

TS08N

8-Channel Self Calibration Capacitive Touch Sensor

SPECIFICATION V1.5



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

1 Specification

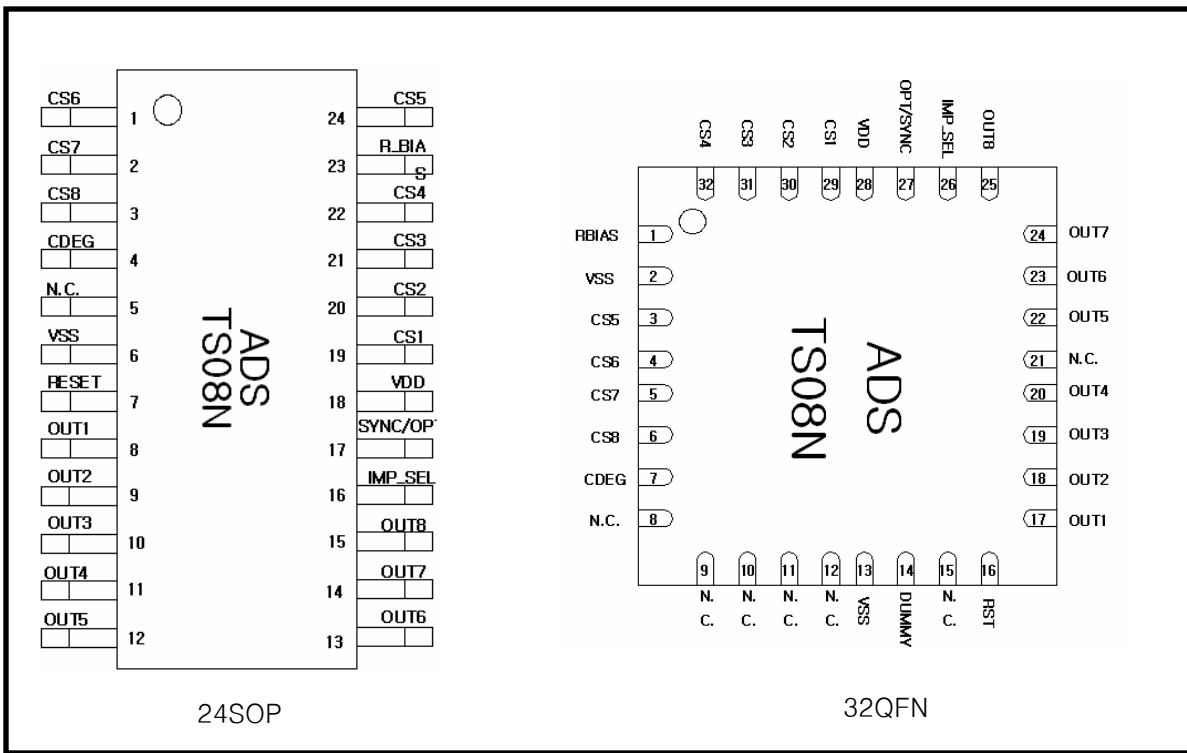
1.1 General Feature

- 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 resistor
- Selectable sense line impedance out of scanning
- Open-drain digital output
- Embedded common and normal noise elimination circuit
- RoHS compliant 24SOP and 32QFN 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 (24SOP / 32QFN)



Drawings not to scale

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

2 Pin Description

2.1 24SOP package

| 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 | IMP_SEL | Digital Input | Sense line impedance selection | VDD/GND |
| 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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2.2 32QFN package

| PIN No. | Name | I/O | Description | Protection |
|---------|----------|----------------------|---|------------|
| 1 | RBIAS | Analog Input | Internal bias adjust input | VDD/GND |
| 2 | VSS | Analog Input | – | VDD/GND |
| 3 | CS5 | Analog Input | CH5 capacitive sensor input | VDD/GND |
| 4 | CS6 | Analog Input | CH6 capacitive sensor input | VDD/GND |
| 5 | CS7 | Analog Input | CH7 capacitive sensor input | VDD/GND |
| 6 | CS8 | Analog Input | CH8 capacitive sensor input | VDD/GND |
| 7 | CDEG | Analog Input | 3 step sensitivity level selection | VDD/GND |
| 8 | N.C. | – | No Connection | – |
| 9 | N.C. | – | No Connection | – |
| 10 | N.C. | – | No Connection | – |
| 11 | N.C. | – | No Connection | – |
| 12 | N.C. | – | No Connection | – |
| 13 | VSS | Ground | Supply ground | VDD |
| 14 | DUMMY | – | No Connection Note 1 | – |
| 15 | N.C. | – | No Connection | – |
| 16 | RST | Digital Input | System reset (High reset) | VDD/GND |
| 17 | OUT1 | Digital Output | CH1 output (Open drain) | VDD/GND |
| 18 | OUT2 | Digital Output | CH2 output (Open drain) | VDD/GND |
| 19 | OUT3 | Digital Output | CH3 output (Open drain) | VDD/GND |
| 20 | OUT4 | Digital Output | CH4 output (Open drain) | VDD/GND |
| 21 | N.C. | – | No Connection | – |
| 22 | OUT5 | Digital Output | CH5 output (Open drain) | VDD/GND |
| 23 | OUT6 | Digital Output | CH6 output (Open drain) | VDD/GND |
| 24 | OUT7 | Digital Output | CH7 output (Open drain) | VDD/GND |
| 25 | OUT8 | Digital Output | CH8 output (Open drain) | VDD/GND |
| 26 | IMP_SEL | Digital Input | Sense line impedance selection | VDD/GND |
| 27 | SYNC/OPT | Digital Input/Output | Output mode selection (Single Output / Multi Output Note 2) Sync pulse input /output | VDD/GND |
| 28 | VDD | Power | Power (2.5V~5.0V) | GND |
| 29 | CS1 | Analog Input | CH1 capacitive sensor input | VDD/GND |
| 30 | CS2 | Analog Input | CH2 capacitive sensor input | VDD/GND |
| 31 | CS3 | Analog Input | CH3 capacitive sensor input | VDD/GND |
| 32 | CS4 | Analog Input | CH4 capacitive sensor input | VDD/GND |

Note 1 : DUMMY pin should be no connection.

Note 2 : Refer to 6.4 SYNC/OPT implementation

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

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°C |
| Operating Temperature | -20 ~ 75°C |
| Junction Temperature | 150°C |

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 |

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

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 |
| | | $V_{DD}= 5.0V$ $R_B=510k$ | – | 200 | 315 | |
| Output maximum sink current | I_{OUT} | $T_A = 25^\circ C$ | – | – | 4.0 | mA |
| Sense input capacitance range Note1 | C_S | | – | 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 |
| | | $C_S = 10pF$, $C_{DEG} = 470pF$ | 0.4 | – | – | |
| | | $C_S = 10pF$, $C_{DEG} = 1000pF$ | 0.8 | – | – | |
| 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 | $V_{DD} = 2.5V$ | 100 | 200 | 470 | k Ω |
| | | $V_{DD} = 3.3V$ | 200 | 330 | 680 | |
| | | $V_{DD} = 5.0V$ | 300 | 510 | 1000 | |
| 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 3 | High sensitivity Note 4 | Short | | | pF |
| | | Medium sensitivity | Open | | | |
| | | Low sensitivity @ $V_{DD}=3.3V$, 5.0V | – | 430 | – | |
| | | Low sensitivity @ $V_{DD}=2.5V$ | – | 470 | – | |

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.

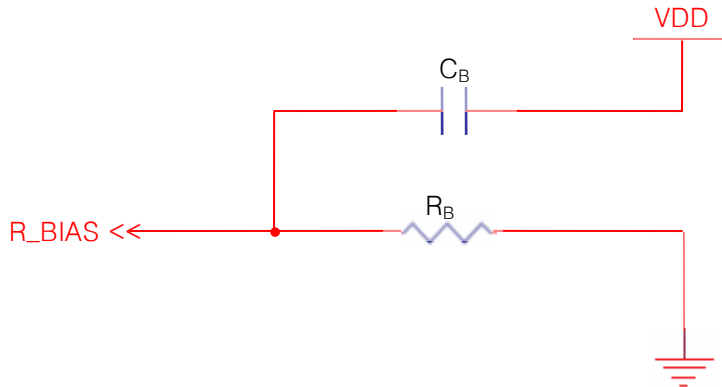
Note 3: C_{DEG} should be in $\pm 5\%$ tolerance.

Note 4: High sensitivity is not recommended in noisy application.

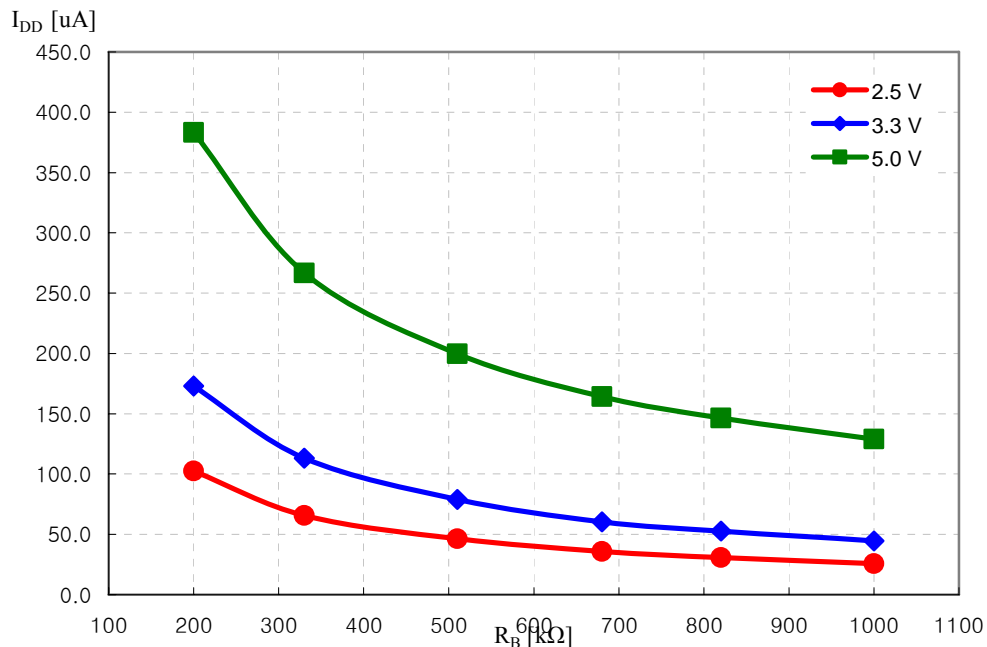
TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

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.)

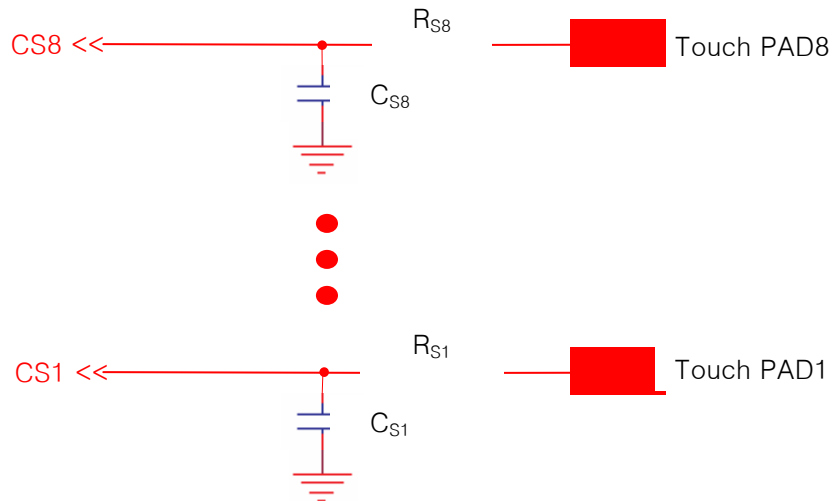


Normal operation current consumption curve

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.

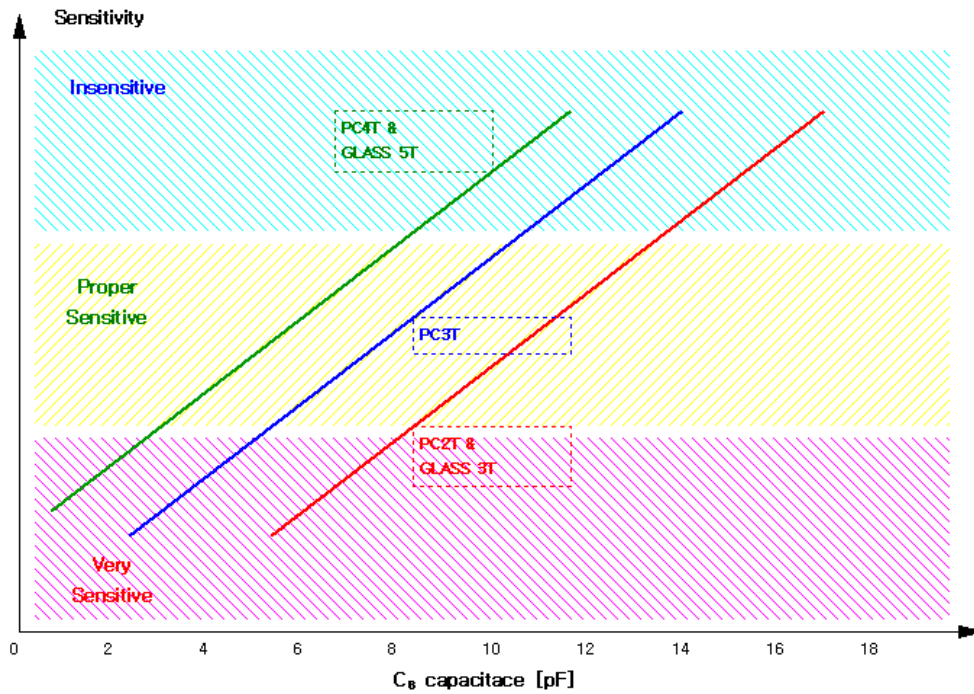
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6.2 CS implementation



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

CDEG << ————— ○ N.C.: Normal Sensitivity

CDEG << ————— ⊥ GND: Higher Sensitivity

The TS08N has internal threshold levels to detect the capacitance variation for the decision of touching. The one of two step sensitivity is decided by CDEG pin connection. The sensitivity is decided by CDEG pin as below table. The high sensitivity is not recommended in noisy applications.

CDEG Connection vs. sensitivity

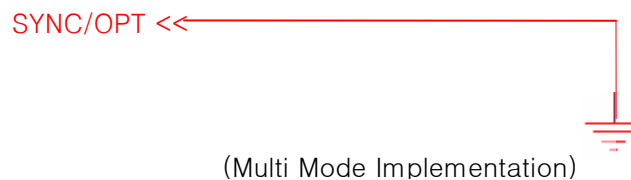
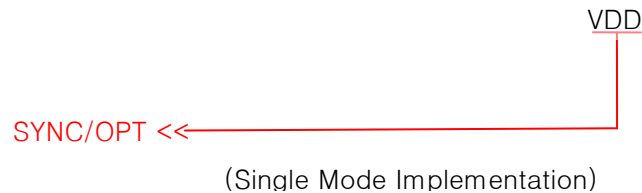
| Sensitivity Level | Normal | High |
|------------------------|---|--|
| CDEG Connection | Not Connect ▪ Compatible with <i>High(CDEG 200pF)</i> sensitivity of TS08 | Connect to GND ▪ Higher sensitivity than <i>High(CDEG 200pF)</i> sensitivity of TS08 |

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

6.4 SYNC/OPT implementation

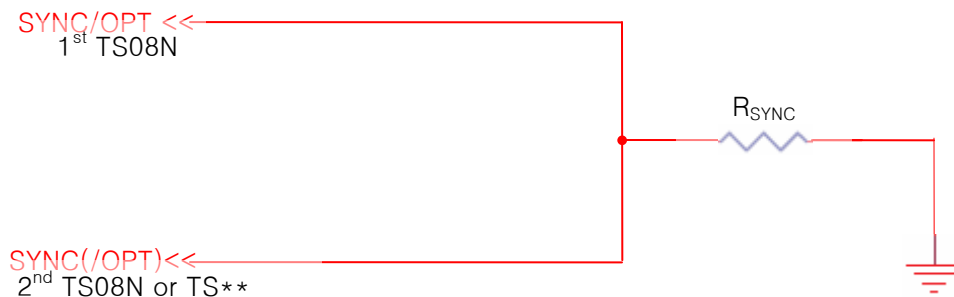
6.4.1 Single Connection

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

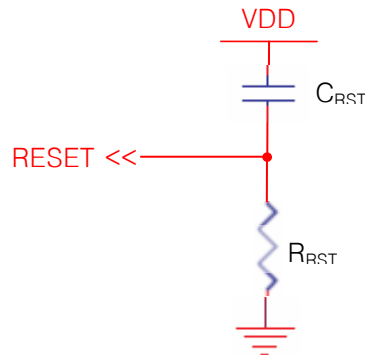
Over two TS08N can work on the one application at the same time thanks to SYNC function with this pin. The SYNC pulse prevents over two sensing signal from interfering with each other. R_{SYNC} is pull-down resistor of SYNC/OPT pin. Too big value of R_{SYNC} makes the SYNC pulse falling delay, and too small value of R_{SYNC} makes rising delay. Typical value of R_{SYNC} is $2M\Omega$. 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.



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

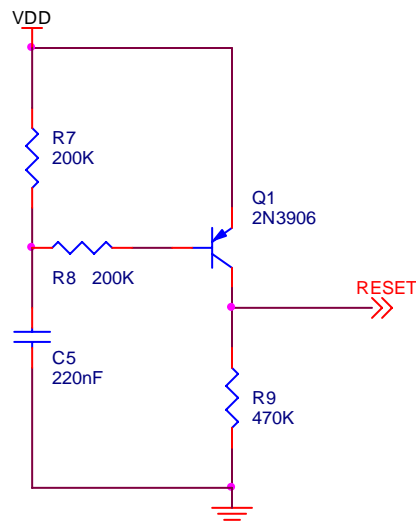
6.5 RESET implementation

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 $330K\Omega$ and $100nF$.



Recommended reset circuits 1

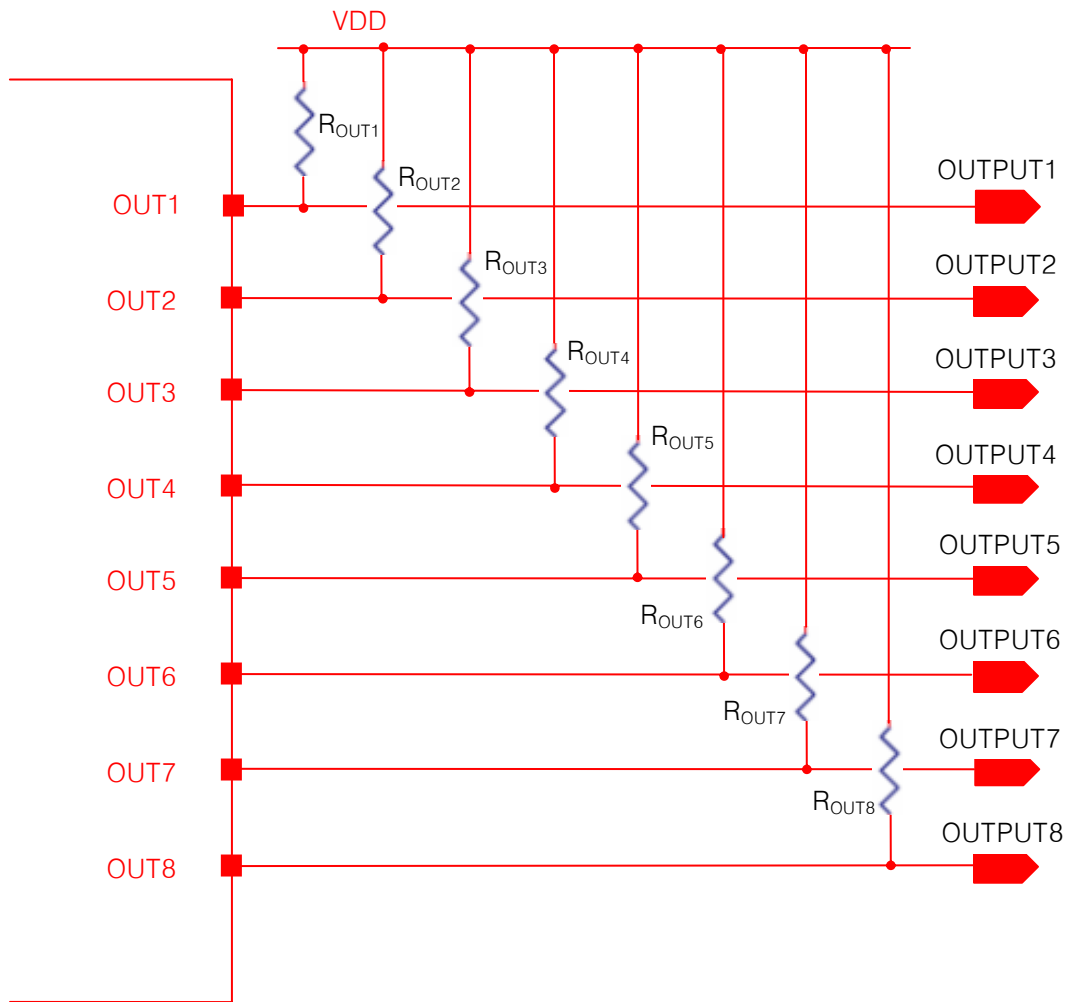
The better performance is warranted with below reset circuit. The Q1 is turned on and makes reset pulse when power is on and VDD is raised to operating voltage. After a few msec (duration time is determined by R7, R8, C5), Q1 is turned off and TS08N can be operated with normal sensitivity.



Recommended reset circuits 2

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

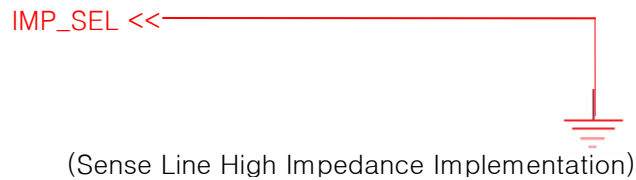
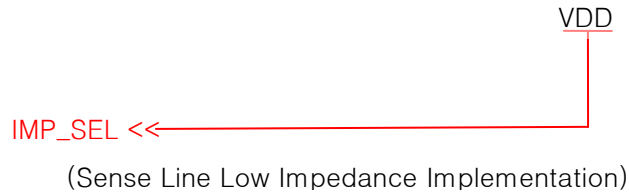
6.6 Output Circuit Implementation



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 $k\Omega$ 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.

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

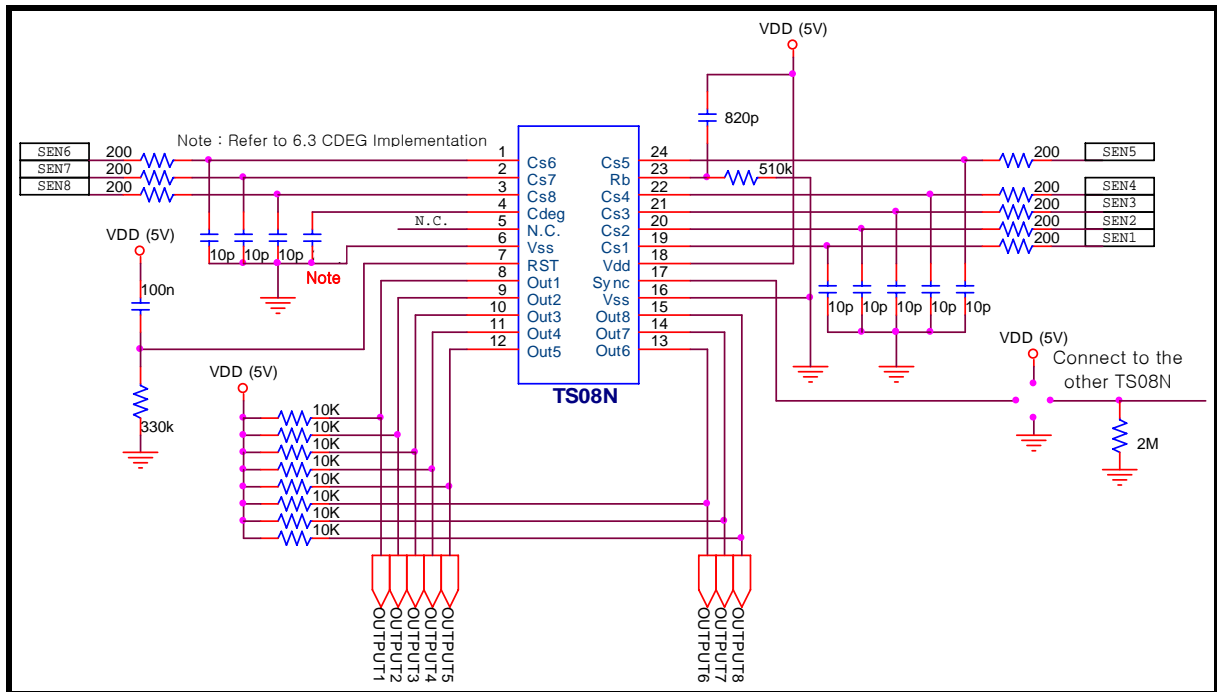
6.7 IMP_SEL (Sense Line Impedance) Implementation



The sense input impedance might be selected by the IMP_SEL pin. In case of multi channel touch sensor application, the sense lines could be drawing side by side with very small gap. In this case, the sensitivity could be affected by the neighbor channel during out of scanning. Therefore the connection of IM_SEL pin is recommended to connect with VDD (low impedance mode). In the other case, the high impedance mode (connection with GND) has an advantage for sensitivity.

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

7 Recommended Circuit Diagram



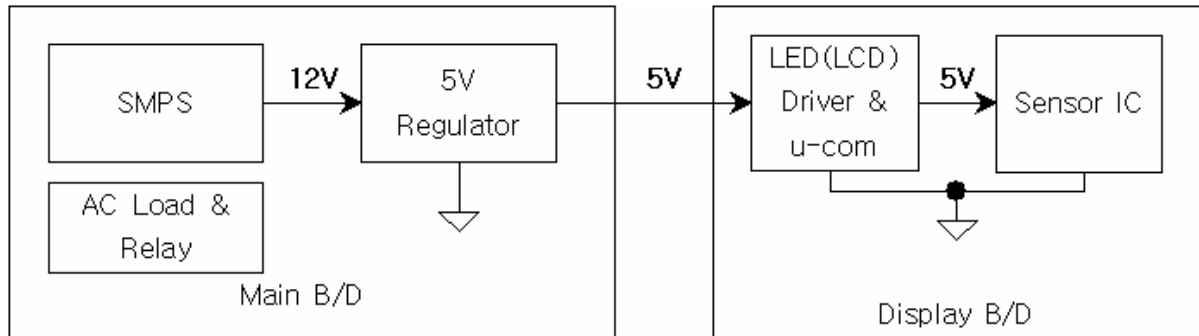
TS08N Application Example Circuit

- ✦ 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.

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

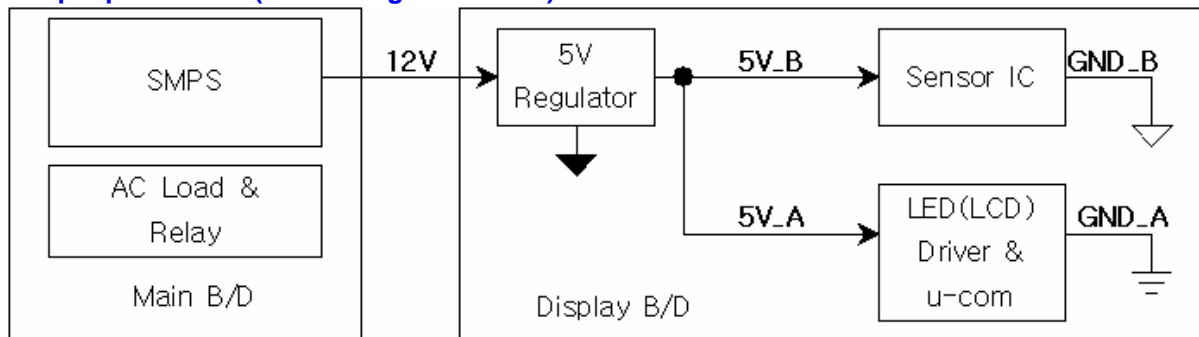
7.1 Example – Power Line Split Strategy PCB Layout

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

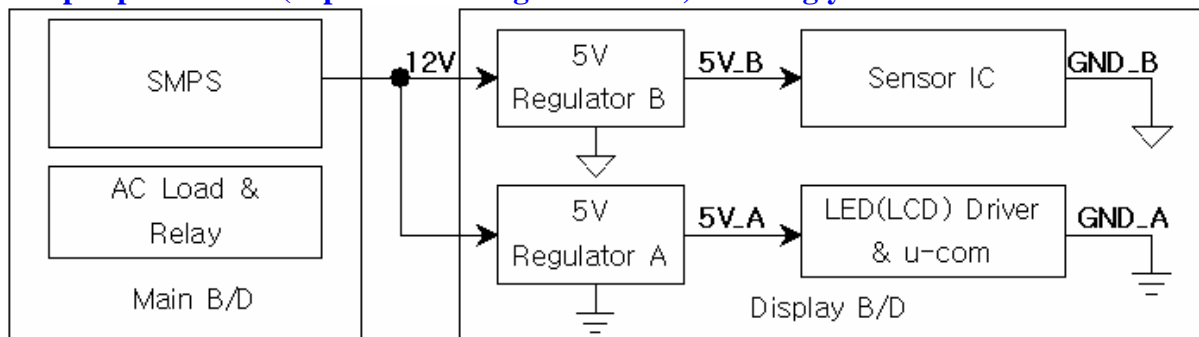


- ✦ The noise that is generated by AC load or relay can be loaded at 5V power line.
- ✦ A big inductance might be appeared in case of the connection line between main board and display board is too long, moreover the voltage ripple could be generated by LED (LCD) display driver at VDD (5V).

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



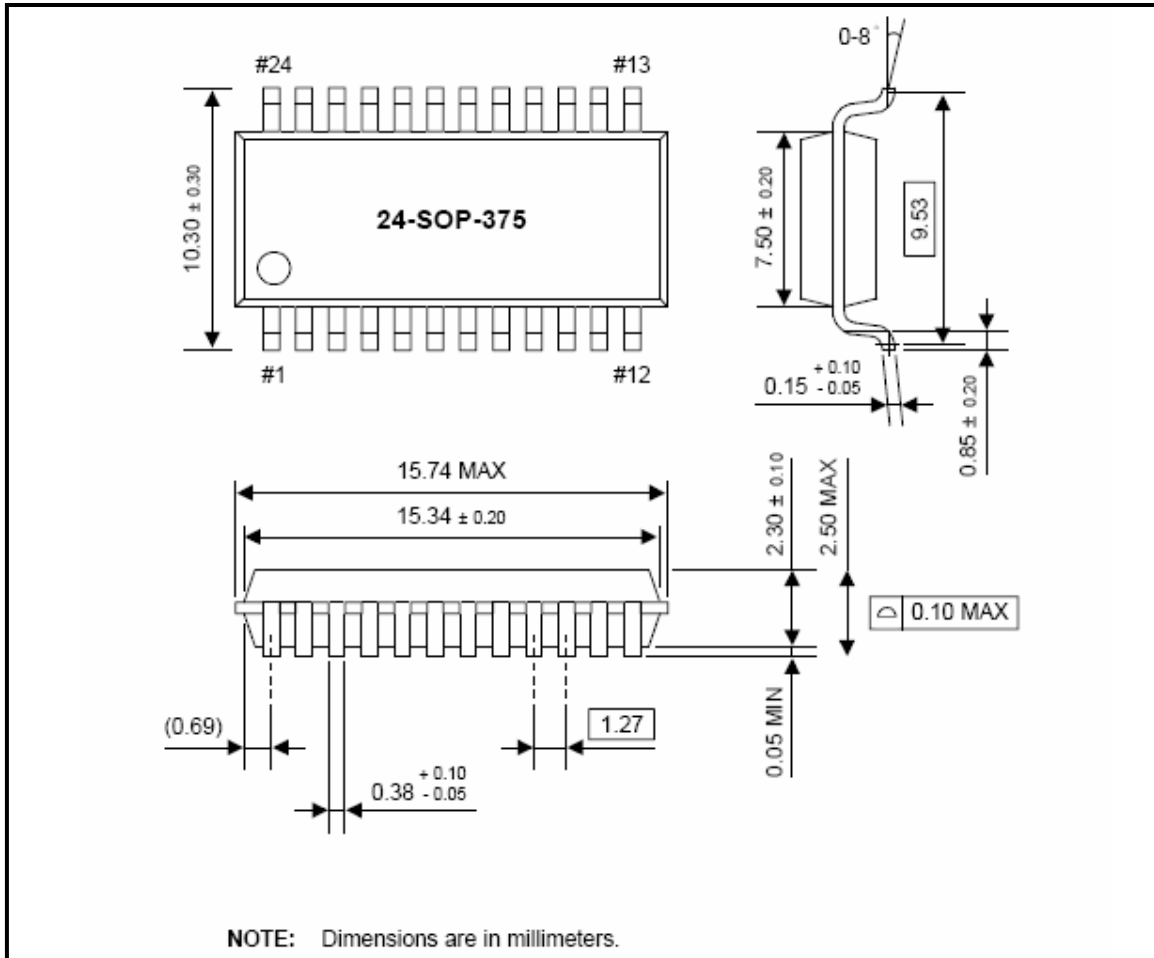
C. Split power Line (Separated 5V regulator used) – Strongly recommended



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

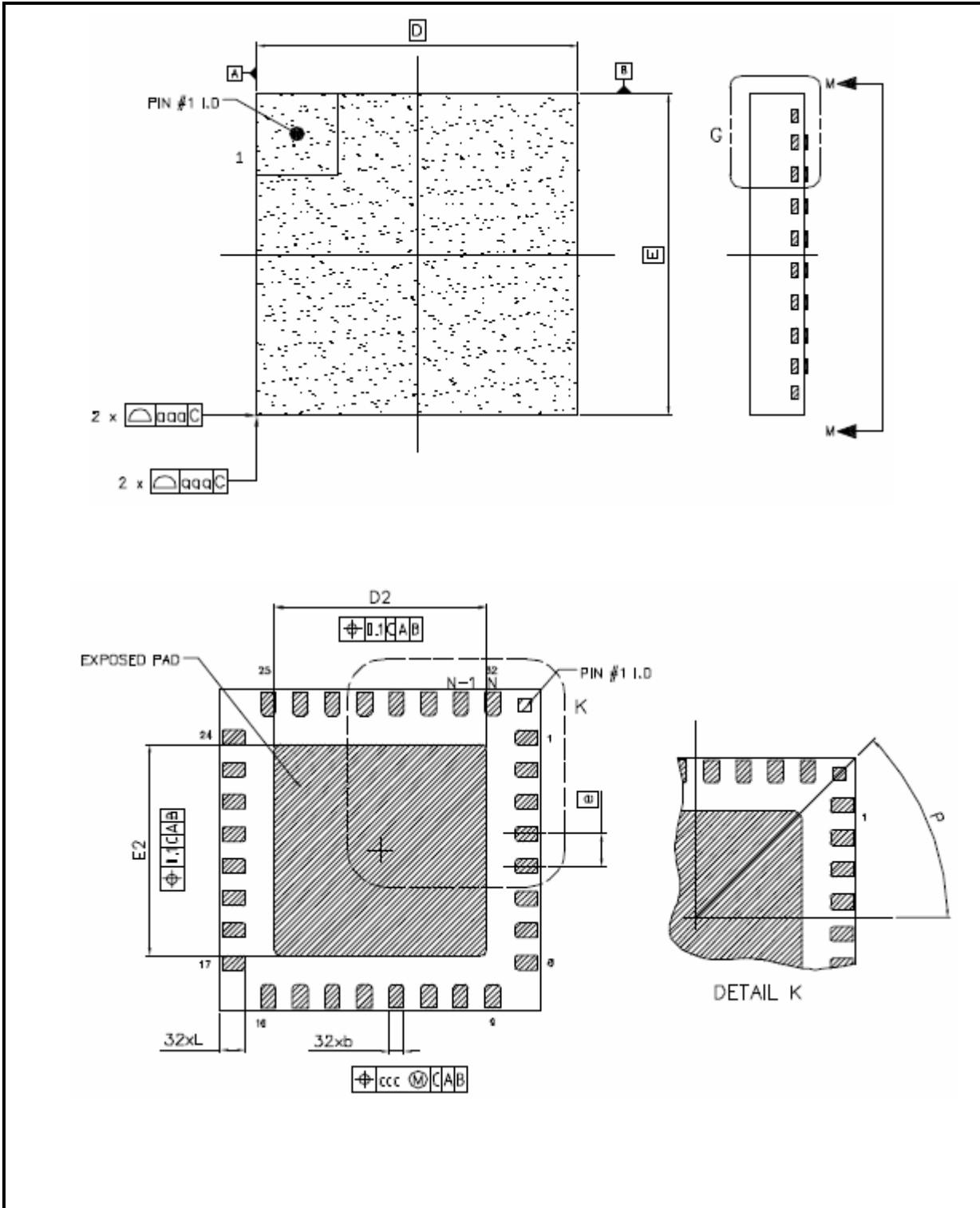
8 MECHANICAL DRAWING

8.1 Mechanical Drawing (24 SOP)

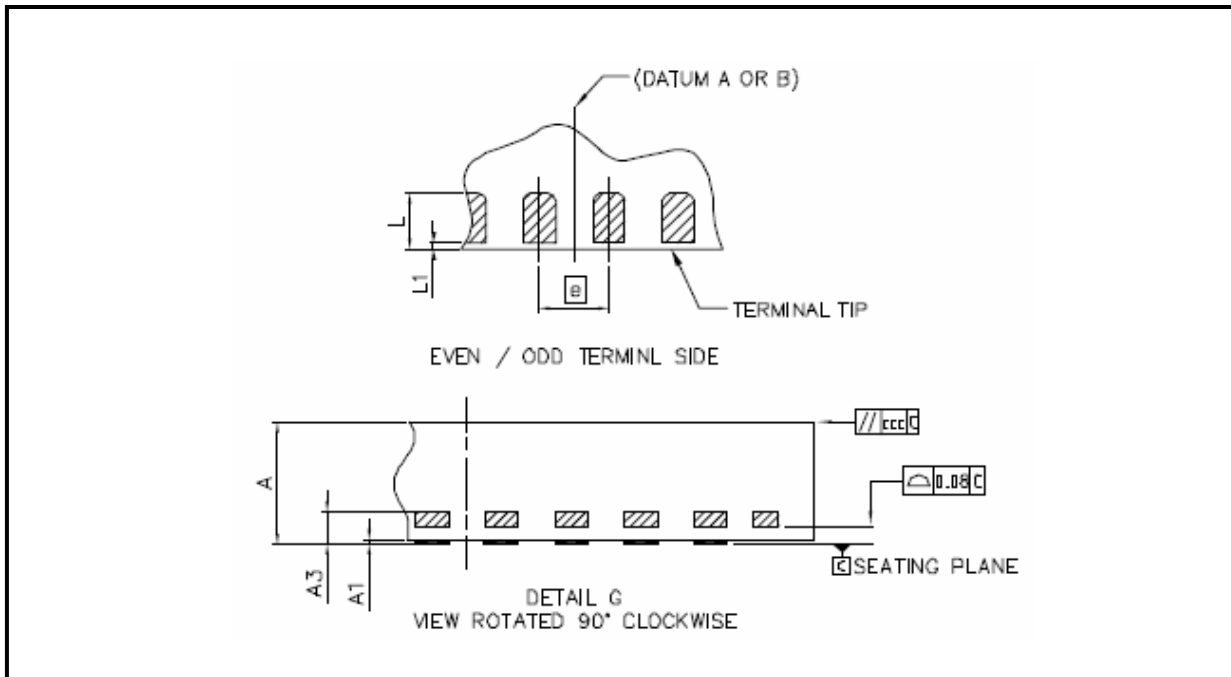


TS08N (8-CH Auto Sensitivity Calibration Capacitive Touch Sensor)

8.2 Mechanical Drawing (32 QFN)



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



| DIM | MIN | NOM | MAX | NOTES |
|-----|------|-----------|------|---|
| A | 0.80 | 0.85 | 0.90 | <p>1. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.</p> <p>2. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP. DIMENSION L1 REPRESENTS TERMINAL FULL BACK FROM PACKAGE EDGE UP TO 0.1mm IS ACCEPTABLE.</p> <p>3. COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL.</p> <p>4. RADIUS ON TERMINAL IS OPTIONAL.</p> |
| A1 | 0.00 | | 0.05 | |
| A3 | | 0.203 REF | | |
| b | 0.18 | 0.23 | 0.30 | |
| D | | 5.00 BSC | | |
| E | | 5.00 BSC | | |
| D2 | 3.20 | 3.30 | 3.40 | |
| E2 | 3.20 | 3.30 | 3.40 | |
| e | | 0.50 BSC | | |
| L | 0.35 | 0.40 | 0.45 | |
| L1 | - | - | 0.10 | |
| P | | 45° BSC | | |
| aaa | | 0.15 | | |
| ccc | | 0.10 | | |

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

9 MARKING DESCRIPTION

Device Code : **T S 0 8 N**

Type of version
Channel Number
Touch Switch Group

Weekly Code : **YY ZZ**

Manufacturing Year
Manufacturing Week

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