



# S-19400/19401 Series

## FOR AUTOMOTIVE 125°C OPERATION LOW CURRENT CONSUMPTION WATCHDOG TIMER WITH RESET FUNCTION

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Rev.2.1\_00

The S-19400/19401 Series is a watchdog timer developed using CMOS technology, which can operate with low current consumption of 3.8  $\mu$ A typ. The reset function and the low voltage detection function are available.

**Caution** This product can be used in vehicle equipment and in-vehicle equipment. Before using the product in the purpose, contact to SII Semiconductor Corporation is indispensable.

### ■ Features

- Detection voltage: 2.0 V to 5.0 V, selectable in 0.1 V step
- Detection voltage accuracy:  $\pm 2.0\%$
- Input voltage:  $V_{DD} = 0.9$  V to 6.0 V
- Hysteresis width: 5% typ.
- Current consumption: 3.8  $\mu$ A typ.
- Reset time-out period: 14.5 ms typ. ( $C_{POR} = 2200$  pF)
- Watchdog operation is switchable: Enable, Disable
- Watchdog operation voltage range: 2.5 V to 6.0 V
- Watchdog mode switching function<sup>\*1</sup>: Time-out mode, window mode
- Watchdog input edge is selectable: Rising edge, falling edge, both rising and falling edges
- Product type is selectable:
  - S-19400 Series  
(Product with  $\overline{W}$  / T pin (Output:  $\overline{WDO}$  pin))
  - S-19401 Series  
(Product without  $\overline{W}$  / T pin (Output:  $\overline{RST}$  pin,  $\overline{WDO}$  pin))
- Operation temperature range:  $T_a = -40^\circ\text{C}$  to  $+125^\circ\text{C}$
- Lead-free (Sn 100%), halogen-free
- AEC-Q100 qualified<sup>\*2</sup>

\*1. The S-19401 Series is fixed to the window mode.

\*2. Contact our sales office for details.

### ■ Applications

- For automotive use (engine, transmission, suspension, ABS, related-devices for EV / HEV / PHEV, etc.)

### ■ Packages

- TMSOP-8
- HSNT-8(2030)

■ **Block Diagrams**

1. **S-19400 Series (Product with  $\overline{W}$  / T pin)**

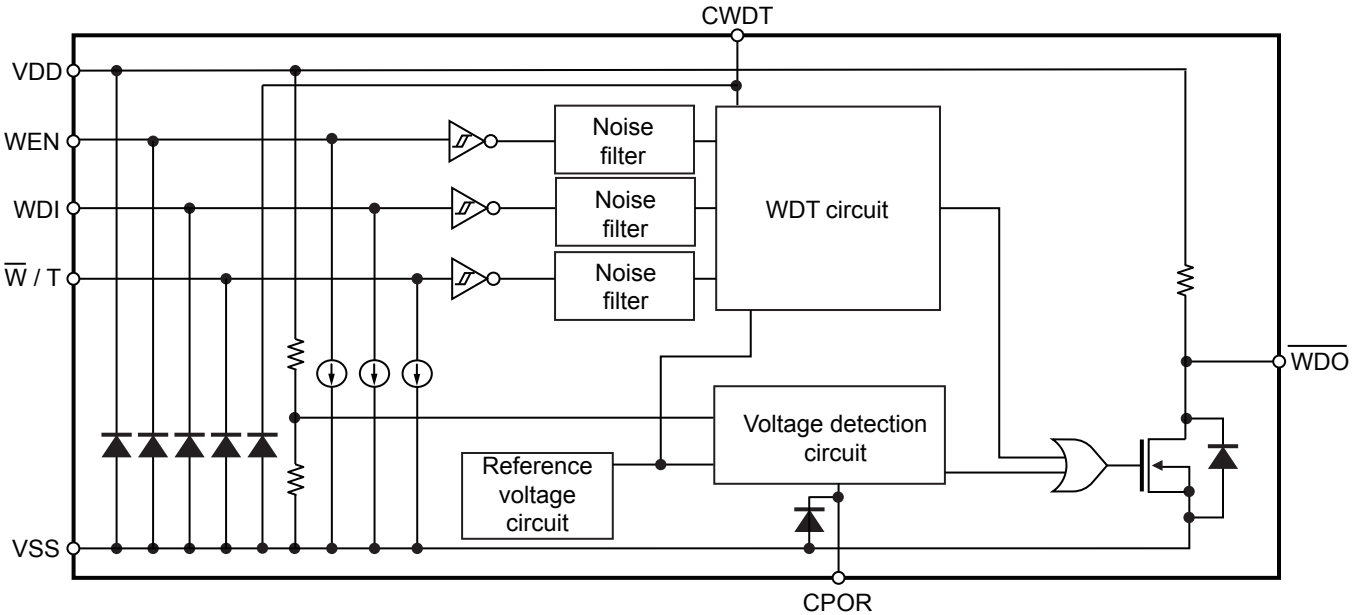


Figure 1

2. **S-19401 Series (Product without  $\overline{W}$  / T pin)**

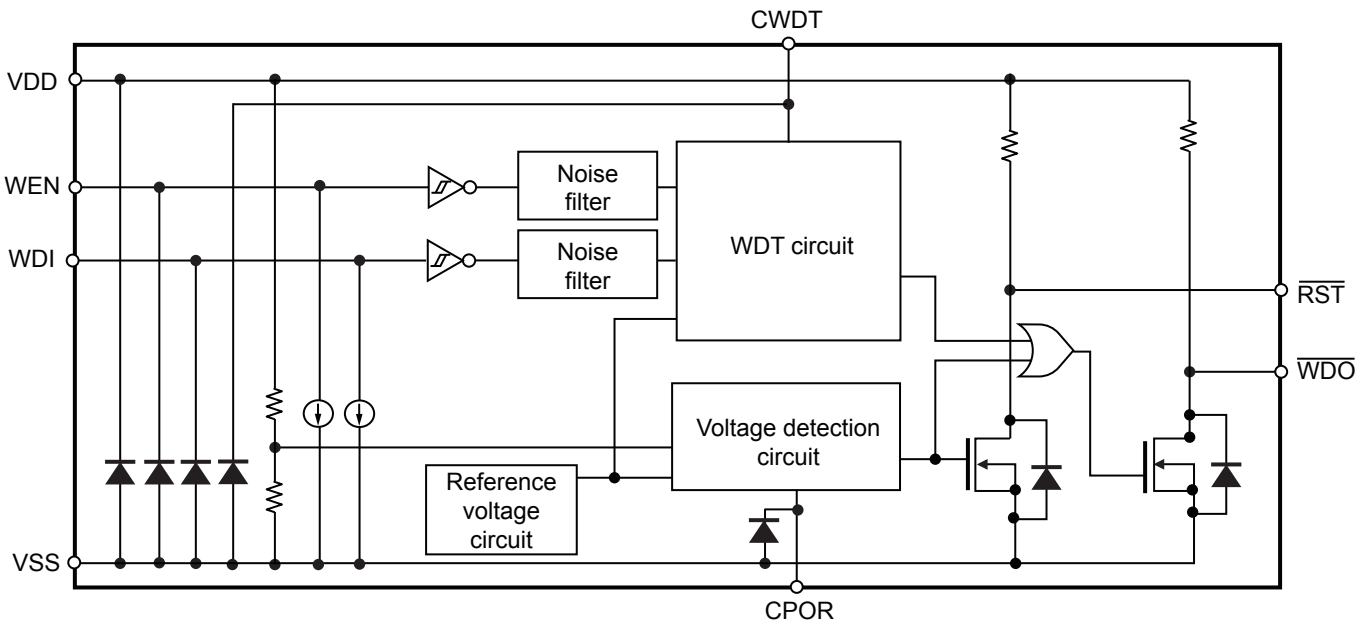


Figure 2

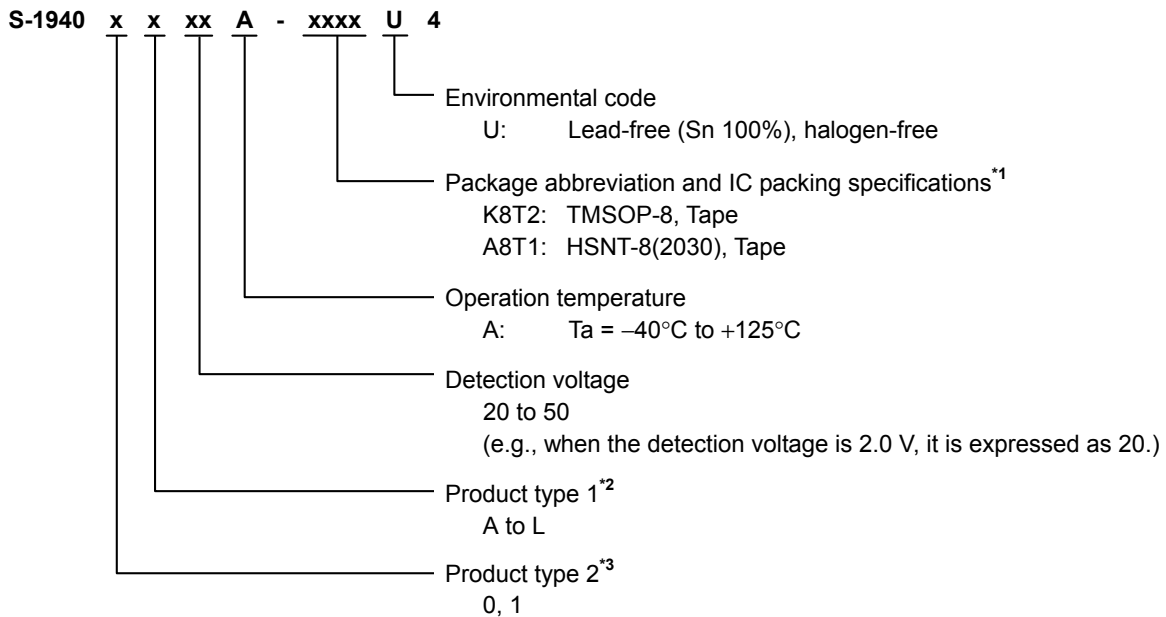
■ **AEC-Q100 Qualified**

This IC supports AEC-Q100 for the operation temperature grade 1.  
 Contact our sales office for details of AEC-Q100 reliability specification.

■ **Product Name Structure**

Users can select the product type, detection voltage, and package type for the S-19400/19401 Series. Refer to "1. Product name" regarding the contents of product name, "2. Product type list" regarding the product types, "3. Packages" regarding the package drawings.

1. Product name



- \*1. Refer to the tape drawing.
- \*2. Refer to "2. Product type list".
- \*3. 0: S-19400 Series (Product with  $\overline{W}$  / T pin)  
 The  $\overline{WDO}$  pin outputs the signals which are from the watchdog timer circuit and the voltage detection circuit.
- 1: S-19401 Series (Product without  $\overline{W}$  / T pin)  
 The  $\overline{WDO}$  pin outputs the signals which are from the watchdog timer circuit and the voltage detection circuit.  
 The  $\overline{RST}$  pin outputs the signal which is from the voltage detection circuit.  
 The watchdog mode is fixed to the window mode.

**2. Product type list**

**Table 1**

Product Type	WEN Pin Logic	Input Edge	Output Pull-up Resistor
A	Active "H"	Rising edge	Available
B	Active "H"	Falling edge	Available
C	Active "H"	Both rising and falling edges	Available
D	Active "L"	Rising edge	Available
E	Active "L"	Falling edge	Available
F	Active "L"	Both rising and falling edges	Available
G	Active "H"	Rising edge	Unavailable
H	Active "H"	Falling edge	Unavailable
I	Active "H"	Both rising and falling edges	Unavailable
J	Active "L"	Rising edge	Unavailable
K	Active "L"	Falling edge	Unavailable
L	Active "L"	Both rising and falling edges	Unavailable

**3. Packages**

**Table 2 Package Drawing Codes**

Package Name	Dimension	Tape	Reel	Land
TMSOP-8	FM008-A-P-SD	FM008-A-C-SD	FM008-A-R-SD	–
HSNT-8(2030)	PP008-A-P-SD	PP008-A-C-SD	PP008-A-R-SD	PP008-A-L-SD

## Pin Configurations

### 1. TMSOP-8

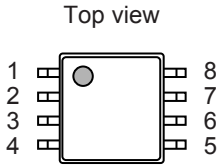


Figure 3

Table 3 S-19400 Series (Product with  $\overline{W}$  / T pin)

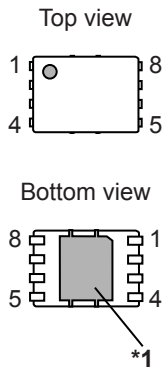
Pin No.	Symbol	Description
1	$\overline{W}$ / T <sup>*1</sup>	Watchdog mode switching pin
2	CPOR	Reset time-out period adjustment pin
3	CWDT	Watchdog time adjustment pin
4	VSS	GND pin
5	WEN	Watchdog enable pin
6	$\overline{WDO}$	Watchdog output pin
7	WDI	Watchdog input pin
8	VDD	Voltage input pin

Table 4 S-19401 Series (Product without  $\overline{W}$  / T pin)

Pin No.	Symbol	Description
1	$\overline{RST}$	Reset output pin
2	CPOR	Reset time-out period adjustment pin
3	CWDT	Watchdog time adjustment pin
4	VSS	GND pin
5	WEN	Watchdog enable pin
6	$\overline{WDO}$	Watchdog output pin
7	WDI	Watchdog input pin
8	VDD	Voltage input pin

- \*1.  $\overline{W}$  / T pin = "H": Time-out mode  
 $\overline{W}$  / T pin = "L": Window mode

**2. HSNT-8(2030)**



**Figure 4**

**Table 5 S-19400 Series (Product with  $\overline{W}$  / T pin)**

Pin No.	Symbol	Description
1	$\overline{W}$ / T <sup>2</sup>	Watchdog mode switching pin
2	CPOR	Reset time-out period adjustment pin
3	CWDT	Watchdog time adjustment pin
4	VSS	GND pin
5	WEN	Watchdog enable pin
6	$\overline{WDO}$	Watchdog output pin
7	WDI	Watchdog input pin
8	VDD	Voltage input pin

**Table 6 S-19401 Series (Product without  $\overline{W}$  / T pin)**

Pin No.	Symbol	Description
1	$\overline{RST}$	Reset output pin
2	CPOR	Reset time-out period adjustment pin
3	CWDT	Watchdog time adjustment pin
4	VSS	GND pin
5	WEN	Watchdog enable pin
6	$\overline{WDO}$	Watchdog output pin
7	WDI	Watchdog input pin
8	VDD	Voltage input pin

- \*1. Connect the heat sink of backside at shadowed area to the board, and set electric potential open or GND. However, do not use it as the function of electrode.
- \*2.  $\overline{W}$  / T pin = "H": Time-out mode  
 $\overline{W}$  / T pin = "L": Window mode

## ■ Pin Functions

Refer to "■ Operation" for details.

### 1. $\overline{W} / T$ pin (S-19400 Series only)

This is a pin to switch the watchdog mode.

The S-19400 Series changes to the time-out mode when the  $\overline{W} / T$  pin is "H", and changes to the window mode when the  $\overline{W} / T$  pin is "L". Switching the mode is prohibited during the operation.

The constant current source (0.3  $\mu$ A typ.) is connected to the  $\overline{W} / T$  pin, and it is pulled down internally.

#### 1.1 Time-out mode ( $\overline{W} / T$ pin = "H")

The S-19400 Series detects an abnormality when not inputting an edge to the WDI pin during the watchdog time-out period ( $t_{WDU}$ ). And then "L" is output from the  $\overline{WDO}$  pin.

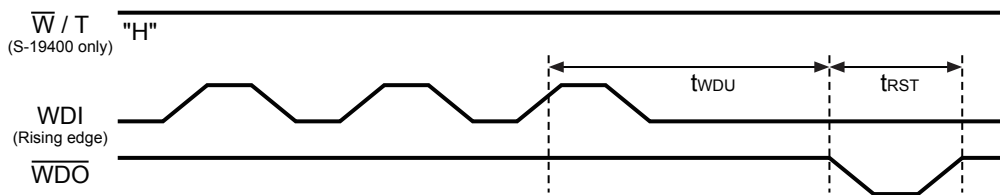


Figure 5 Abnormality Detection in Time-out Mode

#### 1.2 Window mode ( $\overline{W} / T$ pin = "L")

When not inputting an edge to the WDI pin during  $t_{WDU}$ , or when an edge is input to the WDI pin again within a specific period of time (the discharge time due to an edge detection + 1 charge-discharge time ( $t_{WDL}$ )) after inputting an edge to the WDI pin, the  $\overline{WDO}$  pin output changes from "H" to "L".

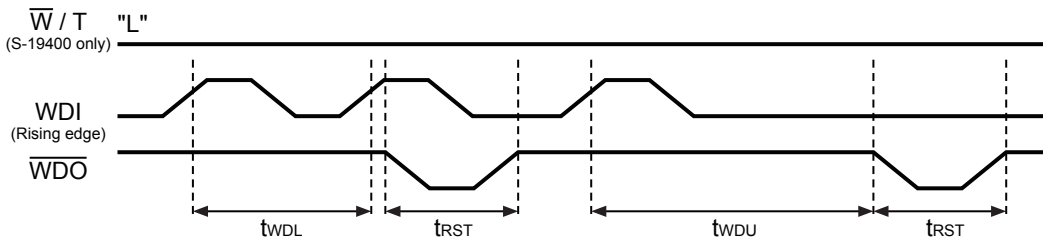


Figure 6 Abnormality Detection in Window Mode

### 2. $\overline{RST}$ pin (S-19401 Series only)

This is a reset output pin. It outputs "L" when detecting a low voltage.

Be sure to connect a pull-up resistor to the  $\overline{RST}$  pin in the product without an output pull-up resistor.

### 3. CPOR pin

This is a pin to connect an external capacitor in order to generate the reset time-out period ( $t_{RST}$ ).

The capacitor is charged and discharged by an internal constant current circuit, and the charge-discharge duration is  $t_{RST}$ .

$t_{RST}$  is calculated by using the following equation.

$$t_{RST} = 6,500,000 \times C_{POR} [F] + 0.0002$$

#### 4. CWDT pin

This is a pin to connect an external capacitor in order to generate the watchdog time-out period ( $t_{WDU}$ ) and the watchdog double pulse detection time ( $t_{WDL}$ ). The capacitor is charged and discharged by an internal constant current circuit.

$t_{WDU}$  is calculated by using the following equation.

$$t_{WDU} = 50,000,000 \times C_{WDT} [F] + 0.0011$$

Moreover,  $t_{WDL}$  is calculated by using the following equation.

$$t_{WDL} = \frac{t_{WDU}}{32}$$

#### 5. WEN pin

This is a pin to switch Enable / Disable of the watchdog timer.

When the WEN pin logic is active "H", the watchdog timer becomes Enable if the input is "H", and the charge-discharge operation is performed at the CWDT pin. In the active "H" product, the constant current source (0.3  $\mu$ A typ.) is connected to the WEN pin, and it is pulled down internally.

#### 6. $\overline{WDO}$ pin

This pin combines the reset output and the watchdog output.

Be sure to connect a pull-up resistor to the  $\overline{WDO}$  pin in the product without an output pull-up resistor.

#### 7. WDI pin

This is an input pin to receive a signal from the monitored object. By being input an edge at an appropriate timing, the WDI pin confirms the normal operation of the monitored object.

The constant current source (0.3  $\mu$ A typ.) is connected to the WDI pin, and it is pulled down internally.



## ■ Absolute Maximum Ratings

Table 7

(Ta = -40°C to +125°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Unit
VDD pin voltage	V <sub>DD</sub>	V <sub>SS</sub> - 0.3 to V <sub>SS</sub> + 7.0	V
WDI pin voltage	V <sub>WDI</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0	V
WEN pin voltage	V <sub>WEN</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0	V
$\overline{W}$ / T pin voltage	V <sub><math>\overline{W}</math> / T</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0	V
CPOR pin voltage	V <sub>CPOR</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0	V
CWDT pin voltage	V <sub>CWDT</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0	V
$\overline{RST}$ pin voltage	A / B / C / D / E / F type	V <sub>RST</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0
	G / H / I / J / K / L type		
$\overline{WDO}$ pin voltage	A / B / C / D / E / F type	V <sub>WDO</sub>	V <sub>SS</sub> - 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 7.0
	G / H / I / J / K / L type		
Operation ambient temperature	T <sub>opr</sub>	-40 to +125	°C
Storage temperature	T <sub>stg</sub>	-40 to +150	°C

**Caution** The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

## ■ Thermal Resistance Value

Table 8

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
Junction-to-ambient thermal resistance *1	$\theta_{ja}$	TMSOP-8	Board 1	-	160	-	°C/W
			Board 2	-	133	-	°C/W
		HSNT-8(2030)	Board 1	-	181	-	°C/W
			Board 2	-	135	-	°C/W

\*1. Test environment: compliance with JEDEC STANDARD JESD51-2A

**Remark** Refer to "■ Thermal Characteristics" for details of power dissipation and test board.

■ Electrical Characteristics

Table 9 (1 / 2)

(WEN pin logic active "H" product,  $V_{DD} = 5.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit	
Detection voltage *1	$-V_{DET}$	–	$-V_{DET(S)} \times 0.98$	$-V_{DET(S)}$	$-V_{DET(S)} \times 1.02$	V	1	
Hysteresis width	$V_{HYS}$	–	$-V_{DET} \times 0.03$	$-V_{DET} \times 0.05$	$-V_{DET} \times 0.07$	V	1	
Current consumption during operation	$I_{SS1}$	When watchdog timer operates	–	3.8	9.0	$\mu\text{A}$	2	
Reset time-out period	$t_{RST}$	$C_{POR} = 2200\text{ pF}$	8.7	14.5	20	ms	3	
Watchdog time-out period	$t_{WDU}$	$C_{WDT} = 470\text{ pF}$	15	24.6	34	ms	3	
Watchdog double pulse detection time	$t_{WDL}$	$C_{WDT} = 470\text{ pF}$	461	769	1077	$\mu\text{s}$	4	
Reset output voltage "H"	$V_{ROH}$	S-19401 Series A / B / C / D / E / F type only	$V_{DD} - 1.0$	–	–	V	5	
Reset output voltage "L"	$V_{ROL}$	–	–	–	0.4	V	6	
Reset output pull-up current	$I_{RUP}$	$V_{RST} = 0\text{ V}$ , S-19401 Series A / B / C / D / E / F type only	–	-0.85	-0.4	$\mu\text{A}$	7	
Reset output current	$I_{ROUT}$	$V_{DS} = 0.4\text{ V}$ , S-19401 Series only	$V_{DD} = 1.5\text{ V}$	0.48	1.1	–	mA	8
			$V_{DD} = 1.8\text{ V}$	0.8	1.6	–	mA	8
			$V_{DD} = 2.5\text{ V}$	1.0	2.6	–	mA	8
			$V_{DD} = 3.0\text{ V}$	1.4	3.3	–	mA	8
Reset output leakage current	$I_{RLEAK}$	$V_{DS} = 6.0\text{ V}$ , $V_{DD} = 6.0\text{ V}$ , S-19401 Series only	–	–	0.096	$\mu\text{A}$	9	
Watchdog output voltage "H"	$V_{WOH}$	A / B / C / D / E / F type only	$V_{DD} - 1.0$	–	–	V	10	
Watchdog output voltage "L"	$V_{WOL}$	–	–	–	0.4	V	11	
Watchdog output pull-up current	$I_{WUP}$	$V_{WDO} = 0\text{ V}$ , A / B / C / D / E / F type only	–	-0.85	-0.4	$\mu\text{A}$	12	
Watchdog output current	$I_{WOUT}$	$V_{DS} = 0.4\text{ V}$	$V_{DD} = 1.5\text{ V}$	0.48	1.1	–	mA	13
			$V_{DD} = 1.8\text{ V}$	0.8	1.6	–	mA	13
			$V_{DD} = 2.5\text{ V}$	1.0	2.6	–	mA	13
			$V_{DD} = 3.0\text{ V}$	1.4	3.3	–	mA	13
Watchdog output leakage current	$I_{WLEAK}$	$V_{DS} = 6.0\text{ V}$ , $V_{DD} = 6.0\text{ V}$	–	–	0.096	$\mu\text{A}$	14	
Input pin voltage 1 "H"	$V_{SH1}$	WEN pin	$0.7 \times V_{DD}$	–	–	V	15	
Input pin voltage 1 "L"	$V_{SL1}$	WEN pin	–	–	$0.3 \times V_{DD}$	V	15	
Input pin voltage 2 "H"	$V_{SH2}$	$\bar{W}$ / T pin, S-19400 Series only	$0.7 \times V_{DD}$	–	–	V	15	
Input pin voltage 2 "L"	$V_{SL2}$	$\bar{W}$ / T pin, S-19400 Series only	–	–	$0.3 \times V_{DD}$	V	15	
Input pin voltage 3 "H"	$V_{SH3}$	WDI pin	$0.7 \times V_{DD}$	–	–	V	15	
Input pin voltage 3 "L"	$V_{SL3}$	WDI pin	–	–	$0.3 \times V_{DD}$	V	15	

Table 9 (2 / 2)

(WEN pin logic active "H" product,  $V_{DD} = 5.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit	
Input pin current 1 "H"	$I_{SH1}$	WEN pin, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $6.0\text{ V}$	A / B / C / G / H / I type	-	0.3	1.0	$\mu\text{A}$	15
			D / E / F / J / K / L type	-0.1	-	0.1	$\mu\text{A}$	15
Input pin current 1 "L"	$I_{SL1}$	WEN pin, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $0\text{ V}$	-0.1	-	0.1	$\mu\text{A}$	15	
Input pin current 2 "H"	$I_{SH2}$	$\bar{W}$ / T pin, S-19400 Series only, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $6.0\text{ V}$	-	0.3	1.0	$\mu\text{A}$	15	
Input pin current 2 "L"	$I_{SL2}$	$\bar{W}$ / T pin, S-19400 Series only, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $0\text{ V}$	-0.1	-	0.1	$\mu\text{A}$	15	
Input pin current 3 "H"	$I_{SH3}$	WDI pin, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $6.0\text{ V}$	-	0.3	1.0	$\mu\text{A}$	15	
Input pin current 3 "L"	$I_{SL3}$	WDI pin, $V_{DD} = 6.0\text{ V}$ , Input pin voltage = $0\text{ V}$	-0.1	-	0.1	$\mu\text{A}$	15	
Input pulse width "H"*2	$t_{high1}$	-	1.5	-	-	$\mu\text{s}$	15	
Input pulse width "L"*2	$t_{low1}$	-	1.5	-	-	$\mu\text{s}$	15	
Watchdog output delay time	$t_{WOUT}$	-	-	25	40	$\mu\text{s}$	3	
Reset output delay time	$t_{ROUT}$	-	-	25	40	$\mu\text{s}$	3	
Input setup time	$t_{iset}$	-	1.0	-	-	$\mu\text{s}$	3	

\*1.  $-V_{DET}$ : Actual detection voltage,  $-V_{DET(S)}$ : Set detection voltage

\*2. The input pulse width "H" ( $t_{high1}$ ) and the input pulse width "L" ( $t_{low1}$ ) are defined as shown in Figure 7.

Inputs to the WEN pin and the WDI pin should be greater than or equal to the min. value specified in "■ Electrical Characteristics".

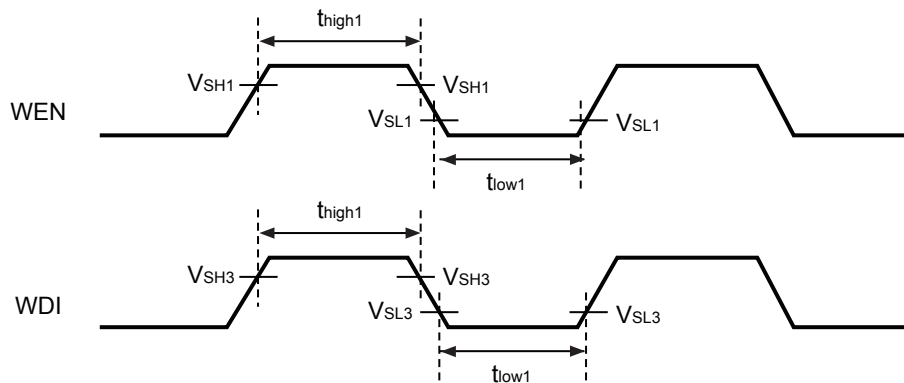


Figure 7

■ Test Circuits

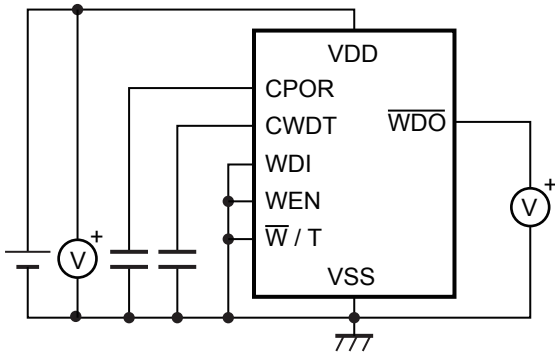


Figure 8 Test Circuit 1

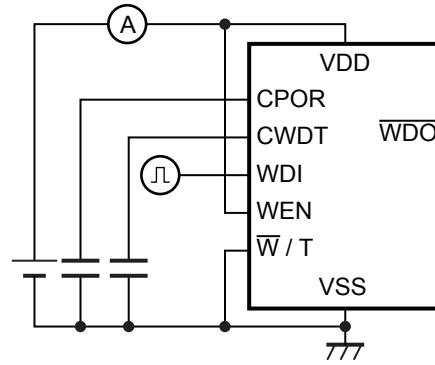


Figure 9 Test Circuit 2

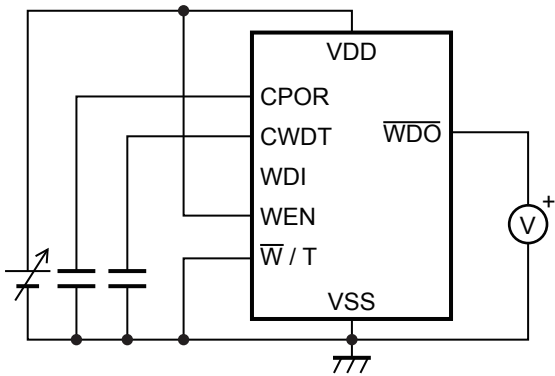


Figure 10 Test Circuit 3

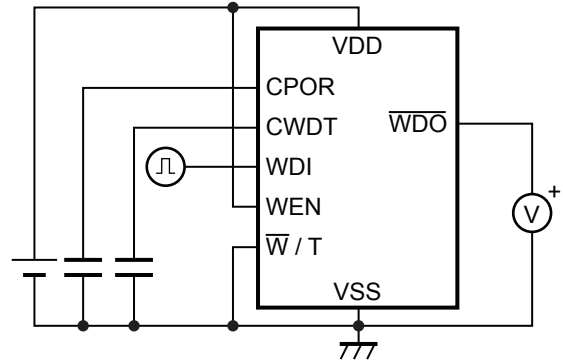


Figure 11 Test Circuit 4

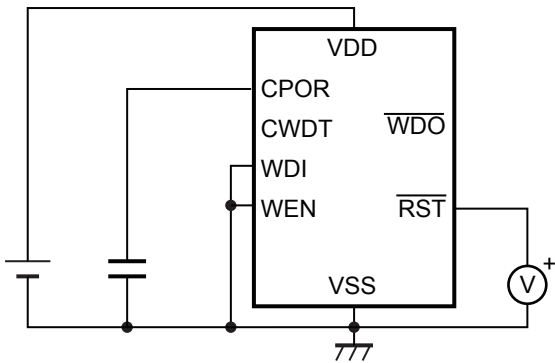


Figure 12 Test Circuit 5

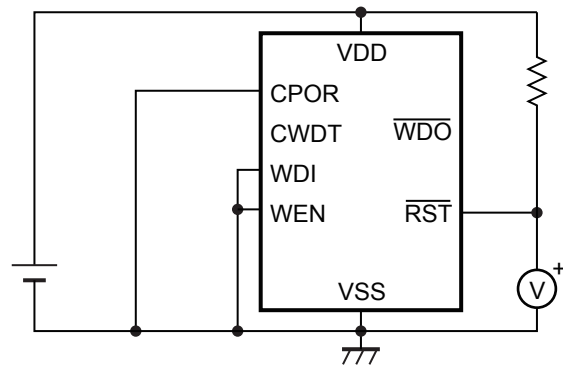


Figure 13 Test Circuit 6

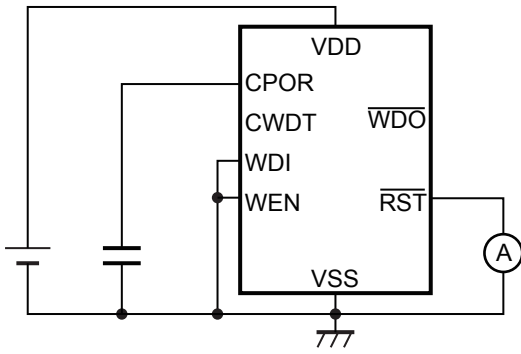


Figure 14 Test Circuit 7

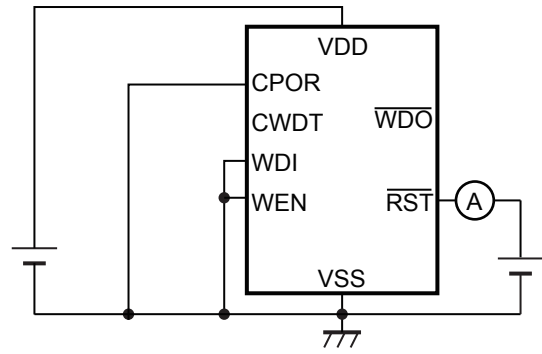


Figure 15 Test Circuit 8

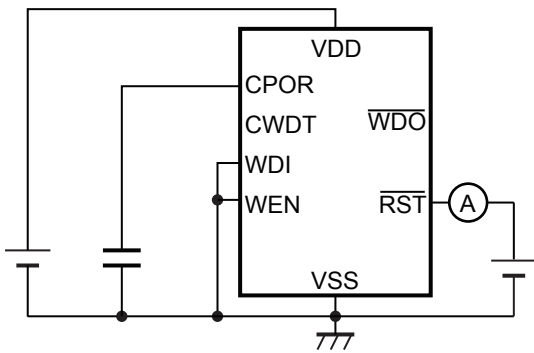


Figure 16 Test Circuit 9

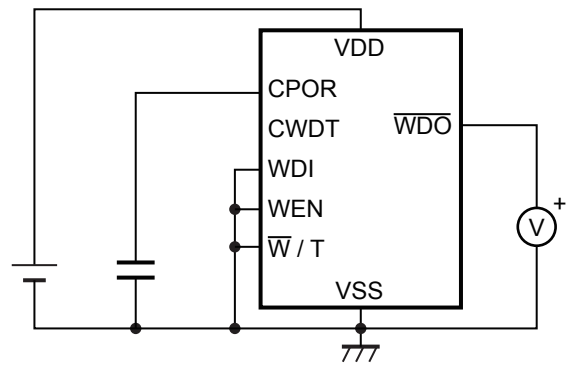


Figure 17 Test Circuit 10

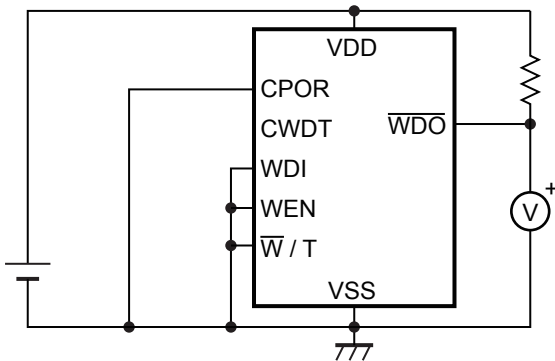


Figure 18 Test Circuit 11

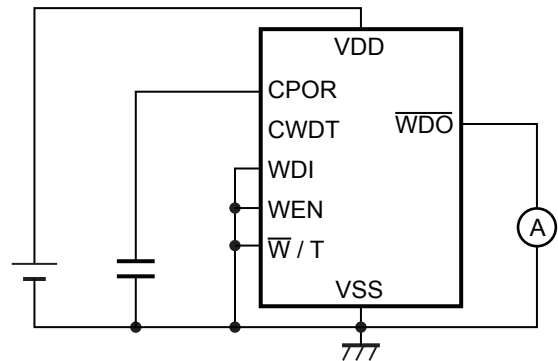


Figure 19 Test Circuit 12

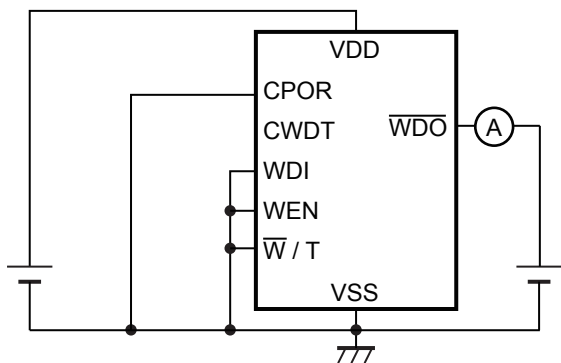


Figure 20 Test Circuit 13

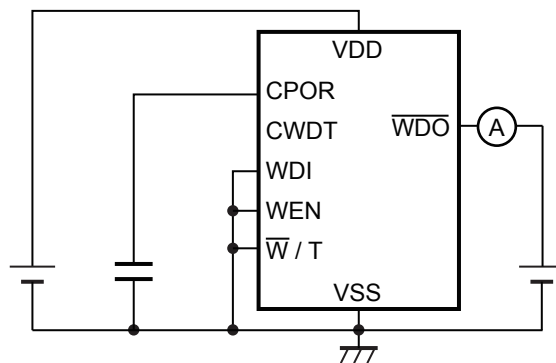


Figure 21 Test Circuit 14

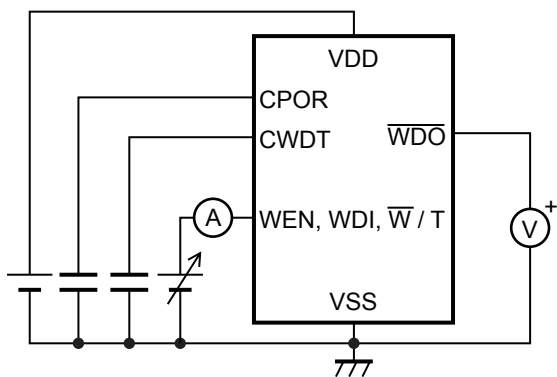
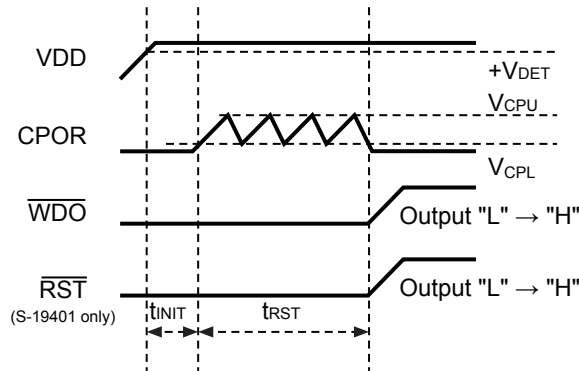


Figure 22 Test Circuit 15

■ Operation

1. From power-on to reset release

The S-19400/19401 Series initiates the initialization if the VDD pin voltage exceeds the release voltage ( $+V_{DET}$ ). The charge-discharge operation to the CPOR pin is initiated after the passage of the initialization time ( $t_{INIT}$ ), and the  $\overline{WDO}$  pin output and the  $\overline{RST}$  pin output change from "L" to "H" after the operation is performed 4 times.



**Remark**  $V_{CPU}$ : CPOR charge upper limit threshold (1.25 V typ.)  
 $V_{CPL}$ : CPOR charge lower limit threshold (0.20 V typ.)

Figure 23

$t_{INIT}$  changes according to the power supply rising time. Refer to Figure 24 for the relation between  $t_{INIT}$  and the power supply rising time.

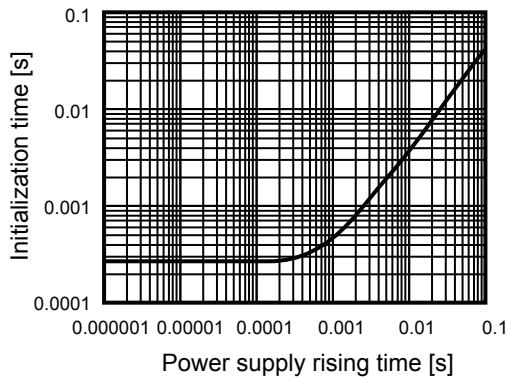
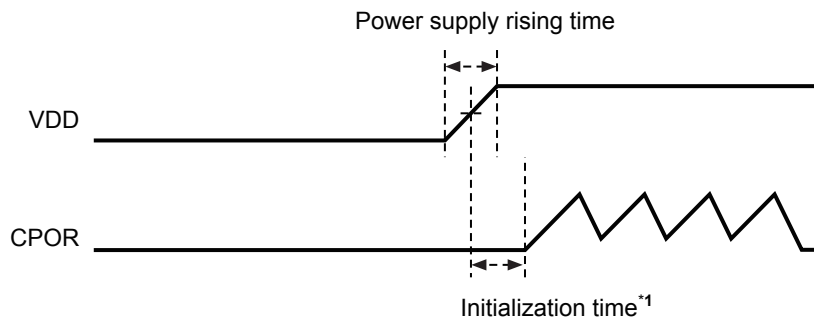


Figure 24 Power Supply Rising Time Dependency of Initialization Time



\*1. The initialization time is the time period from when the VDD pin voltage reaches  $V_{DD} / 2$  to when  $C_{POR}$  rises.

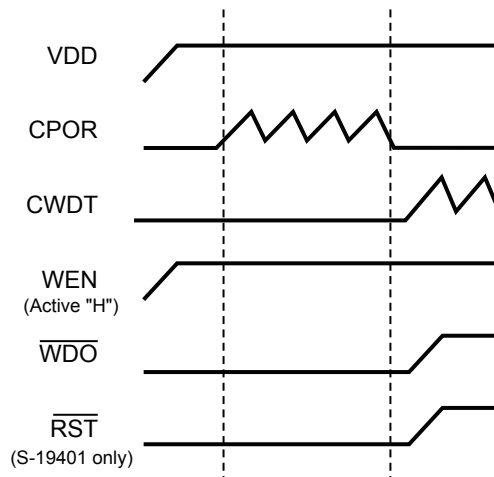
Figure 25 Initialization Time

**2. From reset release to initiation of charge-discharge operation to CWDT pin**

The charge-discharge operation to the CWDT pin differs depending on the status of the WEN pin at the reset release.

**2.1 When WEN pin is "H" at reset release (Active "H")**

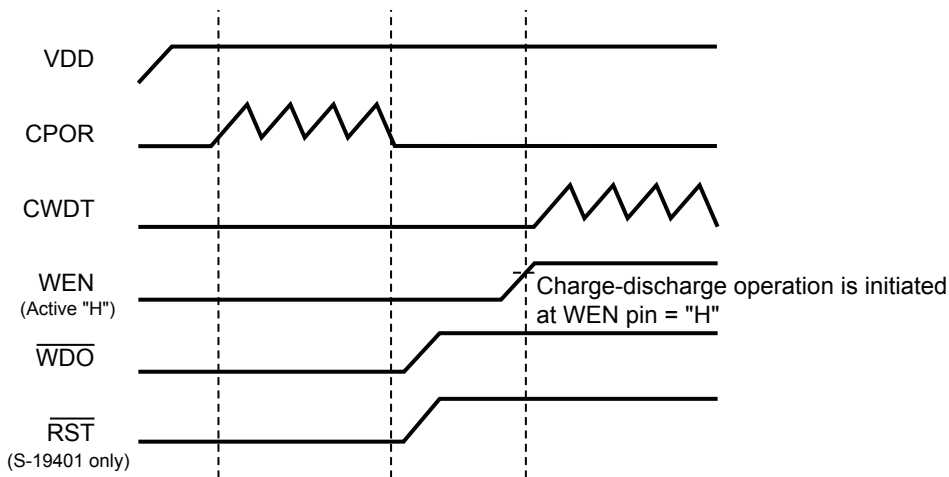
Since the watchdog timer is Enable, the S-19400/19401 Series initiates the charge-discharge operation to the CWDT pin.



**Figure 26 WEN Pin = "H"**

**2.2 When WEN pin is "L" at reset release (Active "H")**

Since the watchdog timer is Disable after the CPOR pin performs the charge-discharge operation 4 times, the S-19400/19401 Series does not initiate the charge-discharge operation to the CWDT pin. If the input to the WEN pin changes to "H" in this status, the S-19400/19401 Series initiates the charge-discharge operation to the CWDT pin.



**Figure 27 WEN Pin = "L" → "H"**



### 3. Watchdog time-out detection

The watchdog timer detects a time-out after the charge-discharge operation to the CWDT pin is performed 32 times, then the  $\overline{WDO}$  pin output changes from "H" to "L".

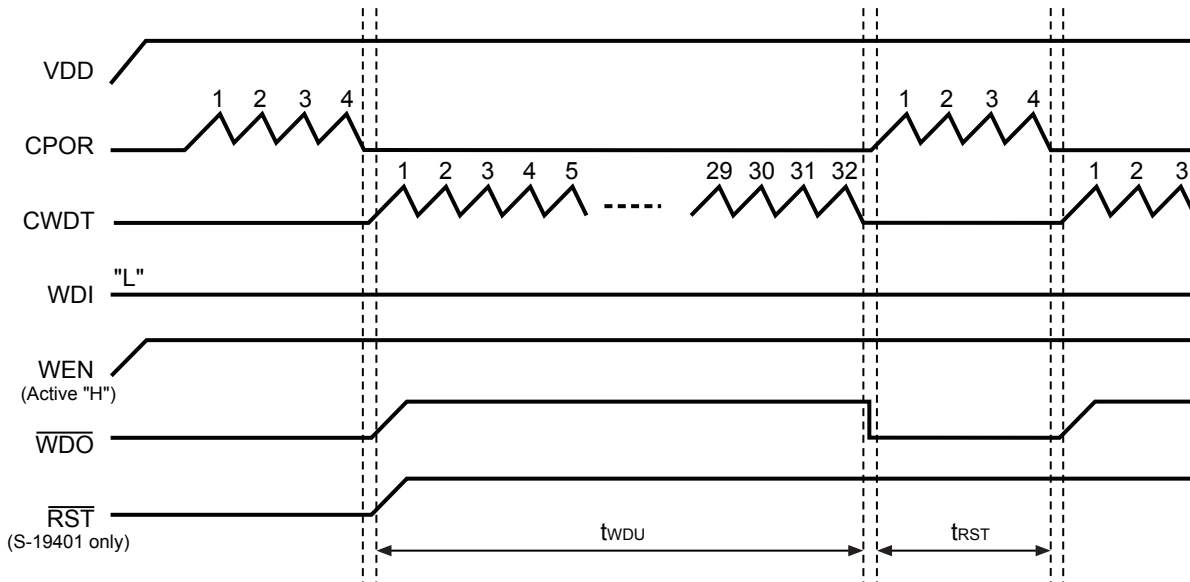


Figure 28

### 4. Internal counter reset due to edge detection

When the WDI pin detects an edge during the charge-discharge operation to the CWDT pin, the internal counter which counts the number of times of the charge-discharge operation is reset. The CWDT pin initiates the discharge operation when an edge is detected, and initiates the charge-discharge operation again after the discharge operation is completed.

#### 4.1 Counter reset due to rising edge detection

(S-1940xAxxA, S-1940xDxxA, S-1940xGxxA, S-1940xJxxA)

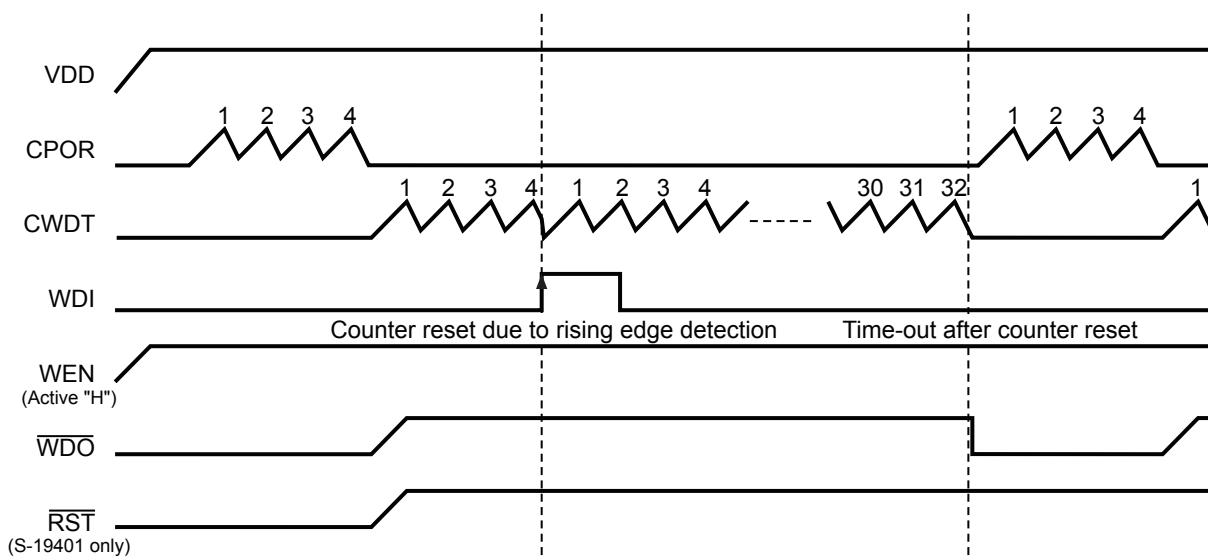


Figure 29

**4.2 Counter reset due to falling edge detection**  
 (S-1940xBxxA, S-1940xExxA, S-1940xHxxA, S-1940xKxxA)

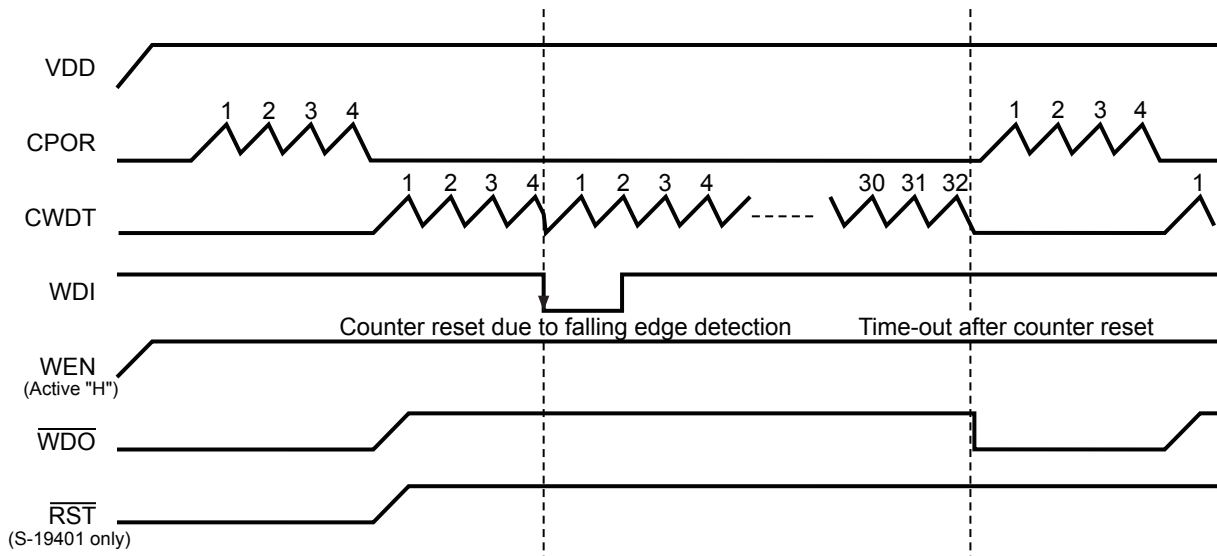


Figure 30

**4.3 Counter reset due to both rising and falling edges detection 1**  
 (S-1940xCxxA, S-1940xFxxA, S-1940xIxxA, S-1940xLxxA)

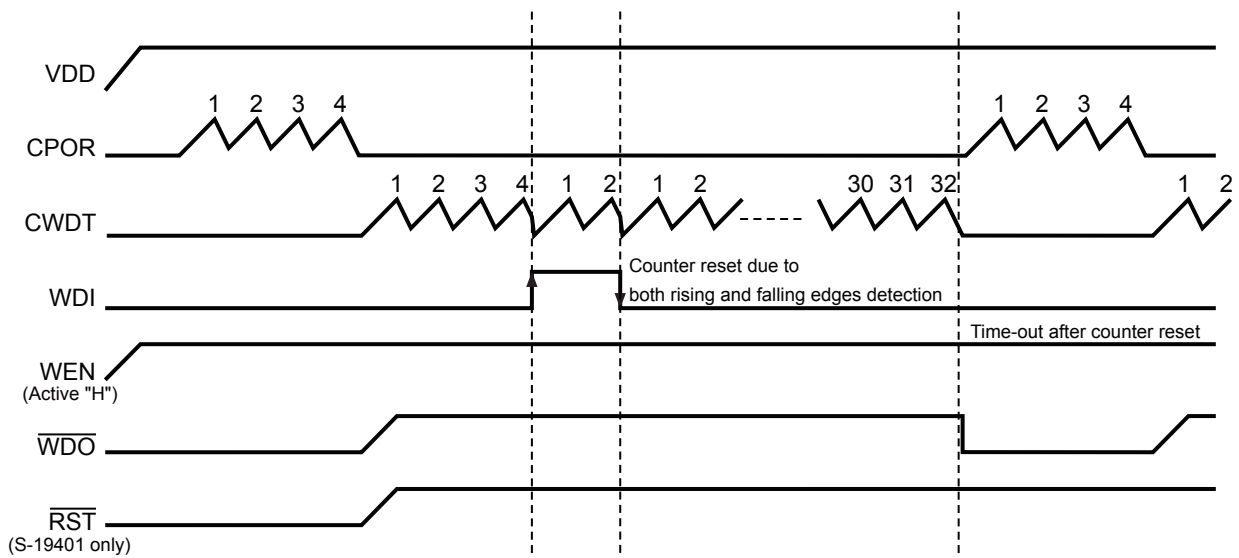


Figure 31

**4. 4 Counter reset due to both rising and falling edges detection 2**  
 (S-1940xCxxA, S-1940xFxxA, S-1940xIxxA, S-1940xLxxA)

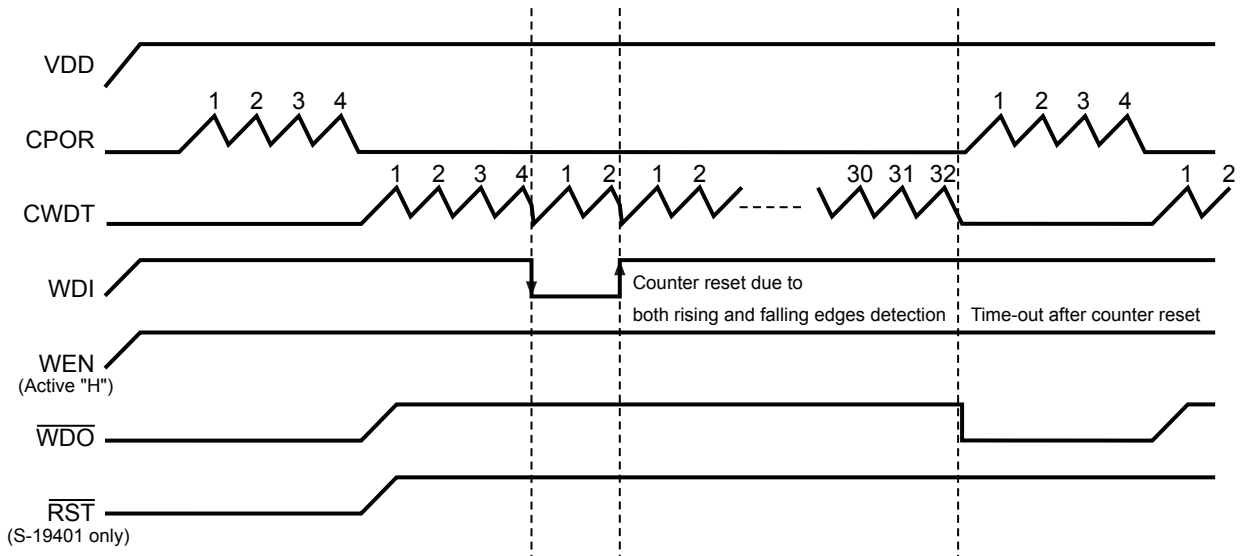


Figure 32

**5. WEN pin operation during charge-discharge operation to CWDT pin**

When the WEN pin changes from "H" to "L" during the charge-discharge operation to the CWDT pin, the CWDT pin performs the discharge operation. Moreover, the internal counter which counts the number of times of the charge-discharge operation for the CWDT pin is also reset.

If the WEN pin changes to "H" again in this status, the CWDT pin initiates the charge-discharge operation.

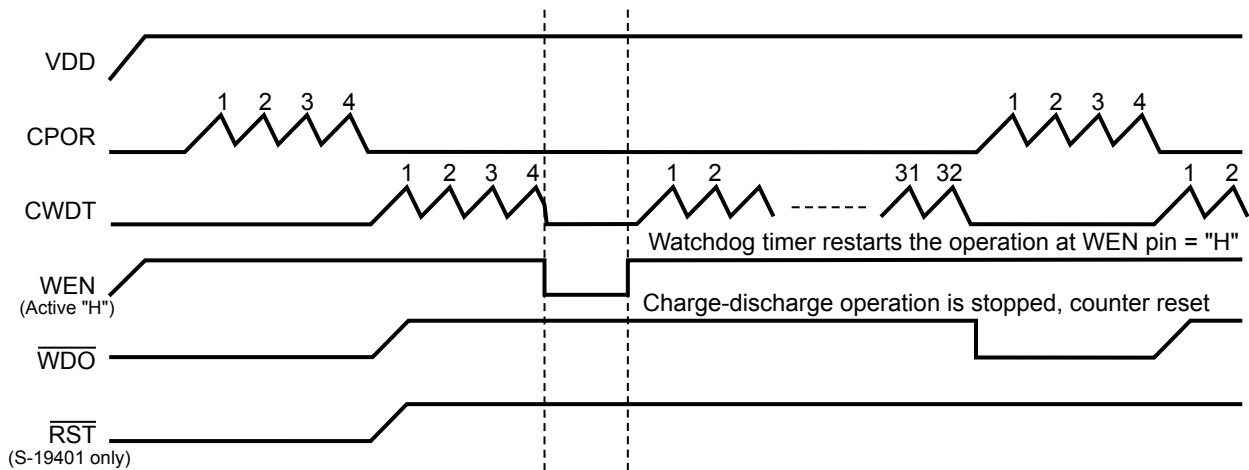


Figure 33

**6. Watchdog double pulse detection**

If an edge is input to the WDI pin again within a specific period of time (the discharge time due to an edge detection + 1 charge-discharge time ( $t_{WDL}$ )) after inputting an edge to the WDI pin when the S-19400/19401 Series is the window mode, the  $\overline{WDO}$  pin output changes from "H" to "L".

When the watchdog timer becomes Disable due to a change of the WEN pin ("H" → "L" → "H") after inputting an edge to the WDI pin, the  $\overline{WDO}$  pin continues outputting "H" even if an edge is input to the WDI pin within the specific period of time mentioned above.

**6.1 Double pulse detection due to rising edge detection  
 (S-1940xAxxA, S-1940xDxxA, S-1940xGxxA, S-1940xJxxA)**

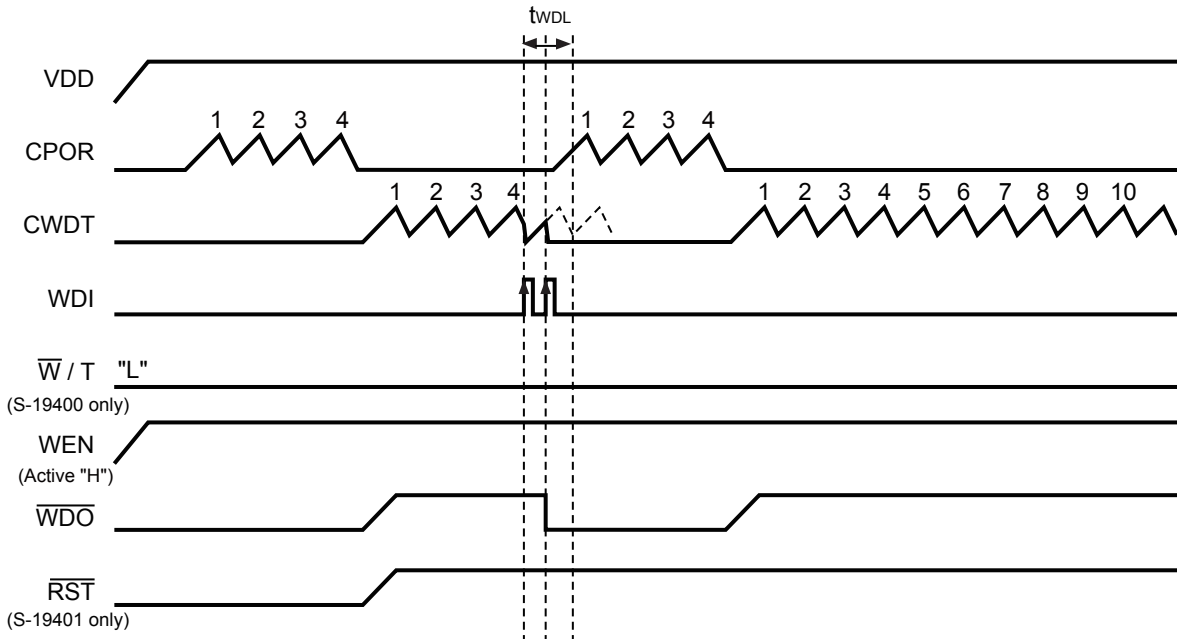


Figure 34

**6.2 Double pulse detection due to falling edge detection  
 (S-1940xBxxA, S-1940xExxA, S-1940xHxxA, S-1940xKxxA)**

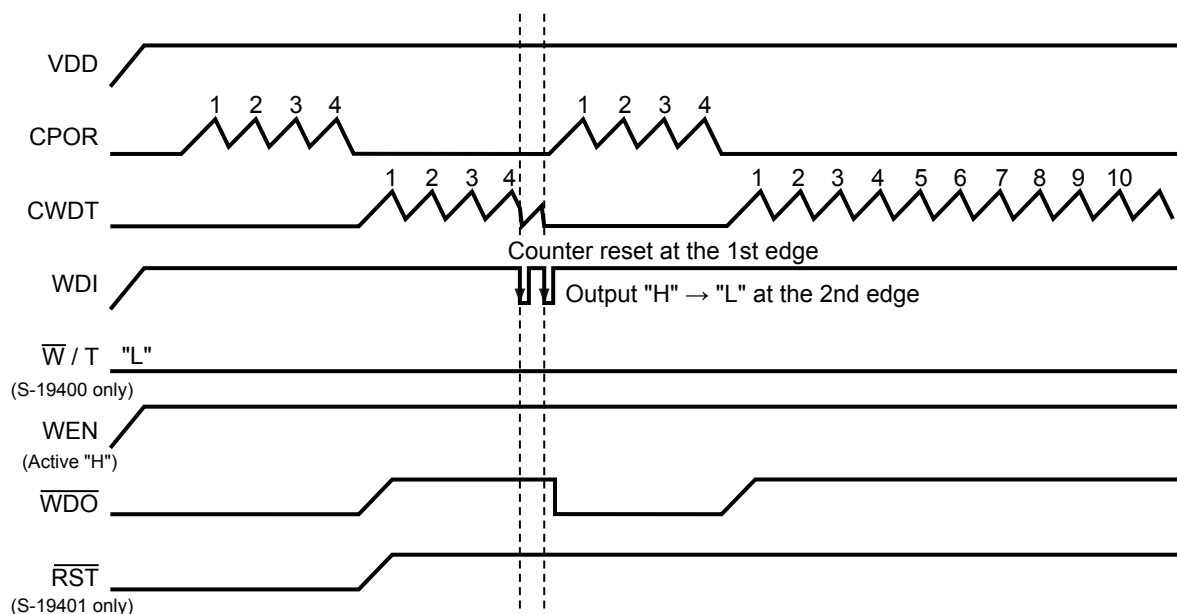


Figure 35

**6.3 Double pulse detection due to both rising and falling edges detection**  
 (S-1940xCxxA, S-1940xFxxA, S-1940xIxxA, S-1940xLxxA)

The double pulse is detected only when edges are input in order of rising and falling.

**6.3.1 When edges are input to WDI pin in order of rising and falling**

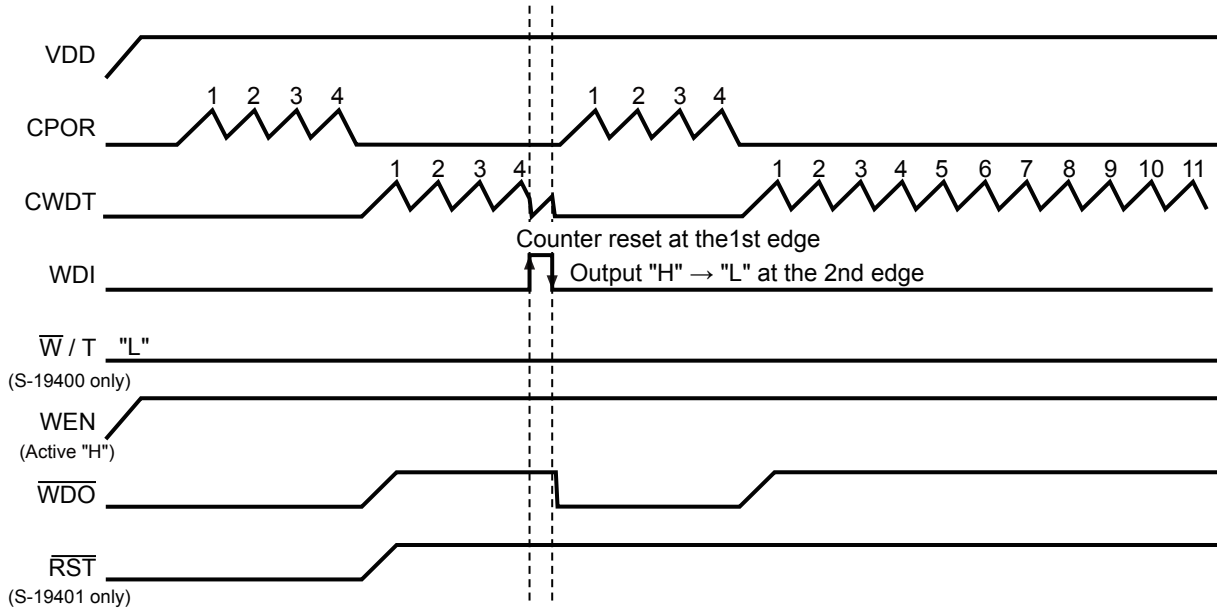


Figure 36 Double Pulse Detection

**6.3.2 When edges are input to WDI pin in order of falling and rising**

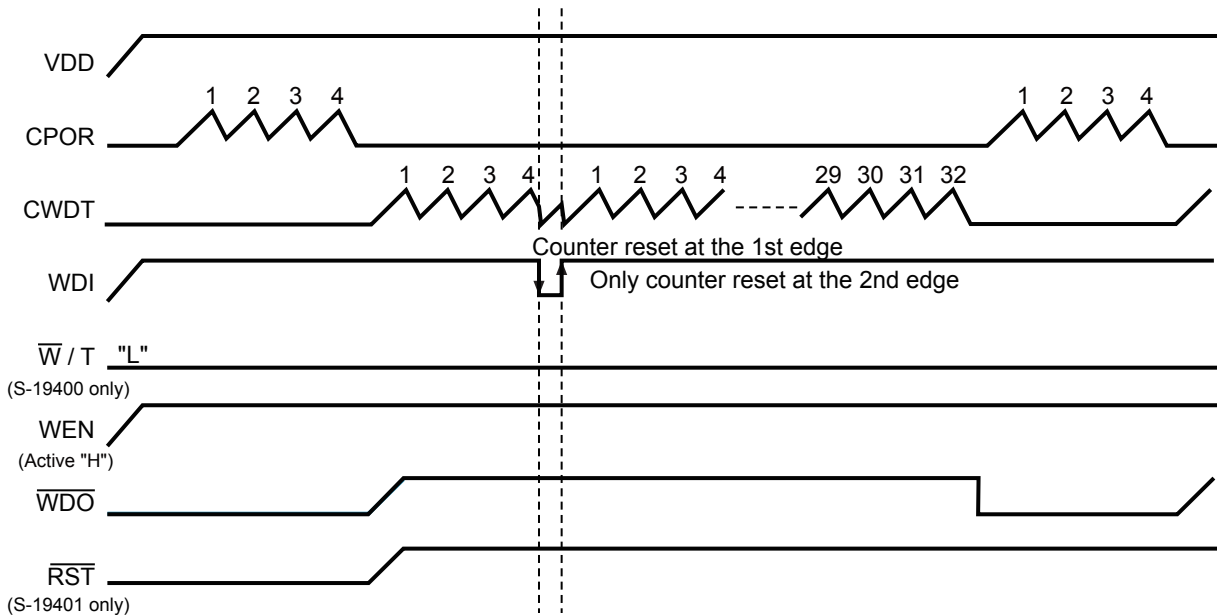
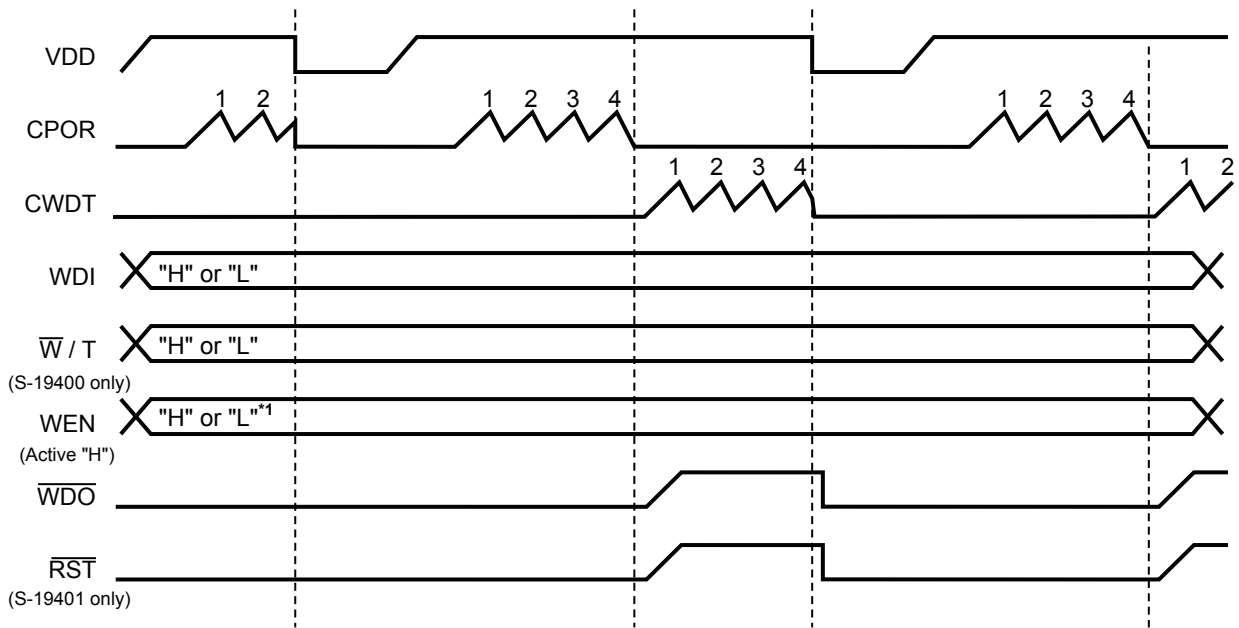


Figure 37 Double Pulse Non-detection

**7. Operation of low voltage detection**

The voltage detection circuit detects a low voltage if the power supply voltage falls below the detection voltage, and then "L" is output from the  $\overline{WDO}$  pin and the  $\overline{RST}$  pin (Only the S-19401 Series). The output is maintained until the charge-discharge operation of the CPOR pin is performed 4 times.

The S-19400/19401 Series can detect a low voltage even if either the CPOR pin or the WDT pin performs the charge-discharge operation. In this case, the status of the WEN pin or the  $\overline{W} / T$  pin does not have an affect.



**Figure 38**

\*1. When the WEN pin is Disable, the charge-discharge operation of CWDT pin is not performed.

**8. WEN pin, WDI pin and  $\overline{W} / T$  pin**

Each of the WEN pin, the WDI pin and the  $\overline{W} / T$  pin has a noise filter.

If the power supply voltage is 5.0 V, noise with a minimum pulse width of 200 ns can be eliminated.

■ Standard Circuits

1. S-19400 Series (Product with  $\overline{W}$  / T pin)

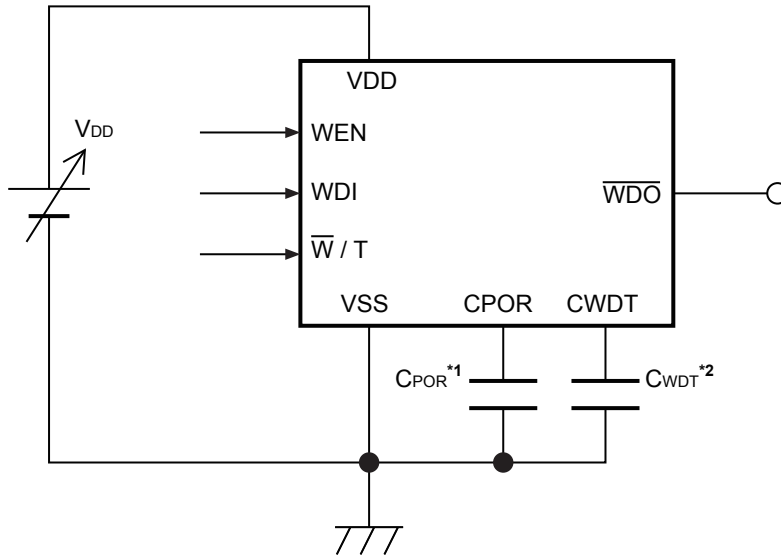


Figure 39

2. S-19401 Series (Product without  $\overline{W}$  / T pin)

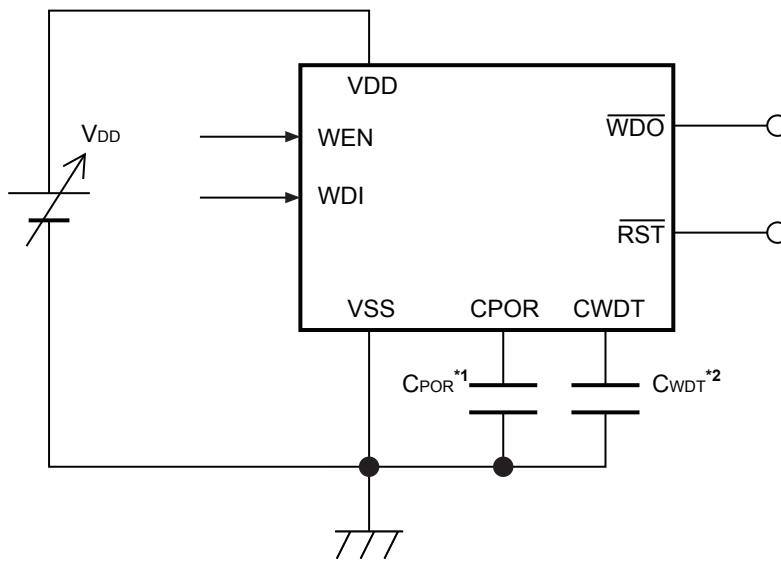


Figure 40

- \*1. Adjustment capacitor for reset output delay time ( $C_{POR}$ ) should be connected directly to the CPOR pin and the VSS pin.
  - \*2. Adjustment capacitor for watchdog output delay time ( $C_{WDT}$ ) should be connected directly to the CWDT pin and the VSS pin.
- A capacitor of 100 pF to 1  $\mu$ F can be used for  $C_{POR}$  and  $C_{WDT}$ .

**Caution** The above connection diagram and constant will not guarantee successful operation. Perform thorough evaluation using the actual application to set the constants.

## ■ Precautions

- It will take time for the discharge operation to be performed if the capacitance of  $C_{POR}$  is extremely large at the low voltage detection, so the discharge operation may not be completed by the time the power supply voltage exceeds the detection voltage. In that case, since the charge-discharge operation of the CPOR pin is performed after the discharge operation is completed, the delay time of the same time length as the discharge operation occurs in reset time-out period ( $t_{RST}$ ).
- Select a capacitor which satisfies the following equation for  $C_{POR}$  and  $C_{WDT}$ . If this condition is not satisfied, the delay time of the same time length as the discharge operation occurs in  $t_{RST}$  since the discharge operation of an external capacitor connected to the CWDT pin is not completed by the time the CWDT pin initiates the next charge-discharge operation.

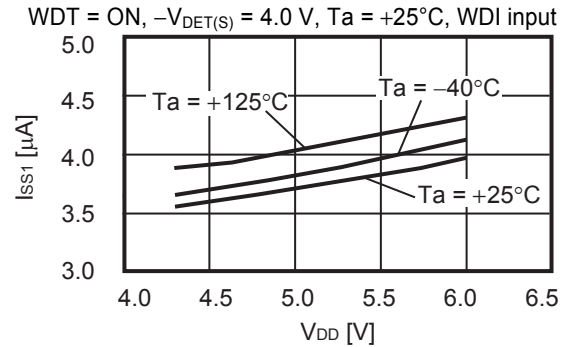
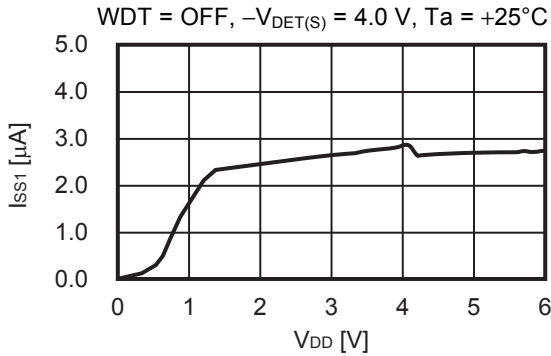
$$C_{WDT} / C_{POR} \leq 600$$

- When the power supply voltage falls to 0.9 V or lower, set a time interval of 20  $\mu$ s or longer by the time the power supply is raised again. If the appropriate time length is not secured, the time-out period after raising the power supply voltage may get delayed.
- When the time that the power supply voltage falls below the detection voltage is short, the S-19400/19401 Series may not detect a voltage. In that case, the time-out period after raising the power supply voltage may get delayed.
- Since input pins (the WEN pin, the WDI pin and the  $\overline{W}$  / T pin) in the S-19400/19401 Series are CMOS configurations, make sure that an intermediate potential is not input when the S-19400/19401 Series operates.
- Since the  $\overline{WDO}$  pin and the  $\overline{RST}$  pin are affected by external resistance and external capacitance, use the S-19400/19401 Series after performing thorough evaluation with the actual application.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- SII Semiconductor Corporation claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

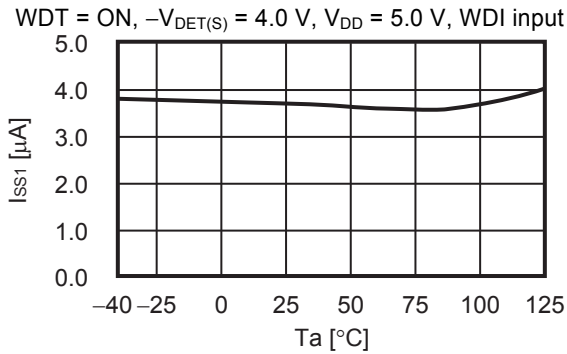


■ Characteristics (Typical Data)

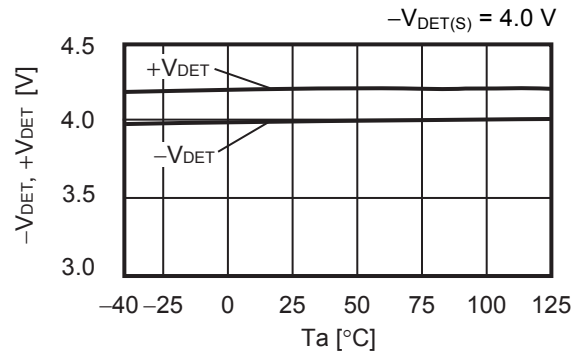
1. Current consumption during operation ( $I_{SS1}$ ) vs. Input voltage ( $V_{DD}$ )



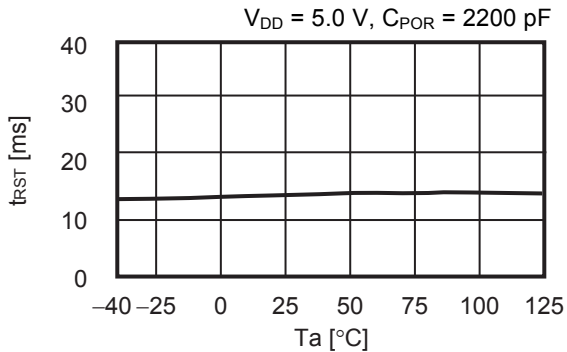
2. Current consumption during operation ( $I_{SS1}$ ) vs. Temperature ( $T_a$ )



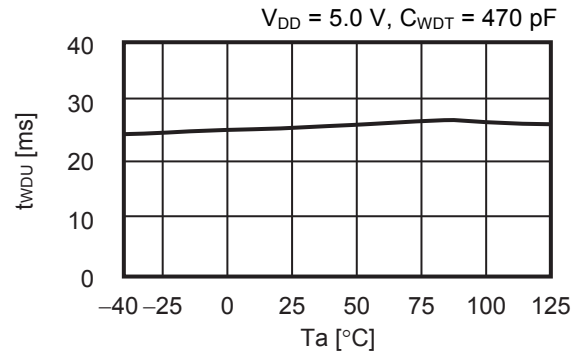
3. Detection voltage ( $-V_{DET}$ ), Release voltage ( $+V_{DET}$ ) vs. Temperature ( $T_a$ )



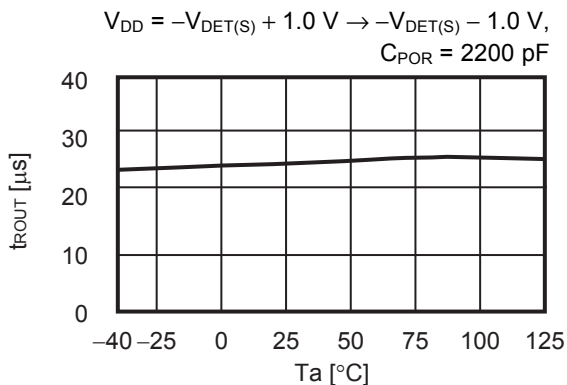
4. Reset time-out period ( $t_{RST}$ ) vs. Temperature ( $T_a$ )



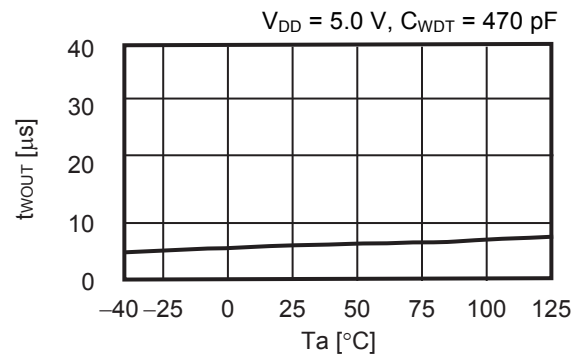
5. Watchdog time-out period ( $t_{WDU}$ ) vs. Temperature ( $T_a$ )



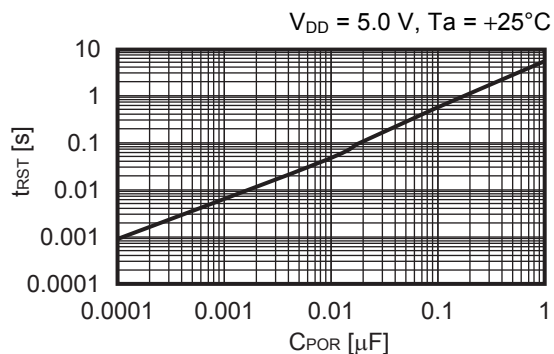
6. Reset output delay time ( $t_{ROUT}$ ) vs. Temperature ( $T_a$ )



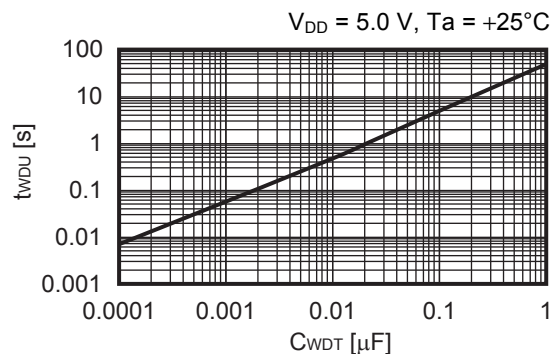
7. Watchdog output delay time ( $t_{WOUT}$ ) vs. Temperature ( $T_a$ )



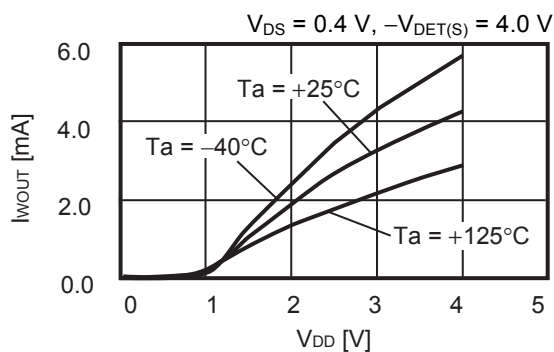
**8. Reset time-out period ( $t_{RST}$ ) vs.  $C_{POR}$**



**9. Watchdog time-out period ( $t_{WDT}$ ) vs.  $C_{WDT}$**



**10. Nch driver output current ( $I_{WOUT}$ ) vs. Input voltage ( $V_{DD}$ )**



■ Thermal Characteristics

1. TMSOP-8

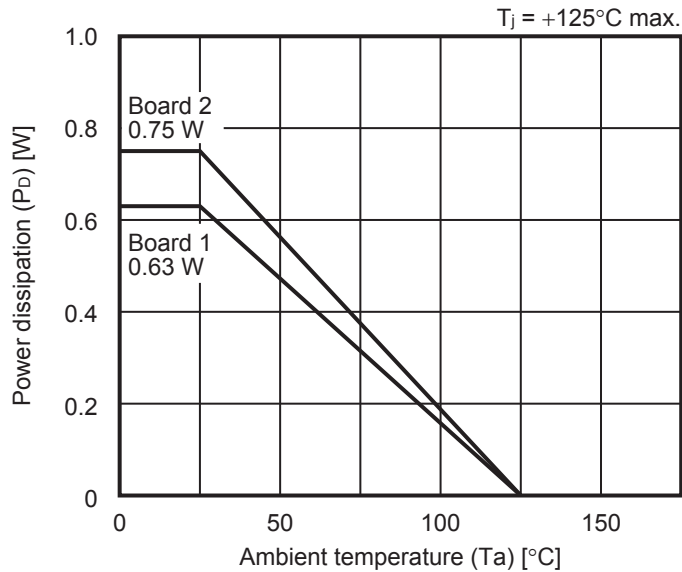


Figure 41 Power Dissipation of Package (When Mounted on Board)

1.1 Board 1

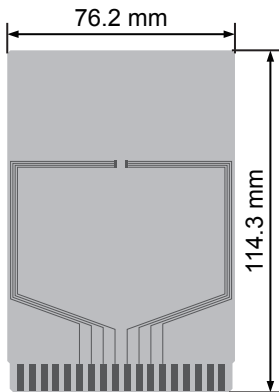


Figure 42

Item	Specification
Thermal resistance value ( $\theta_{ja}$ )	160°C/W
Size	114.3 mm × 76.2 mm × t1.6 mm
Material	FR-4
Number of copper foil layer	2
Copper foil layer	1 Land pattern and wiring for testing: t0.070 mm
	2 -
	3 -
	4 74.2 mm × 74.2 mm × t0.070 mm
Thermal via	-

1.2 Board 2

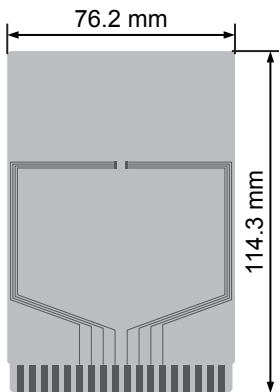
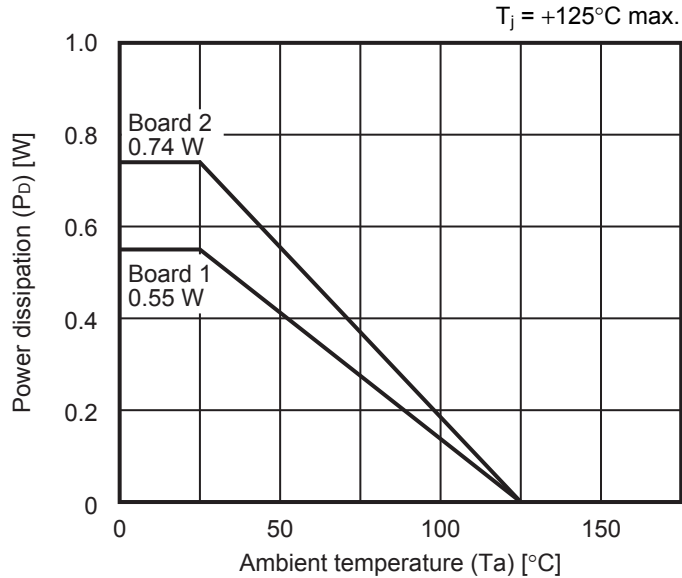


Figure 43

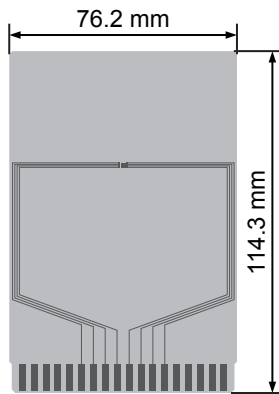
Item	Specification
Thermal resistance value ( $\theta_{ja}$ )	133°C/W
Size	114.3 mm × 76.2 mm × t1.6 mm
Material	FR-4
Number of copper foil layer	4
Copper foil layer	1 Land pattern and wiring for testing: t0.070 mm
	2 74.2 mm × 74.2 mm × t0.035 mm
	3 74.2 mm × 74.2 mm × t0.035 mm
	4 74.2 mm × 74.2 mm × t0.070 mm
Thermal via	-

**2. HSNT-8(2030)**



**Figure 44 Power Dissipation of Package (When Mounted on Board)**

**2.1 Board 1**

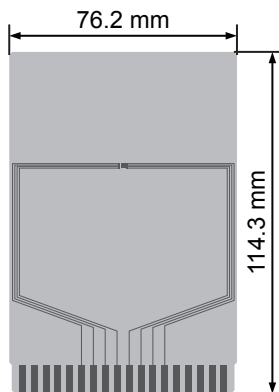


**Figure 45**

**Table 12**

Item	Specification
Thermal resistance value ( $\theta_{ja}$ )	181°C/W
Size	114.3 mm × 76.2 mm × t1.6 mm
Material	FR-4
Number of copper foil layer	2
Copper foil layer	1 Land pattern and wiring for testing: t0.070 mm
	2 -
	3 -
	4 74.2 mm × 74.2 mm × t0.070 mm
Thermal via	-

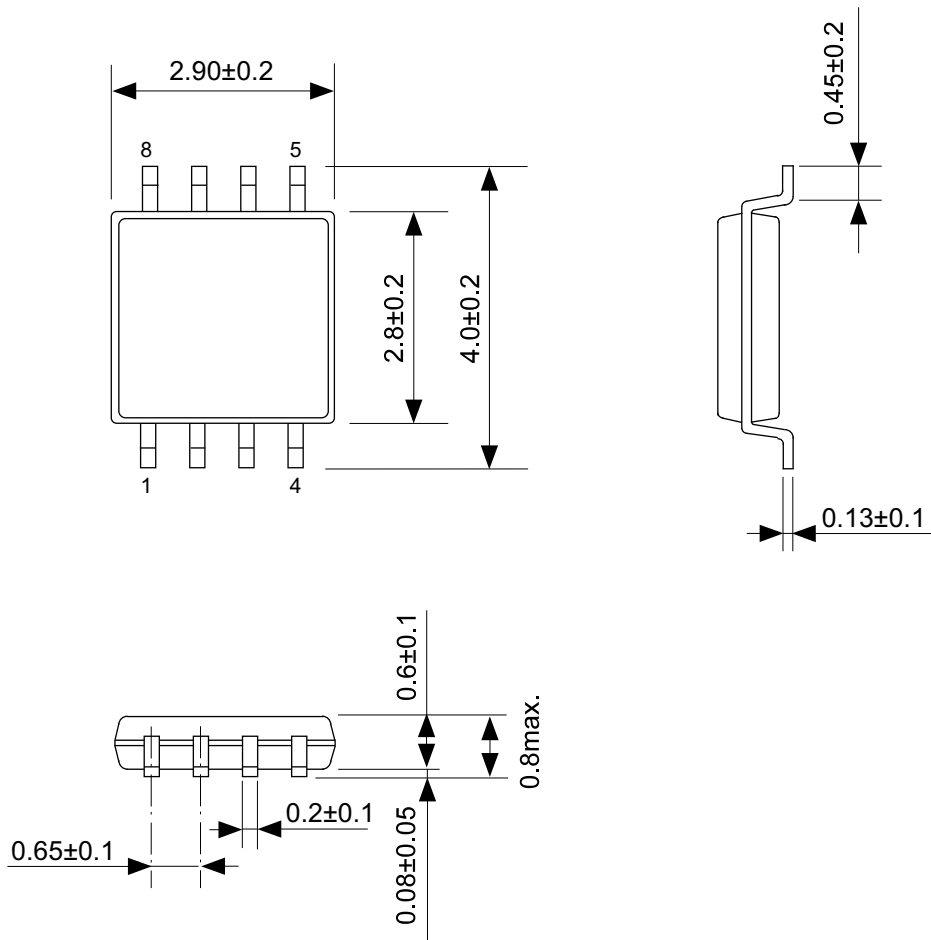
**2.2 Board 2**



**Figure 46**

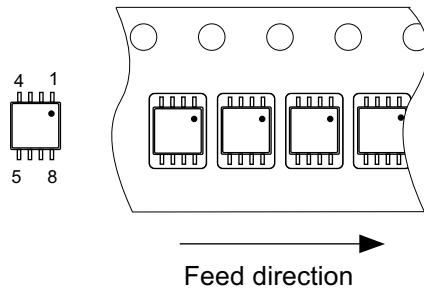
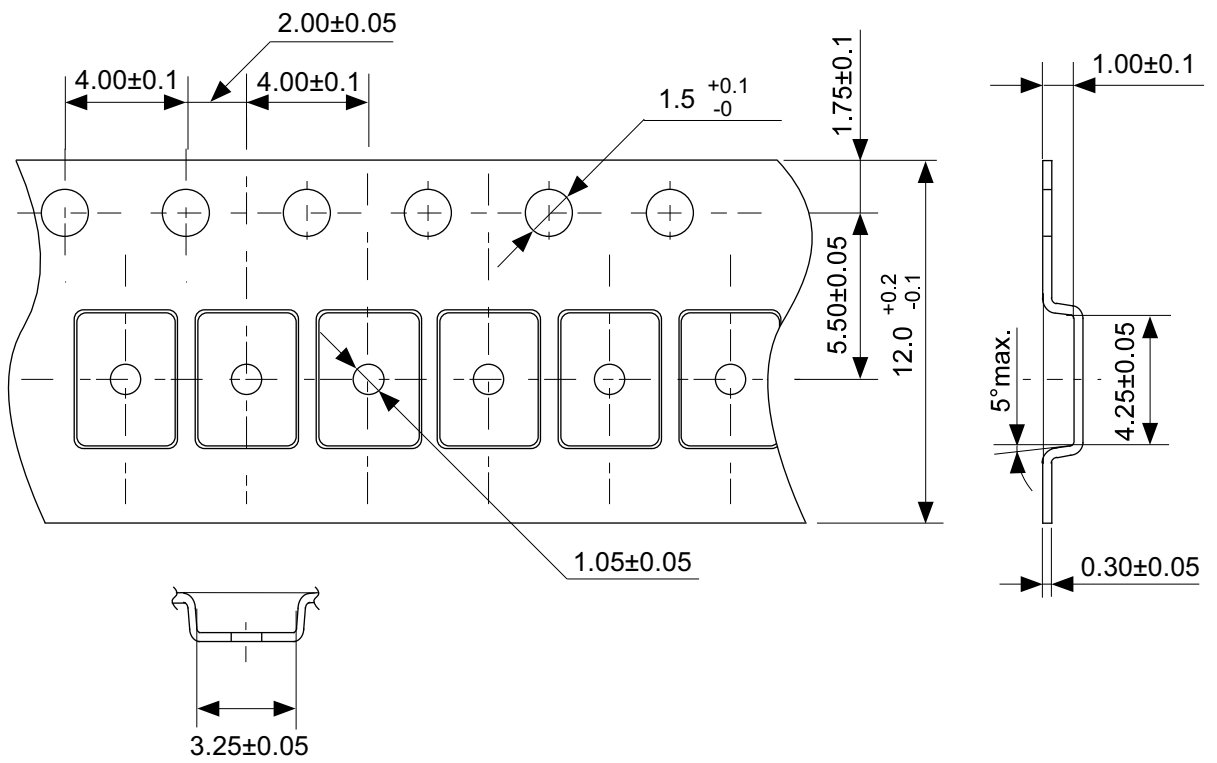
**Table 13**

Item	Specification
Thermal resistance value ( $\theta_{ja}$ )	135°C/W
Size	114.3 mm × 76.2 mm × t1.6 mm
Material	FR-4
Number of copper foil layer	4
Copper foil layer	1 Land pattern and wiring for testing: t0.070 mm
	2 74.2 mm × 74.2 mm × t0.035 mm
	3 74.2 mm × 74.2 mm × t0.035 mm
	4 74.2 mm × 74.2 mm × t0.070 mm
Thermal via	-



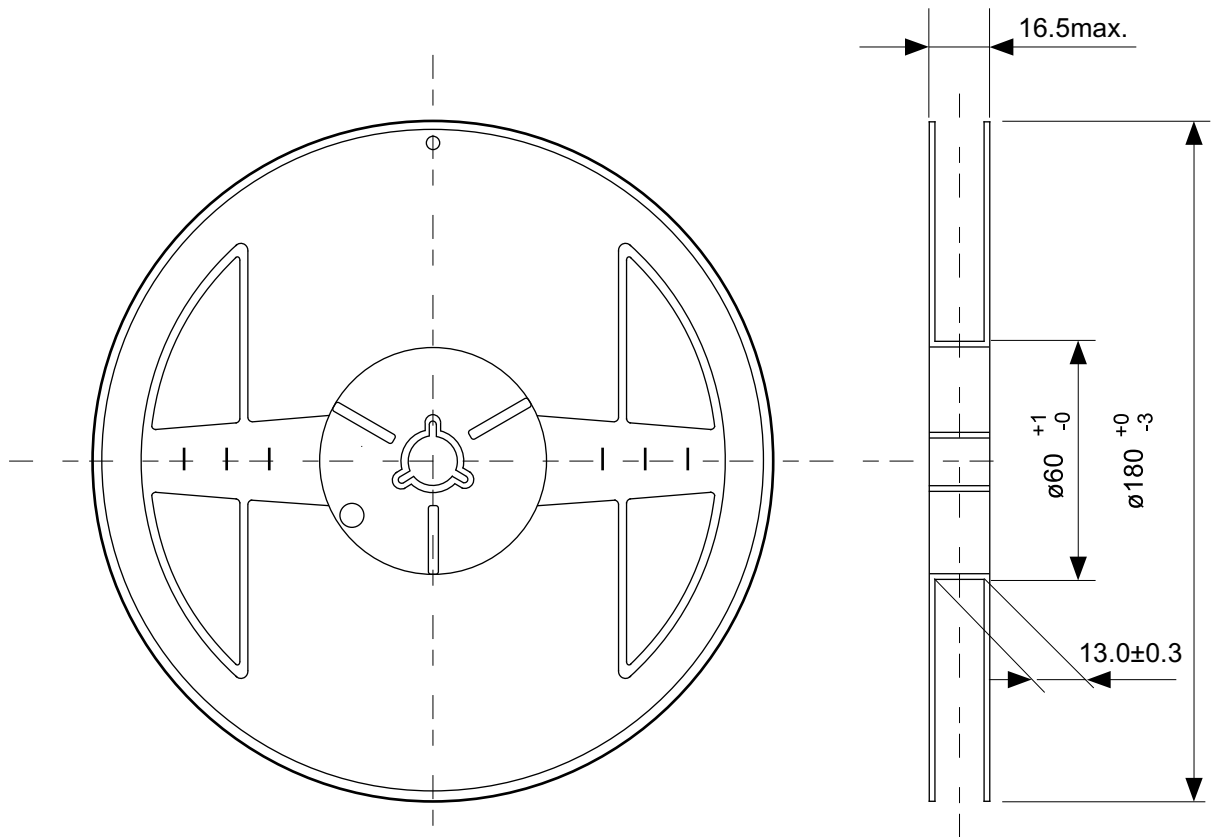
No. FM008-A-P-SD-1.2

TITLE	TMSOP8-A-PKG Dimensions
No.	FM008-A-P-SD-1.2
ANGLE	
UNIT	mm
SII Semiconductor Corporation	

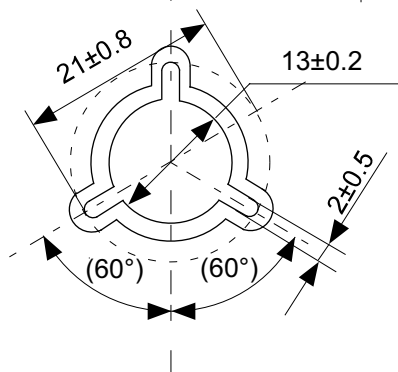


No. FM008-A-C-SD-2.0

TITLE	TMSOP8-A-Carrier Tape
No.	FM008-A-C-SD-2.0
ANGLE	
UNIT	mm
SII Semiconductor Corporation	

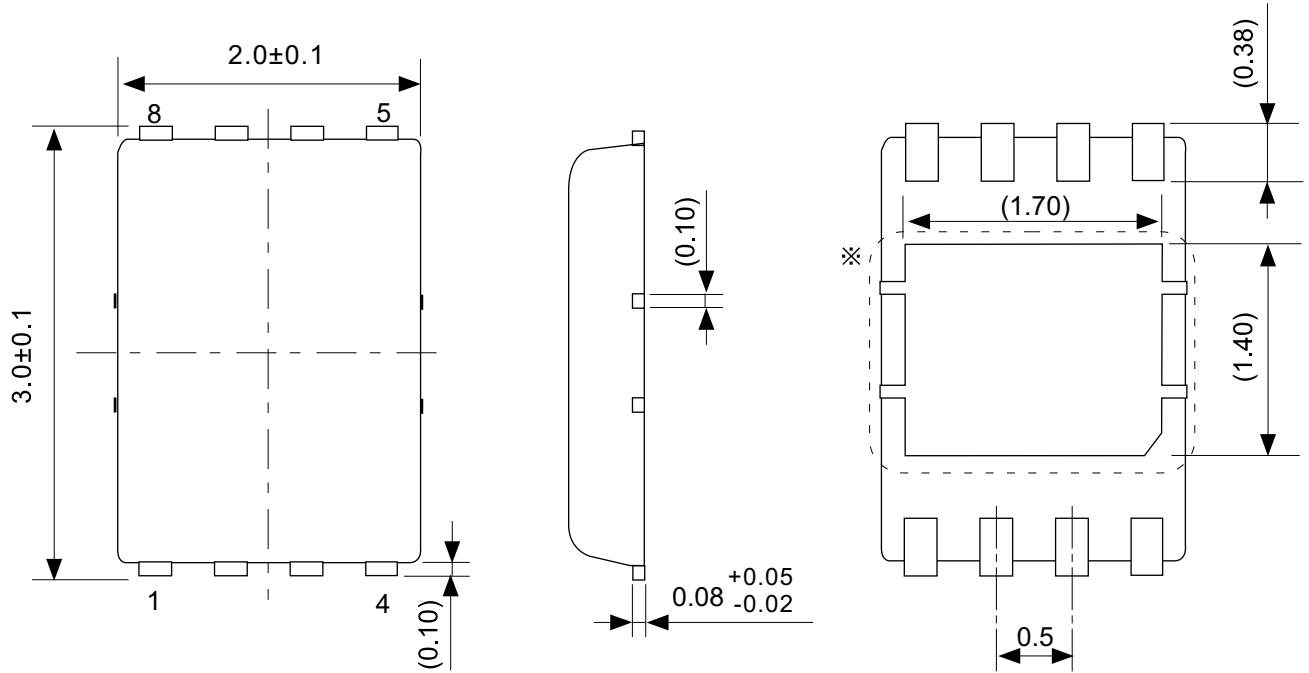


Enlarged drawing in the central part



No. FM008-A-R-SD-1.0

TITLE	TMSOP8-A-Reel		
No.	FM008-A-R-SD-1.0		
ANGLE		QTY.	4,000
UNIT	mm		
SII Semiconductor Corporation			

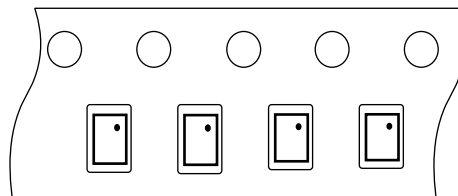
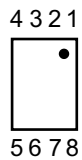
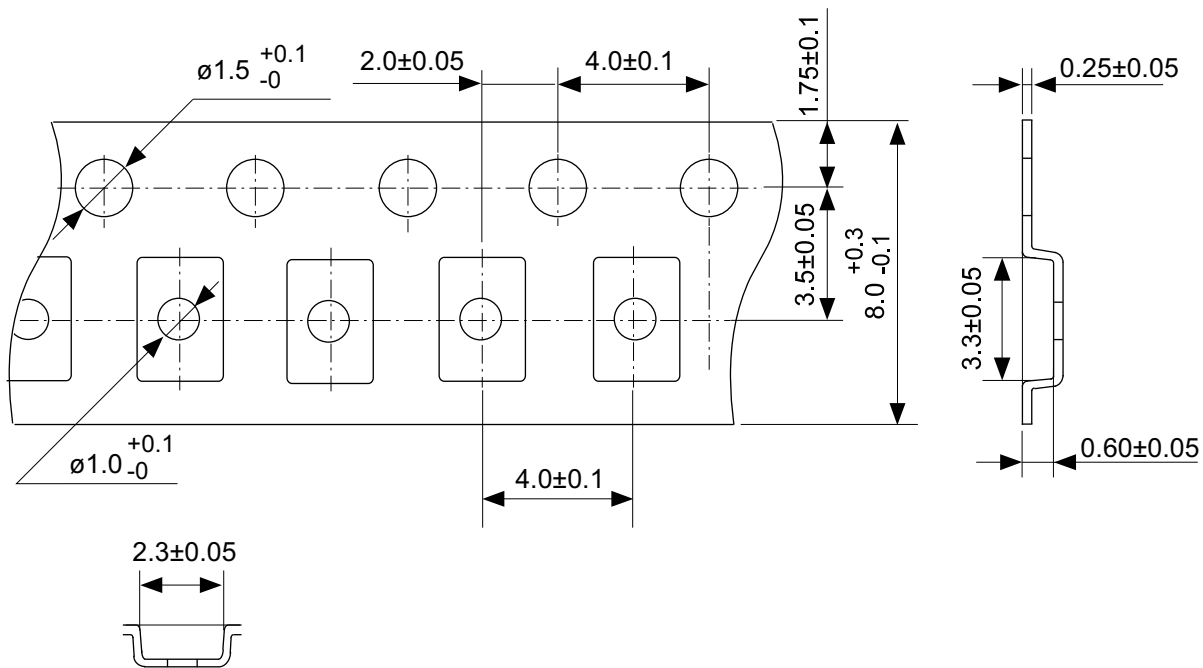


No. PP008-A-P-SD-2.0

※ The heat sink of back side has different electric potential depending on the product.  
 Confirm specifications of each product.  
 Do not use it as the function of electrode.

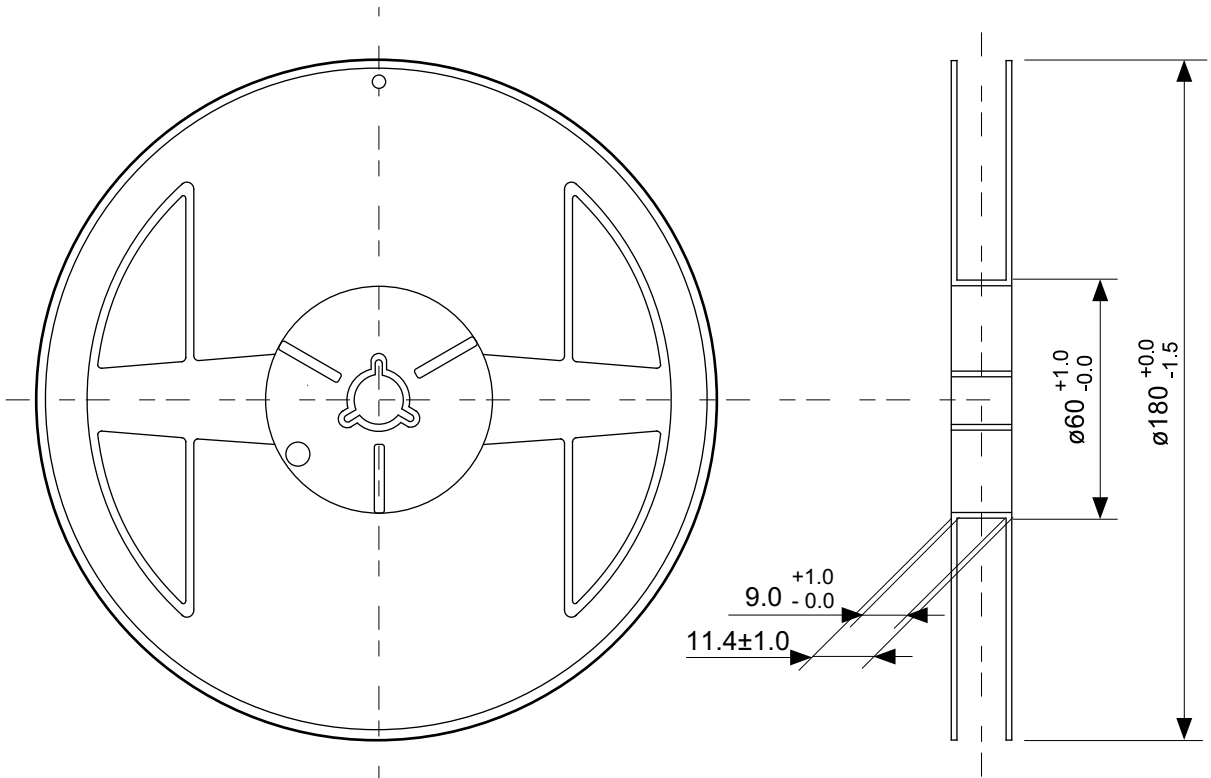
TITLE	DFN-8/HSNT-8-A-PKG Dimensions
No.	PP008-A-P-SD-2.0
ANGLE	
UNIT	mm
SII Semiconductor Corporation	



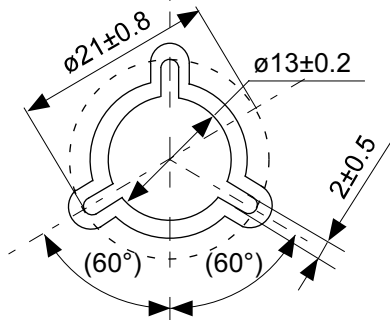


No. PP008-A-C-SD-1.0

TITLE	DFN-8/HSNT-8-A-Carrier Tape
No.	PP008-A-C-SD-1.0
ANGLE	
UNIT	mm
SII Semiconductor Corporation	

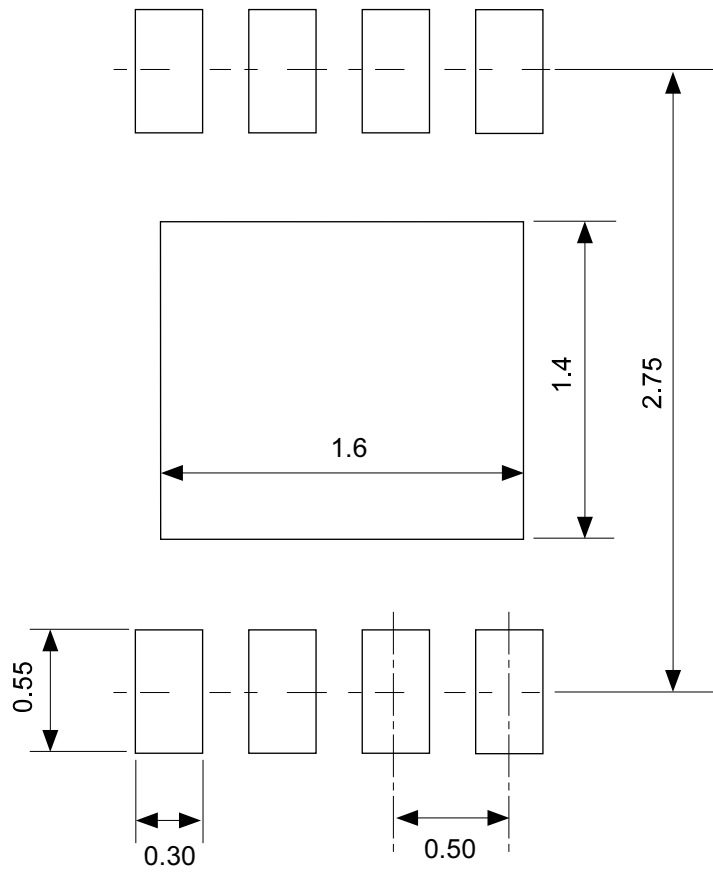


Enlarged drawing in the central part



No. PP008-A-R-SD-1.0

TITLE	DFN-8/HSNT-8-A-Reel		
No.	PP008-A-R-SD-1.0		
ANGLE		QTY.	5,000
UNIT	mm		
SII Semiconductor Corporation			



No. PP008-A-L-SD-1.0

TITLE	DFN-8/HSNT-8-A -Land Recommendation
No.	PP008-A-L-SD-1.0
ANGLE	
UNIT	mm
SII Semiconductor Corporation	

## Disclaimers (Handling Precautions)

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3. SII Semiconductor Corporation is not responsible for damages caused by the incorrect information described herein.
4. Take care to use the products described herein within their specified ranges. Pay special attention to the absolute maximum ratings, operation voltage range and electrical characteristics, etc.  
SII Semiconductor Corporation is not responsible for damages caused by failures and/or accidents, etc. that occur due to the use of products outside their specified ranges.
5. When using the products described herein, confirm their applications, and the laws and regulations of the region or country where they are used and verify suitability, safety and other factors for the intended use.
6. When exporting the products described herein, comply with the Foreign Exchange and Foreign Trade Act and all other export-related laws, and follow the required procedures.
7. The products described herein must not be used or provided (exported) for the purposes of the development of weapons of mass destruction or military use. SII Semiconductor Corporation is not responsible for any provision (export) to those whose purpose is to develop, manufacture, use or store nuclear, biological or chemical weapons, missiles, or other military use.
8. The products described herein are not designed to be used as part of any device or equipment that may affect the human body, human life, or assets (such as medical equipment, disaster prevention systems, security systems, combustion control systems, infrastructure control systems, vehicle equipment, traffic systems, in-vehicle equipment, aviation equipment, aerospace equipment, and nuclear-related equipment), excluding when specified for in-vehicle use or other uses. Do not use those products without the prior written permission of SII Semiconductor Corporation. Especially, the products described herein cannot be used for life support devices, devices implanted in the human body and devices that directly affect human life, etc.  
Prior consultation with our sales office is required when considering the above uses.  
SII Semiconductor Corporation is not responsible for damages caused by unauthorized or unspecified use of our products.
9. Semiconductor products may fail or malfunction with some probability.  
The user of these products should therefore take responsibility to give thorough consideration to safety design including redundancy, fire spread prevention measures, and malfunction prevention to prevent accidents causing injury or death, fires and social damage, etc. that may ensue from the products' failure or malfunction.  
The entire system must be sufficiently evaluated and applied on customer's own responsibility.
10. The products described herein are not designed to be radiation-proof. The necessary radiation measures should be taken in the product design by the customer depending on the intended use.
11. The products described herein do not affect human health under normal use. However, they contain chemical substances and heavy metals and should therefore not be put in the mouth. The fracture surfaces of wafers and chips may be sharp. Take care when handling these with the bare hands to prevent injuries, etc.
12. When disposing of the products described herein, comply with the laws and ordinances of the country or region where they are used.
13. The information described herein contains copyright information and know-how of SII Semiconductor Corporation.  
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14. For more details on the information described herein, contact our sales office.

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