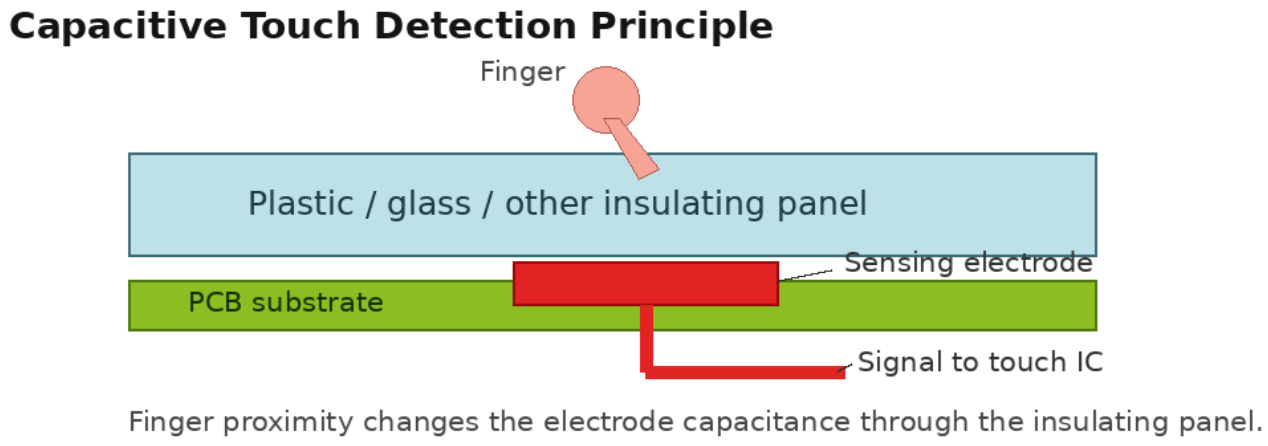
FTC334B Capacitive Touch-Key Controller IC

Product Datasheet - Version 0.6

Overview

Capacitive touch-sensing keys are a modern alternative to mechanical buttons. They can operate through insulating materials such as glass or plastic by detecting the capacitance change caused by a human finger. This avoids mechanical contacts and direct metal-touch arrangements while enabling reliable, durable and visually clean user interfaces.

FTC334B is a dedicated touch-key processing IC using high-precision digital capacitance-measurement technology. It is designed to resist radiated and power-supply interference, reduce the influence of water droplets on the touch panel, and operate from a wide range of supplies. It supports up to 8 touch keys and provides a 4-bit binary-coded output that may also be converted to an analog voltage through a resistor network. A sensitivity-selection pin and a key-valid indication output are also provided.

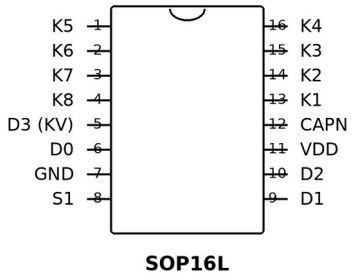


Capacitive touch detection principle

Key Features

- Strong EMC immunity; designed to resist disturbance from nearby transmitters such as walkie-talkies with RF output power up to 5 W.
- Very simple external circuitry; the minimum application requires only one reference capacitor. Series resistors may be added to improve ESD and EMC performance.
- Water-film / water-droplet interference resistance for touch-panel applications.
- Wide operating-voltage range: 3.0 V to 5.5 V.
- Automatic compensation for supply-voltage, temperature and humidity changes.
- Adjustable sensitivity through the external reference capacitor Cs and the S1 sensitivity-select input.
- Direct binary-coded output interface and fast power-on initialization of approximately 300 ms.
- Automatic adaptation to different key-trace parasitic capacitances; SOP16L package.

Package and Pinout

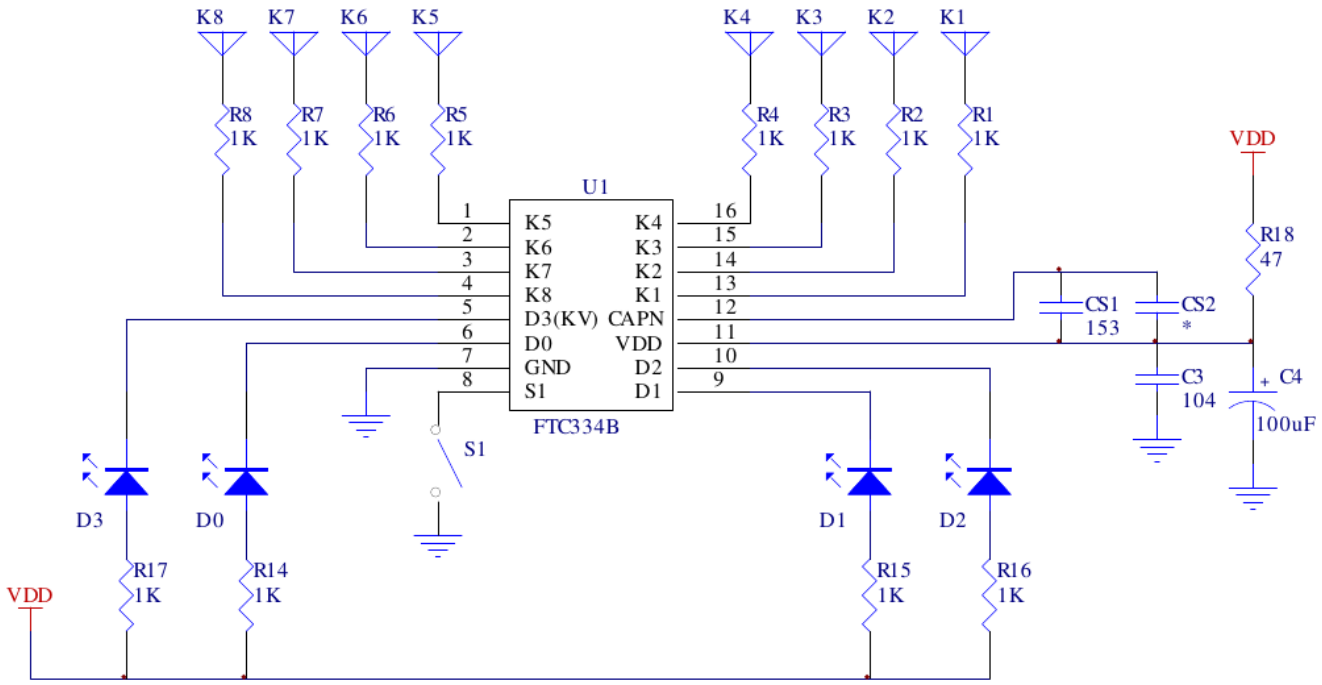


SOP16L pinout

Pin Description

Pin	Name	Type	Function / Description
1-4	K5-K8	I/O	Touch-pad capacitance-signal inputs. In normal use, add a 470 ohm to 1 kohm series resistor to improve RF interference immunity and ESD robustness.
5	D3 (KV)	Output	Binary-code output D3. Also usable as the key-valid signal: LOW when a valid key is detected; HIGH when all keys are released.
6	D0	Output	Binary-code output D0.
7	GND	-	Negative power-supply terminal / ground.
8	S1	Input	Sensitivity-selection input with internal pull-up. Leave open for high sensitivity; connect to ground for low sensitivity.
9	D1	Output	Binary-code output D1.
10	D2	Output	Binary-code output D2.
11	VDD	-	Positive power-supply terminal. When using a 1628-type display driver in the same system, RC filtering of the touch-IC supply is strongly recommended.
12	CAPN	-	Connect to the negative terminal of reference capacitor Cs; connect the positive terminal of Cs to VDD. Use a 5% polyester leaded capacitor, or an SMD NPO/X7R capacitor with 10% or better tolerance.
13-16	K1-K4	I/O	Touch-pad capacitance-signal inputs. In normal use, add a 470 ohm to 1 kohm series resistor to improve RF interference immunity and ESD robustness.

Typical Application Circuit



Reference application circuit

Application Notes

- Use the key inputs in the order K1, K2, ... K8. Connect unused higher-numbered key inputs to ground.
- The usable Cs range is limited by PCB layout and parasitic capacitance. If Cs is too large or too small, the system may not operate. Example values are for reference only.
- The two Cs capacitors shown are used only to make adjustment convenient; the effective Cs value is the sum of the two capacitors.
- If high ESD and RF-interference immunity are not required, resistors R1-R8 may be omitted.
- If a 1628-type display driver is powered from the same supply, RC filtering of the touch-IC supply is strongly recommended.

Functional Description

1. Key Detection

The IC contains a capacitance-measurement circuit and high-precision logic that measure and process the capacitance from each key input to ground. When a finger approaches a touch-sensing pad, the capacitance at that input increases slightly, typically by about 0.2-0.5 pF. When the change reaches the trigger threshold and remains valid for more than 60 ms, the IC accepts the key press and outputs the corresponding key information. When the finger leaves the sensing area and the release condition remains valid for more than 60 ms, the IC recognizes the key release.

2. Sensitivity

According to $C = \varepsilon S / (4\pi kd)$, where ε is the dielectric constant of the insulating material, S is the electrode area, and d is the separation distance:

- A higher dielectric constant generally gives higher touch sensitivity.
- For the same material, a thinner insulating panel gives higher sensitivity; a thicker panel gives lower sensitivity.
- A larger effective touch-electrode area gives higher sensitivity; a smaller area gives lower sensitivity.

Sensitivity Adjustment and Key Processing

Sensitivity Adjustment Using Cs

When the panel material, panel thickness and touch-electrode area are fixed, sensitivity can also be changed by adjusting the reference capacitor Cs. Cs is used as a reference during the internal capacitance calculation, so changing Cs changes the trigger threshold.

A smaller Cs gives higher sensitivity; a larger Cs gives lower sensitivity. If Cs is too large, calculation speed may decrease and overflow may occur; if Cs is too small, accuracy and stability may be reduced. In the sensitivity discussion, the source recommends approximately 6800 pF (682) to 15000 pF (153). A larger Cs generally gives more stable data but increases calculation time. For conducted-immunity (CS) testing, use a smaller Cs where possible while maintaining stability.

3. Abnormal-Key Suppression

Long-press suppression: if a continuous key signal is detected for more than 30 s, the IC treats it as an illegal condition, resets and reinitializes the environmental baseline.

Multi-key suppression: if valid key signals are detected simultaneously on more than three key inputs, the IC treats this as an illegal condition, resets and reinitializes the environmental baseline.

4. Key Priority

If the FTC334B detects two or more non-combination keys at the same time, it selects the output first by time priority and then by signal-strength priority.

5. S1 Option

S1 is a sensitivity-selection input with an internal pull-up resistor. Leave S1 open for high sensitivity; connect S1 to ground for low sensitivity. Use S1 as an auxiliary adjustment if changing Cs alone cannot provide the desired sensitivity. For conducted-immunity (CS) testing, the source recommends the low-sensitivity setting and a smaller Cs value.

6. Key Output

FTC334B uses binary-coded outputs. Key codes are provided through D0-D2, with D3 also serving as the key-valid (KV) indication as described below.

Key	D3	D2	D1	D0	Remark
K1	0	0	0	0	
K2	0	0	0	1	
K3	0	0	1	0	
K4	0	0	1	1	
K5	0	1	0	0	
K6	0	1	0	1	
K7	0	1	1	0	
K8	0	1	1	1	
K1 + K5	1	1	0	0	Combination key
K2 + K6	1	1	0	1	Combination key
K3 + K7	1	1	1	0	Combination key
No key	1	1	1	1	

In the table, "1" means the output is at the supply voltage and "0" means the output is 0 V.

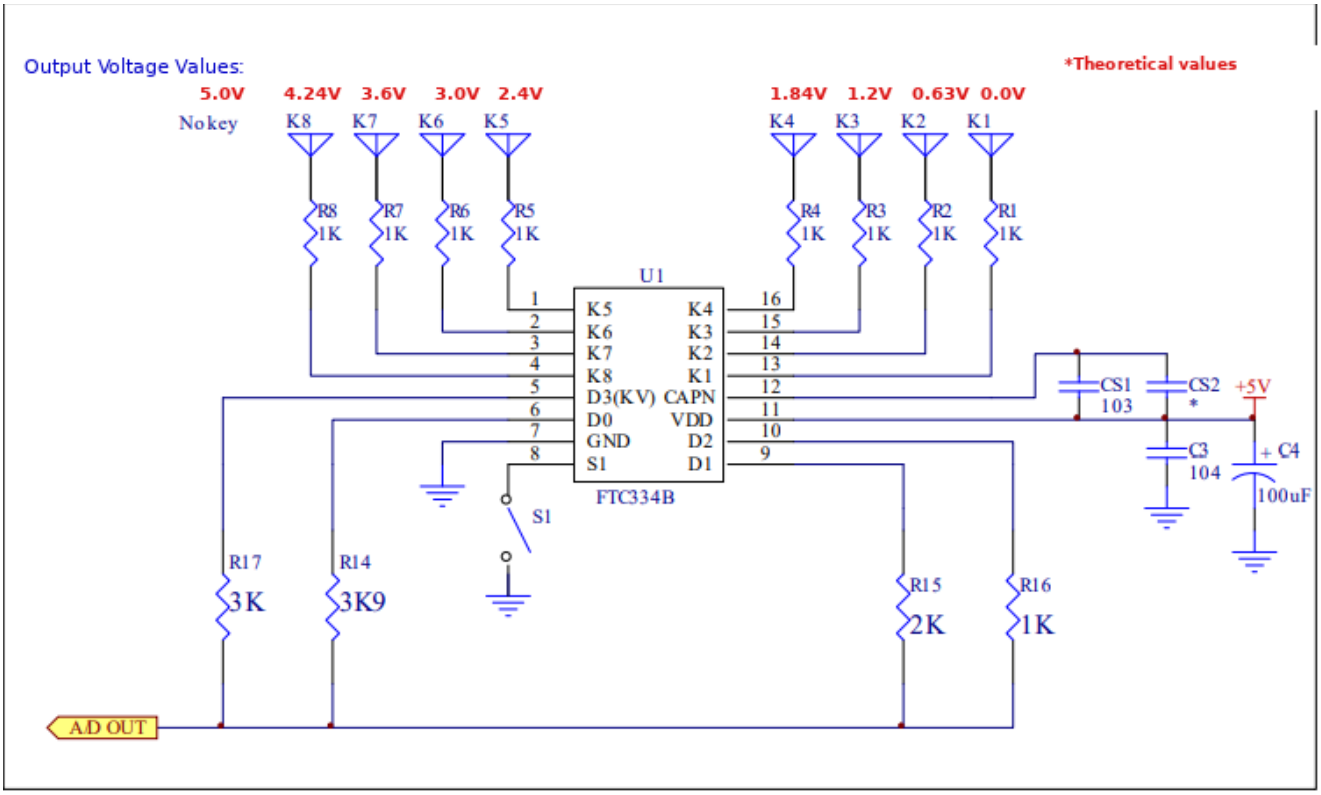
Key-Valid Signal and Analog-Voltage Output

7. D3 (KV) Signal

When a key is detected, binary output D3 acts as the key-valid (KV) signal. It is LOW while a key is active and returns HIGH when the key is released. KV may be used as a notification signal for the main system or to drive a key indicator. According to the output table, KV does not go LOW for the defined combination-key outputs.

8. Analog-Voltage Output

The binary-coded outputs can be converted to an analog voltage using a resistor-divider network. The main system can then read key information through an A/D converter, reducing the number of required digital I/O lines.



Example resistor network for analog key-voltage output

State	No key	K8	K7	K6	K5	K4	K3	K2	K1
Output	5.0 V	4.24 V	3.6 V	3.0 V	2.4 V	1.84 V	1.2 V	0.63 V	0.0 V

The output-voltage values above are theoretical calculated values from the source datasheet.

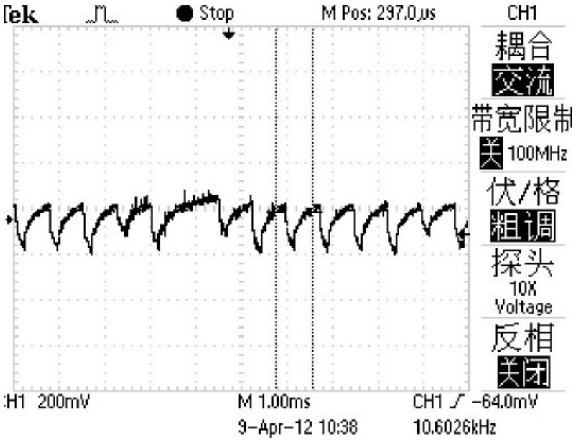
Power-Supply Requirements

The FTC series operates from 3.0 V to 5.5 V. Within this range, the IC can operate normally. However, during each measurement cycle (10 ms), the IC supply voltage must remain relatively smooth and stable; otherwise ripple or noise can interfere with the internal analog capacitance-measurement circuitry.

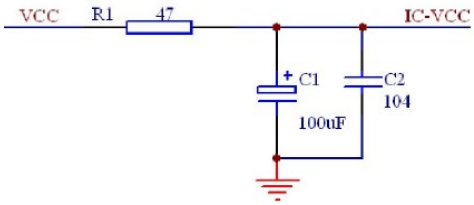
Power-Supply Filtering and Ripple

In most applications, a three-terminal voltage regulator provides a sufficiently smooth supply. In some systems, however, strong high-frequency ripple may still appear at the IC supply pin because of variations in system load. In this case, the touch-IC supply must be further filtered, for example with an RC filter.

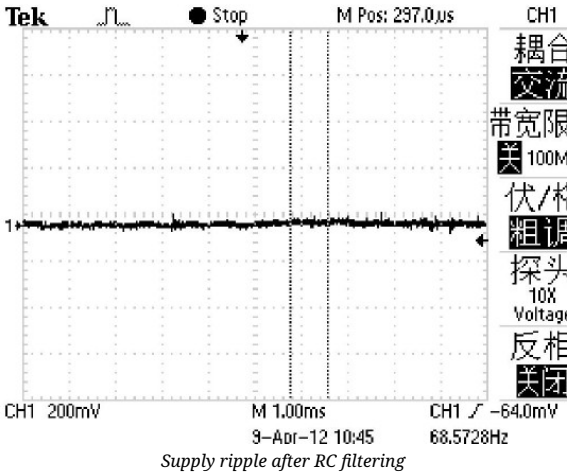
Typical examples include systems using a 1628-type display driver, high-current multiplexed LED scanning, or an AC buzzer. The source shows an example in which touch-key operation became unstable in a system using a 1628 display driver because of obvious supply ripple.



Supply ripple before RC filtering



Recommended RC supply filter



Supply ripple after RC filtering

A simple RC filter is a common and effective way to attenuate high-frequency noise. Select R and C according to the application, but account for the voltage drop across R. Loads such as buzzers and LEDs should be powered from the supply side before the filter resistor.

In the illustrated system, using approximately R = 39 ohms and C = 47 µF for the touch-IC supply made the touch keys stable and significantly reduced supply ripple. The source therefore recommends RC filtering before the touch IC, especially in products using 1628-type display-driver ICs.

Design Precautions

1. For a double-sided PCB, circular, square or other shapes may be used as touch-sensing pads on the top layer. Route the trace from each touch pad to the IC on the opposite side where possible. Keep the trace thin and short. Single-sided boards generally require touch-sensing spring contacts.
2. For a single-layer PCB, a sensing spring is generally used as the touch pad. Because the side surface of a spring can also form an electric field with the finger, a sensing spring can provide higher sensitivity than a PCB touch pad.
3. Greater parasitic capacitance from the touch pad to ground requires a larger Cs value, reducing the available Cs selection range and sensitivity-adjustment range. On double-sided PCBs, avoid ground copper around and behind touch pads where possible. Keep at least about 2 mm between touch pads and avoid long parallel traces from different pads running too close together.
4. For products requiring improved EMC test performance, ground copper may be added on the key PCB, but keep ground conductors at least about 2 mm away from touch pads and their traces.
5. Keep the trace from the touch pad or sensing spring to the IC as short and direct as possible. Avoid coupling capacitance between touch traces and avoid coupling to high-frequency signal traces.
6. Sensitivity is approximately proportional to the touch-pad or sensing-spring area and inversely proportional to enclosure thickness. Select an appropriate touch area for the enclosure thickness and dimensions. In general, glass provides better field penetration than plastic.
7. Leave adequate spacing between touch pads so one finger does not cover two pads simultaneously and to prevent excessive parasitic capacitance.
8. Because air has a low dielectric constant and is affected by humidity, avoid air gaps in the dielectric stack. Press the touch pad or sensing spring tightly and evenly against the insulating enclosure. A non-conductive adhesive may be used between the enclosure and pad; the source cites acrylic adhesive such as the 3M HBM series.
9. Use a reference capacitor Cs with a low temperature coefficient and good tolerance to prevent sensitivity mismatch or temperature-dependent sensitivity changes. For leaded capacitors, the source recommends a 5% polyester capacitor. For SMD capacitors, use NPO or X7R material with 10% or better tolerance.
10. Use a regulated supply and/or RC/LC filtering to prevent AC ripple from disturbing the IC. When using a 1628-type display-driver IC, RC filtering of the touch-IC supply is strongly recommended.

Electrical Characteristics

Absolute Maximum Ratings

Parameter	Symbol	Condition	Rating	Unit
Operating temperature	TOP	-	-20 to +70	°C
Storage temperature	TSTG	-	-50 to +125	°C
Supply voltage	VDD	25 °C	VSS - 0.3 to VSS + 5.5	V
Input voltage	VIN	25 °C	VSS - 0.3 to VDD + 0.3	V
ESD voltage	ESD	-	> 5	kV

DC/AC Characteristics (Ta = 25 °C)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Operating voltage	VDD	-	3.0	-	5.5	V
Operating current	IOP	VDD = 3.3 V, operating	-	1	-	mA
Reference capacitor*	Cs	-	6800	-	18000	pF
Input LOW threshold	VIL	Input LOW voltage	0	-	0.2 VDD	V
Input HIGH threshold	VIH	Input HIGH voltage	0.8 VDD	-	1.0 VDD	V
Output sink current	IOL	VDD = 5 V, VOL = 0.6 V	-	8	-	mA
Output source current	IOH	VDD = 5 V, VOH = 4.3 V	-	-4	-	mA
Input pull-up resistance	Rpu	VDD = 3.3 V	-	75k	-	ohm
Low-voltage reset	LVR	-	2.20	2.50	3.00	V

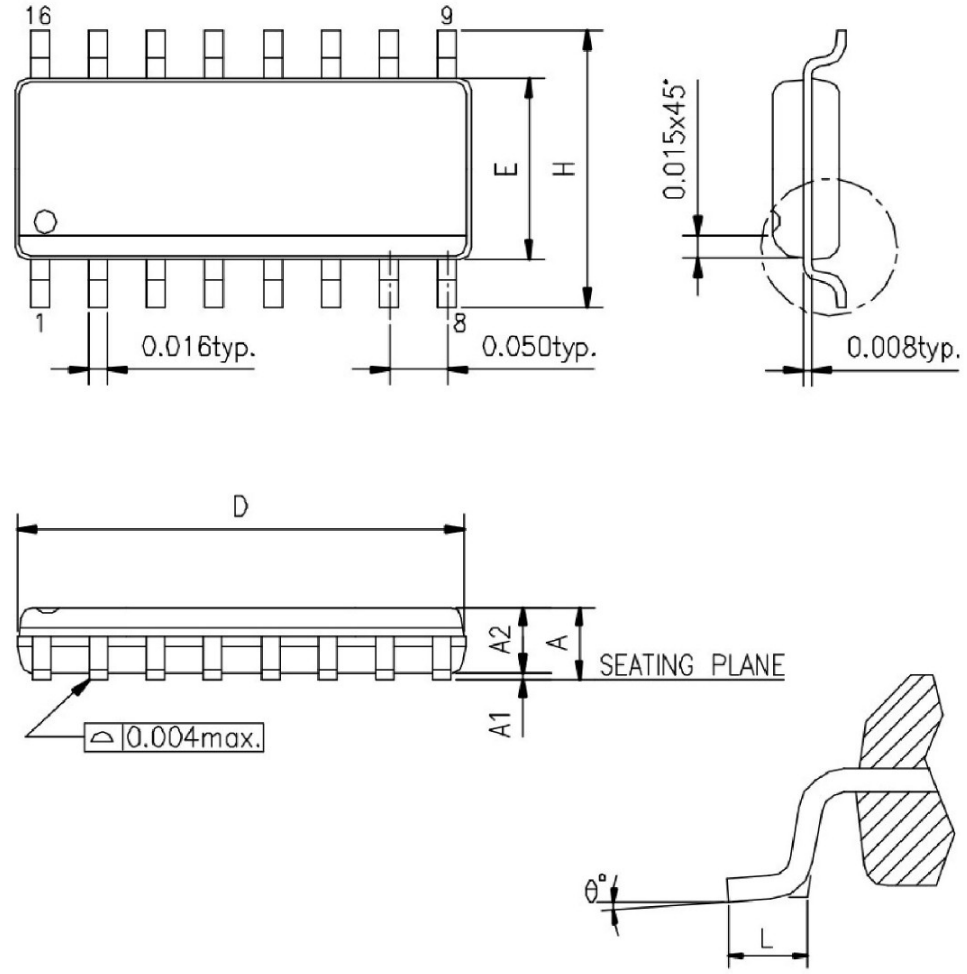
* Adjust Cs according to PCB trace/parasitic capacitance and required sensitivity. The usable Cs range depends on PCB layout and supply voltage; a value that is too large or too small may prevent correct operation. A larger Cs gives lower sensitivity.

The source recommends a 5% polyester capacitor with a low temperature coefficient. For SMD capacitors, use NPO or X7R material with 10% or better tolerance.

Functional Timing Parameters

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Valid key-press time	Tpress	From key action to valid output	60	-	80	ms
Valid key-release time	Trelease	From key release to output deassertion	40	-	60	ms
Maximum simultaneous keys	Kmax	Without system reset	-	2	-	keys
Allowed continuous key-hold time	Tmax	Without system reset	-	30	-	s

SOP16L Package Dimensions



SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
D	0.386	0.394
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ	0	8

UNIT : INCH

NOTES:
1.JEDEC OUTLINE : MS-012 AC
2.DIMENSIONS "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .15mm (.006in) PER SIDE.
3.DIMENSIONS "E" DOES NOT INCLUDE INTER-LEAD FLASH, OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .25mm (.010in) PER SIDE.

SOP16L package outline - dimensions in inches as specified by the source

Package outline reference: MS-012 AC. The dimensional notes and tolerances shown in the drawing are retained from the source datasheet.

Statement / Disclaimer

1. The company may revise or update the information in this document without notifying users.

2. The company will make every effort to ensure high product quality and stable performance. Nevertheless, because semiconductor devices are electrically sensitive and can be damaged by external physical conditions, failures may occur under extreme conditions or due to improper user design or use. Users should follow the latest product documentation and design the product reasonably and in accordance with the specified conditions.

3. The products described in this document are designed for general electronic products such as computers, household appliances, office equipment, consumer-entertainment electronics and general electronic instruments. This product must not be used in special equipment requiring exceptionally high touch-key reliability where failure could cause injury or serious property damage. Prohibited applications listed by the source include nuclear-control equipment, aircraft and aviation equipment, traffic-control equipment, combustion-control equipment, medical equipment and any product in which a touch-key failure could cause personal injury or major property loss. The company accepts no responsibility for losses or injury resulting from use in these excluded applications.

Revision History

Date	Version	Change
2011-08-18	V0.1	Initial release.
2011-11-01	V0.2	Key-suppression quantity changed to 3 keys.
2011-12-11	V0.3	Added A/D output diagram.
2012-02-15	V0.4	Added combination-key output.
2012-09-01	V0.5	Added power-supply requirements and recommendation to use RC filtering.
2012-09-21	V0.6	Corrected description error in output table.