

Features

- Operating voltage: 2.2V~5.5V
- Low standby current
- Auto-calibration
- Reliable touch detections
- High power supply rejection
- Standby and normal operating modes
- Maximum key on duration time detection
- Adaptive voltage drop function
- Level Hold, selectable active level-low or high
- NMOS output with internal pull-high/CMOS-direct output
- Both serial interface and parallel outputs
- Sensitivity adjustment using an external capacitor
- Minimal number of external components

General Description

The BS81x is a series of 3~ 8 key touch key devices which can detect human body contact using external touch pads. The high level of device integration enable applications to be implemented with a minimum number of external components.

The BS81x series devices are equipped with serial or parallel interfaces to allow easy communication with an external MCU for device setup and for touch pin monitoring purposes. Special internal circuitry is also employed to ensure excellent power noise rejection to reduce the possibility of false detections, increasing the touch switch application reliability under adverse environmental conditions.

With auto-calibration, low standby current, excellent resistance to voltage fluctuation and other features, this range of touch key devices provide a simple and effective means of implementing touch key operation in a wide variety of applications.

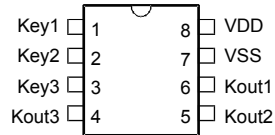
Selection Table

For this device series, most of the feature are similar. The BS814A-2 and BS818A-2 include a serial interface function while the BS813A-1, BS814A-1 and BS816A-1 have parallel outputs. The BS816A-1 and BS818A-2 also include two options. The following table summarizes the main characteristics of each device.

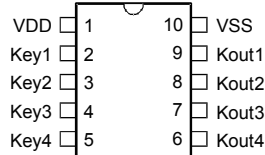
Part. No.	Touch Key	OPTION	Istb@3V	Parallel Outputs	Serial Interface	Power Mode	Auto Calibration	Package
BS813A-1	3-Key	×	4.5μA	NMOS (internal pull-high)	×	Normal and Standby	√	8SOP
BS814A-1	4-Key	×	5.0μA		×		√	10MSOP
BS814A-2	4-Key	×	5.0μA	×	√		√	8SOP
BS816A-1	6-Key	OMS/LSC (Note *)	12μA/6μA	NMOS (internal pull-high)/ CMOS-Direct	×		√	16NSOP
BS818A-2	8-Key	OMS/LSC (Note *)	12μA/6μA	Binary	√		√	16NSOP

Note: * OMS and LSC refer to the option table.

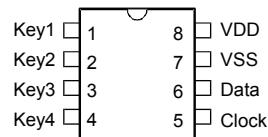
Pin Assignment



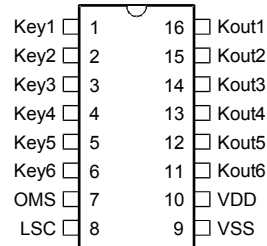
BS813A-1
8 SOP-A



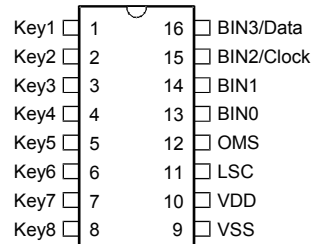
BS814A-1
10 MSOP-A



BS814A-2
8 SOP-A



BS816A-1
16 NSOP-A



BS818A-2
16 NSOP-A

Pin Description

BS813A-1

Pin name	I/O	Description
Key1~Key3	Input	Touch key input pin, unused touch keys require grounding
Kout1~ Kout3	NMOS output	Touch key output pin with internal pull high
VSS	—	Negative power supply, ground
VDD	—	Positive power supply

BS814A-1

Pin name	I/O	Description
Key1~Key4	Input	Touch key input pin, unused touch keys require grounding
Kout1~ Kout4	NMOS output	Touch key output pin with internal pull high
VSS	—	Negative power supply, ground
VDD	—	Positive power supply

BS814A-2

Pin name	I/O	Description
Key1~Key4	Input	Touch key input pin, unused touch keys require grounding
Clock	Input	2-wire series interface Clock input with internal pull high
Data	NMOS output	2-wire series interface Data NMOS output with internal pull high
VSS	—	Negative power supply, ground
VDD	—	Positive power supply

BS816A-1

Pin name	I/O	Description
Key1~Key6	Input	Touch key input pin, unused touch keys require grounding
OMS	Input	Output Mode Selection. Open=NMOS output (low active) Grounded=CMOS-Direct output (high active)
LSC	Input	Power-saving mode selection Open= General power-saving mode; refer to D.C. Characteristics I_{STB3} . Grounded=More power-saving mode; refer to D.C. Characteristics I_{STB4} .
Kout1~ Kout6	NMOS output	OMS open, NMOS output with internal pull-high.
	CMOS output	OMS grounded, CMOS-Direct output
VSS	—	Negative power supply, ground
VDD	—	Positive power supply

BS818A-2

Pin name	I/O	Description
Key1~Key8	Input	Touch key input pin, unused touch keys require grounding
OMS	Input	Output Mode Selection. Open = 2-wire serial mode Grounded = 4-wire binary parallel mode
LSC	Input	Power-saving mode selection Open=General power-saving mode; refer to D.C. Characteristics I_{STB3} . Grounded=More power-saving mode; refer to D.C. Characteristics I_{STB4} .
Clock	Input	OMS open, 2-wire series interface Clock input - internal pull- high
Data	NMOS output	OMS open, series interface Data NMOS output - internal pull-high
BIN3~ BIN0	CMOS output	OMS grounded, Binary output mode
VSS	—	Negative power supply, ground
VDD	—	Positive power supply

Absolute Maximum Ratings

Supply Voltage	$V_{SS}-0.3V \sim V_{SS}+6.6V$	Storage Temperature	$-50^{\circ}C \sim 125^{\circ}C$
Input Voltage	$V_{SS}-0.3V \sim V_{DD}+0.3V$	Operating Temperature	$-40^{\circ}C \sim 85^{\circ}C$
I_{OL} Total	80mA	Total Power Dissipation	500mW
I_{OH} Total	-80mA		

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to these devices. Functional operation of these devices at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect devices reliability.

D.C. Characteristics

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Operating Voltage	—	—	2.2	—	5.5	V
I_{DD}	Operating Current	3V	No load	—	0.8	1.5	mA
		5V		—	1.5	3.0	mA
I_{STB1}	Standby Current (BS813A-1)(Note 1)	3V	No load	—	4.5	—	mA
		5V		—	9	—	mA
I_{STB2}	Standby Current (BS814A-1/BS814A-2) (Note 1)	3V	No load	—	5.0	—	mA
		5V		—	10	—	mA
I_{STB3}	Standby Current (BS816A-1/BS818A-2) (Note 1) LSC=Open (Note 2)	3V	No load	—	12	—	mA
		5V		—	25	—	mA
I_{STB4}	Standby Current (BS816A-1/BS818A-2) (Note 1) LSC= V_{SS} (Note 2)	3V	No load	—	6.0	—	mA
		5V		—	12	—	mA
V_{IL}	Input Low Voltage for Clock pin	5V	—	0	—	1.5	V
		—	—	0	—	$0.2V_{DD}$	V
V_{IH}	Input High Voltage for Clock pin	5V	—	3.5	—	5.0	V
		—	—	$0.8V_{DD}$	—	V_{DD}	V
I_{OL}	Kout/Data Sink Current (NMOS)	3V	$V_{OL}=0.1V_{DD}$	4	8	—	mA
		5V	$V_{OL}=0.1V_{DD}$	10	20	—	mA
I_{OH}	BIN0~BIN3 Source Current (CMOS)	3V	$V_{OH}=0.9V_{DD}$	-2	-4	—	mA
		5V	$V_{OH}=0.9V_{DD}$	-5	-10	—	mA
R_{PH}	Pull-high Resistance to Kout	3V	—	20	60	100	k Ω
		5V	—	10	30	50	k Ω

Note: 1. I_{STB} is the average standby current.

2. LSC instruction refer to the Option table.

A.C. Characteristics

Ta =25°C

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
t _{KRT1}	Key Response Time --Normal Mode	—	—	100	125	150	ms
t _{KRT2}	Key Response Time --Standby Mode BS813A-1 / BS814A-1 / BS814A-2	—	—	100	150	250	ms
t _{KRT3}	Key Response Time --Standby Mode BS816A-1 / BS818A-2	—	LSC=Open	100	150	250	ms
		—	LSC=V _{SS}	400	600	1000	ms
t _{KH}	Maximum Key Hold Time	—	—	60	64	68	s
t _{CAL1}	Auto-Calibration Period - Normal Mode	—	—	—	1	—	s
t _{CAL2}	Auto-Calibration Period - Standby Mode	—	—	—	32	—	s
t _{NS}	Normal to Standby Mode conversion time	—	—	7	8	9	s

Serial interface Characteristics

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V _{DD}	Conditions				
T _{START}	Start bit low time	—	—	—	—	t _{NS}	s
T _{LOW}	Clock low time	—	—	20	—	—	us
T _{HIGH}	Clock high time	—	—	20	—	—	us
T _{BR}	Data transfer rate	—	—	—	—	25	Kbps
T _{ED}	Delay time between a error reading and the next reading	—	—	6	—	—	ms

Functional Description

Introduction

This range of BS81x touch key devices offer an easy and reliable means of implementing touch switch functions in a wide range of applications which require 3~8 touch keys. Very few external components are required for full touch key implementations. In addition to simple parallel output, a two-wire serial interface and binary output offer a convenient communication with an external MCU. Sensitivity adjustment is also an easy matter. By the simple connection of a small capacitor to the touch key input pin, the changes in the capacitor value will be reflected in different sensitivity values. By having a fully integrated adaptive voltage drop function, touch switch applications can save on the usually required LDO.

Option Table

The BS816A-1 and BS818A-2 provide two options to enhance application flexibility.

OMS

	OMS - Output Mode Selection	Description
BS816A-1	Open	NMOS output with internal pull- high, low active
	Vss	CMOS output, high active
BS818A-2	Open	2-wire serial mode
	Vss	4-wire Binary parallel mode

LSC

	LSC- Lower Standby Current	Description
BS816A-1/ BS818A-2	Open	General power-saving
	Vss	More power-saving (wake-up time of 0.5 ~1s)

Operating Mode

There are two operating modes for this device series, the normal mode and the standby mode. During the 8 seconds after power-on, if no touch key actions are detected, the devices will automatically enter the standby mode to reduce their power consumption. If a key or keys are pressed, the device will be woken up and will then enter the normal mode and output the key state value until all keys are released. After 8 seconds, the system will then revert to the standby mode again.

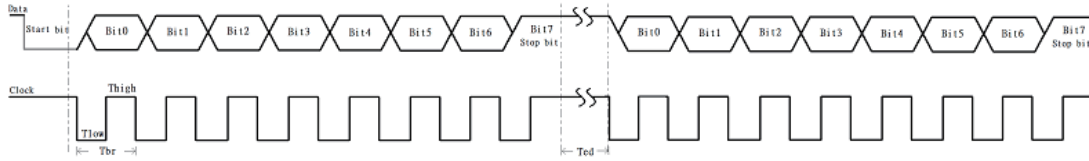
Touch Key Outputs

For the BS813A-1 and BS814A-1 devices, all output pins are NMOS structures with connected internal pull-high resistors. The non touch detect output logic level is high. When a touch action is detected, the corresponding output will change to a low state. For the BS816A-1 device, except the NMOS output type, users can also select a CMOS output type. The non touch detect output logic level is low. When a touch action is detected, the corresponding output will change to a high state.

Serial Interface

Both the BS814A-2 and BS818A-2 are equipped with a serial interface allowing for easy interfacing to an external master MCU. When the device detects that a touch key has been pressed, it will output a low on the Data pin which can be used to wake up the master MCU. After receiving this low level, the master can then send a clock signal to the Clock pin and read back the key status from the Data pin.

When a low clock signal is received the key status data is prepared by the touch key device. When the clock signal changes to a high level, the master reads the touch key status data from the Data line. The timings associated with the communication protocol can be fully described within 8 clock periods. Without waiting for a start bit, the touch key status condition can also be directly read using a polling method. If there are any errors in reading the data, it is necessary to wait for about 6ms and then read the data again.


Data Transfer Timing – BS814A-2
4-key Data Format

After a clock signal is received on the Clock pin, an 8-bit data byte will be generated by the touch key device and shifted out on the Data pin. Data bits, bit6~bit4, will also generate a checksum whose content informs how many touch keys have been touched. For example, if the check sum is equal to “010”, it means that two keys have been touched. As to which keys are actually touched, this information can be retrieved from the condition of data bits, bit3~bit0. The state of the data bits, bit3~bit0, is used to indicate which touch keys, key4~key1, are touched or not respectively. A low bit means the corresponding key is touched. Otherwise, the key is not touched if the corresponding data condition is high.

Start bit: When a key changes state, the Data pin outputs a low, which can wake up the master, which can then read the key status.

Bit0: Key1 state - “0”= touch, “1”= no touch

Bit1: Key2 state - “0”= touch, “1”= no touch

Bit2: Key3 state - “0”= touch, “1”= no touch

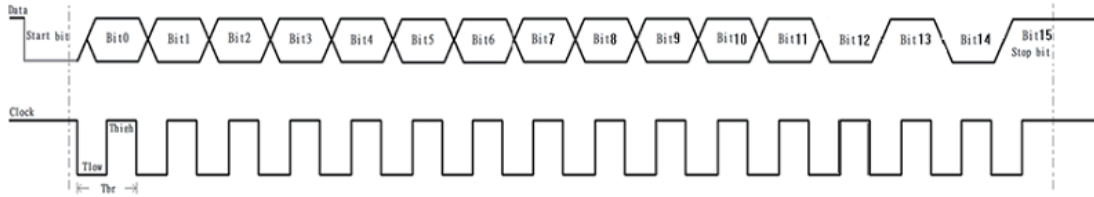
Bit3: Key4 state - “0”= touch, “1”= no touch

Bit6~4: Checksum – the total number of “0”s is used to indicate how many keys have been touched.

Bit7: Stop bit, always a “1”, high level.

Bit	7	6~4	3~0	Descriptions
Function	Stop bit	Check Sum	Key4 ~Key1 state	0: touched / 1: not touched
Data Stream	1	100	0000	Check Sum = 100, Four keys are touched.
		011	0001, 0010, 0100 or 1000	Check Sum = 011, Three keys are touched.
		010	0011, 0101, 0110, 1001, 1010 or 1100	Check Sum = 010, Two keys are touched.
		001	0111, 1011, 1101 or 1110	Check Sum = 001, One key is touched.
		000	1111	Check Sum = 000, No key is touched.

4-key Serial Data Stream Format


Data Transfer Timing – BS818A-2
8-key Data Format

After a clock signal is received on the Clock pin, a 16-bit data byte will be generated by the touch key device and shifted out on the Data pin. Data bits, bit11~bit8, will also generate a checksum whose content informs how many touch keys have been touched. For example, if the check sum is equal to “0010”, it means that two keys have been touched. As to which keys are actually touched, this information can be retrieved from the condition of data bits, bit7~bit0. The state of the data bits, bit7~bit0, is used to indicate which touch keys, key8~key1, are touched or not respectively. A low bit means the corresponding key is touched. Otherwise, the key is not touched if the corresponding data condition is high.

Start bit: When a key state is changed, Data pin outputs a low, which can wake up the master, which can then read the key status.

Bit0: Key1 state - “0”= touch, “1”= no touch

Bit1: Key2 state - “0”= touch, “1”= no touch

Bit2: Key3 state - “0”= touch, “1”= no touch

Bit3: Key4 state - “0”= touch, “1”= no touch

Bit4: Key5 state - “0”= touch, “1”= no touch

Bit5: Key6 state - “0”= touch, “1”= no touch

Bit6: Key7 state - “0”= touch, “1”= no touch

Bit7: Key8 state - “0”= touch, “1”= no touch

Bit11~8: Checksum – the total number of “0”s is used to indicate how many keys have been touched.

Bit15~12: Stop bits, always “1010B”.

Bit	15~12	11~8	7~0	Descriptions
Function	Stop bit	Check Sum	Key8 ~Key1 state	0: touched / 1: not touched
Data Stream	1010	1000	00000000	Check Sum = 1000, 8 keys are touched.
		0111	00000001, 00000010, 00000100, 00001000 00010000, 00100000, 01000000 or 10000000	Check Sum = 0111, 7 keys are touched.
		0110	00000011,00000110,00011000,00110000 11000000 or 10000001	Check Sum = 0110, 6 keys are touched.
		0101	00000111,00001110,11100000,10000011, 10000110, 10001100 or 10011000.....	Check Sum = 0101, 5 keys is touched.
		0100	00001111,00011110,00111100,01111000, 11110000 or 10000111.....	Check Sum = 0100, 4 keys is touched.
		0011	00011111,00111110,01111100,11111000 100011111 or 110001111.....	Check Sum = 0011, 3 keys are touched.
		0010	00111111,01111110,11111100, 01111110, 01111101or 01111011.....	Check Sum = 0010, 2 keys are touched.
		0001	11111110, 11111101, 11111011, 11110111 11101111, 11011111, 10111111 or 01111111	Check Sum = 0001, 1 key is touched.
		0000	11111111	Check Sum = 0000, No key is touched.

Serial Data Stream Format for 8-key

Parallel Interface

The BS818A-2 also provides a parallel interface function which shows directly the key state condition. When the parallel output type is selected, the touch key data reflects only one key state, not more keys, at the same time. When no touch key is pressed, BIN3~BIN0 are high. When any key is pressed, BIN3 must output a low to wake up the master while BIN2~BIN0 reflect which keys are pressed as shown in the following table.

Pressed key	BIN3	BIN2	BIN1	BIN0
No key	1 (high)	1	1	1
Key1	0 (low)	1	1	1
Key2	0	1	1	0
Key3	0	1	0	1
Key4	0	1	0	0
Key5	0	0	1	1
Key6	0	0	1	0
Key7	0	0	0	1
Key8	0	0	0	0

Maximum Key On Duration Time

To minimise the possibility of unintentional switch detections, such as undesired objects covering the sensing electrodes, the devices include a Maximum Key On duration time function. To implement this function the devices include an internal timer, which starts running after each switch detection. If the key on time of a touch key exceeds a value of about 64 seconds, then the device will re-calibrate the key state, obtain a new reference value, while the output status is reset to the initial state.

Auto-calibration Function

The devices include a full auto-calibration function which will be initiated after the device is powered-on. In addition to the power-on calibration, if no switch detection has been made for about more than 1 second in the normal mode or 32 seconds in the standby mode, then a further calibration procedure will be carried out. By implementing this feature, changes in the touch key environmental conditions are automatically catered for dynamically.

Adaptive Voltage Drop

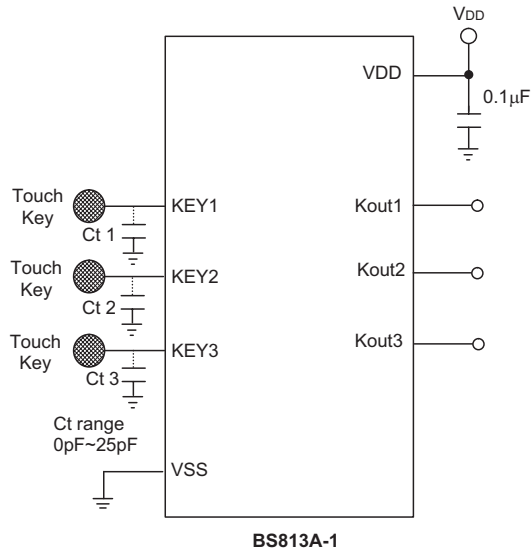
This series of touch key devices include an adaptive voltage drop function which prevent touch key malfunction due to power supply voltage variations which may be caused by high current switching. With the adaptive voltage drop function, there is no need for an external LDO to deal with these voltage drop issues.

Sensitivity Adjustment

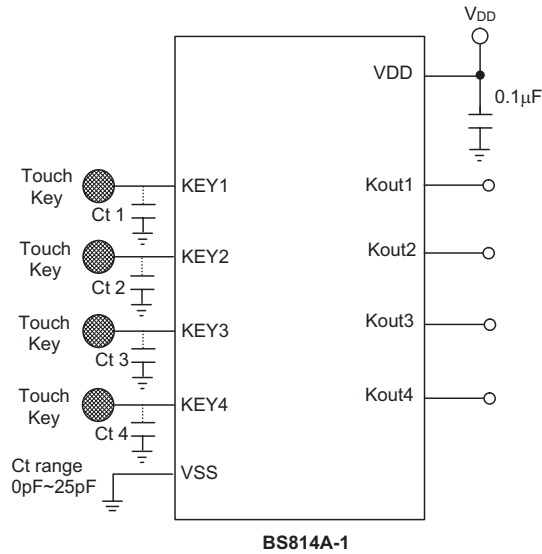
The sensitivity of the switch is a very important consideration in most applications whose requirements will vary according to the user application. The user should therefore be aware of the methods which can adjust the sensitivity of their touch key application. Changing the PCB electrode size, the conductive layout area below the electrode and the thickness of the dielectric material panel can all be used to adjust the touch switch sensitivity. Additionally for this device series, an external capacitor connected to the touch key input pin can also be used to adjust the sensitivity for different applications. Note that adding an external capacitor to the touch key input pin will reduce the sensitivity.

Application Circuits

BS813A-1

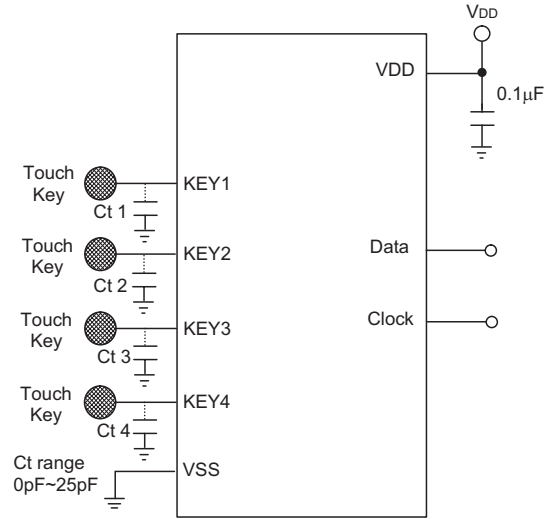


BS814A-1



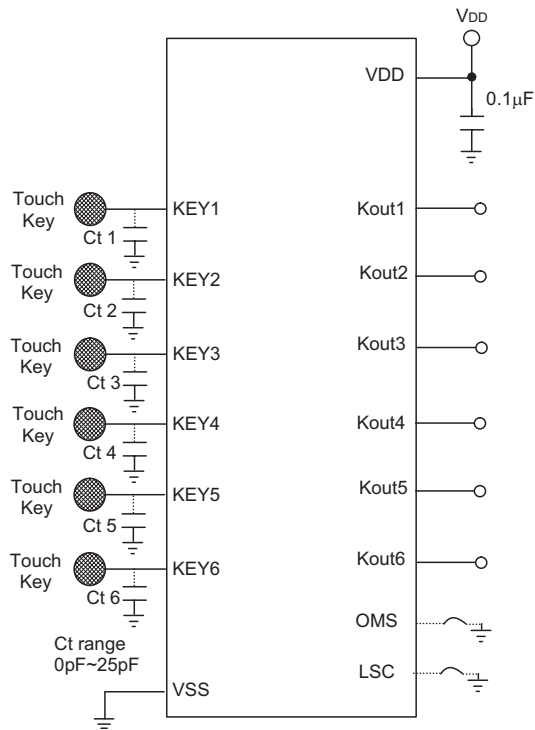
- Note: 1. Ct (C threshold) is used for adjustment of Trigger Threshold. Recommended value: 0~25 pF
 2. Ct value can be changed to obtain different sensitivity values. Higher Ct values will result in lower sensitivity levels. (0pF = no Ct)

BS814A-2



BS814A-2

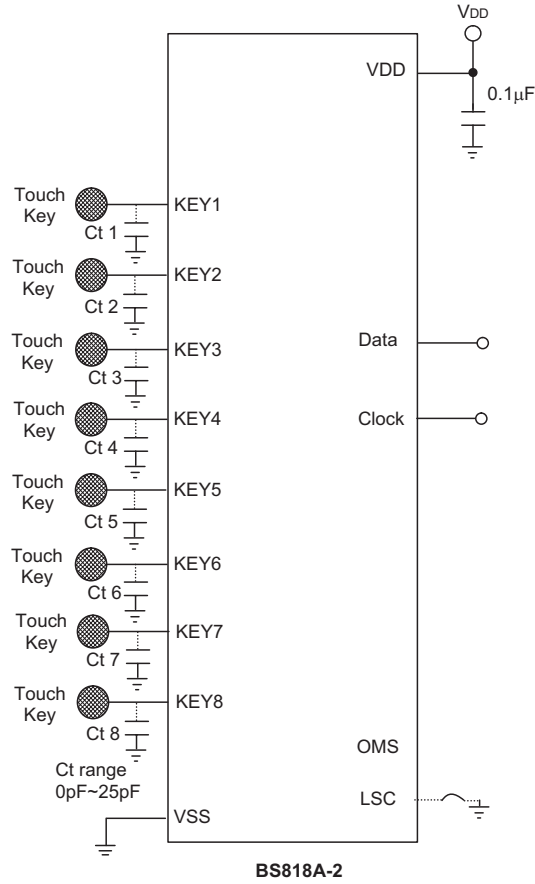
BS816A-1



BS816A-1

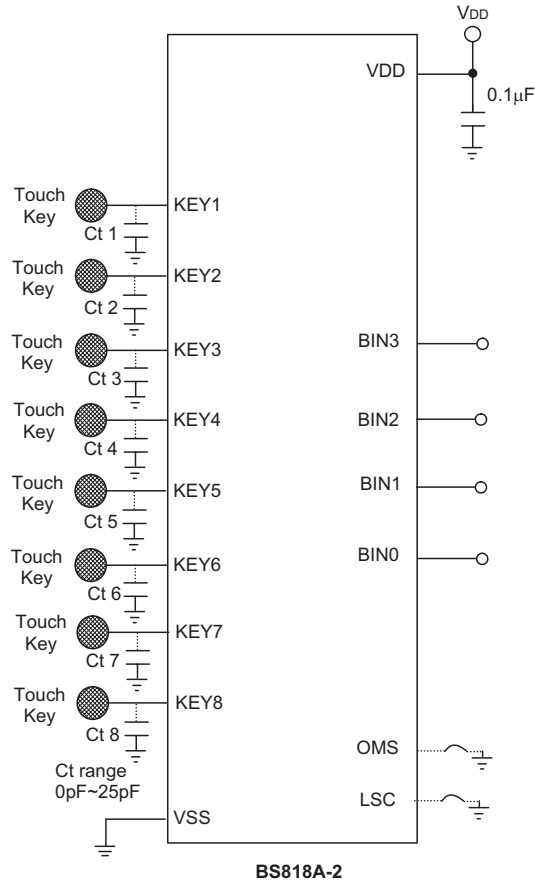
- Note: 1. Ct (C threshold) is used for adjustment of Trigger Threshold. Recommended value: 0~25 pF
 2. Ct value can be changed to obtain different sensitivity values. Higher Ct values will result in lower sensitivity levels. (0pF = no Ct)

BS818A-2 – Serial Interface Mode



- Note: 1. Ct (C threshold) is used for adjustment of Trigger Threshold. Recommended value: 0~25 pF
 2. Ct value can be changed to obtain different sensitivity values. Higher Ct values will result in lower sensitivity levels. (0pF = no Ct)

BS818A-2 – Parallel Interface Mode



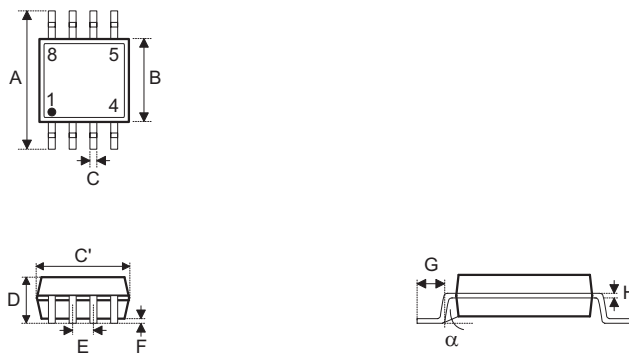
- Note: 1. Ct (C threshold) is used for adjustment of Trigger Threshold. Recommended value: 0~25 pF
 2. Ct value can be changed to obtain different sensitivity values. Higher Ct values will result in lower sensitivity levels. (0pF = no Ct)

Package Information

Note that the package information provided here is for consultation purposes only. As this information may be updated at regular intervals users are reminded to consult the [Holtek website](#) for the latest version of the package information.

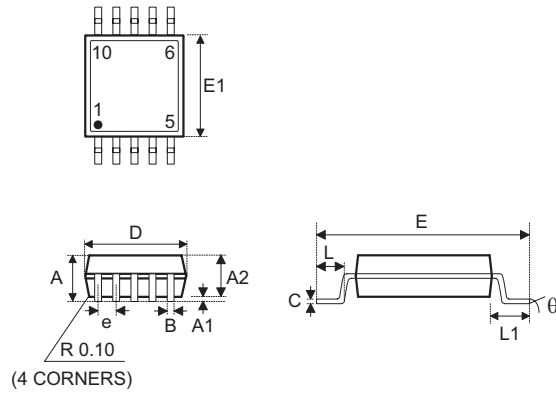
Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

- [Further Package Information](#) (include Outline Dimensions, Product Tape and Reel Specifications)
- [Packing Materials Information](#)
- [Carton information](#)

8-pin SOP (150mil) Outline Dimensions


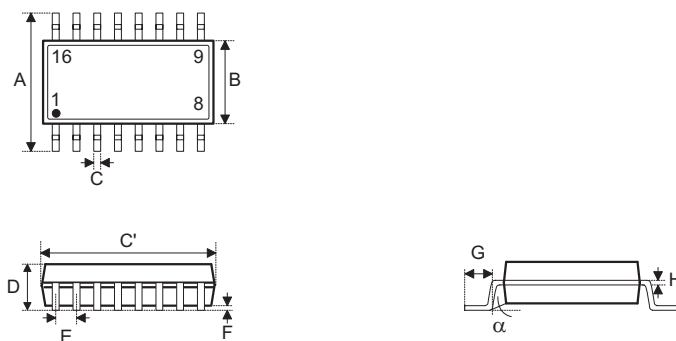
Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	0.236 BSC	—
B	—	0.154 BSC	—
C	0.012	—	0.020
C'	—	0.193 BSC	—
D	—	—	0.069
E	—	0.050 BSC	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.004	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	6.0 BSC	—
B	—	3.9 BSC	—
C	0.31	—	0.51
C'	—	4.9 BSC	—
D	—	—	1.75
E	—	1.27 BSC	—
F	0.10	—	0.25
G	0.40	—	1.27
H	0.10	—	0.25
α	0°	—	8°

10-pin MSOP Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	—	0.043
A1	0.000	—	0.006
A2	0.030	0.033	0.037
b	0.007	—	0.013
c	0.003	—	0.009
D	—	0.118 BSC	—
E	—	0.193 BSC	—
E1	—	0.118 BSC	—
e	—	0.020 BSC	—
L	0.016	0.024	0.031
L1	—	0.037 BSC	—
y	—	0.004	—
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	—	1.10
A1	0.00	—	0.15
A2	0.75	0.85	0.95
b	0.17	—	0.33
c	0.08	—	0.23
D	—	3.0 BSC	—
E	—	4.9 BSC	—
E1	—	3.0 BSC	—
e	—	0.5 BSC	—
L	0.40	0.60	0.80
L1	—	0.95 BSC	—
y	—	0.1	—
α	0°	—	8°

16-pin NSOP (150mil) Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	0.236 BSC	—
B	—	0.154 BSC	—
C	0.012	—	0.020
C'	—	0.390 BSC	—
D	—	—	0.069
E	—	0.050 BSC	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.004	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	6.0 BSC	—
B	—	3.9 BSC	—
C	0.31	—	0.51
C'	—	9.9 BSC	—
D	—	—	1.75
E	—	1.27 BSC	—
F	0.10	—	0.25
G	0.40	—	1.27
H	0.10	—	0.25
α	0°	—	8°

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