

# ASSP For Power Supply Applications

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.

There is also a mask option that can detect voltages of 4.9 to 2.4 V in 0.1-V steps.

The model number is MB3793-45 corresponding to the detected voltage. The model number and package code are as shown below.

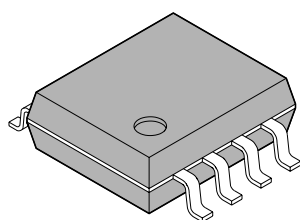
| Model No. | Package code | Detection voltage |
|-----------|--------------|-------------------|
| MB3793-45 | 3793-7       | 4.5 V             |

#### FEATURES

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

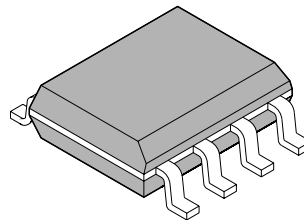
#### PACKAGE

8-pin plastic SOP



(FPT-8P-M01)

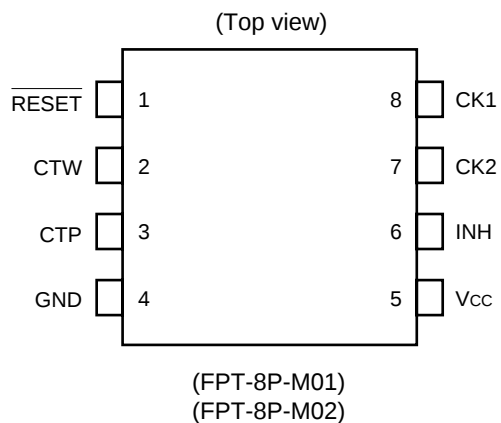
8-pin plastic SOL



(FPT-8P-M02)

# MB3793-45

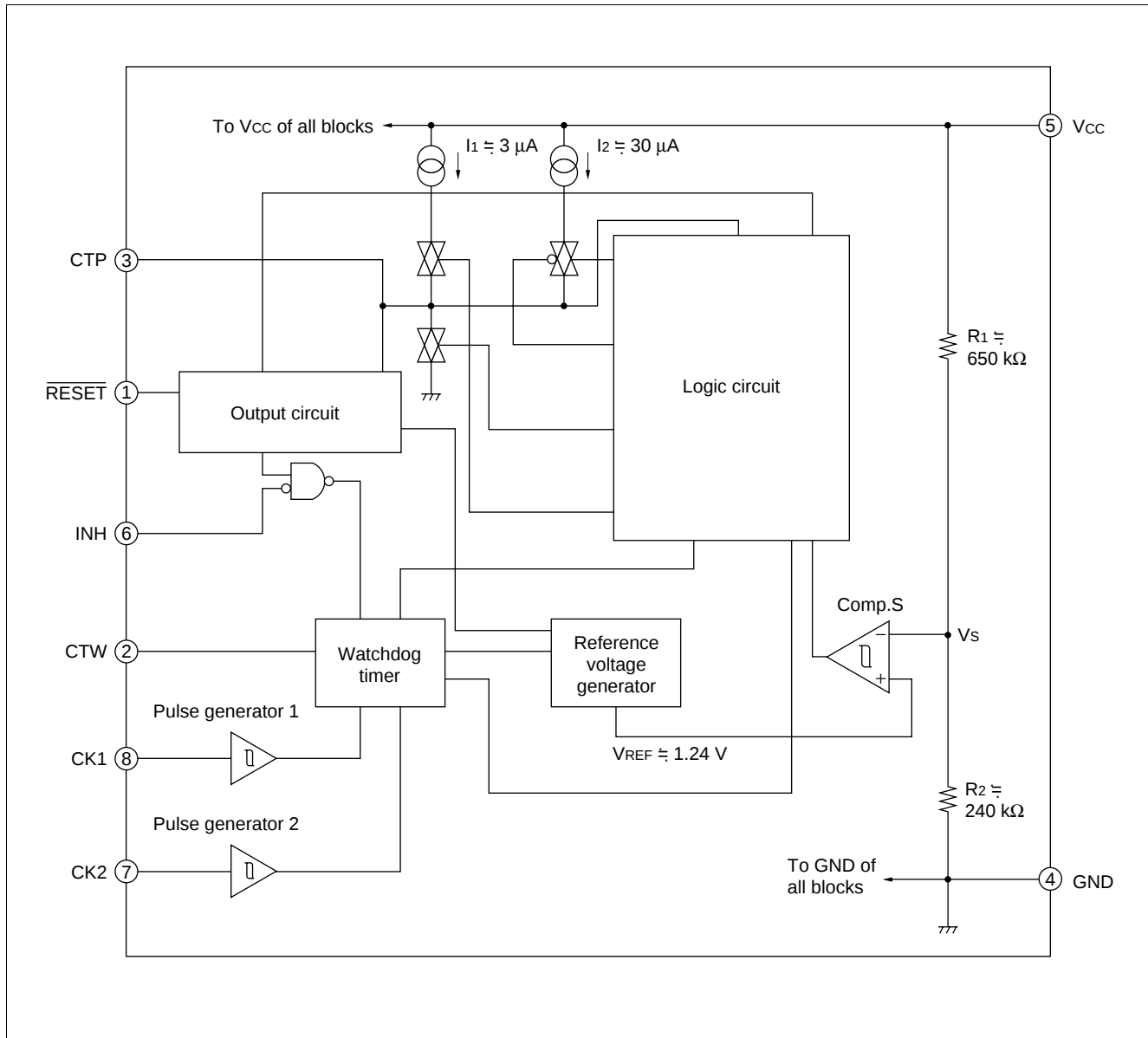
## ■ PIN ASSIGNMENT



## ■ PIN DESCRIPTION

| Pin no. | Symbol                    | Descriptions                            | Pin no. | Symbol | Descriptions       |
|---------|---------------------------|-----------------------------------------|---------|--------|--------------------|
| 1       | $\overline{\text{RESET}}$ | Outputs reset pin                       | 5       | Vcc    | Power supply pin   |
| 2       | CTW                       | Watchdog timer monitor time setting pin | 6       | INH    | Inhibit pin        |
| 3       | CTP                       | Power-on reset hold time setting pin    | 7       | CK2    | Inputs clock 2 pin |
| 4       | GND                       | Ground pin                              | 8       | CK1    | Inputs clock 1 pin |

## ■ BLOCK DIAGRAM



## ■ BLOCK DESCRIPTION

### 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 1 and 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  $\mu$ s when the power is cut or falls abruptly.

### 2. Output circuit

The output circuit contains a  $\overline{\text{RESET}}$  output control comparator that compares the voltage at the CTP pin to the threshold voltage to release the  $\overline{\text{RESET}}$  output if the CTP pin voltage exceeds the threshold value.

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

### 3. Pulse generator

The pulse generator generates pulses when the voltage at the CK1 and CK2 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

The logic circuit contains flip-flops.

Flip-flop RSFF1 controls the charging and discharging of the power-on reset time setting capacitor ( $C_{TP}$ ).

Flip-flop RSFF2 turns on/off the circuit that accelerates charging of the power-on reset time setting capacitor ( $C_{TP}$ ) at a reset. The RSFF2 operates only at a reset; it does not operate at a power-on reset when the power is turned on.

## ■ ABSOLUTE MAXIMUM RATINGS

(Ta = +25°C)

| Parameter             | Symbol                    | Conditions                         | Rating |      | Unit |
|-----------------------|---------------------------|------------------------------------|--------|------|------|
|                       |                           |                                    | Min.   | Max. |      |
| Power supply voltage* | V <sub>CC</sub>           | —                                  | −0.3   | +7   | V    |
| Input voltage         | CK1                       | V <sub>CK1</sub>                   | −0.3   | +7   | V    |
|                       | CK2                       | V <sub>CK2</sub>                   |        |      |      |
|                       | INH                       | I <sub>INH</sub>                   |        |      |      |
| Reset output current  | $\overline{\text{RESET}}$ | I <sub>OL</sub><br>I <sub>OH</sub> | −10    | +10  | mA   |
| Allowable loss        | P <sub>D</sub>            | Ta ≤ +85°C                         | —      | 200  | mW   |
| Storage temperature   | T <sub>stg</sub>          | —                                  | −55    | +125 | °C   |

\*: The power supply 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 <sub>CC</sub>                    | —          | 1.2   | —    | 6.0  | V    |
| Reset ( $\overline{\text{RESET}}$ ) output current | I <sub>OL</sub><br>I <sub>OH</sub> | —          | −5    | —    | +5   | mA   |
| Power-on reset hold time setting capacity          | C <sub>TP</sub>                    | —          | 0.001 | —    | 10   | μF   |
| Watchdog-timer monitoring time setting capacity    | C <sub>TW</sub>                    | —          | 0.001 | —    | 1    | μF   |
| Operating temperature                              | Ta                                 | —          | −40   | —    | +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 FUJITSU representatives beforehand.

## ■ ELECTRICAL CHARACTERISTICS

### 1. DC Characteristics

(V<sub>CC</sub> = +5 V, Ta = +25°C)

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

\*: The values enclosed in parentheses ( ) are setting assurance values.

### 2. AC Characteristics

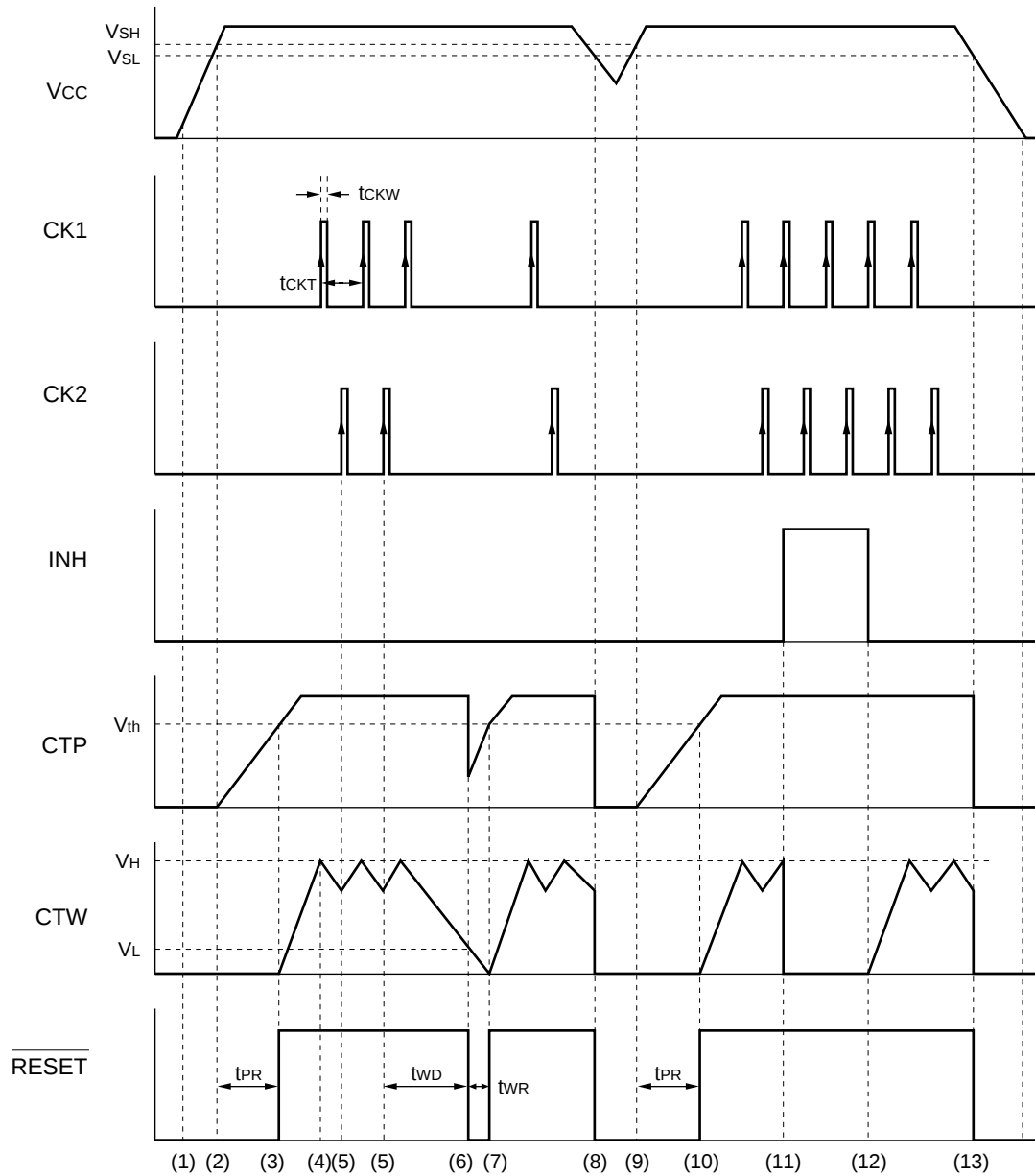
(V<sub>CC</sub> = +5 V, Ta = +25°C)

| Parameter                                                   |         | Symbol           | Conditions                                             | Value |      |      | Unit |
|-------------------------------------------------------------|---------|------------------|--------------------------------------------------------|-------|------|------|------|
|                                                             |         |                  |                                                        | Min.  | Typ. | Max. |      |
| Power-on reset hold time                                    |         | t <sub>PR</sub>  | C <sub>TP</sub> = 0.1 μF                               | 80    | 130  | 180  | ms   |
| Watchdog timer reset time                                   |         | t <sub>WD</sub>  | C <sub>TW</sub> = 0.01 μF,<br>C <sub>TP</sub> = 0.1 μF | 7.5   | 15   | 22.5 | ms   |
| Watchdog timer reset time                                   |         | t <sub>WR</sub>  | C <sub>TP</sub> = 0.1 μF                               | 5     | 10   | 15   | ms   |
| Clock input pulse width                                     |         | t <sub>CKW</sub> | —                                                      | 500   | —    | —    | ns   |
| Clock input pulse cycle                                     |         | t <sub>CKT</sub> | —                                                      | 20    | —    | —    | μs   |
| Reset ( $\overline{\text{RESET}}$ ) output transition time* | Rising  | t <sub>r</sub> * | C <sub>L</sub> = 50 pF                                 | —     | —    | 500  | ns   |
|                                                             | Falling | t <sub>r</sub> * | C <sub>L</sub> = 50 pF                                 | —     | —    | 500  | ns   |

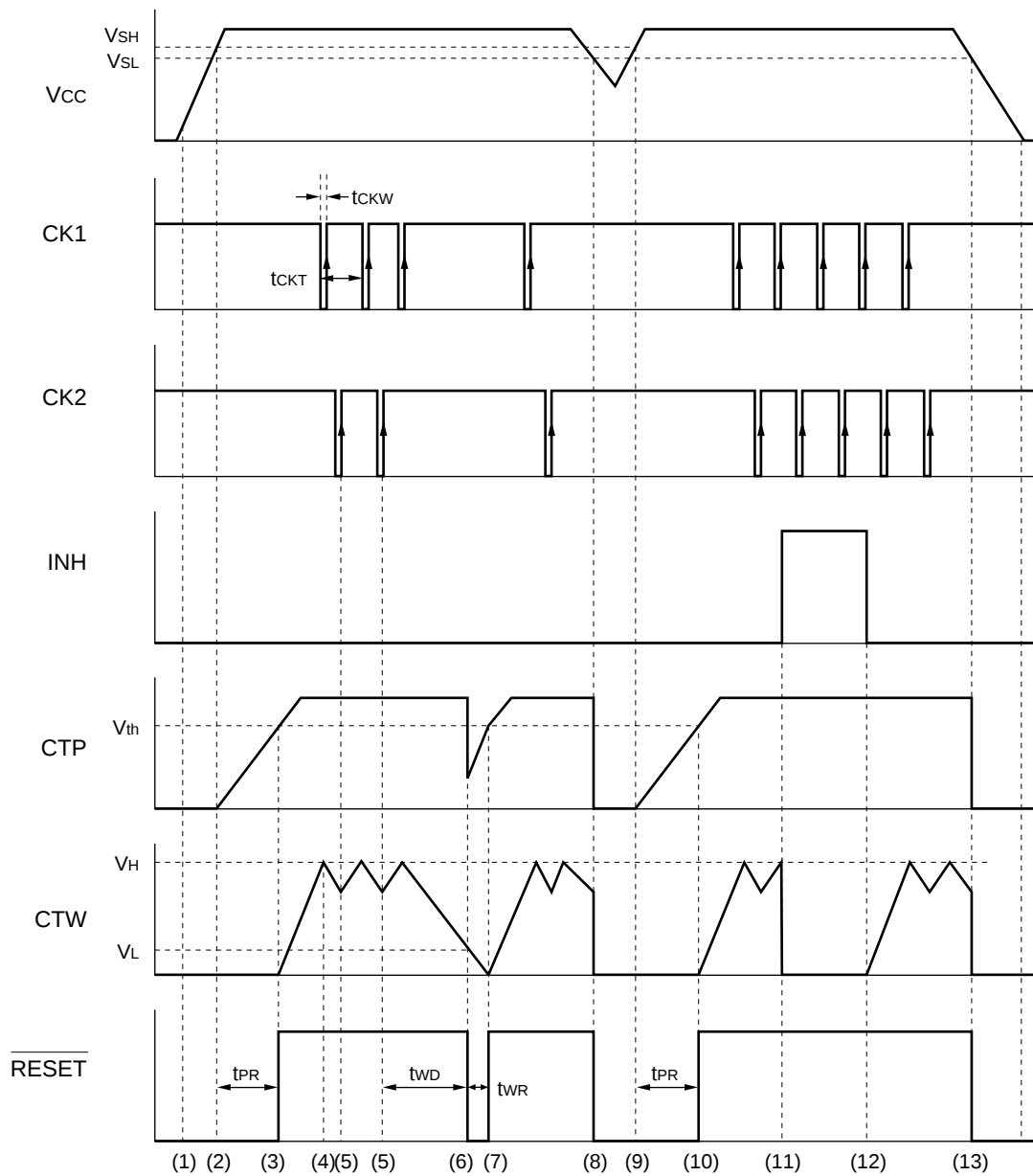
\*: The voltage range is 10% to 90% at testing the reset output transition time.

## ■ DIAGRAM

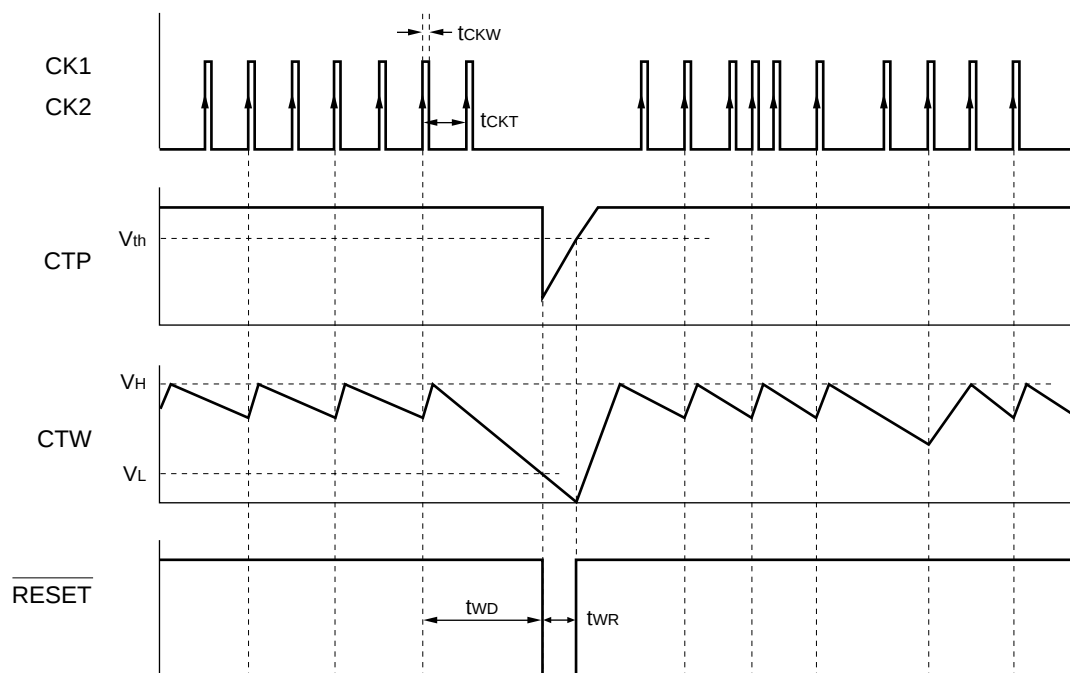
### 1. Basic operation (Positive clock pulse)



## 2. Basic operation (Negative clock pulse)

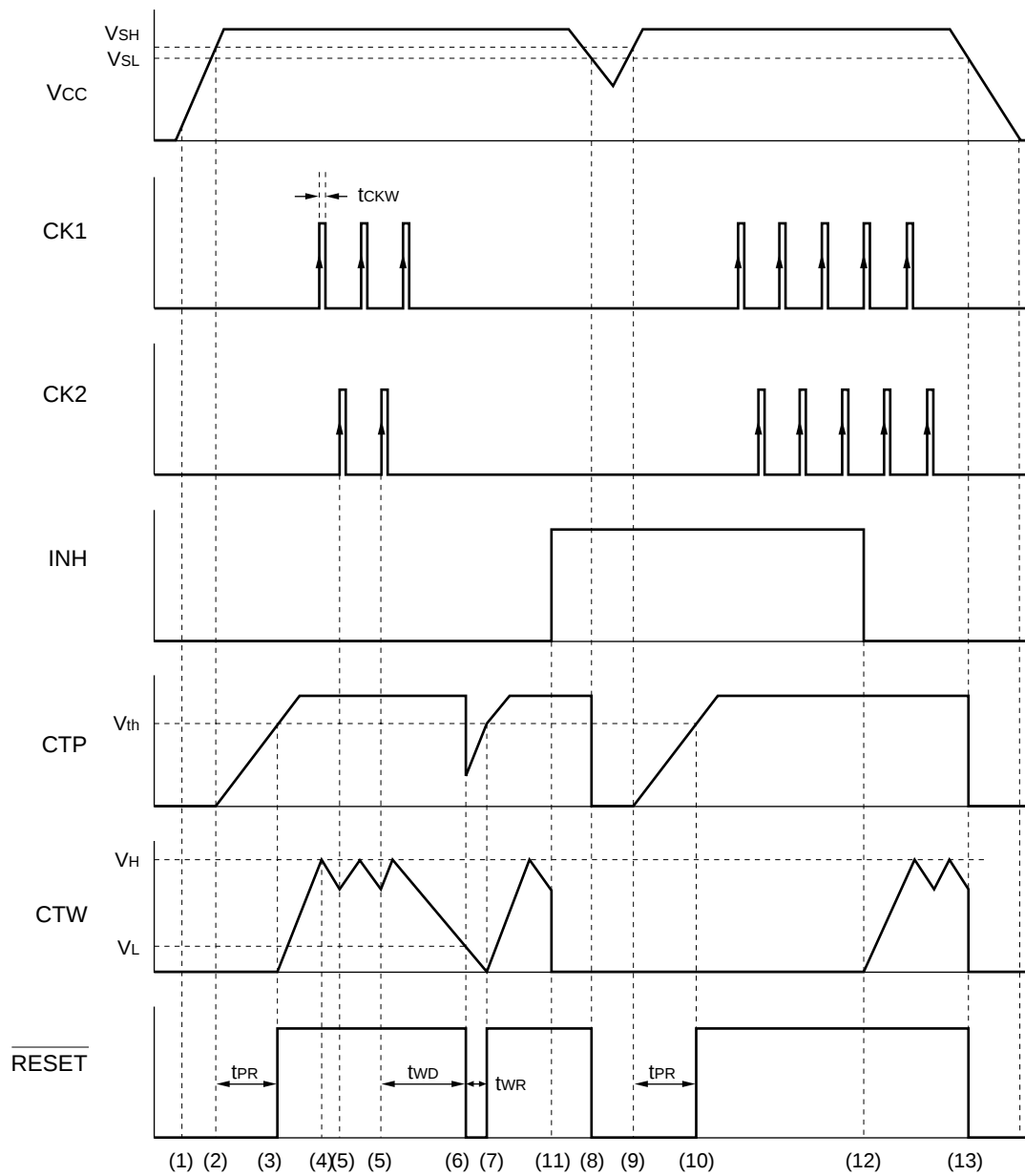


## 3. Single-clock input monitoring (Positive clock pulse)

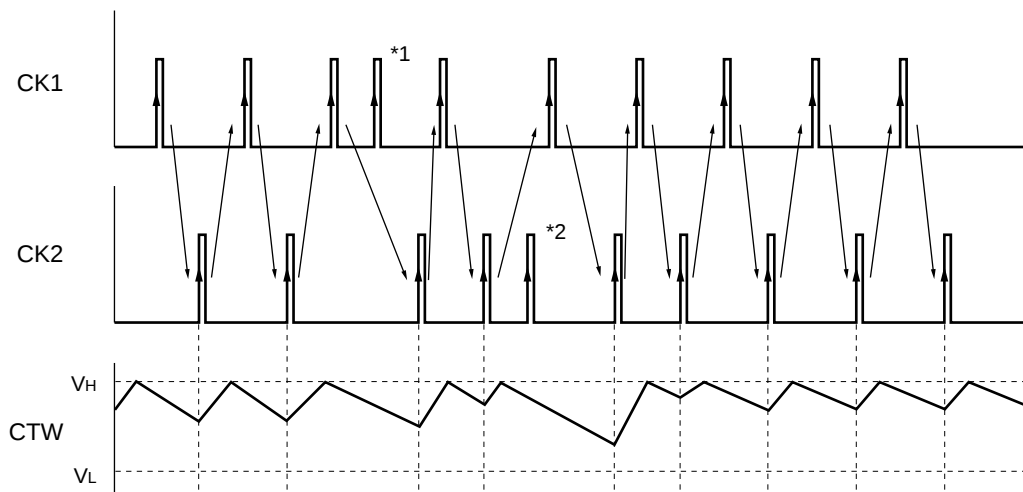


Note: The MB3793 can monitor only one clock.  
 The MB3793 checks the clock signal at every other input pulse. Therefore, set watchdog timer monitor time  $t_{WD}$  to the time that allows the MB3793 to monitor the period twice as long as the input clock pulse.

## 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

See “1. Basic operation (positive clock pulse)” under “■ DIAGRAM”.

### 2. Negative clock pulse input

See “2. Basic operation (negative clock pulse)” under “■ 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.

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

### 4. Description of Operations

The numbers given to the following items correspond to numbers (1) to (13) used in “■ 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 about 4.60 V.
- (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  $\overline{RESET}$  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 timer monitor time  $t_{PR}$  is set with the following equation:

$$t_{PR} \text{ (ms)} \approx A \times C_{TP} \text{ (}\mu\text{F)}$$

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  $C_{TW}$  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  $C_{TW}$  pin is set to the “L” level threshold voltage  $V_L$  or less and the MB3793 outputs a reset signal (setting the  $\overline{RESET}$  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:

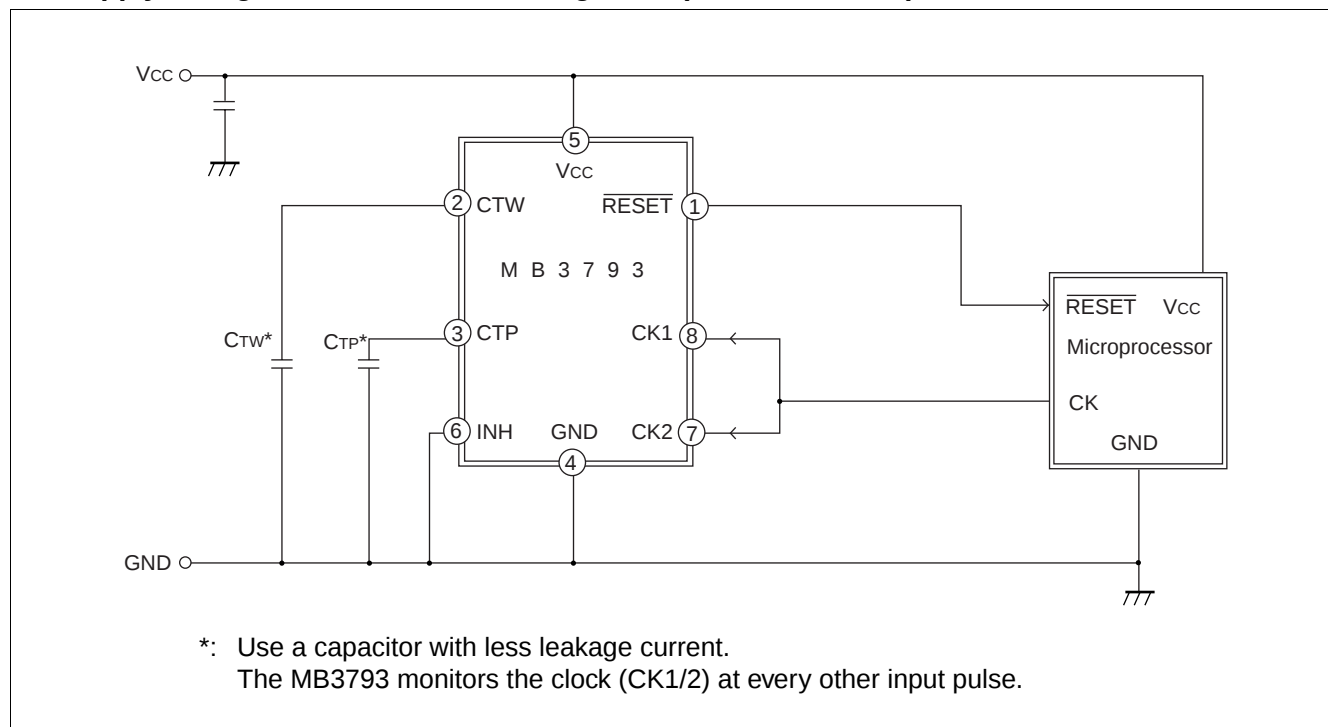
$$t_{WD} \text{ (ms)} \approx B \times C_{TW} \text{ (}\mu\text{F)}$$

The value of B is hardly affected by the supply voltage; it is about 1500 with  $V_{CC} = 5.0$  V.

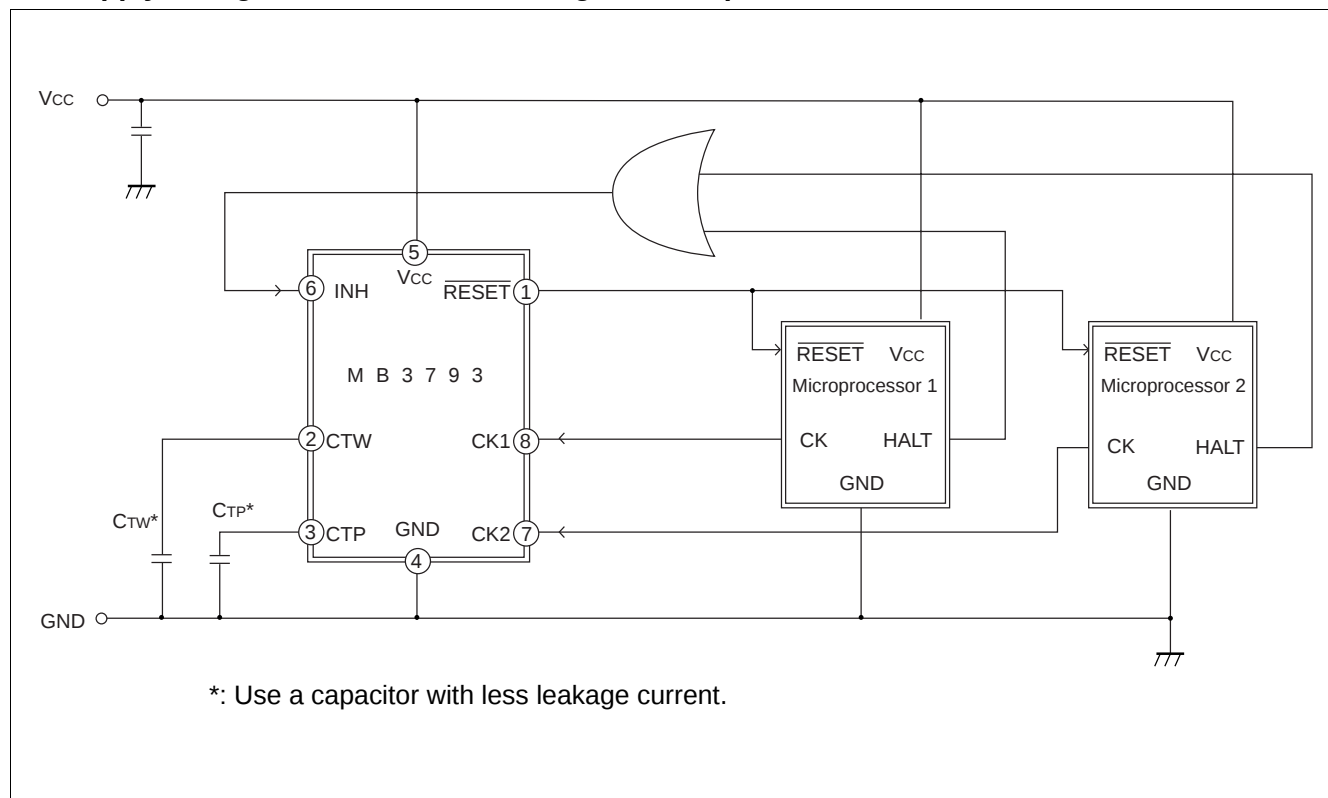
- (7) When a certain period of time  $t_{WR}$  has passed (until the CTP pin voltage reaches or exceeds  $V_{th}$  again after recharging the  $C_{TP}$ ), the MB3793 cancels the reset signal and starts operating the watchdog timer.  
The watchdog timer monitor reset time  $t_{WR}$  is set with the following equation:  
 $t_{WR} \text{ (ms)} \approx D \times C_{TP} \text{ (}\mu\text{F)}$   
The value of D is about 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  $\overline{RESET}$  pin to “L” level from “H” level).  
The value of  $V_{SL}$  is 4.5 V
- (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.
- (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.

## ■ APPLICATION EXAMPLE

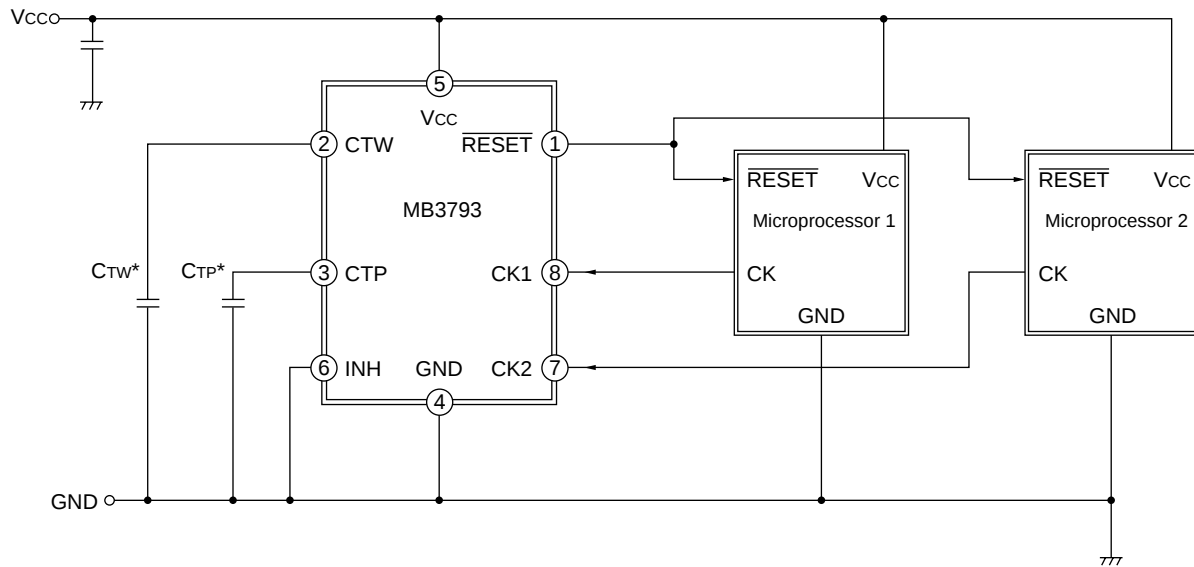
### 1. Supply voltage monitor and watchdog timer (1-clock monitor)



### 2. Supply voltage monitor and watchdog timer stop



## ■ TYPICAL APPLICATION



\*: Use a capacitor with less leakage current.

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

$$t_{PR} [\text{ms}] \approx A \times C_{TP} [\mu\text{F}]$$

$$t_{WD} [\text{ms}] \approx B \times C_{TW} [\mu\text{F}] + C \times C_{TP} [\mu\text{F}]$$

$$\text{However, when } \frac{C_{TP}}{C_{TW}} \leq \text{about } 10, t_{WD} [\text{ms}] \approx B \times C_{TW} [\mu\text{F}]$$

$$t_{WR} [\text{ms}] \approx D \times C_{TP} [\mu\text{F}]$$

Values of A, B, C, and D

| A    | B    | C | D   | Remark                   |
|------|------|---|-----|--------------------------|
| 1300 | 1500 | 3 | 100 | $V_{CC} = 5.0 \text{ V}$ |

### 2. (Example) when $C_{TP} = 0.1 \mu\text{F}$ and $C_{TW} = 0.01 \mu\text{F}$

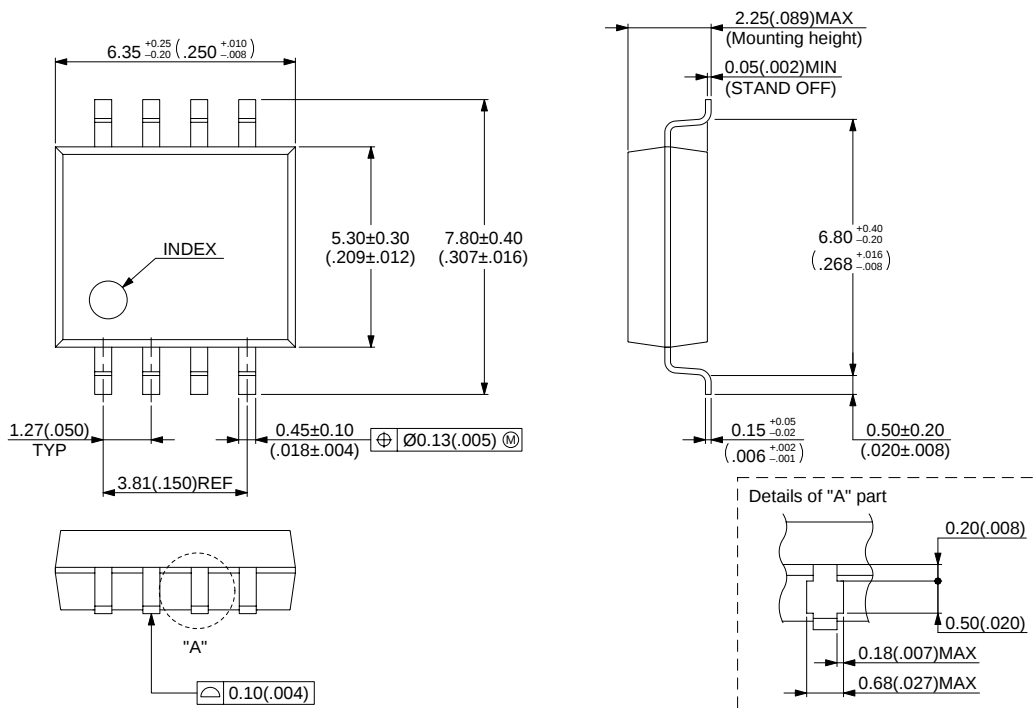
|              |          |               |
|--------------|----------|---------------|
| time<br>(ms) | $t_{PR}$ | $\approx 130$ |
|              | $t_{WD}$ | $\approx 15$  |
|              | $t_{WR}$ | $\approx 10$  |

## ■ ORDERING INFORMATION

| Part number  | Package                           | Remarks |
|--------------|-----------------------------------|---------|
| MB3793-45PF  | 8-pin Plastic SOP<br>(FPT-8P-M01) |         |
| MB3793-45PNF | 8-pin Plastic SOL<br>(FPT-8P-M02) |         |

## ■ PACKAGE DIMENSIONS

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



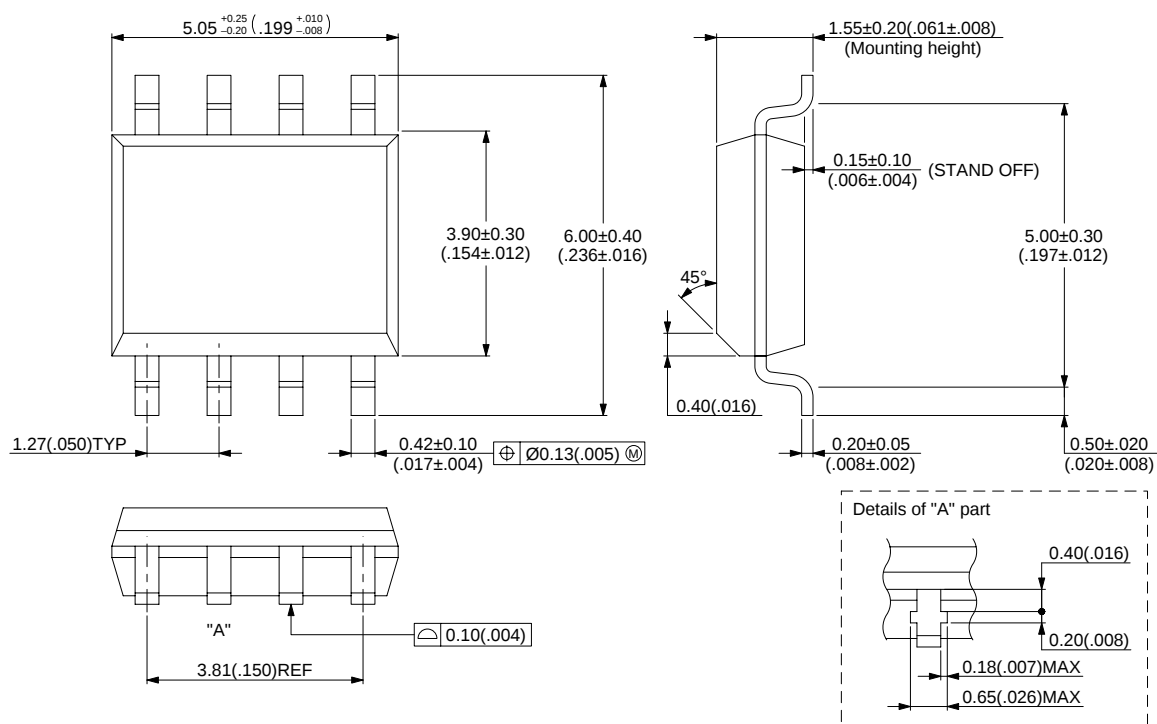
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Dimensions in mm (inches)

(Continued)

(Continued)

## 8-pin plastic SOL (FPT-8P-M02)



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Dimensions in mm (inches)

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