

## HIGH-PRECISION PWM SUPPORTED ADC MCU

### DESCRIPTION

SC51P66E04 adopts SC51 core with built-in 4Kbyte OTP, 128 byte RAM and 256 byte E<sup>2</sup>PROM. It integrates one 16MHz high-precision RCK, one 6-channel 12-bit precision ADC, one universal pulse generator, supporting 2-channel complementary PWM output and it suitable for intelligent lighting, switching dimming and color matching etc.

### APPLICATIONS

- ◆ Intelligent lighting
- ◆ Switching dimming and color matching
- ◆ Mobile power pack
- ◆ Toy plane
- ◆ Electric car charger
- ◆ Small Appliances
- ◆ E-cigarette
- ◆ HID



### FEATURES

- ◆ 8-bit SC51 CPU
  - Compatible with MCS51 instruction set, dual DPTR; support software reset instruction.
  - Improved instruction structure, the execution time of 90% instructions is two to four clock cycles.
  - Stack overflow reset
- ◆ On-chip Memory
  - 4K-byte OTP, data retention time > 10 years.
  - 128-byte RAM.
  - 256-byte E<sup>2</sup>PROM, data retention time > 10 years, write cycles > 500,000.
  - Support In-System-Programming (ISP), only 5-pins are needed (including VDD/VSS).
  - Support Multi-Time-Programming (MTP): 1K×4 / 2K×2 / 4K×1.
  - Support OTP page encryption, page size: 1K
- ◆ Power supply and Reset
  - Operation voltage: 2.4V~5.5V
  - Built-In Power-On-Reset(POR)
  - Built-In Low-Voltage-Reset (LVR) with 4 levels selectable: 2.0V, 2.6V, 3.0V, 3.6V
  - Built-In Low-Voltage-Detect (LVD) with 8 levels selectable.
  - Built-in watchdog (WDT)
- ◆ System clock
  - Built-in 20KHz low frequency RCL.
  - Built-in 16KHz high precision RCH.

- Maximum CPU frequency: 8MHz @ 2.4~5.5V
- Pre-scale factors of system clock: 2/4/8/16
- ◆ Input /Output
  - Support up to 6 I/O ports.
  - P1 driving capability: 2 levels selectable
  - P1 (4pins) ports support keyboard interrupt wake-up function, interrupt polarity selectable
  - 2-channel external interrupt, interrupt polarity selectable
- ◆ Peripheral devices
  - Two 16-bit Timers (T0/T1), compatible with traditional MCS51, T0 supports square wave output while T1 supports PWM output
  - 12-bit universal pulse generator (UPG), supporting 8+4 precision expansion and 2-channel complementary PWM output
  - One 4-channel 12-bit ADC, sample rate is up to 200ksps
  - 1-channel UART
- ◆ Operation Modes
  - Normal mode
  - IDLE mode
  - STOP mode
- ◆ Operating temperature
  - $T_A = -40 \sim 85^{\circ}\text{C}$  (default)
  - $T_A = -40 \sim 105^{\circ}\text{C}$  (T version)
- ◆ Package
  - 8-pin SOP.

## ORDERING INFORMATION

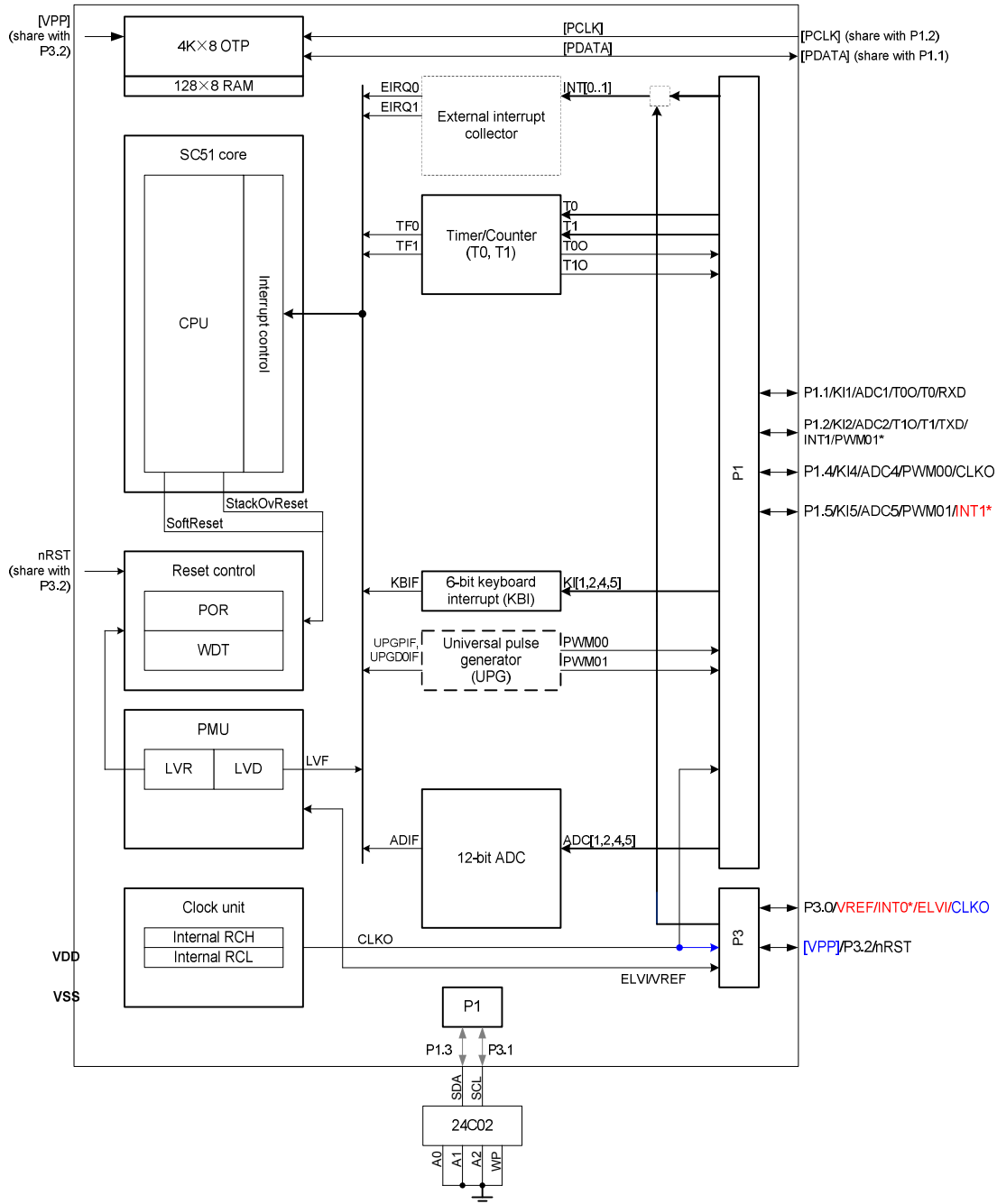
### ORDERING INFORMATION

Part No.	Package	Marking	Hazardous Substance Control	Packing
SC51P66E04SA1G	SOP-8-225-1.27	66E04SA1	Halogen free	Tube
SC51P66E04SA1GTR		66E04SA1	Halogen free	Tape&Reel

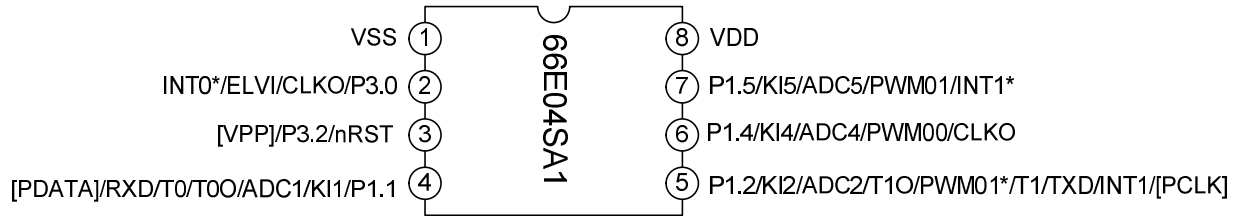
### RESOURCE INFORMATION

Feature	66E04
FLASH	4K Byte
RAM	128 Byte
EEPROM	256 Byte
I/O	6
External interrupt	2
T0	Capture input and square wave output
T1	Capture input and PWW output
KBI	4-channel input
UPG	2-way PWM output
ADC	4-channel
UART	1-way

**BLOCK DIAGRAM**



## PIN CONFIGURATION



## PIN DESCRIPTION

### PIN MULTIPLEX

I/O	Pin structure	Pin No.	System	External interrupt	Timer	Keyboard interrupt	ADC	Serial port	Program ming
P1.1	A	4	--	--	T0/T0O	KI1	ADC1	RXD	[PDATA]
P1.2	A	5	--	--	T1/T1O/ PWM01	KI2	ADC2	TXD	[PCLK]
P1.3	A	--	--	--	--	--	--	SDA	--
P1.4	A	6	--	--	PWM00	KI4	ADC4	--	--
P1.5	A	7	--	INT1	PWM01	KI5	ADC5	--	--
P3.0	A	2	CLKO/ ELVI	INT0	--	--	--	--	--
P3.1	A	--	--	--	--	--	--	SCL	--
P3.2	B	3	nRST	--	--	--	--	--	[VPP]
VDD	P1	8	--	--	--	--	--	--	--
VSS	P0	1	--	--	--	--	--	--	--

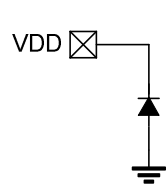
### PIN DESCRIPTION

I/O	Pin Type	Function Description
<b>Port</b>		
P1.1~P1.5	I/O	5-bit bidirectional I/O ports, bit operation available
P3.0~P3.2	I/O	3-bit bidirectional I/O ports, bit operation available
<b>Programming</b>		
[PCLK]	I	Programming clock
[PDATA]	I/O	Programming data
[VPP]	I	High voltage programming pin
<b>SYSTEM</b>		
nRST	I	External reset input, low voltage active
CLKO	O	Clock output
INT0/1	I/O	External interrupt 0/1
ELVI	I	External low voltage detect pin

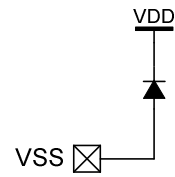
I/O	Pin Type	Function Description
<b>Timer</b>		
T0	I	T0 external clock input
T1	I	T1 external clock input
T0O	O	T0 output
T1O	O	T1 output
PWM00	O	UPG output
PWM01	O	UPG output
<b>Keyboard interrupt</b>		
KI1/2/4/5	I	4-bit keyboard interrupt input
<b>ADC</b>		
ADC1/2/4/5	I	ADC input channel 1/2/4/5
<b>Serial port</b>		
RXD	I	UART input
TXD	O	UART output
SCL	I	E2 clock input
SDA	I/O	E2 data input/output
<b>Power GND</b>		
VDD	P	Power supply
VSS	P	GND

**Notes:** In Pin Type column: "P" denotes Power pins, "I/O" denotes normal input/output pins, "I" denotes input pins, "O" denotes output pins.

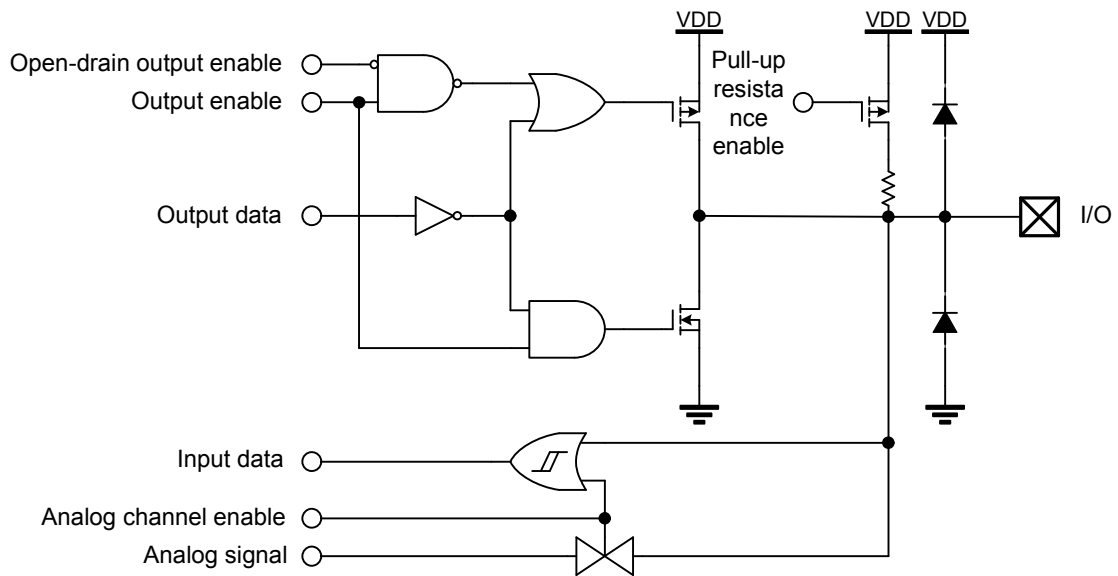
**PIN STRUCTURE**



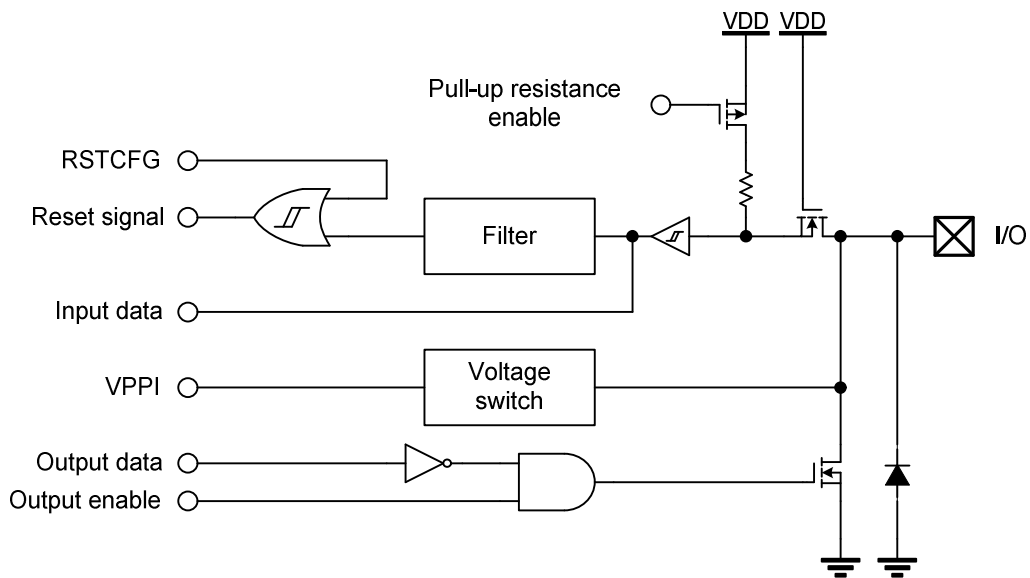
Pin structure P1



Pin structure P0



Pin structure A



Pin structure B

## ABSOLUTE MAXIMUM RATINGS

Characteristics	Symbol	Range	Unit
Supply voltage	$V_{DD}$	-0.3 ~ +7.0	V
Input voltage	$V_I$	-0.3 ~ $V_{DD}+0.3$	V
Storage temperature	$T_{STG}$	-40 ~ +125	°C
Operating temperature	$T_{OPR}$	-40 ~ +85	°C

## DC ELECTRICAL CHARACTERISTICS (unless otherwise specified, $V_{DD}=5V$ , $T_{AMB}=25^{\circ}C$ )

Note: typical data are given only as design guidelines and are not tested.

### Power supply characteristics

Table 1: Power supply

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Typical condition: $V_{DD}=5.0V$ , $25^{\circ}C$ , all IO output low, no load.						
Operating voltage	$V_{DD}$		2.4	5.0	5.5	V
Operating Current, considering the temperature	$I_{DD}$	MCIk=1MHz	-	0.6	-	mA
		MCIk=2MHz	-	0.8	-	
		MCIk=4MHz	-	1.25	-	
		MCIk=8MHz	-	2.2	-	
Idle current	$I_{IDLE}$	MCIk=1MHz	-	0.4	-	mA
		MCIk=2MHz	-	0.44	-	
		MCIk=4MHz	-	0.55	-	mA
		MCIk=8MHz	-	0.77	-	
Stop current	$I_{STOP}$	Other modules are off	-	0.5		uA

Note : \* indicates simulation value, not the test.

### IO characteristics

Table 2: IO characteristics

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit	
Typical condition: $V_{DD}=5.0V$ , temperature = $25^{\circ}C$ .							
High input voltage	$V_{IH}$	P1/P3	$0.7V_{DD}$	-	$V_{DD}$	V	
Low input voltage	$V_{IL}$	P1/P3	0	-	$0.3V_{DD}$	V	
Input hysteresis	$V_{HYS (IO)}$	P1/P3.0-P3.1	-	1.0	-	V	
		P3.2	-	0.3	-	V	
$V_{DD}=5.0V$							
Output source current	$I_{OH}$	$V_{OH}=0.9V_{DD}$	P1(P1DS=0)/P3.0/P3.1	-	6.0	-	mA
			P1(P1DS=1)	-	12.0	-	
Output sink current	$I_{OL}$	$V_{OL}=0.1V_{DD}$	P1(P1DS=0)	-	8.5	-	mA
			P1(P1DS=1)/P3	-	17.0	-	



Characteristics	Symbol	Test condition		Min.	Typ.	Max.	Unit
Total current	I <sub>total</sub>	-	All ports	-	-	60	mA
V <sub>DD</sub> =3.3V							
Output source current	I <sub>OH</sub>	V <sub>OH</sub> =0.9V <sub>DD</sub>	P1(P1DS=0)/P3.0/P3.1	-	2.2	-	mA
			P1(P1DS=1)	-	10	-	
Output sink current	I <sub>OL</sub>	V <sub>OL</sub> =0.1V <sub>DD</sub>	P1(P1DS=0)/P3	-	4	-	mA
			P1(P1DS=1)	-	10	-	
Pull-up resistor	R <sub>pu</sub>	V <sub>IN</sub> =0V	P1/P3	35	50	65	kΩ
Leakage current (high temperature)	I <sub>IL</sub>	High-impedance input power supply or GND	P1/P3	-	-	±100	nA
Effective pulse width	T <sub>PW(IO)</sub>	External reset pin	-	-	2	4	us
		External interrupt/KBI	-	-	200	400	ns
Note: it may not be checked if the min. pulse width of input signal is less than the parameter time.							

Note : \* indicates simulation value, not the test.

## System monitoring and reset characteristics

Table 3: System monitoring and reset

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Typical condition: V <sub>DD</sub> =5.0V, 25°C.						
POR release voltage*	V <sub>POR</sub>	-	-	0.7	-	V
Low reset voltage	V <sub>LVR</sub>	LVRS=00	-	2.0	-	V
		LVRS=01	-	2.6	-	
		LVRS=10	-	3.0	-	
		LVRS=11	-	3.6	-	
LVR release hysteresis voltage	V <sub>HYS(LVR)</sub>	-	-	10	-	mV
LVR module operating current	I <sub>LVR</sub>	IDLE mode enabled	-	14	-	uA
LVD voltage	V <sub>LVD</sub>	L <sub>VDS</sub> = 000	-	4.3	-	V
		L <sub>VDS</sub> = 001	-	3.9	-	
		L <sub>VDS</sub> = 010	-	3.7	-	
		L <sub>VDS</sub> = 011	-	3.5	-	
		L <sub>VDS</sub> = 100	-	3.0	-	
		L <sub>VDS</sub> = 101	-	2.7	-	
		L <sub>VDS</sub> = 110	-	2.5	-	
		L <sub>VDS</sub> = 111	-	2.3	-	
LVD release hysteresis voltage	V <sub>HYS(LVD)</sub>	V <sub>DD</sub> ≥ 3.0	-	100	-	mV

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
		$V_{DD} < 3.0$	-	50	-	
LVD module operating current	$I_{LVD}$	IDLE mode	-	30	-	uA
Power-on reset delay time	$T_{PWRT}$		1	5	-	ms

Note : \* indicates simulation value, not the test.

## Oscillation and clock characteristics

Table 4: Oscillation and clock characteristics

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Typical condition: $V_{DD}=5.0V$ , temperature= $25^{\circ}C$ .						
Internal RCH after calibration*	$F_{RCH}$	$2.4\sim 5.5V$ , $-10\sim 50^{\circ}C$	15.84	16.00	16.16	MHz
		$2.4\sim 5.5V$ , $-40\sim 85^{\circ}C$	15.52	16.00	16.48	
RCH step frequency*	$F_{RCHSTEP}$	$5.0V$ , $25^{\circ}C$	315	-	560	KHz
RCH start time*	$T_{RCHSTR}$	-	-	10	-	us
RCH stabilization delay counted period	$T_{DRCH}$	-	-	1024	-	Cycles
RCH stabilization time*	$T_{SRCH}$	-	-	32	-	us
RCH operating current*	$I_{RCH}$	$5.0V$ , $25^{\circ}C$	-	125	-	uA
RCL frequency	$F_{RCL}$	$2.0\sim 5.5V$ , $-40\sim 85^{\circ}C$	4	-	30	KHz
		$5.0V$ , $-40\sim 85^{\circ}C$	12	-	25	
RCL operating current	$I_{RCL}$	Turn on RCL in STOP mode, measure the current increasing value	-	0.3	1.0	uA

Note : \* data based on characterization results, not tested in production.

## RAM min. retention voltage

Table 5: RAM data hold voltage

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Typical condition: $V_{DD}=5.0V$ , temperature= $25^{\circ}C$ .						
RAM retention voltage	$V_{DR}$	$-40^{\circ}C < TA < +85^{\circ}C$	1.5	-	-	V

## A/D converter characteristics

Table 6: ADC characteristics

Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
Typical condition: $V_{DD}=5.0V$ , temperature= $25^{\circ}C$ .						
ADC operating voltage range	$V_{DDAD}$	$1MHz < F_{adclk} < 2MHz$	2.7	-	5.5	V
		$F_{adclk} < 1MHz$	2.5	-	5.5	V
Input analog voltage range	$V_{ADIN}$		0	-	$V_{DDAD}$	V
Sample & hold capacitor	$C_{ADIN}$		-	6	-	pF
Analog channel impedance	$R_{ADIN}$	$2.5V < V_{DDAD} < 5.5V$	-	1	10	k $\Omega$

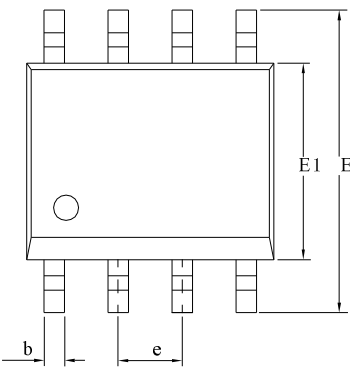
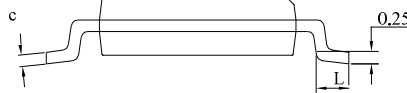
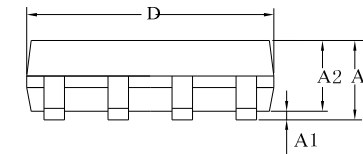
Characteristics	Symbol	Test condition	Min.	Typ.	Max.	Unit
		$2.0V < V_{DDAD} < 2.5V$	-	-	100	k $\Omega$
Input source impedance	$R_{AS}$	$1MHz < Fadclk < 2MHz$	-	-	5	k $\Omega$
		$Fadclk < 1MHz$	-	-	10	k $\Omega$
ADC clock frequency	$Fadclk$		-	-	2	MHz
ADC clock period	$T_{AD}$		0.5	-	-	$\mu s$
Sample time	$T_{smp}$	Turn on the software	-	2.5	Can be set through software	TAD
Conversion time	$T_{conv}$		-	12	-	TAD
ADC operating current	$I_{DDAD}$	$Fadclk = 2MHz$	-	200	-	$\mu A$
Differential nonlinearity*	DNL	12-bit accuracy	-	-	$\pm 4$	LSB
		10-bit accuracy	-	-	$\pm 1$	
Integral nonlinearity	INL	12-bit accuracy	-	-	$\pm 4$	LSB
		10-bit accuracy	-	-	$\pm 1$	
Offset error	$E_{zs}$	12-bit accuracy	-	-	$\pm 4$	LSB
		10-bit accuracy	-	-	$\pm 1$	
Gain error	$E_{fs}$	12-bit accuracy	-	-	$\pm 12$	LSB
		10-bit accuracy	-	-	$\pm 3$	
Global uncorrected error	$E_{TUE}$	12-bit accuracy	-	-	$\pm 16$	LSB
		10-bit accuracy	-	-	$\pm 4$	
Resolution	NR		-	12	-	Bit

Note: all data of ADC based on characterization results, not tested in production.

**PACKAGE OUTLINE**

SOP-8-225-1.27

Unit: mm



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.05	0.15	0.25
A2	1.25	--	1.65
b	0.32	0.42	0.52
c	0.15	0.2	0.26
D	4.70	4.90	5.30
E	5.60	6.00	6.40
E1	3.60	3.90	4.20
e	1.27BSC		
L	0.30	—	1.27



**MOS DEVICES OPERATE NOTES:**

Electrostatic charges may exist in many things. Please take following preventive measures to prevent effectively the MOS electric circuit as a result of the damage which is caused by discharge:

- The operator must put on wrist strap which should be earthed to against electrostatic.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed in antistatic/conductive containers for transportation.

**Disclaimer :**

- Silan reserves the right to make changes to the information herein for the improvement of the design and performance without prior notice! Customers should obtain the latest relevant information before placing orders and should verify that such information is complete and current.
- All semiconductor products malfunction or fail with some probability under special conditions. When using Silan products in system design or complete machine manufacturing, it is the responsibility of the buyer to comply with the safety standards strictly and take essential measures to avoid situations in which a malfunction or failure of such Silan products could cause loss of body injury or damage to property.
- Silan will supply the best possible product for customers!

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Rev: 1.0

Revision history:

1. First release
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