



TS02NR

2-Channel Self Calibration Capacitive Touch Sensor

SPECIFICATION V1.1

R&D	R&D	Marketing	Q A	Approval

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TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

■ Revision History

Rev.	Description of change	Date	Originator
1.0	Initial Release	10.02.17	KD PARK
1.1	Inserting history page Revise the current consumption and current consumption curve	10.09.07	KD PARK

TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

1 Specification

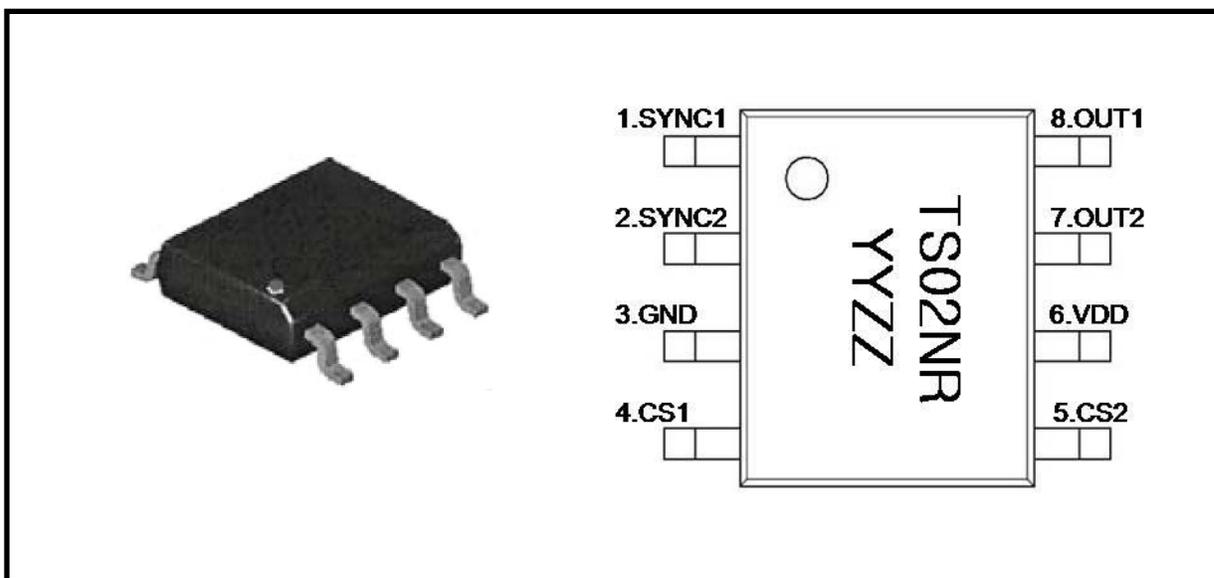
1.1 General Feature

- 2-Channel capacitive touch sensor with self sensitivity calibration
- Low power consumption
- Uniformly adjustable sensitivity
- Sync function for parallel operation
- 9 steps sensitivity available without external component
- Open-drain digital output
- Embedded noise elimination circuit
- Embedded Internal power reset circuit
- RoHS compliant 8SOP package

1.2 Application

- Home appliance
- Membrane switch replacement
- Human interface for toys & interactive games
- Sealed control panels, keypads

1.3 Package (8 SOP)



TS02NR 8SOP (Drawings not to scale)

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2 Pin Description (8 SOP)

PIN Number	Name	I/O	Description	Protection
1	SYNC1	Digital Input /Output	Sensitivity selection input 1 (Note 1) Sync pulse input /output 1	VDD/GND
2	SYNC2	Digital Input /Output	Sensitivity selection input 2 (Note 1) Sync pulse input /output 2	VDD/GND
3	GND	Ground	Supply ground	VDD
4	CS1	Analog Input	Sense channel 1	VDD/GND
5	CS2	Analog Input	Sense channel 2	VDD/GND
6	VDD	Power	Power (2.5V ~ 5.0V)	GND
7	OUT2	Digital Output	Ch2 touch detect output Open drain output (Active Low)	VDD/GND
8	OUT1	Digital Output	Ch1 touch detect output Open drain output (Active Low)	VDD/GND

3 Absolute Maximum Rating

Supply voltage	5.5 V
Maximum voltage on any pin	VDD+0.3 V
Maximum current on any PAD	100mA
Continuous power Dissipation	800mW
Storage Temperature	-50 ~ 150°C
Operating Temperature	-20 ~ 75°C
Junction Temperature	150°C

Note Unless otherwise noted, all above are operated in normal temperature

4 ESD & Latch-up Characteristics

4.1 ESD Characteristics

Mode	Polarity	Max	Reference	Reference Document
H.B.M	Pos / Neg	7000V	VDD	JESD22-A114-E
			VSS	
			P TO P	
M.M	Pos / Neg	400V	VDD	JESD22-A115-A
			VSS	
			P TO P	
C.D.M	Pos / Neg	800V	DIRECT	JESD22-C101C

4.2 Latch-up Characteristics

Mode	Polarity	Max	Test Step	Reference Document
I Test	Positive	100mA	25mA	JESD78A
	Negative	-100mA		
V supply over 5.0V	Positive	8.0V	1.0V	



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5 Electrical Characteristics

▪ $V_{DD}=3.3V$, (Unless otherwise noted), $T_A = 25^\circ C$

Characteristics	Symbol	Test Condition	Min	Typ	Max	Units
Operating supply voltage	V_{DD}		2.5	3.3	5.0	V
Current consumption	I_{DD}	$V_{DD}= 3.3V$	–	180	230	μA
		$V_{DD}= 5.0V$	–	260	340	
Output maximum sink current	I_{OUT}	$T_A = 25^\circ C$	–	–	4.0	mA
Sense input capacitance range Note1	C_{S1} C_{S2}		–	10	100	pF
Sense input resistance range	R_S		–	200	1000	Ω
Minimum detectable capacitance difference	ΔC	$C_S = 10pF$	0.2	–	–	pF
Output impedance (open drain)	Z_O	$\Delta C > 0.2pF$	–	12	–	Ω
		$\Delta C < 0.2pF$	–	30M	–	
Self calibration time after power on	T_{CAL}	$V_{DD} = 3.3V$	–	100	–	ms
		$V_{DD} = 5.0V$	–	80	–	
Expire Time Note2	E_T	$V_{DD}=3.3V$		38		sec.

Note 1: The sensitivity can be increased with lower C_S value.

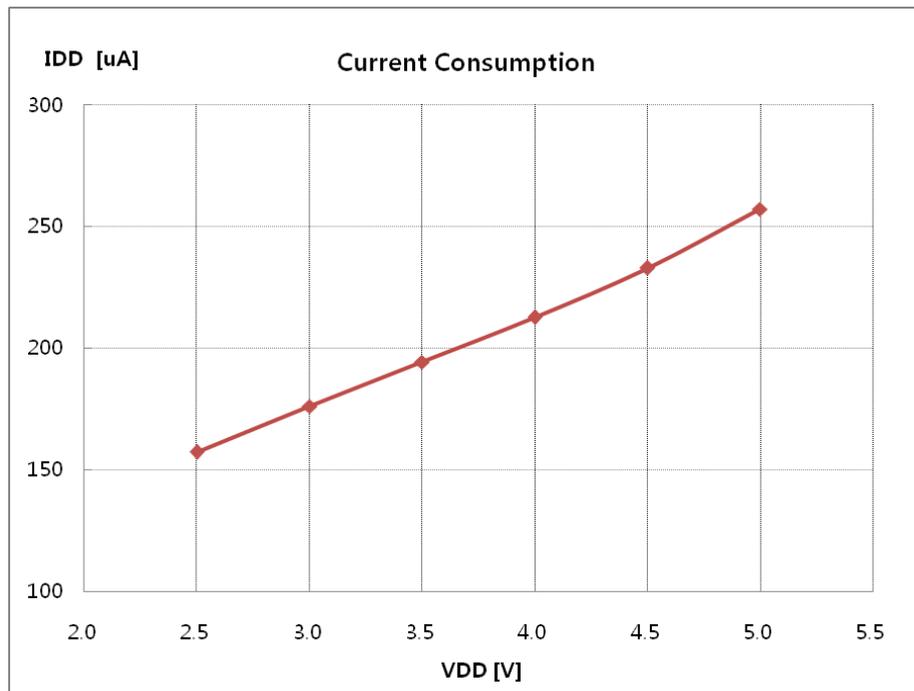
The recommended value of C_S is 10pF when using 3T PC(Poly Carbonate) cover and 10 mm x 7 mm touch pattern.

Note 2: Expire Time is the maximum time of touch duration.

6 Implementation of TS02NR

6.1 Typical current consumption

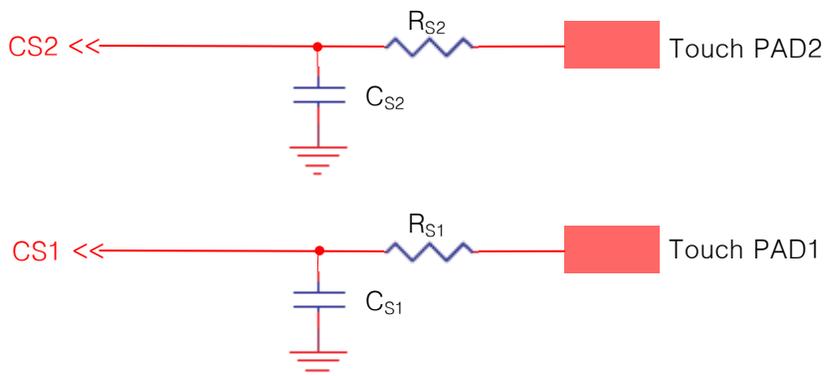
TS02NR uses internal bias circuit, so internal clock frequency and current consumption is fixed and no external bias circuit is needed. The typical current consumption curve of TS02NR is represented in accordance with V_{DD} voltage as below.



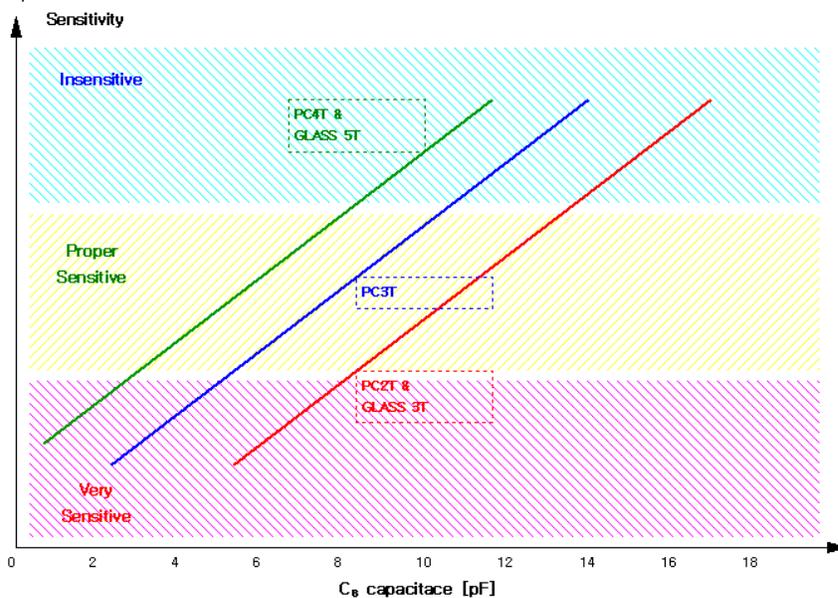
Typical current consumption curve of TS02NR

TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

6.2 CS implementation



The parallel capacitor C_{S2} is added to CS2 and C_{S1} to CS1 to adjust sensitivity. The sensitivity will be increased when smaller value of C_{S2} and C_{S1} are used. (Ref. below Sensitivity Example Figure) It could be useful in case detail sensitivity mediation is required. The TS02NR has two independent touch sensor input CS1 and CS2. Internal touch decision processes of CS1 and CS2 are separated from each other. Therefore two channel touch key board can be designed by using only one TS02NR. R_{S1} and R_{S2} are serial connection resistors to avoid mal-function from external surge and ESD. From 200Ω to $1k\Omega$ is recommended for R_{S1} and R_{S2} values. 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 $10\text{ mm} \times 7\text{ mm}$). The connection line of CS1 and CS2 to touch PAD is recommended to be routed as short as possible to prevent from abnormal touch detect caused by connection line. The unused CS pin must be connected with the ground to prevent the unpredictable mal-function that occurred in the floating CS pin.



Sensitivity Example Figure

TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

6.3 SYNC implementation

The TS02NR has two SYNC pins to make it possible to operate with two optional functions such as SYNC™ function, sensitivity selections. No external component is used for above selections. The determination of SYNC pins connection of TS02NR is accomplished initial operation periods. Therefore changing connection of SYNC pin after initial operation period cannot affect the optional function selection.

6.3.1 SYNC™ function

For SYNC™ function, all SYNC pins (form SYNC1 to SYNC5) have same function. So, at least, one of five SYNC pins operates as SYNC™ function, TS02NR can be operated with other TS02NR or TSxx series without interfering with each other. Inside of TS02NR, there is internal Oscillator for SYNC pulse so no external component is used for SYNC™ function. Simply, it is needed to connect SYNC pin to other SYNC pin of TS02NR or TSxx series for using SYNC™ function. For proper SYNC™ function, less five other TS02NR or TSxx series can be connected with.



6.3.2 Sensitivity selections

SYNC1 and SYNC2 pin of TS02NR can be used as sensitivity selection pin. Both of two SYNC pins have three methods of connection. Open connection (N.C., SYNC connection), connection to GND, and connection to VDD are these methods. As below table, TS02NR has 9 step sensitivity selections. When SYNC1 pin or SYNC2 pin has no connection to GND or VDD, that SYNC pin may be simultaneously used for SYNC™ function.

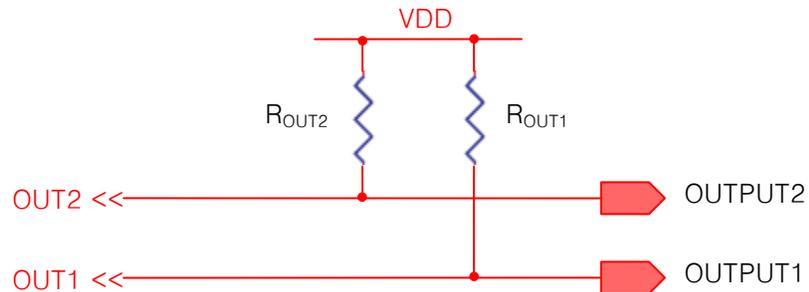
Sensitivity level (thickness [mm] of proper poly-carbonate insulator) of each sensitivity selection

SYNC1 \ SYNC2	Connect to VDD	Connect to GND	N.C. (SYNC connection)
Connect to GND	15.0	8.0	6.5
N.C. (SYNC connection)	12.0	10.0	7.5
Connect to VDD	4.5	3.0	6.0

Note 9: The size of touch PAD is 10 mm x 7 mm used.

Note 10: Above proper thickness is reliable but it can be changed by insulator material and application.

6.4 OUTPUT implementation



The OUT1 and OUT2 have open drain output structure. For this reason, the connection of pull-up resistor R_{OUT} is required between OUT1, OUT2 and VDD. The maximum output sink current is 4mA, so over a few k Ω must be used as R_{OUT1} and R_{OUT2} . Normally 10k Ω is used as R_{OUT1} and R_{OUT2} . The reset value of OUT1 and OUT2 is high in normal situation, and the value is low when a touch is detected on CS1 or CS2.

6.5 Internal reset operation

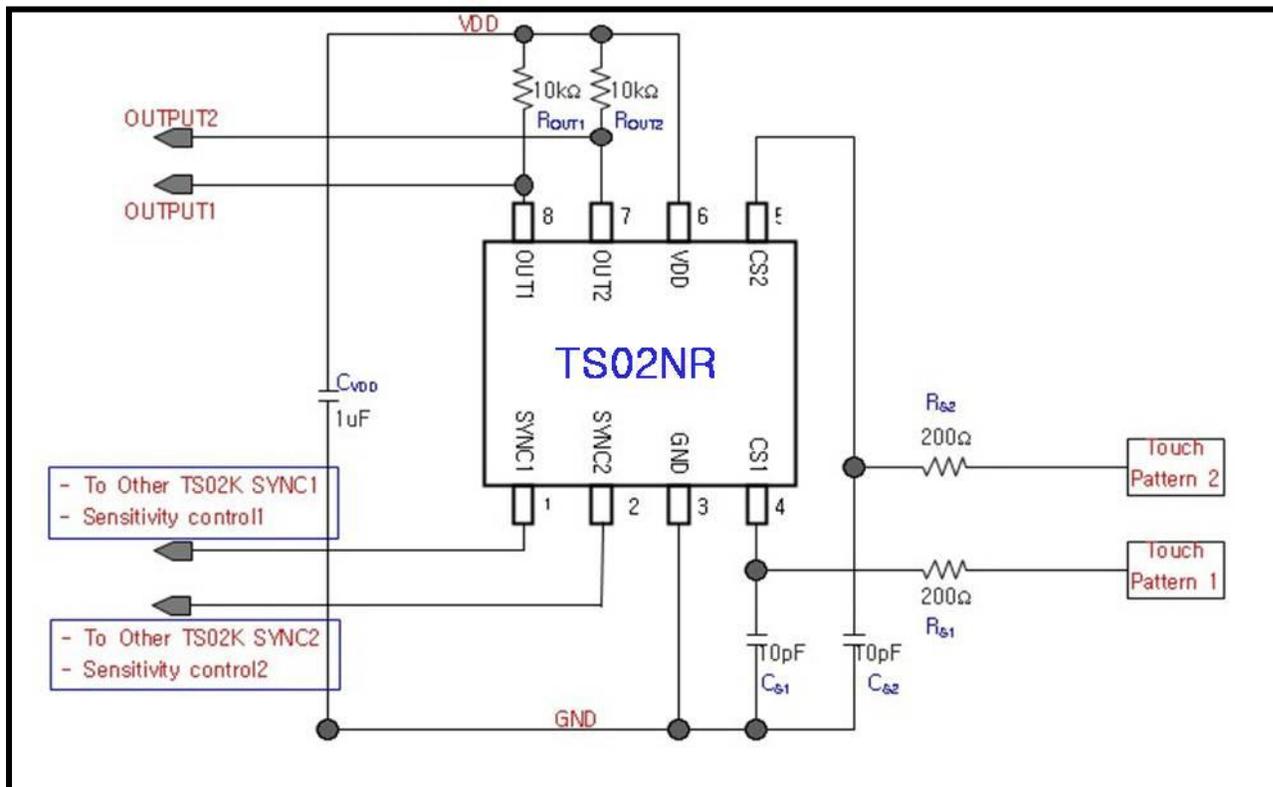
The TS02NR has stable internal reset circuit to offer reset pulse to digital block. The supply voltage for a system start or restart should be under 0.3·VDD of normal operation VDD. No external components required for TS02NR power reset, that helps simple circuit design and to realize the low cost application.

TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

7 Recommended Application

Two channel touch key board can be designed by using only one TS02NR. The TS02NR is embedded intelligent internal power reset circuit that makes possible to save circuit cost because of reducing external components for reset.

The sensitivity calibration operation can help to prevent abnormal detection caused by external noise, temperature variation, and supply voltage drop.



TS02NR Application Example Circuit

- ✦ TS02NR is reset by internal reset circuit. VDD voltage rising time should be shorter than 100msec for proper operation.
- ✦ The VDD periodic voltage ripple over 50mV and the ripple frequency is lower than 10 kHz can cause wrong sensitivity calibration. To prevent above problem, power (VDD, GND) line of touch circuit should be separated from other circuit. Especially LED driver power line or digital switching circuit power line certainly should be treated to be separated from touch circuit.
- ✦ The CS patterns also should be routed as short as possible and the width of line might be about 0.25mm.
- ✦ Parallel capacitor of CS pin could be useful in case detail sensitivity mediation is required such as for complementation sensitivity difference between channels.

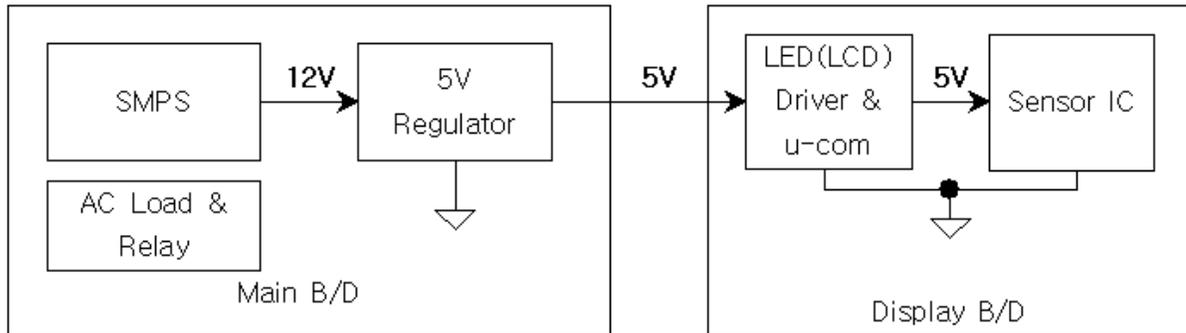
TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

- ✦ Serial connection resistor of CS pins may be used to avoid mal-function from external surge and ESD.
- ✦ The capacitor that is between VDD and GND is an obligation. It should be located as close as possible from TS02NR.
- ✦ The CS pattern routing should be formed by bottom metal (opposite metal of touch PAD).
- ✦ The empty space of PCB must be filled with GND pattern to strengthen GND pattern and to prevent external noise from interfere with sensing frequency.
- ✦ The sensitivity can be changed by connection of SYNC1 and SYNC2.
(See 6.3.2 Sensitivity selections)
- ✦ The OUT1 ~ OUT2 are open drain output ports.
- ✦ At least, one of five SYNC pins has SYNC connection, TS02NR can be operated with other TS02NR or TSxx series without interfering with each other. (See 6.3.1 SYNC™ function)
- ✦ Unused CS pins may be connected to GND for stable operation.

TS02NR (2-CH Sensitivity Calibration Capacitive Touch Sensor)

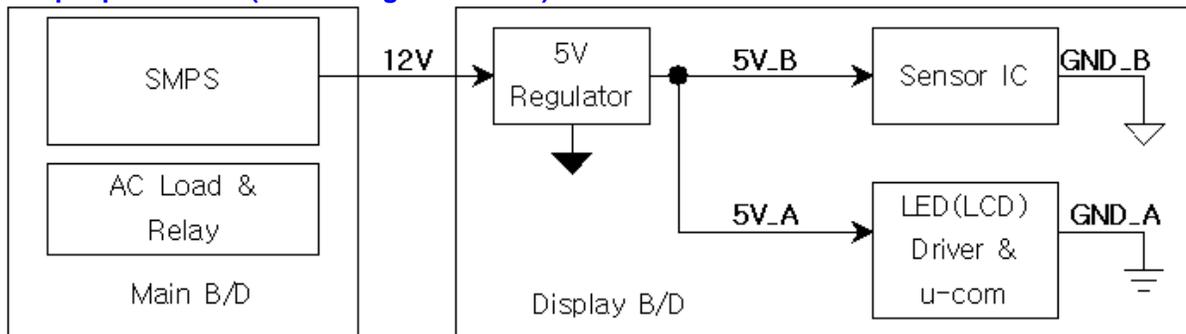
7.1 Example – Power Line Split Strategy PCB Layout

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

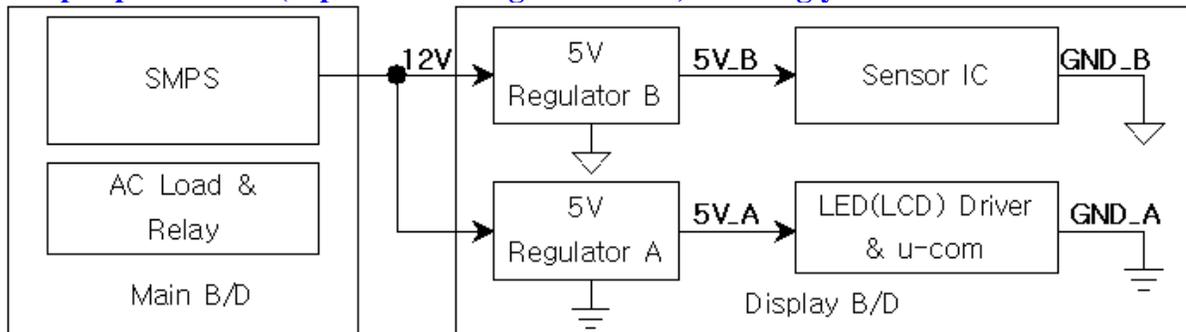


- ✦ The noise that is generated by AC load or relay can be loaded at 5V power line.
- ✦ A big inductance might be appeared in case of the connection line between main board and display board is too long, moreover the voltage ripple could be generated by LED (LCD) display driver at VDD (5V).

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



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



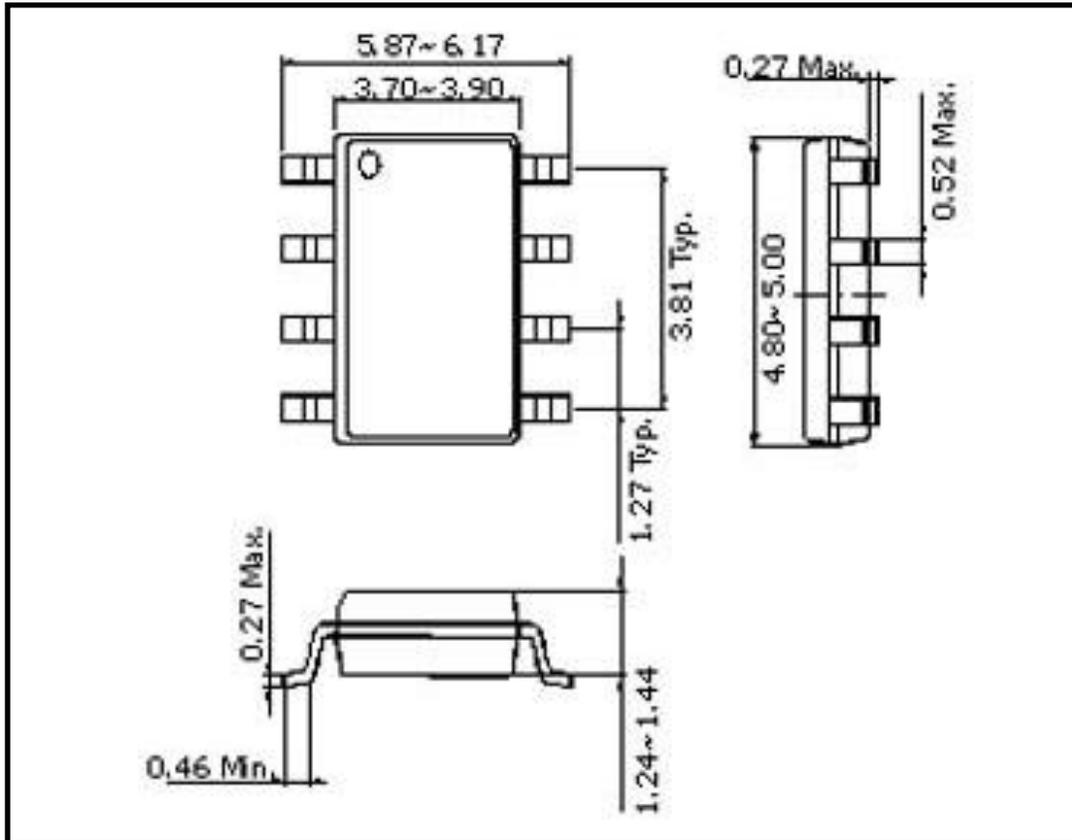
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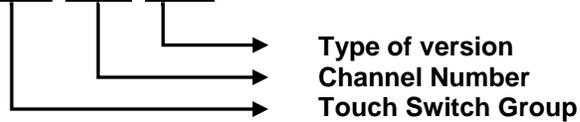
8 PACKAGE DESCRIPTION

8.1 Mechanical Drawing



8.2 Marking Description

Device Code : **TS02NR**



Weekly Code : **YY ZZ**



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NOTES:

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