Nutech Semiconductor

General Description

With human-machine interfacing requiring ever higher functionality and intuitiveness, touch panel type interfaces are rapidly becoming the norm for the new millennium.

TC312 is a 12 channel capacitive sensing device. The device can operate as a controller for 12 keys.
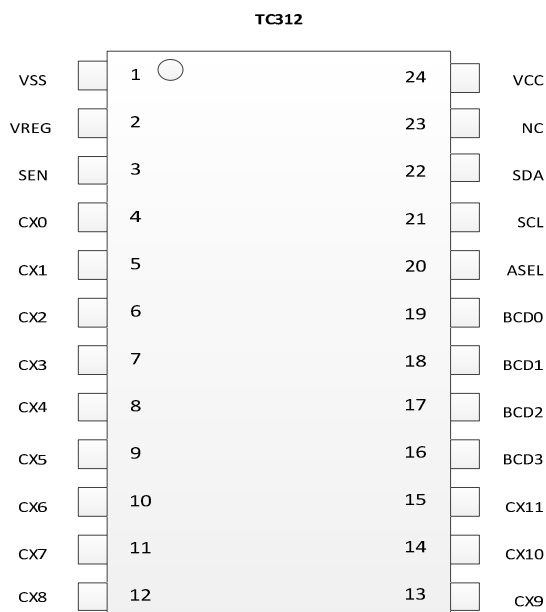
Features

☐ The device controls 12 completely independent touch sensing keys
☐ Autocal for life - no adjustments required
☐ System cost reduction
☐ I2C interface and BCD code output
☐ Reliability through reducing system complexity
☐ Embedded noise immunity circuit
☐ Low current consumption in IDLE state
☐ RoHS compliant SSO-24 package

Applications

☐ Media Players
☐ Consumer Electronics
☐ Home appliances
☐ Keypads
☐ Mechanical switch replacement
☐ Sealed control panels, keypads

Pin Diagram

TC312

Pin				Pin
VSS	1		24	VCC
VREG	2		23	NC
SEN	3		22	SDA
CX0	4		21	SCL
CX1	5		20	ASEL
CX2	6		19	BCD0
CX3	7		18	BCD1
CX4	8		17	BCD2
CX5	9		16	BCD3
CX6	10		15	CX11
CX7	11		14	CX10
CX8	12		13	CX9

TC Serial touch sensor

Pin Description

Pin	Name	I/O	Description
1	VSS	Ground	Supply Ground
2	VREG	Analog Output	Reference output
3	SEN	Analog I/O	Sensitivity Set
4	CX0	Analog I/O	Sensor pad for chanel0
5	CX1	Analog I/O	Sensor pad for chanel1
6	CX2	Analog I/O	Sensor pad for chanel2
7	CX3	Analog I/O	Sensor pad for chanel3
8	CX4	Analog I/O	Sensor pad for chanel4
9	CX5	Analog I/O	Sensor pad for chanel5
10	CX6	Analog I/O	Sensor pad for chanel6
11	CX7	Analog I/O	Sensor pad for chanel7
12	CX8	Analog I/O	Sensor pad for chanel8
13	CX9	Analog I/O	Sensor pad for chanel9
14	CX10	Analog I/O	Sensor pad for chanel10
15	CX11	Analog I/O	Sensor pad for chanel11
16	BCD3	Digital Output	BCD bit3 output
17	BCD2	Digital Output	BCD bit2 output
18	BCD1	Digital Output	BCD bit1 output
19	BCD0	Digital Output	BCD bit0 output
20	ASEL	Digital In	Address select pin
21	SCL	Digital In	I2C clock pin
22	SDA	Digital I/O	I2C data pin
23	NC		
24	VCC	Pwr	Power in

SEN

Sensitivity set pin, the capacitance range is 10pf ~100pf , the smaller the value the higher the sensitivity.

VREG

Reference voltage output, connected to 4.7nf capacitance.

CX0~CX8

Capacitive sense pins connected to electrodes. Series resistance is 3KΩ.

BCD0~BCD3

BCD code output pin. If no touch is detected, all the BCD pins output high level. When touch is detected,those pin will output corresponding BCD code(if more than one touch is detected at the same time, the highest priority BCD code will be outputted.
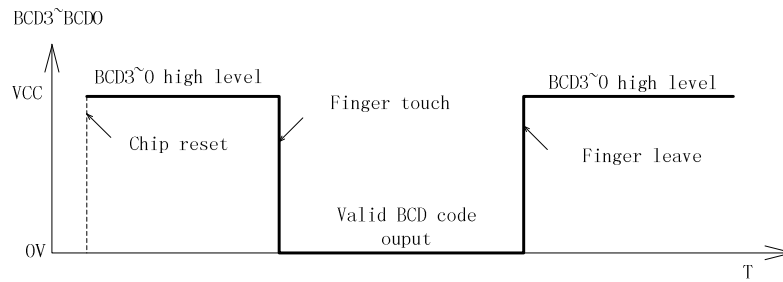
The output priority is reduced by CX0 to CX11.

●touch is detected ×no touch －regardless

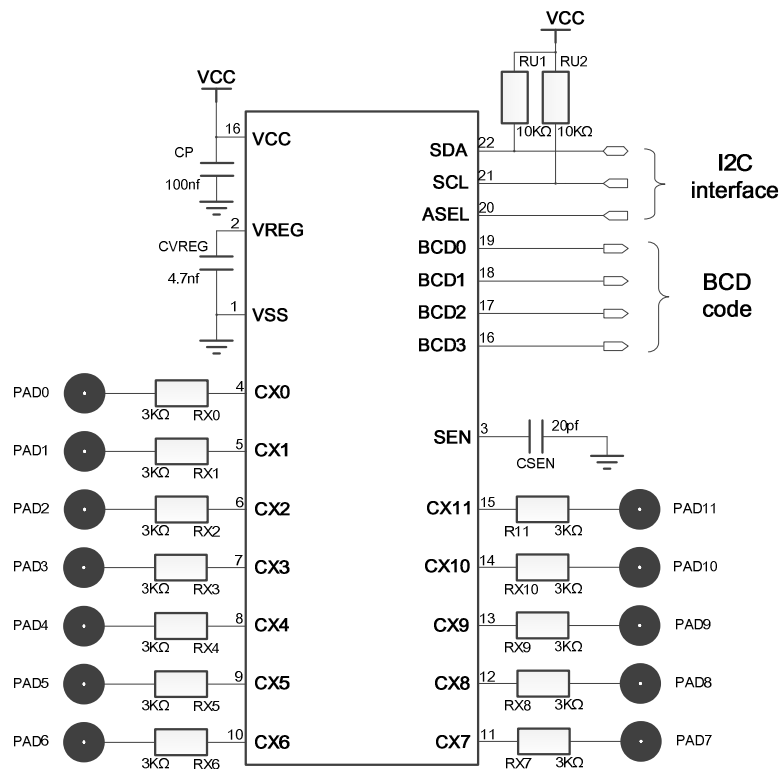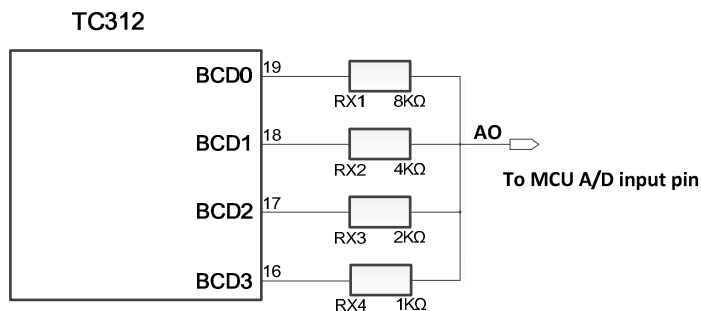| CX0	CX1	CX2	CX3	CX4	CX5	CX6	CX7	CX8	CX9	CX10	CX11	BCD3	BCD2	BCD1	BCD0
●	−	−	−	−	−	−	−	−	−	−	−	0	0	0	0
×	●	−	−	−	−	−	−	−	−	−	−	0	0	0	1
×	×	●	−	−	−	−	−	−	−	−	−	0	0	1	0
×	×	×	●	−	−	−	−	−	−	−	−	0	0	1	1
×	×	×	×	●	−	−	−	−	−	−	−	0	1	0	0
×	×	×	×	×	●	−	−	−	−	−	−	0	1	0	1
×	×	×	×	×	×	●	−	−	−	−	−	0	1	1	0
×	×	×	×	×	×	×	●	−	−	−	−	0	1	1	1
×	×	×	×	×	×	×	×	●	−	−	−	1	0	0	0
×	×	×	×	×	×	×	×	×	●	−	−	1	0	0	1
×	×	×	×	×	×	×	×	×	×	●	−	1	0	1	0
×	×	×	×	×	×	×	×	×	×	×	●	1	0	1	1
×	×	×	×	×	×	×	×	×	×	×	×	1	1	1	1

ASEL

I2C device address select pin。

SCL,SDA

SCL is I2C clock input pin and SDA is I2C data I/O pin. SDA pin have a weak internal pull-up resistor.

Application Circuit

Analog Voltage Output

When using the BCD port to generate analog voltage, the corresponding relationship between the key and the AO voltage is as follows:

KEY	BCD[3:0]output	Voltage of AO
KEY0(CX0) Pushed	0000	0v
KEY1(CX1) Pushed	0001	0.067*VCC
KEY2(CX2) Pushed	0010	0.133*VCC
KEY3(CX3) Pushed	0011	0.200*VCC
KEY4(CX4) Pushed	0100	0.267*VCC
KEY5(CX5) Pushed	0101	0.333*VCC
KEY6(CX6) Pushed	0110	0.400*VCC

|		
KEY7(CX7) Pushed	0111	0.467*VCC
KEY8(CX8) Pushed	1000	0.533*VCC
KEY9(CX9) Pushed	1001	0.600*VCC
KEY10(CX10) Pushed	1010	0.667*VCC
KEY11(CX11) Pushed	1011	0.733*VCC
NO KEY	1111	VCC

I2C Interface

1. **Start and Stop signal**

   Start signal(S)

   A high to low transition on the SDA line while SCL is high defines a START condition.
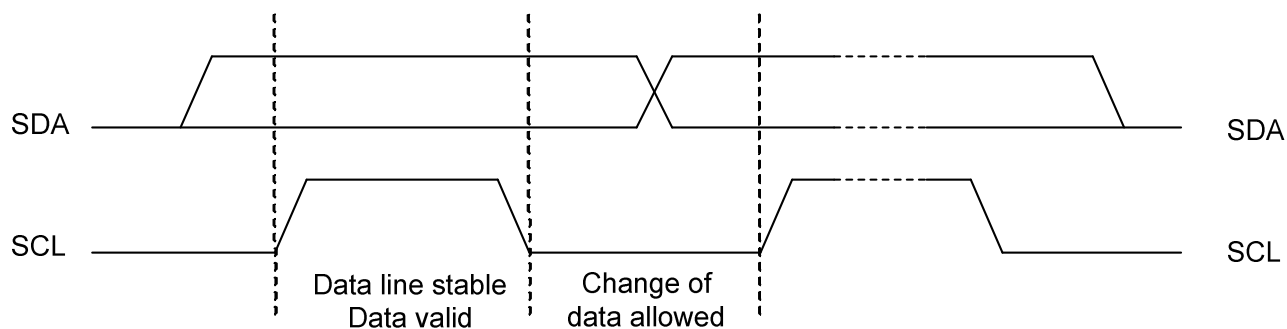
   Stop signal(P)

   A low to high transition on the SDA line while SCL is high defines a STOP condition.
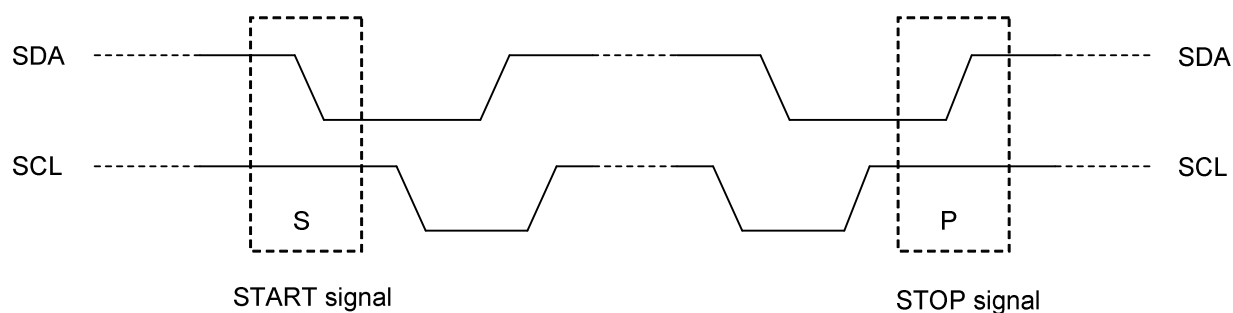
2. **Data Validity**

   The data on the SDA line must be stable during the high period of the SCL line. The high or low state of the SDA line can be changed when the clock signal on the SCL line is LOW.

3. Byte format

The byte structure is composed with 8 Bit data and an acknowledge signal.

4. Device address

Device address of TC312 is selected by the level of ASEL port.

	ASEL high level	ASEL floating	ASEL low level
Address (A[6:0])	44H	40H	42H
Read command (A[6:0]+RWB)	89H	81H	85H
Write command(A[6:0]+RWB)	88H	80H	84H

5. TC312 is a slave device, supporting Read and Write operation mode
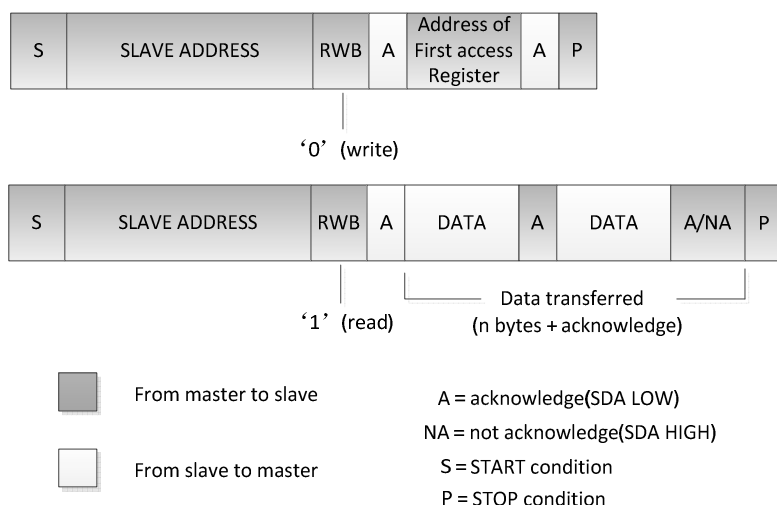
1) Write operation
    - ■ The first byte gives the device address plus the direction bit (RWB = 0).
    - ■ The second byte contains the internal address of the first register to be accessed.
    - ■ The third byte is what to be written in the internal register.
    - ■ The transfer lasts until stop conditions are encountered.
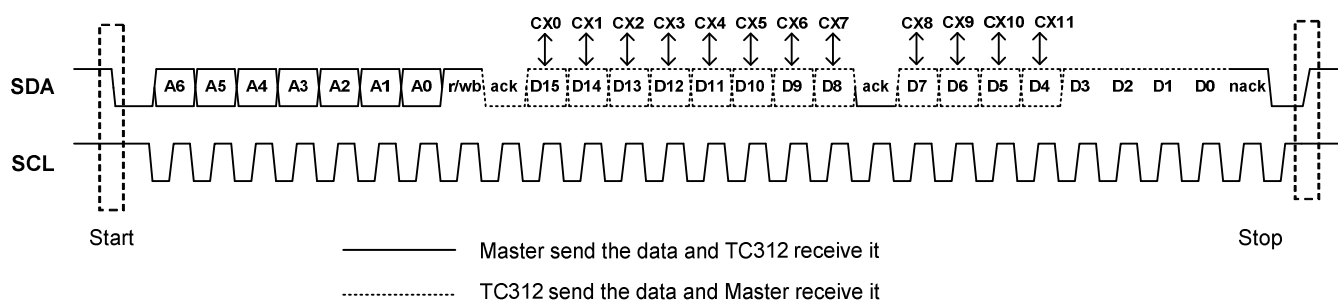   - ■ The TC312 acknowledges every byte transfer.
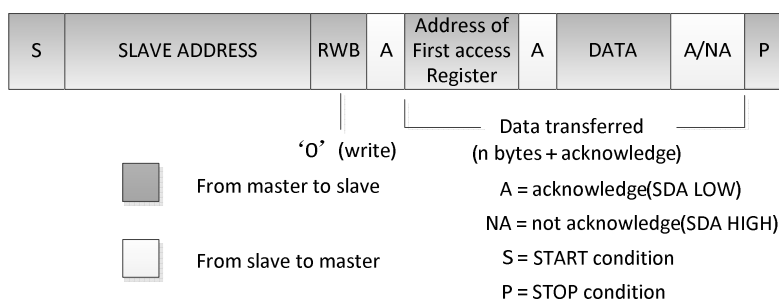
2) Read operation

    The address of the first register to read is programmed in a write operation without data, and terminated by the stop condition. Then, another start is followed by the device address and R/W= 1. All following bytes are now data to be read at successive positions starting from the initial address.。

				Address of		
S	SLAVE ADDRESS	RWB	A	First access Register	A	P

'0' (write)

S	SLAVE ADDRESS	RWB	A	DATA	A	DATA	A/NA	P

'1' (read)　　　Data transferred
　　　　　　(n bytes + acknowledge)

□ From master to slave

□ From slave to master

A = acknowledge(SDA LOW)
NA = not acknowledge(SDA HIGH)
S = START condition
P = STOP condition

3) Simplified read operation

The default address of read register is 08H. So, if no other registers have been accessed, the key information can be read as the following diagram directly.

SDA

SCL

Start

Stop

―――― Master send the data and TC312 receive it

·········· TC312 send the data and Master receive it

6．TC312 control registers list

Register	Address (HEX)	R/W	Initial Value(BIN)	Register function description							
				Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
SenSet0	00H	W	0111 1001	SENSET0[7:0]							
SenSetCOM	01H	W	0111 1001	SENSETCOM[7:0]							
CTRL0	02H	W	100 0 0 0 11	SLPCYC[2:0]			SLPNOW	HOLD	KVF	RTM[1]	RTM[0]
Output1	08H	R	0000 0000	CH0	CH1	CH2	CH3	CH4	CH5	CH6	CH7
Output2	09H	R	0000 0000	CH8	CH9	CH10	CH11				

6.1 Sensitivity Set register　SenSet0(Address 00H)　SenSetCOM (Address 01H)

SENSET0[7:0] 　　　　　Sensitivity setting for channel CX0

SENSETCOM[7:0] 　　　Sensitivity setting for other channels

There are 16 values for setting sensitivity. Sensitivity from low to high :　04H , 15H , 25H , 36H , 47H 58H , 68H , 79H , 8AH , 9BH , ACH , BCH , CDH , DEH , EFH , FFH .The initial default value is 79H

Channel CX0 can be used as a proximity sensor because SENSET0[7:0] is independent .If channel CX0 is used as a common key, SENSET0[7:0] should be just set same as SENSETCOM[7:0]

6.2 Control register CTRL0(Address 02H)

SLPCYC[2:0]   Setting for interval of sampling in idle state

SLPCYC[2:0]	0	1	2	3	4(default)	5	6	7
Sampling interval	infinite	0.5T	1.5T	2.5T	3.5T	4.5T	5.5T	6.5T

T≈120ms

SLPNOW

SLPNOW	1	0(default)
	Enter idle state right now, when no key detected	If no key is detected for 75S,then enter idle state

HOLD

HOLD	1	0(default)
	Stop auto calculation	Auto calculation for reference

6.3 Output register for key   Output0 (Address 08H)   Output1(Address 09H)

CH[11:0]   Respectively corresponding to channel CX[8:0]. When key is detected ,it's zero, otherwise, it's 1.

PCB Layout Notice

1． VCC and VSS power line should be drawn alone, and can not share power line with other chips(micro-controller and LCD driver,etc.). So as to prevent the chip from being affected by noise signal going throng the power line.

2． CP，CVREG，CSEN these three capacitances should be placed as close as possible to the chip. And the series resistors on wire of sense pad should also be placed as close as possible to the chip.

3.   The larger area of grounded copper, the more immunity to noise Interference.

4.   The sense traces and pad should be paid more attention to. The chip should be placed as close as possible to sense pad. The sense traces should be drawn to sense pad directly.   The length of the different sense traces is not necessarily equal. The width of sense traces should be as small as possible. There should not be other power line and signal traces around the sense trace. If it can not be avoided, the other traces should cross the sense trace vertically. The distance between sense pads should be greater than 5mm. The distance between sense pad and grounded copper should be greater than 1.5mm.

Absolute Maximum Rating *

Operating temperature	-40 ~ +85ºC
Storage temp	-50 ~ +150ºC
VCC	-0.3 ~ +6.5V
Max continuous pin current, any control or drive pin	±10mA

Voltage forced onto any pin	-0.3V ~ (Vcc+ 0.3) Volts

* NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

Electrical Characteristics

TA = 25℃

Characteristics	Symbo	Condition	Min	Typ	Max	Units
Operating voltage	Vcc		2.5		6.5	V
Current consumption	Idd	VCC=5.0V		1.15		mA
		VCC=3.0V		620		uA
		VCC=5.0V &SLEEP		40		uA
		VCC=3.0V &SLEEP		22		uA
Self calibration time after chip reset	Tini			300		ms
Range of capacitance on Pad	CX				2.5*CSEN	
Output impedance (open drain)	Zo	Low voltage		50		Ohm
		Hi-z		100M		
Output sink current	Isk	VCC=5V			10.0	mA
Minimum detective capacitance difference	delta_CX	CSEN=15pf		0.2		pF
Sample cycle	Tsi	Normal working state		13		ms
Time of Enter IDLE state	Tidle	No key		75		s

ESD Characteristics

Mode	Polarity	Max	Reference
H.B.M	POS/NEG	8000V	VDD
		8000V	VSS
		8000V	P to P
M.M	POS/NEG	500V	VDD
		500V	VSS
		500V	P to P

Package Diagram (SSOP-24)
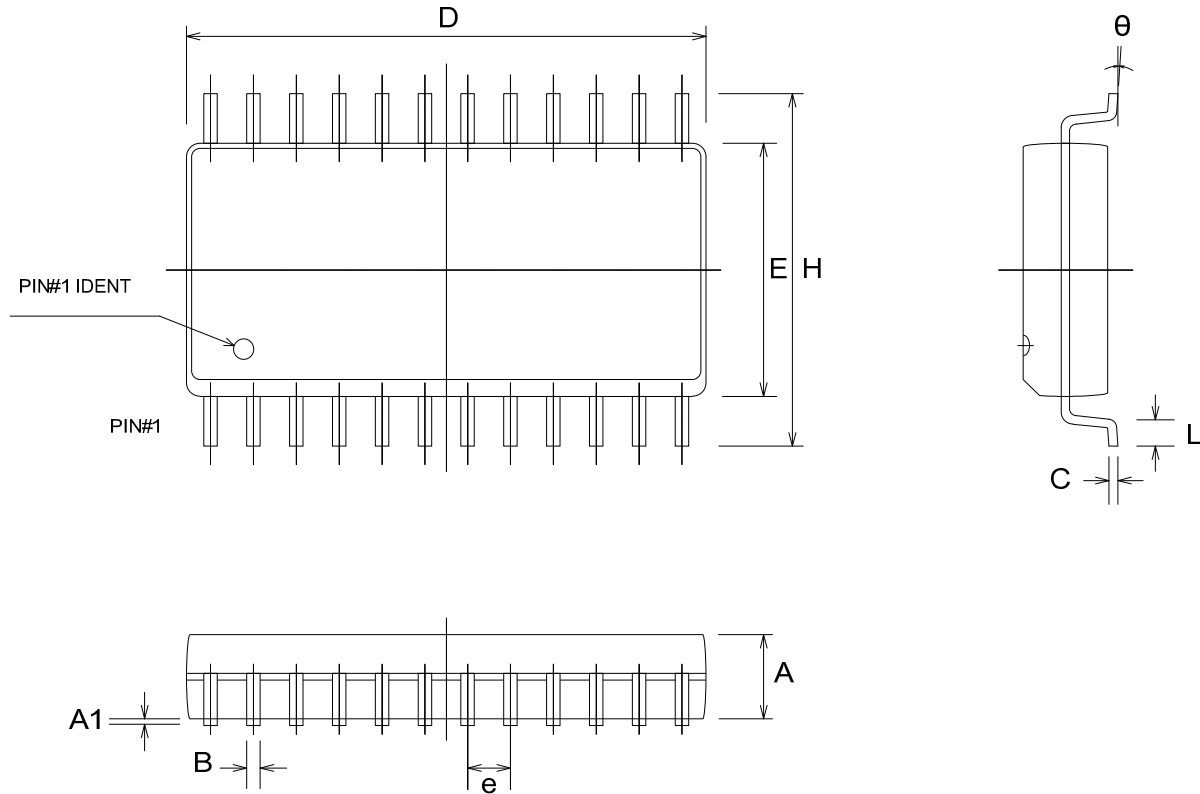
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.25	1.55	0.049	0.061
A1	0.05	0.25	0.002	0.010
B	0.194	0.314	0.008	0.012
C	0.15	0.25	0.006	0.010
D	8.55	8.75	0.337	0.344
E	3.80	4.00	0.015	0.157
e	0.635		0.025	
H	5.70	6.30	0.224	0.248
L	0.30	0.90	0.012	0.035
θ	0°	7°	0°	7°