S-19400/19401 Series

AUTOMOTIVE, 125°C OPERATION, 3.8 μA CURRENT CONSUMPTION WATCHDOG TIMER WITH RESET FUNCTION

www.ablicinc.com

Rev.2.2_01

The S-19400/19401 Series is a watchdog timer developed using CMOS technology, which can operate with low current consumption of 3.8 μA 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 ABLIC Inc. is indispensable.**

■ Features

- Detection voltage: 2.0 V to 5.0 V, selectable in 0.1 V step
- Detection voltage accuracy: ±2.0%
- Input voltage: V_{DD} = 0.9 V to 6.0 V
- Hysteresis width: 5% typ.
- Current consumption: 3.8 μA 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[*1]: 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: Ta = −40°C to +125°C
- Lead-free (Sn 100%), halogen-free
- AEC-Q100 qualified[*2]

***1.** The S-19401 Series is fixed to the window mode.
***2.** Contact our sales office for details.

■ Applications

- Automotive (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)

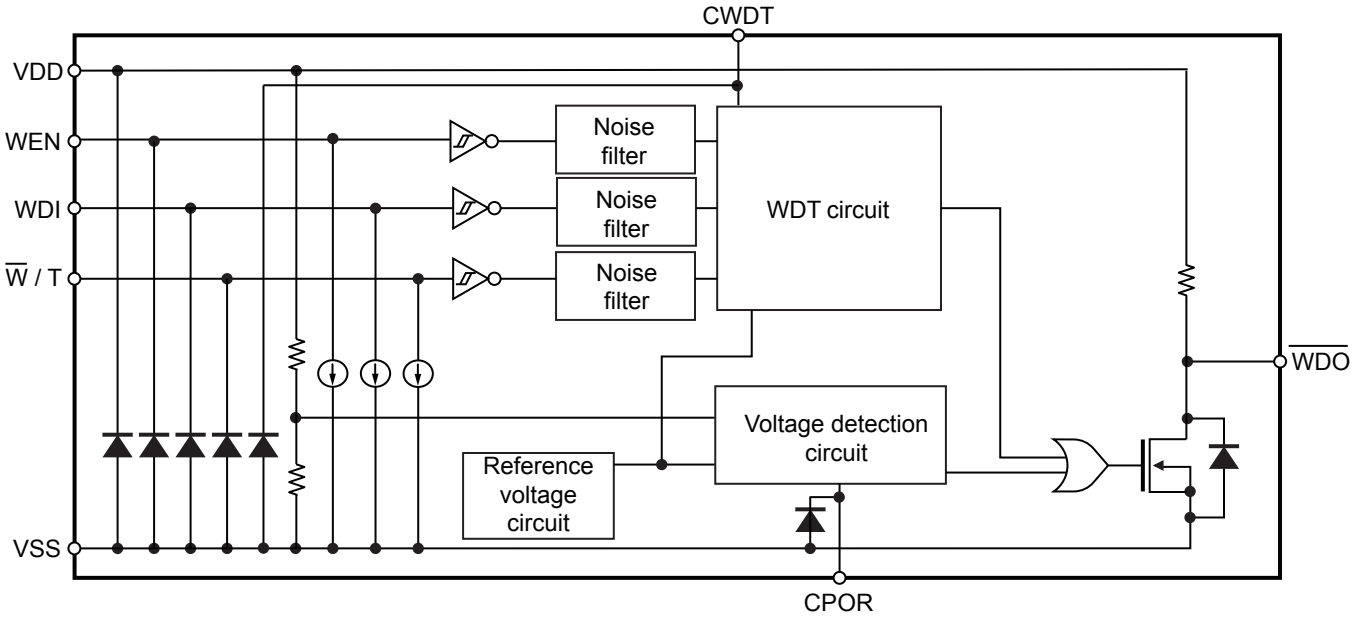


Figure 1

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

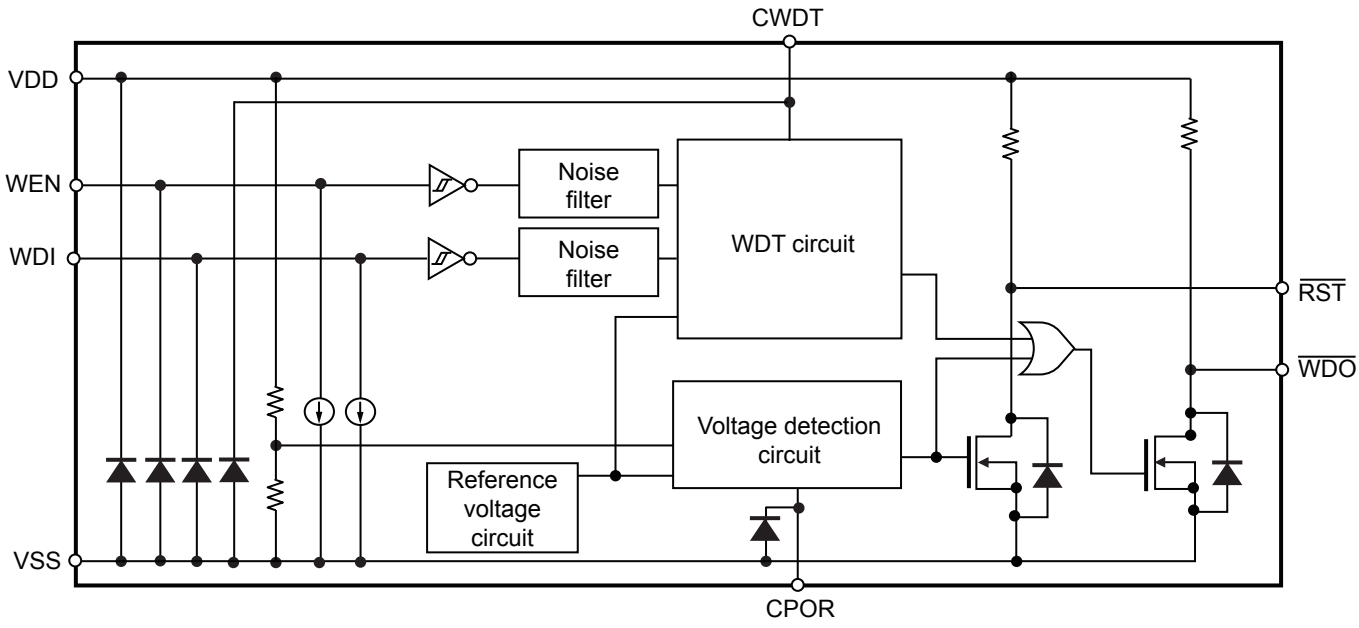


Figure 2

■ 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

S-1940 x x xx A - xxxx U 4

- Environmental code
  - U: Lead-free (Sn 100%), halogen-free
- Package abbreviation and IC packing specifications*1
  - K8T2: TMSOP-8, Tape
  - A8T1: HSNT-8(2030), Tape
- Operation temperature
  - A: Ta = −40°C to +125°C
- Detection voltage
  - 20 to 50
  - (e.g., when the detection voltage is 2.0 V, it is expressed as 20.)
- Product type 1*2
  - A to L
- Product type 2*3
  - 0, 1

***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

Top view

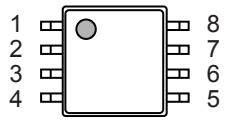


Figure 3

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

Pin No.	Symbol	Description
1	$\overline{W}$ / T*1	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)

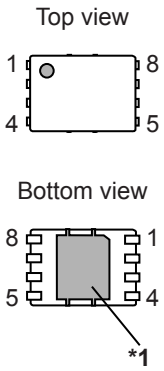


Figure 4

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

Pin No.	Symbol	Description
1	$\overline{W}$ / T*2	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 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 μA 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.

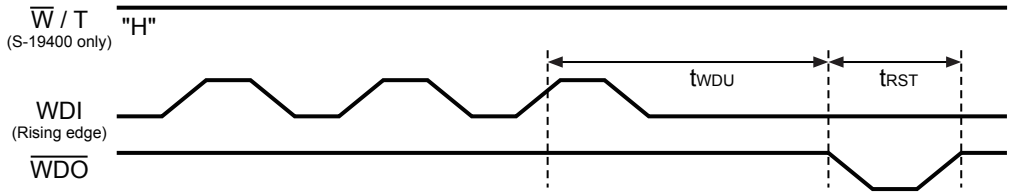


Figure 5 Abnormality Detection in Time-out Mode

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".

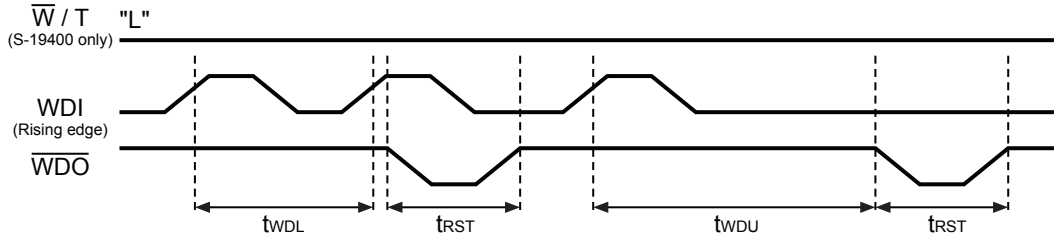


Figure 6 Abnormality Detection in Window Mode

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 μA typ.) is connected to the WEN pin, and it is pulled down internally.

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

This pin combines the reset output and the watchdog output.
Be sure to connect a pull-up resistor to the $\overline{\text{WDO}}$ 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 inputting an edge at an appropriate timing, the WDI pin confirms the normal operation of the monitored object.
The constant current source (0.3 μA 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_{DD}	V_{SS} − 0.3 to V_{SS} + 7.0	V
WDI pin voltage		V_{WDI}	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
WEN pin voltage		V_{WEN}	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
$\overline{W}$ / T pin voltage		$V_{\overline{W}/T}$	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
CPOR pin voltage		V_{CPOR}	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
CWDT pin voltage		V_{CWDT}	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
$\overline{RST}$ pin voltage	A / B / C / D / E / F type	$V_{\overline{RST}}$	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
	G / H / I / J / K / L type		V_{SS} − 0.3 to V_{SS} + 7.0	V
$\overline{WDO}$ pin voltage	A / B / C / D / E / F type	$V_{\overline{WDO}}$	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 7.0	V
	G / H / I / J / K / L type		V_{SS} − 0.3 to V_{SS} + 7.0	V
Operation ambient temperature		T_{opr}	−40 to +125	°C
Storage temperature		T_{stg}	−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	θ_{JA}	TMSOP-8	Board A	−	160	−	°C/W
			Board B	−	133	−	°C/W
			Board C	−	−	−	°C/W
			Board D	−	−	−	°C/W
			Board E	−	−	−	°C/W
		HSNT-8(2030)	Board A	−	181	−	°C/W
			Board B	−	135	−	°C/W
			Board C	−	40	−	°C/W
			Board D	−	42	−	°C/W
			Board E	−	32	−	°C/W

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

Remark Refer to "■ **Power Dissipation**" and "**Test Board**" for details.

■ Electrical Characteristics

Table 9 (1 / 2)

(WEN pin logic active "H" product, V_{DD} = 5.0 V, Ta = −40°C to +125°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	μA	2
Reset time-out period	t_{RST}	C_{POR} = 2200 pF		8.7	14.5	20	ms	3
Watchdog time-out period	t_{WDU}	C_{WDT} = 470 pF		15	24.6	34	ms	3
Watchdog double pulse detection time	t_{WDL}	C_{WDT} = 470 pF		461	769	1077	μs	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}	$V_{\overline{RST}}$ = 0 V, S-19401 Series A / B / C / D / E / F type only		−	−0.85	−0.4	μA	7
Reset output current	I_{ROUT}	V_{DS} = 0.4 V, S-19401 Series only	V_{DD} = 1.5 V	0.48	1.1	−	mA	8
			V_{DD} = 1.8 V	0.8	1.6	−	mA	8
			V_{DD} = 2.5 V	1.0	2.6	−	mA	8
			V_{DD} = 3.0 V	1.4	3.3	−	mA	8
Reset output leakage current	I_{RLEAK}	V_{DS} = 6.0 V, V_{DD} = 6.0 V, S-19401 Series only		−	−	0.096	μA	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}	$V_{\overline{WDO}}$ = 0 V, A / B / C / D / E / F type only		−	−0.85	−0.4	μA	12
Watchdog output current	I_{WOUT}	V_{DS} = 0.4 V	V_{DD} = 1.5 V	0.48	1.1	−	mA	13
			V_{DD} = 1.8 V	0.8	1.6	−	mA	13
			V_{DD} = 2.5 V	1.0	2.6	−	mA	13
			V_{DD} = 3.0 V	1.4	3.3	−	mA	13
Watchdog output leakage current	I_{WLEAK}	V_{DS} = 6.0 V, V_{DD} = 6.0 V		−	−	0.096	μA	14
Input pin voltage 1 "H"	V_{SH1}	WEN pin		0.7 × V_{DD}	−	−	V	15
Input pin voltage 1 "L"	V_{SL1}	WEN pin		−	−	0.3 × V_{DD}	V	15
Input pin voltage 2 "H"	V_{SH2}	$\overline{W}$ / T pin, S-19400 Series only		0.7 × V_{DD}	−	−	V	15
Input pin voltage 2 "L"	V_{SL2}	$\overline{W}$ / T pin, S-19400 Series only		−	−	0.3 × V_{DD}	V	15
Input pin voltage 3 "H"	V_{SH3}	WDI pin		0.7 × V_{DD}	−	−	V	15
Input pin voltage 3 "L"	V_{SL3}	WDI pin		−	−	0.3 × V_{DD}	V	15

Table 9 (2 / 2)

(WEN pin logic active "H" product, V_{DD} = 5.0 V, Ta = −40°C to +125°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 V, Input pin voltage = 6.0 V	A / B / C / G / H / I type	–	0.3	1.0	μA	15
			D / E / F / J / K / L type	−0.1	–	0.1	μA	15
Input pin current 1 "L"	I_{SL1}	WEN pin, V_{DD} = 6.0 V, Input pin voltage = 0 V		−0.1	–	0.1	μA	15
Input pin current 2 "H"	I_{SH2}	$\overline{W}$ / T pin, S-19400 Series only, V_{DD} = 6.0 V, Input pin voltage = 6.0 V		–	0.3	1.0	μA	15
Input pin current 2 "L"	I_{SL2}	$\overline{W}$ / T pin, S-19400 Series only, V_{DD} = 6.0 V, Input pin voltage = 0 V		−0.1	–	0.1	μA	15
Input pin current 3 "H"	I_{SH3}	WDI pin, V_{DD} = 6.0 V, Input pin voltage = 6.0 V		–	0.3	1.0	μA	15
Input pin current 3 "L"	I_{SL3}	WDI pin, V_{DD} = 6.0 V, Input pin voltage = 0 V		−0.1	–	0.1	μA	15
Input pulse width "H"*2	t_{high1}	–		1.5	–	–	μs	15
Input pulse width "L"*2	t_{low1}	–		1.5	–	–	μs	15
Watchdog output delay time	t_{WOUT}	–		–	25	40	μs	3
Reset output delay time	t_{ROUT}	–		–	25	40	μs	3
Input setup time	t_{iset}	–		1.0	–	–	μs	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**".

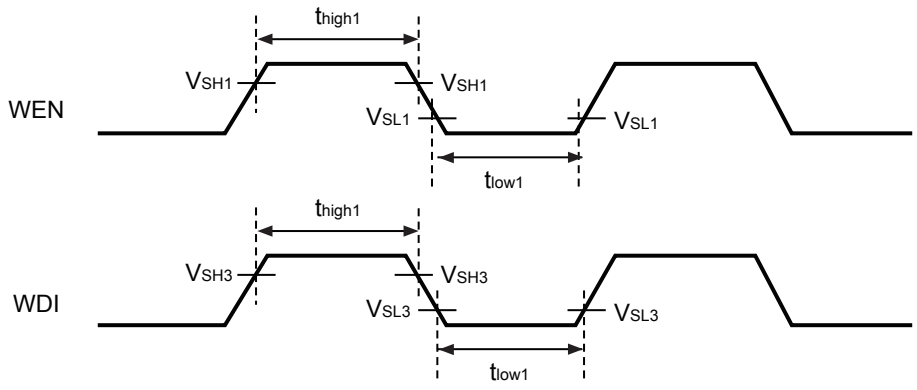


Figure 7

■ Test Circuits

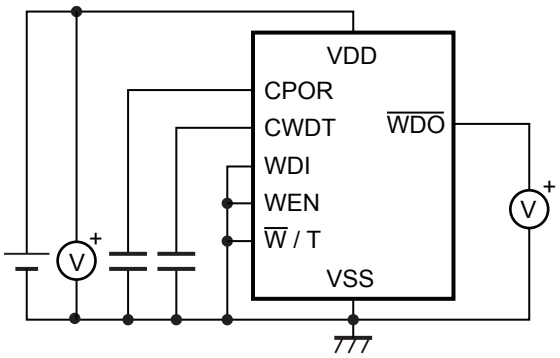


Figure 8 Test Circuit 1

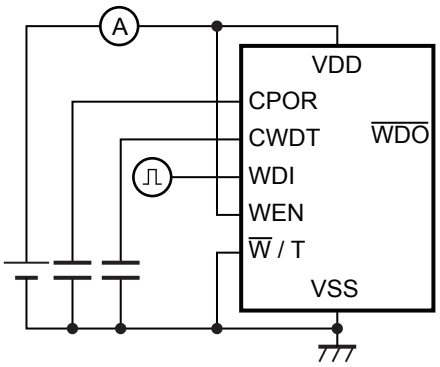


Figure 9 Test Circuit 2

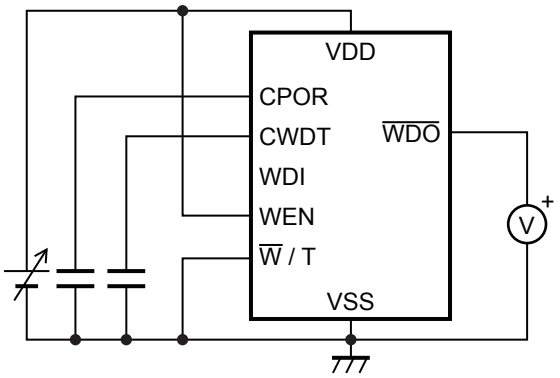


Figure 10 Test Circuit 3

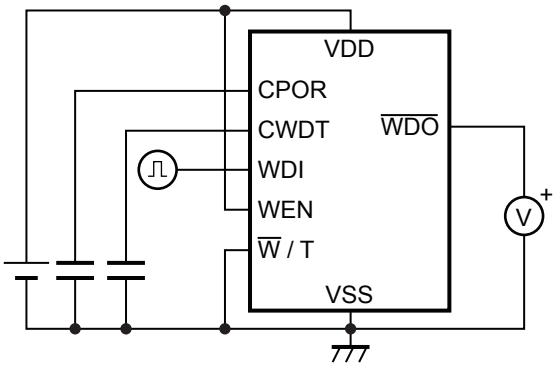


Figure 11 Test Circuit 4

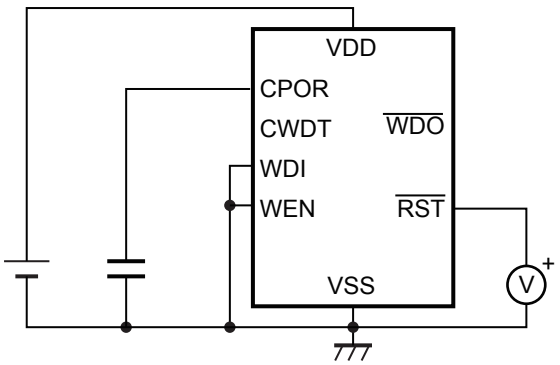


Figure 12 Test Circuit 5

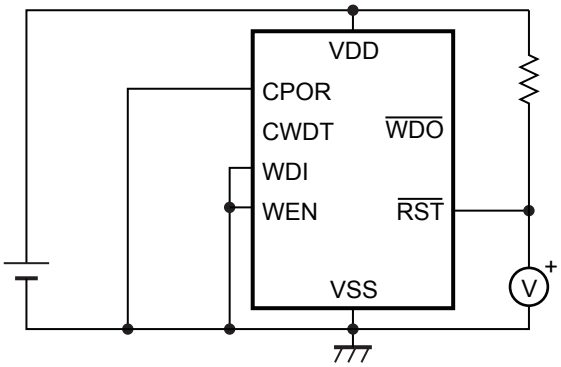


Figure 13 Test Circuit 6

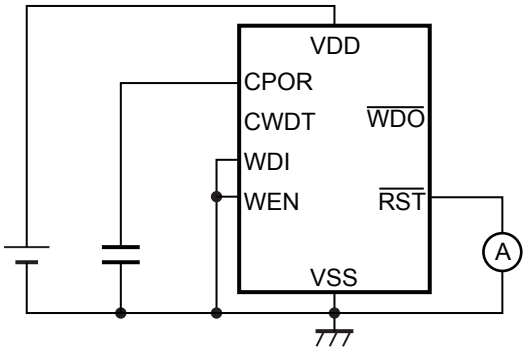


Figure 14 Test Circuit 7

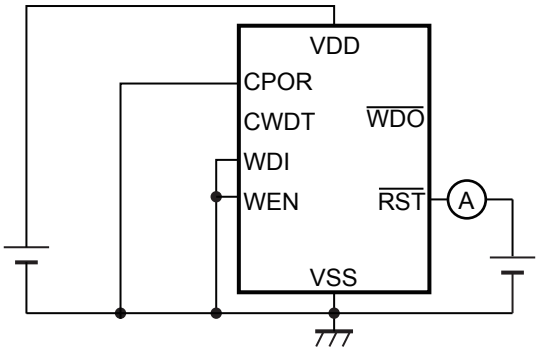


Figure 15 Test Circuit 8

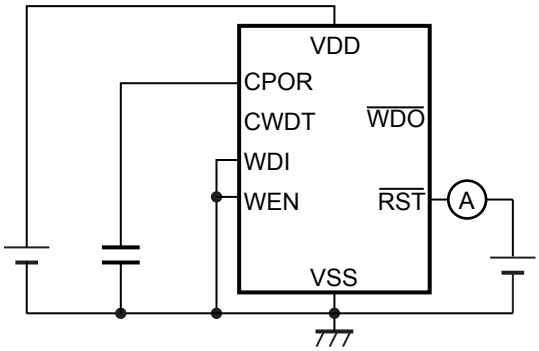


Figure 16 Test Circuit 9

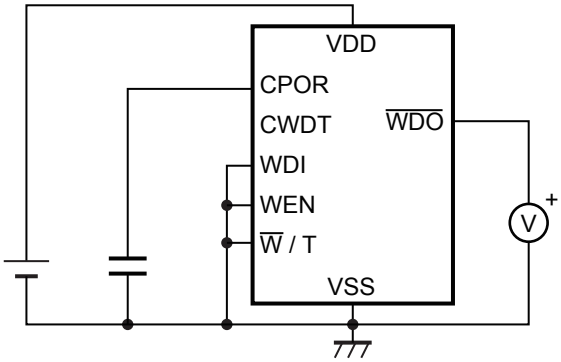


Figure 17 Test Circuit 10

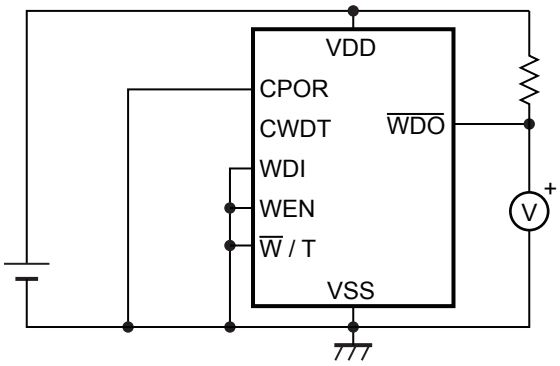


Figure 18 Test Circuit 11

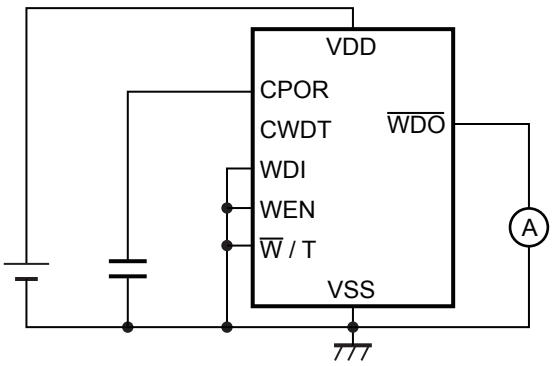


Figure 19 Test Circuit 12

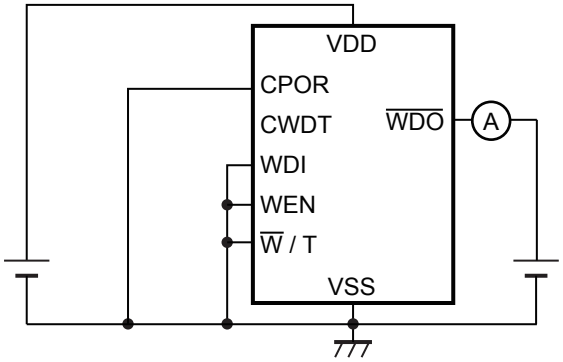


Figure 20 Test Circuit 13

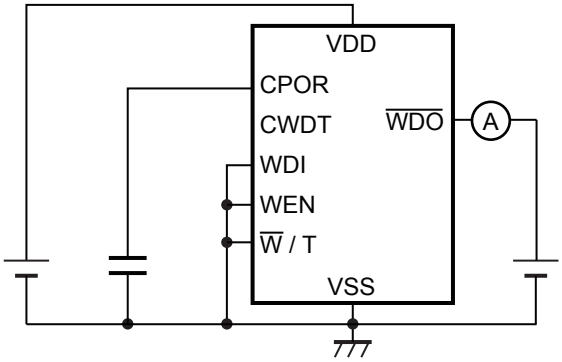


Figure 21 Test Circuit 14

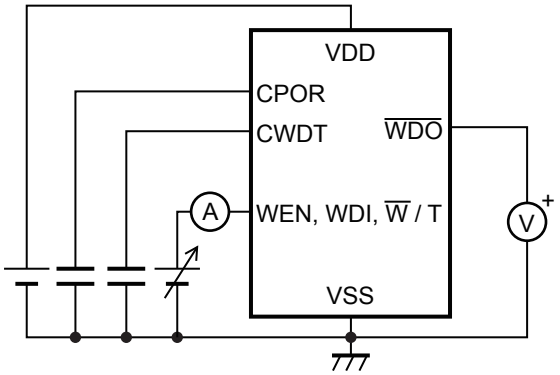
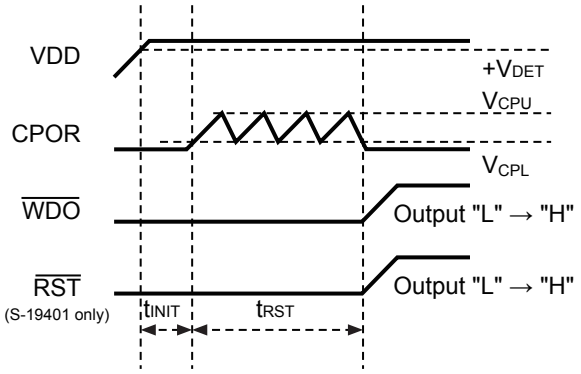


Figure 22 Test Circuit 15

■ 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.

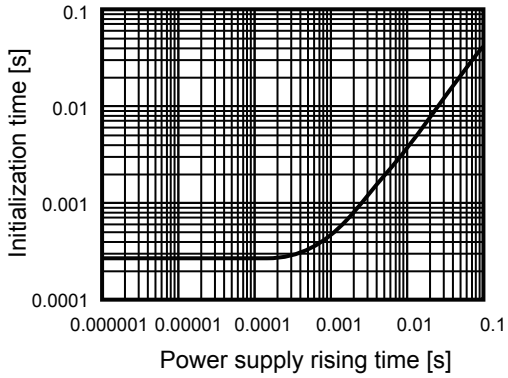
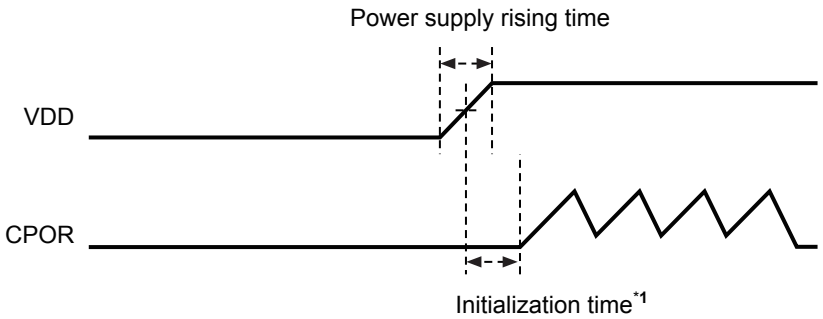


Figure 24 Power Supply Rising Time Dependency of Initialization Time



***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.

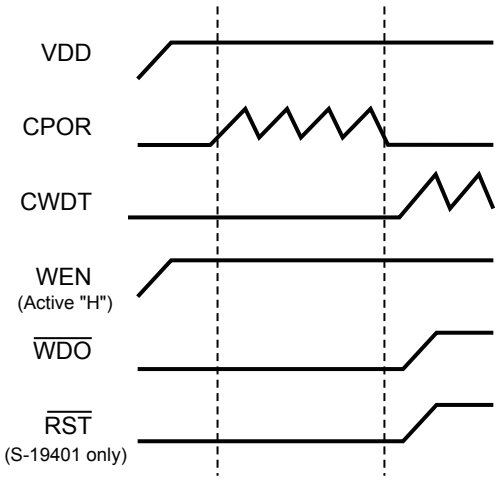


Figure 26 WEN Pin = "H"

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.

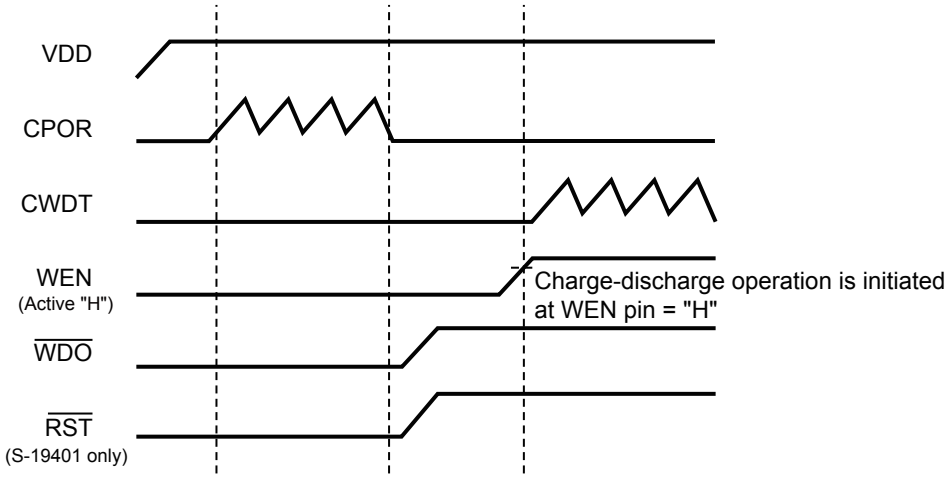


Figure 27 WEN Pin = "L" → "H"

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".

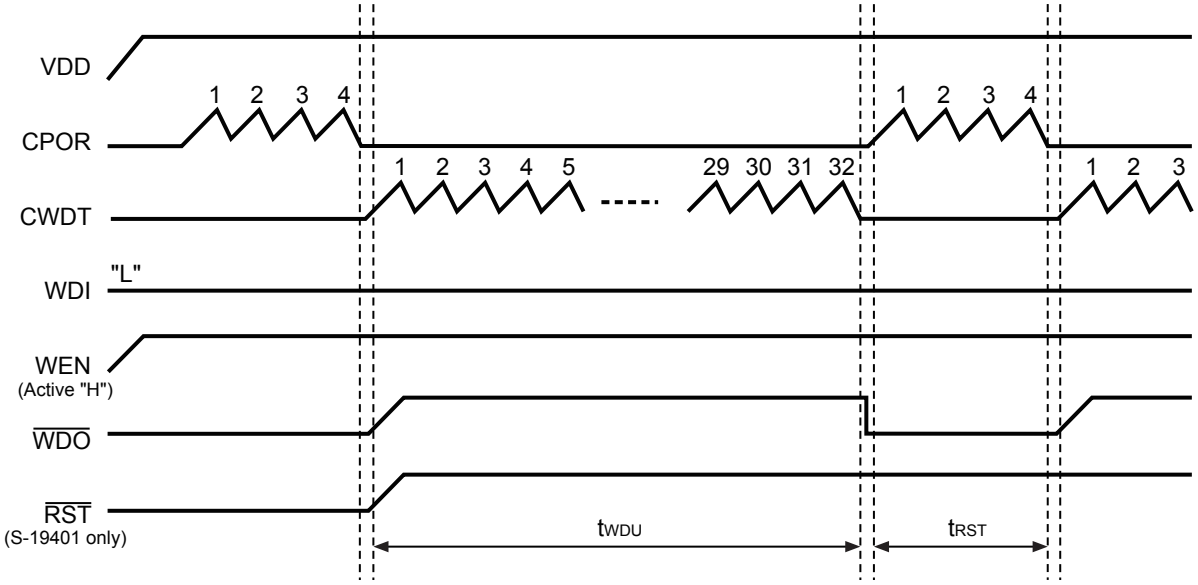


Figure 28

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)

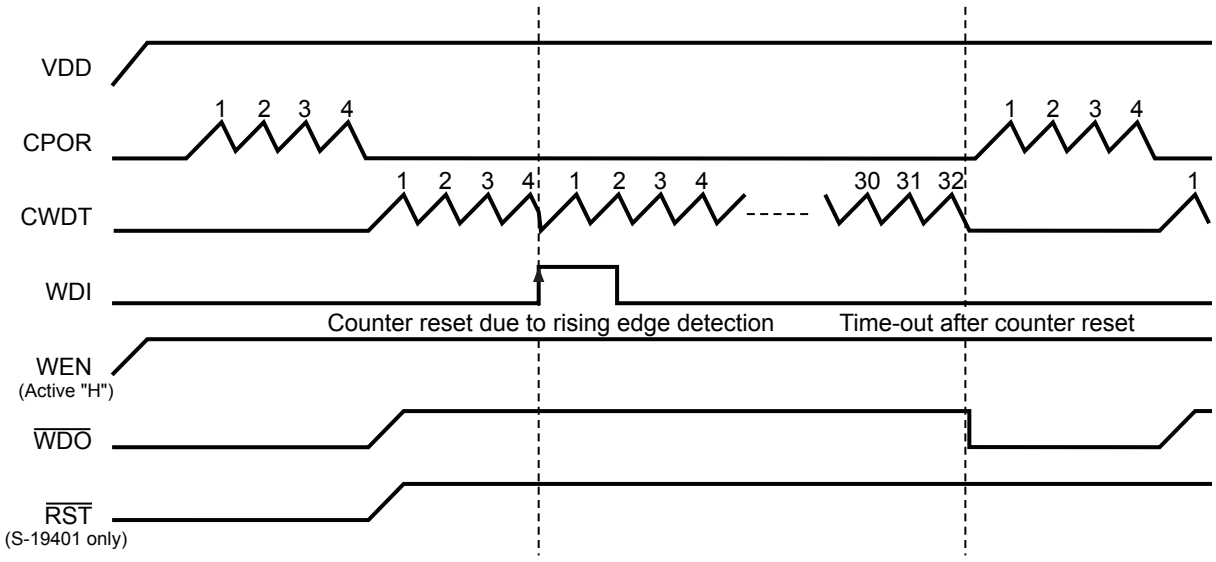


Figure 29

4. 2 Counter reset due to falling edge detection (S-1940xBxxA, S-1940xExxA, S-1940xHxxA, S-1940xKxxA)

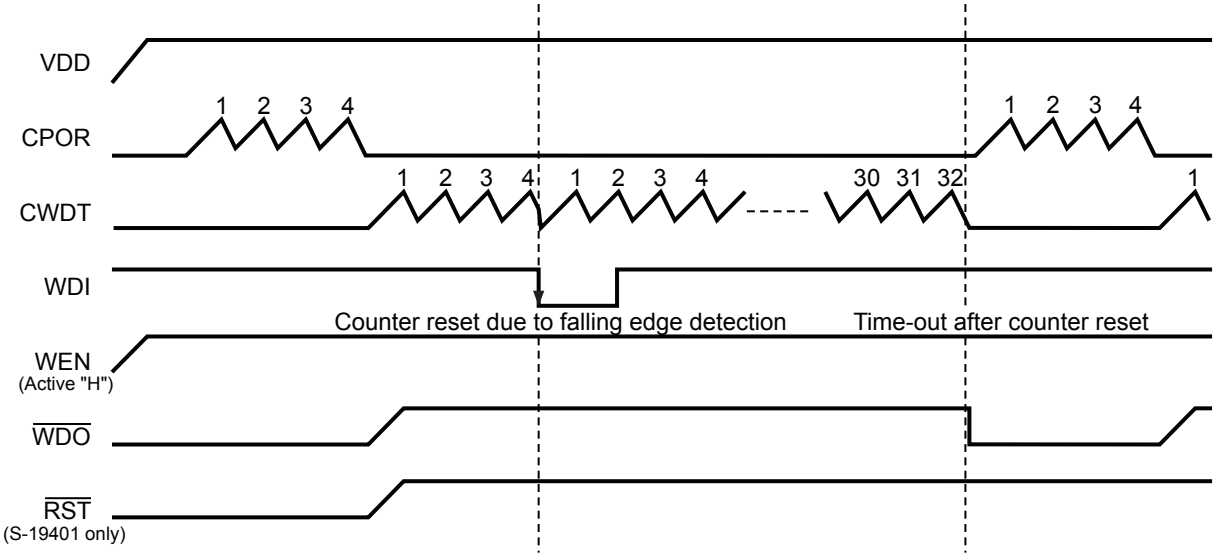


Figure 30

4. 3 Counter reset due to both rising and falling edges detection 1 (S-1940xCxxA, S-1940xFxxA, S-1940xIxxA, S-1940xLxxA)

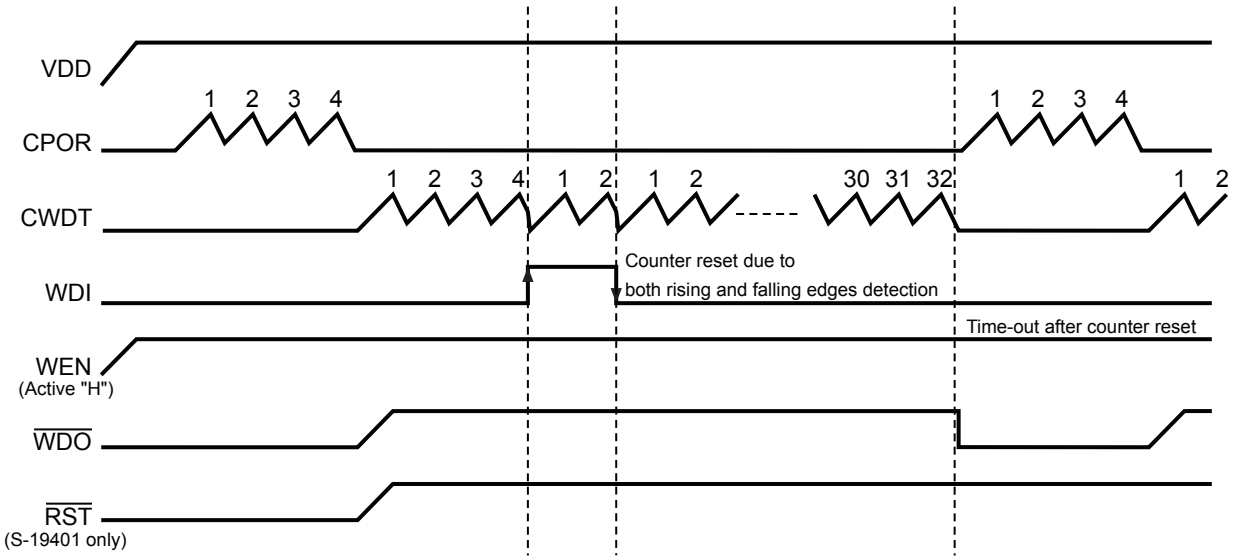


Figure 31

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

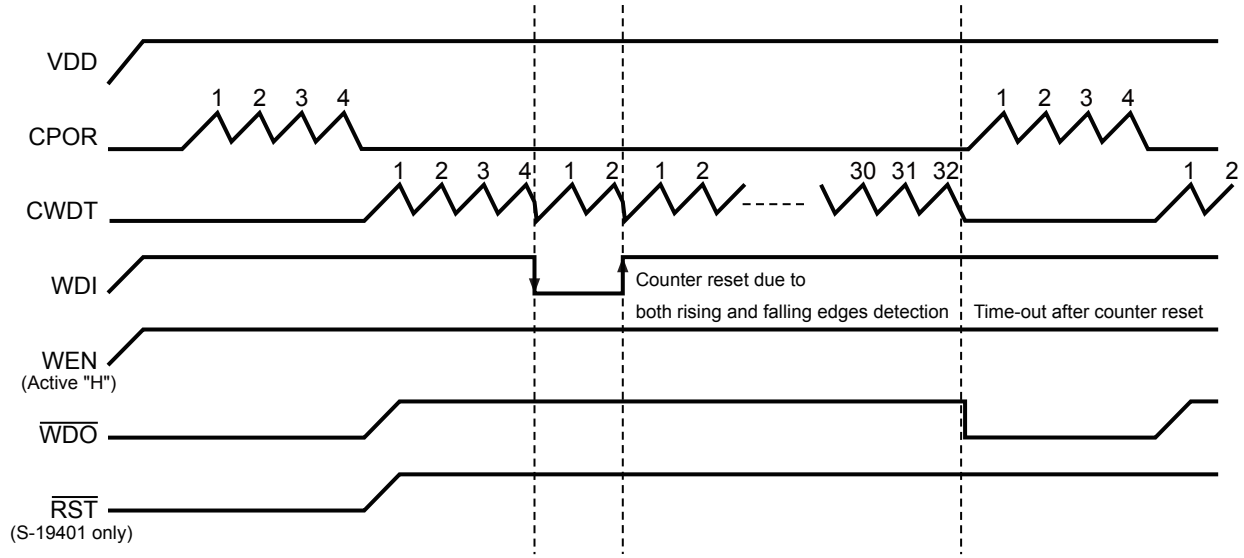


Figure 32

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.

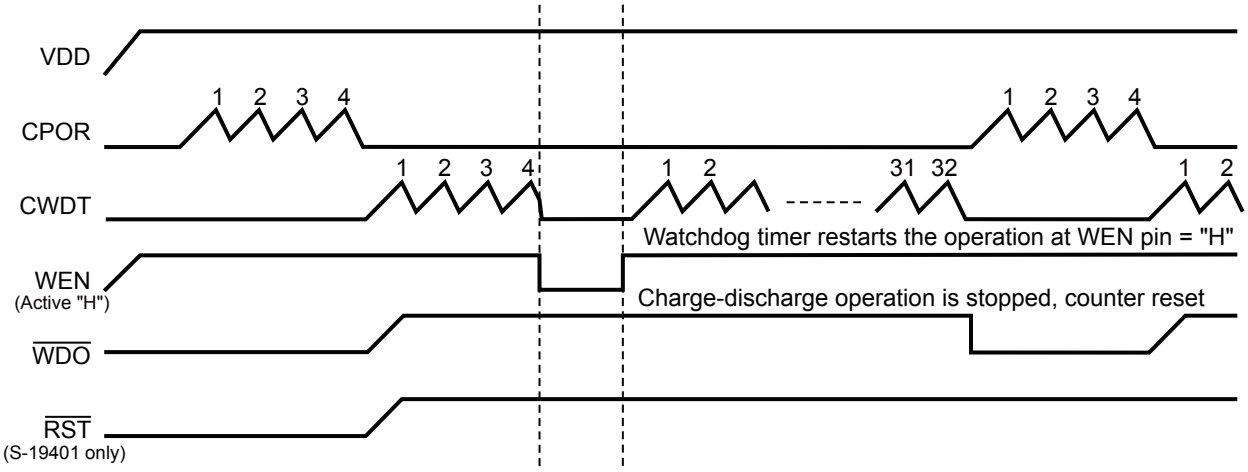


Figure 33

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)

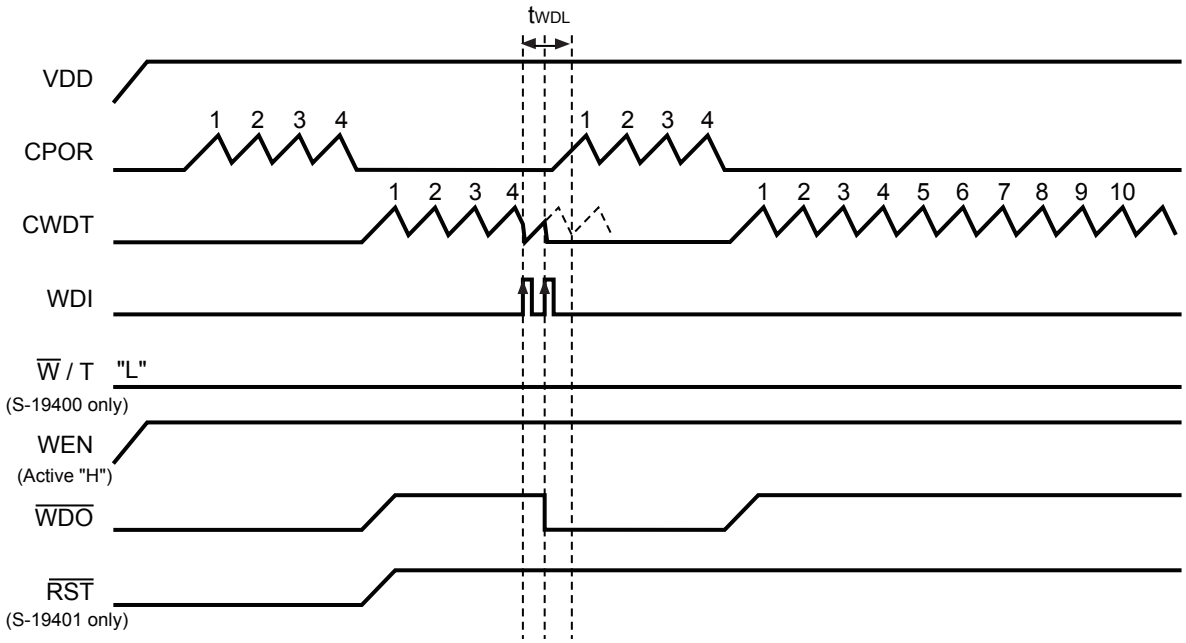


Figure 34

6. 2 Double pulse detection due to falling edge detection (S-1940xBxxA, S-1940xExxA, S-1940xHxxA, S-1940xKxxA)

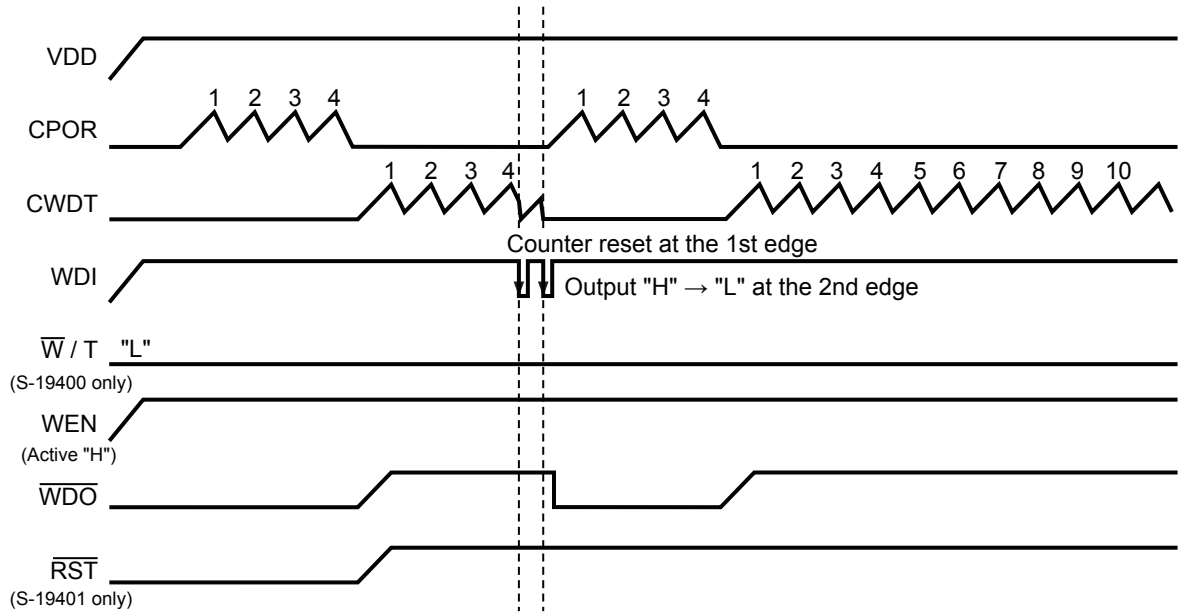


Figure 35

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

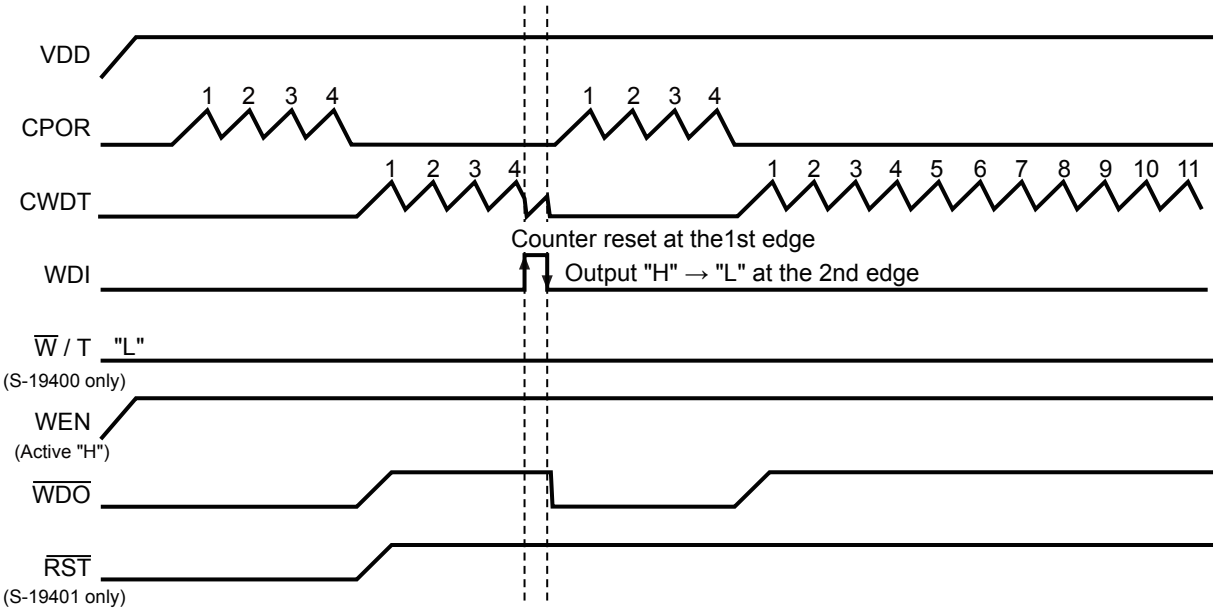


Figure 36 Double Pulse Detection

6. 3. 2 When edges are input to WDI pin in order of falling and rising

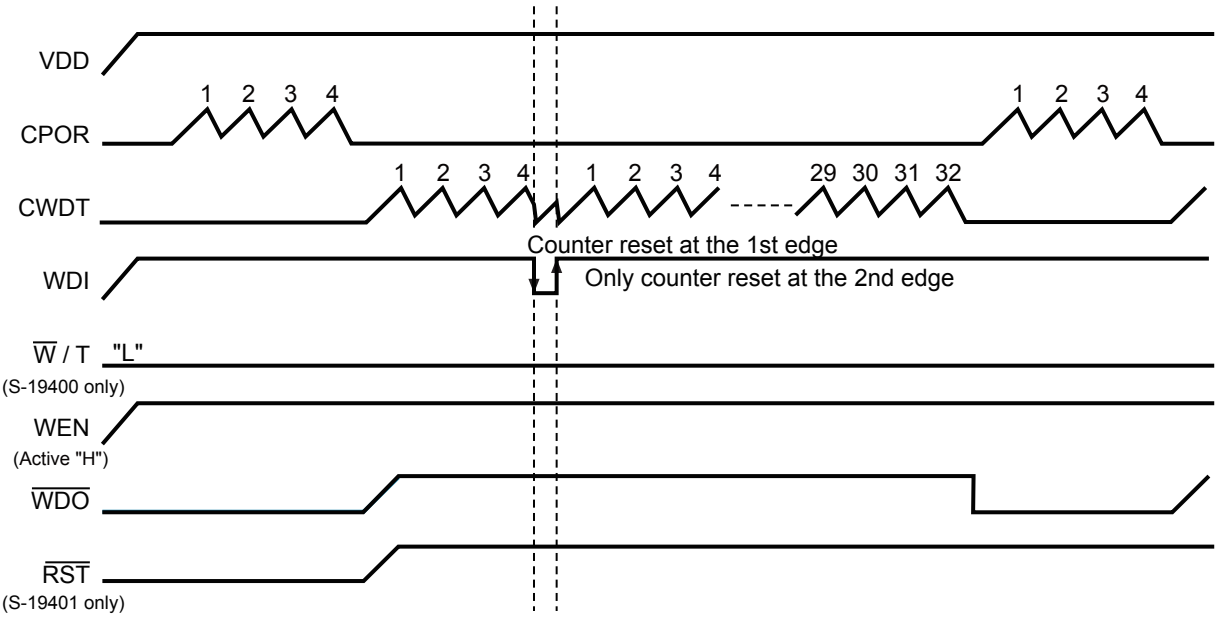


Figure 37 Double Pulse Non-detection

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 $\overline{\text{WDO}}$ pin and the $\overline{\text{RST}}$ 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 $\overline{\text{W}}$ / T pin does not have an affect.

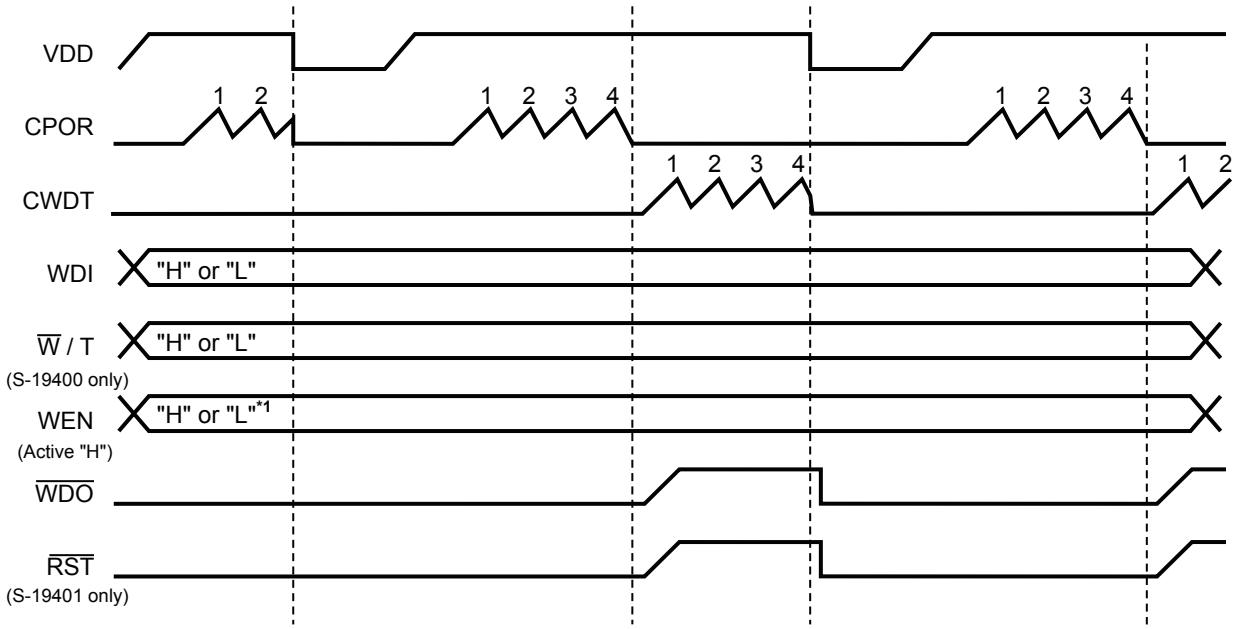


Figure 38

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

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

Each of the WEN pin, the WDI pin and the $\overline{\text{W}}$ / 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)

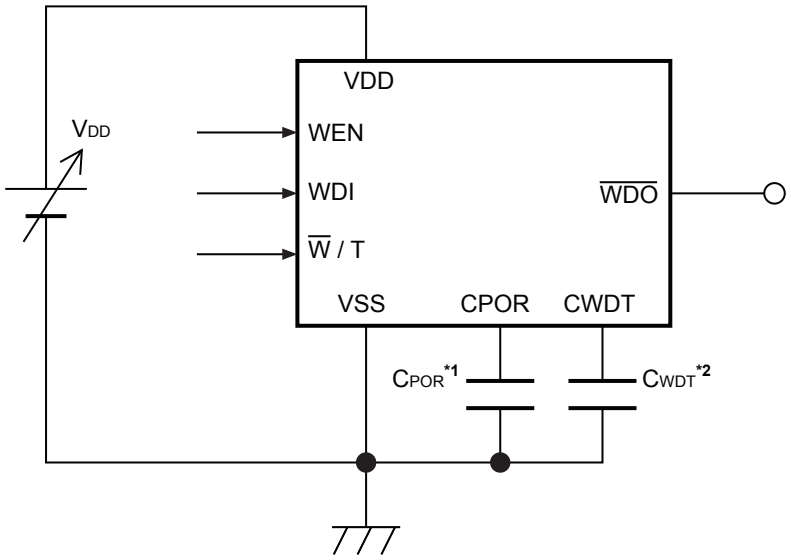


Figure 39

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

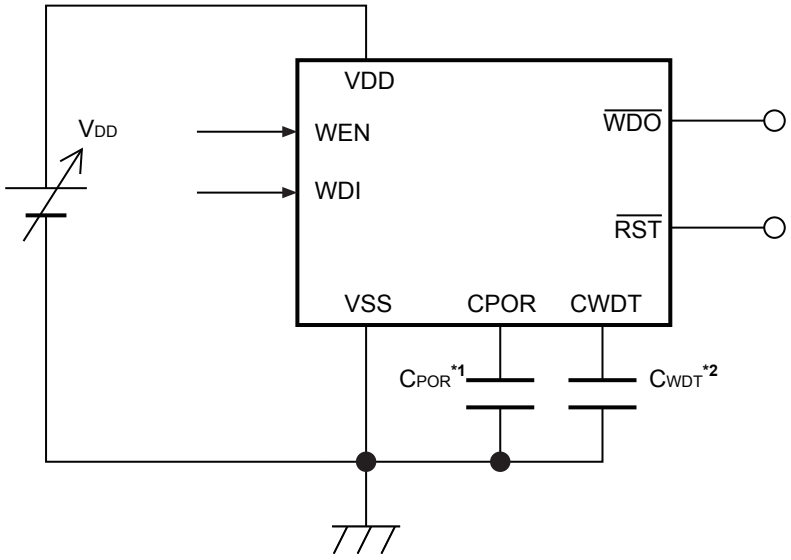


Figure 40

***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 μF 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 μs 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.

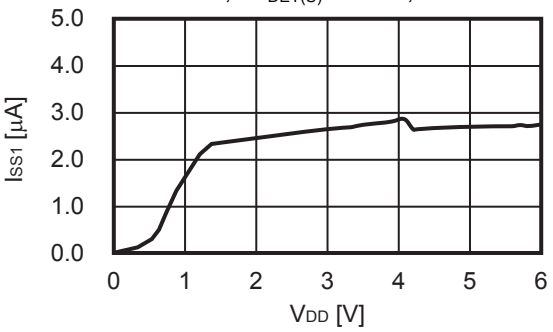
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.

- ABLIC Inc. 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.

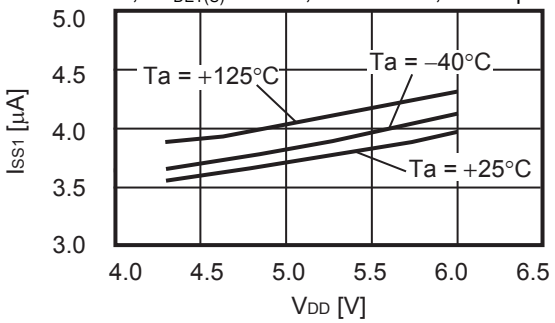
■ Characteristics (Typical Data)

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

WDT = OFF, $-V_{DET(S)}$ = 4.0 V, Ta = +25°C

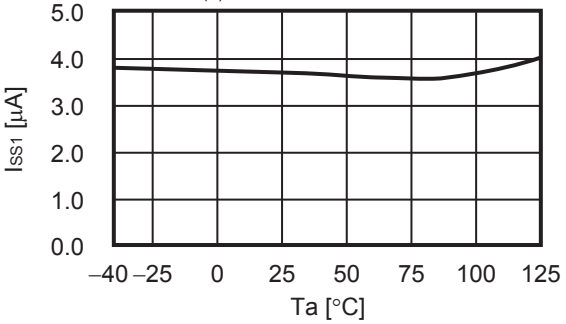


WDT = ON, $-V_{DET(S)}$ = 4.0 V, Ta = +25°C, WDI input



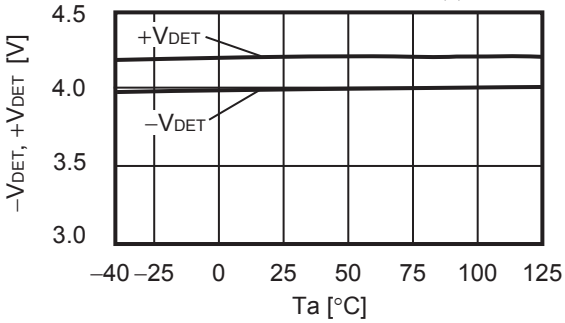
2. Current consumption during operation (I_{SS1}) vs. Temperature (Ta)

WDT = ON, $-V_{DET(S)}$ = 4.0 V, V_{DD} = 5.0 V, WDI input



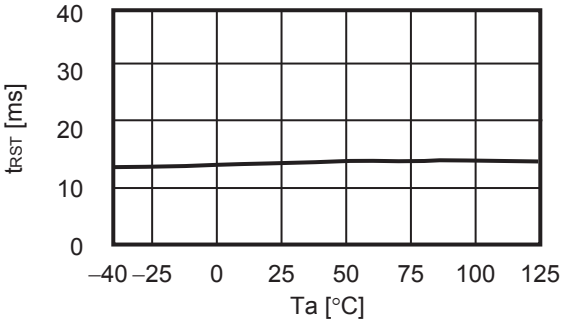
3. Detection voltage ($-V_{DET}$), Release voltage ($+V_{DET}$) vs. Temperature (Ta)

$-V_{DET(S)}$ = 4.0 V



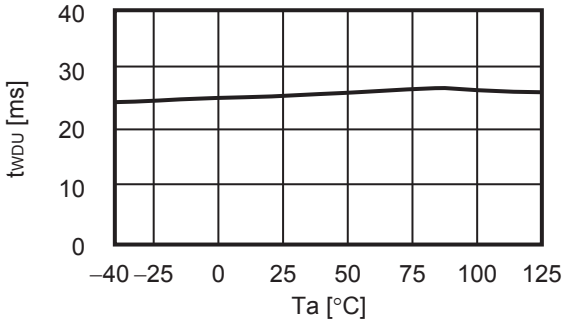
4. Reset time-out period (t_{RST}) vs. Temperature (Ta)

V_{DD} = 5.0 V, C_{POR} = 2200 pF



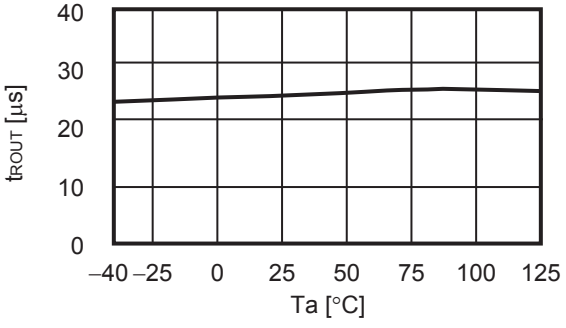
5. Watchdog time-out period (t_{WDU}) vs. Temperature (Ta)

V_{DD} = 5.0 V, C_{WDT} = 470 pF



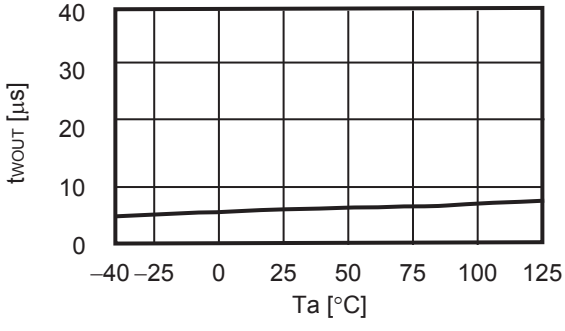
6. Reset output delay time (t_{ROUT}) vs. Temperature (Ta)

V_{DD} = $-V_{DET(S)}$ + 1.0 V → $-V_{DET(S)}$ − 1.0 V,
C_{POR} = 2200 pF

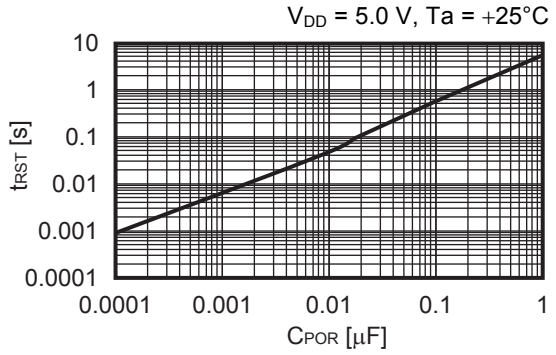


7. Watchdog output delay time (t_{WOUT}) vs. Temperature (Ta)

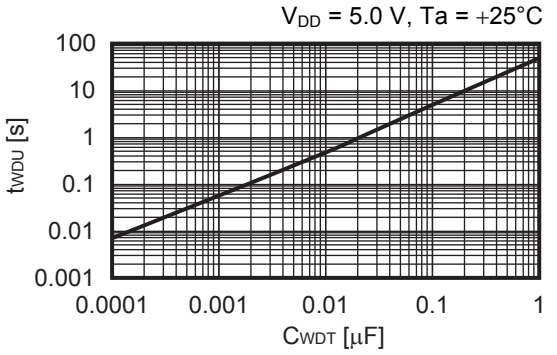
V_{DD} = 5.0 V, C_{WDT} = 470 pF



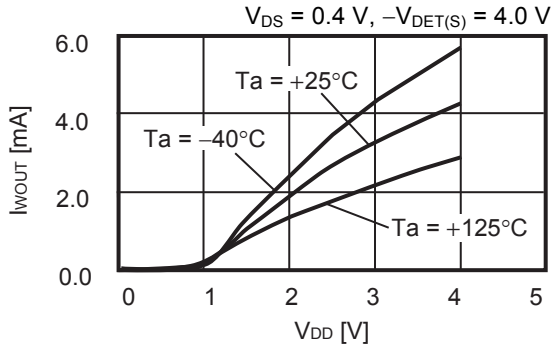
8. Reset time-out period (t_{RST}) vs. C_{POR}



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

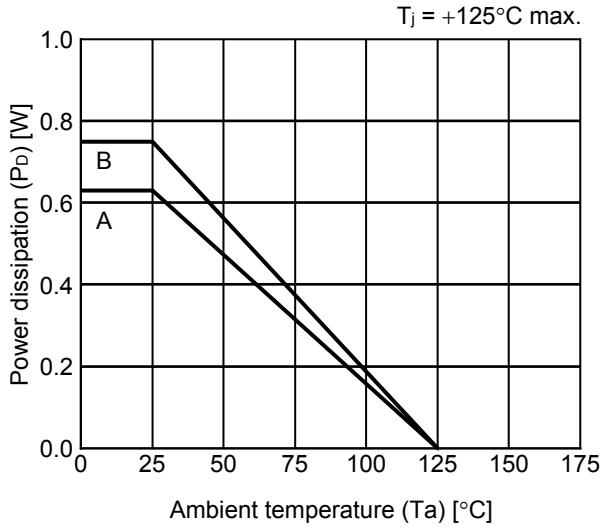


10. Nch driver output current (I_{WOUT}) vs. Input voltage (V_{DD})



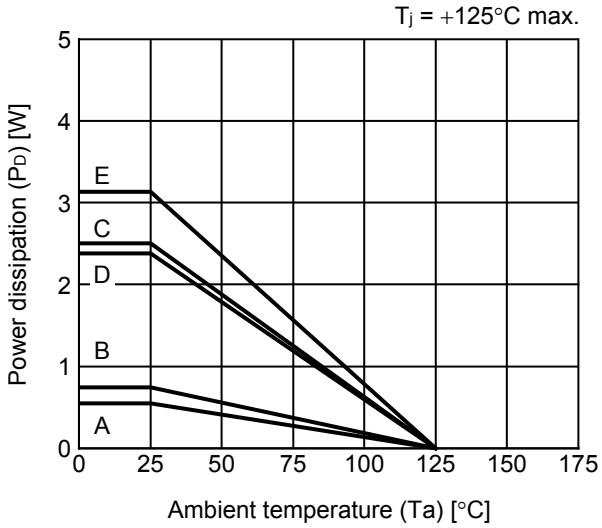
■ Power Dissipation

TMSOP-8



Board	Power Dissipation (P_D)
A	0.63 W
B	0.75 W
C	–
D	–
E	–

HSNT-8(2030)

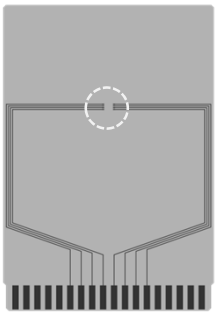


Board	Power Dissipation (P_D)
A	0.55 W
B	0.74 W
C	2.50 W
D	2.38 W
E	3.13 W

TMSOP-8 Test Board

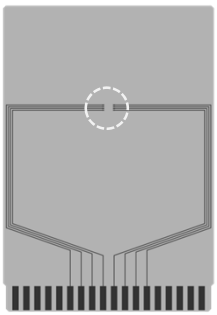
(1) Board A

IC Mount Area



Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



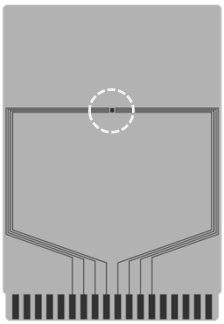
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

No. TMSOP8-A-Board-SD-1.0

HSNT-8(2030) Test Board

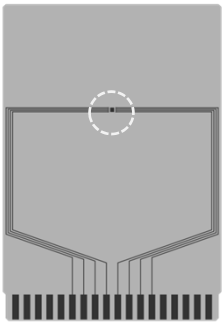
IC Mount Area

(1) Board A



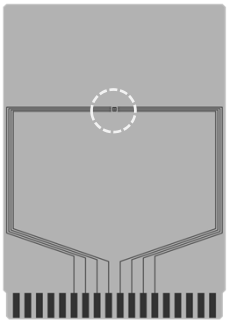
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

(3) Board C



enlarged view

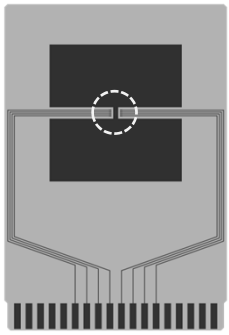
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		Number: 4 Diameter: 0.3 mm

No. HSNT8-A-Board-SD-2.0

HSNT-8(2030) Test Board

IC Mount Area

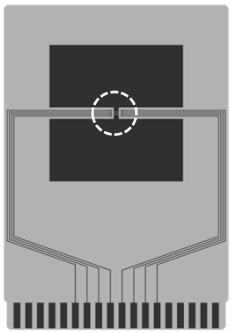
(4) Board D



enlarged view

Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Pattern for heat radiation: 2000mm^2 t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

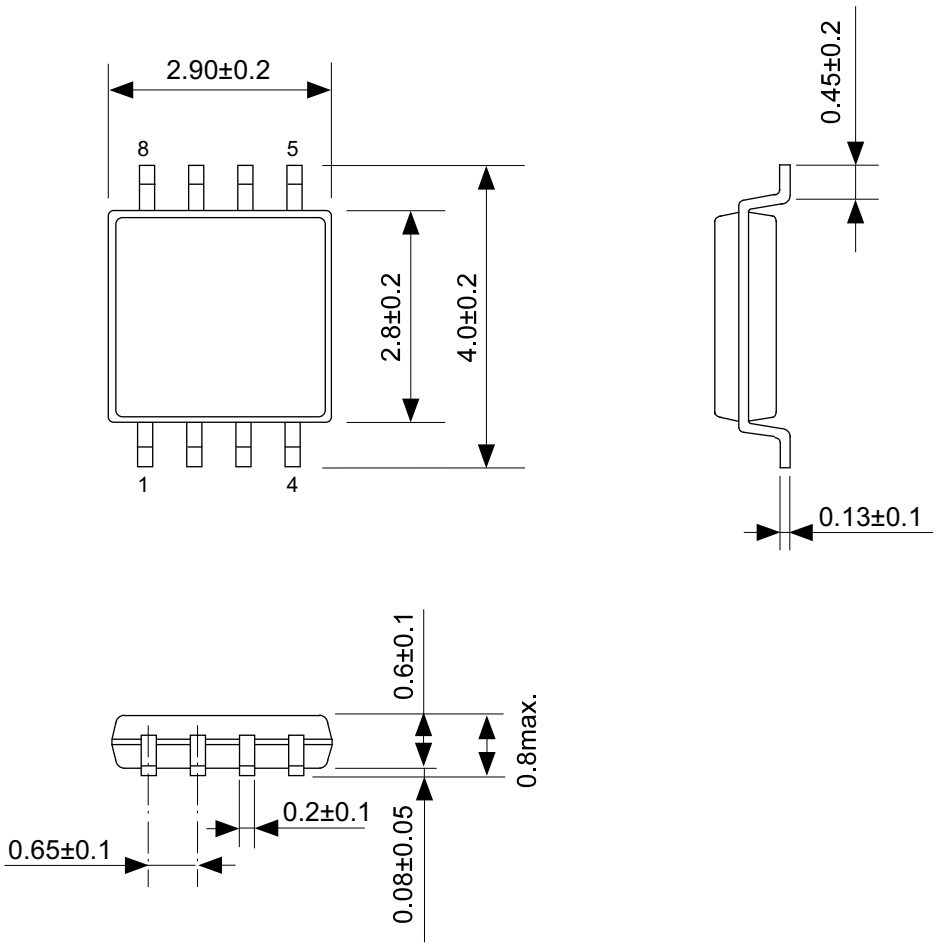
(5) Board E



enlarged view

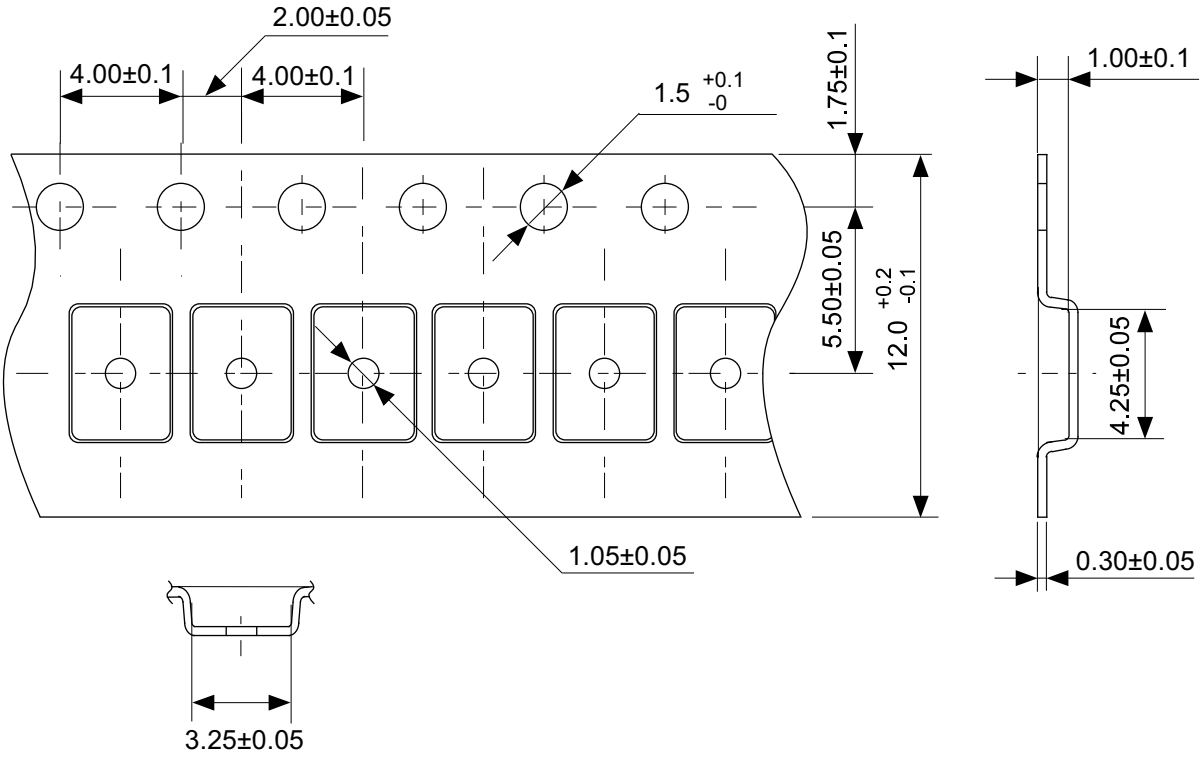
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Pattern for heat radiation: 2000mm^2 t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		Number: 4 Diameter: 0.3 mm

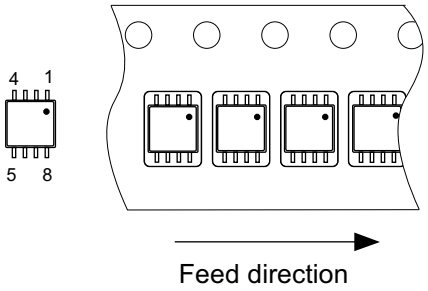
No. HSNT8-A-Board-SD-2.0



No. FM008-A-P-SD-1.2

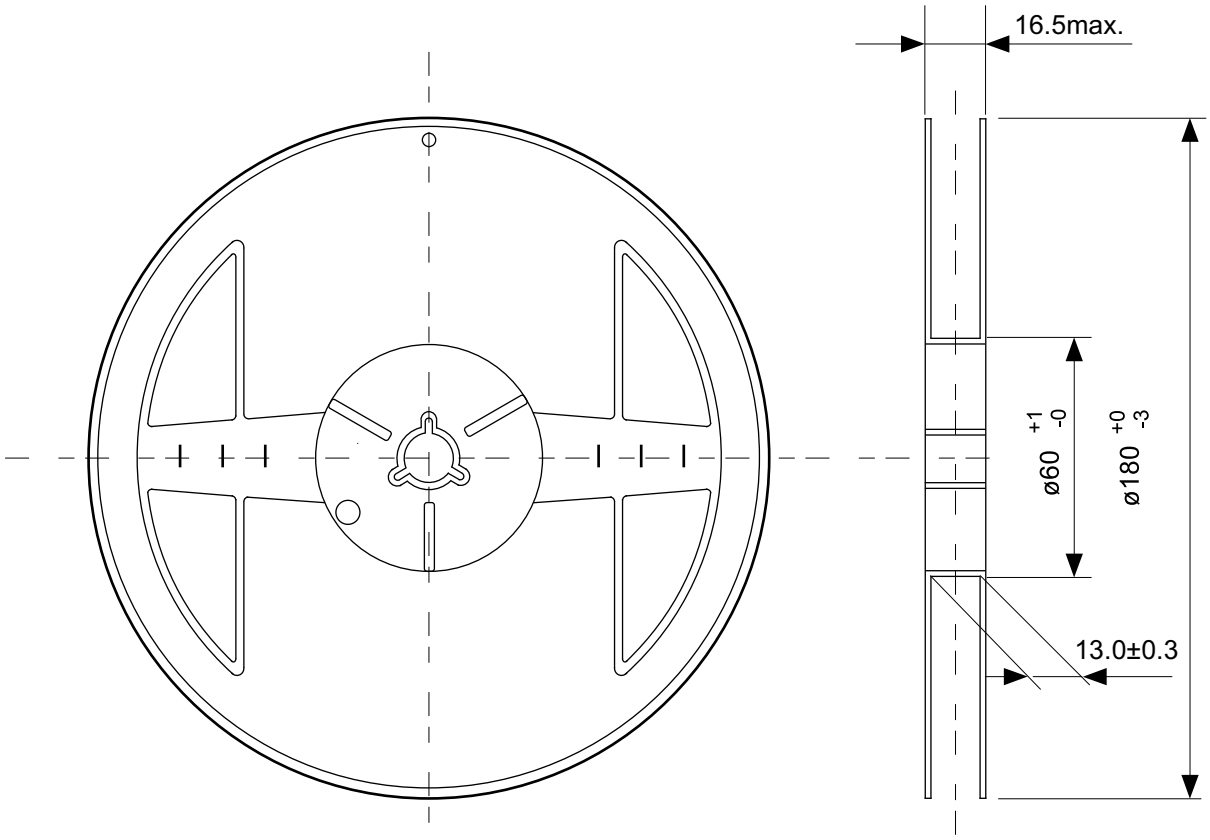
TITLE	TMSOP8-A-PKG Dimensions
No.	FM008-A-P-SD-1.2
ANGLE	
UNIT	mm
ABLIC Inc.	



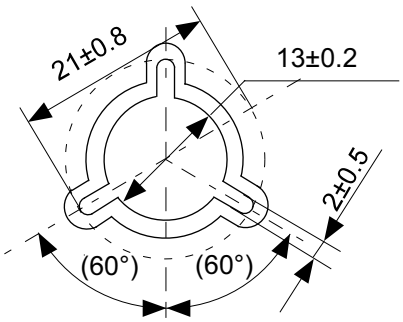


No. FM008-A-C-SD-2.0

TITLE	TMSOP8-A-Carrier Tape
No.	FM008-A-C-SD-2.0
ANGLE	
UNIT	mm
ABLIC Inc.	

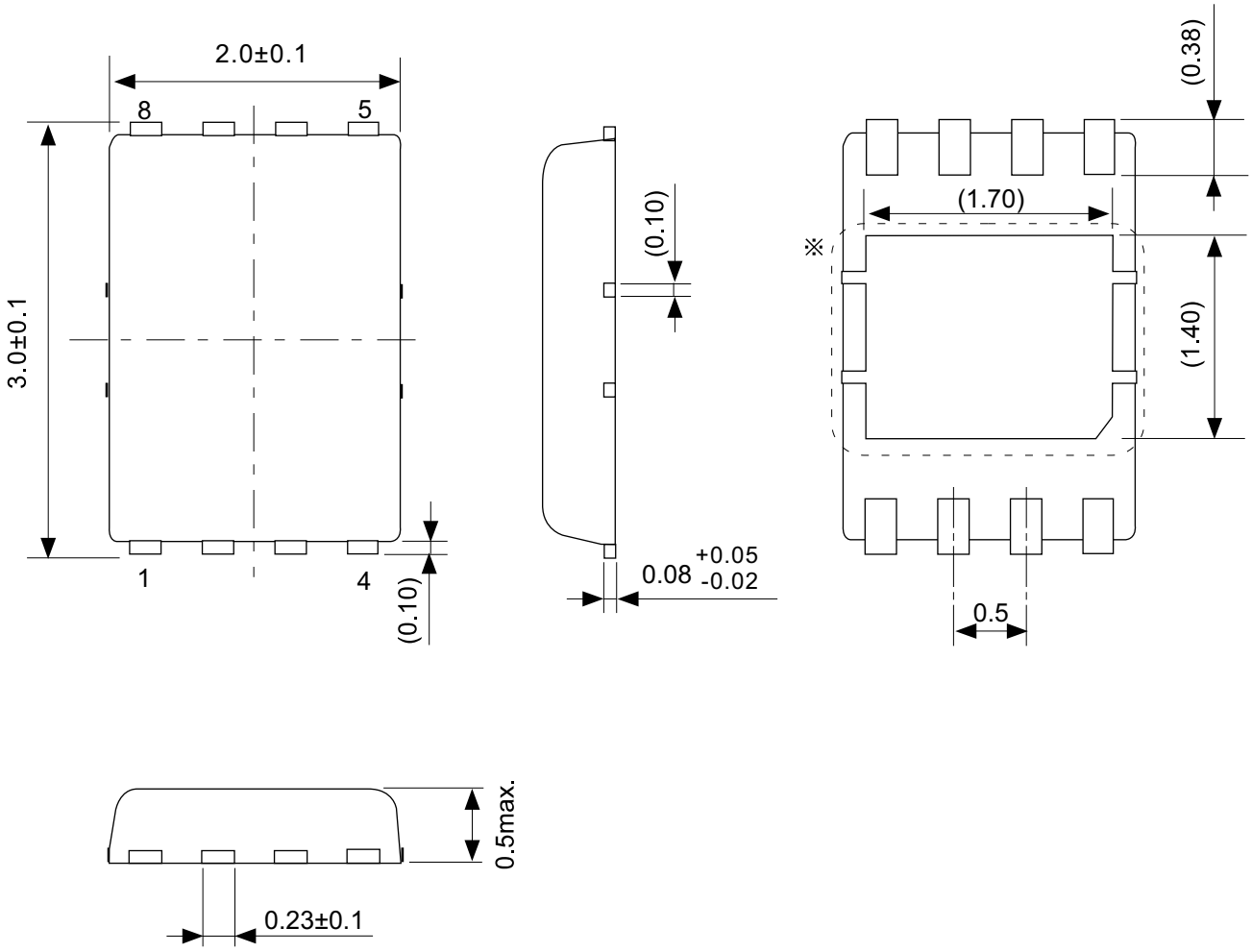


Enlarged drawing in the central part



No. FM008-A-R-SD-1.0

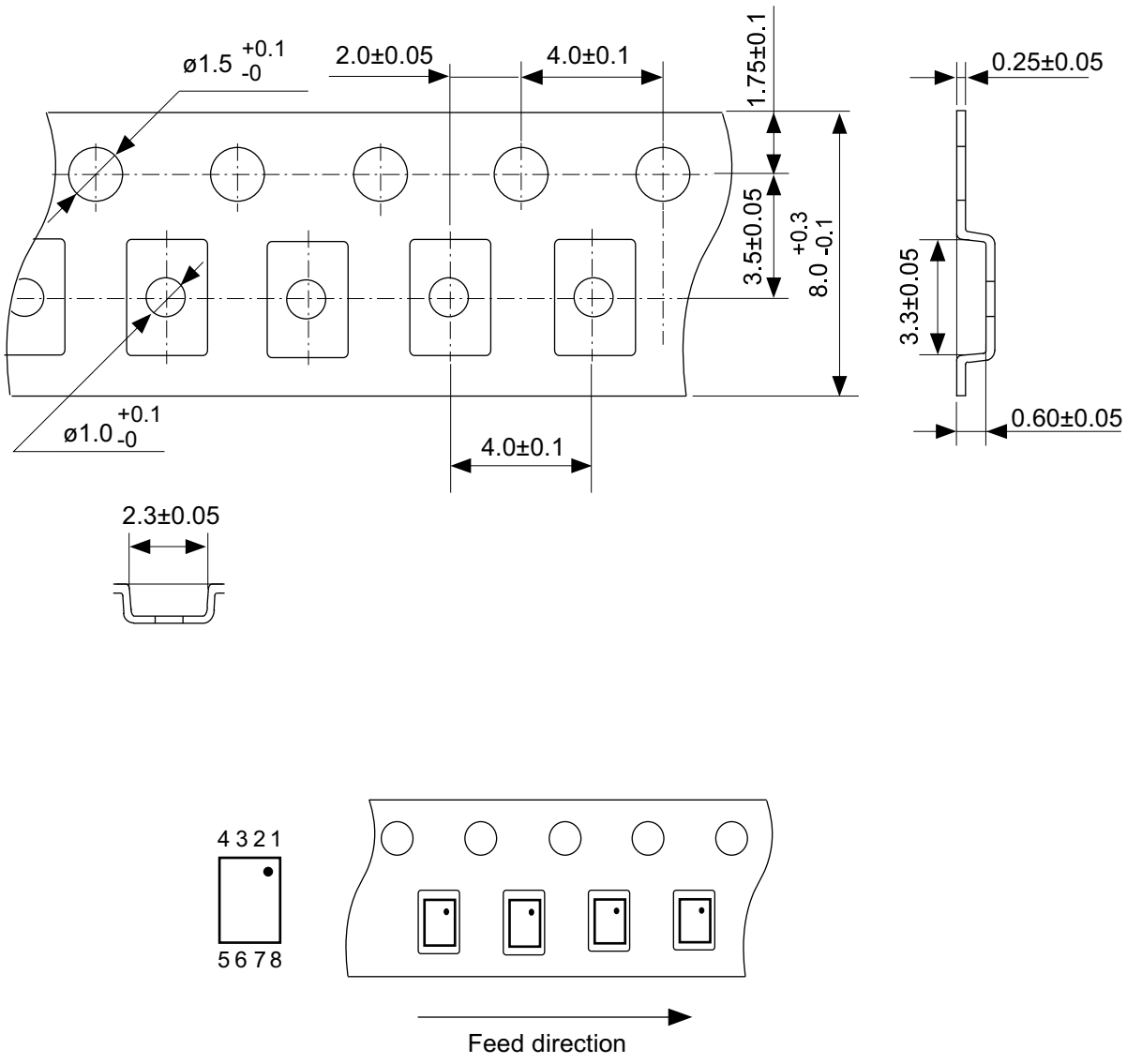
TITLE	TMSOP8-A-Reel		
No.	FM008-A-R-SD-1.0		
ANGLE		QTY.	4,000
UNIT	mm		
ABLIC Inc.			



No. PP008-A-P-SD-2.0

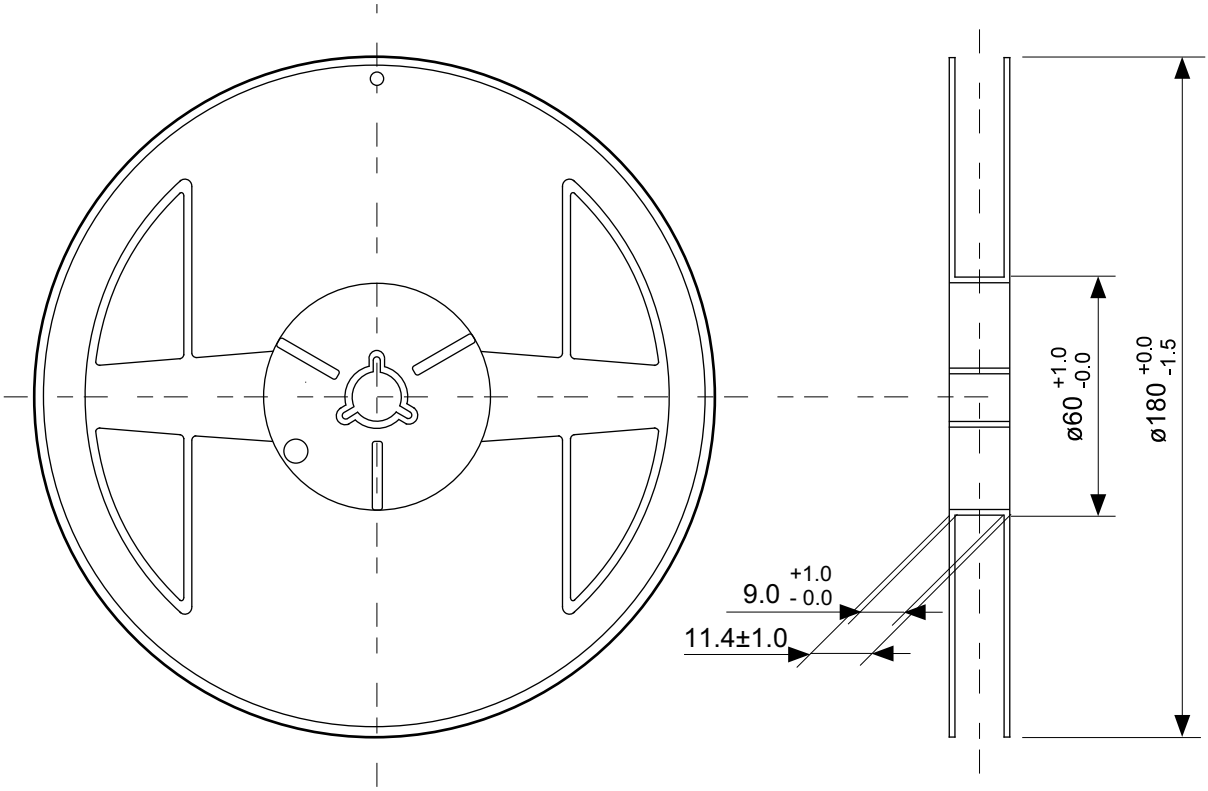
※ The heat sink of back side has different electric potential depending on the product.
Confirm specifications of each product.
Do not use it as the function of electrode.

TITLE	DFN-8/HSNT-8-A-PKG Dimensions
No.	PP008-A-P-SD-2.0
ANGLE	
UNIT	mm
ABLIC Inc.	

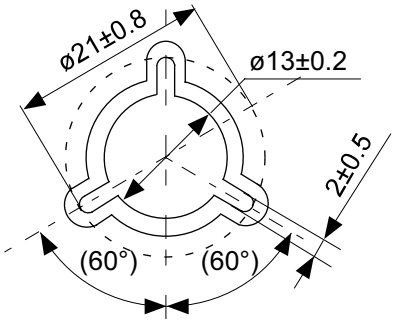


No. PP008-A-C-SD-1.0

TITLE	DFN-8/HSNT-8-A-Carrier Tape
No.	PP008-A-C-SD-1.0
ANGLE	
UNIT	mm
ABLIC Inc.	

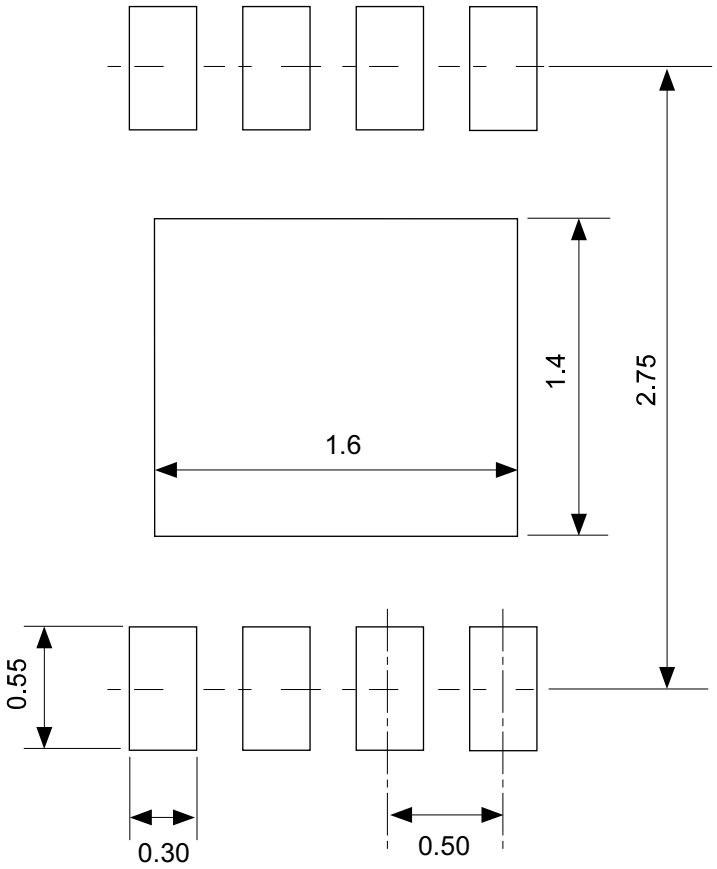


Enlarged drawing in the central part



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		
ABLIC Inc.			



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
ABLIC Inc.	

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