# SPC21A1

20KB SOUND CONTROLLER

SUNPLUS
凌陽科技

GENERAL DESCRIPTION

The SPC21A1 is a CPU based two-channel speech/melody synthesizer including CMOS 8-bit microprocessor with 69 instructions, 20K-byte ROM for speech and melody data (Speech is compressed by a 4-bit ADPCM with approx. 6 sec speech duration @ 7KHz sampling rate) and 64-byte working SRAM. It includes two Timer/Counters, 10 Software Selectable I/Os, and one 8-bit current D/A output. For audio processing, melody and speech can be mixed into one output. It operates over a wide voltage range of 2.4V - 5.5V and includes Low Voltage Reset function. The Low Voltage Reset automatically resets when the working voltage is less than 2.2V. In addition, SPC21A1 has a Clock Stop mode for power savings. The power savings mode saves the RAM contents, but freezes the oscillator, causing all other chip functions to be inoperative. The Max. CPU clock frequency is 6.0MHz. It has an Instruction Cycle Rate of 2 clock cycles (min.) – 6 clock cycles (max.). The SPC21A1 includes, not only the latest technology, but also the full commitment and technical support of Sunplus.

FEATURES

- 8-bit microprocessor
- **Provides 20K-byte ROM for program and audio data**
- **64-byte working SRAM**
- Software-based audio processing
- Wide operating voltage: 2.4V – 3.4V @ 4.0MHz
  3.6V – 5.5V @ 6.0MHz
- **Supports Rosc only**
- Max. CPU clock: 4.0MHz @ 3V, 6.0MHz @ 5V
- Standby mode (Clock Stop mode) for power Savings. Max. 2μA @ 5V
- 500ns instruction cycle time @ 4.0MHz CPU clock
- **Provides 10 general I/Os**
- Two 12-bit timer/counters
- 6 INT sources
- Key wake -up function
- **Approx. 6 sec speech @ 7KHz sampling rate with ADPCM**
- **One D/A output**
- **Low Voltage Reset**

BLOCK DIAGRAM
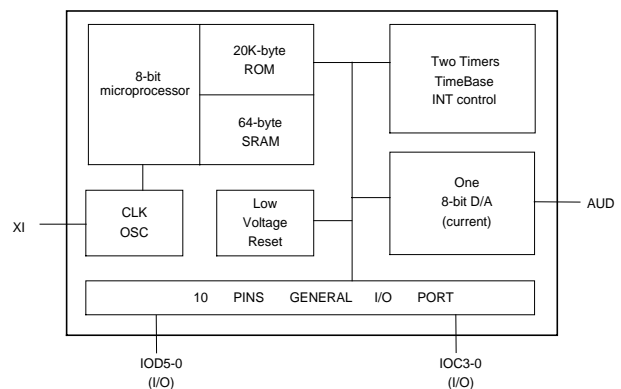
APPLICATION FIELD

- Intelligent education toys
  Ex. Pattern to voice (animal, car, color, etc.)
  Spelling (English or Chinese)
  Math
- High end toy controller
- Talking instrument controller
- General speech synthesizer
- Industrial controller

© Sunplus Technology Co., Ltd.   1   Rev.: 1.1   1999.11.19

FUNCTION DESCRIPTIONS

■ CPU

The SPC21A1 8-bit microprocessor is a high performance processor equipped with Accumulator, Program Counter, X Register, Stack pointer and Processor Status Register (this is the same as the 6502 instruction structure).   SPC21A1 is able to perform with 6.0MHz (max.) depending on the application specifications.

■ ROM AREA

The SPC21A1 provides a 20K-byte ROM that can be defined as the program area, audio data area, or both.

■ RAM AREA

The SPC21A1 total RAM consists of 64-bytes (including Stack) at locations from $C0 through $FF.

■ MAP OF MEMORY AND I/Os

*I/O PORT:

  - PORT IOC $0004

            IOD $0005

  - I/O CONFIG $0000

            $0001
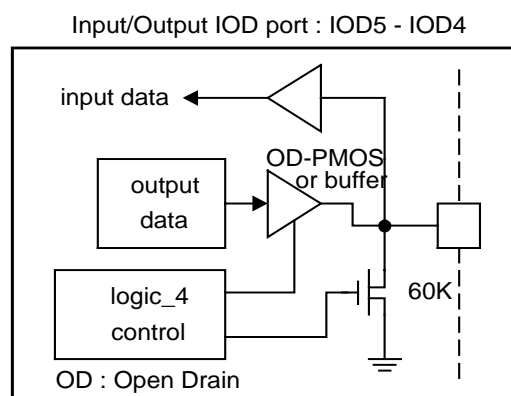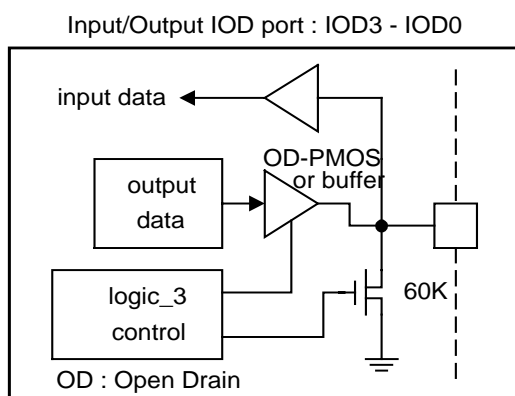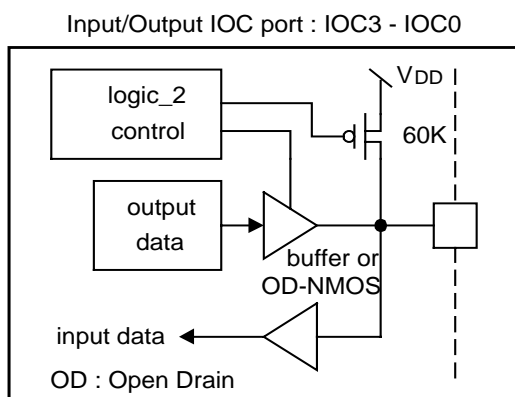
*NMI SOURCE:

  - INTA   (from TIMER A)

*INT SOURCE:

  - INTA (from TIMER A)

  - INTB (from TIMER B)

  - CPU CLK / 1024

  - CPU CLK / 8192

  - CPU CLK / 65536

  - EXT INT

*MEMORY MAP (From ROM view)

Address	Region
$00000	Hardware register, I/Os
$000C0	USER RAM and STACK
$00100	UNUSED
$00200	SUNPLUS TEST PROGRAM
$00600	USER'S PROGRAM & DATA AREA
$03FFF	DUMMY AREA
$07000	USER'S PROGRAM & DATA AREA
$07FFF	

■ I/O PORT CONFIGURATION*

Input/Output IOC port : IOC3 - IOC0

Input/Output IOD port : IOD3 - IOD0

Input/Output IOD port : IOD5 - IOD4

*Values shown are for VDD = 5.0V test conditions only.

■ **POWER SAVINGS MODE**

The SPC21A1 provides a power savings mode (Standby mode) for those applications that require very low stand-by current.   To enter standby mode, the Wake-Up Register should be enabled and then stop the CPU clock by writing the STOP CLOCK Register.   The CPU will then go to the stand-by mode.   In such a mode, RAM and I/Os will remain in their previous states until being awakened.   Port IOD7-0 is the only wake-up source in the SPC21A1.   After the SPC21A1 is awakened, the internal CPU will go to the RESET State (Tw ≧ 65536 x T1) and then continue processing the program.   Wakeup Reset will not affect RAM or I/Os (FIG.1).
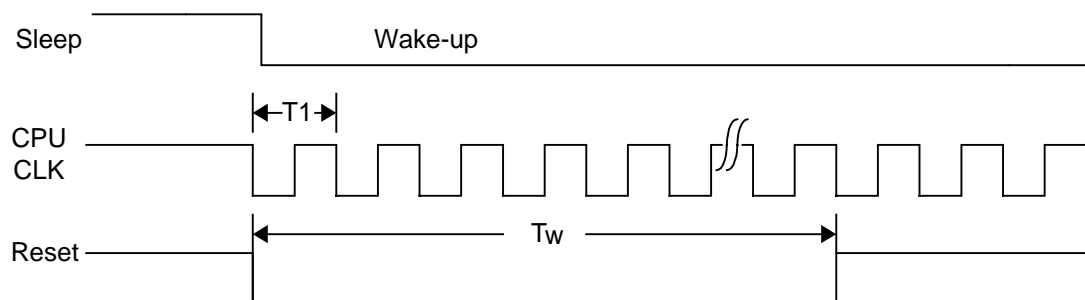

FIG. 1

$T1 = 1 / (F_{CPU})$, Tw $\geqq 65536$ x T1

■ **LOW VOLTAGE RESET**

The SPC21A1 includes a Low Voltage Reset (LVR) function. Below the minimum power-supply voltage of 2.2V, the CPU system will become unstable and malfunction.   Low Voltage Reset will reset all functions into the initial operational (stable) state if the VDD power-supply voltage drops below 2.2V (FIG.2).

$T2 \geqq 2 * T1$
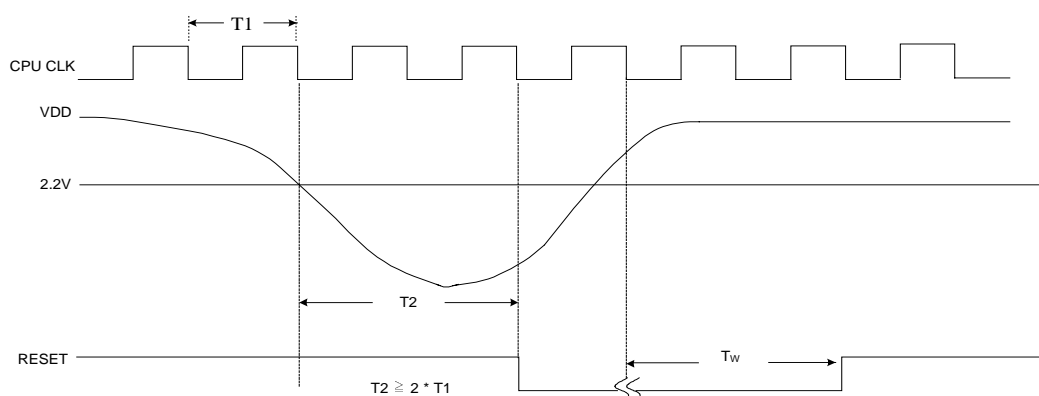
(The LVR function is the same as Power ON Reset or External Reset.)

FIG. 2

■ **TIMER/COUNTER**

The SPC21A1 contains two 12-bit timer/counters, TMA and TMB respectively. TMA can be specified as a timer or a counter, but TMB can only be used as a timer. In the timer mode, TMA and TMB are re-loaded up-counters. When timer overflows from $0FFF to $0000, the carry signal will make the timer automatically reload to the user's pre-set value and be up-counted again. At the same time, the carry signal will generate the INT signal if the corresponding bit is enabled in the INT ENABLE Register. If TMA is specified as a counter, users can reset by loading #0 into the counter. After the counter has been activated, the value of the counter can also be read from the counters at the same time. The read instruction will not affect the value of the counter or reset it.

Clock source of Timer/Counter can be selected as follows:

Timer/Counter		Clock Source
TMA	12-BIT TIMER	CPU CLOCK (T) or T/4
	12-BIT COUNTER	T/64, T/8192, T/65536 or EXT CLK
TMB	12-BIT TIMER	T or T/4
MODE SELECT REGISTER		TMA only, select timer or counter
TIMER CLOCK SELECTOR		Select T or T/4

■ **SPEECH AND MELODY**

Since the SPC21A1 provides a large ROM and wide range of CPU operation speeds, it is most suitable for speech and melody synthesis.

For speech synthesis, the SPC21A1 can provide NMI for accurate sampling frequency. Users can record or synthesize the sound and digitize it into the ROM. The sound data can be played back in the sequence of the control functions as designed by the user's program. Several algorithms are recommended for high fidelity and compression of sound including PCM, LOG PCM, and ADPCM.

For melody synthesis, the SPC21A1 provides the dual tone mode. After selecting the dual tone mode, users only need to fill either TMA or TMB, or both TMA and TMB to generate expected frequency for each channel. The hardware will toggle the tone wave automatically without entering into an interrupt service routine. Users are able to simulate musical instruments or sound effects by simply controlling the envelope of tone output.

PIN DESCRIPTION*

Mnemonic	PIN No.	Type	Description
VDD	8	I	Supply voltage input
VSS	7	I	Ground
XI	9	I	Oscillator crystal input or RESISTOR (Resistor should be connected to VDD)
RESET	2	I	RESET
TEST	11	I	TEST MODE
AUD	10	O	AUDIO OUTPUT
IOC0 IOC1 IOC2 IOC3	6 5 4 3	I/O I/O I/O I/O	Port C is an 4-bit bi-directional programmable Input / Output port with Pull-high or Open-drain option.　As inputs, Port C can be in either the Pure or Pull-high states.　As outputs Port C can be a Buffer or Open-drain NMOS type (sink current). IOC1:EXT INT IN IOC2:EXT COUNT IN **See note 1 and 2 below.
IOD0 IOD1 IOD2 IOD3 IOD4 IOD5	17 16 15 14 13 12	I/O I/O I/O I/O I/O I/O	Port D is an 6-bit bi-directional programmable Input / Output port with Pull-low or Open-drain option.　As inputs, Port D can be either Pure or Pull-low states.　As outputs, Port D can be either Buffer or Open-drain PMOS type (send current). (Key change, Wake up I/O) **See note 1 and 2 below.

* Refer to SPC Programming Guide for complete information.

**Note: 1.) Two input states can be specified; Pure Input, Pull-High or Pull Low.

　　　2.) Three output states can be specified as Buffer output, Open Drain PMOS output (send), or Open Drain NMOS output (sink).

ABSOLUTE MAXIMUM RATINGS

Characteristics	Symbol	Ratings
DC Supply Voltage	V+	< 7V
Input Voltage Range	V_{IN}	-0.5V to V+ + 0.5V
Operating Temperature	T_A	0℃ to +60℃
Storage Temperature	T_{STO}	-50℃ to +150℃

Note: Stresses beyond those given in the Absolute Maximum Rating table may cause operational errors or damage to the device.　For normal operational conditions see AC/DC Electrical Characteristics.

AC CHARACTERISTICS (TA = 25 ℃)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
OSC Frequency	F$_{OSC2}$	-	2.0	4.0	MHz	VDD = 3V
		-	4.0	6.0	MHz	VDD = 5V

DC CHARACTERISTICS (TA = 25 °C, VDD = 3 V)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Operating Voltage	V$_{DD}$	2.4	-	3.4	V	For 2-battery
Operating Current	I$_{OP}$	-	1.5	2.0	mA	F$_{CPU}$ = 3.0MHz @ 3V, no load
Standby Current	I$_{STBY}$	-	-	2.0	μA	VDD = 3V
Audio output current	I$_{AUD}$	-	-1.5	-	mA	VDD = 3V,one-channel
Input High Level	V$_{IH}$	2.0	-	-	V	VDD = 3V
Input Low Level	V$_{IL}$	-	-	0.8	V	VDD = 3V
Output High I IOC,IOD	I$_{OH}$	-1.0	-	-	mA	VDD = 3V V$_{OH}$ = 2V
Output Sink I IOC,IOD	I$_{OL}$	2.0	-	-	mA	VDD = 3V V$_{OL}$ = 0.8V
Input Resistor IOD	R$_{IN}$	-	110	-	Kohm	Pull Low VDD = 3V

DC CHARACTERISTICS (TA = 25 °C, VDD = 5 V)

Characteristics	Symbol	Limit			Unit	Test Condition
		Min.	Typ.	Max.		
Operating Voltage	V$_{DD}$	3.6	-	5.5	V	For 3-battery
Operating Current	I$_{OP}$	-	4.0	5.0	mA	F$_{CPU}$ = 4.0MHz @ 5V, no load
Standby Current	I$_{STBY}$	-	-	2.0	μA	VDD = 5V
Audio output current	I$_{AUD}$	-	-3.0	-	mA	VDD = 5V, one-channel
Input High Level	V$_{IH}$	3.0	-	-	V	VDD = 5V
Input Low Level	V$_{IL}$	-	-	0.8	V	VDD = 5V
Output High I IOC,IOD	I$_{OH}$	-1.0	-	-	mA	VDD = 5V V$_{OH}$ = 4.2V
Output Sink I IOC,IOD	I$_{OL}$	4.0	-	-	mA	VDD = 5V V$_{OL}$ = 0.8V
Input Resistor IOD	R$_{IN}$	-	60	-	Kohm	Pull Low VDD = 5V

SUNPLUS 凌陽科技

SPC21A1

The relationship between the Rosc and the F$_{CPU}$

VDD = 3.0V , Ta = 25℃
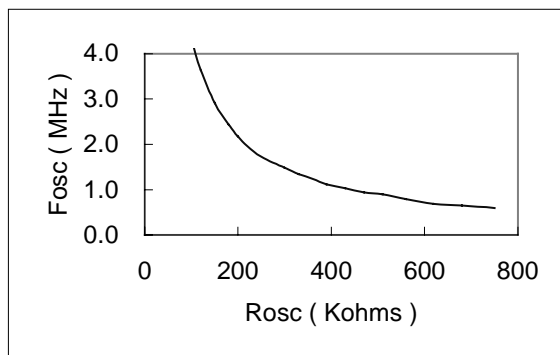
VDD = 4.5V , Ta = 25℃
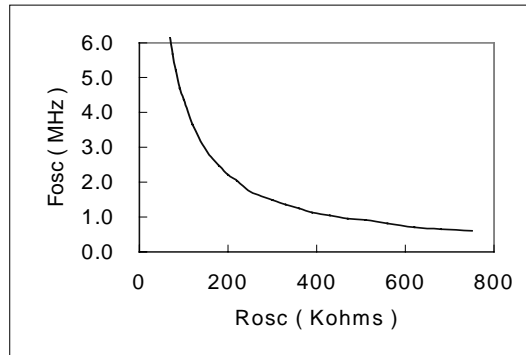
Frequency vs. Temperature
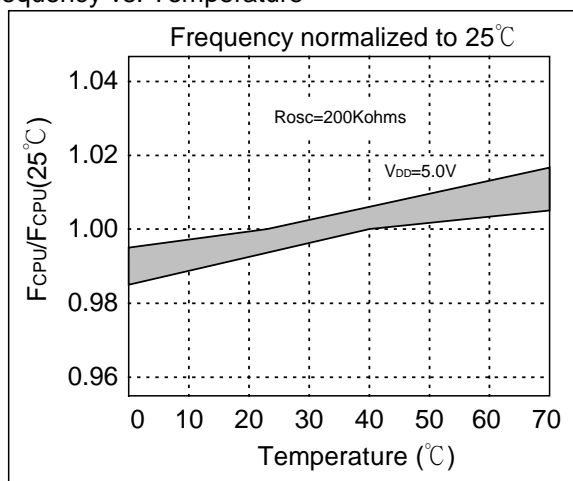
Frequency vs. VDD
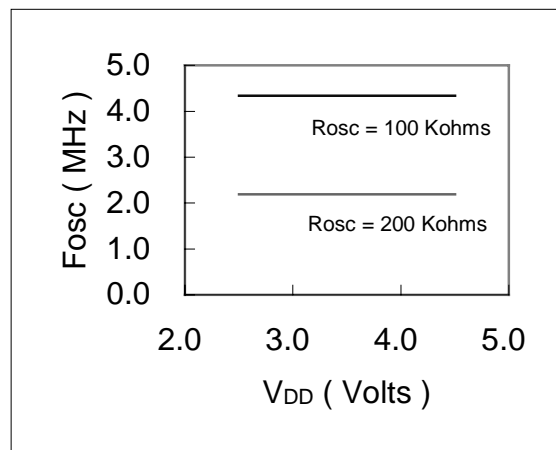
Operating current vs. Frequency vs. VDD

© Sunplus Technology Co., Ltd.   8   Rev.: 1.1   1999.11.19

SPC21A1

VDD

R1
50K

RESET

C1
0.1 μ

RESET

VDD

C3
220 μF

C4
0.1 μ

Pin	Signal
2	RESET
3	IOC3
4	IOC2
5	IOC1
6	IOC0
8	VDD

SPC21A1

VDD

R2
150K

Speaker

XI 9

AUD 10

C2
0.1 μ

R3
680

Q1
8050

Pin	Signal
12	IOD5
13	IOD4
14	IOD3
15	IOD2
16	IOD1
17	IOD0
1, 7	VSS
11	TEST

凌陽科技 SUNPLUS
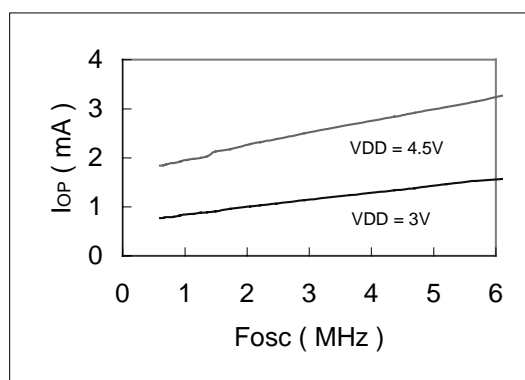
SPC21A1
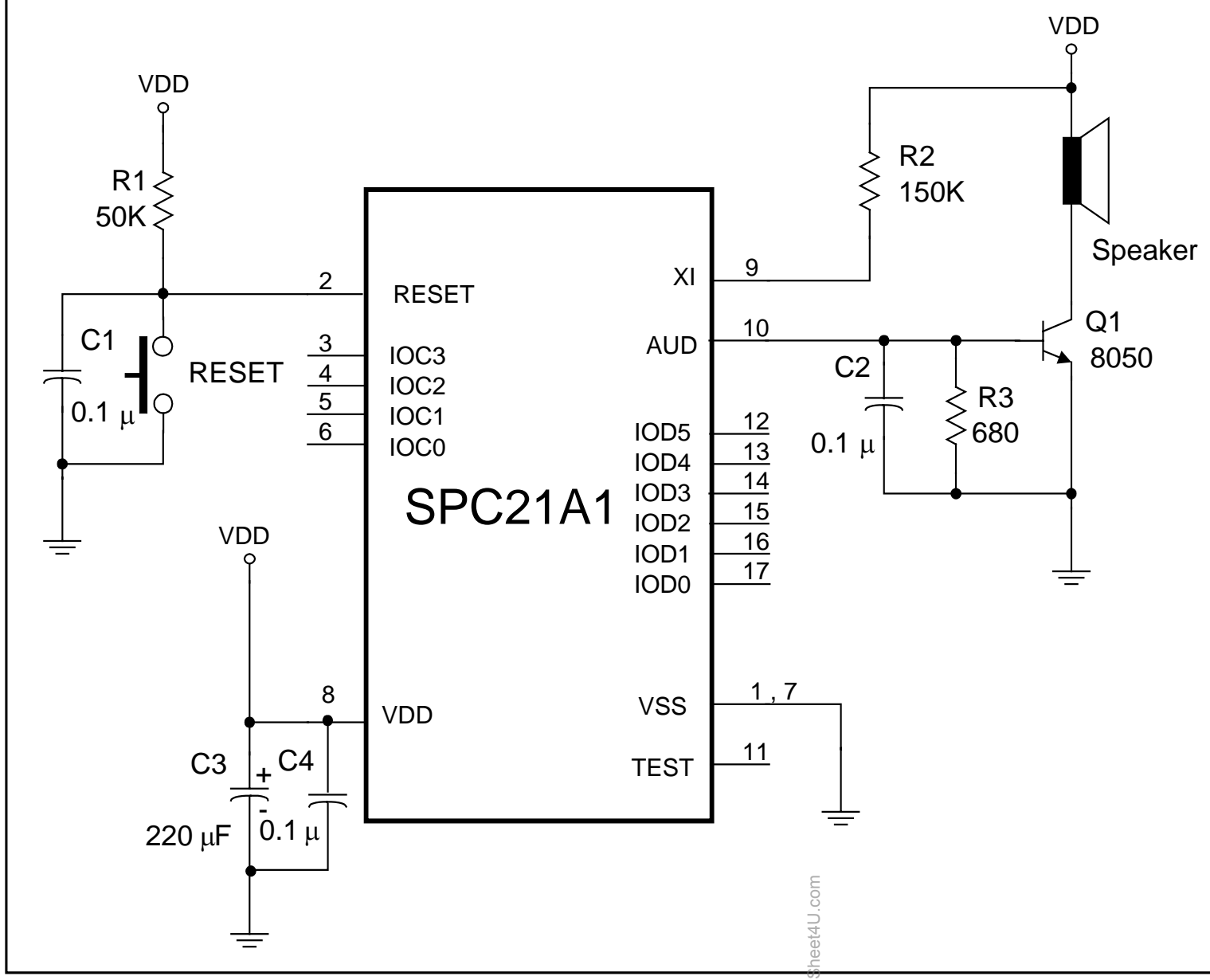
■ **Current Mode DAC Speaker Driver**

C1: 0.1μF ~ 1μF
RB1: 680 ~ 1.5K

VDD

4Ω ~ 8Ω

AUD
C1   RB1   8050

Figure 1

RB1: 10K ~ 50K
RB2: 820 ~ 1.5K
C1: 0.1μF ~ 1μF

VDD

32Ω ~ 64Ω

AUD   RB1   8050
RB2   C1

Figure 2

RB1: 2K~10K; C1: 1μF~10μF
RB2: ~1K;   C2: ~0.1μF

VDD

4Ω ~ 64Ω

C2
AUD   RB1   8050
RB2   C1

Figure 3

RB1: 2K~10K; C1: 1μF~10μF
RB2: ~1K;   C2: ~0.1μF

VDD

4Ω ~ 8Ω

Enable   RB1
C2
AUD   8050
RB2   C1

Figure 4

VDD

4Ω ~ 64Ω

RB1: ~ 360Ω (Vol)
RB2: ~ 4.7Ω

AUD   8050
1N4148
RB1   RE1

Figure 5

Power

AUDP   3   6   220μF
LM386   5   +
RB1   2   7   10
4   0.1μF
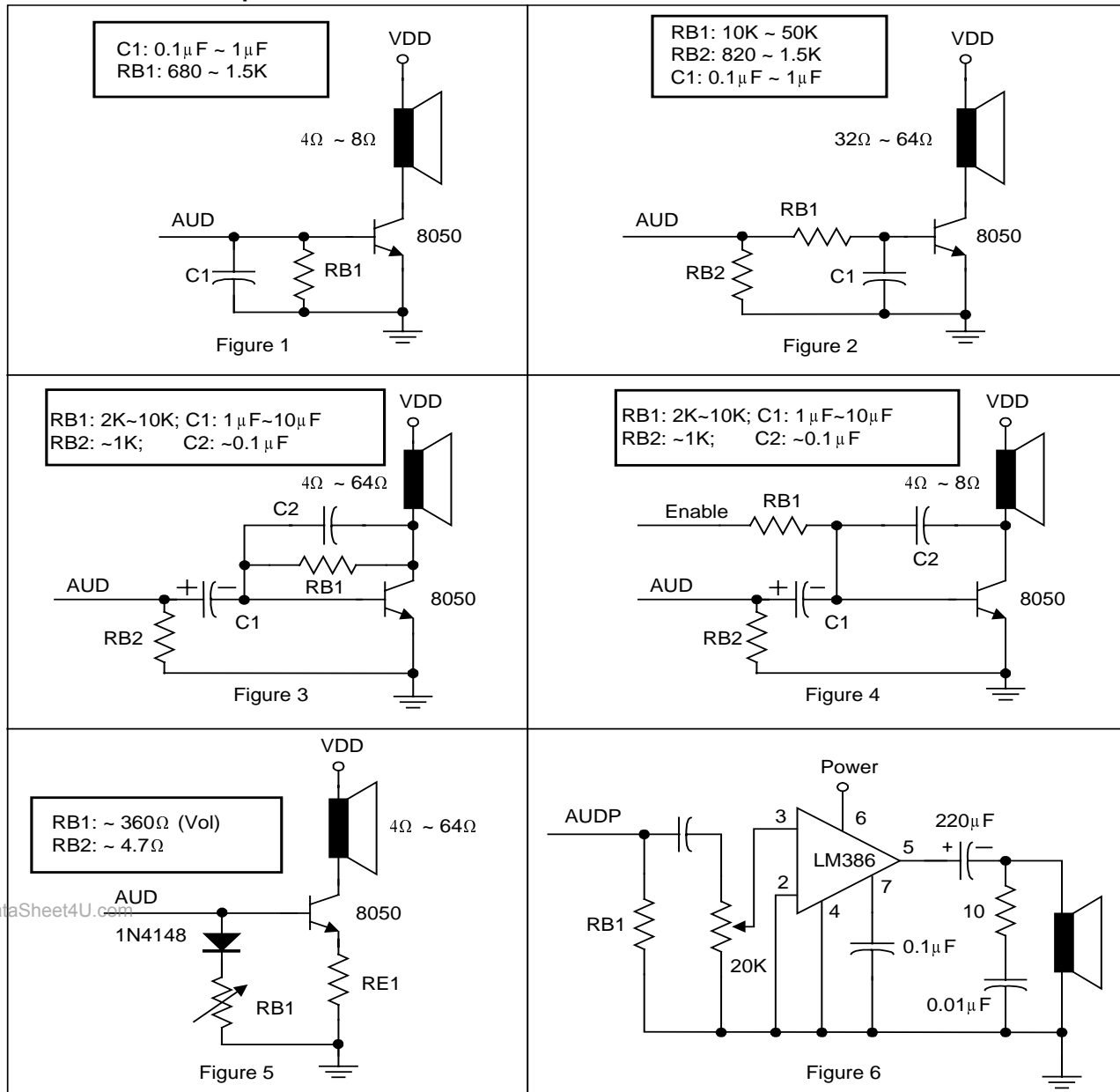20K   0.01μF

Figure 6

Figure 1:The simplest CKT uses with low impedance speaker.   It has high operation current, but low cost.

Figure 2:It is the same as Figure 1 but a high impedance speaker is used.

Figure 3:The CKT contains a low pass filter.   It is capable of providing higher speech quality, but it takes higher operation current.

Figure 4:Improved version of Figure 3.   The standby current can be controlled by the enable pin.
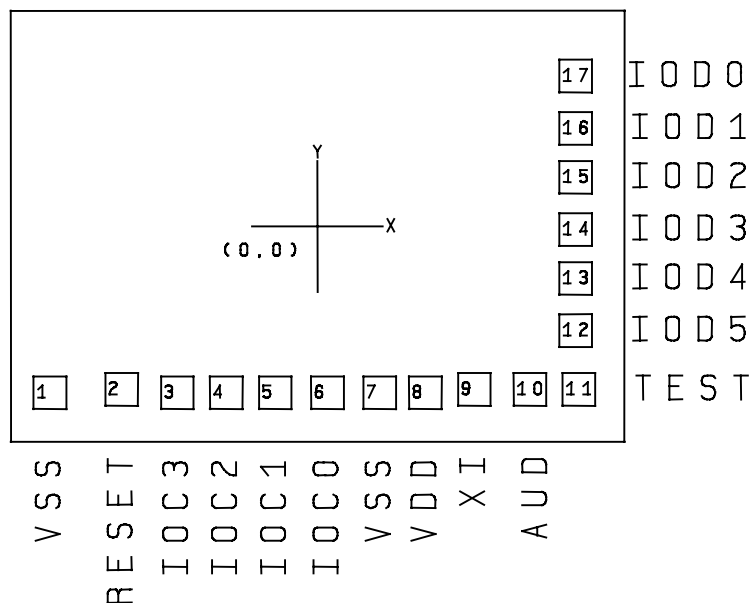
Figure 5:The current mirror mode.   It is able to control the volume.   In addition, it is more stable and has lower operation current than Figure 1-3.

Figure 6:High quality, low operation current CKT, but more expensive.

SPC21A1

PAD ASSIGNMENT AND LOCATIONS

■ PAD Assignment

Chip Size: 1980μm x 1420μm

This IC substrate should be connected to VSS

Note: To ensure that the IC functions properly, bond all VDD, VSS, AVDD and AVSS pins.

Ordering Information

Product Number	Package Type
SPC21A1-nnnnV-C	Chip form

Note1: Code number (nnnnV) is assigned for customer.

Note2: Code number (nnnn = 0000 - 9999) ; version (A = A - Z).

NOTE: SUNPLUS TECHNOLOGY CO., LTD reserves the right to make changes at any time without notice in order to improve the design and performance and to supply the best possible product.

■ **PAD Locations**

Pad No	Pad Name	X	Y
1	VSS	-822	-509
2	RESET	-604	-498
3	IOC3	-431	-509
4	IOC2	-276	-509
5	IOC1	-125	-509
6	IOC0	30	-509
7	VSS	187	-509
8	VDD	327	-509
9	XI	482	-498
10	AUD	648	-498
11	TEST	803	-498
12	IOD5	788	-316
13	IOD4	788	-157
14	IOD3	788	-6
15	IOD2	788	153
16	IOD1	788	305
17	IOD0	788	464

DISCLAIMER

The information appearing in this publication is believed to be accurate.

Integrated circuits sold by Sunplus Technology are covered by the warranty and patent indemnification provisions stipulated in the terms of sale only.   SUNPLUS makes no warranty, express, statutory implied or by description regarding the information in this publication or regarding the freedom of the described chip(s) from patent infringement.   FURTHERMORE, SUNPLUS MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PURPOSE. SUNPLUS reserves the right to halt production or alter the specifications and prices at any time without notice.   Accordingly, the reader is cautioned to verify that the data sheets and other information in this publication are current before placing orders. Products described herein are intended for use in normal commercial applications.   Applications involving unusual environmental or reliability requirements, e.g. military equipment or medical life support equipment, are specifically not recommended without additional processing by SUNPLUS for such applications.   Please note that application circuits illustrated in this document are for reference purposes only.