FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27401-6E

ASSP

Power Supply Monitor with Watch-Dog Timer

MB3773

■ DESCRIPTION

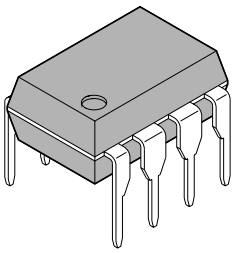
MB3773 generates the reset signal to protect an arbitrary system when the power-supply voltage momentarily is intercepted or decreased. It is IC for the power-supply voltage watch and “Power on reset” is generated at the normal return of the power supply. MB3773 sends the microprocessor the reset signal when decreasing more than the voltage, which the power supply of the system specified, and the computer data is protected from an accidental deletion.

In addition, the watchdog timer for the operation diagnosis of the system is built into, and various microprocessor systems can provide the fail-safe function. If MB3773 does not receive the clock pulse from the processor for an specified period, MB3773 generates the reset signal.

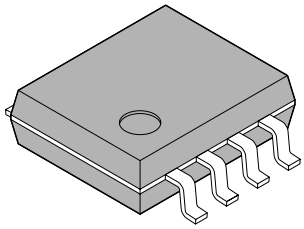
■ FEATURES

- Precision voltage detection (V_S = 4.2 V ± 2.5 %)
- Detection threshold voltage has hysteresis function
- Low voltage output for reset signal (V_{CC} = 0.8 V Typ)
- Precision reference voltage output (V_R = 1.245 V ± 1.5%)
- With built-in watchdog timer of edge trigger input.
- External parts are few.(1 piece in capacity)
- The reset signal outputs the positive and negative both theories reason.

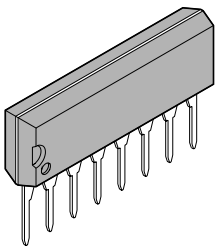
■ PACKAGES



(DIP-8P-M01)



(FPT-8P-M01)



(SIP-8P-M03)

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

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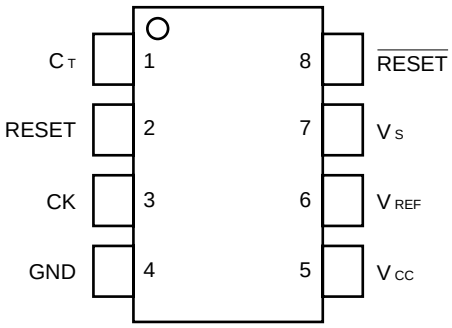
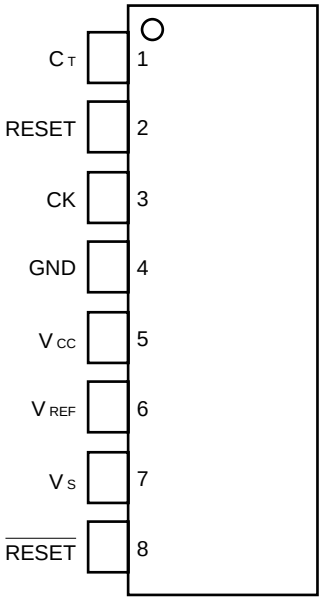
■ PIN ASSIGNMENT

(TOP VIEW)



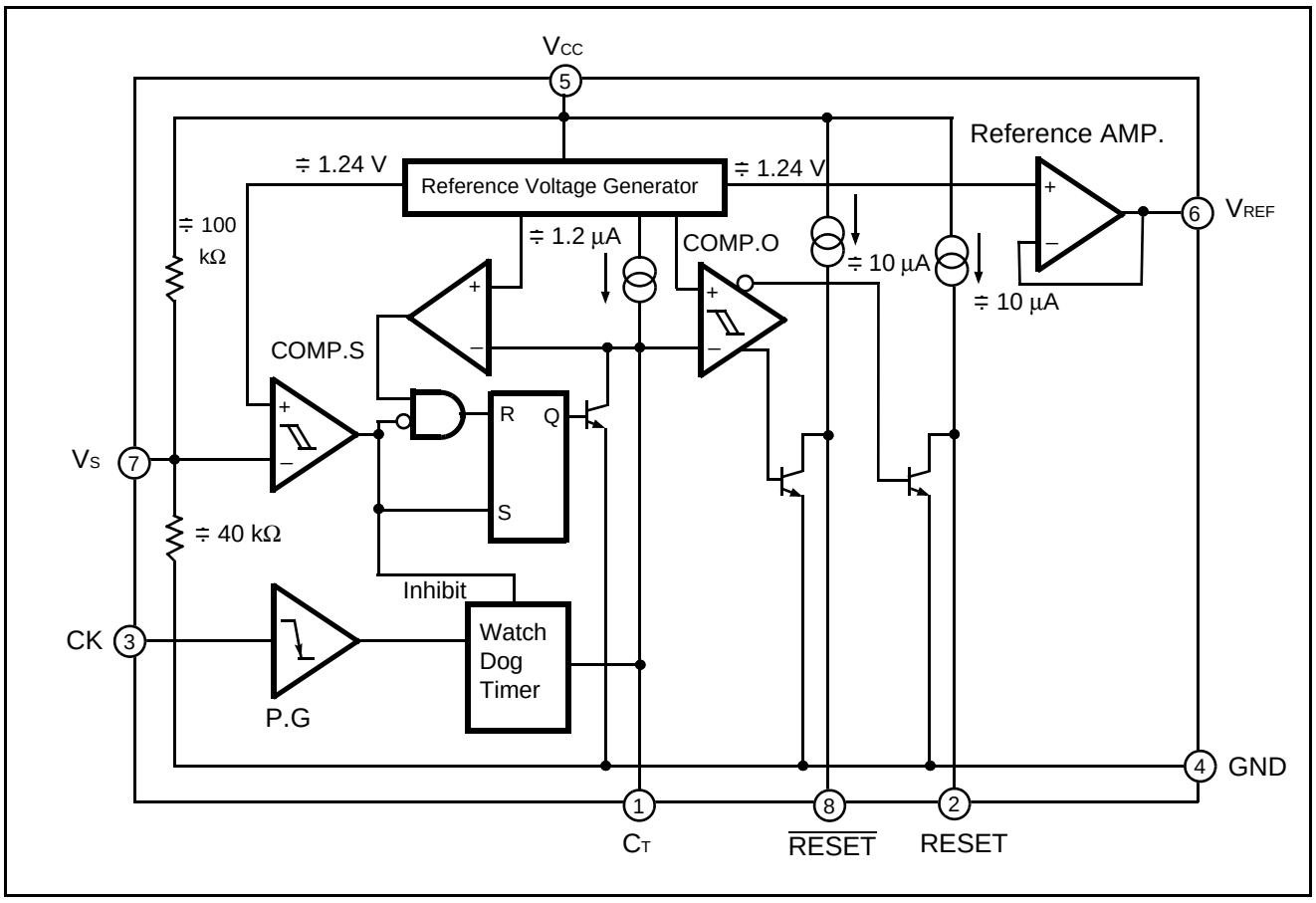
(DIP-8P-M01)
(FPT-8P-M01)

(FRONT VIEW)



(SIP-8P-M03)

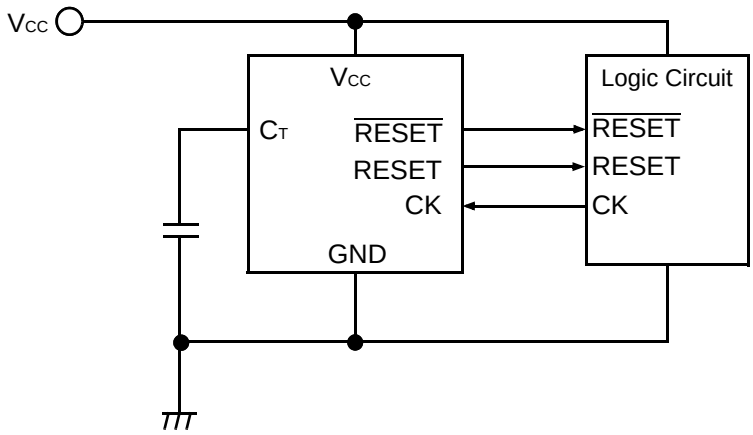
■ BLOCK DIAGRAM



■ FUNCTIONAL DESCRIPTIONS

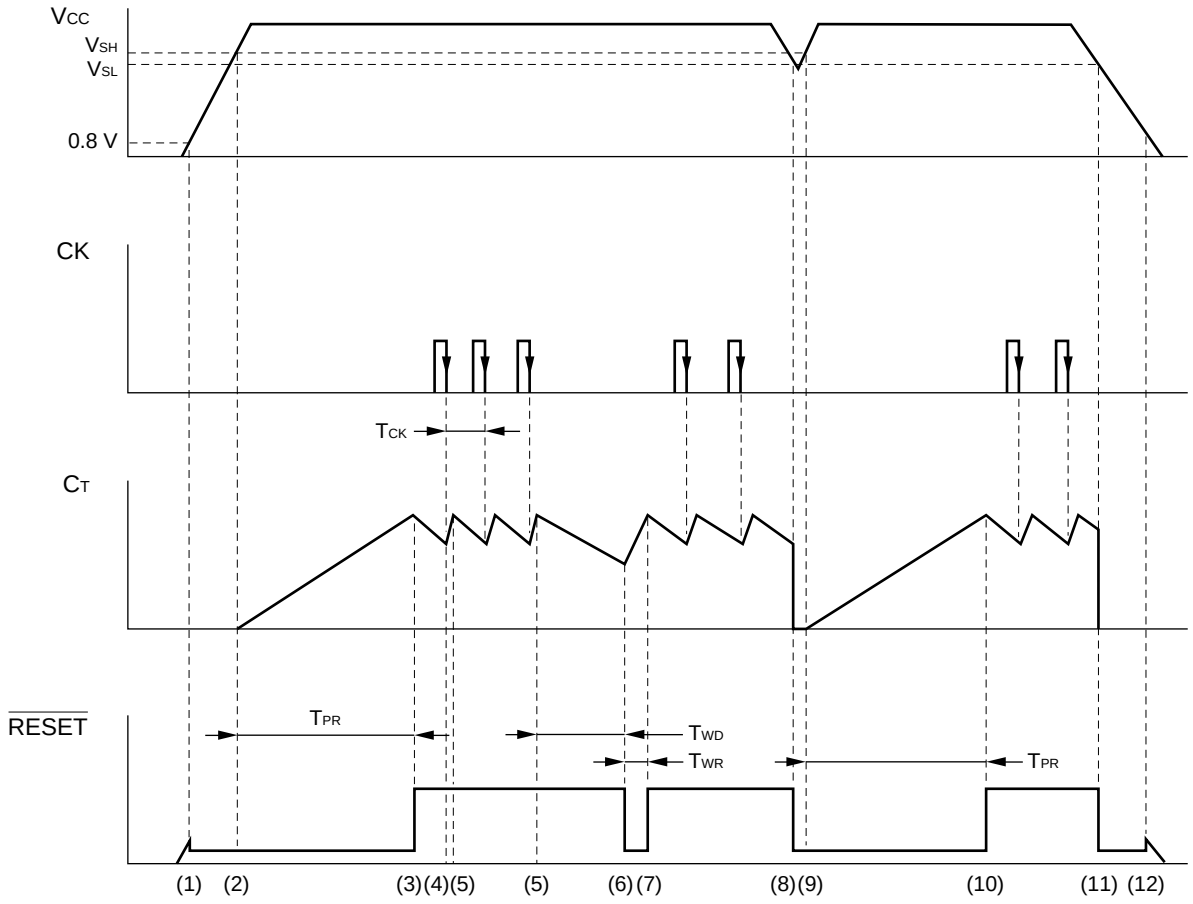
Comp.S is comparator including hysteresis. it compare the reference voltage and the voltage of Vs, so that when the voltage of Vs terminal falls below approximately 1.23 V, reset signal outputs.
Instantaneous breaks or drops in the power can be detected as abnormal conditions by the MB3773 within a 2 μs interval.
However because momentary breaks or drops of this duration do not cause problems in actual systems in some cases, a delayed trigger function can be created by connecting capacitors to the Vs terminal.
Comp.O is comparator for turning on/off the output and, compare the voltage of the Cr terminal and the threshold voltage. Because the RESET/$\overline{\text{RESET}}$ outputs have built-in pull-up circuit, there is no need to connect to external pull-up resistor when connected to a high impedance load such as CMOS logic IC.
(It corresponds to 500 kΩ at Vcc = 5 V.) when the voltage of the CK terminal changes from the “high” level into the “Low” level, pulse generator is sent to the watch-dog timer by generating the pulse momentarily at the time of drop from the threshold level.
When power-supply voltages fall more than detecting voltages, the watch-dog timer becomes a interdiction.
The Reference amplifier is a op-amp to output the reference voltage.
If the comparator is put up outside, two or more power-supply voltage monitor and overvoltage monitor can be done.
If it uses a comparator of the open-collector output, and the output of the comparator is connected with the Vs terminal of MB3773 without the pull-up resistor, it is possible to voltage monitor with reset-hold time.

• MB3773 Basic Operation



T_{PR} (ms) ≒ 1000 · C_T (μF)
T_{WD} (ms) ≒ 100 · C_T (μF)
T_{WR} (ms) ≒ 20 · C_T (μF)

Example : C_T = 0.1 μF
T_{RR} (ms) ≒ 100 (ms)
T_{WD} (ms) ≒ 10 (ms)
T_{WR} (ms) ≒ 2 (ms)



■ OPERATION SEQUENCE

(1) When Vcc rises to about 0.8 V, $\overline{\text{RESET}}$ goes “Low” and RESET goes “High”.
The pull-up current of approximately 1 μA (Vcc = 0.8 V) is output from RESET.

(2) When Vcc rises to V_{SH} (≒ 4.3V) , the charge with C_T starts.
At this time, the output is being reset.

(3) When C_T begins charging, $\overline{\text{RESET}}$ goes “High” and RESET goes “Low”.
After T_{PR} reset of the output is released.
Reset hold time: T_{PR} (ms) ≒ 1000 × C_T (μF)
After releasing reset, the discharge of C_T starts, and watch-dog timer operation starts.
T_{PR} is not influenced by the CK input.

(4) C changes from the discharge into the charge if the clock (Negative edge) is input to the CK terminal while discharging C_T.

(5) C changes from the charge into the discharge when the voltage of C_T reaches a constant threshold (≒ 1.4 V) .
(4) and (5) are repeated while a normal clock is input by the logic system.

(6) When the clock is cut off, gets, and the voltage of C_T falls on threshold (≒ 0.4 V) of reset on, $\overline{\text{RESET}}$ goes “Low” and RESET goes “High”.
Discharge time of C_T until reset is output: T_{WD} is watch-dog timer monitoring time.
T_{WD} (ms) ≒ 100 × C_T (μF)
Because the charging time of C_T is added at accurate time from stop of the clock and getting to the output of reset of the clock, T_{WD} becomes maximum T_{WD} + T_{WR} by minimum T_{WD}.

(7) Reset time in operating watch-dog timer:T_{WR} is charging time where the voltage of C_T goes up to off threshold (≒ 1.4 V) for reset.
T_{WR} (ms) ≒ 20 × C_T (μF)
Reset of the output is released after C_T reaches an off threshold for reset, and C_T starts the discharge, after that if the clock is normally input, operation repeats (4) and (5) , when the clock is cut off, operation repeats (6) and (7) .

(8) When Vcc falls on V_{SL} (≒ 4.2 V) , reset is output. C_T is rapidly discharged of at the same time.

(9) When Vcc goes up to V_{SH}, the charge with C_T is started.
When Vcc is momentarily low,
After falling V_{SL} or less Vcc, the time to going up is the standard value of the Vcc input pulse width in V_{SH} or more.
After the charge of C_T is discharged, the charge is started if it is T_{PI} or more.

(10) Reset of the output is released after T_{PR}, after Vcc becomes V_{SH} or more, and the watch-dog timer starts.
After that, when Vcc becomes V_{SL} or less, (8) to (10) is repeated.

(11) While power supply is off, when Vcc becomes V_{SL} or less, reset is output.

(12) The reset output is maintained until Vcc becomes 0.8 V when Vcc falls on 0 V.

■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating		Unit
		Min	Max	
Supply voltage	V_{CC}	– 0.3	+ 18	V
Input voltage	V_S	– 0.3	V_{CC} + 0.3 (≤ +18)	V
	V_{CK}	– 0.3	+ 18	V
$\overline{RESET}$, RESET Supply voltage	V_{OH}	– 0.3	V_{CC} + 0.3 (≤ +18)	V
Power dissipation (Ta ≤ 85 °C)	P_D	—	200	mW
Storage temperature	T_{STG}	– 55	+ 125	°C

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	Value		Unit
		Min	Max	
Supply voltage	V_{CC}	+ 3.5	+ 16	V
RESET, $\overline{RESET}$ sink current	I_{OL}	0	20	mA
V_{REF} output current	I_{OUT}	– 200	+ 5	µA
Watch clock setting time	t_{WD}	0.1	1000	ms
CK Rising/falling time	t_{FC}, t_{RC}	—	100	µs
Terminal capacitance	C_T	0.001	10	µF
Operating ambient temperature	Ta	– 40	+ 85	°C

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.

■ ELECTORICAL CHARACTERISTICS

(1) DC Characteristics

(V_{CC} = 5 V, Ta = + 25 °C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
Supply current	I_{CC}	Watch dog timer operating	—	600	900	µA
Detection voltage	V_{SL}	V_{CC} ↘	4.10	4.20	4.30	V
		Ta = – 40 °C to + 85 °C	4.05	4.20	4.35	
	V_{SH}	V_{CC} ↗	4.20	4.30	4.40	
		Ta = – 40 °C to + 85 °C	4.15	4.30	4.45	
Hysteresis width	V_{HYS}	V_{CC} ↗↘	50	100	150	mV
Reference voltage	V_{REF}	—	1.227	1.245	1.263	V
		Ta = – 40 °C to + 85 °C	1.215	1.245	1.275	
Reference voltage change rate	ΔV_{REF1}	V_{CC} = 3.5 V to 16 V	—	3	10	mV
Reference voltage output loading change rate	ΔV_{REF2}	I_{OUT} = – 200 µA to + 5 µA	– 5	—	+ 5	mV
CK threshold voltage	V_{TH}	Ta = – 40 °C to + 85 °C	0.8	1.25	2.0	V
CK input current	I_{IH}	V_{CK} = 5.0 V	—	0	1.0	µA
	I_{IL}	V_{CK} = 0.0 V	– 1.0	– 0.1	—	
C_T discharge current	I_{CTD}	Watch dog timer operating V_{CT} = 1.0 V	7	10	14	µA
High level output voltage	V_{OH1}	V_S open, $I_{\overline{RESET}}$ = – 5 µA	4.5	4.9	—	V
	V_{OH2}	V_S = 0 V, I_{RESET} = – 5 µA	4.5	4.9	—	
Output saturation voltage	V_{OL1}	V_S = 0 V, $I_{\overline{RESET}}$ = 3 mA	—	0.2	0.4	V
	V_{OL2}	V_S = 0 V, $I_{\overline{RESET}}$ = 10 mA	—	0.3	0.5	
	V_{OL3}	V_S open, I_{RESET} = 3 mA	—	0.2	0.4	
	V_{OL4}	V_S open, I_{RESET} = 10 mA	—	0.3	0.5	
Output sink current	I_{OL1}	V_S = 0 V, $V_{\overline{RESET}}$ = 1.0 V	20	60	—	mA
	I_{OL2}	V_S open, V_{RESET} = 1.0 V	20	60	—	
C_T charge current	I_{CTU}	Power on reset operating V_{CT} = 1.0 V	0.5	1.2	2.5	µA
Min supply voltage for $\overline{RESET}$	V_{CCL1}	$V_{\overline{RESET}}$ = 0.4 V, $I_{\overline{RESET}}$ = 0.2 mA	—	0.8	1.2	V
Min supply voltage for RESET	V_{CCL2}	V_{RESET} = V_{CC} – 0.1 V, R_L (pin 2 – GND) = 1 MΩ	—	0.8	1.2	V

(2)AC Characteristics

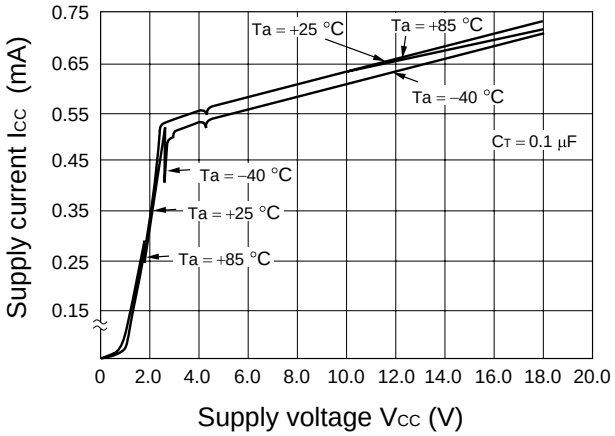
(V_{CC} = 5 V, Ta = + 25 °C)

Parameter	Symbol	Condition	Value			Unit
			Min	Typ	Max	
V_{CC} input pulse width	T_{PI}	V_{CC} 5 V / 4 V	8.0	—	—	µs
CK input pulse width	T_{CKW}	CK or	3.0	—	—	µs
CK input frequency	T_{CK}	—	20	—	—	µs
Watch dog timer watching time	T_{WD}	C_T = 0.1 µF	5	10	15	ms
Watch dog timer reset time	T_{WR}	C_T = 0.1 µF	1	2	3	ms
Rising reset hold time	T_{PR}	C_T = 0.1 µF, V_{CC}	50	100	150	ms
Output propagation delay time from V_{CC}	T_{PD1}	$\overline{RESET}$, R_L = 2.2 kΩ, C_L = 100 pF	—	2	10	µs
	T_{PD2}	RESET, R_L = 2.2 kΩ, C_L = 100 pF	—	3	10	
Output rising time*	t_R	R_L = 2.2 kΩ, C_L = 100 pF	—	1.0	1.5	µs
Output falling time*	t_F	R_L = 2.2 kΩ, C_L = 100 pF	—	0.1	0.5	

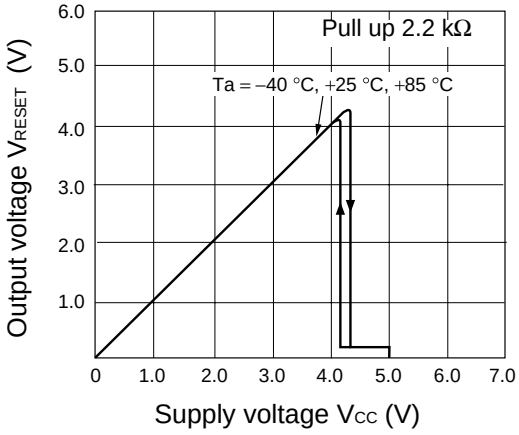
* : Output rising/falling time are measured at 10 % to 90 % of voltage.

■ TYPICAL CHARACTERISTIC CURVES

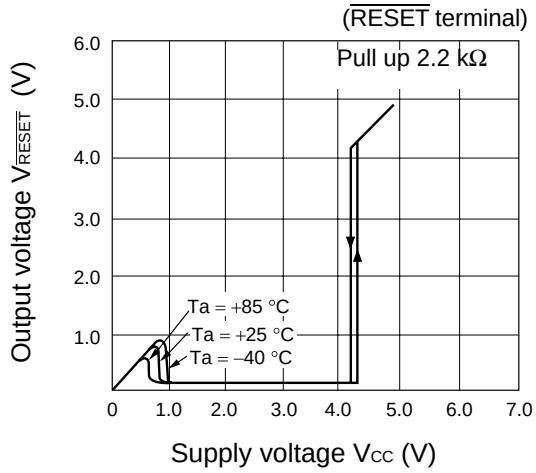
Supply current vs. Supply voltage



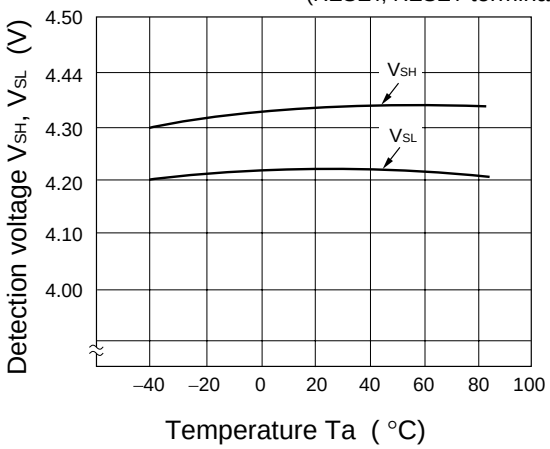
Output voltage vs. Supply voltage
(RESET terminal)



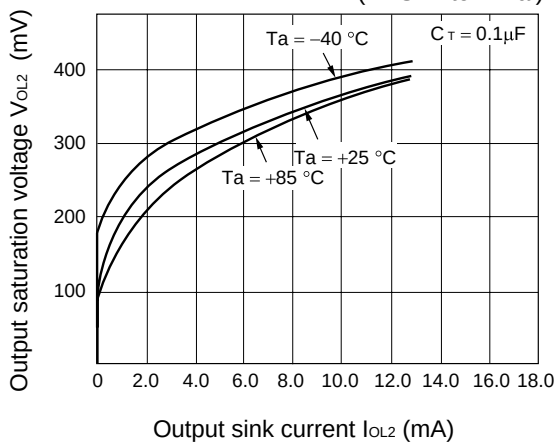
Output voltage vs. Supply voltage
($\overline{\text{RESET}}$ terminal)



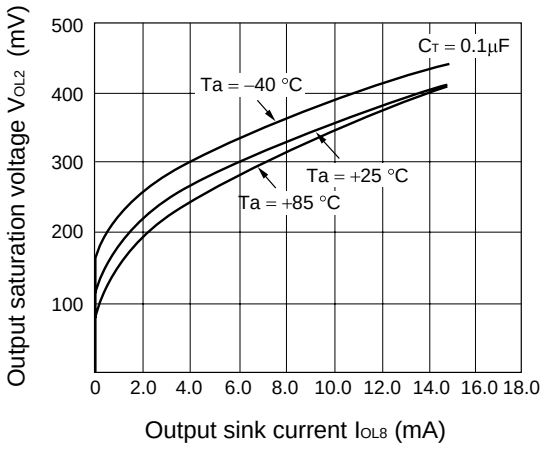
Detection voltage (V_{SH}, V_{SL}) vs. Temperature
($\overline{\text{RESET}}$, RESET terminal)



Output saturation voltage vs. Output sink current
(RESET terminal)



Output saturation voltage vs. Output sink current
($\overline{\text{RESET}}$ terminal)



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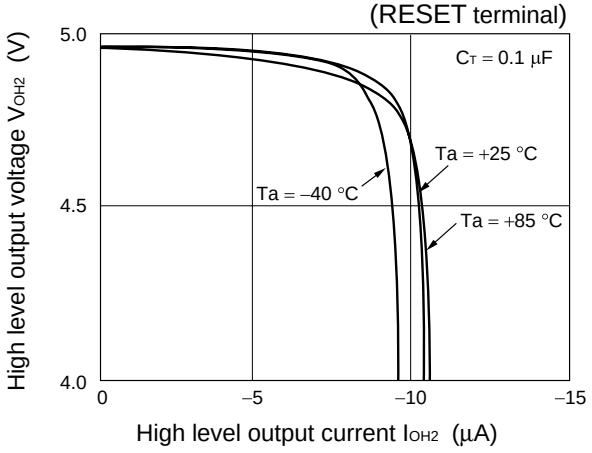
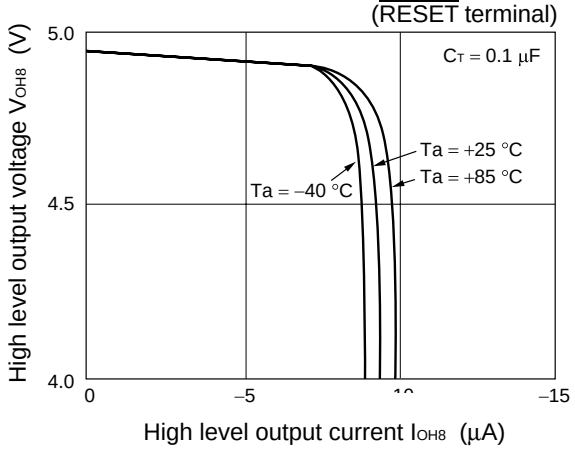
High level output voltage vs. High level output current

(RESET terminal)

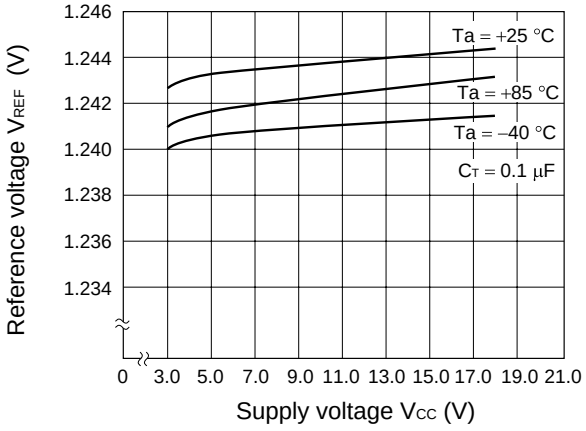


High level output voltage vs. High level output current

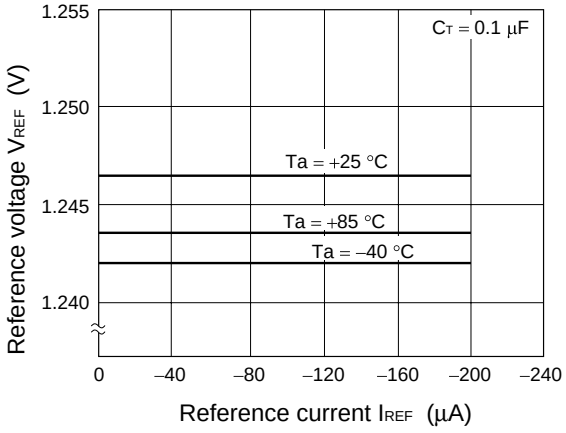
($\overline{\text{RESET}}$ terminal)



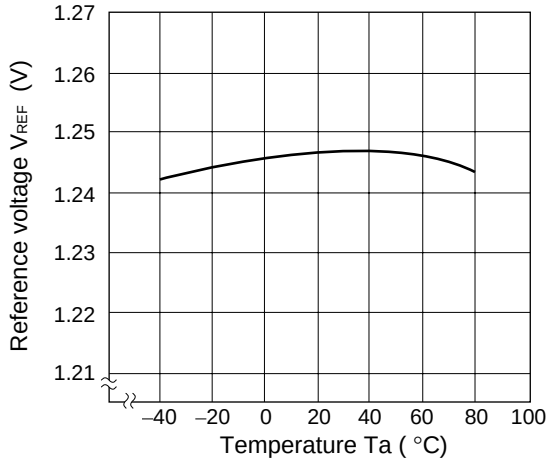
Reference voltage vs. Supply voltage



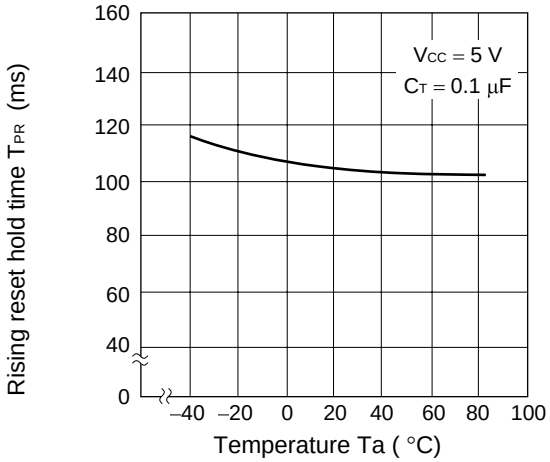
Reference voltage vs. Reference current



Reference voltage vs. Temperature



Rising reset hold time vs. Temperature



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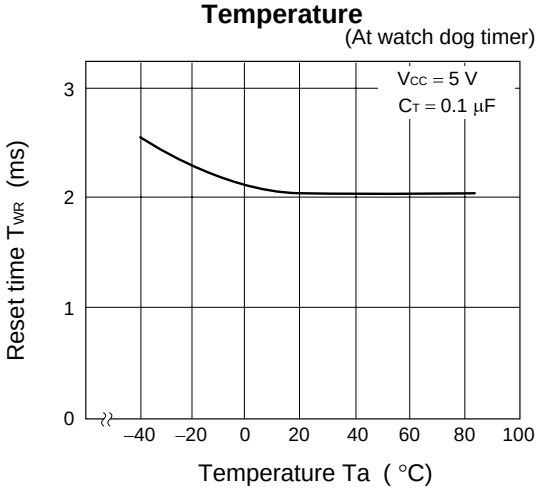
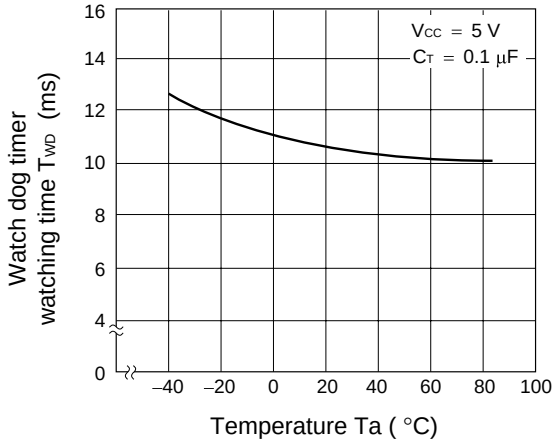
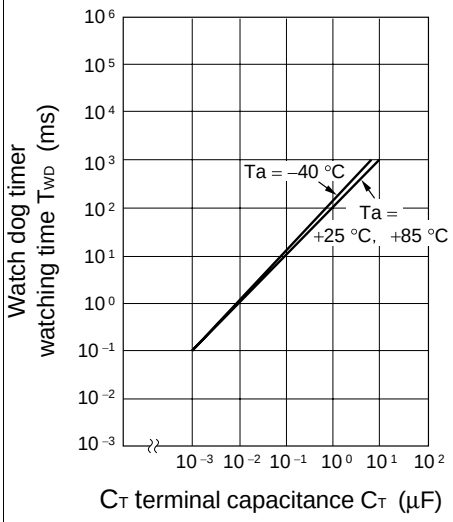
Reset time vs. Temperature



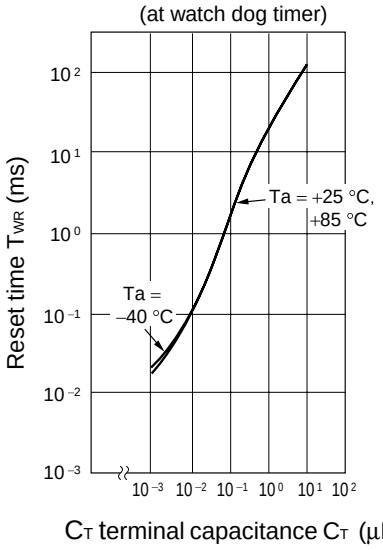
Watch dog timer watching time vs. Temperature



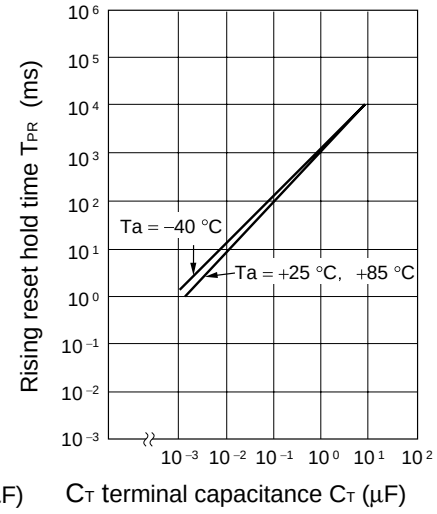
CT terminal capacitance vs. Watch dog timer watching time



CT terminal capacitance vs. Reset time

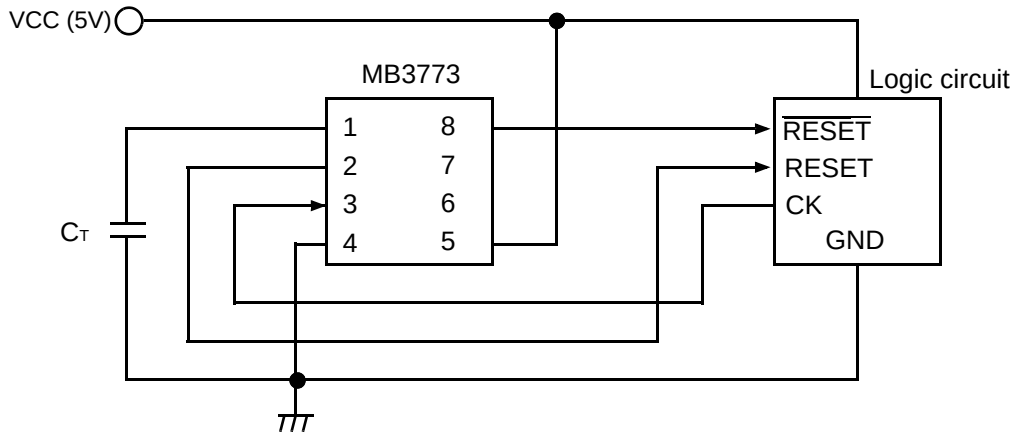


CT terminal capacitance vs. Rising reset hold time



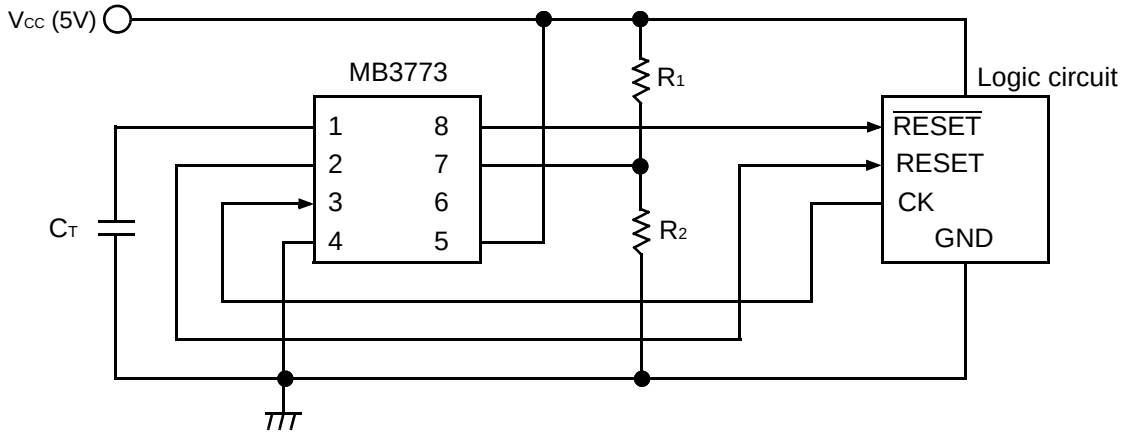
■ APPLICATION CIRCUIT

EXAMPLE 1: Monitoring 5V Supply Voltage and Watch-dog Timer



Notes : • Supply voltage is monitored using V_S.
• Detection voltage are V_{SH} and V_{SL}.

EXAMPLE 2: 5V Supply Voltage Monitoring (external fine-tuning type)

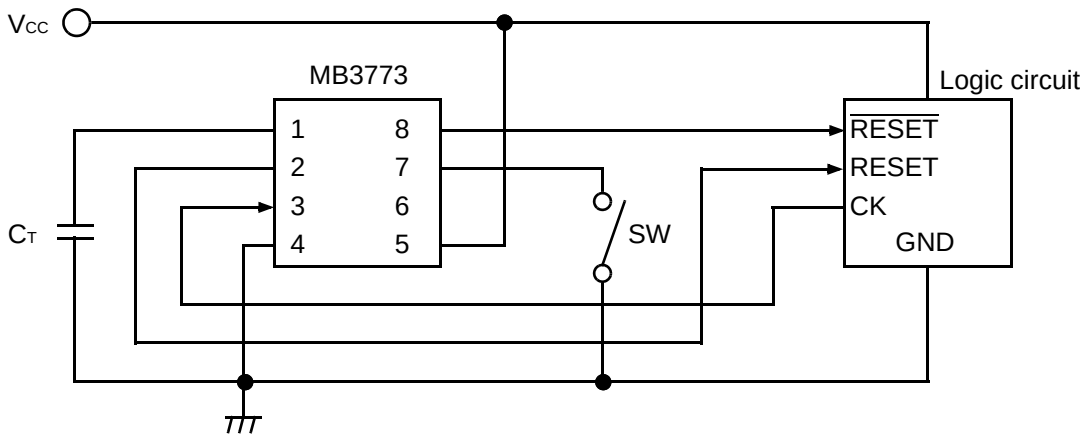


Notes : • Vs detection voltage can be adjusted externally.
• Based on selecting R_1 and R_2 values that are sufficiently lower than the resistance of the IC's internal voltage divider, the detection voltage can be set according to the resistance ratio of R_1 and R_2 (See the table below.)

R_1 (kΩ)	R_2 (kΩ)	Detection voltage: V_{SL} (V)	Detection voltage: V_{SH} (V)
10	3.9	4.4	4.5
9.1	3.9	4.1	4.2

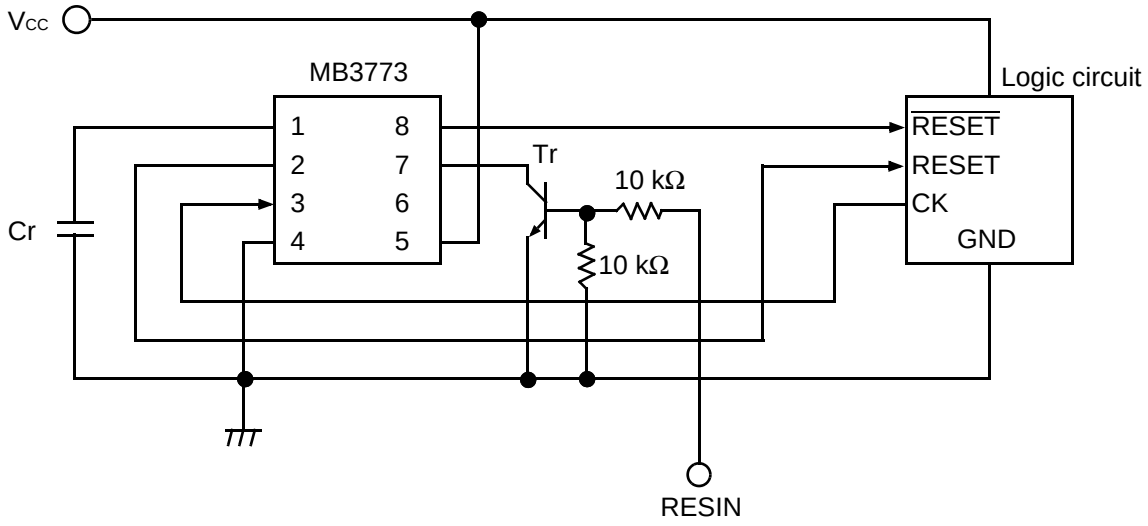
EXAMPLE 3: With Forced Reset (with reset hold)

(a)



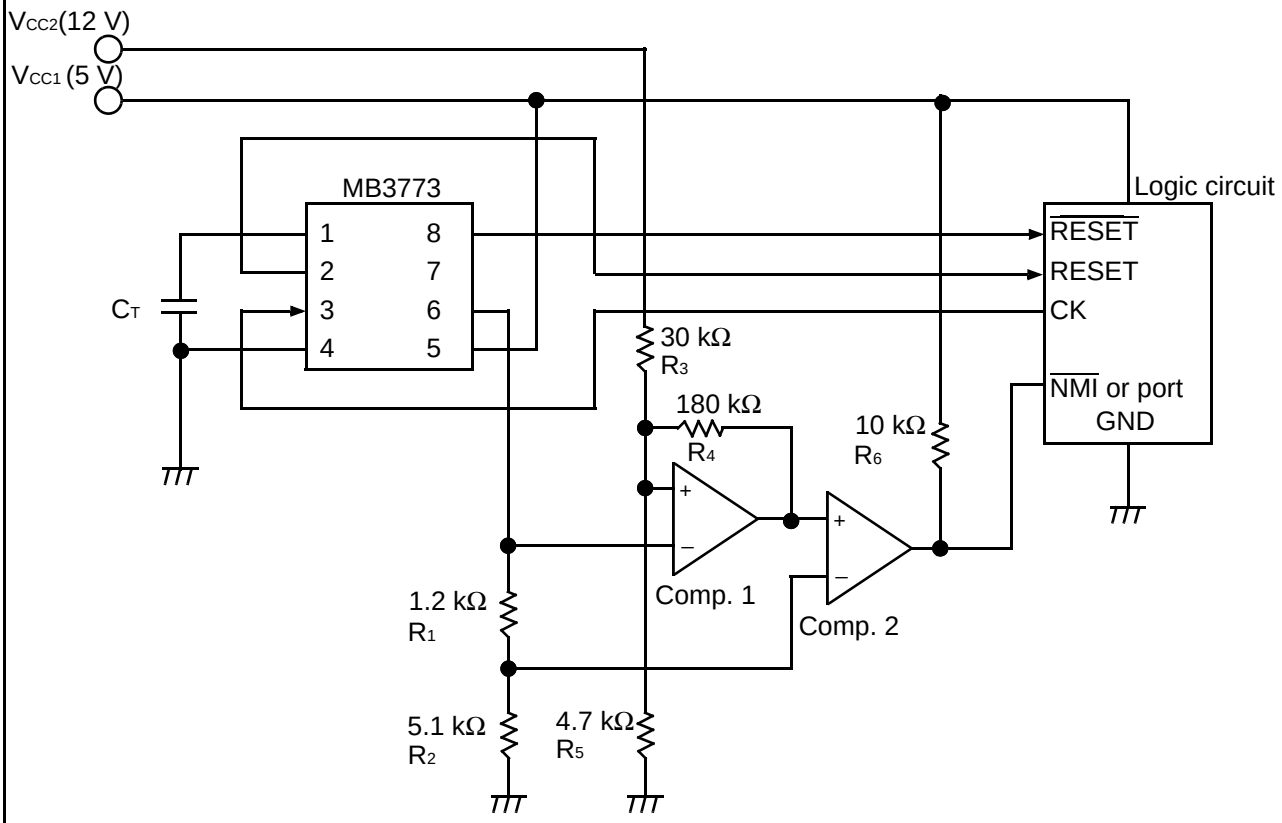
Note : Grounding pin 7 at the time of SW ON sets $\overline{\text{RESET}}$ (pin 8) to Low and RESET (pin 2) to High.

(b)



Note : Feeding the signal to terminal RESIN and turning on Tr sets the $\overline{\text{RESET}}$ terminal to Low and the RESET terminal to High.

EXAMPLE 4: Monitoring Two Supply Voltages (with hysteresis, reset output and $\overline{\text{NMI}}$)



Example : Comp. 1, Comp. 2
: MB4204, MB47393

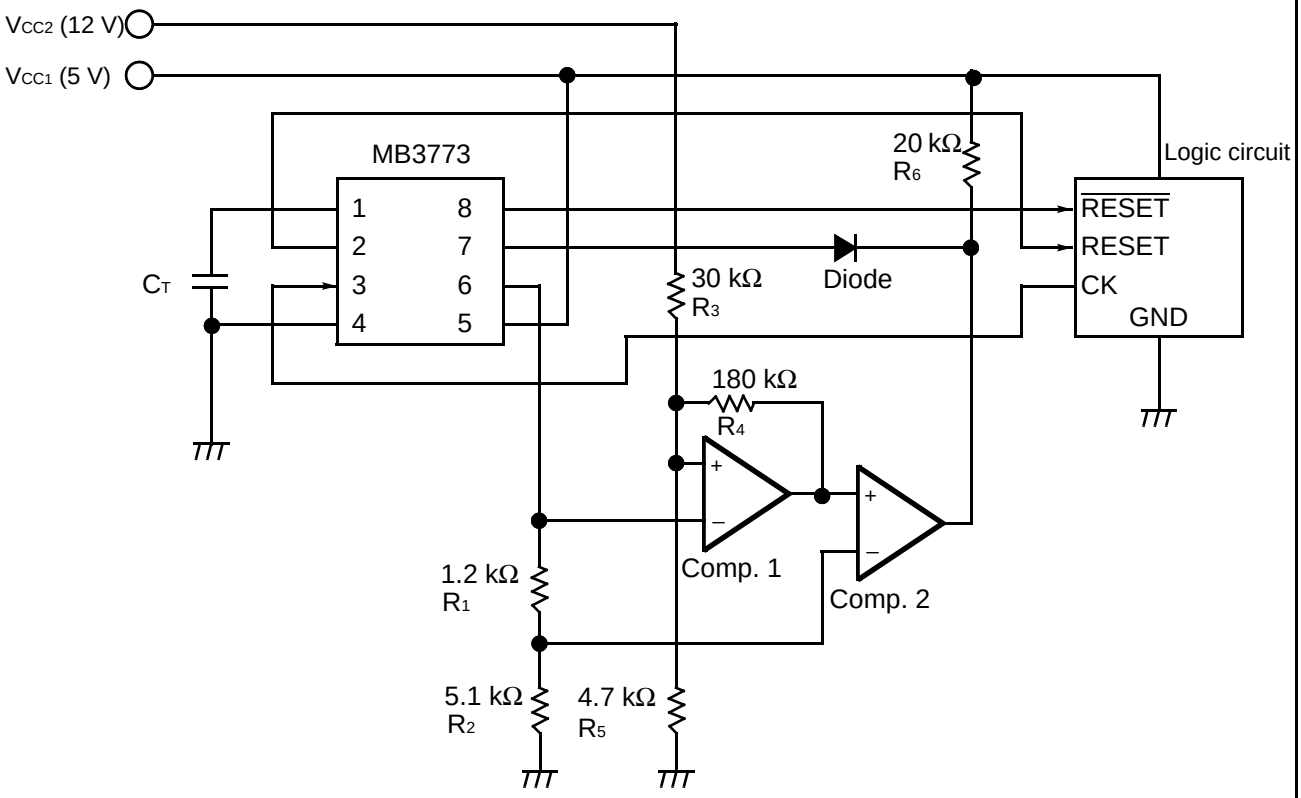
Notes :
- The 5 V supply voltage is monitored by the MB3773.
- The 12 V supply voltage is monitored by the external circuit. Its output is connected to the $\overline{\text{NMI}}$ terminal and, when voltage drops, Comp. 2 interrupts the logic circuit.
- Use V_{CC1} (= 5 V) to power the comparators (Comp. 1 and Comp. 2) in the external circuit shown above.
- The detection voltage of the V_{CC2} (= 12 V) supply voltage is approximately 9.2 V/9.4 V and has a hysteresis width of approximately 0.2 V.
  V_{CC2} detection voltage and hysteresis width can be found using the following formulas:

→ Detection voltage $V_{2H} = \dfrac{R_3 + (R_4 // R_5)}{R_4 // R_5} \times V_{REF}$ (Approximately 9.4 V in the above illustration)

$V_{2L} = \dfrac{R_3 + R_5}{R_5} \times V_{REF}$ (Approximately 9.2 V in the above illustration)

→ Hysteresis width $V_{HYS} = V_{2H} - V_{2L}$

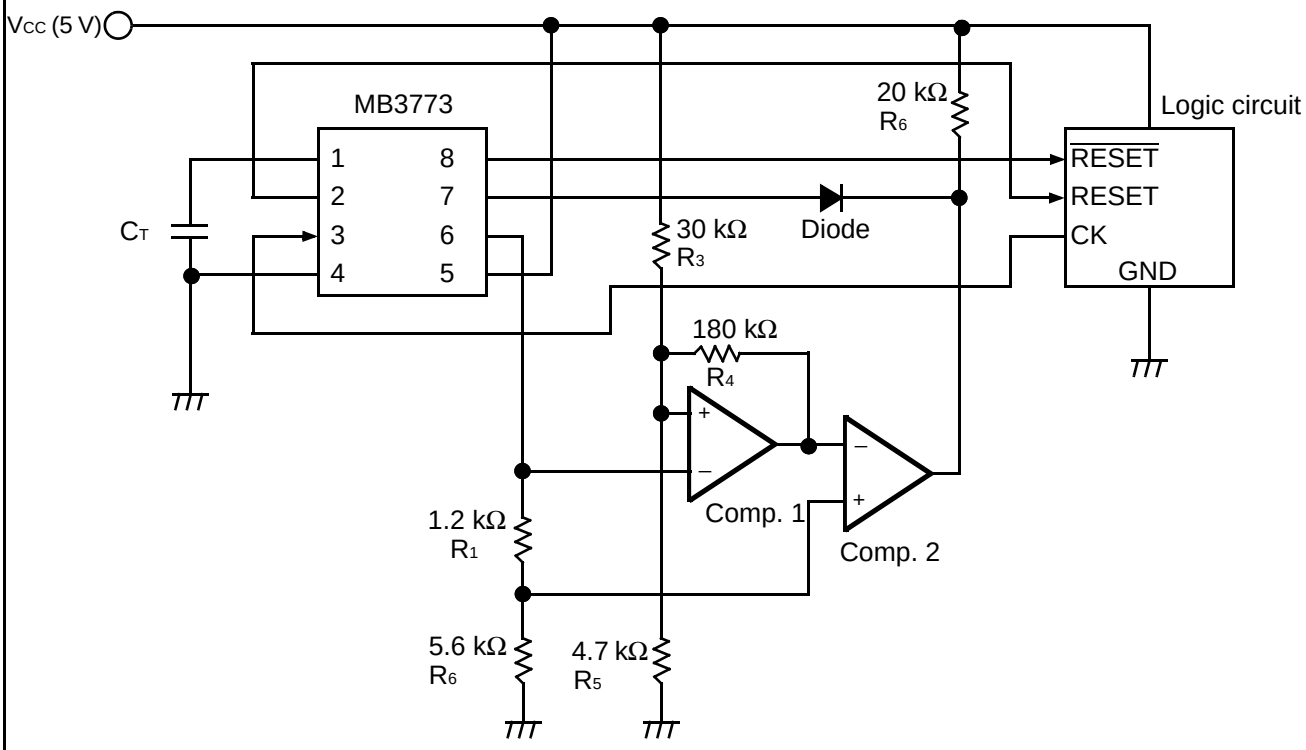
EXAMPLE 5: Monitoring Two Supply Voltages (with hysteresis and reset output)



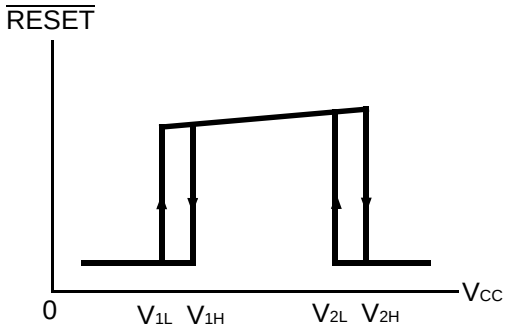
Example : Comp. 1, Comp. 2
: MB4204, MB47393

Notes :
- When either 5 V or 12 V supply voltage decreases below its detection voltage (V_{SL}), the MB3773 RESET terminal is set to High and the MB3773 $\overline{\text{RESET}}$ terminal is set to Low.
- Use V_{CC1} (= 5 V) to power the comparators (Comp. 1 and Comp. 2) in the external circuit shown above.
- The detection voltage of the V_{CC2} (= 12 V) supply voltage is approximately 9.2 V/9.4 V and has a hysteresis width of approximately 0.2 V. For the formulas for finding hysteresis width and detection voltage, see section 4.

EXAMPLE 6: Monitoring Low voltage and Overvoltage Monitoring (with hysteresis)

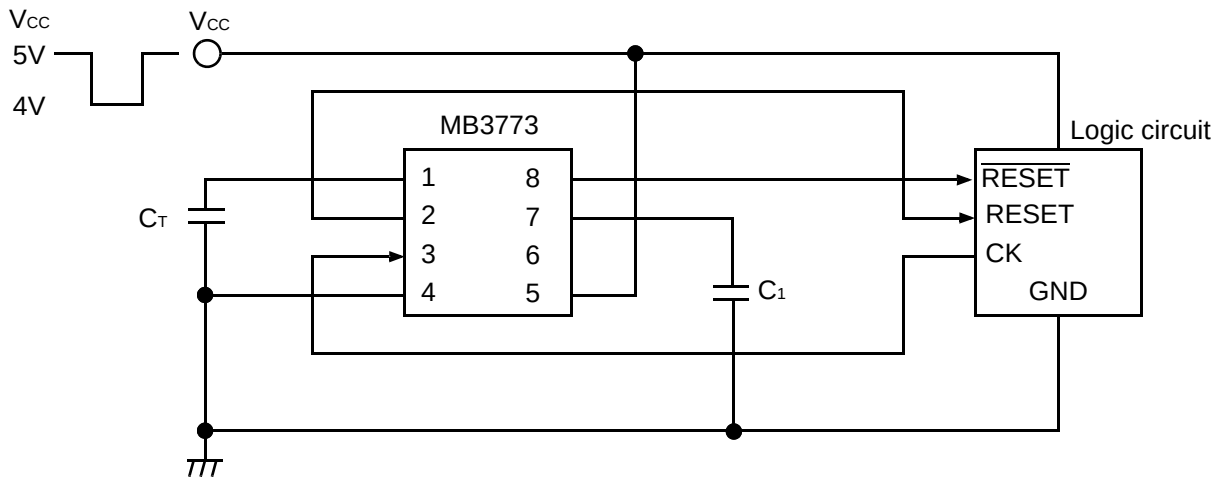


Example : Comp. 1, Comp. 2
: MB4204, MB47393



Notes : • Comp. 1 and Comp. 2 are used to monitor for overvoltage while the MB3773 is used to monitor for low voltage. Detection voltages V_{1L}/V_{1H} at the time of low voltage are approximately 4.2 V/4.3 V. Detection voltages V_{2L}/V_{2H} at the time of overvoltage are approximately 6.0 V/6.1 V.
For the formulas for finding hysteresis width and detection voltage, see EXAMPLE 4.
• Use V_{CC} (= 5 V) to power the comparators (Comp. 1 and Comp. 2) in the external circuit shown above.

EXAMPLE 7: Monitoring Supply Voltage Using Delayed Trigger



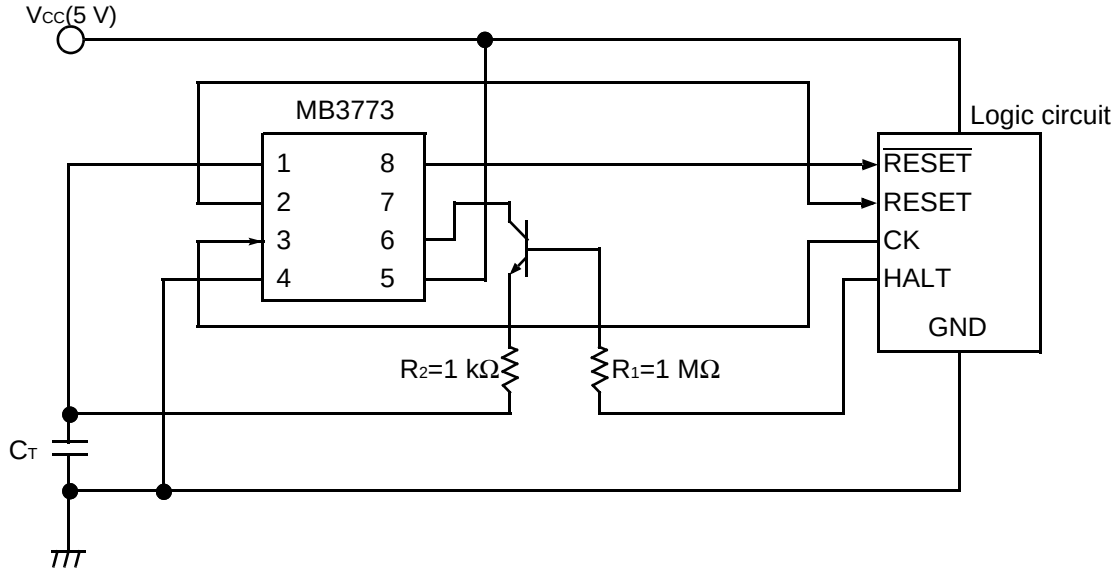
Note : Adding voltage such as shown in the figure to V_{CC} increases the minimum input pulse width by 50 μs (C_1 = 1000 pF).

EXAMPLE 8: Stopping Watch-dog Timer (Monitoring only supply voltage)

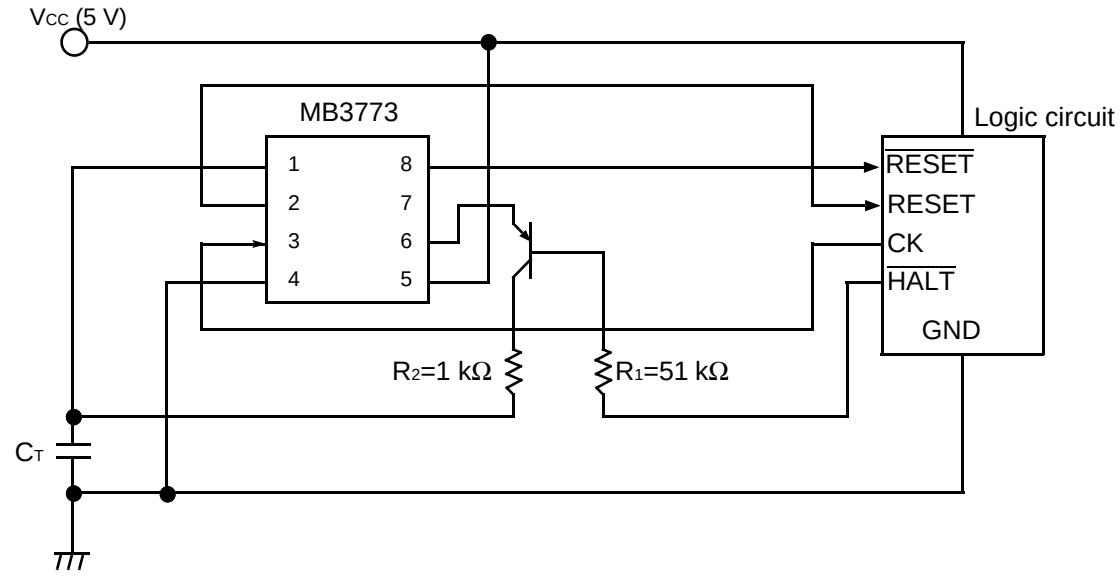
These are example application circuits in which the MB3773 monitors supply voltage alone without resetting the microprocessor even if the latter, used in standby mode, stops sending the clock pulse to the MB3773.

- The watch-dog timer is inhibited by clamping the C_T terminal voltage to V_{REF}.
  The supply voltage is constantly monitored even while the watch-dog timer is inhibited.
  For this reason, a reset signal is output at the occurrence of either instantaneous disruption or a sudden drop to low voltage.
  Note that in application examples (a) and (b), the hold signal is inactive when the watch-dog timer is inhibited at the time of resetting.
  If the hold signal is active when tie microprocessor is reset, the solution is to add a gate, as in examples (c) and (d).

(a) Using NPN transistor



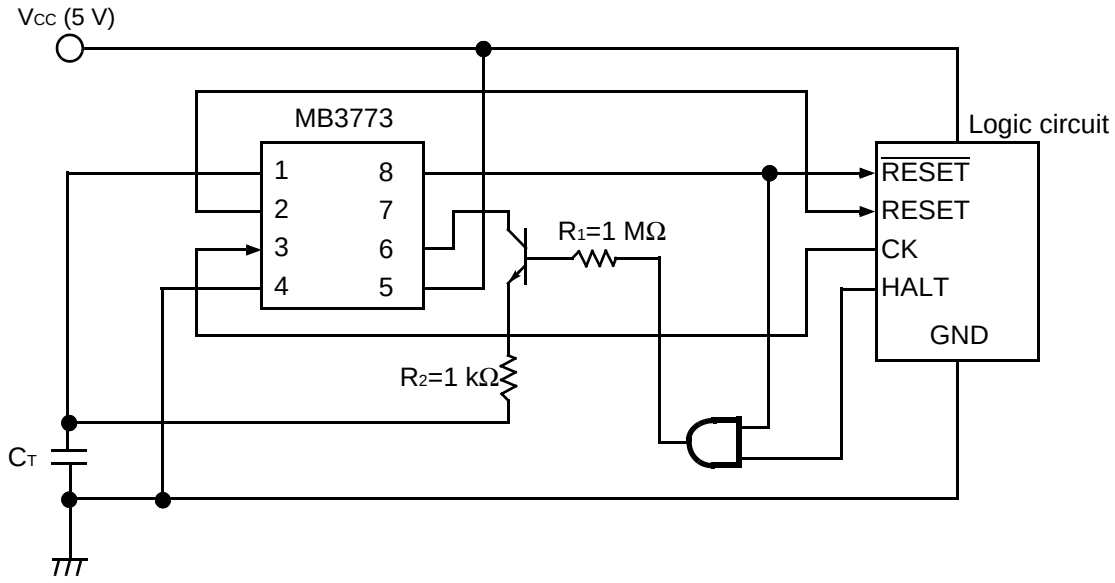
(b) Using PNP transistor



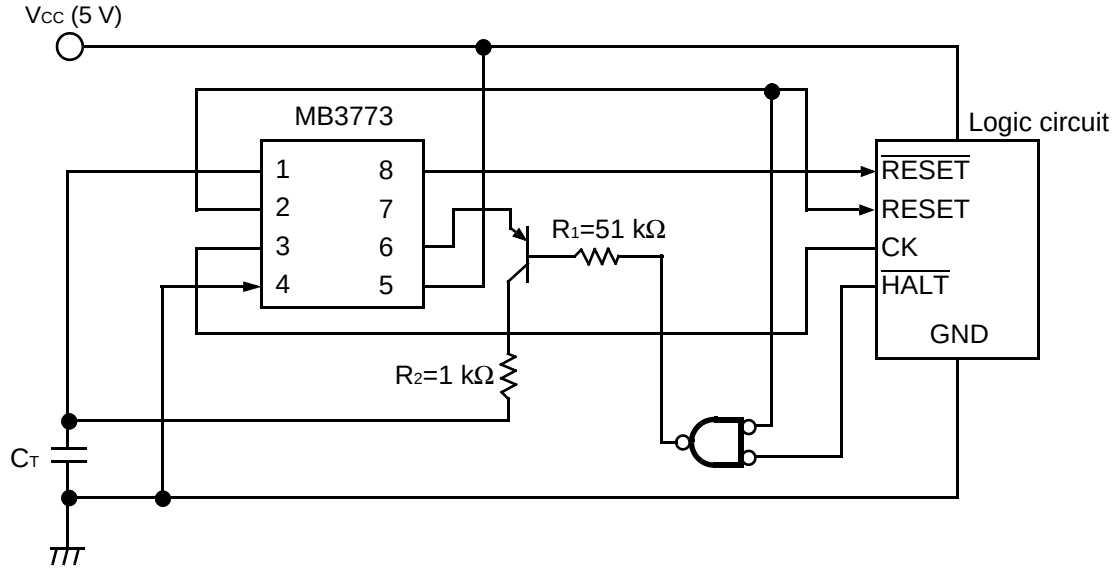
(Continued)

(Continued)

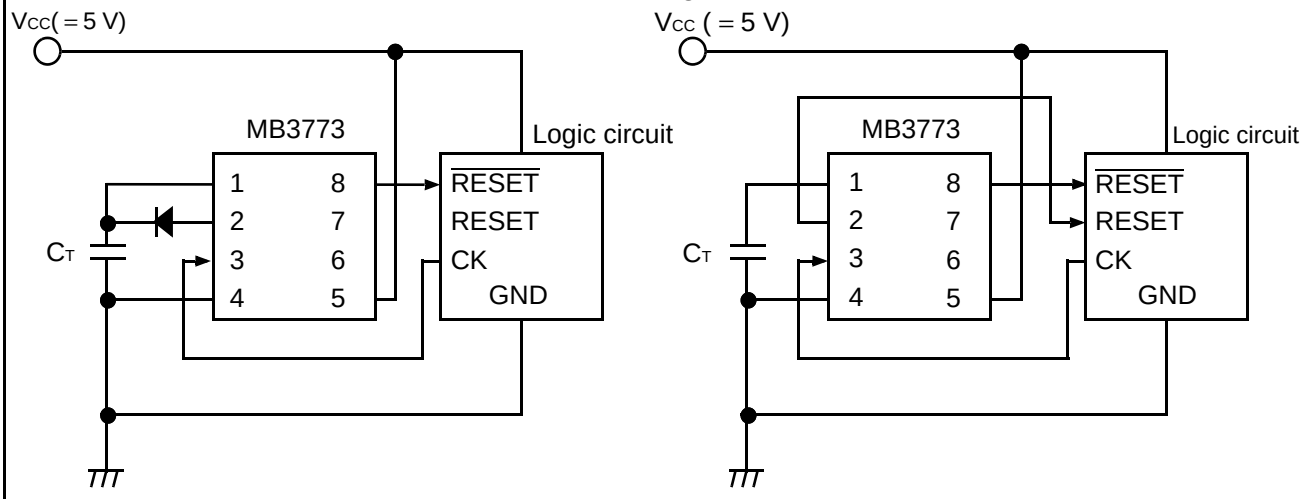
(c) Using NPN transistor



(d) Using PNP transistor



EXAMPLE 9: Reducing Reset Hold Time



(a) T_{PR} reduction method

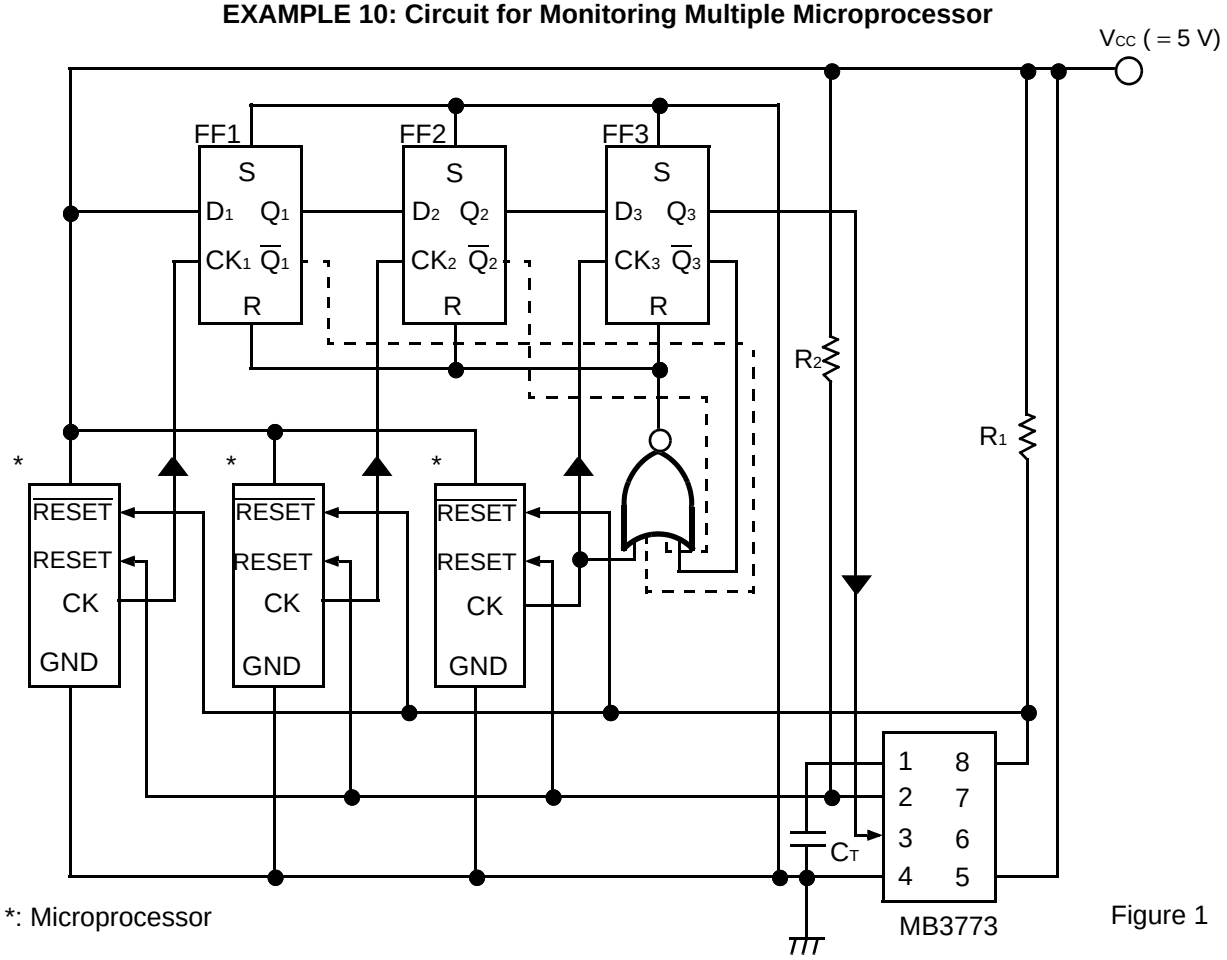
(b) Standard usage

- $\overline{\text{RESET}}$ is the only output that can be used.
- Standard T_{PR}, T_{WD} and T_{WR} value can be found using the following formulas.
  Formulas: T_{PR} (ms) ≒ 100 × C_T (µF)
  T_{WD} (ms) ≒ 100 × C_T (µF)
  T_{WR} (ms) ≒ 16 × C_T (µF)
- The above formulas become standard values in determining T_{PR}, T_{WD} and T_{WR}.
  Reset hold time is compared below between the reduction circuit and the standard circuit.

C_T = 0.1 µF

	T_{PR} reduction circuit	**Standard circuit**
T_{PR} ≒	10 ms	100 ms
T_{WD} ≒	10 ms	10 ms
T_{WR} ≒	1.6 ms	2.0 ms

EXAMPLE 10: Circuit for Monitoring Multiple Microprocessor



*: Microprocessor

Figure 1

- - - - - - connects from FF1 and FF2 outputs $\overline{Q}_1$ and $\overline{Q}_2$ to the NOR input.
- Depending on timing, these connections may not be necessary.
- Example : $R_1 = R_2 = 2.2\ k\Omega$
  $C_T = 0.1\ \mu F$

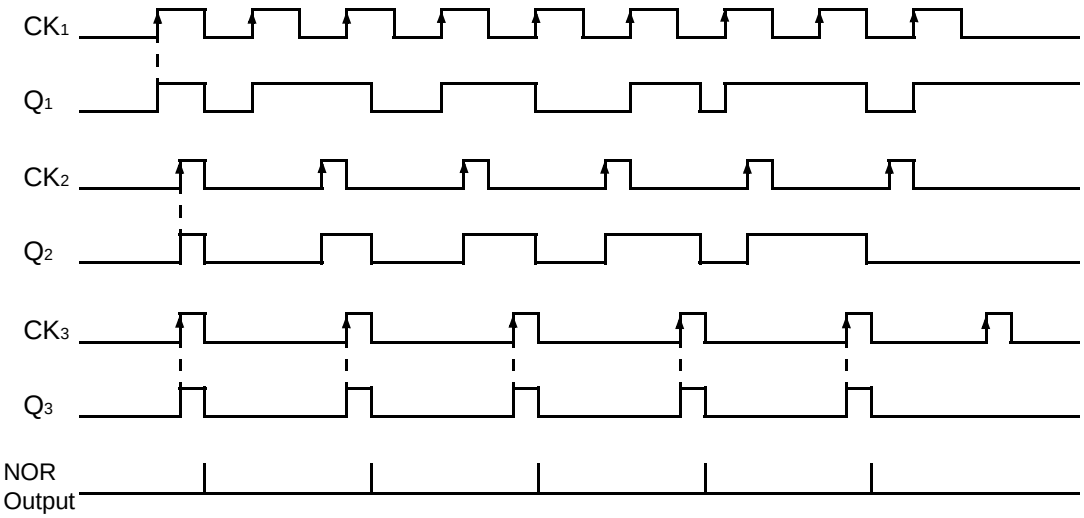


Figure 2

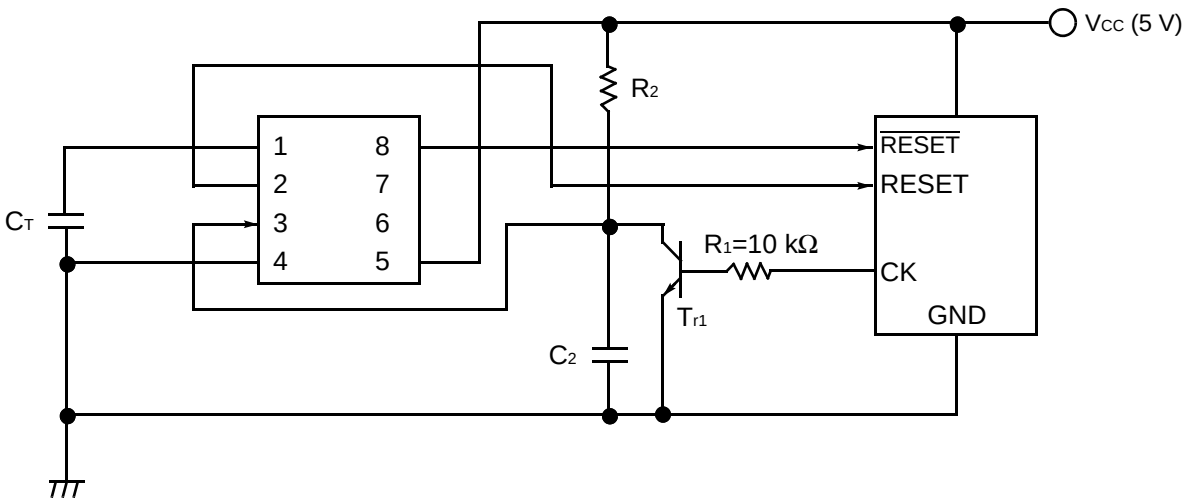
Description of Application Circuits

Using one MB3773, this application circuit monitors multiple microprocessor in one system. Signals from each microprocessor are sent to FF1, FF2 and FF3 clock inputs. Figure 2 shows these timings. Each flip-flop operates using signals sent from microprocessor as its clock pulse. When even one signal stops, the relevant receiving flip-flop stops operating. As a result, cyclical pulses are not generated at output Q_3. Since the clock pulse stops arriving at the CK terminal of the MB3773, the MB3773 generates a reset signal.
Note that output Q_3 frequency f will be in the following range, where the clock frequencies of CK1, CK2 and CK3 are f_1, f_2 and f_3 respectively.

$$\Rightarrow \quad \frac{1}{f_0} \leq \frac{1}{f} \leq \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$$

where f_0 is the lowest frequency among f_1, f_2 and f_3.

EXAMPLE 11: Circuit for Limiting Upper Clock Input Frequency

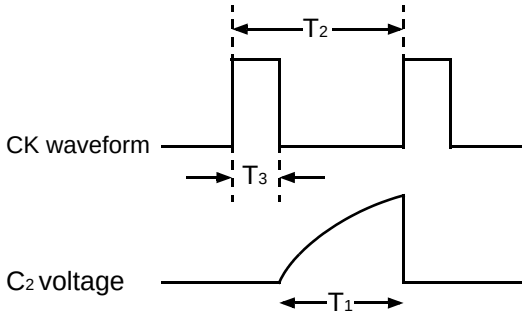


Notes : • This is an example application to limit upper frequency f_H of clock pulses sent from the microprocessor.
If the CK cycle sent from the microprocessor exceeds f_H, the circuit generates a reset signal. (The lower frequency has already been set using C_T.)

• When a clock pulse such as shown below is sent to terminal CK, a short T_2 prevents C_2 voltage from reaching the CK input threshold level (≒ 1.25 V), and will cause a reset signal to be output. The T_1 value can be found using the following formula :

$$T_1 \fallingdotseq 0.3\ C_2R_2$$

where $V_{CC} = 5$ V, $T_3 \geq 3.0$ µs, $T_2 \geq 20$ µs

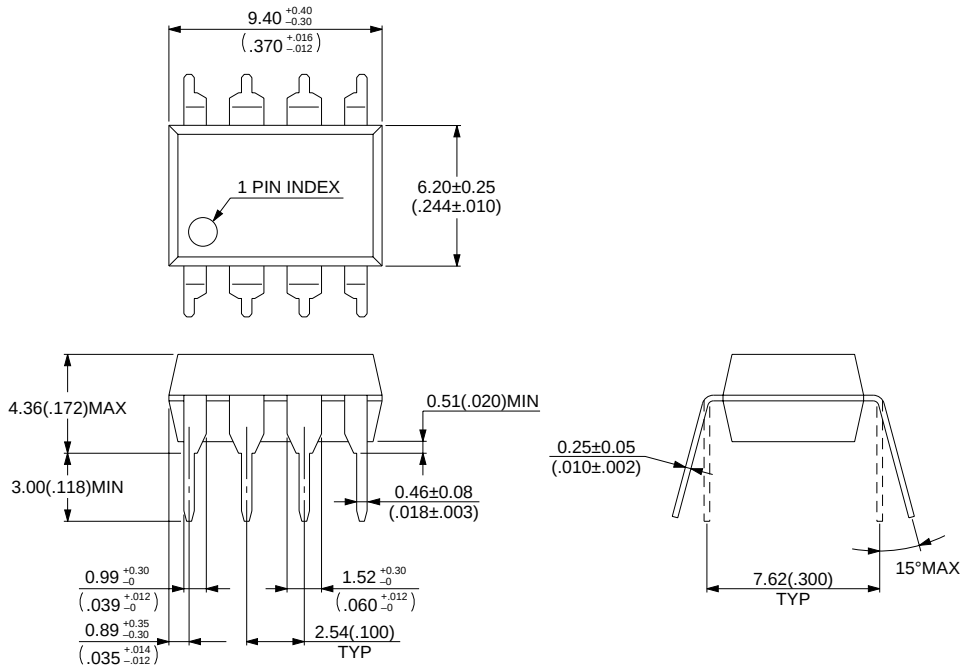


Example : Setting C and R allow the upper T_1 value to be set (See the table below).

C	R	T_1
0.01 µF	10 kΩ	30 µs
0.1 µF	10 kΩ	300 µs

■ PACKAGE DIMENSIONS

8-lead plastic DIP
(DIP-8P-M01)

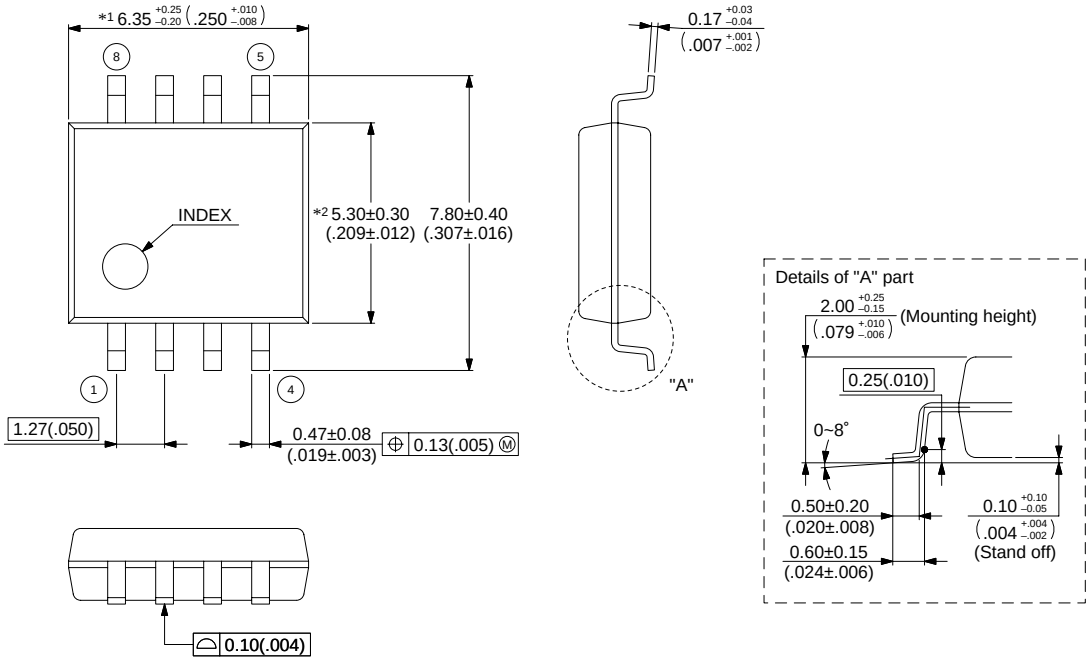


Dimensions in mm (Inches)

(Continued)

8-lead plastic FPT
(FPT-8P-M01)

Note1 : *1 : These dimensions include resin protrusion.
Note2 : *2 : These dimensions do not include resin protrusion.
Note3 : Pins width and pins thickness include plating thickness.
Note4 : Pins width do not include tie bar cutting remainder.

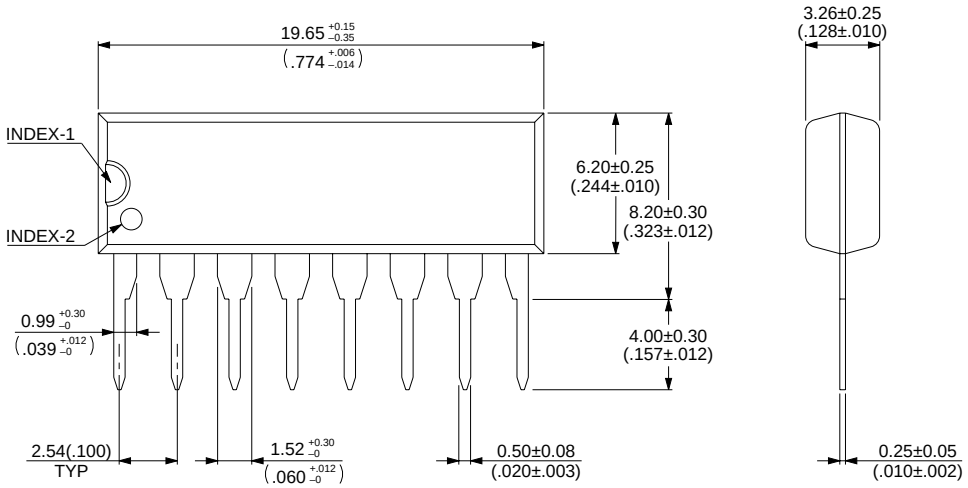


Dimensions in mm (Inches)

(Continued)

(Continued)

8-lead plastic SIP
(SIP-8P-M03)



Dimensions in mm (Inches)

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