

## Power-Voltage Monitoring IC with Watchdog Timer Datasheet

### 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
MB3793-28A	3793AR	2.8 V

### Features

- Precise detection of power voltage fall:  $\pm 2.5\%$
- Detection voltage with hysteresis
- Low power dispersion:  $I_{CC} = 41 \mu\text{A}$  (Typ)
- Internal dual-input watchdog timer
- Watchdog timer halt function
- Independently-set watchdog and reset times

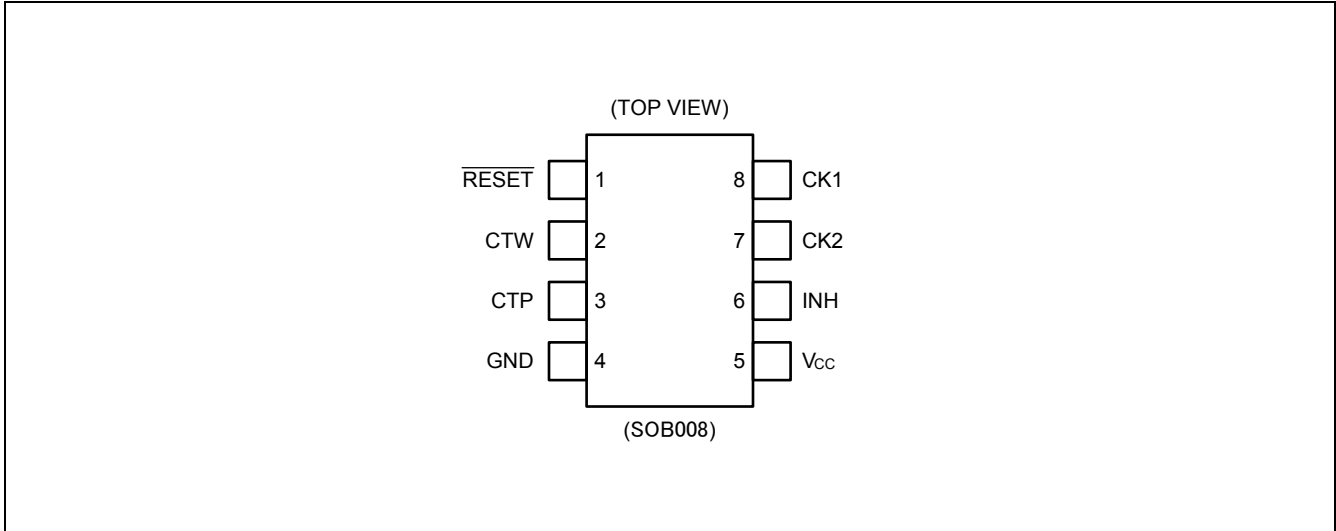
### Application

- Arcade Amusement      etc.

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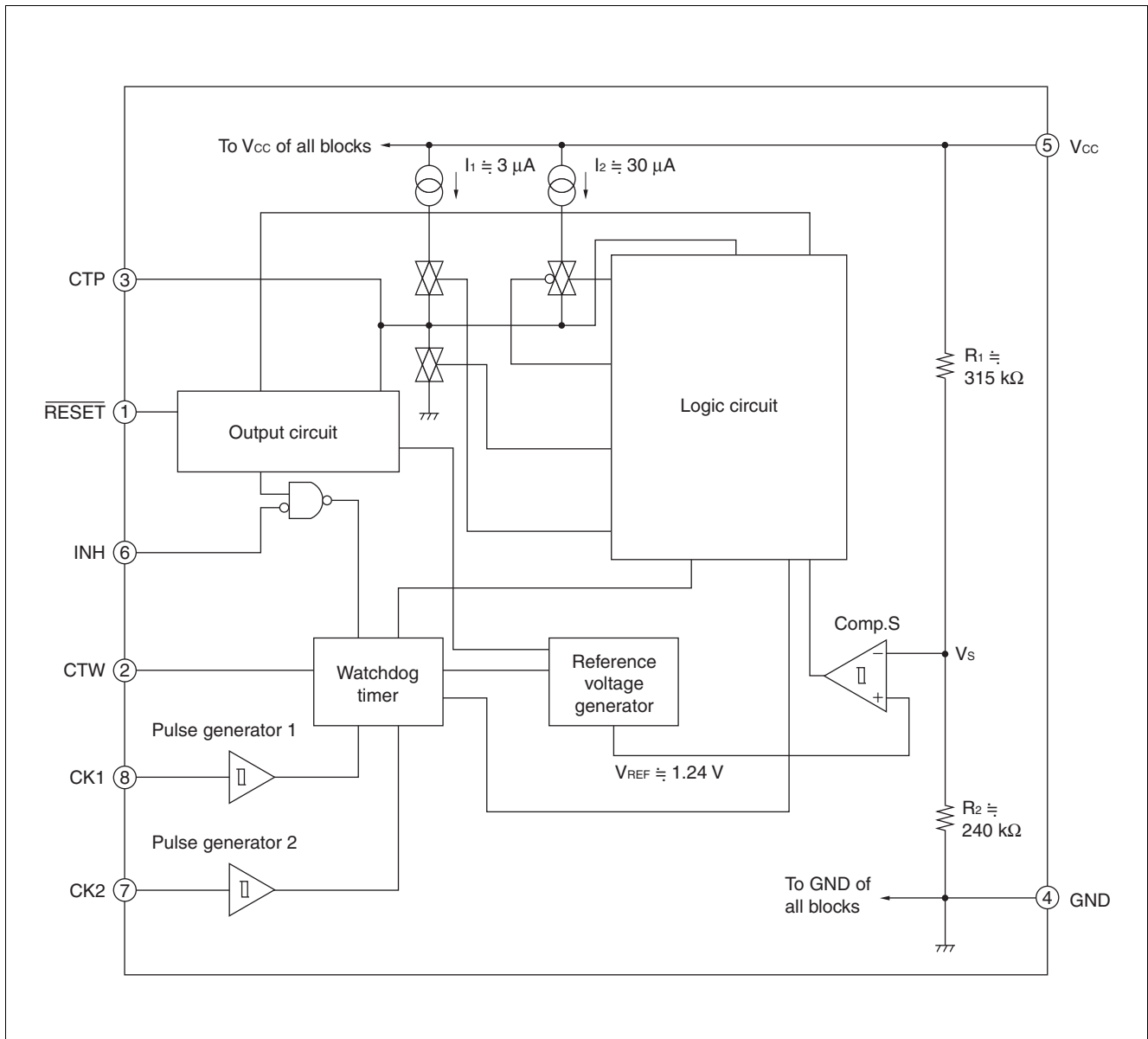
## 1. Pin Assignment



## 2. Pin Description

Pin No.	Symbol	Description
1	$\overline{\text{RESET}}$	Outputs reset pin
2	CTW	Sets watchdog timer monitoring time pin
3	CTP	Sets power-on reset hold time pin
4	GND	Ground pin
5	VCC	Power supply pin
6	INH	This pin forces the watchdog timer on/off. When this pin is High level, the watchdog timer is stopped.
7	CK2	Inputs clock 2 pin
8	CK1	Inputs clock 1 pin

### 3. Block Diagram



## 4. Block Functions

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

### 4.2 Output Circuit

The output circuit has a comparator to control the reset signal ( $\overline{\text{RESET}}$ ) 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 ( $\overline{\text{RESET}}$ ) output buffer has the CMOS organization, no pull-up resistor is needed.

### 4.3 Pulse Generator

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

### 4.4 Watchdog Timer

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

### 4.5 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.

## 5. 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	$V_{CC} + 0.3$ ( $\leq +7$ )	V
	CK2	$V_{CK2}$			
	INH	$V_{INH}$			
Reset output voltage*	$\overline{RESET}$	$V_{OL}$	-0.3	$V_{CC} + 0.3$ ( $\leq +7$ )	V
		$V_{OH}$			
Reset output current	$\overline{RESET}$	$I_{OL}$	-10	+10	mA
		$I_{OH}$			
Power dissipation	$P_D$	$T_a \leq +85 \text{ }^\circ\text{C}$	/	200	mW
Storage temperature	$T_{stg}$	—	-55	+125	$^\circ\text{C}$

\* : 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.

## 6. Recommended Operating Conditions

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power supply voltage	$V_{CC}$	—	1.2	3.3	4.0	V
Reset ( $\overline{RESET}$ ) 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	$\mu\text{F}$
Watchdog-timer monitoring time setting capacity*	$C_{TW}$	—	0.001	0.01	1	$\mu\text{F}$
Operating ambient temperature	$T_a$	—	-40	+25	+85	$^\circ\text{C}$

\* : 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.

## 7. Electrical Characteristics

### 7.1 DC Characteristics

 (V<sub>CC</sub> = +3.3 V, Ta = +25°C)

Parameter	Symbol	Conditions	Value			Unit	
			Min	Typ	Max		
Power current	ICC1	After exit from reset	—	41	55	μA	
Detection voltage	VSL	VCC falling	Ta = +25°C	2.73	2.80	2.87	V
			Ta = -40 to +85°C	2.69*	2.80	2.91*	
	VSH	VCC rising	Ta = +25°C	2.80	2.87	2.94	V
			Ta = -40 to +85°C	2.76*	2.87	2.98*	
Detection voltage hysteresis difference	VSHYS	VSH - VSL	25	70	100	mV	
CK input threshold voltage	VCIH	—	0.7*	1.3	1.9	V	
	VCIL	—	0.5	1.0	1.5*	V	
CK input hysteresis	VCHYS	—	0.1*	0.3	0.6*	V	
INH input voltage	VIH	—	2.2	—	V <sub>CC</sub>	V	
	VIL	—	0	—	0.8	V	
Input current (CK1,CK2,INH)	I <sub>IH</sub>	V <sub>IH</sub> = V <sub>CC</sub>	—	0	1.0	μA	
	I <sub>IL</sub>	V <sub>IL</sub> = 0 V	-1.0	0	—	μA	
Reset output voltage	VOH	$\overline{\text{I}}\text{RESET} = -3 \text{ mA}$	2.8	3.1	—	V	
	VOL	$\overline{\text{I}}\text{RESET} = +3 \text{ mA}$	—	0.12	0.4	V	
Reset-output minimum power voltage	VCCL	$\overline{\text{I}}\text{RESET} = +50 \mu\text{A}$	—	0.8	1.2	V	

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

### 7.2 AC Characteristics

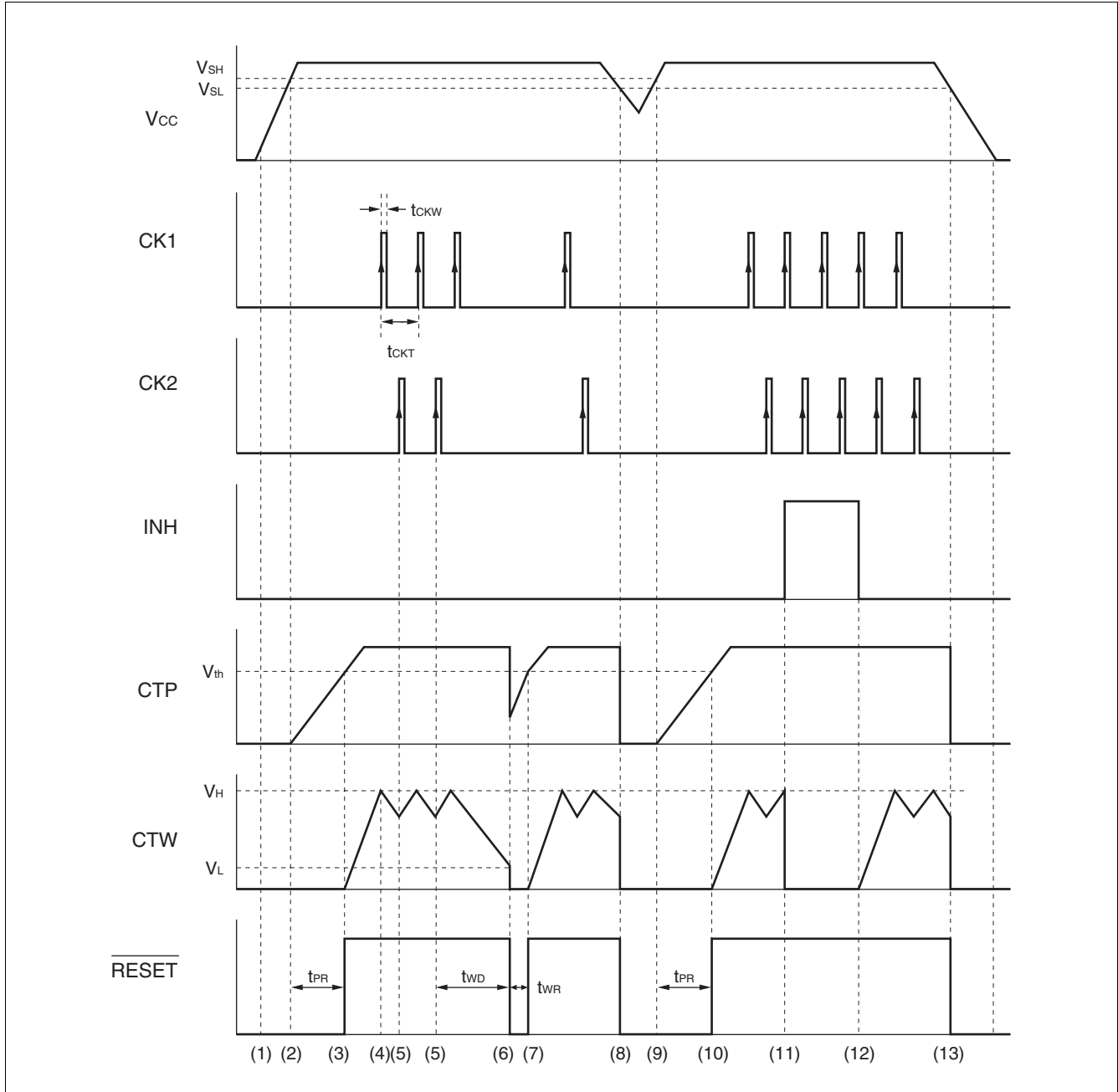
 (V<sub>CC</sub> = +3.3 V, Ta = +25°C)

Parameter	Symbol	Conditions	Value			Unit
			Min	Typ	Max	
Power-on reset hold time	tPR	CTP = 0.1 μF	30	75	120	ms
Watchdog timer monitoring time	tWD	CTW = 0.01 μF, CTP = 0.1 μF	8	16	24	ms
Watchdog timer reset time	tWR	CTP = 0.1 μF	2	5.5	9	ms
CK input pulse width	tCKW	—	500	—	—	ns
CK input pulse cycle	tCKT	—	20	—	—	μs
Reset ( $\overline{\text{RESET}}$ ) output transition time	Rising	tr*	—	—	500	ns
	Falling	tf*	—	—	500	ns

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

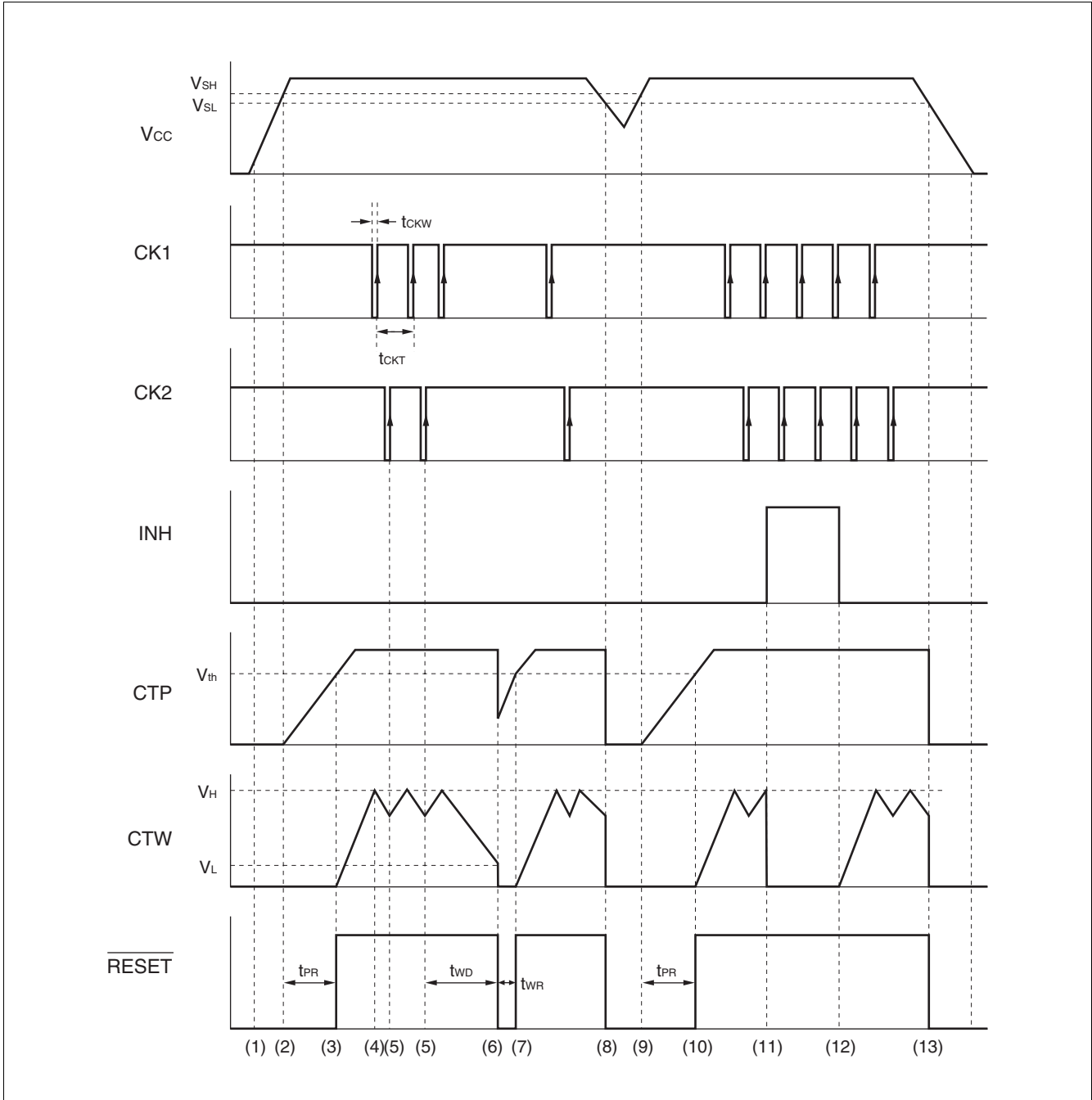
## 8. Timing Diagram

### 8.1 Basic Operation (Positive Clock Pulse)

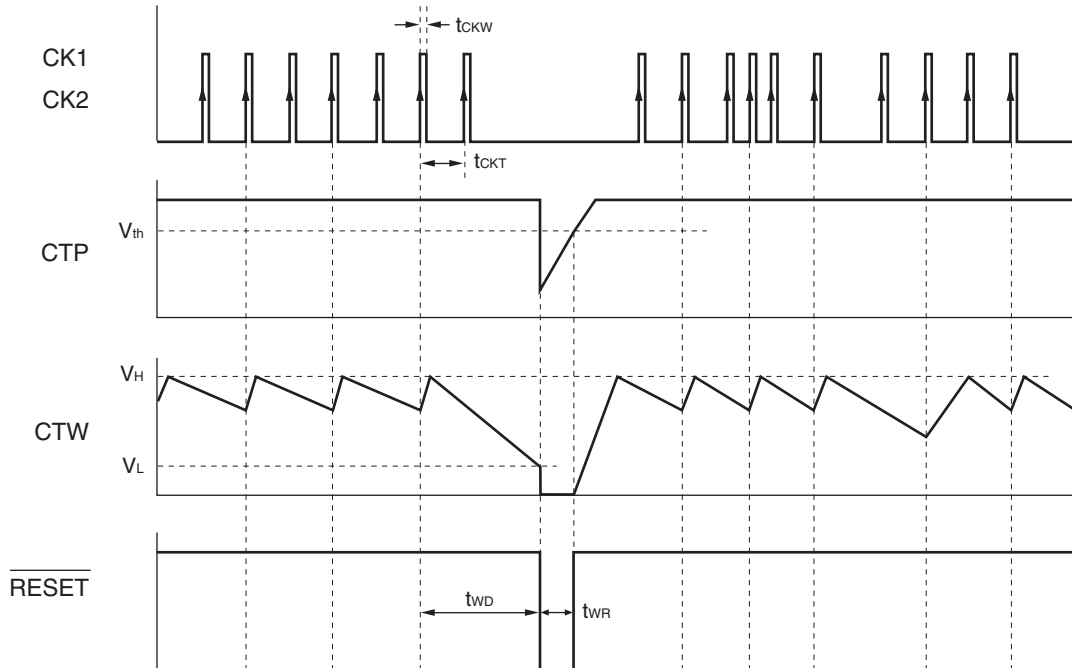




8.2 Basic Operation (Negative Clock Pulse)

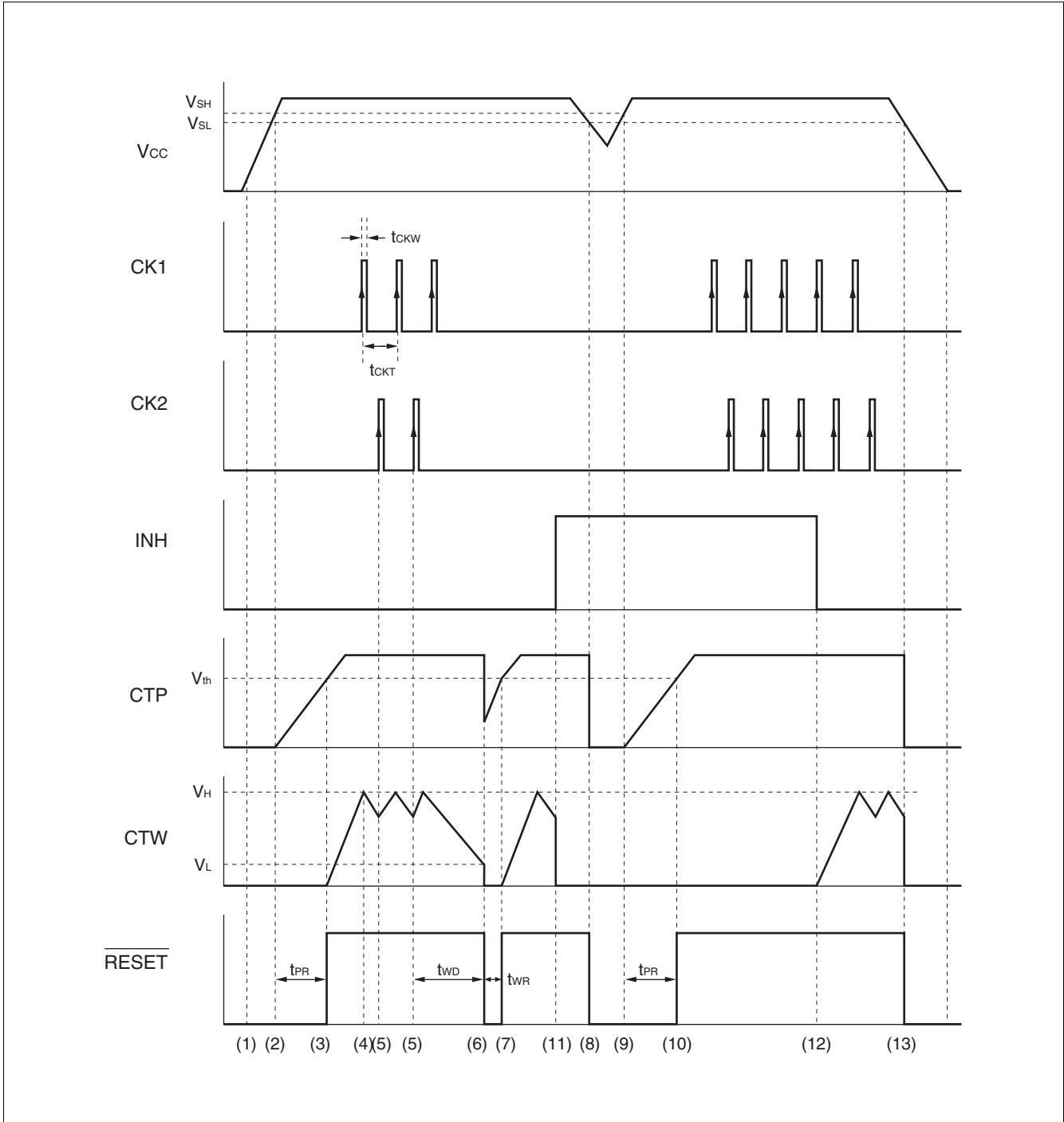


### 8.3 Single-clock Input Monitoring (Positive Clock Pulse)

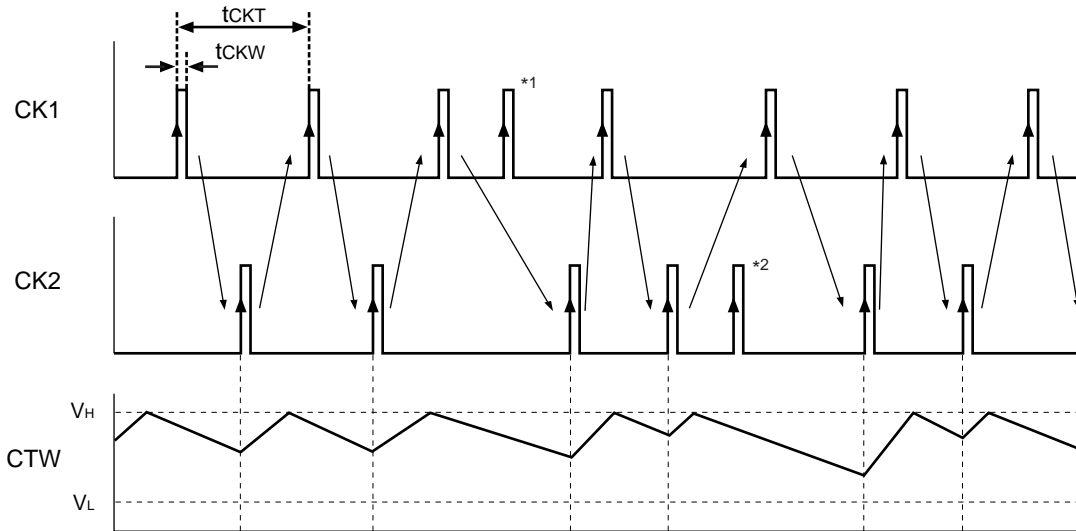


Note : The MB3793 can monitor only one clock.  
 The MB3793 checks the clock signal at every other input pulse.  
 Therefore, set watchdog timer monitor time  $t_{WD}$  to the time that allows the MB3793 to monitor the period twice as long as the input clock pulse.

**8.4 Inhibition Operation (Positive Clock Pulse)**



8.5 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<sub>TW</sub>) 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.

## 9. Operation Sequence

### 9.1 Positive Clock Pulse Input

Refer to “Basic Operation (Positive Clock Pulse)” under “Timing Diagram”.

### 9.2 Negative Clock Pulse Input

Refer to “Basic Operation (Negative Clock Pulse)” under “Timing Diagram”.

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

### 9.3 Single-clock Input 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 “Single-clock Input Monitoring (Positive Clock Pulse)” under “Timing Diagram”.

### 9.4 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 2.87 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  $\overline{RESET}$  pin to “H” level from “L” level).  
The  $V_{th}$  value is about 2.4 V with  $V_{CC} = 3.3$  V

The power-on reset hold time  $t_{PR}$  is set with the following equation:

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

The value of A is about 750 with  $V_{CC} = 3.3$  V and about 700 with  $V_{CC} = 3.0$  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  $\overline{RESET}$  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:  
$$t_{WD} \text{ (ms)} \approx B \times C_{TW} \text{ (\mu F)} + C \times C_{TP} \text{ (\mu F)}$$
  
The value of B is hardly affected by the power supply voltage; it is about 1600 with  $V_{CC} = 3.0$  V to 3.3 V.  
The value of C is 0.  
For this reason:  
$$t_{WD} \text{ (ms)} \approx B \times C_{TW} \text{ (\mu F)}$$

- (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 55 with  $V_{CC} = 3.3 \text{ V}$  and about 50 with  $V_{CC} = 3.0 \text{ V}$ .  
 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 RESET pin to “L” level from “H” level).  
 The value of  $V_{SL}$  is 2.80 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

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

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

However, when  $C_{TP}/C_{TW} \approx 10$  or less,  $t_{WD} \text{ [ms]} \approx B \times C_{TW} \text{ [}\mu\text{F]}$

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

Values of A, B, C, and D

A	B	C	D	Remark
750	1600	0	55	$V_{CC} = 3.3 \text{ V}$
700	1600	0	50	$V_{CC} = 3.0 \text{ V}$

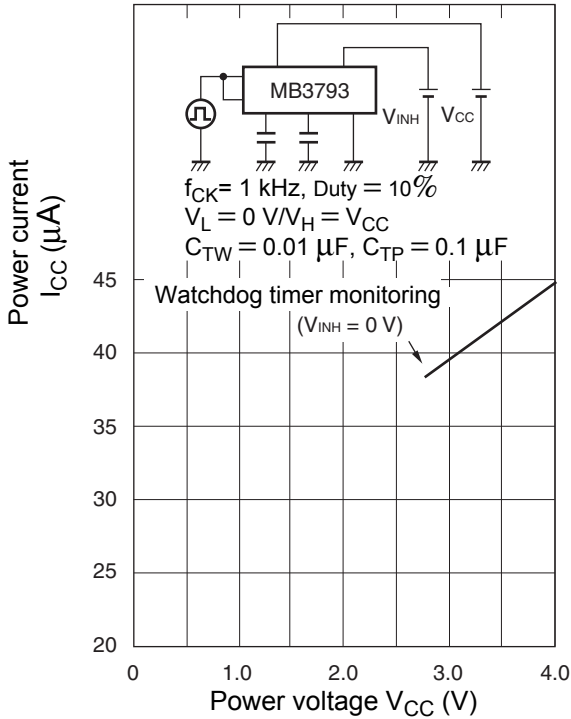
Note: The width of value of  $t_{PR}$ ,  $t_{WD}$  and  $t_{WR}$  becomes the same ratio as width (Min, Max) of each specification value.

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

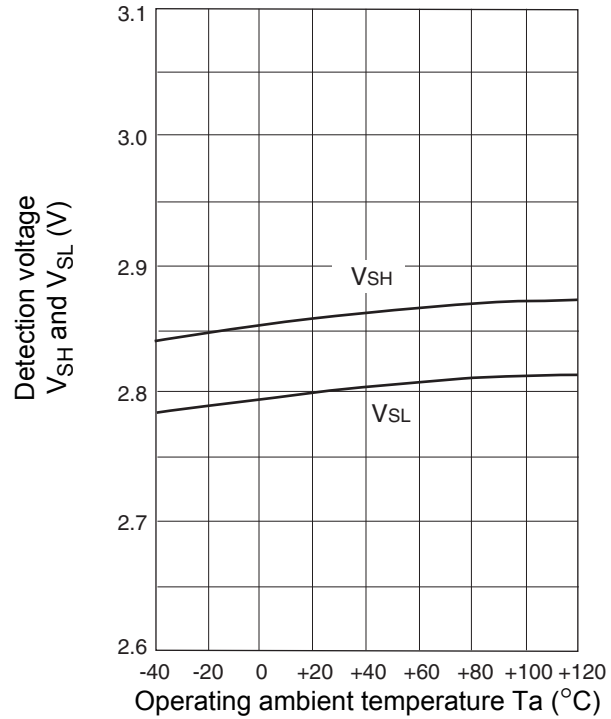
time (ms)	Symbol	$V_{CC} = 3.3 \text{ V}$	$V_{CC} = 3.0 \text{ V}$
	$t_{PR}$	75	70
	$t_{WD}$	16	16
	$t_{WR}$	5.5	5

10. Typical Characteristics

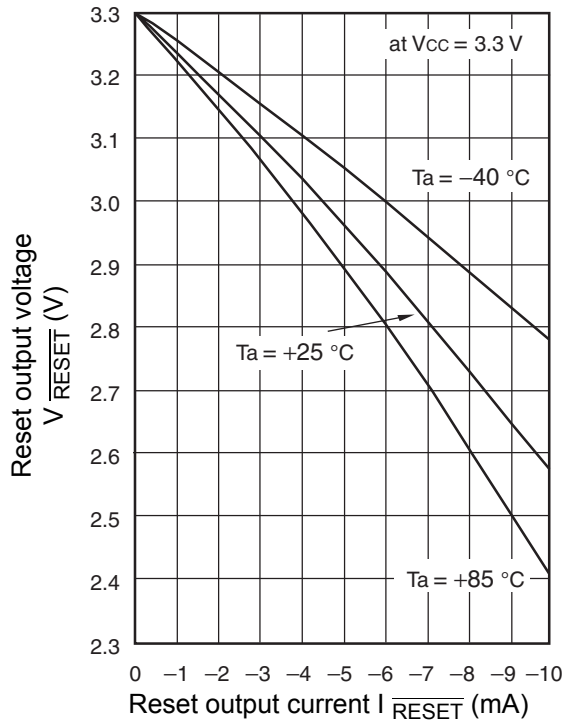
$I_{CC} - V_{CC}$  characteristics



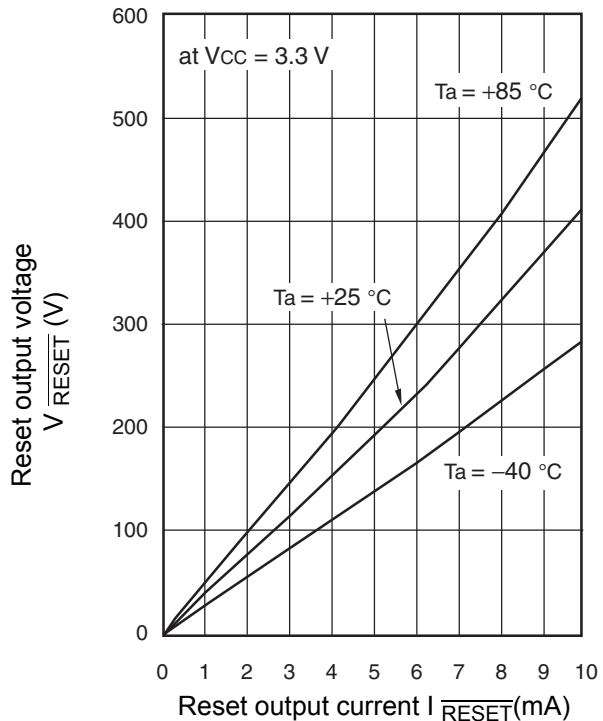
$V_{SH}, V_{SL} - T_a$  characteristics



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



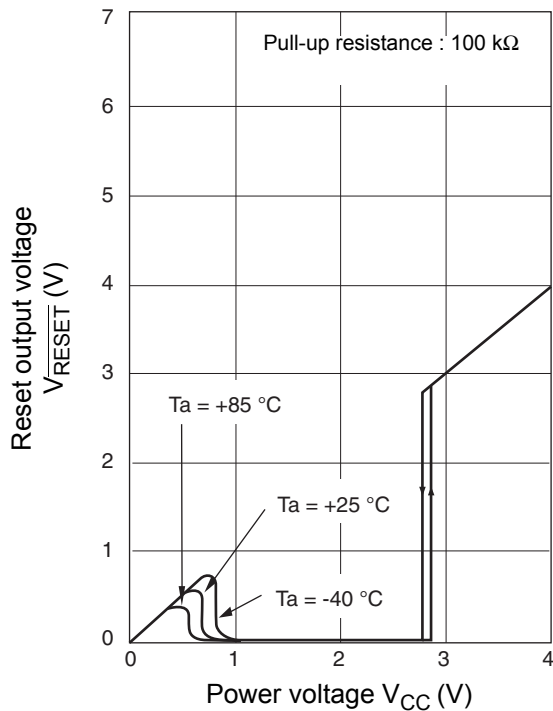
$V_{\overline{RESET}} - I_{\overline{RESET}}$  characteristics (N-MOS side)



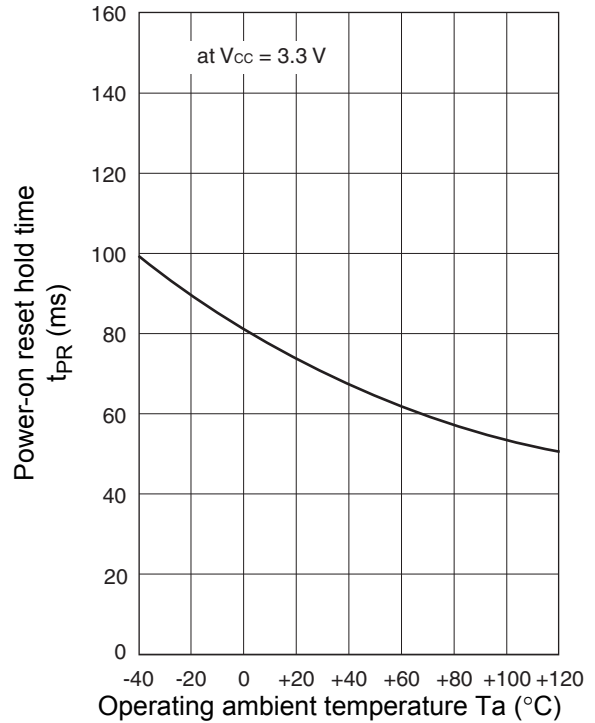
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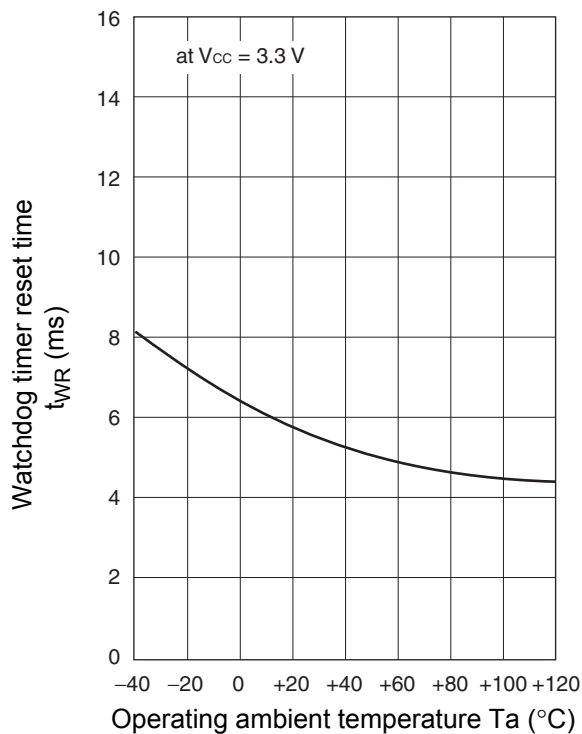
**$\overline{V}_{RESET} - V_{CC}$  characteristics**



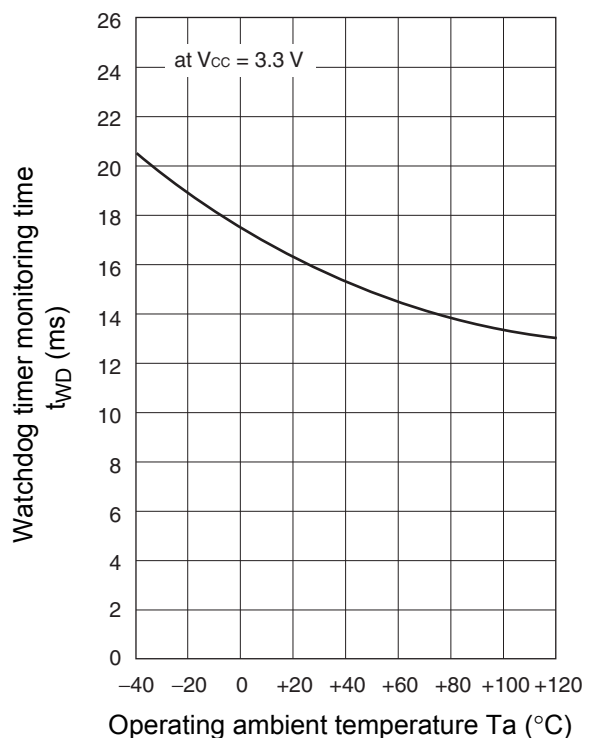
**$t_{PR} - T_a$  characteristics**



**$t_{WR} - T_a$  characteristics**



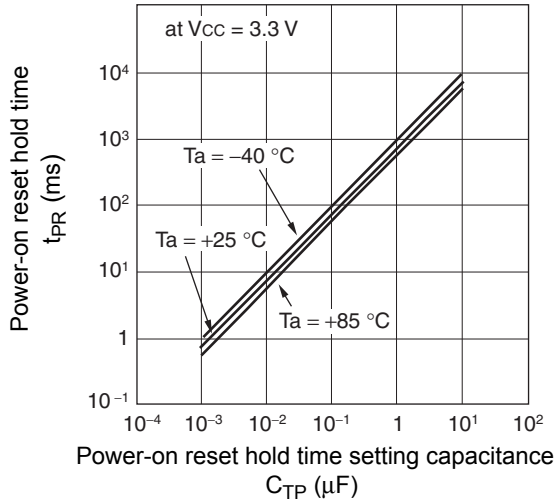
**$t_{WD} - T_a$  characteristics**



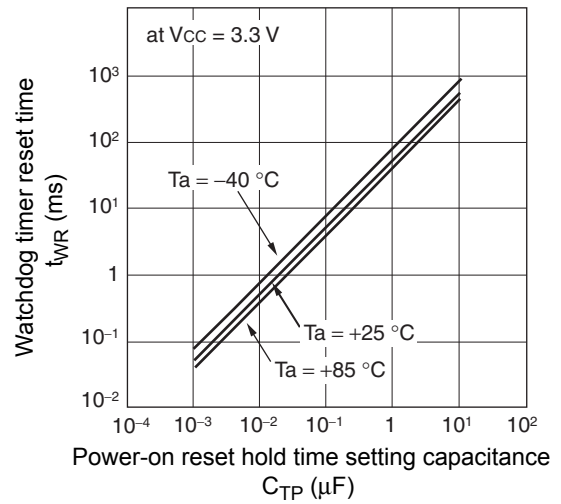


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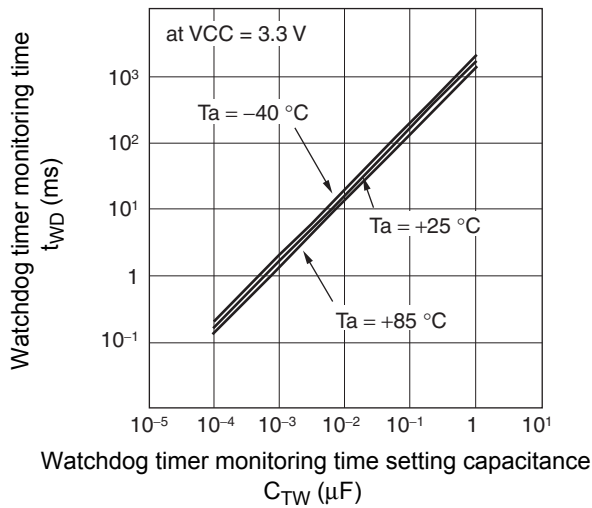
**$t_{PR}$  -  $C_{TP}$  characteristics**



**$t_{WR}$  -  $C_{TP}$  characteristics**



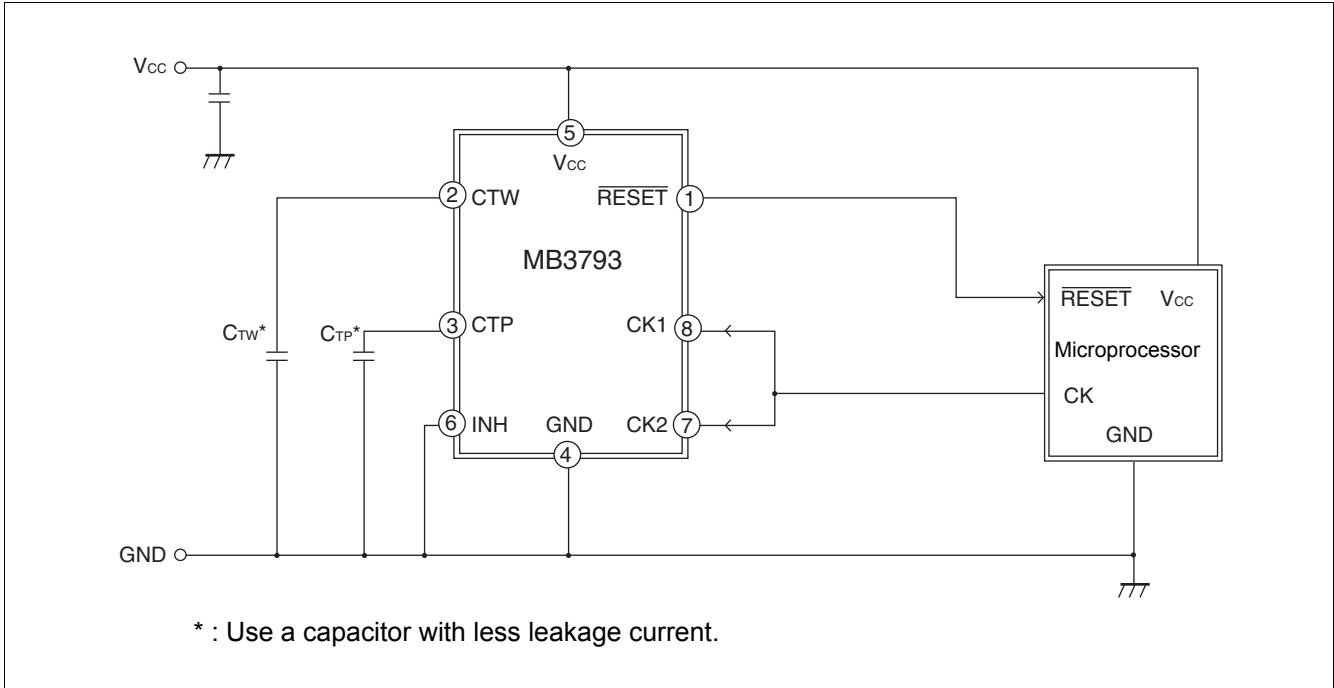
**$t_{WD}$  -  $C_{TW}$  characteristics**



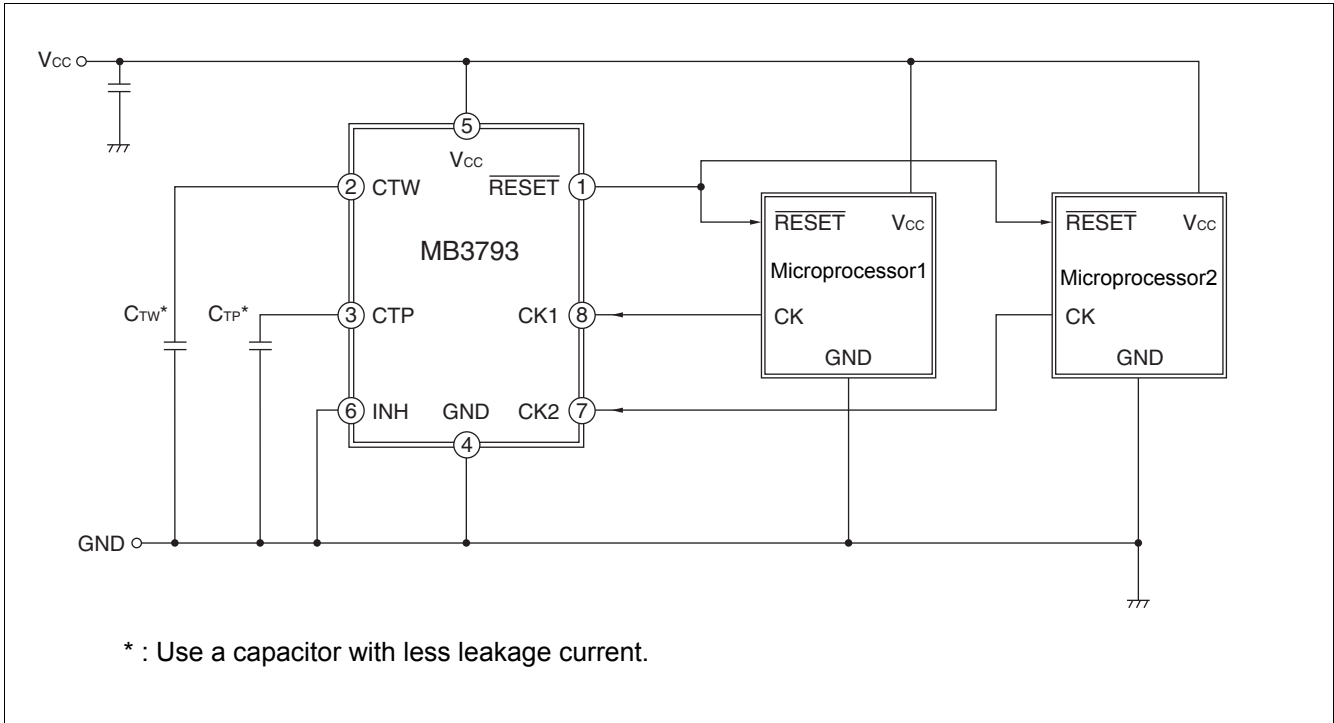
## 11. Application Example

### 11.1 Supply Voltage Monitor and Watchdog Timer

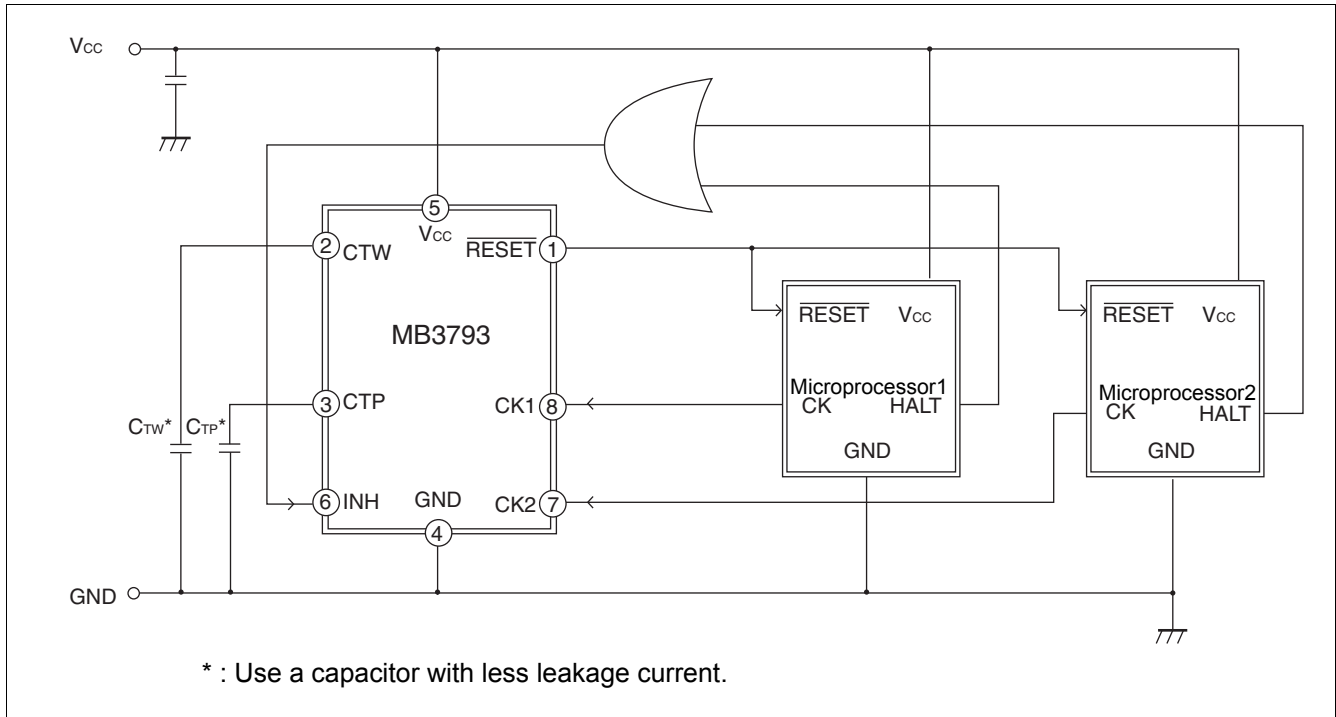
#### 11.1.1 1-clock monitor



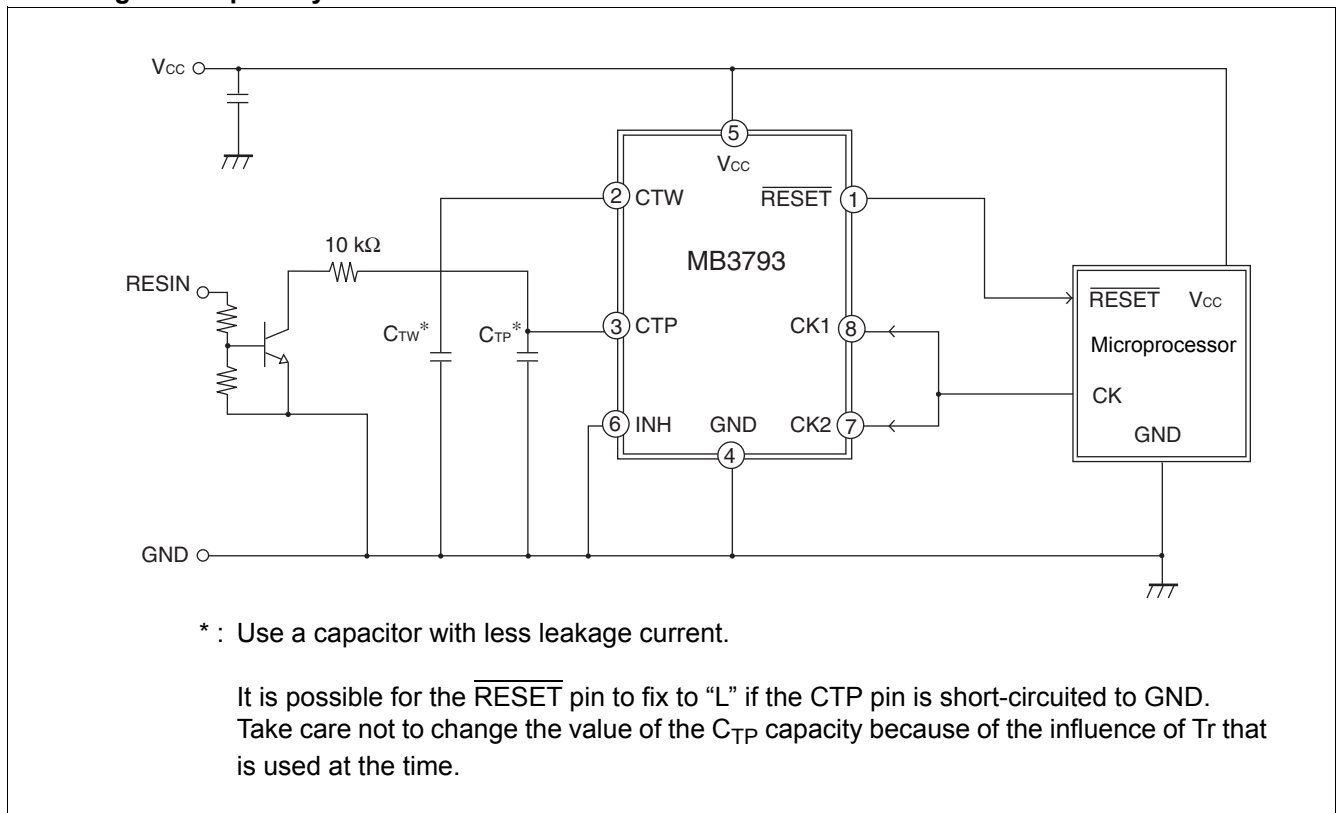
#### 11.1.2 2-clock monitor



### 11.2 Supply Voltage Monitor and Watchdog Timer Stop



### 11.3 Setting of Compulsory Reset



## 12. Usage Precaution

### 1. Do not Configure the IC Over the Maximum Ratings

If the IC is used over the maximum ratings, the LSI 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 LSI 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  $-0.3\text{ V}$  may create parasitic transistors on LSI lines, which can cause malfunctions.

## 13. Ordering Information

Part Number	Package	Remarks
MB3793-28APNF	8-pin plastic SOP (SOB008)	-

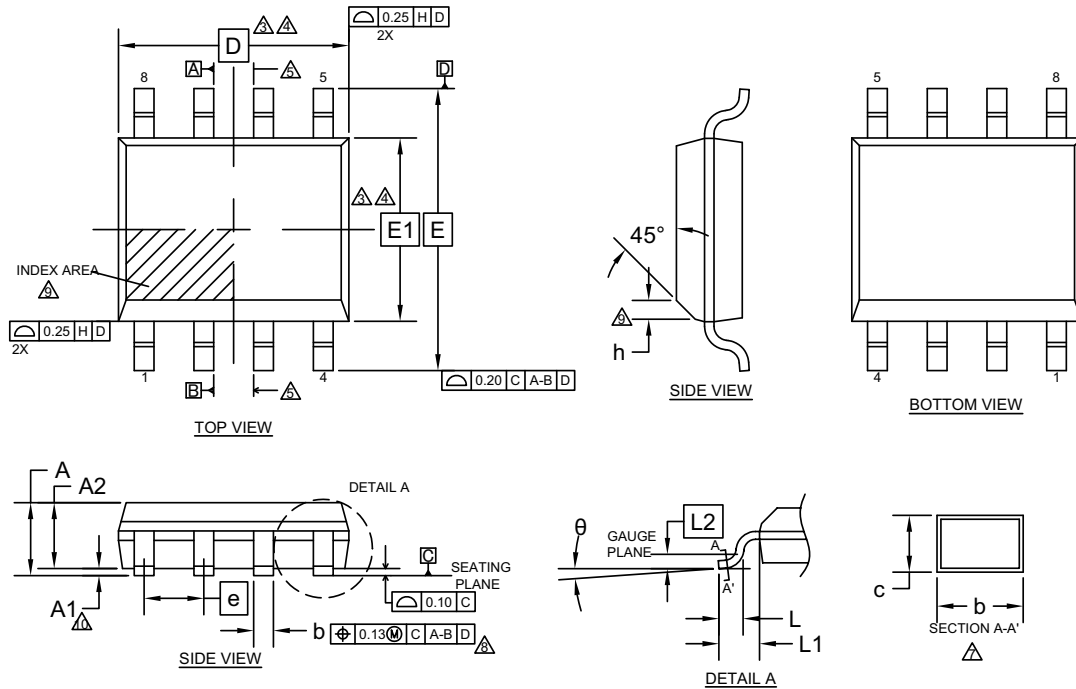
## 14. RoHS Compliance Information of Lead (Pb) Free version

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.

15. Package Dimensions

Package Code: SOB008



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	—	—	1.75
A1	0.05	—	0.25
A2	1.30	1.40	1.50
D	5.05 BSC.		
E	6.00 BSC.		
E1	3.90 BSC.		
θ	0°	—	8°
c	0.15	—	0.25
b	0.36	0.44	0.52
L	0.45	0.60	0.75
L 1	1.05 REF		
L 2	0.25 BSC		
e	1.27 BSC.		
h	0.40 BSC.		

NOTES

- ALL DIMENSIONS ARE IN MILLIMETER.
- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
- DIMENSIONING D INCLUDE MOLD FLASH, DIMENSIONING E1 DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.025 mm PER SIDE. D and E1 DIMENSION ARE DETERMINED AT DATUM H.
- THE PACKAGE TOP MAY BE SMALLER THAN THE PACKAGE BOTTOM. DIMENSIONING D and E1 ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY EXCLUSIVE OF MOLD FLASH, THE BAR BURRS, GATE BURRS AND INTERLEAD FLASH, BUT INCLUDING ANY MISMATCH BETWEEN THE TOP AND BOTTOM OF THE PLASTIC BODY.
- DATUMS A & B TO BE DETERMINED AT DATUM H.
- "N" IS THE MAXIMUM NUMBER OF TERMINAL POSITIONS FOR THE SPECIFIED PACKAGE LENGTH.
- THE DIMENSION APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10 mm TO 0.25mm FROM THE LEAD TIP.
- DIMENSION "b" DOES NOT INCLUDE THE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.10mm TOTAL IN EXCESS OF THE "b" DIMENSION AT MAXIMUM MATERIAL CONDITION. THE DAMBAR MAY NOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT.
- THIS CHAMFER FEATURE IS OPTIONAL. IF IT IS NOT PRESENT, THEN A PIN 1 IDENTIFIER MUST BE LOCATED WITHIN THE INDEX AREA INDICATED
- "A1" IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY EXCLUDING THE LID AND OR THERMAL ENHANCEMENT ON CAVITY DOWN PACKAGE CONFIGURATIONS.
- JEDEC SPECIFICATION NO. REF : N/A

002-15856 Rev. \*\*

**16. Document History**

Document Title: MB3793-28A Power-Voltage Monitoring IC with Watchdog Timer Datasheet Document Number: 002-08559				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	—	TAOA	12/03/2009	Migrated to Cypress and assigned document number 002-08559. No change to document contents or format.
*A	5186892	TAOA	03/31/2016	Updated to Cypress template
*B	5606220	HIXT	02/07/2017	Updated <a href="#">Pin Assignment</a> : Change the package name from FPT-8P-M01 to SOE008 Updated <a href="#">Ordering Information</a> : Change the package name from FPT-8P-M01 to SOE008 Updated <a href="#">Package Dimensions</a> : Updated to Cypress format Deleted "Marking Format (Lead Free version)" Deleted "Labeling Sample (Lead free version)" Deleted "MB3793-28APNF Recommended Conditions of Moisture Sensitivity Level"

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