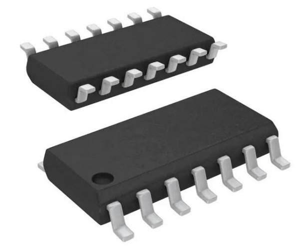
TS04
4-CH Auto Sensitivity Calibration Capacitive Touch Sensor

General Description

The TS04 is a monolithic IC which has high performance capacitive touch sensor with self calibration function.

The TS04 is available in standard SOP14 package.


SOP14

Features

- 4-Channel Capacitive Sensor with Auto Sensitivity Calibration
- Parallel Output Interface
- Independently Adjustable Sensitivity with External Capacitor
- Adjustable Internal Frequency with External Resister
- Embedded High Frequency Noise Elimination Circuit
- Low Current Consumption

Package Information

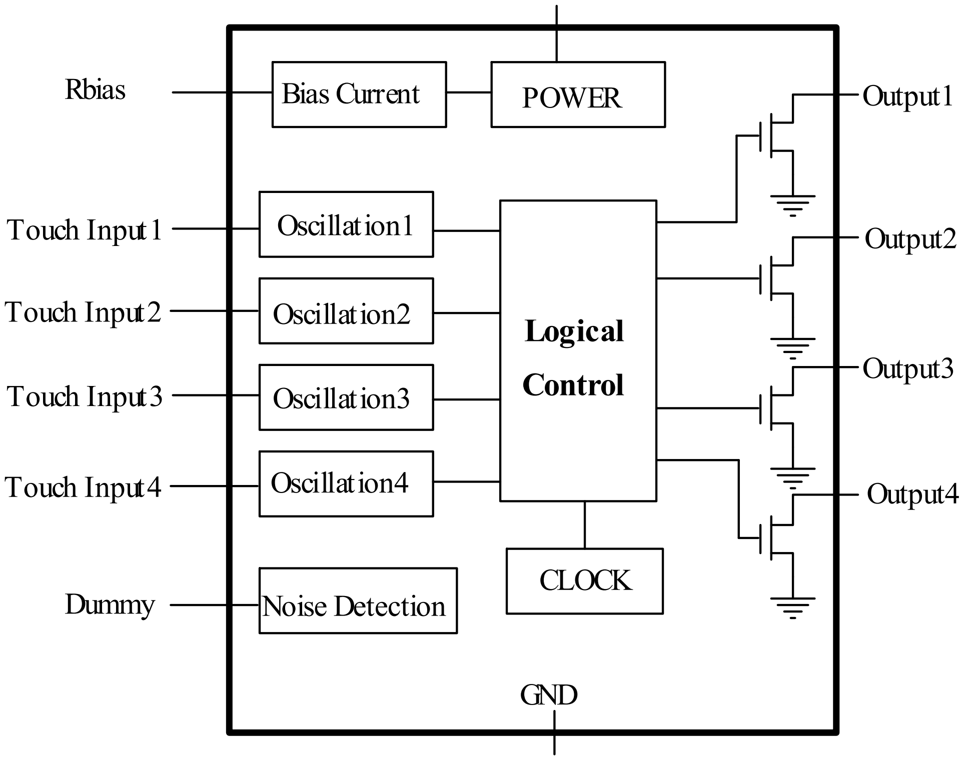
Part NO.	Package Description	Package Marking	Package Option
TS04	SOP14	CHMC SXXXXX TS04	50/Tube 4000/Reel

CHMC：Trademark TS04:Part NO. SXXXX:Lot NO.

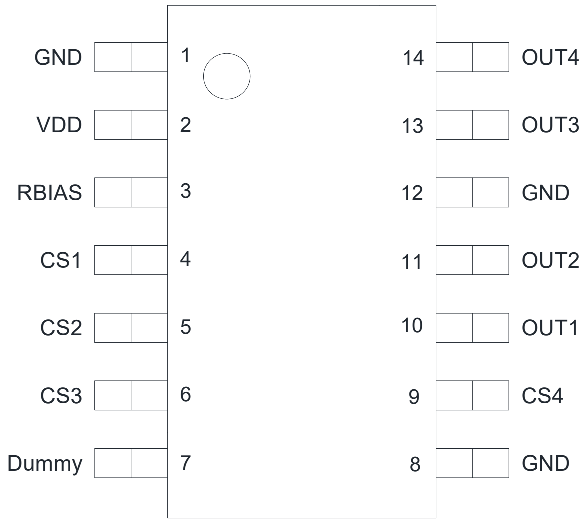
Applications

- Mobile Application (Mobile Phone / PDA / PMP / MP3 etc)
- Membrane Switch Replacement
- Sealed Control Panels, Keypads
- Door Key-Lock Matrix Application

Functional Block Diagram



Pin Configuration



TS04(SOP14)

Pin Description

Pin Number	Pin Name	Function Description
1	GND	Connect to GND
2	VDD	Power (2.5V~5.0V)
3	RBIAS	Internal bias adjust input
4	CS1	CH1 capacitive sensor input
5	CS2	CH2 capacitive sensor input
6	CS3	CH3 capacitive sensor input
7	Dummy	Internal noise monitoring input .Do not connect to anywhere
8	GND	Supply ground
9	CS4	CH4 capacitive sensor input
10	OUT1	Output1 for CS1 (open drain structure)
11	OUT2	Output2 for CS2 (open drain structure)
12	GND	Supply ground
13	OUT3	Output3 for CS3 (open drain structure)
14	OUT4	Output4 for CS4 (open drain structure)

Absolute Maximum Ratings (Ta=25℃)

Parameter Name	Symbol	Value	Unit
Battery Supply Voltage	VDD	5.0	V
Maximum Voltage On Any Pin	V_{MAX}	VDD+0.3	V
Maximum Current On Any PAD	I_{MAX}	100	mA
Power Dissipation	P_{DMAX}	800	mW
Storage Temperature	Tstg	-50 ~ 150	℃
Operating Temperature	T_{OP}	-20 ~ 75	℃
Junction Temperature	T_J	150	℃

Note: Unless any other command is noted, all above are operated in normal temperature.

Electrical Characteristics

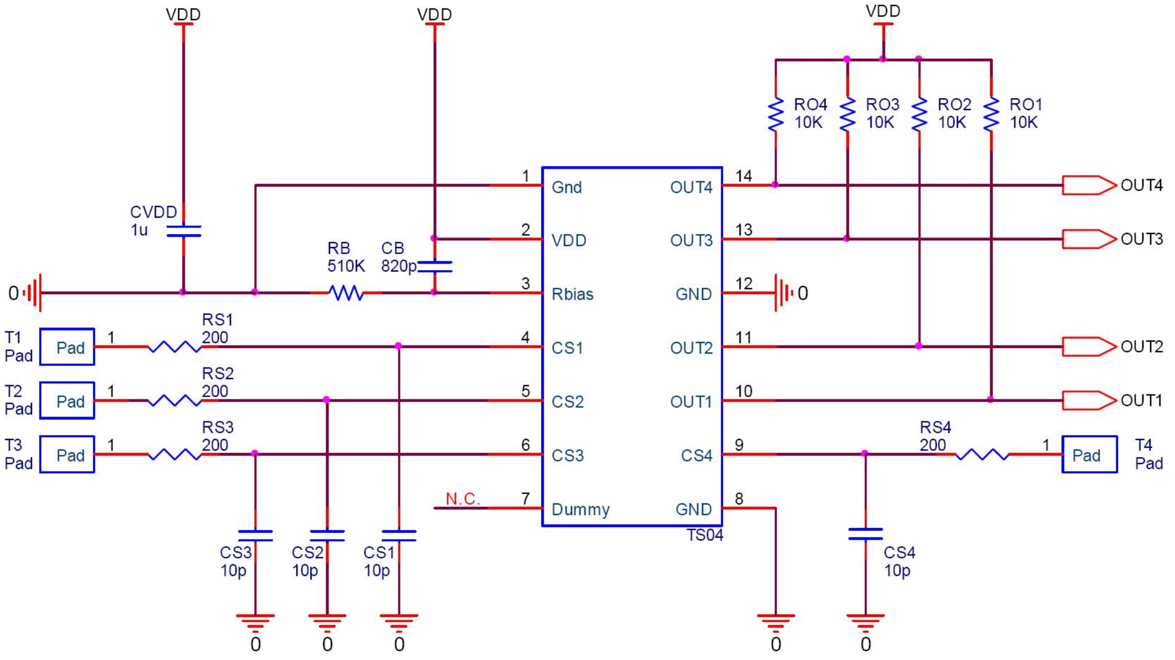
(Unless otherwise specified: T_A = 25℃,V_{DD}=3.3V, R_b=510k)

Parameter Name	Symbol	Test Conditions	Min	Typ	Max	Units
Operating Supply Voltage	V_{DD}		2.5	3.3	5.0	V
Current Consumption	I_{DD}	V_{DD} =3.3V,R_B=510k		40	70	μA
		V_{DD} =5.0V,R_B=510k		80	140	
Digital Output Maximum Sink Current	I_{OUT}	T_A = 25℃			4.0	mA
Internal Reset Criterion V_{dd} Voltage	V_{DD_RST}	T_A = 25℃, R_B=510k			$0.3 \cdot V_{DD}$	V
Sense Input Capacitance Range **(Note1)**	Cs				100	pF
Minimum Detective Capacitance Difference	ΔC	Cs=10pF	0.2			pF
Output Impedance (Open Drain)	Zo	ΔC＞0.2pF,Cs=10pF		12		Ω
		ΔC＜0.2pF,Cs=10pF		30		MΩ
Self Calibration Time After System Reset	T_{CAL}	V_{DD} =3.3V,R_B=510k		100		mS
		V_{DD} =5.0V,R_B=510k		80		
Sense Input Resistance Range	R_S			200	1000	Ω
Recommended Bias Resistance Range **(Note 2)**	R_B	V_{DD} =3.3V	200	510	820	kΩ
		V_{DD} =5.0V	330	620	1200	
Maximum Bias Capacitance	C_{B_MAX}			820	1000	pF

Note1 : The sensitivity can be increased with lower Cs value. The recommended value of Cs is 10pF when using 3T PC(Poly Carbonate) cover and 10 mm x 7mm touch pattern.

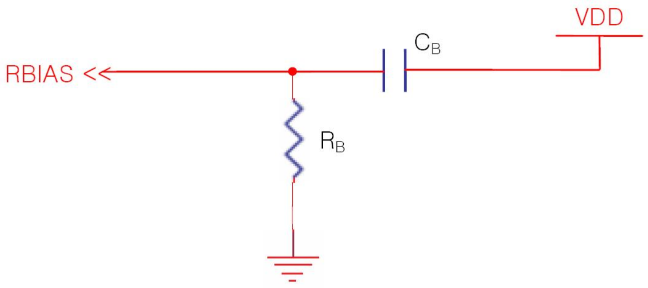
Note2 : The lower R_B is recommended in noisy condition.

Typical Application

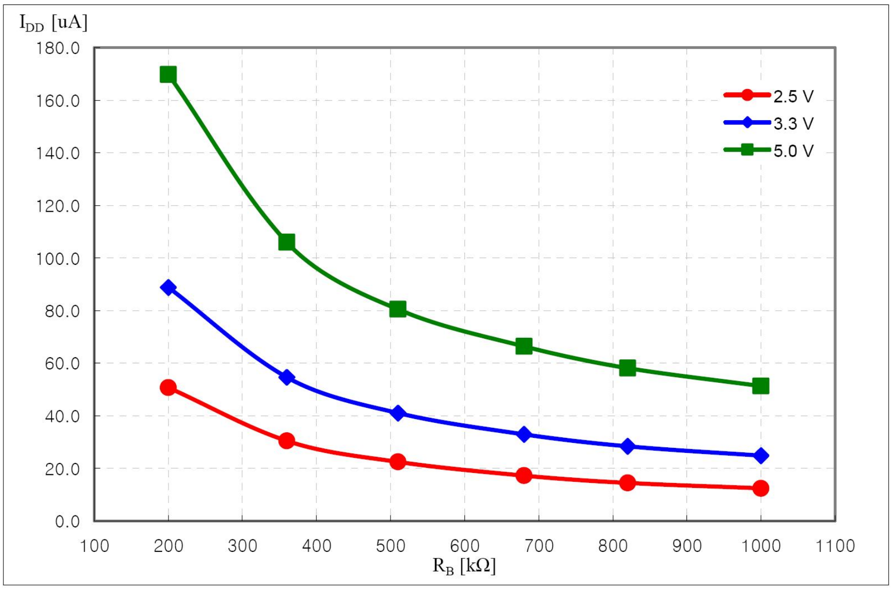


Application Information

RBIAS & SRBIAS implementation



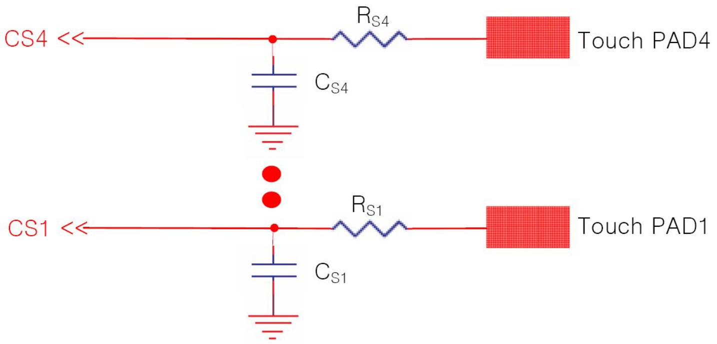
The RBIAS is connected the resistor to decide the oscillator and internal bias current. The sensing frequency, internal clock frequency and current consumption are therefore able to be adjusted with R_B. A voltage ripple on RBIAS can make critical internal error, so C_B is connected to the VDD (not GND) is recommended. (The typical value of C_B is 820pF and the maximum Value is 1nF.)



Normal operation current consumption curve

The current consumption curve of TS04 is represented in accordance with R_B value as above. The lower R_B requires more current consumption but it is recommended in noisy application. For example, refrigerator, air conditioner and so on.

CS implementation



The TS04 has available sensing channel up to 4. The parallel capacitor CS1 is added to CS1 and CS4 to CS4 to adjust fine sensitivity. The sensitivity would increase when a smaller value of CS is used. (Refer to the below Sensitivity Example Figure) It could be useful in case detail sensitivity mediation is required. The internal touch decision process of each channel is separated from each other. The four channel touch key board application can therefore be designed by using only one TS04 without coupling problem. The RS is serial connection resistor to avoid malfunction from external surge and ESD. (It might be optional.) From 200Ω to 1kΩ is recommended for RS. The size and shape of PAD might have influence on the sensitivity. The sensitivity will be optimal when the size of PAD is approximately an half of the first knuckle (it’s about 10 mm x 7 mm).

The connection line of CS1 ~ CS4 to touch PAD is recommended to be routed as short as possible to prevent from abnormal touch detect caused by connection line.

There are some sensitivity difference among CS1, CS2 and CS3, and CS4 caused by internal parasitic capacitance. That sensitivity difference could be compensated by using different CS capacitor or sensitivity setting with internal register. To use different touch pattern area could be used for sensitivity compensation but not recommended. The sensitivity of each channel can be represented as below.

Sensitivity of CS1 ≥ Sensitivity of CS2, CS3 > Sensitivity of CS4

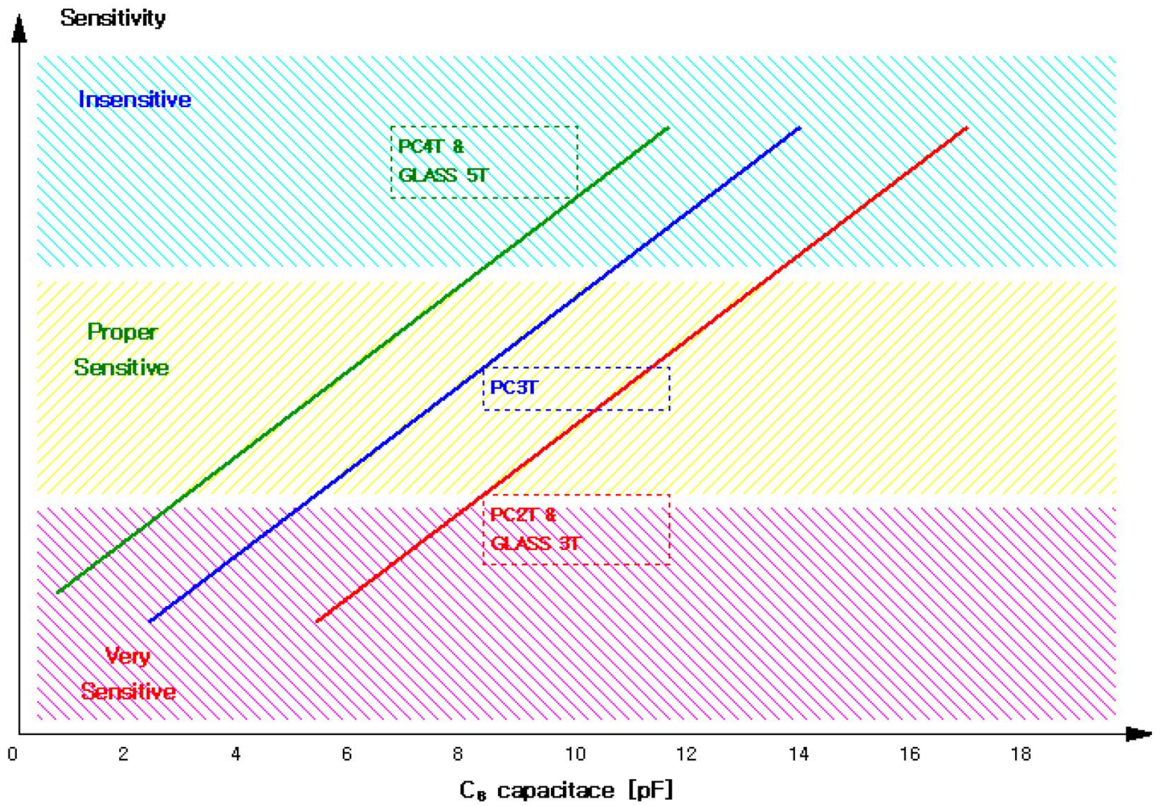
(In case of the external parasitic capacitance value is same on each channel.)

C_{CS1_PARA} + about 3.5pF = $C_{CS2,3\_PARA}$ + about 3pF = C_{CS4_PARA}

* C_{CS1_PARA} : Parasitic capacitance of CS1

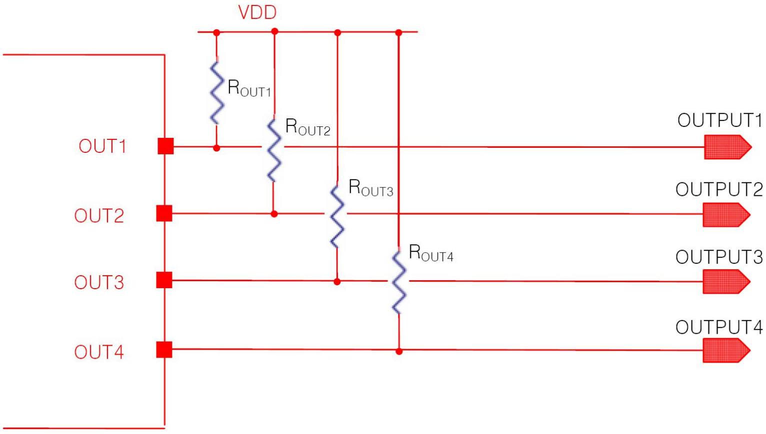
* $C_{CS2,3\_PARA}$: Parasitic capacitance of CS2 and CS3

* C_{CS4_PARA} : Parasitic capacitance of CS4



Sensitivity example figure with default sensitivity selection

Output Circuit Implementation



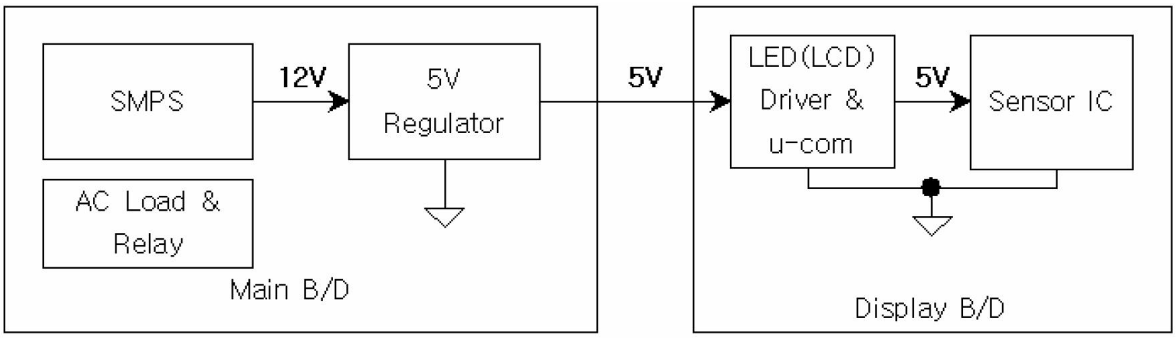
The OUTPUT pins have an open drain structure. For this reason, the connection of pull-up resistor R_{OUT} is required between OUTPUT and VDD. The maximum output sink current is 4mA, so over a few kΩ must be used as R_{OUT}. Normally 10kΩ is used as R_{OUT}. The OUTPUT is high in normal situation, and the value is low when a touch is detected on the corresponding CS.

Internal reset operation

The TS04 has stable internal reset circuit to offer reset pulse to digital block. The supply voltage for a system start or restart should be under 0.3·VDD of normal operation VDD. No external components required for TS04 power reset, that helps simple circuit design and to realize the low cost application.

Example – Power Line Split Strategy PCB Layout

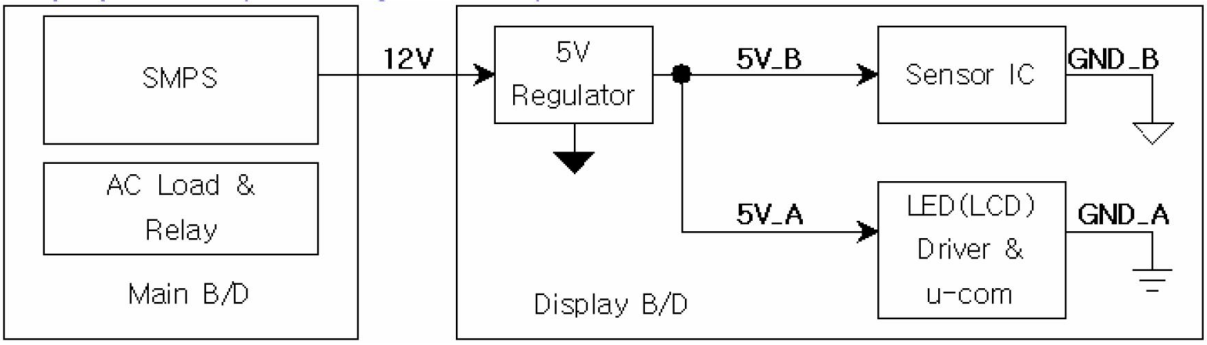
A. Not split power line (Bad power line design)



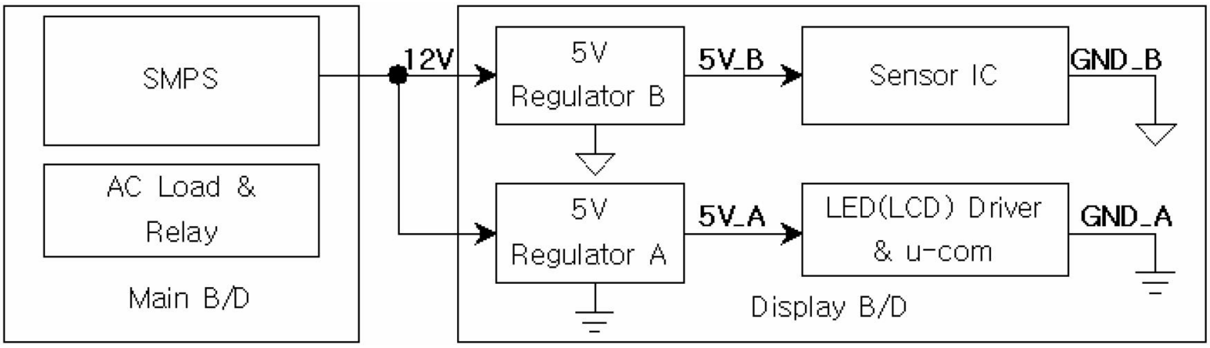
*The noise that is generated by AC load or relay can be loaded at 5V power line.

*A big inductance might be appeared in case of the connection line between main board and display board is too long, moreover the voltage ripple could be generated by LED (LCD) display driver at VDD (5V).

B. Split power line (One 5V regulator used) – Recommended

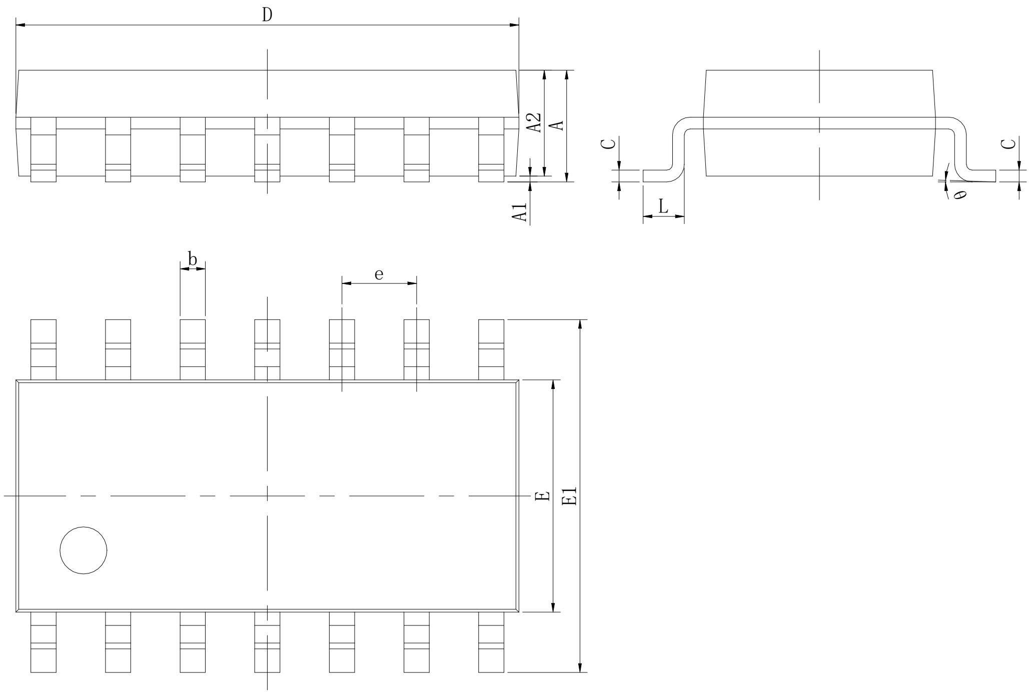


C. Split power line (Separated 5V regulator used) – Strongly recommended



Outline Dimensions

SOP14 Unit:mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	8.360	8.760	0.329	0.345
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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