FUJITSU MICROELECTRONICS
DATA SHEET

DS04-27405-2E

ASSP

BIPOLAR

POWER-VOLTAGE MONITORING IC WITH WATCHDOG TIMER

MB3793-45

■ DESCRIPTION

The MB3793 is an integrated circuit to monitor power voltage; it incorporates a watchdog timer.
A reset signal is output when the power is cut or falls abruptly. When the power recovers normally after resetting, a power-on reset signal is output to microprocessor units (MPUs). An internal watchdog timer with two inputs for system operation diagnosis can provide a fail-safe function for various application systems.

Model No.	Marking Code	Detection voltage
MB3793-45	3793-7	4.5 V

■ FEATURES

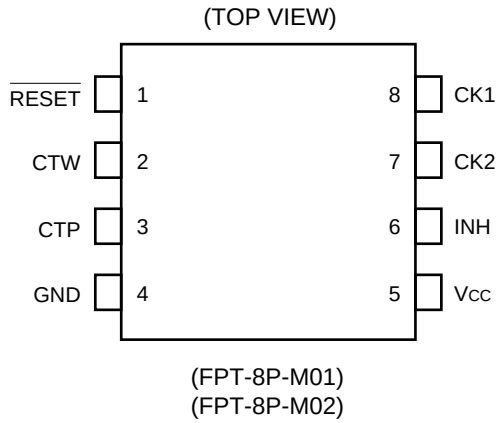
- Precise detection of power voltage fall: ±2.5%
- Detection voltage with hysteresis
- Low power dispersion: I_{CC} = 31 µA (reference)
- Internal dual-input watchdog timer
- Watchdog timer halt function (by inhibition pin)
- Independently-set watchdog and reset times

■ APPLICATION

- Arcade Amusement etc.

2009.9

■ PIN ASSIGNMENT

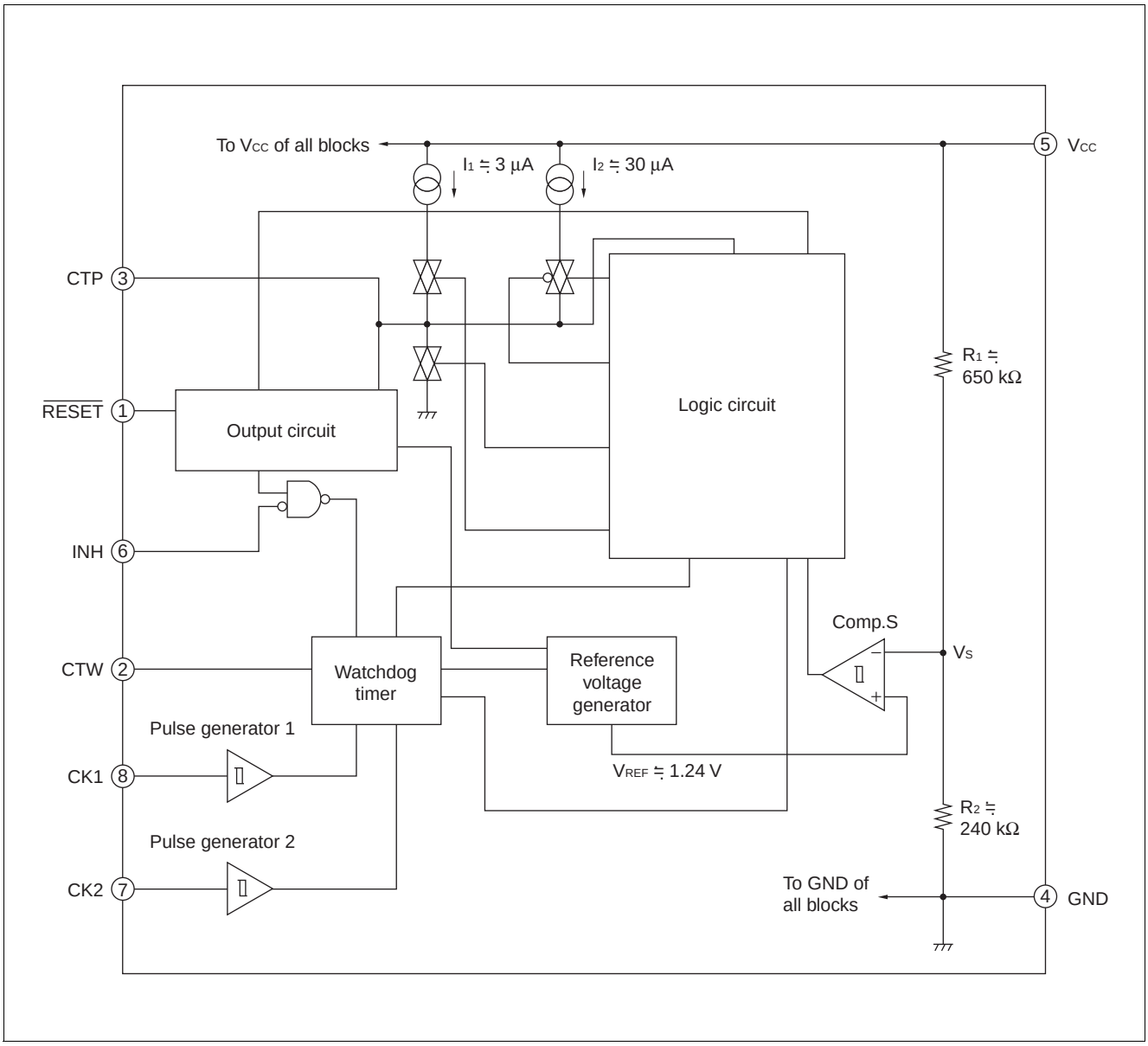


(FPT-8P-M01)
(FPT-8P-M02)

■ PIN DESCRIPTION

Pin No.	Symbol	Description
1	$\overline{\text{RESET}}$	Outputs reset
2	CTW	Sets monitoring time
3	CTP	Sets power-on reset hold time
4	GND	Ground
5	V_{CC}	Power supply
6	INH	Inhibits watchdog timer function
7	CK2	Inputs clock 2
8	CK1	Inputs clock 1

■ BLOCK DIAGRAM



■ BLOCK FUNCTIONS

1. Comp. S

Comp. S is a comparator with hysteresis to compare the reference voltage with a voltage (V_S) that is the result of dividing the power voltage (V_{CC}) by resistors R_1 and R_2. When V_S falls below 1.24 V, a reset signal is output. This function enables the MB3793 to detect an abnormality within 1 µs when the power is cut or falls abruptly.

2. Output circuit

The output circuit has a comparator to control the reset signal ($\overline{RESET}$) output. When the voltage at the CTP pin for setting the power-on reset hold time exceeds the threshold voltage, resetting is canceled.

Since the reset ($\overline{RESET}$) output buffer has the CMOS organization, no pull-up resistor is needed.

3. Pulse generator

The pulse generator generates pulses when the voltage at the CK1 and CK2 input clock pins changes to High from Low level (positive-edge trigger) and exceeds the threshold voltage; it sends the clock signal to the watchdog timer.

4. Watchdog timer

The watchdog timer can monitor two clock pulses. Short-circuit the CK1 and CK2 clock pins to monitor a single clock pulse.

5. Inhibition pin

The inhibition (INH) pin forces the watchdog timer on/off. When this pin is High level, the watchdog timer is stopped.

6. Logic circuit

Logic circuit controls charging and discharging of the power-on reset hold time setting capacity (C_{TP}) on a signal of Comp.S and Watchdog timer.

■ ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Conditions	Rating		Unit
				Min	Max	
Power supply voltage*		V_{CC}	—	–0.3	+7	V
Input voltage*	CK1	V_{CK1}	—	–0.3	V_{CC} + 0.3 (≤ +7)	V
	CK2	V_{CK2}	—			
	INH	I_{INH}	—			
Reset output voltage*	$\overline{\text{RESET}}$	V_{OL} V_{OH}	—	–0.3	V_{CC} + 0.3 (≤ +7)	V
Reset output current		I_{OL} I_{OH}	—	–10	+10	mA
Power dissipation		P_D	Ta ≤ +85 °C	—	200	mW
Storage temperature		Tstg	—	–55	+125	°C

* : The voltage is based on the ground voltage (0 V).

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power supply voltage	V_{CC}	—	1.2	5.0	6.0	V
Reset ($\overline{\text{RESET}}$) output current	I_{OL}	—	0	—	+ 5	mA
	I_{OH}	—	–5	—	0	
Power-on reset hold time setting capacity	C_{TP}	—	0.001	0.1	10	µF
Watchdog-timer monitoring time setting capacity*	C_{TW}	—	0.001	0.01	1	µF
Operating ambient temperature	Ta	—	–40	+25	+85	°C

* : The watchdog timer monitor time range depends on the rating of the setting capacitor.

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their representatives beforehand.

■ ELECTRICAL CHARACTERISTICS

1. DC Characteristics

(V_{CC} = +5 V, Ta = +25°C)

Parameter	Symbol	Conditions		Value			Unit
				Min	Typ	Max	
Power current	I_{CC1}	After exit from reset		—	31	45	µA
Detection voltage	V_{SL}	V_{CC} falling	Ta = +25°C	4.40	4.50	4.60	V
			Ta = –40 to +85°C	4.35*	4.50	4.65*	
	V_{SH}	V_{CC} rising	Ta = +25°C	4.50	4.60	4.70	V
			Ta = –40 to +85°C	4.45*	4.60	4.75*	
Detection voltage hysteresis difference	V_{SHYS}	V_{SH} - V_{SL}		50	100	150	mV
CK input threshold voltage	V_{CIH}	—		1.4*	1.9	2.5	V
	V_{CIL}	—		0.8	1.3	1.8*	V
CK input hysteresis	V_{CHYS}	—		0.4*	0.6	0.8*	V
INH input voltage	V_{IIH}	—		3.5	—	V_{CC}	V
	V_{IIL}	—		0	—	0.8	V
Input current (CK1,CK2,INH)	I_{IH}	V_{CK} = V_{CC}		—	0	1.0	µA
	I_{IL}	V_{CK} = 0 V		–1.0	0	—	µA
Reset output voltage	V_{OH}	$I_{\overline{RESET}}$ = –5 mA		4.5	4.75	—	V
	V_{OL}	$I_{\overline{RESET}}$ = +5 mA		—	0.12	0.4	V
Reset-output minimum power voltage	V_{CCL}	$I_{\overline{RESET}}$ = +50 µA		—	0.8	1.2	V

* : This parameter is guaranteed by design, which is not supported by a final test.

2. AC Characteristics

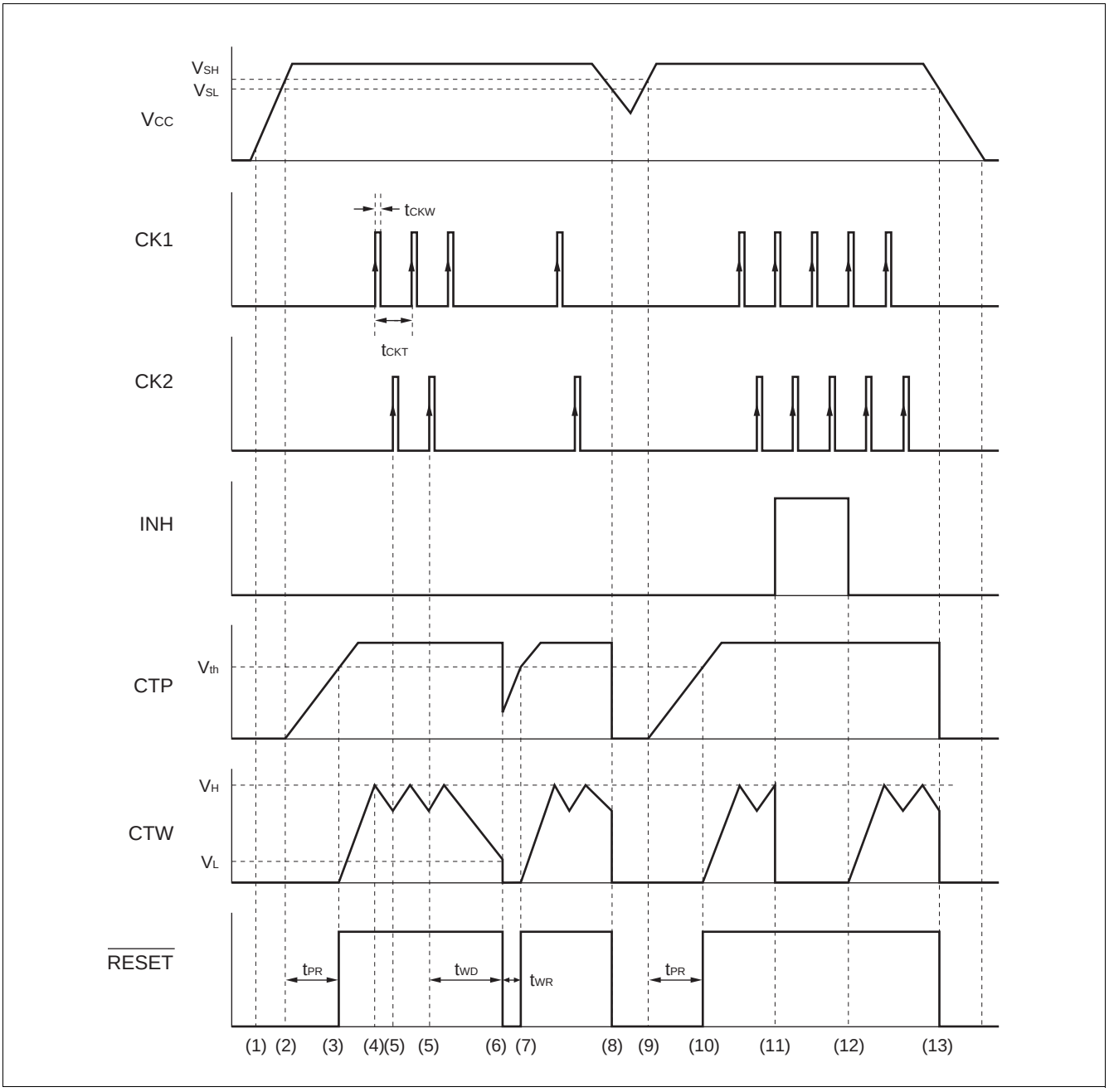
(V_{CC} = +5 V, Ta = +25°C)

Parameter		Symbol	Conditions	Value			Unit
				Min	Typ	Max	
Power-on reset hold time		t_{PR}	C_{TP} = 0.1 µF	80	130	180	ms
Watchdog timer monitoring time		t_{WD}	C_{TW} = 0.01 µF C_{TP} = 0.1 µF	7.5	15	22.5	ms
Watchdog timer reset time		t_{WR}	C_{TP} = 0.1 µF	5	10	15	ms
CK input pulse duration		t_{CKW}	—	500	—	—	ns
CK input pulse cycle		t_{CKT}	—	20	—	—	µs
Reset ($\overline{\text{RESET}}$) output transition time	Rising	tr*	C_L = 50 pF	—	—	500	ns
	Falling	tf*	C_L = 50 pF	—	—	500	ns

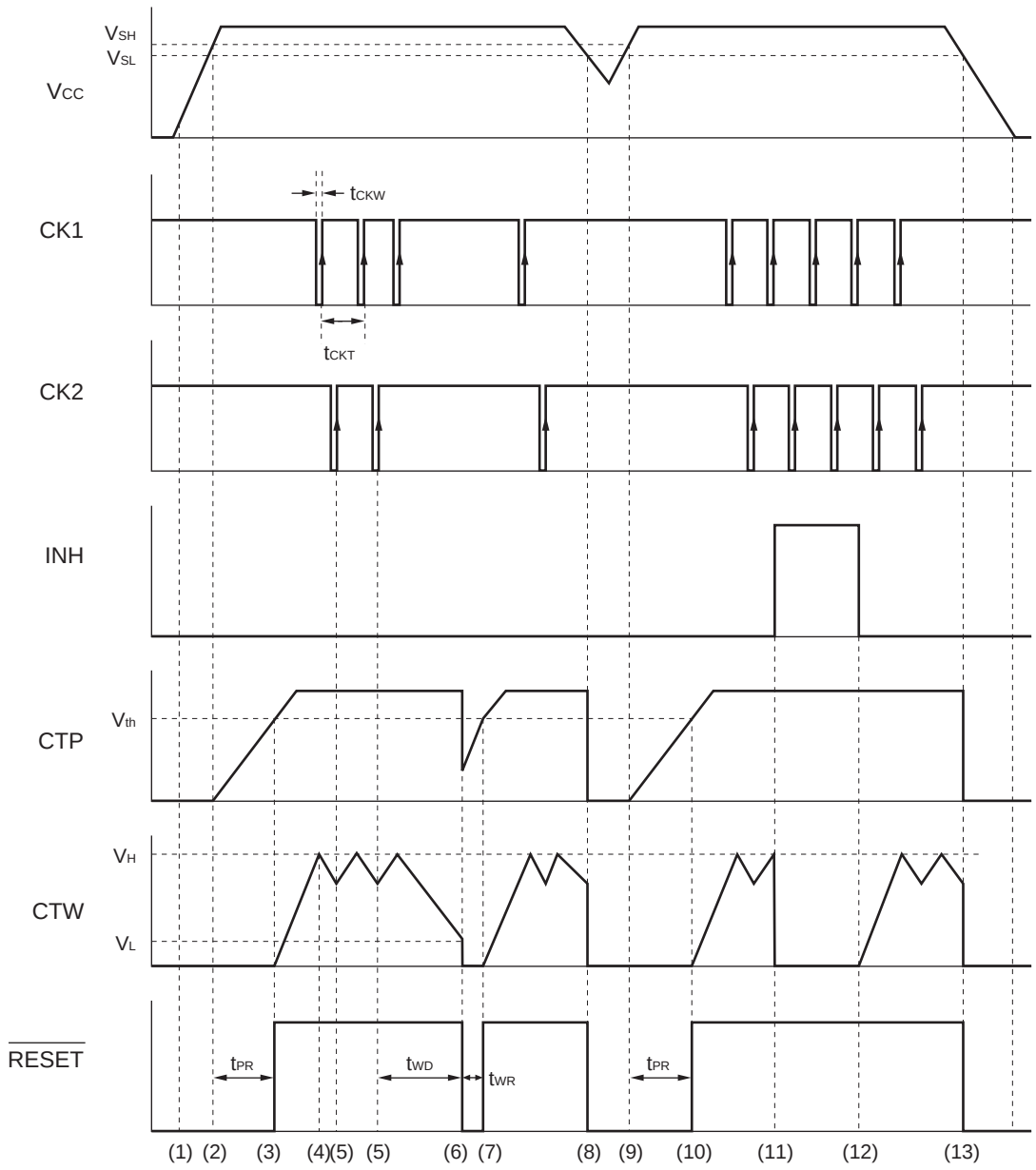
*: The voltage range is 10% to 90% at testing the reset output transition time.

■ TIMING DIAGRAM

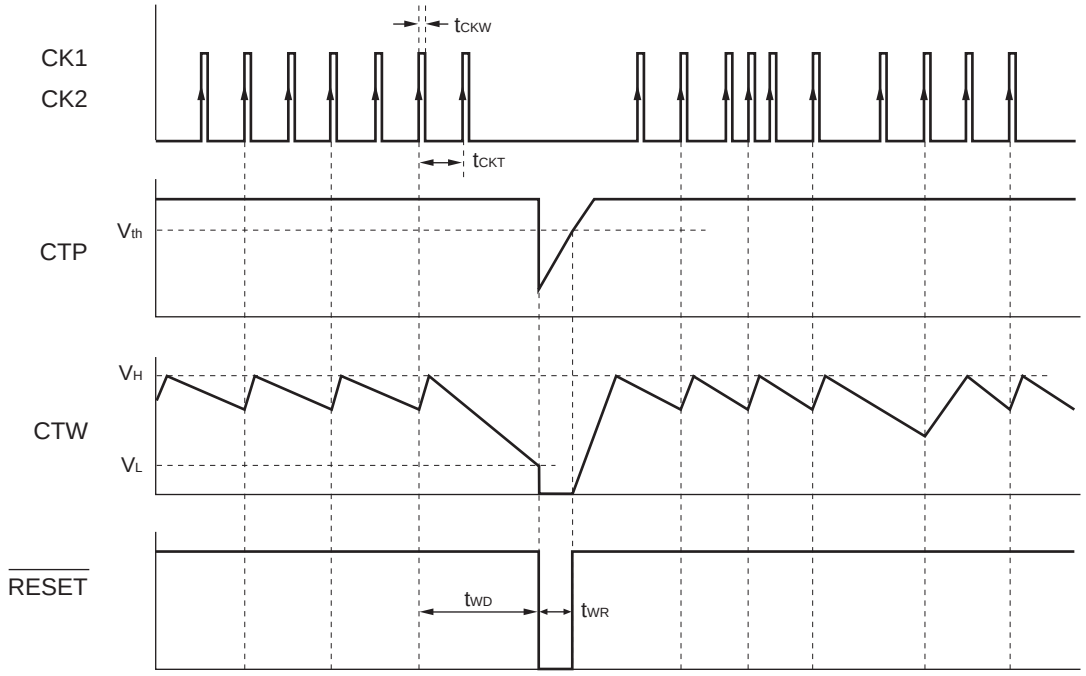
1. Basic operation (Positive clock pulse)



2. Basic operation (Negative clock pulse)

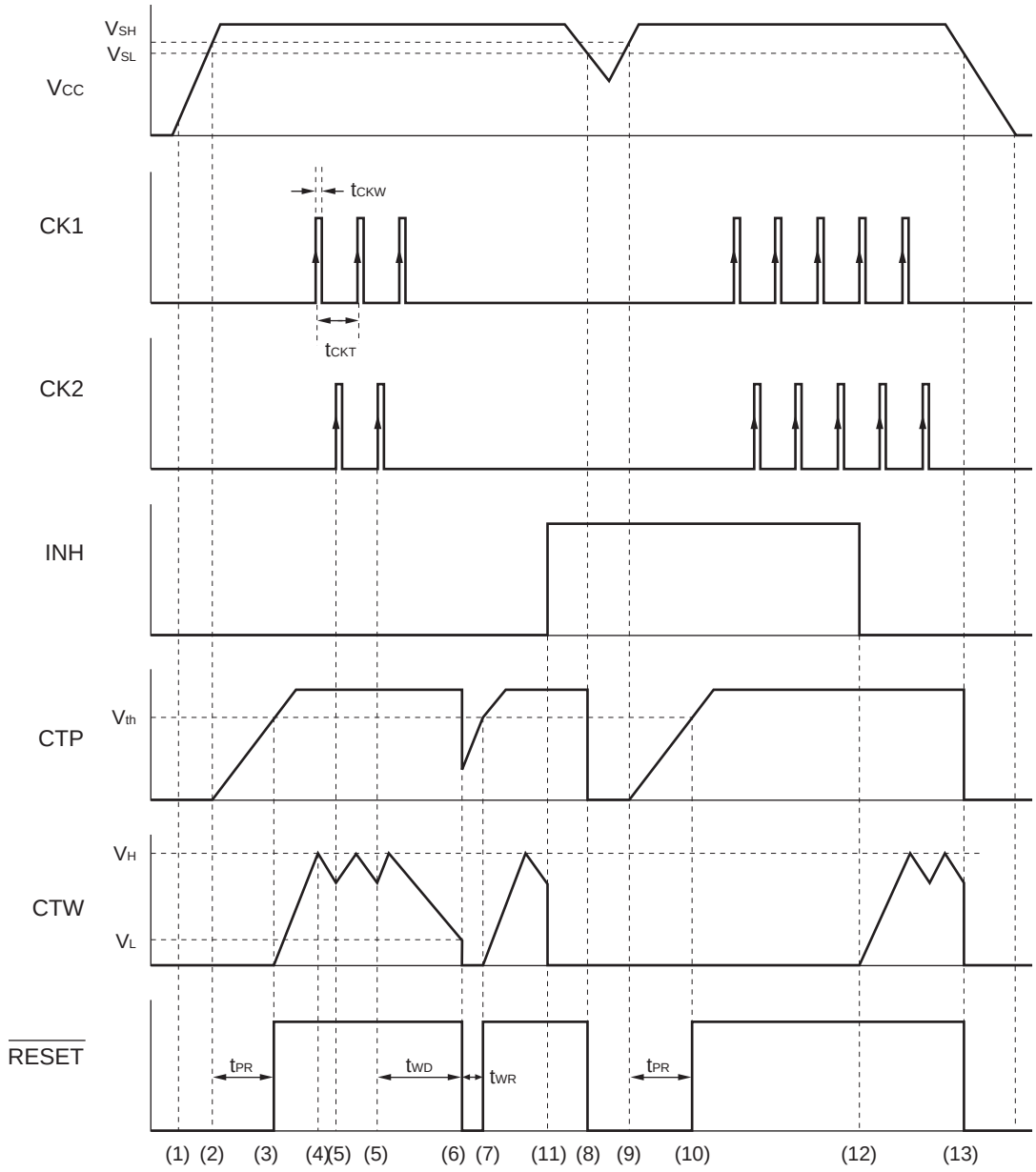


3. Single-clock input monitoring (Positive clock pulse)

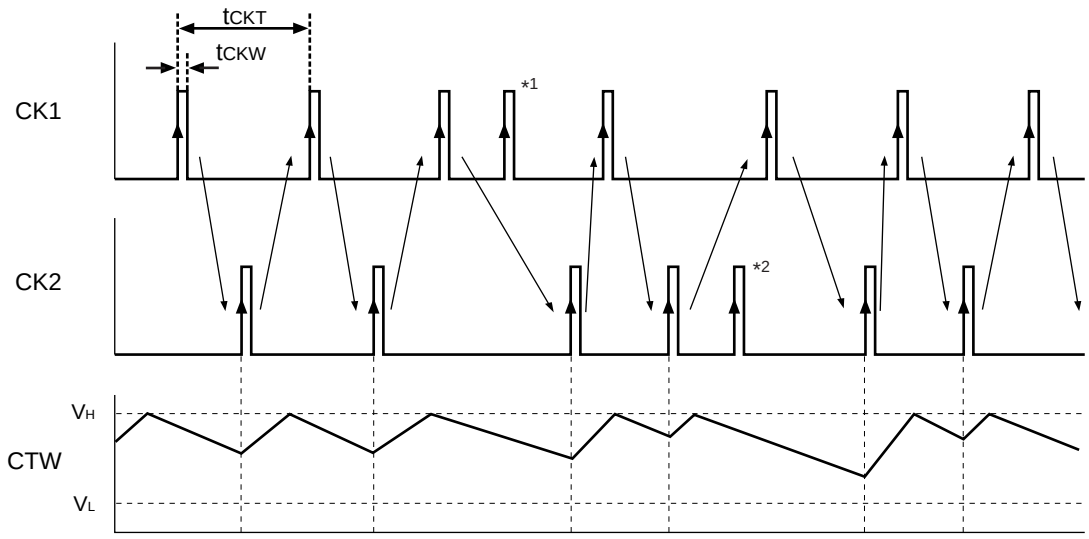


Note : The MB3793 can monitor only one clock.
The MB3793 checks the clock signal at every other input pulse.
Therefore, set watchdog timer monitor time t_{WD} to the time that allows the MB3793 to monitor the period twice as long as the input clock pulse.

4. Inhibition operation (Positive clock pulse)



5. Clock pulse input supplementation (Positive clock pulse)



Note : The MB3793 watchdog timer monitors Clock1 (CK1) and Clock2 (CK2) pulses alternately.
When a CK2 pulse is detected after detecting a CK1 pulse, the monitoring time setting capacity (C_{TW}) switches to charging from discharging.
When two consecutive pulses occur on one side of this alternation before switching, the second pulse is ignored.
In the above figure, pulse *1 and *2 are ignored.

■ OPERATION SEQUENCE

1. Positive clock pulse input

Refer to “1. Basic operation (positive clock pulse)” under “■ TIMING DIAGRAM.”

2. Negative clock pulse input

Refer to “2. Basic operation (negative clock pulse)” under “■ TIMING DIAGRAM.”

The MB3793 operates in the same way whether it inputs positive or negative pulses.

3. Clock monitoring

To use the MB3793 while monitoring only one clock, connect clock pins CK1 and CK2.

Although the MB3793 operates basically in the same way as when monitoring two clocks, it monitors the clock signal at every other input pulse.

Refer to “3. Single-clock input monitoring (positive clock pulse)” under “■ TIMING DIAGRAM.”

4. Description of Operations

The numbers given to the following items correspond to numbers (1) to (13) used in “■ TIMING DIAGRAM.”

(1) The MB3793 outputs a reset signal when the supply voltage (V_{CC}) reaches about 0.8 V (V_{CCL})

(2) If V_{CC} reaches or exceeds the rise-time detected voltage V_{SH}, the MB3793 starts charging the power-on reset hold time setting capacitor C_{TP}. At this time, the output remains in a reset state. The V_{SH} value is 4.60 V (Typ) .

(3) When C_{TP} has been charged for a certain period of time T_{PR} (until the CTP pin voltage exceeds the threshold voltage (V_{th}) after the start of charging), the MB3793 cancels the reset (setting the $\overline{\text{RESET}}$ pin to “H” level from “L” level).
The V_{th} value is about 3.6 V with V_{CC} = 5.0 V

The power-on reset hold time t_{PR} is set with the following equation:
t_{PR} (ms) ≒ A × C_{TP} (µF)
The value of A is about 1300 with V_{CC} = 5.0 V. The MB3793 also starts charging the watchdog timer monitor time setting capacitor (C_{TW}).

(4) When the voltage at the watchdog timer monitor time setting pin C_{TW} reaches the “H” level threshold voltage V_H, the CTW switches from the charge state to the discharge state.
The value of V_H is always about 1.24 V regardless of the detected voltage.

(5) If the CK2 pin inputs a clock pulse (positive edge trigger) when the C_{TW} is being discharged in the CK1-CK2 order or simultaneously, the C_{TW} switches from the discharge state to the charge state.
The MB3793 repeats operations (4) and (5) as long as the CK1/CK2 pin inputs clock pulses with the system logic circuit operating normally.

(6) If no clock pulse is fed to the CK1 or CK2 pin within the watchdog timer monitor time t_{WD} due to some problem with the system logic circuit, the CTW pin is set to the “L” level threshold voltage V_L or less and the MB3793 outputs a reset signal (setting the $\overline{\text{RESET}}$ pin to “L” level from “H” level).
The value of V_L is always about 0.24 V regardless of the detected voltage.
The watchdog timer monitor time t_{WD} is set with the following equation:
t_{WD} (ms) ≒ B × C_{TW} (µF) + C × C_{TP} (µF)
The value of B is hardly affected by the power supply voltage; it is about 1500 with V_{CC} = 5.0 V.
The value in C is about 3 which is tremendously smaller than the value in B. For this reason, it is possible to simplify the formula as below when C_{TP}/C_{TW} ≒ 10 or less.
t_{WD} (ms) ≒ B × C_{TW} (µF)

(7) When a certain period of time t_{WR} has passed (until the CTP pin voltage reaches or exceeds Vth again after recharging the C_{TP}), the MB3793 cancels the reset signal and starts operating the watchdog timer. The watchdog timer monitor reset time t_{WR} is set with the following equation:
t_{WR} (ms) ≒ D x C_{TP} (µF)
The value of D is 100 with V_{CC} = 5.0 V.
The MB3793 repeats operations (4) and (5) as long as the CK1/CK2 pin inputs clock pulses. If no clock pulse is input, the MB3793 repeats operations (6) and (7).

(8) If V_{CC} is lowered to the fall-time detected voltage (V_{SL}) or less, the CTP pin voltage decreases and the MB3793 outputs a reset signal (setting the $\overline{\text{RESET}}$ pin to “L” level from “H” level).
The value of V_{SL} is 4.50 V (Typ) .

(9) When V_{CC} reaches or exceeds V_{SH} again, the MB3793 starts charging the C_{TP}.

(10) When the CTP pin voltage reaches or exceeds V_{th}, the MB3793 cancels the reset and restarts operating the watchdog timer. It repeats operations (4) and (5) as long as the CK1/CK2 pin inputs clock pulses.

(11) Making the inhibit pin active (setting the INH pin to “H” from “L”) forces the watchdog timer to stop operation.
This stops only the watchdog timer, leaving the MB3793 monitoring V_{CC} (operations (8) to (10)).
The watchdog timer remains inactive unless the inhibit input is canceled.
The inhibition (INH) pin must be connecting a voltage of more low impedance, to evade of the noise.

(12) Canceling the inhibit input (setting the INH pin to “L” from “H”) restarts the watchdog timer.

(13) The reset signal is output when the power supply is turned off to set V_{CC} to V_{SL} or less.

1. Equation of time-setting capacitances (C_{TP} and C_{TW}) and set time

t_{PR} [ms] ≒ A × C_{TP} [µF]

t_{WD} [ms] ≒ B × C_{TW} [µF] + C × C_{TP} [µF]

However, when C_{TP}/C_{TW} ≒ 10 or less, t_{WD} [ms] ≒ B × C_{TW} [µF]

t_{WR} [ms] ≒ D × C_{TP} [µF]

Values of A, B, C, and D

A	B	C	D	Remark
1300	1500	3	100	V_{CC} = 5.0 V

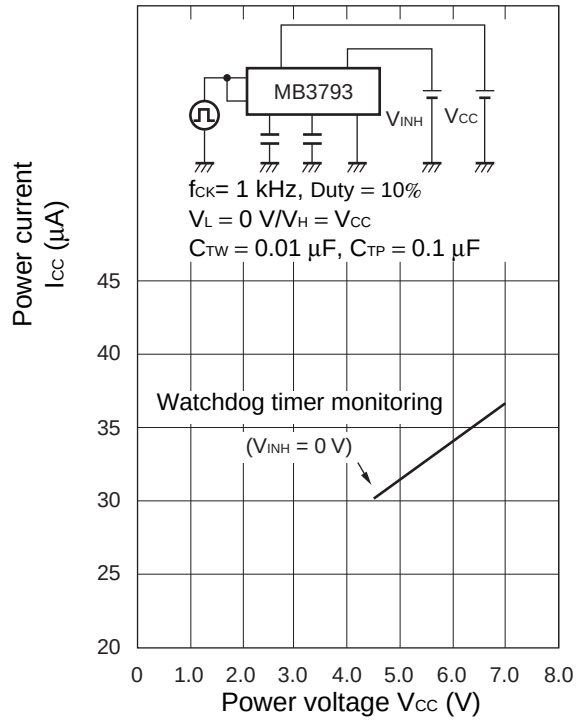
Note: The width of value of t_{PR}, t_{WD} and t_{WR} becomes the same ratio as width (Min, Max) of each specification value.

2. Example (when C_{TP} = 0.1 µF and C_{TW} = 0.01 µF)

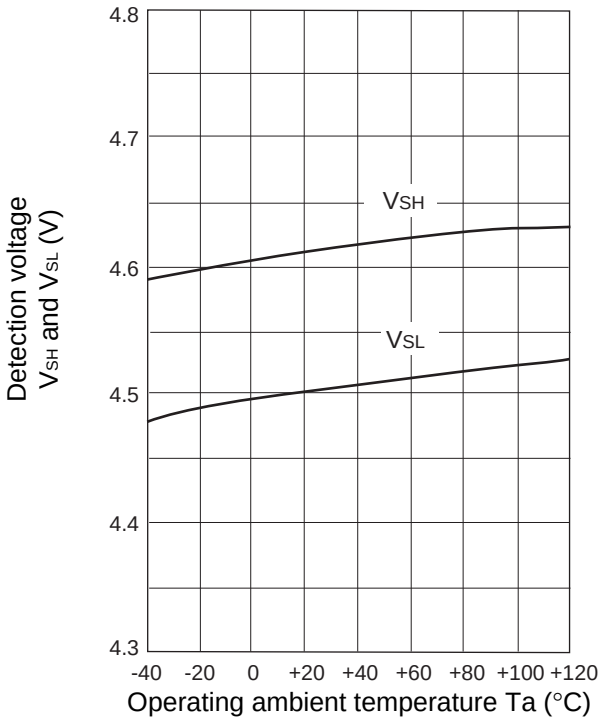
	Symbol	V_{CC} = 5.0 V
time (ms)	t_{PR}	130
	t_{WD}	15
	t_{WR}	10

■ TYPICAL CHARACTERISTICS

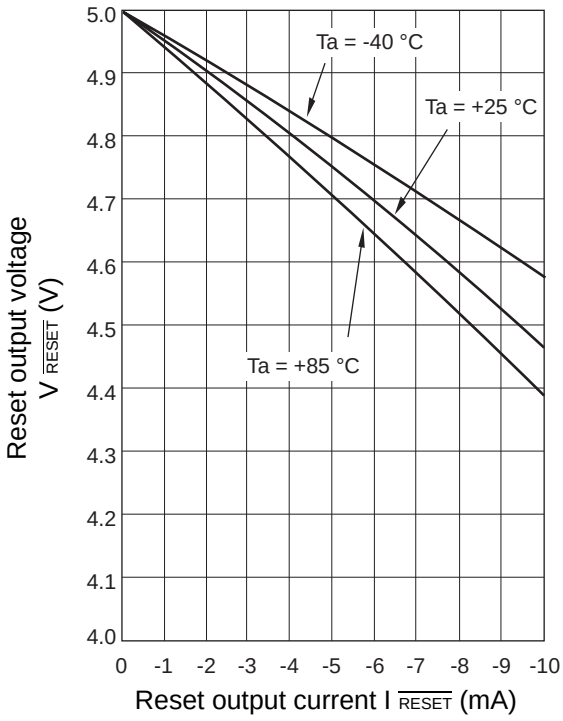
I_{CC} - V_{CC} characteristics



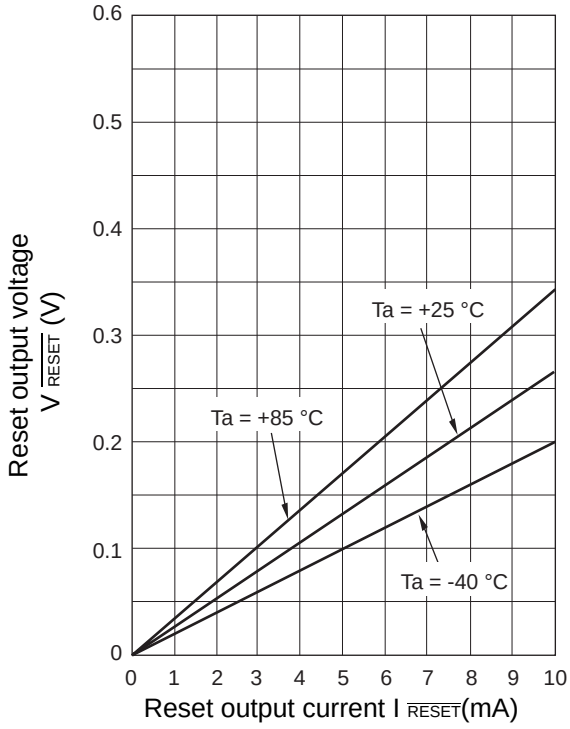
V_{SH}, V_{SL} - Ta characteristics



$V_{\overline{RESET}}$ - $I_{\overline{RESET}}$ characteristics (P-MOS side)



$V_{\overline{RESET}}$ - $I_{\overline{RESET}}$ characteristics (N-MOS side)



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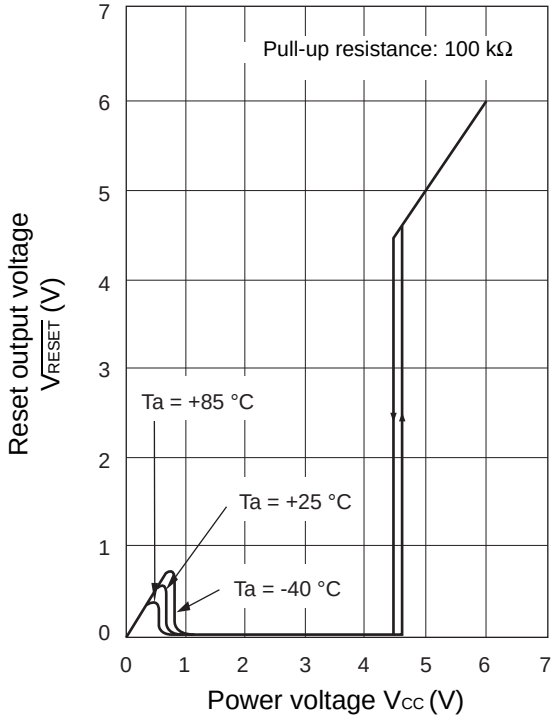
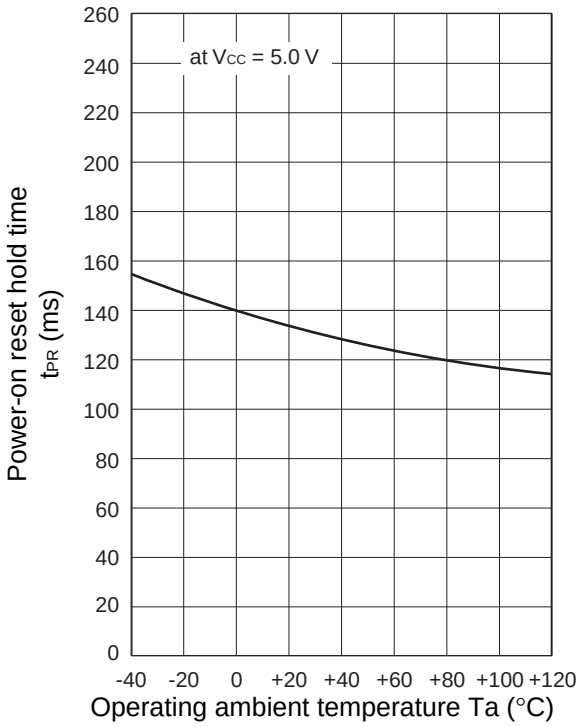
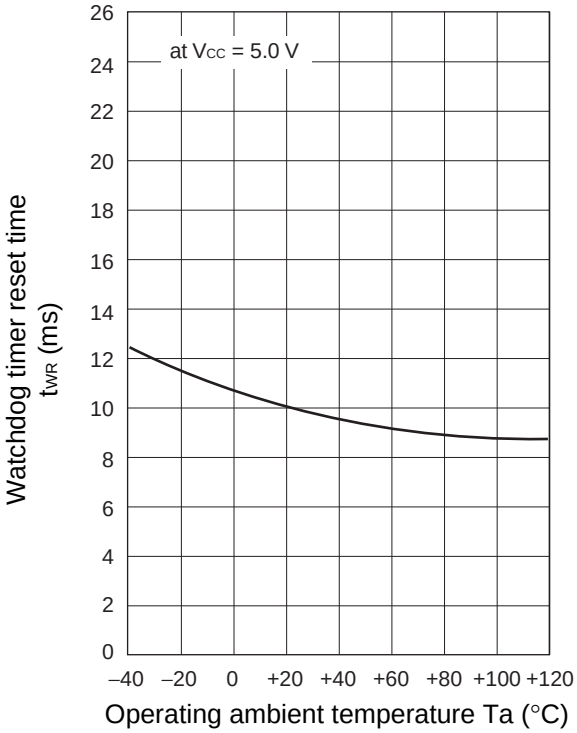
$V_{\overline{RESET}}$ - V_{CC} characteristics



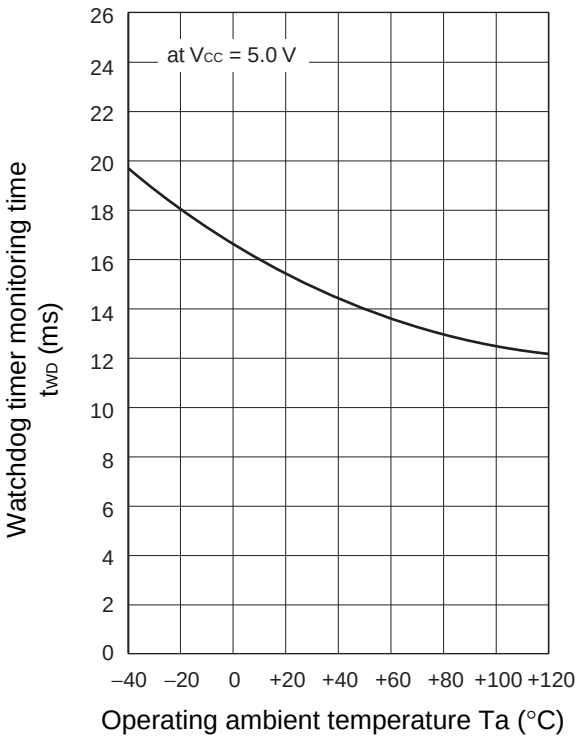
t_{PR} - Ta characteristics



t_{WR} - Ta characteristics



t_{WD} - Ta characteristics



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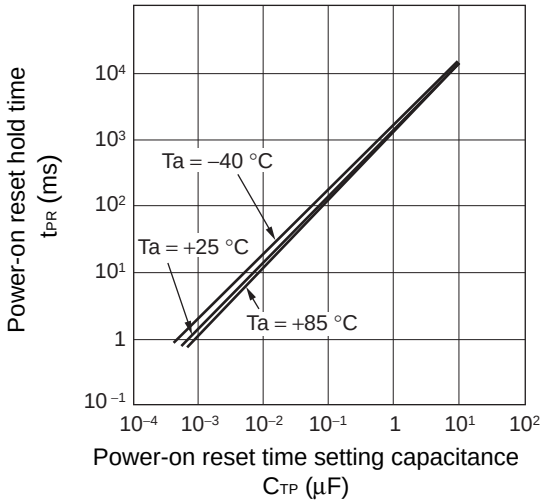
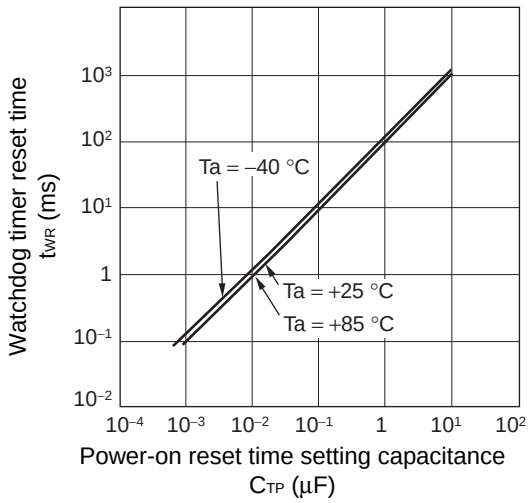
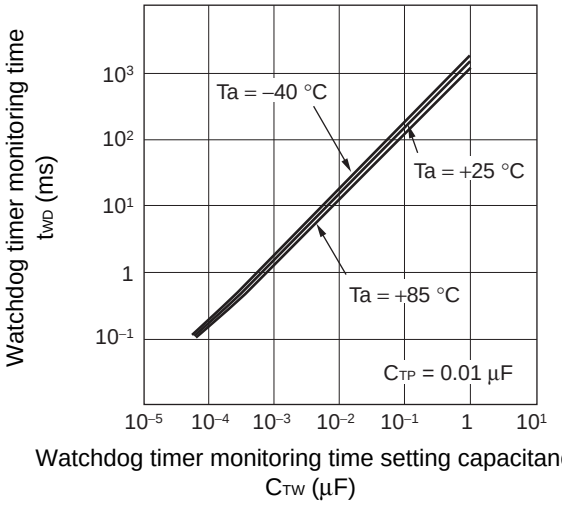
t_{PR} - C_{TP} characteristics



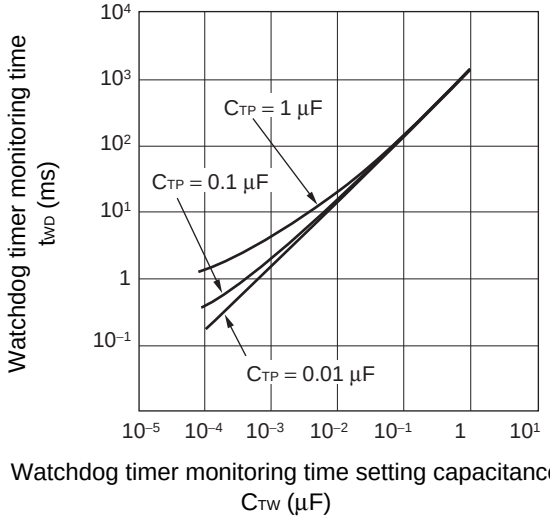
t_{WR} - C_{TP} characteristics



t_{WD} - C_{TW} characteristics



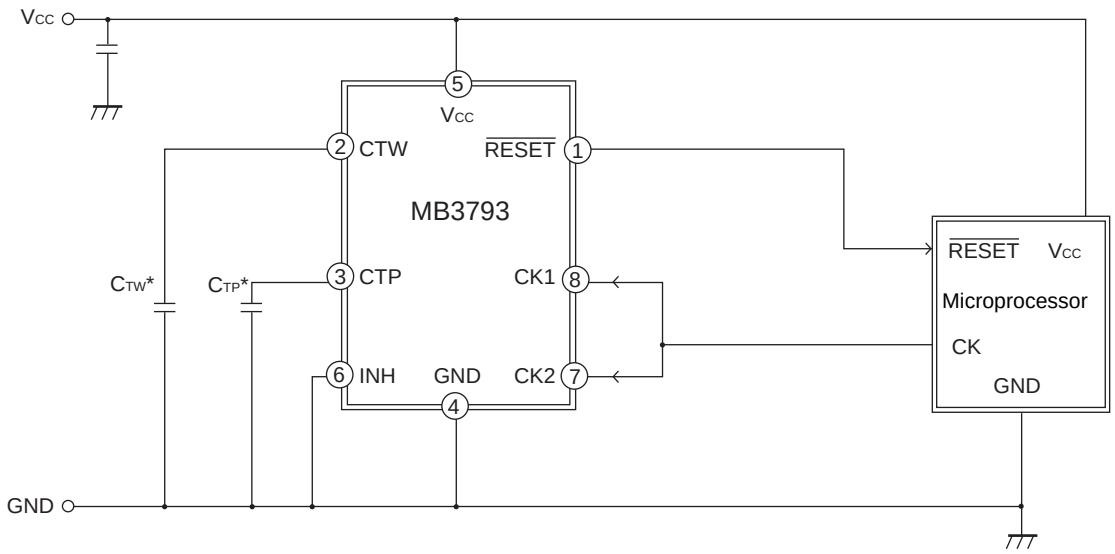
t_{WD} - C_{TW} characteristics



■ APPLICATION EXAMPLE

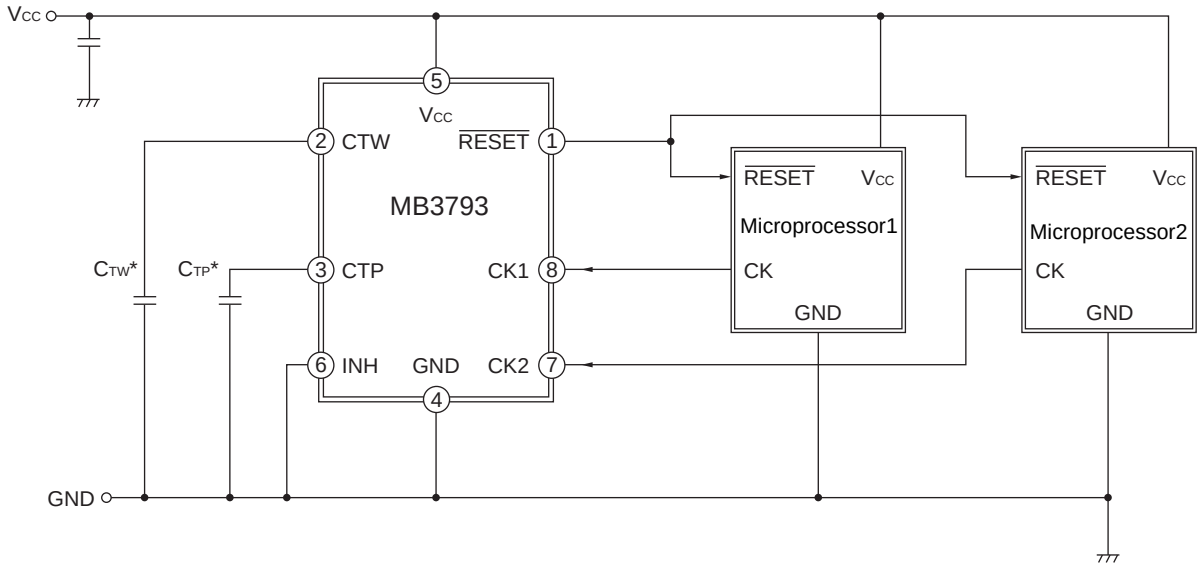
1. Supply voltage monitor and watchdog timer

(1) 1-clock monitor



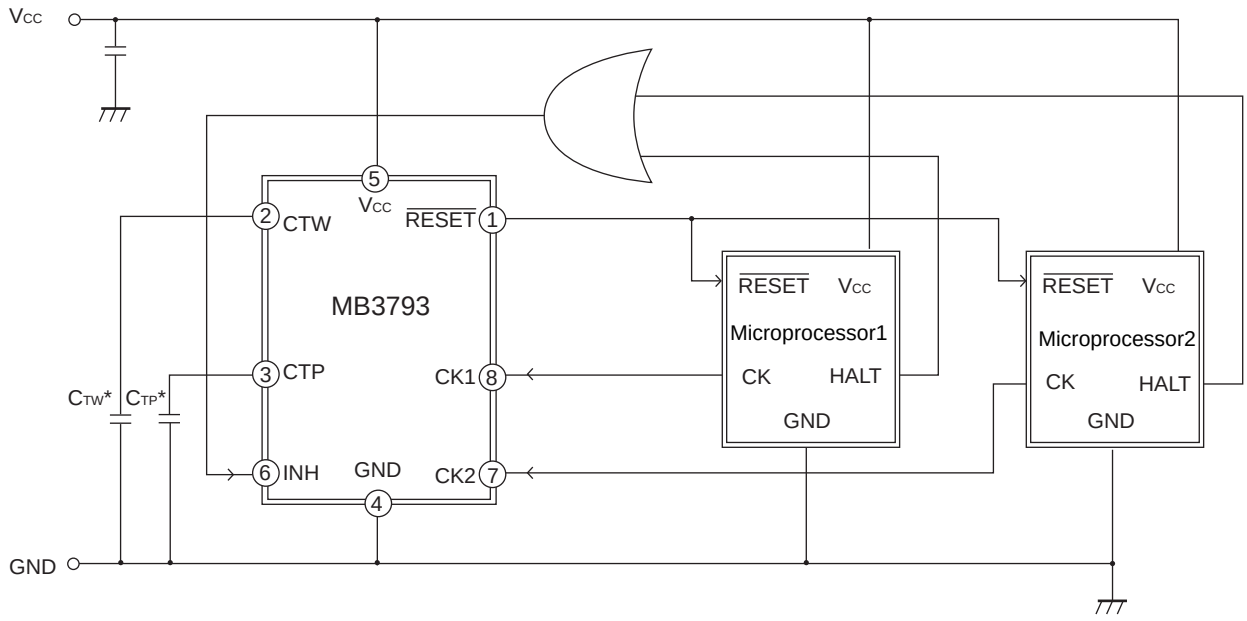
* : Use a capacitor with less leakage current.

(2) 2-clock monitor



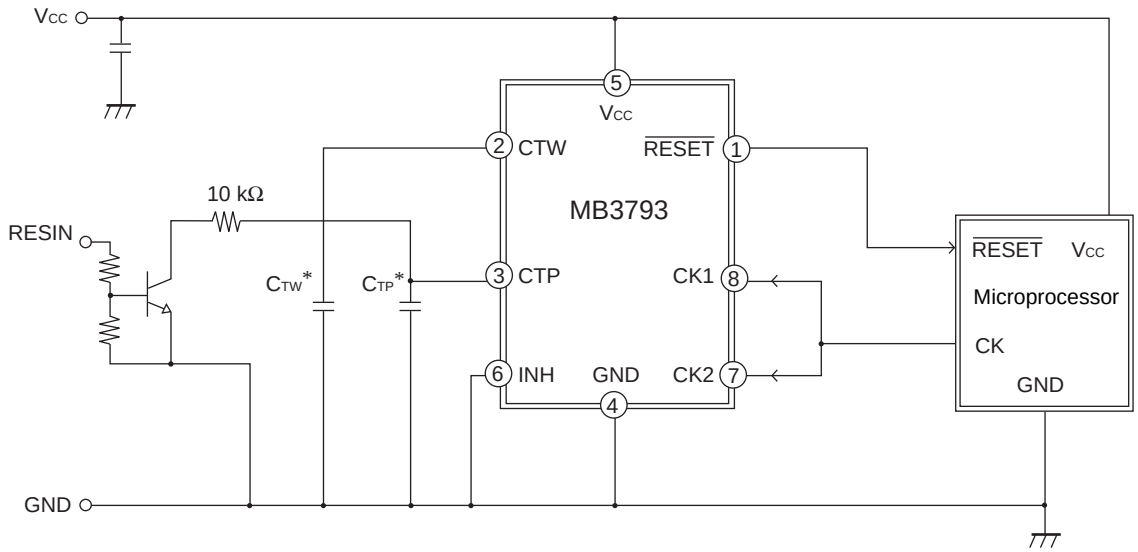
* : Use a capacitor with less leakage current.

2. Supply voltage monitor and watchdog timer stop



* : Use a capacitor with less leakage current.

3. Setting of compulsory reset



* : Use a capacitor with less leakage current.

It is possible for the $\overline{\text{RESET}}$ pin to fix to “L” if the CTP pin is short-circuited to GND. Take care not to change the value of the C_{TP} capacity because of the influence of Tr that is used at the time.

■ USAGE PRECAUTION

1. Do not configure the IC over the maximum ratings

If the lC is used over the maximum ratings, the LSl may be permanently damaged.
It is preferable for the device to normally operate within the recommended usage conditions. Usage outside of these conditions can have a bad effect on the reliability of the LSI.

2. Use the devices within recommended operating conditions

The recommended operating conditions are under which the LSl is guaranteed to operate.
The electrical ratings are guaranteed when the device is used within the recommended operating conditions and under the conditions stated for each item.

3. Printed circuit board ground lines should be set up with consideration for common impedance

4. Take appropriate measures against static electricity

- Containers for semiconductor materials should have anti-static protection or be made of conductive material.
- After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
- Work platforms, tools, and instruments should be properly grounded.
- Working personnel should be grounded with resistance of 250 kΩ to 1 MΩ between body and ground.

5. Do not apply negative voltages

The use of negative voltages below –0.3 V may create parasitic transistors on LSI lines, which can cause malfunctions.

■ ORDERING INFORMATION

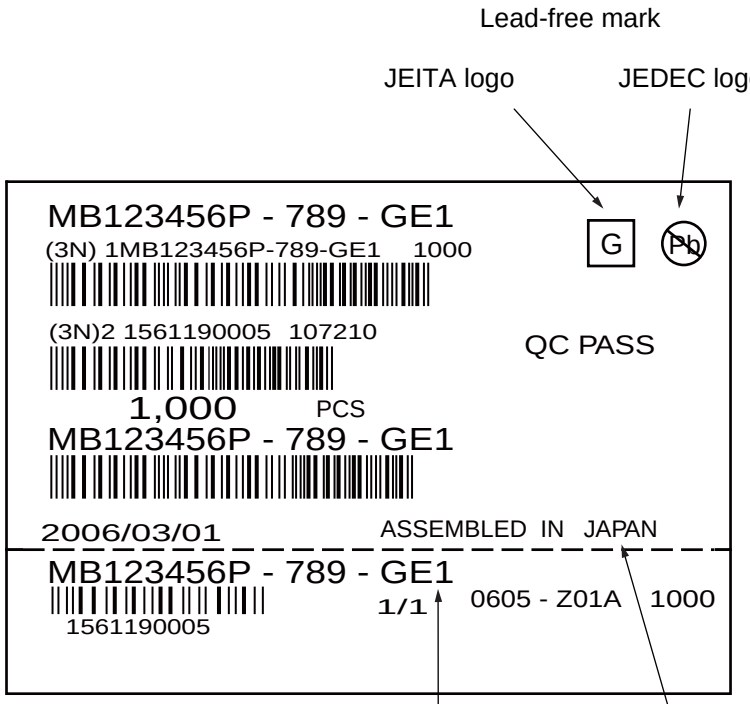
Part number	Package	Remarks
MB3793-45PF	8-pin plastic SOP (FPT-8P-M01)	
MB3793-45PNF	8-pin plastic SOP (FPT-8P-M02)	

■ RoHS Compliance Information of Lead (Pb) Free version

The LSI products of Fujitsu Microelectronics with “E1” are compliant with RoHS Directive , and has observed the standard of lead, cadmium, mercury, Hexavalent chromium, polybrominated biphenyls (PBB) , and polybrominated diphenyl ethers (PBDE) .

The product that conforms to this standard is added “E1” at the end of the part number.

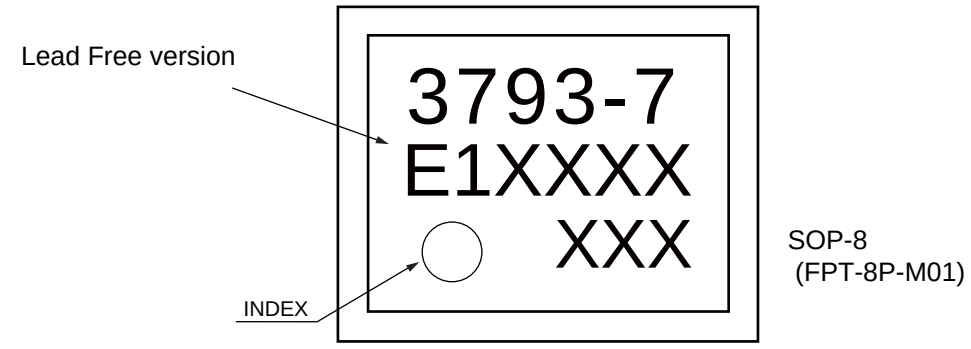
■ LABELING SAMPLE (Lead free version)

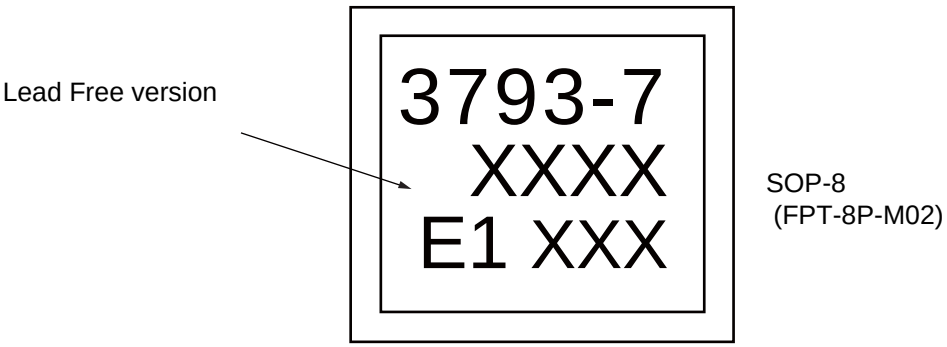


The part number of a lead-free product has the trailing characters “E1”.

“ASSEMBLED IN CHINA” is printed on the label of a product assembled in China.

■ MARKING FORMAT (Lead Free version)



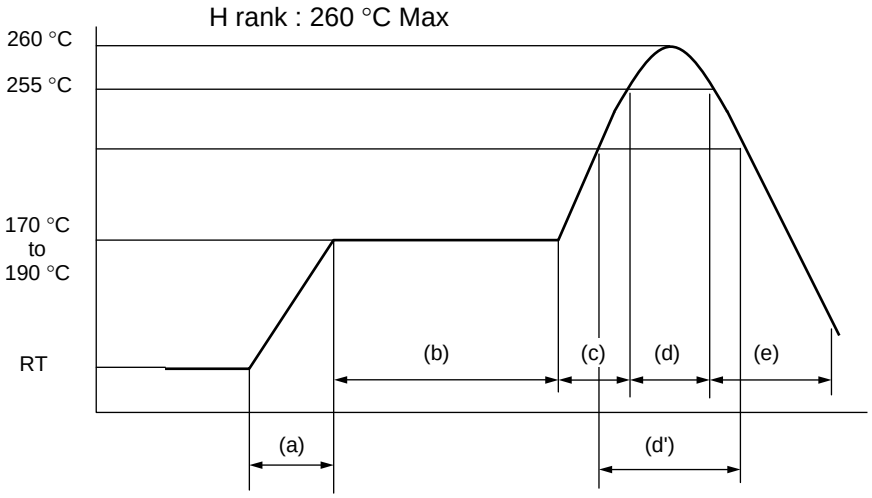


■ MB3793-45PF, MB3793-45PNF RECOMMENDED CONDITIONS OF MOISTURE SENSITIVITY LEVEL

Item	Condition	
Mounting Method	IR (infrared reflow) , Manual soldering (partial heating method)	
Mounting times	2 times	
Storage period	Before opening	Please use it within two years after Manufacture.
	From opening to the 2nd reflow	Less than 8 days
	When the storage period after opening was exceeded	Please processes within 8 days after baking (125 °C, 24H)
Storage conditions	5 °C to 30 °C, 70%RH or less (the lowest possible humidity)	

[Temperature Profile for FJ Standard IR Reflow]

(1) IR (infrared reflow)



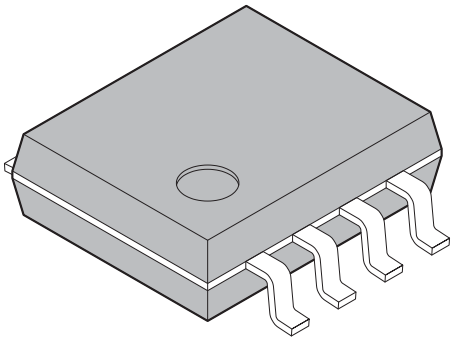
(a) Temperature Increase gradient : Average 1 °C/s to 4 °C/s
(b) Preliminary heating : Temperature 170 °C to 190 °C, 60s to 180s
(c) Temperature Increase gradient : Average 1 °C/s to 4 °C/s
(d) Actual heating : Temperature 260 °C Max; 255 °C or more, 10s or less
(d') : Temperature 230 °C or more, 40s or less
or
Temperature 225 °C or more, 60s or less
or
Temperature 220 °C or more, 80s or less
(e) Cooling : Natural cooling or forced cooling

Note : Temperature : the top of the package body

(2) Manual soldering (partial heating method)

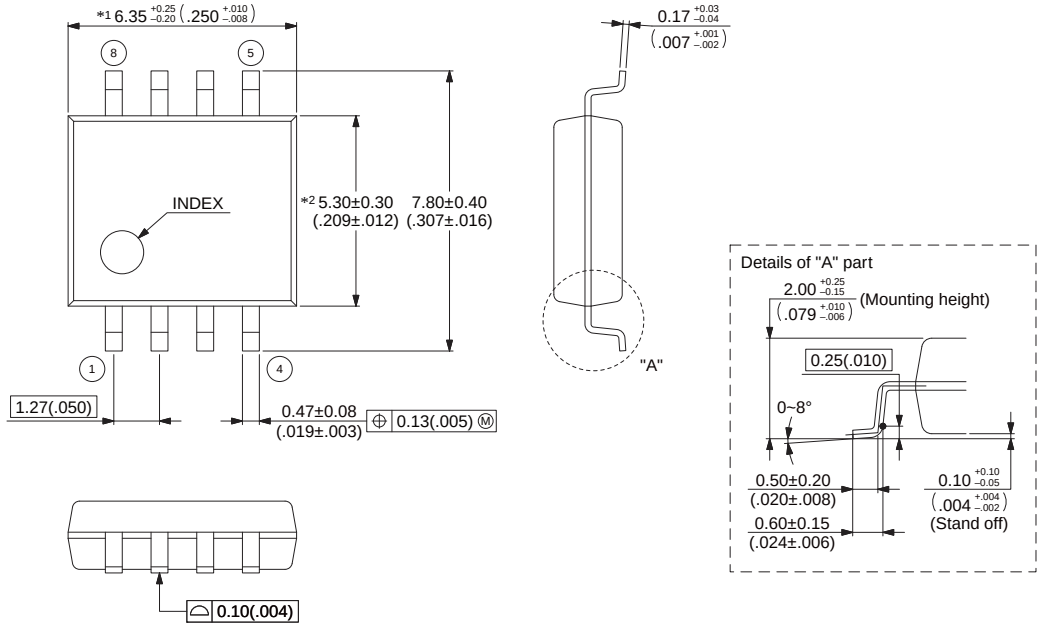
Conditions : Temperature 400 °C Max
Times : 5 s max/pin

■ PACKAGE DIMENSIONS

8-pin plastic SOP		
 (FPT-8P-M01)	Lead pitch	1.27 mm
	Package width × package length	5.3 × 6.35 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	2.25 mm MAX
	Weight	0.10 g
	Code (Reference)	P-SOP8-5.3×6.35-1.27

8-pin plastic SOP
(FPT-8P-M01)

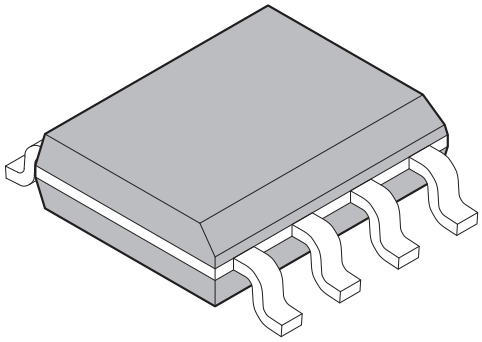
Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

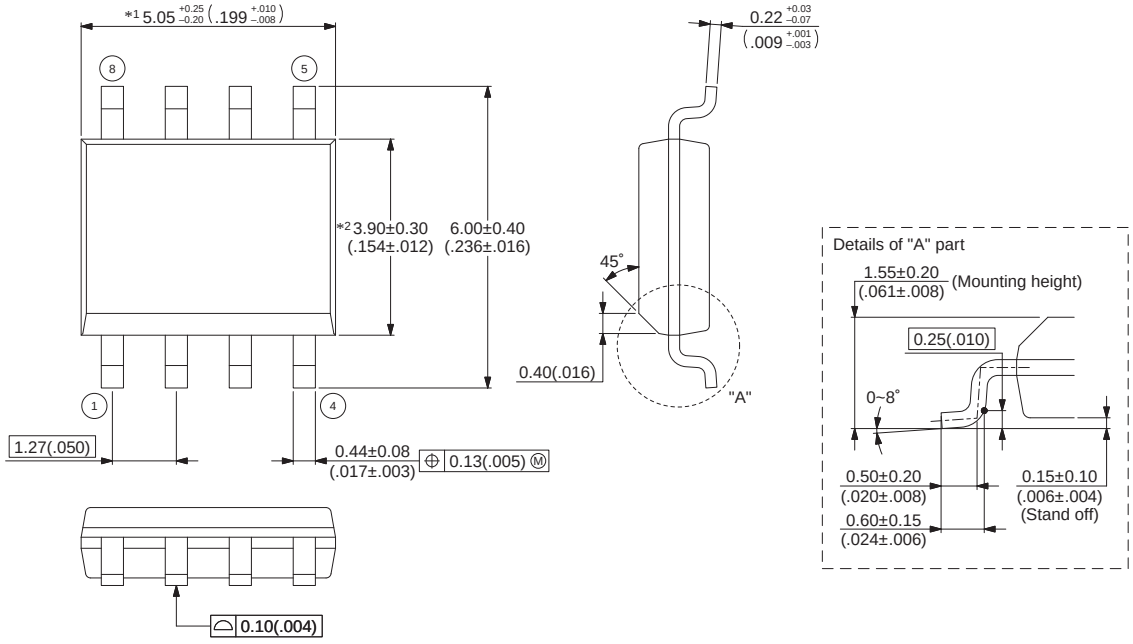
(Continued)

(Continued)

8-pin plastic SOP		
 (FPT-8P-M02)	Lead pitch	1.27 mm
	Package width × package length	3.9 × 5.05 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.75 mm MAX
	Weight	0.06 g

8-pin plastic SOP
(FPT-8P-M02)

Note 1) *1 : These dimensions include resin protrusion.
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.



Dimensions in mm (inches).
Note: The values in parentheses are reference values.

Please check the latest package dimension at the following URL.
http://edevice.fujitsu.com/package/en-search/

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Edited: Sales Promotion Department