWM1 serves as data IO.

VOICE SOLUTION

Voice files created by the PC base developing system are stored in the built-in EPROM of the SD0810 chip as a number of unfixed length Voice Steps.Voice steps are then selected and grouped into Voice Groups for playback.Up to 64 Voice Groups are allowed.

Chip	AK040F-DIP16
Memory size	1M bits
Max no.of Voice Step	700
Voice Length(@6KHz 4bit sampling rate)	40 sec

Example of Voice Steps Combination

Assume here we have three voice files,they are "Welcome to SOUND!",Sound Effect and Music.Each of the voice is stored into the memory as a step .

Voice File 1 -"Welcome to SOUND!" is stored in Voice Step 1.

Voice File 2 –Sound Effect is stored in Voice Step2.

Voice File 2 –Music is stored in Voice Step3.

Voice Steps are grouped together using Voice Table to form Voice Group for playback:

Group no.	Voice Group contents	Voice Steps
Group 1	"Welcome to SOUND!"	Step1
Group 2	Sound Effect + "Welcome to SOUND!"	Step2, Step1
Group 3	"Welcome to SOUND!" + Music	Step1, Step3
Group 4	Music	Step3

Voice Data Compression

Voice File data is stored in the on-chip EPROM as 4bit,5bit or 8bit format.Voice data stored as 4bit provides 2:1 data compression which can save 50% of memory space.Voice data are stored as 8bit means no data compression is employed but voice playback quality will be better.User also can select 5bit data compression format to store the voice.The voice playback quality will be better than 4bit format and will save more memory space than 8bit format

Programmable Options

Setting the Programmable Options User can select different trigger functions and output signals in all the trigger modes .Programmable Options contains:Whole Chip Option;Pin Option;Output Option.

Whole Chip Option

User selectable options that affect all input pins in all of Key Trigger Mode Serial Trigger Mode and CPU mode.

- Debounce time 50us / 10ms

Pin Options

User defines each of the I/O pin as input pin or output pin.

- TGxx(I/O pin): Input / Output

Output Options

The options set up each of output pins to send out signal during the voice playback in both Key Trigger Mode and CPU Mode.Seven settings are alowed:

- Default Level Higt / Low.
- 0.75Hz Flash
- 1.5Hz Flash
- 3Hz Flash
- 6Hz Flash
- Busy High
- Busy Low

Note:more than one output pins select Flash setting,they will output flash signals sequentially during the voice playback.

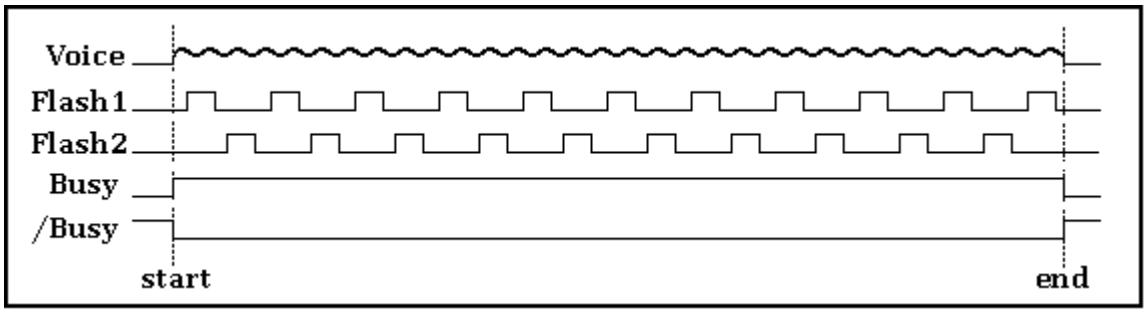


Fig.1 Output waveforms

Input Options:

User selectable options how to trigger each individual group for each input pin in Key Trigger Mode.They are：

- Edge / Level trigger
- Unholdable / Holdable trigger
- Re-triggerable / Non-retriggerable

Fig.2 ~ Fig.8 show the voice playback with different combination of triggering mode and the relationship between outputs and voice playback.

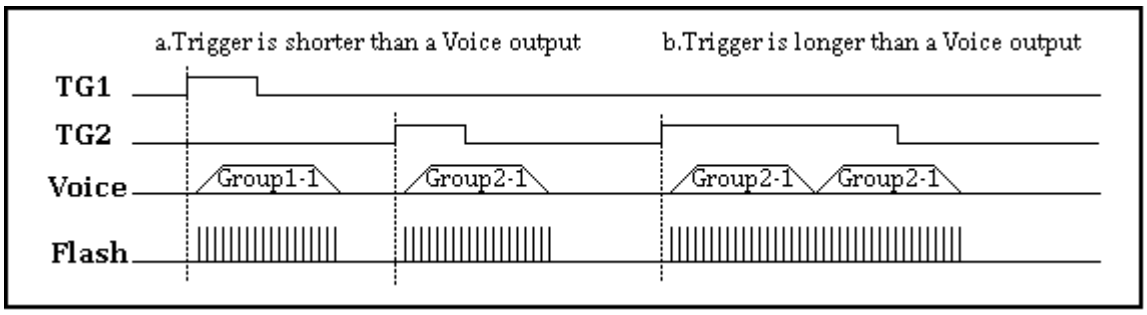


Fig.2 Level, Unholdable,Non-retriggerable

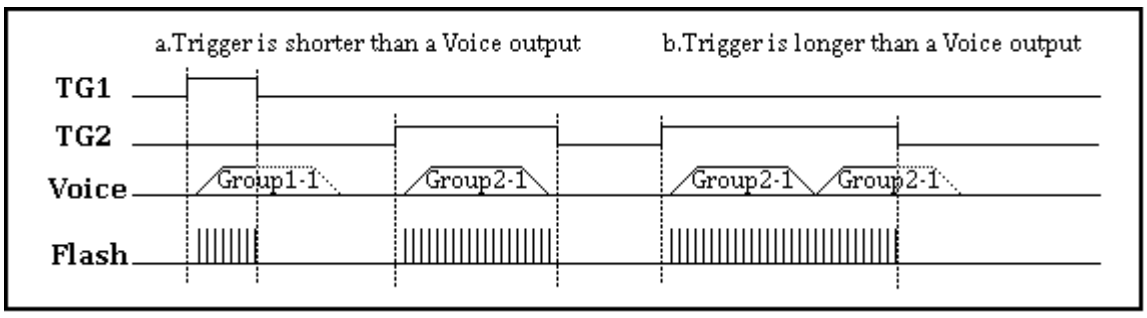


Fig.3 Level, holdable

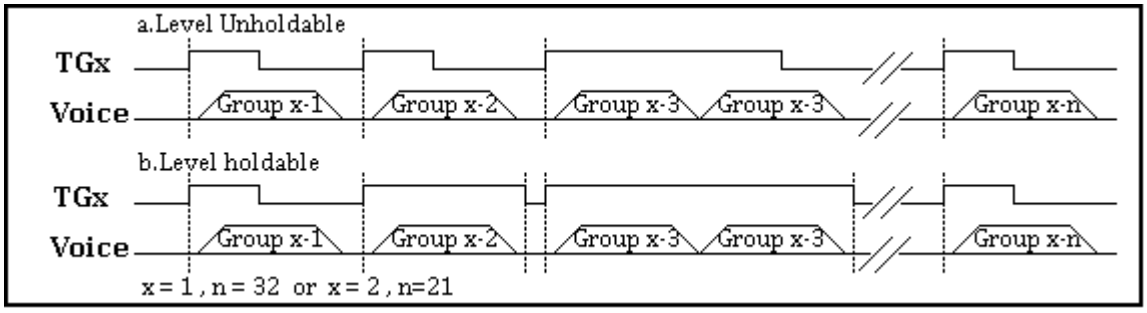


Fig.4 TG1 or TG2 sequential trigger with Level, holdable and Unholdable in Key Trigger Mode

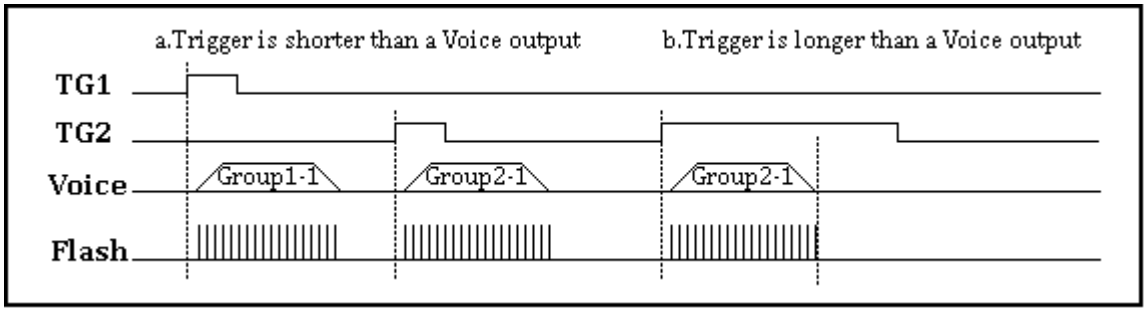


Fig.5 Edge, Unholdable,Non-retriggerable

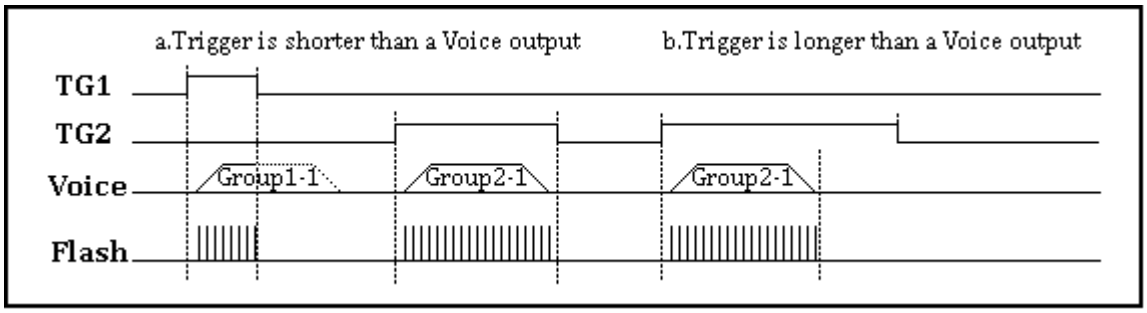


Fig.6 Edge, holdable

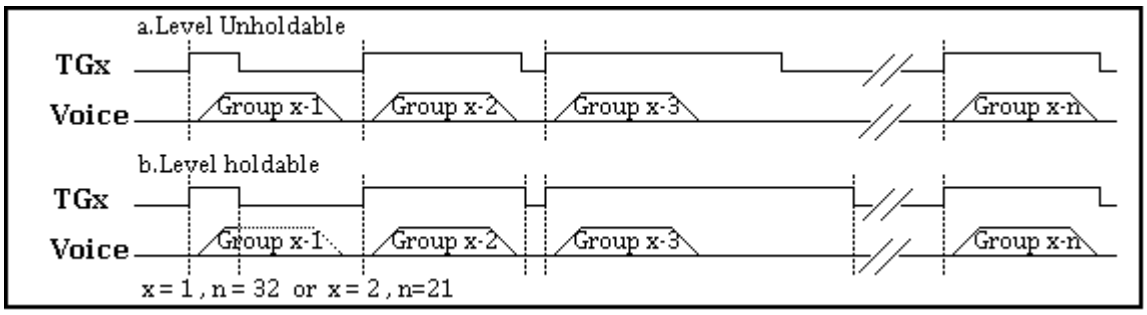


Fig.7 TG1 or TG2 sequential trigger with Edge, holdable and Unholdable in Key Trigger Mode.

TRIGGER MODES

Key or CPU Trigger modes are determined by setting the EPORM programmable options during voice data compilation.

Key Trigger Mode

In this trigger mode,TG1 is set to trigger maximum 32 Voice Groups one by one sequentially;TG2 is set to trigger maximum 21 Voice Groups one by one sequentially;TG11 (as input pin) is set to trigger maximum 1 Voice Group; TG12 (as input pin) is set to trigger maximum 1 Voice Group.

Serial Trigger Mode

In this trigger mode, up to 32 Voice Groups are triggered by TG1,TG5.The No. of Voice Group which is commanded to playback is matched the mounts of the plus which is shifted input into the chip through the TG1.TG1 must be setted with Edge/Unholdable/Retrigger。

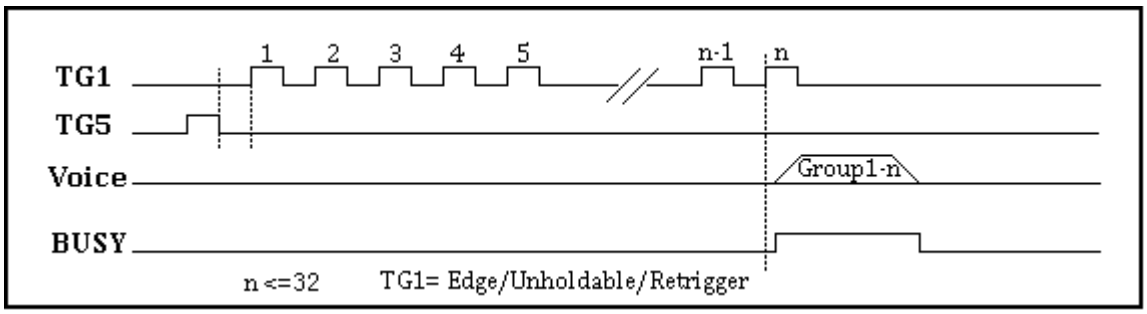


Fig.8 Serial Trigger Timing

CPU Command Mode

In this Mode,TG1 is Chip Select(CS) pin to initiate the command input.S2 is the Serial Clock (SCK) pin which clocks the input command while the data bits into the chip .TG11 and TG12 are the Data In (DI) pin in which comand and data bits are shifed input into the chip.

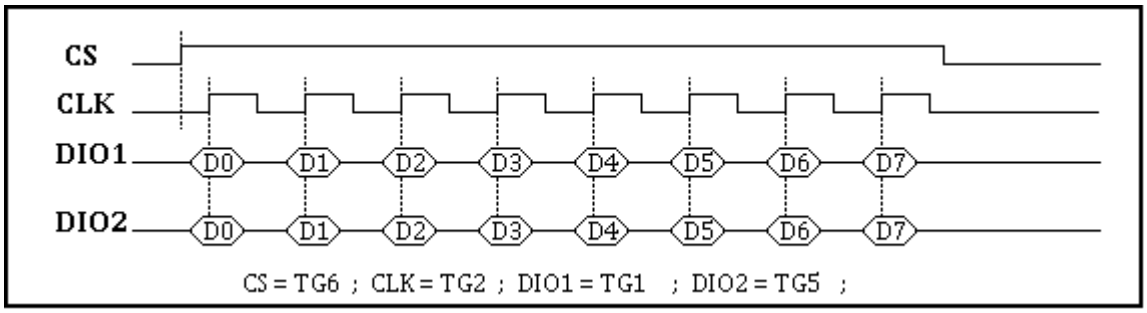


Fig.9 CPU Command Timing

Command input into the chip may contains 8bit data.Table 1 summarize the available commands and their functions.

Command	Pin	D0	D1	D2	D3	D4	D5	D6	D7	Description
START	DIO1	1	0	1	0	0	1	0	1	Wake up the chip with ramp-up to rise up the current.
	DIO2	1	0	1	0	0	0	0	0	
END	DIO1	1	0	0	0	0	0	0	1	Power down the chip into standby status to cut down the current
	DIO2	1	0	1	0	0	0	0	0	
RESET	DIO1	1	1	0	0	0	0	0	1	Stop the playback and wait new comand
	DIO2	1	1	0	0	0	0	0	0	
PAUSE	DIO1	1	0	1	0	0	0	0	1	Pause the playback and hold at current value
	DIO2	1	1	1	0	0	0	0	0	
RESUME	DIO1	1	0	1	0	0	0	0	0	Resume playback from the previous value
	DIO2	1	1	1	0	0	0	0	0	

Fig.10 ~ Fig.15 show the relationship between CS,CLK,DIO1,DIO2 in waveforms of each command.

Power up the chip with ramp-up(START)

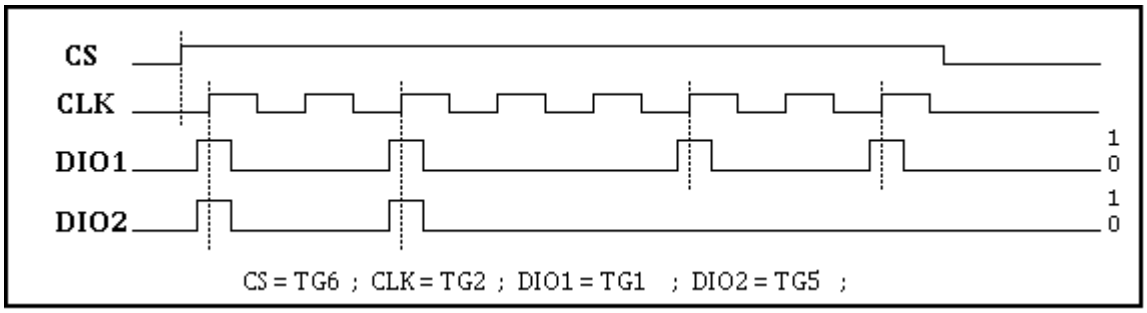


Fig.10 Power up will start after 350us(at 6KHz sampling rate)

Power down the chip with ramp-down(END)

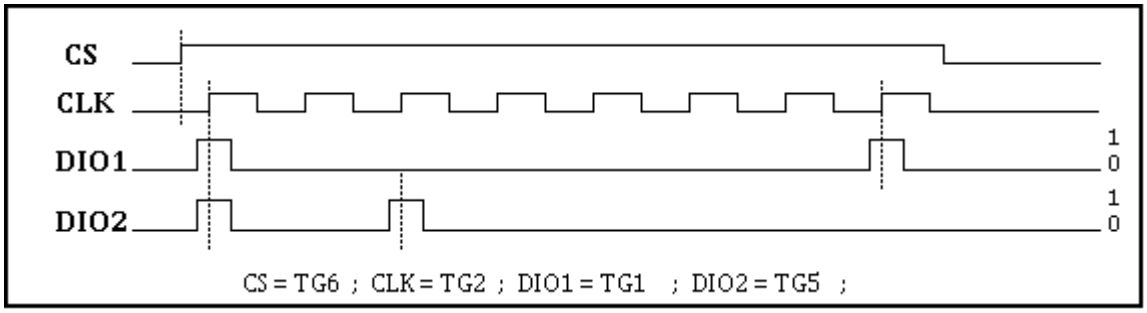


Fig.11 Power down will start after 350us(at 6KHz sampling rate)

Playback Voice GroupN(PLAY)

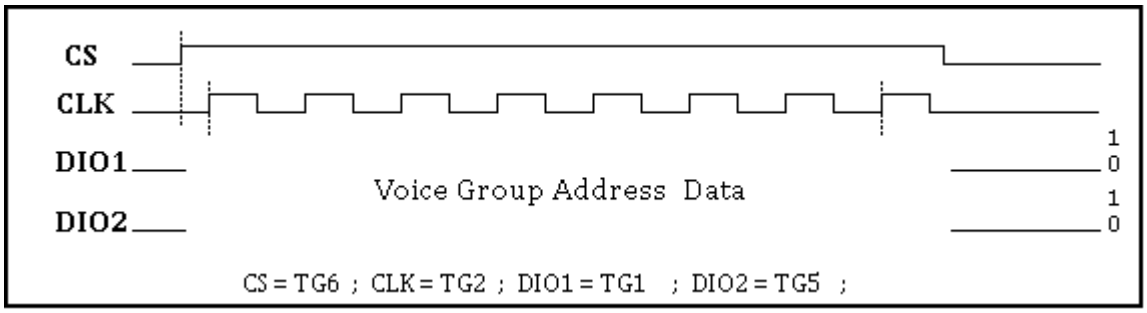


Fig.12 Once the 8bit data command are clock into the chip, the Voice Group which is matched command data will be played accordingly.

Reset the chip(RESET)

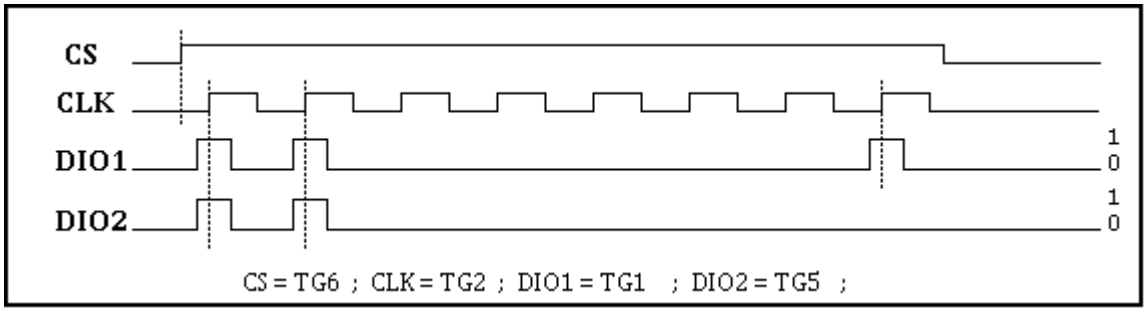


Fig.13

Pause the playback(PAUSE)

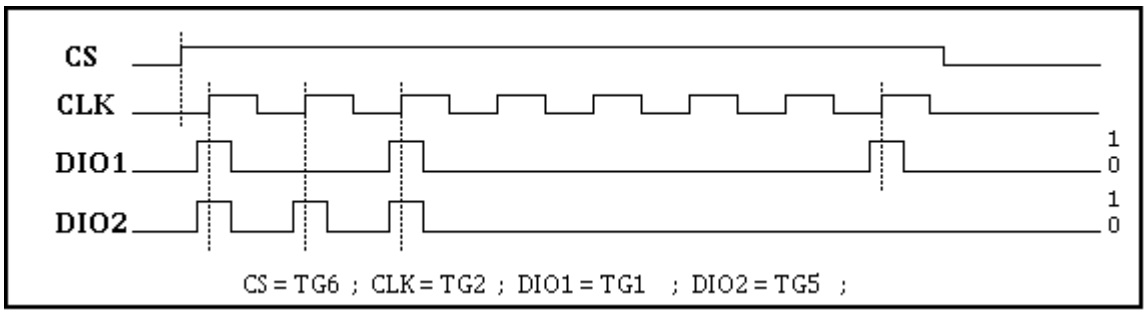


Fig.14 In pause state,PWM1 and PWM2 will stay at logic low. The pause state will be released by RESUME command.

Resume the playback(RESUME)

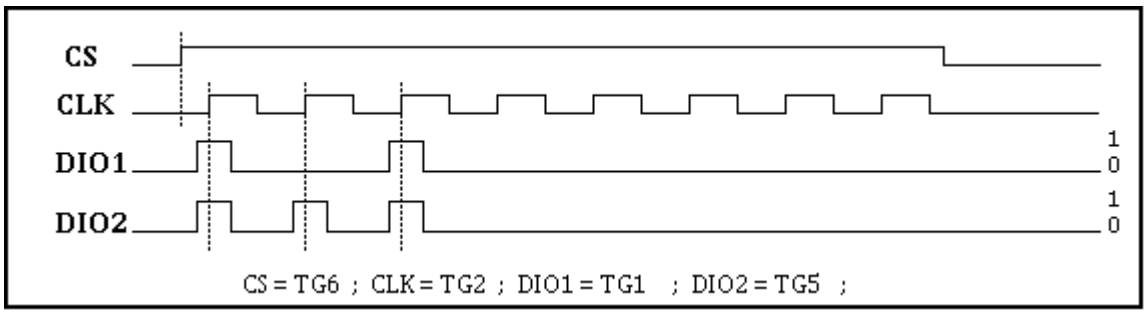


Fig.15 When Resume command is clocked into chip,the chip will continue to play the Voice Group which is paused.

DC CHARACTERISTICS (T=0~70℃， VCC = 3.0V， VSS = 0V)

Symbol	Parameter	Min.	Typ.	Max.	Unit.	Condition
V_{DD}	Operating Voltage	2.4	3.0	5.0	V	-
I_{SB}	Standby current	-	1	-	uA	I/O open
I_{OP}	Operating current	-	600	-	uA	I/O open
V_{IN}	“H” Input Voltage	-	3.0	-	V	V_{DD}=3.0V
V_{IL}	“L” Input Voltage	-	0	-	V	V_{DD}=3.0V
I_{OL}	Vout low O/P Current	-	200	-	mA	V_{out}=0.3V, V_{DD} =5.0V
I_{OH}	Vout high O/P Current	-	200	-	mA	V_{out}=2.5V, V_{DD} =5.0V
I_{CO}	Cout O/P Current	-	5	-	mA	VCOUT=1.0V
I_{OL}	O/P low Current	-	3	-	mA	V_{OH}=0.3V, V_{DD} =5.0V
I_{OH}	O/P high Current	-	10	-	mA	V_{OL}=2.5V, V_{DD} =5.0V

AVSOLUTE MAXIMUM RATINGS

Symbol	Rating	Unit
V_{DD} - V_{SS}	-0.5 ~ +6	V
V_{IN}	V_{SS}-0.3< V_{IN} <$V_{DD/3.3}$+0.3	V
V_{OUT}	V_{SS}< V_{OUT} <$V_{DD/3.3}$	V
T(Operationg)		℃
DIP	-20 ~ +70	
SOP	-20 ~ +85	
T(Junction)	-20 ~ +125	
T(Storage)	-20 ~ +125	

PLAY RATE LEVEL

AK040DIP16 can provide different play rate in one code as follow:

Play rate(Khz)	Play rate(Khz)	Play rate(Khz)
3	4.364	8.727
3.097	4.8	9.6
3.2	5.053	10.667
3.31	5.33	12
3.429	5.647	13.714
3.556	6	16
3.692	6.4	19.2
3.84	6.857	24
4	7.385	
4.147	8	

TIMING WAVEFORMS

KEY Trigger Mode

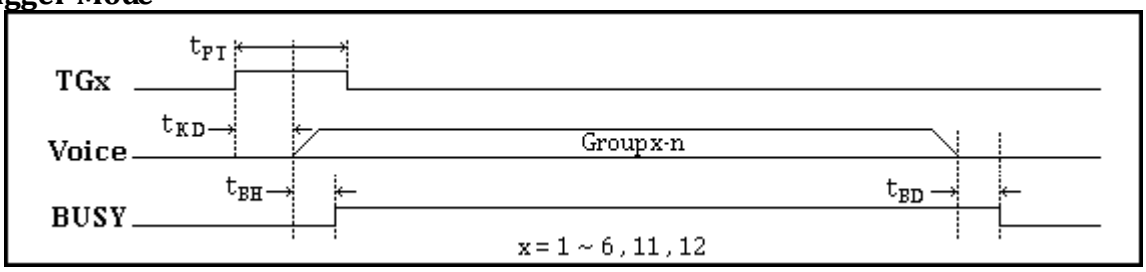


Fig.16

Serial Trigger Mode

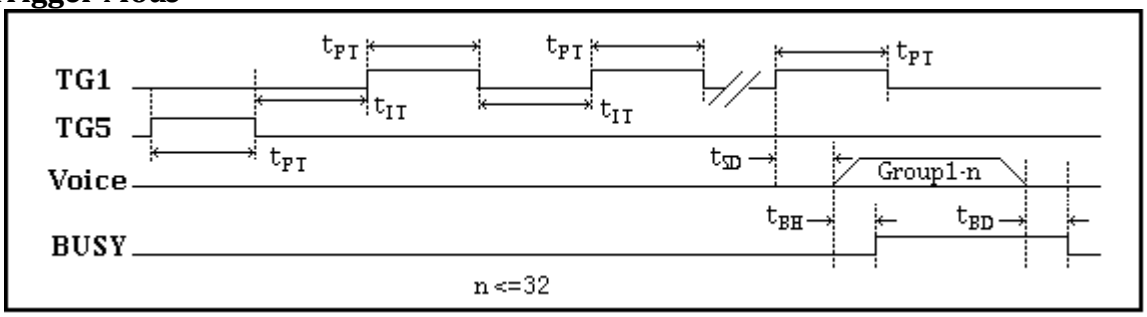


Fig.17

CPU Command Mode

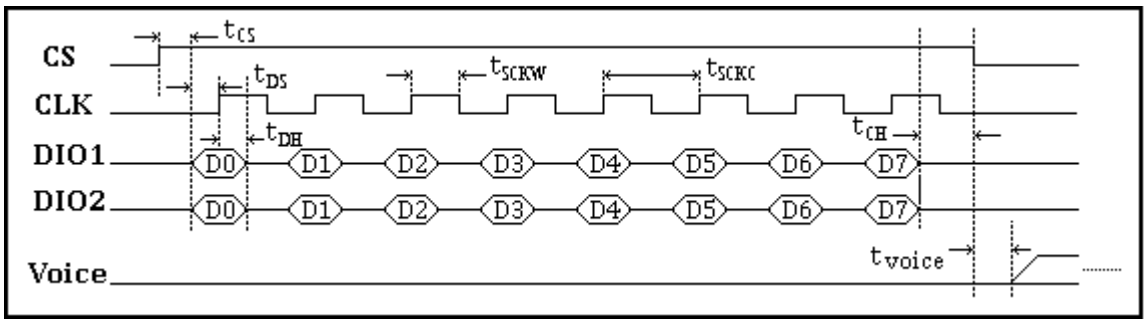


Fig.18

AC CHARACTERISTICS (T=0~70℃， VCC = 3.0V，VSS = 0V)

Symbol	Parameter	Min.	Typ.	Max.	Unit
t_{KD}	Key trigger debounce time(long)	14	-	-	ms
t_{KD}	Key trigger debounce time(short)	50	-	-	us
t_{PT}	Plus width	100	-	-	us
t_{BH}	Busy signal output delay time	400	-	-	us
t_{BD}	Busy signal output hold time	400	-	-	us
t_{IT}	The interval of two plus	100	-	-	us
t_{SD}	Voice output delay time	400	-	-	us
t_{CS}	Chip select set-up time	1	-	-	us
t_{DS}	Data-in set-up time	1	-	-	us
t_{DH}	Data-in hold time	1	-	-	us
t_{SCKW}	Clock pulse width	1	-	-	us
t_{SCRC}	Clock cycle time	2	-	-	us
t_{CH}	Chip select hold time	1	-	-	us
t_{VOICE}	Voice output delay time	400	-	-	us

Notes: 1.The long or short debounce time is selectable as whole chip option during Voice Files Compiling.
2.This parameter is proportional to the Operating voltage.

TYPICAL APPLICATIONS

KEY Trigger Mode

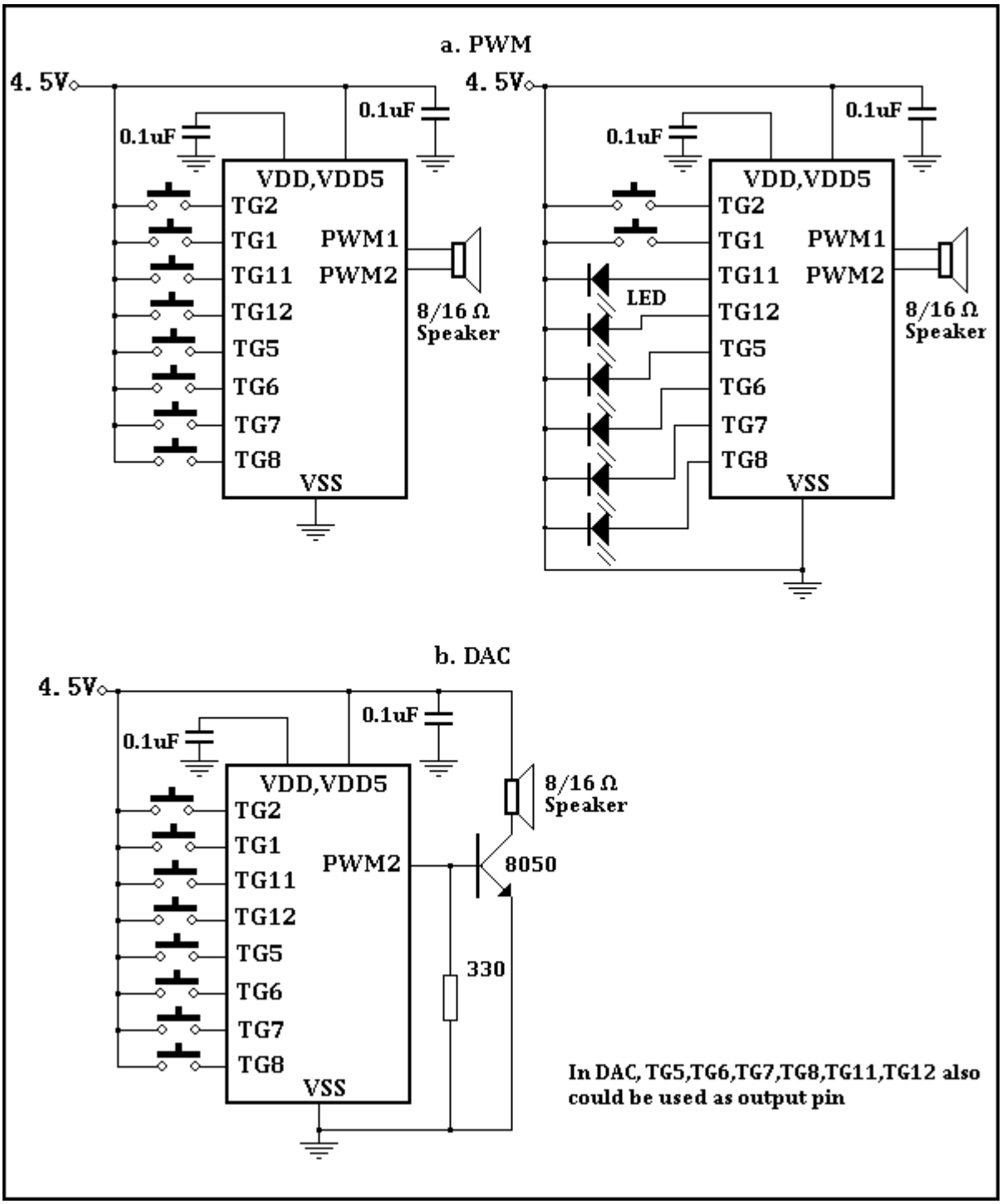


Fig19. Using 4.5V power supply

Notes:

1. The value of the 330 Ohm base resistor should be modified according to different Vdd value,the kind of speaker and NPN transistor or OP.

Serial Trigger Mode

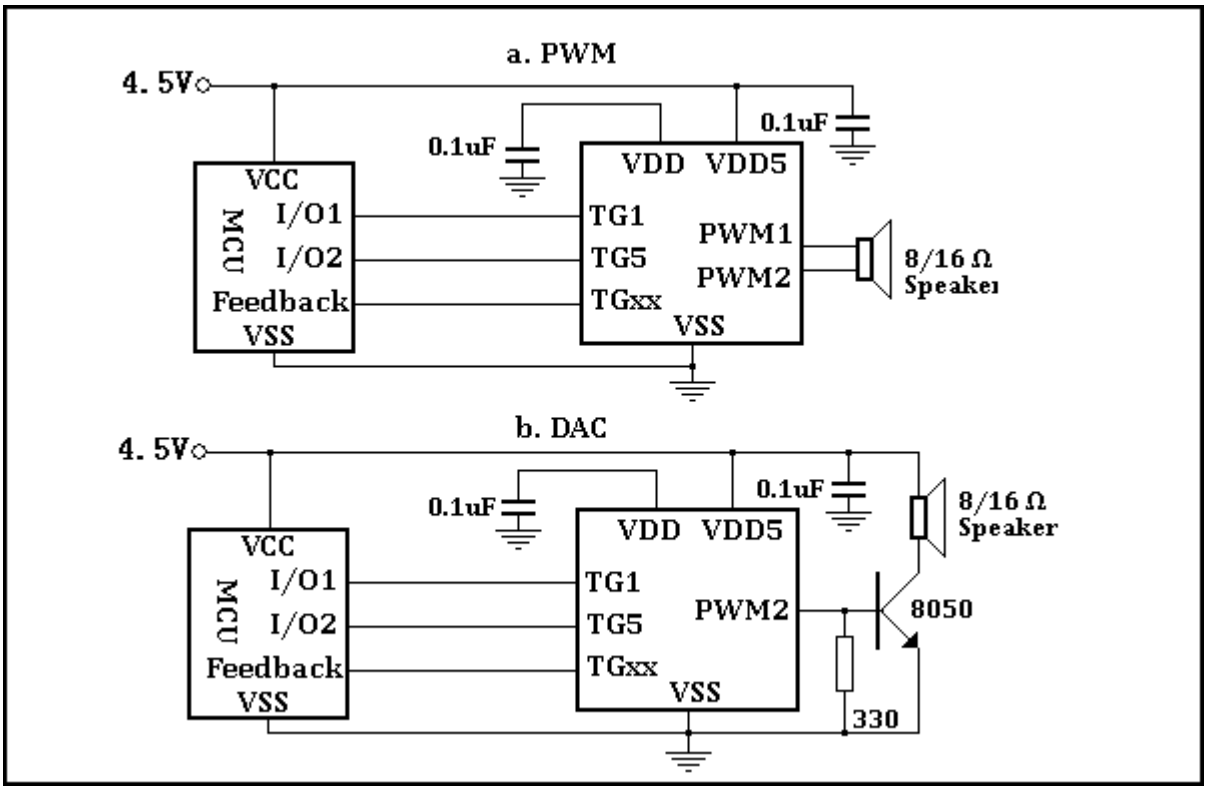


Fig20.Using 4.5V power supply

CPU Command Mode

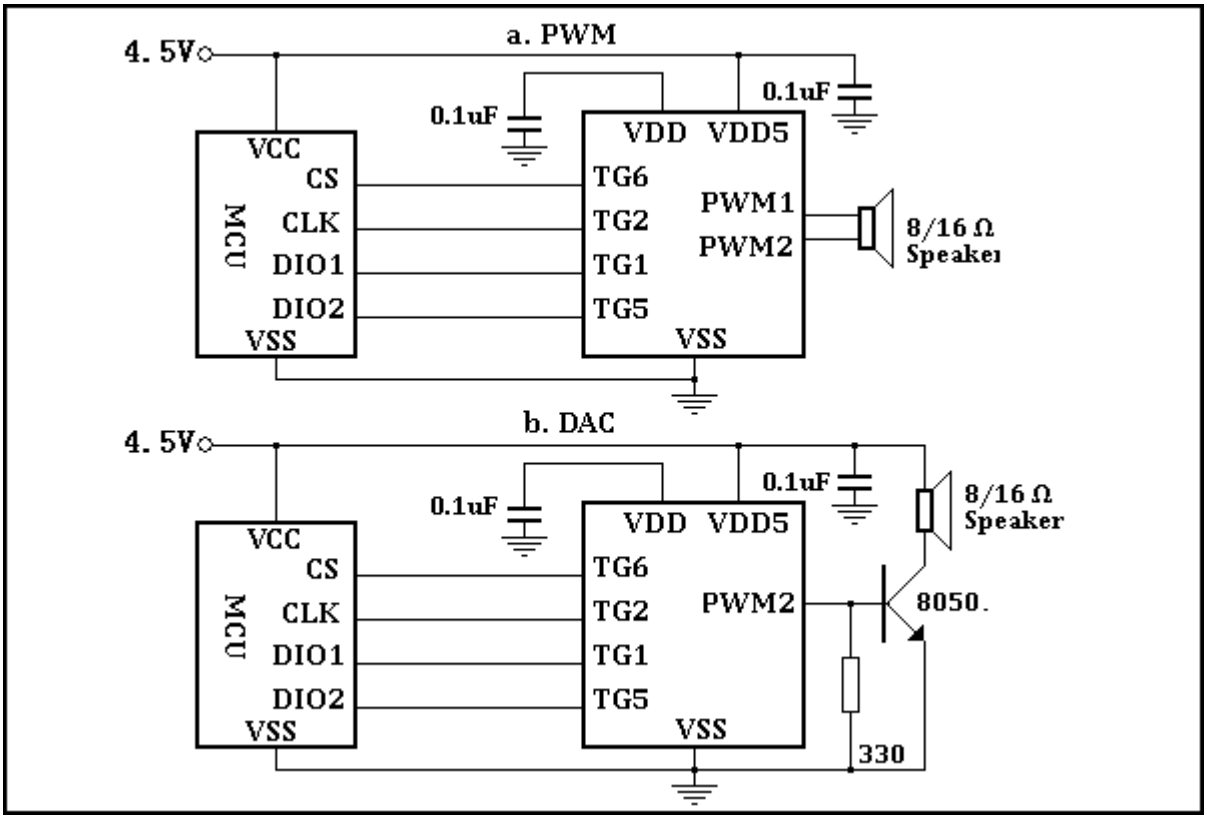
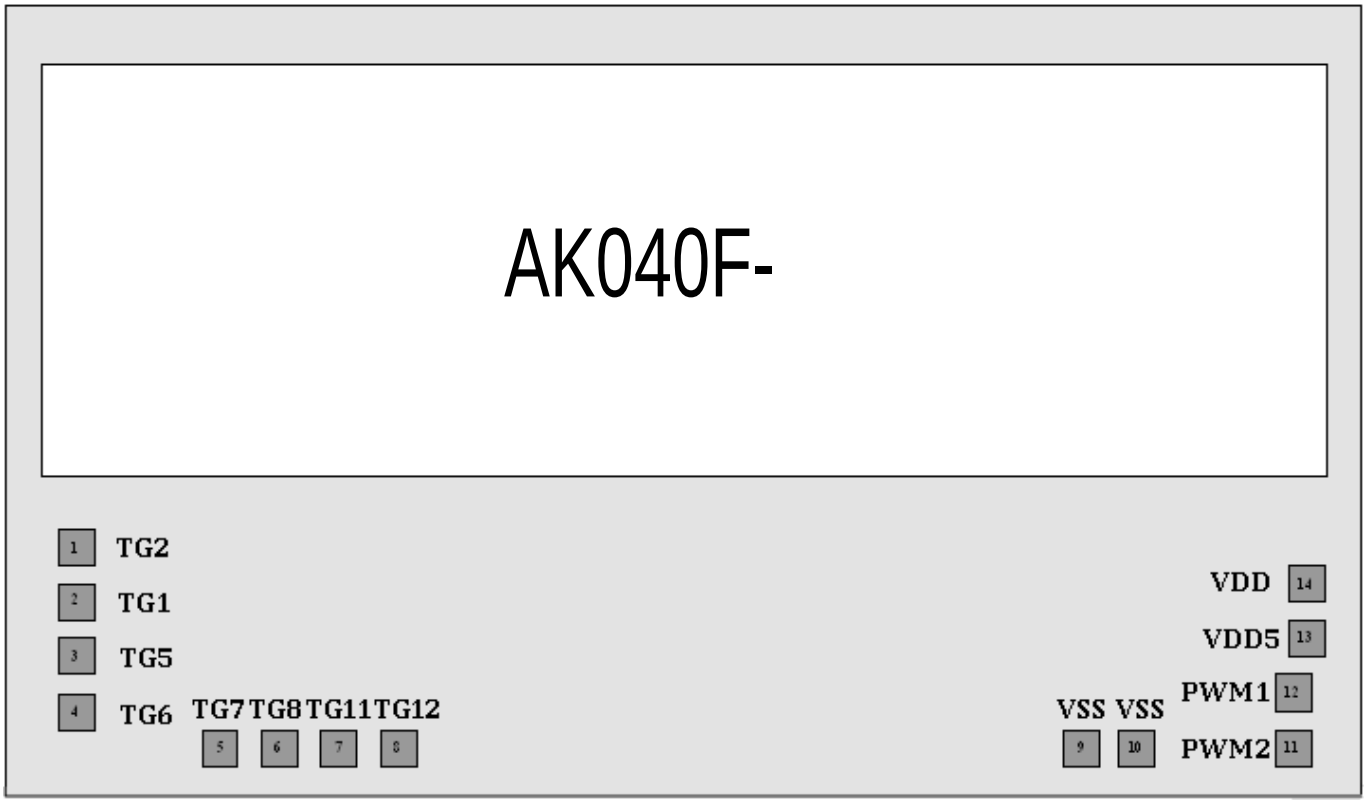


Fig21.Using 4.5V power supply

BONDING PAD DIAGRAMS



Notes:

1.VDD pad should be connected to the Positive Power Supply during voice playback.

2.Two VSS pads should be connected to the Power GND.

3.The substrate should be connect to Power GND.