



TS08N

8-Channel Self Calibration Capacitive Touch Sensor

SPECIFICATION V1.1

TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

1 Specification

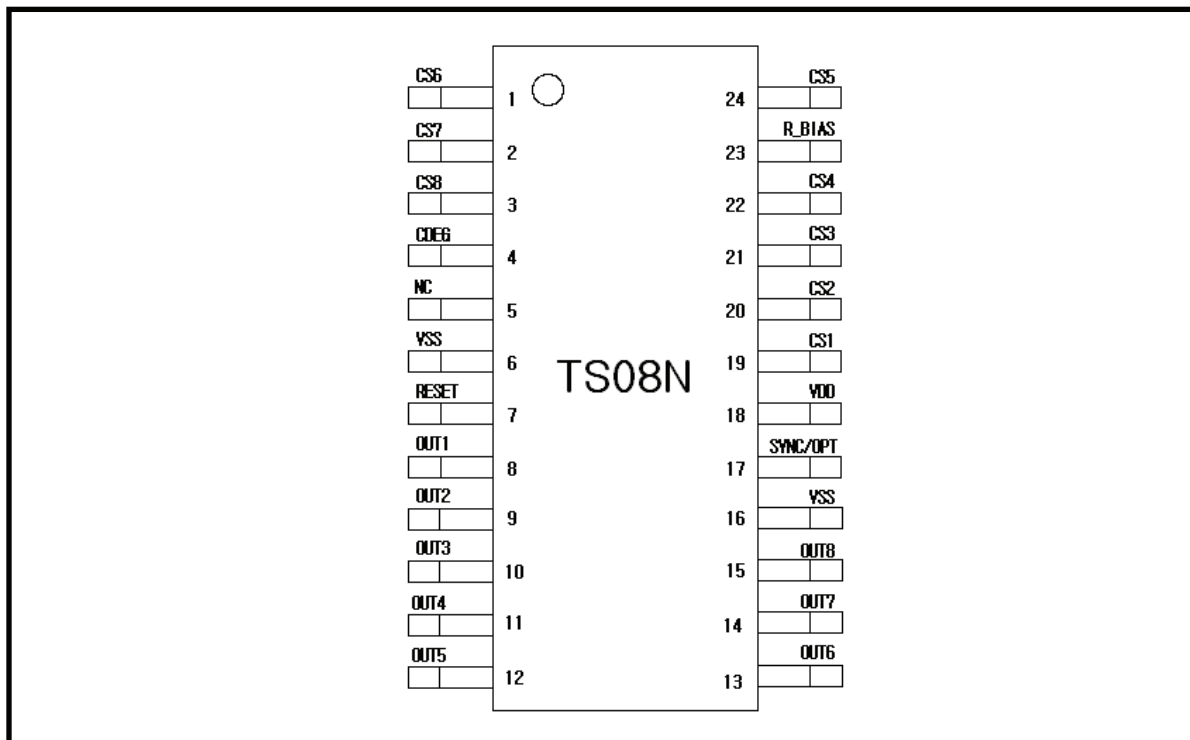
1.1 General Feature

- 8-Channel capacitive sensor with auto sensitivity calibration
- Selectable output operation (single or multi output mode)
- Low current consumption
- Uniformly adjustable 3 step sensitivity
- Sync function for parallel operation
- Adjustable internal frequency with external resister
- Open-drain digital output
- Embedded common and normal noise elimination circuit
- RoHS compliant 24SOP and 24TSSOP package

1.2 Application

- Home application
- Membrane switch replacement
- Sealed control panels, keypads
- Door key-lock matrix application
- Touch screen replacement application

1.3 Package (24 SOP / 24 TSSOP)



TS08N 24SOP / 24TSSOP (Drawings not to scale)

TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

2 Pin Description (24SOP / 24TSSOP)

PIN Number	Name	I/O	Description	Protection
1	CS6	Analog Input	CH6 capacitive sensor input	VDD/GND
2	CS7	Analog Input	CH7 capacitive sensor input	VDD/GND
3	CS8	Analog Input	CH8 capacitive sensor input	VDD/GND
4	CDEG	Analog Input	3 step sensitivity level selection	VDD/GND
5	N.C.	–	–	–
6	VSS	Ground	Supply ground	VDD
7	RST	Digital Input	System reset (High reset)	VDD/GND
8	OUT1	Digital Output	CH1 output (Open drain)	VDD/GND
9	OUT2	Digital Output	CH2 output (Open drain)	VDD/GND
10	OUT3	Digital Output	CH3 output (Open drain)	VDD/GND
11	OUT4	Digital Output	CH4 output (Open drain)	VDD/GND
12	OUT5	Digital Output	CH5 output (Open drain)	VDD/GND
13	OUT6	Digital Output	CH6 output (Open drain)	VDD/GND
14	OUT7	Digital Output	CH7 output (Open drain)	VDD/GND
15	OUT8	Digital Output	CH8 output (Open drain)	VDD/GND
16	VSS	Ground	Supply ground	VDD
17	SYNC/OPT	Analog Input/Output	Output mode selection (Note 1) Sync input/output	VDD/GND
18	VDD	Power	Power (2.5V~5.0V)	GND
19	CS1	Analog Input	CH1 capacitive sensor input	VDD/GND
20	CS2	Analog Input	CH2 capacitive sensor input	VDD/GND
21	CS3	Analog Input	CH3 capacitive sensor input	VDD/GND
22	CS4	Analog Input	CH4 capacitive sensor input	VDD/GND
23	R_BIAS	Analog Input	Internal bias adjust input	VDD/GND
24	CS5	Analog Input	CH5 capacitive sensor input	VDD/GND

Note 1 : Refer to 6.4 SYNC/OPT implementation

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3 Absolute Maximum Rating

Battery supply voltage	5.5V
Maximum voltage on any pin	VDD+0.3
Maximum current on any PAD	100mA
Power Dissipation	800mW
Storage Temperature	-50 ~ 150℃
Operating Temperature	-20 ~ 75℃
Junction Temperature	150℃

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

4 ESD & Latch-up Characteristics

4.1 ESD Characteristics

Mode	Polarity	Max	Reference
H.B.M	Pos / Neg	2000V	VDD
		2000V	VSS
		2000V	P to P
M.M	Pos / Neg	200V	VDD
		200V	VSS
		200V	P to P
C.D.M	Pos / Neg	500V	DIRECT
		800V	

4.2 Latch-up Characteristics

Mode	Polarity	Max	Test Step
I Test	Positive	200mA	25mA
	Negative	-200mA	
V supply over 5.0V	Positive	8.0V	1.0V

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5 Electrical Characteristics (Preliminary)

■ $V_{DD}=3.3V$, $R_B=510k$, (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}	$V_{DD}= 3.3V$ $R_B=510k$	–	80	130	μA
		$V_{DD}= 5.0V$ $R_B=510k$	–	190	315	
Output maximum sink current	I_{OUT}	$T_A = 25^\circ C$	–	–	4.0	mA
Sense input capacitance range Note1	C_S	$C_{DEG} = 200pF$	–	10	100	pF
Sense input resistance range	R_S		–	200	1000	Ω
Minimum detective capacitance difference	ΔC	$C_S = 10pF$, $C_{DEG} = 200pF$	0.2	–	–	pF
Output impedance (open drain)	Z_O	$\Delta C > 0.2pF$, $C_S = 10pF$, $C_{DEG} = 200pF$	–	12	–	Ω
		$\Delta C < 0.2pF$, $C_S = 10pF$, $C_{DEG} = 200pF$	–	30M	–	
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	–	
Recommended bias resistance range Note2	R_B	$V_{DD} = 3.3V$	200	510	820	k Ω
		$V_{DD} = 5.0V$	330	620	1200	
Maximum bias capacitance	C_{B_MAX}		–	820	1000	pF
Recommended sync resistance range	R_{SYNC}		1	2	20	M Ω
Sensitivity level selection	C_{DEG} (Note 2)	High Sensitivity @3.3V	–	200	–	pF
		Medium Sensitivity @3.3V	–	600	–	
		Low Sensitivity @3.3V	–	1200	–	

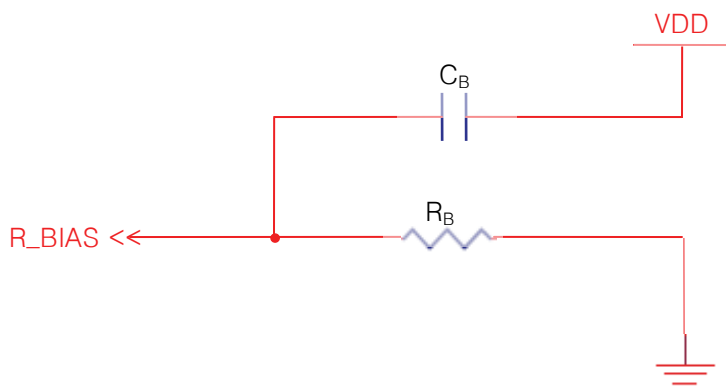
Note 1: The sensitivity can be increased with lower C_S value.

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

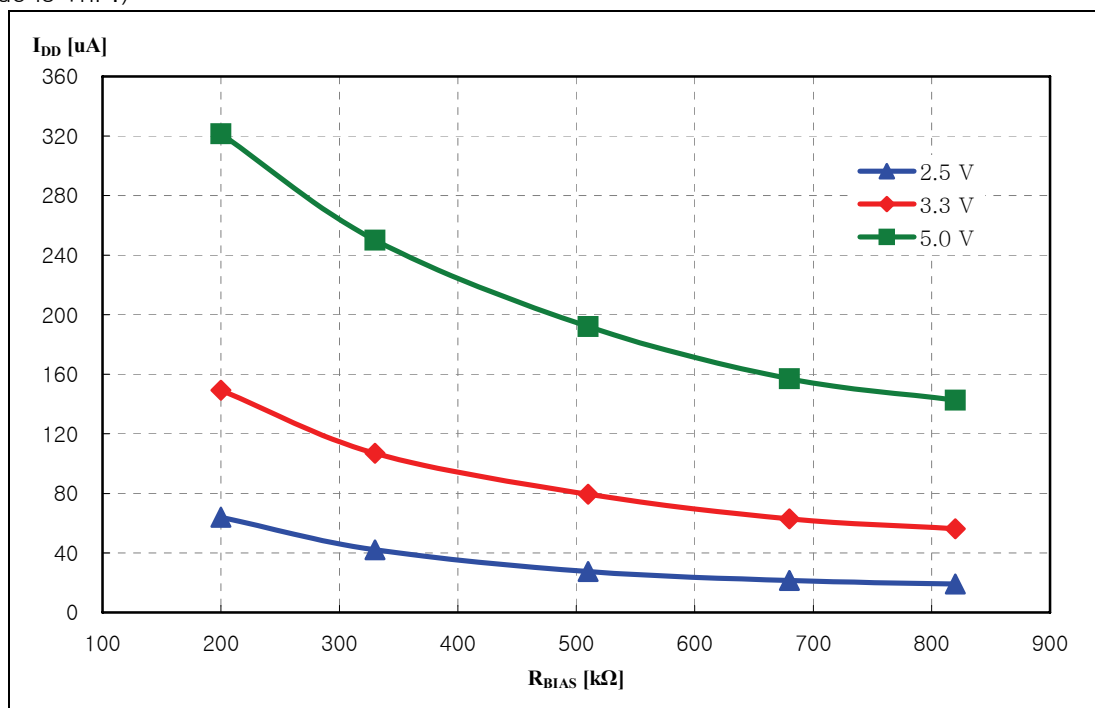
Note 2: The lower R_B is recommended in noisy condition.

6 TS08N Implementation

6.1 R_BIAS implementation



The R_{BIAS} is connected to 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 R_{BIAS} 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.)

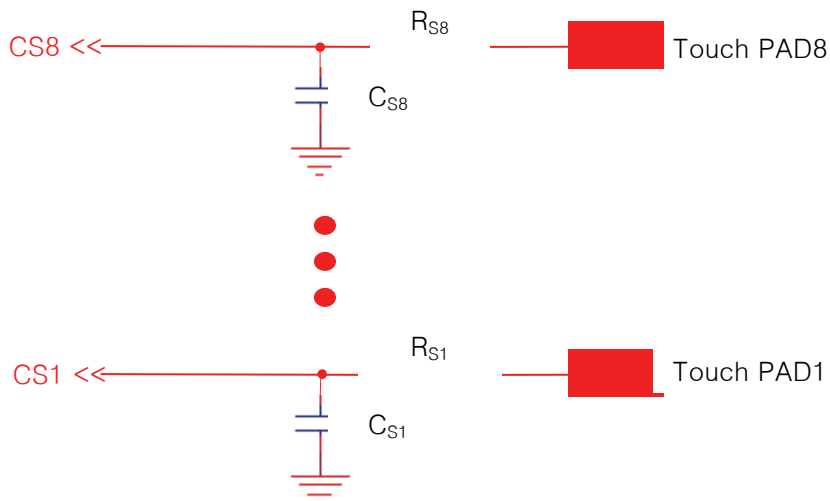


Current consumption curve

The current consumption curve of TS08N 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.

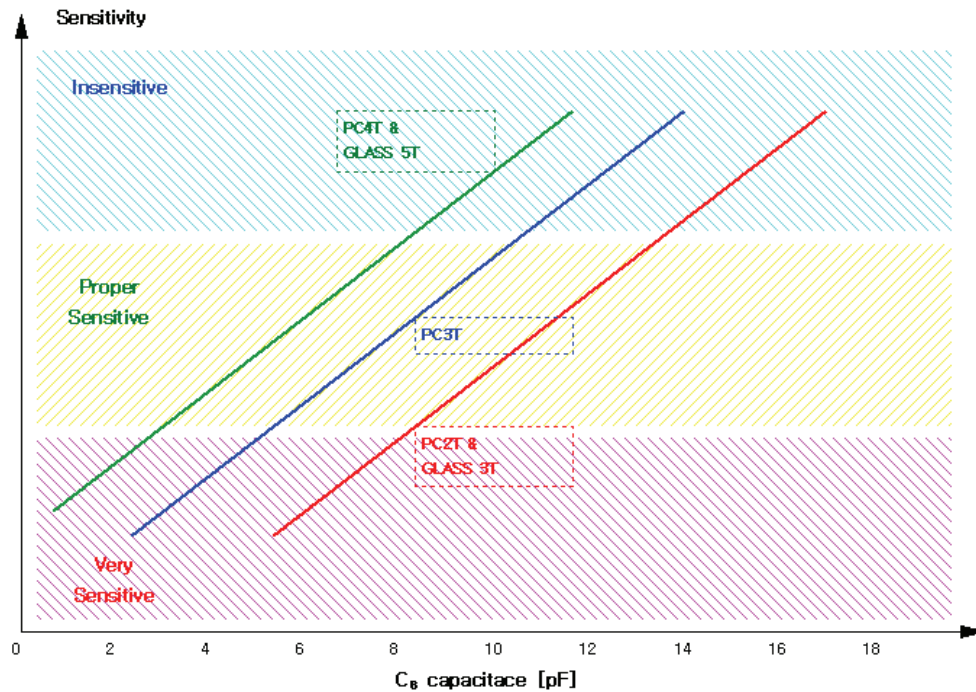
TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

6.2 CS implementation



The parallel capacitor C_{S1} is added to CS1 and C_{S8} to CS8 to adjust sensitivity. The sensitivity will be increased when smaller value of C_S is used. (Refer to the below Sensitivity Example Figure) It could be useful in case detail sensitivity mediation is required. The TS08N has three steps sensitivity and it is available to control with CDEG pin. (Refer to 6.3 CDEG implementation chapters) The TS08N has eight independent touch sensor input from CS1 to CS8. The internal touch decision process of each channel is separated from each other. Therefore eight channel touch key board application can be designed by using only one TS08N without coupling problem. The R_S is serial connection resistor to avoid mal-function from external surge and ESD. (It might be optional.) From 200Ω to $1k\Omega$ is recommended for R_S . 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.

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Sensitivity Example Figure at High sensitivity

6.3 CDEG implementation



The TS08N has internally a standard level to detect the capacitance variation for the decision of touching. The one of three step sensitivity is decided by C_{DEG} . The value of C_{DEG} is represented according to the standard variation level as below table.

CDEG capacitor value vs. sensitivity

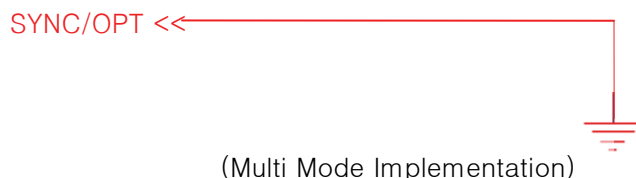
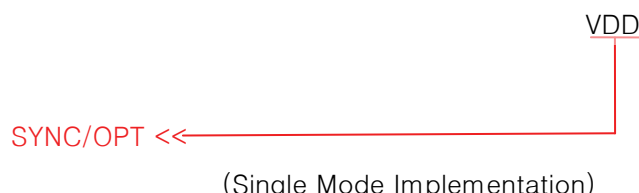
Sensitivity Level	High	Meddle	Low
CDEG Capacitor Typical Value	200pF	600pF	1200pF

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6.4 SYNC/OPT implementation

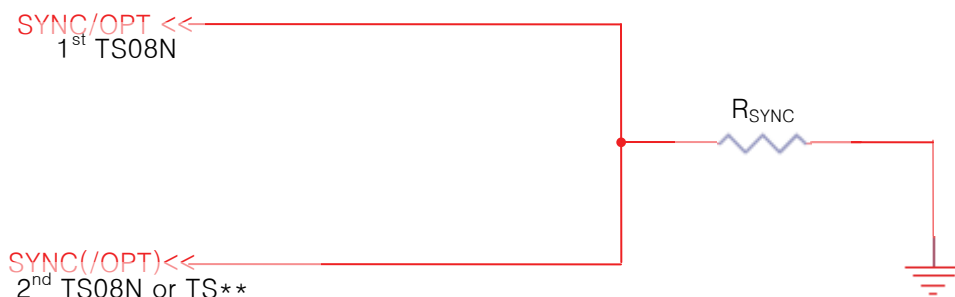
6.4.1 Single Connection

This pin will be assigned for the output option selection. It will decide that TS08N is working on single or multi touch detection mode. It should be implemented as below for these.



6.4.2 Multi Connection

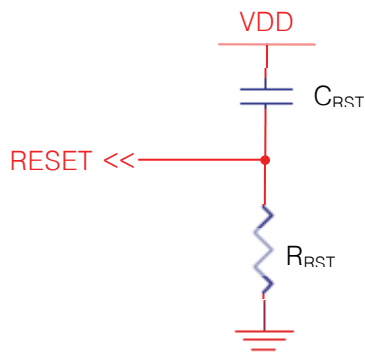
Over two TS08N can work on the one application at the same time thanks to SYNC function with this pin. The SYNC pulse prevents over two sensing signal from interfering with each other. R_{SYNC} is pull-down resistor of SYNC/OPT pin. Too big value of R_{SYNC} makes the SYNC pulse falling delay, and too small value of R_{SYNC} makes rising delay. Typical value of R_{SYNC} is 2M Ω . The Sync pin should be implemented as below. The TS08N can also be used with the other TSxx series by employing this SYNC function. The TS08N could only operate on multi output mode in this configuration.



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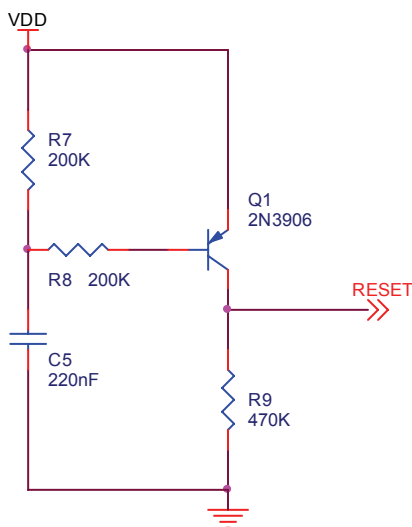
6.5 RESET implementation

TS08N has internal data latches, so initial state of these latches must be reset by external reset pulse before normal operation starts. The reset pulse can be controlled by host MCU directly or other reset device. If not, the circuit should be composed as below figure. The reset pulse must have high pulse duration about a few msec to cover power VDD rising time. The recommended value of R_{RST} and C_{RST} are 330K Ω and 100nF.



Recommended reset circuits 1

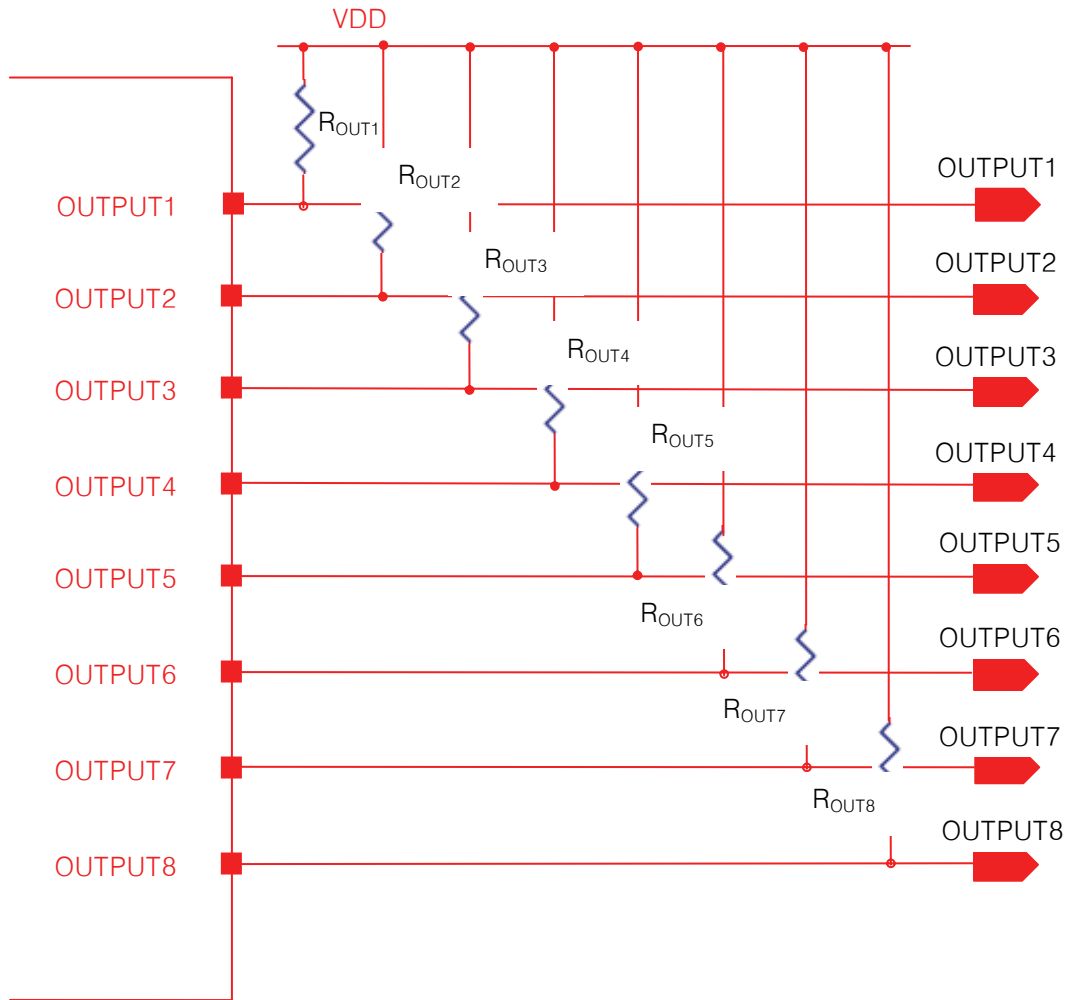
The better performance is warranted with below reset circuit. The Q1 is turned on and makes reset pulse when power is on and VDD is raised to operating voltage. After a few msec (duration time is determined by R7, R8, C5), Q1 is turned off and TS08N can be operated with normal sensitivity.



Recommended reset circuits 2

TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

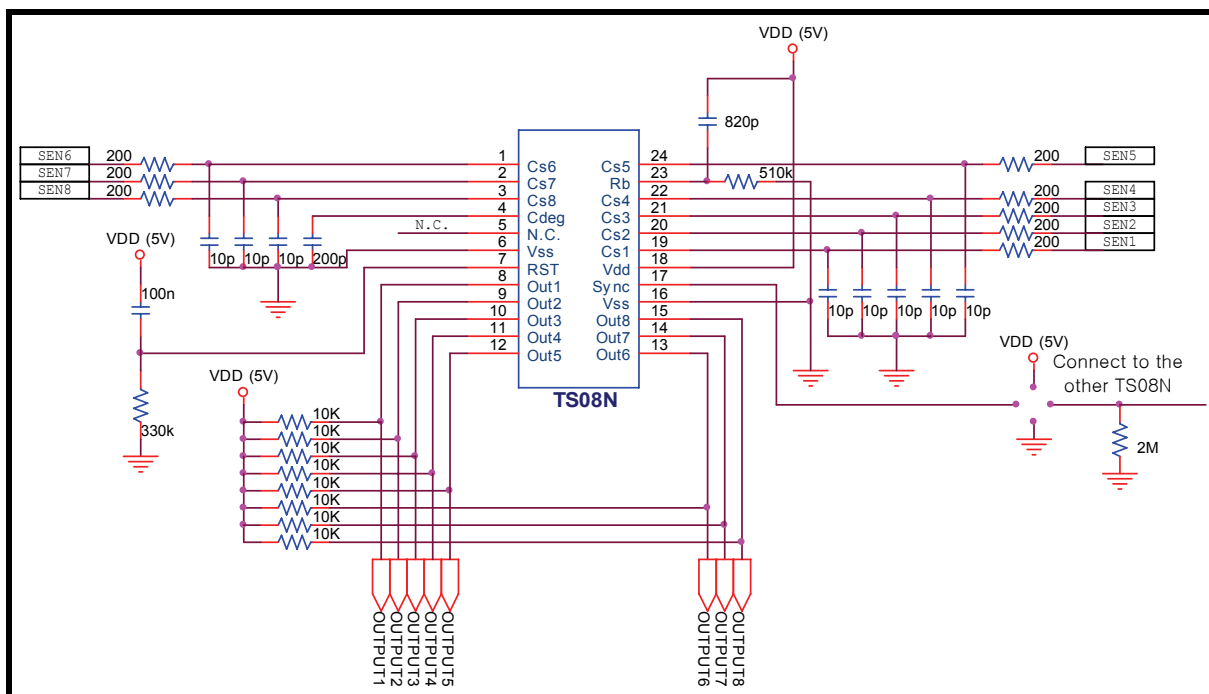
6.6 Output Circuit Implementation



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 k Ω must be used as R_{OUT} . Normally 10k Ω 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.

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7 Recommended Circuit Diagram

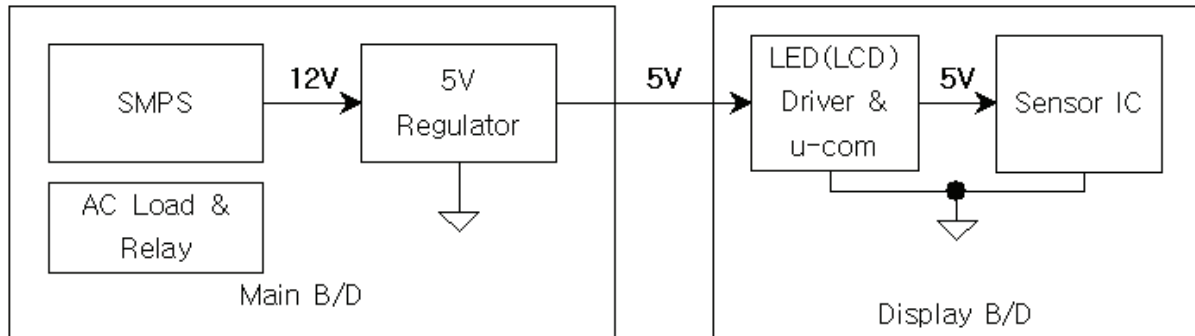


TS08N Application Example Circuit

- ✚ 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.
- ✚ When TS08N used in noisy environment, Lower R_B is recommended.
- ✚ In PCB layout, R_B should not be placed on touch pattern. If not, C_B has to be connected. The R_B pattern should be routed as short as possible.
- ✚ The C_S patterns also should be routed as short as possible and the width of line might be about 0.25mm.
- ✚ The capacitor that is between VDD and GND is an obligation. It should be located as close as possible from TS08N.
- ✚ The C_S 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 capacitor which is connected with CDEG allows changing the sensitivity. (See 6.3 CDEG implementation chapter)
- ✚ The TS08N is reset if RST Pin is high. (See 6.5 Reset implementation chapter)
- ✚ The OUT1 ~ OUT8 are open drain output ports. Therefore the pull-up resistor should be needed as above figure.
- ✚ The TS08N is working with single output mode if SYNC pin is high and it will be in multi output mode when it's low. The resistor which is connected with GND should be connected with SYNC pin when the application is required over two TS08N devices.

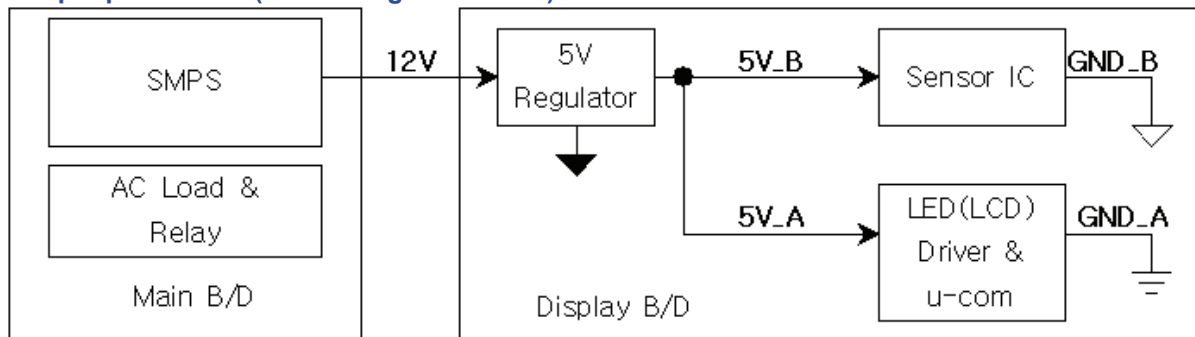
7.1 Example – Power Line Split Strategy PCB Layout

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

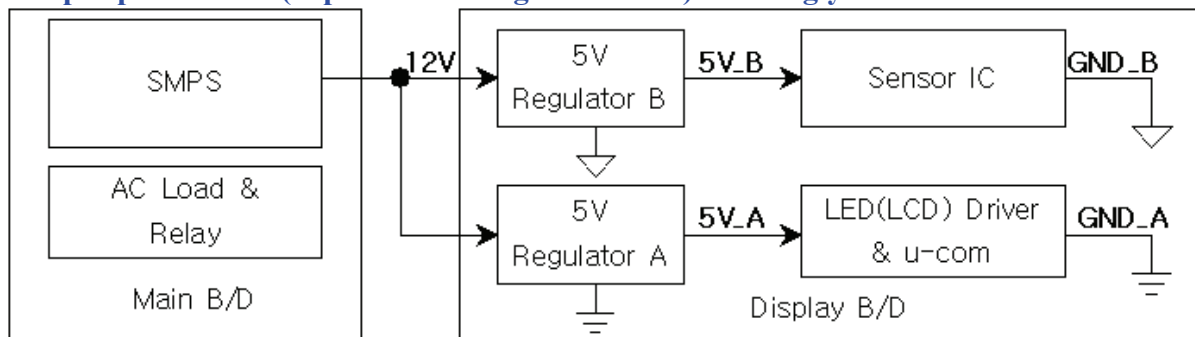


- ✚ The noise that is generated by AC load or relay can be loaded at 5V power line.
- ✚ A big inductance might be appeared in case of the connection line between main board and display board is too long, moreover the voltage ripple could be generated by LED (LCD) display driver at VDD (5V).

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



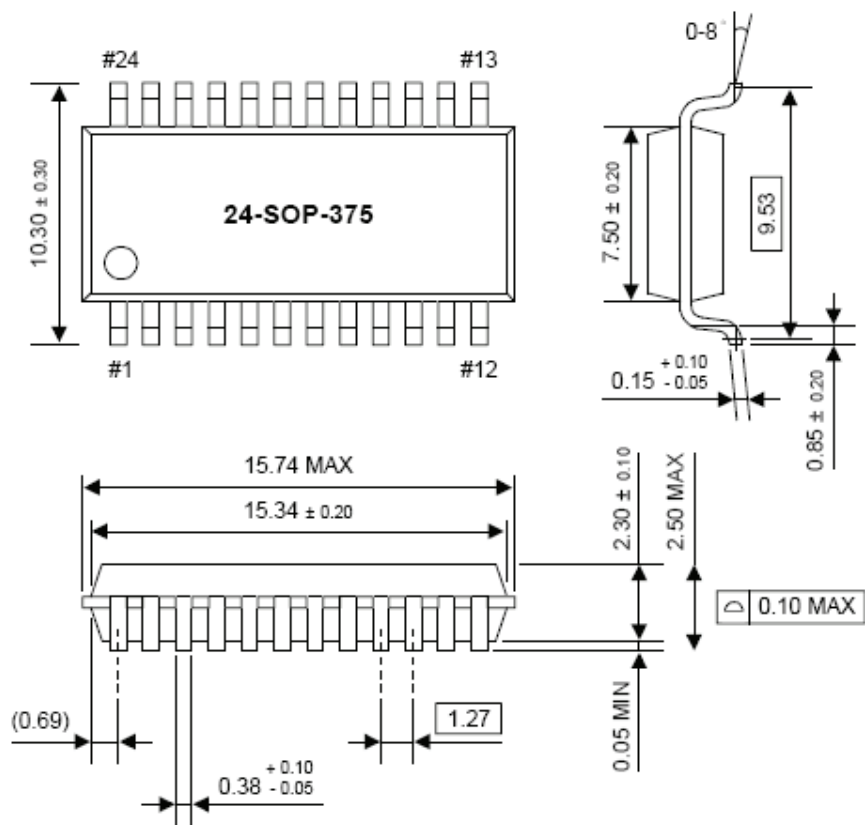
C. Split power Line (Separated 5V regulator used) – Strongly recommended



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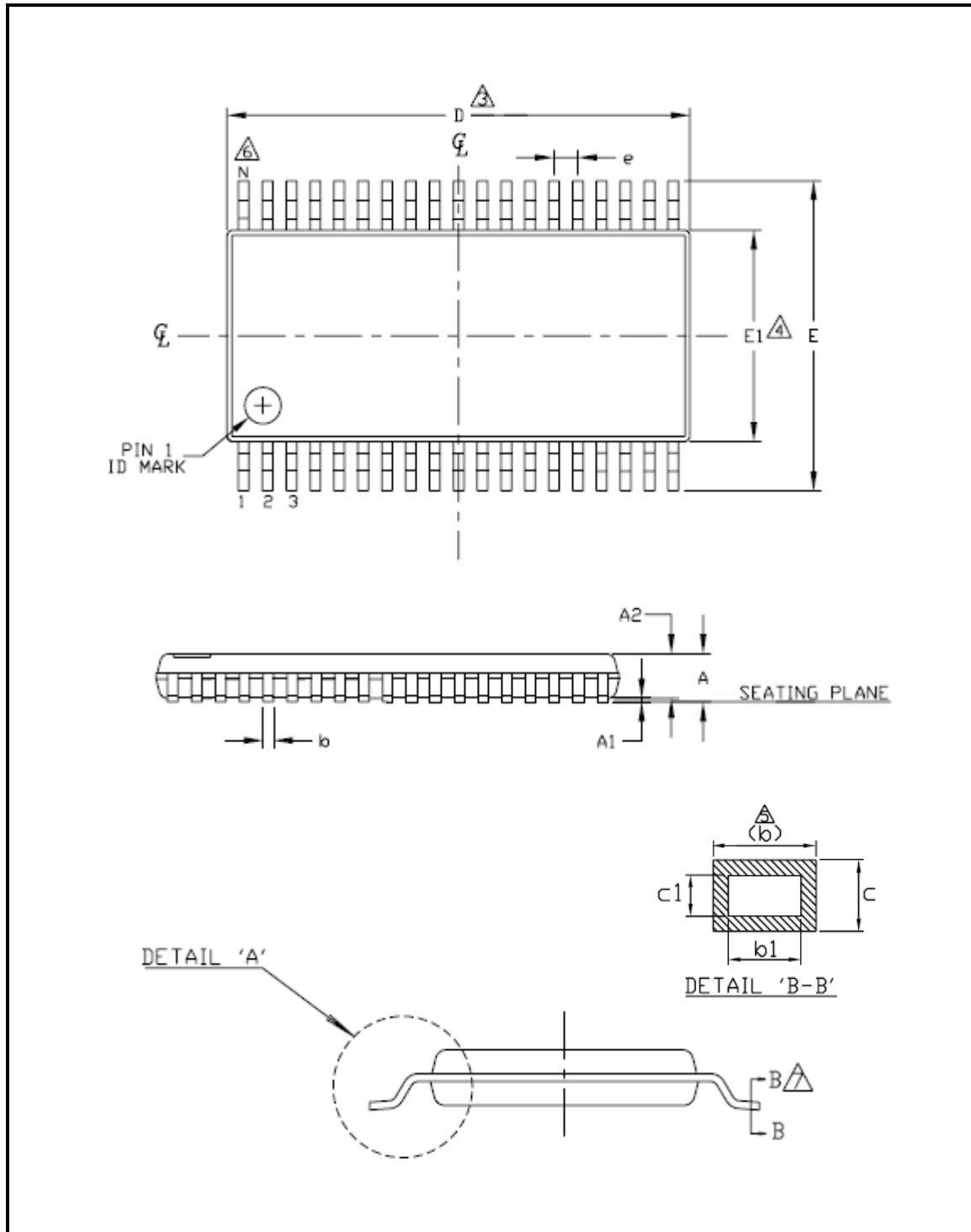
8 MECHANICAL DRAWING

8.1 Mechanical Drawing (24 SOP)

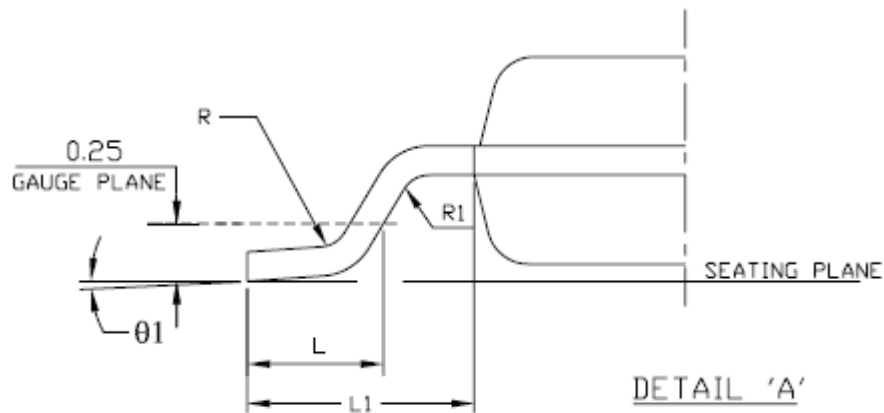


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8.2 Mechanical Drawing (24 TSSOP)



TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)



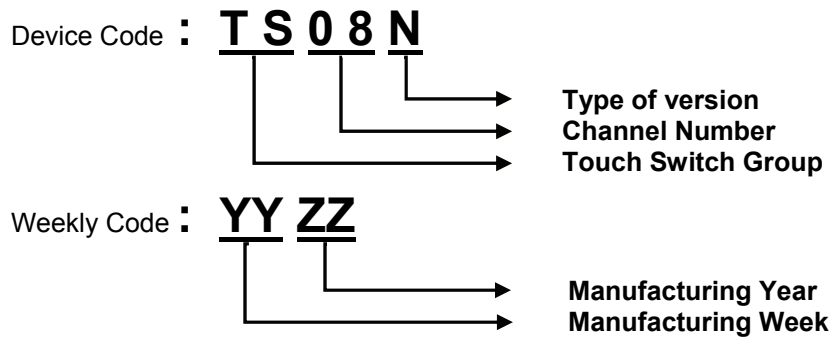
SYMBOL	24L TSSOP		
	MIN	NOM.	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.80	0.90	1.05
D	7.7	7.8	7.9
E1	4.3	4.4	4.5
E	6.2	6.4	6.6
L	0.45	0.60	0.75
R	0.09	—	—
R1	0.09	—	—

SYMBOL	24L TSSOP		
	MIN	NOM.	MAX
b	0.19	—	0.30
b1	0.19	0.22	0.25
c	0.09	—	0.20
c1	0.09	—	0.16
θ1	0°	—	8°
L1	1.0 REF		
e	0.65 BSC		
N	24		
Ref.	Jedec MO-153 Issue C Variation AD		

Notes

1. ALL DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
 2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M-1994.
- ⚠ DIMENSION 'D' DOES NOT INCLUDE MOLD FLASH ,PROTRUSIONS OR GATE BURRS.
 - ⚠ DIMENSION 'E1' DOES NOT INCLUDE INTERNAL FLASH OR PROTRUSION.
 - ⚠ DIMENSION 'b' DOES NOT INCLUDE DAMBAR PROTRUSION.
 - ⚠ "N" IS THE MAXIMUM NUMBER OF LEAD TERMINAL POSITIONS FOR THE SPECIFIED PACKAGE LENGTH.
 - ⚠ CROSS SECTION B-B TO BE DETERMINED AT 0.10 TO 0.25MM FROM THE LEAD TIP.

9 MARKING DESCRIPTION



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" Free from Common Mode Noise "

TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

NOTES:

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