

MITSUBISHI (Dig./Ana. INTERFACE)  
**M5295AL/P/FP**

**WATCHDOG TIMER**

**DESCRIPTION**

M5295A is a semiconductor integrated circuit which is designed for System Reset to detect +5V power supply.

This IC keeps the operation microcomputer watching. When the system is abnormal, it generates Reset output until the system returns to normal states of the System.

It is possible to vary the two detective voltage by connecting the resistor, so it is suitable to high quality and high performance system.

**FEATURES**

- Watch Dog Timer
- Power on Reset Timer
- Low circuit current 0.8mA (Typ, V<sub>CC</sub> = 5V)
- Wide Range of power supply

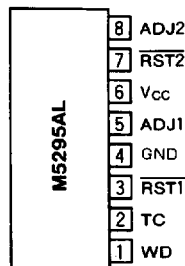
**APPLICATION**

Microcomputer Systems

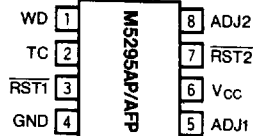
**RECOMMENDED OPERATING CONDITIONS**

Supply voltage . . . . . 4V to 15V  
 Rated supply voltage . . . . . 5V

**PIN CONFIGURATION (TOP VIEW)**

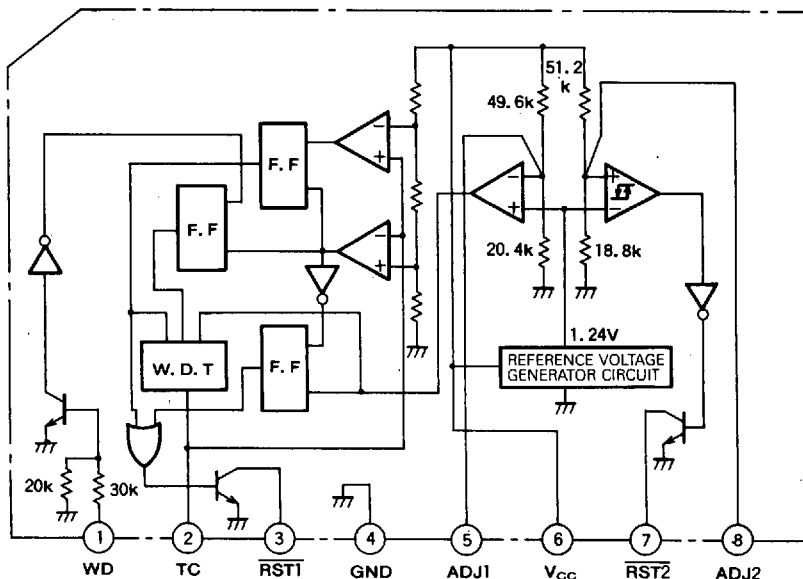


**Outline 8P5(L)**



**Outline 8P4(AP)  
 8P2S-A(AFP)**

**BLOCK DIAGRAM**



6249826 0023843 943



**ABSOLUTE MAXIMUM RATINGS** (Ta = 25°C, unless otherwise noted)

Symbol	Parameter	Conditions	Ratings	Unit
V <sub>CC</sub>	Supply voltage		15	V
V <sub>IN</sub>	Input voltage		-10 to 10	V
V <sub>OUT</sub>	Output voltage		15	V
I <sub>OUT</sub>	Output current		10	mA
P <sub>d</sub>	Power dissipation		800(SIP)/625(DIP)/440(FP)	mW
K <sub>θ</sub>	Thermal derating	Ta ≥ 25°C	8(SIP)/6.25(DIP)/4.4(FP)	mW/°C
T <sub>opr</sub>	Operating temperature		-20 to +75	°C
T <sub>stg</sub>	Storage temperature		-55 to +125	°C

**ELECTRICAL CHARACTERISTICS** (Ta = 25°C, V<sub>CC</sub> = 5V, unless otherwise noted)

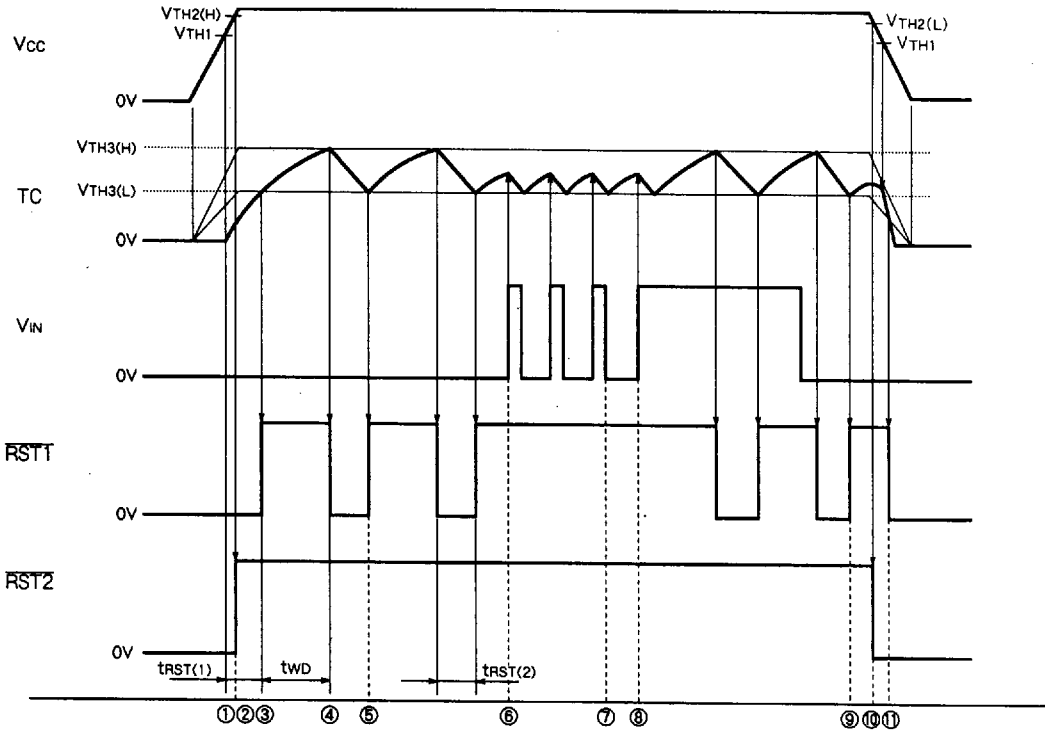
**(1) DC FEATURES**

Symbol	Parameter	Pin	Test conditions	Limits			Unit
				Min	Typ	Max	
I <sub>IH</sub>	WD Input current	WD	V <sub>IN</sub> = 5V	0.06	0.15	0.25	mA
I <sub>IL</sub>			V <sub>IN</sub> = -5V	0.05	-0.1	-0.15	mA
V <sub>IH</sub>	WD Input voltage	WD		2			V
V <sub>IL</sub>						0.8	
I <sub>OUT</sub>	TC output current	TC	V <sub>IN</sub> = 1.5V			-1	μA
I <sub>IN</sub>	TC input current	TC	V <sub>OUT</sub> = 4.2V		3.3		mA
V <sub>VH3(H)</sub>	Threshold voltage of watch dog timer	TC		3.7	4	4.3	V
V <sub>VH3(L)</sub>				1.7	2	2.3	V
V <sub>OL</sub>	Output voltage	RST1	I <sub>OUT</sub> = 1mA		0.1	0.5	V
I <sub>LEAK</sub>	Output leak current	RST2	V <sub>OUT</sub> = 15V			5	μA
V <sub>TH1</sub>	V <sub>CC</sub> detective voltage (1)	V <sub>CC</sub>		4.05	4.25	4.45	V
V <sub>TH2(H)</sub>	V <sub>CC</sub> detective voltage (2)	V <sub>CC</sub>		4.5	4.7	4.9	V
V <sub>TH2(L)</sub>				4.45	4.6	4.75	V
ΔV <sub>TH2</sub>				0.05	0.1	0.2	V
V <sub>5</sub>	ADJ1 voltage	ADJ1		1.17	1.46	1.75	V
V <sub>6</sub>	ADJ2 voltage	ADJ2		1.07	1.34	1.61	V
RST1	RST1 on voltage	RST1	V <sub>CC</sub> = 1.2V, R <sub>L</sub> = 4.7K			0.5	V
RST2	RST2 on voltage	RST2	V <sub>CC</sub> = 1.2V, R <sub>L</sub> = 4.7K			0.5	V
I <sub>CC</sub>	Circuit current	V <sub>CC</sub>			0.8	1.5	V

**(2) AC FEATURES**

Symbol	Parameter	Pin	Test conditions	Limits			Unit
				Min	Typ	Max	
t <sub>WD</sub>	Watch dog timer	RST1			1.1·C·R1		s
			C = 0.1μF, R1 = 10kΩ	0.5	1.1	1.7	ms
t <sub>RST(1)</sub>	Reset timer (1)	RST1			0.5·C·R1		s
			C = 0.1μF, R1 = 10kΩ	0.2	0.5	1.1	ms
t <sub>RST(2)</sub>	Reset timer (2)	RST1	R1 = 10kΩ		830·C		s
			C = 0.1μF, R1 = 10kΩ	40	83	220	μs
t <sub>WD IN</sub>	Input pulse width	WD		3			μs
t <sub>d1</sub>	Transmittal delay time	RST1			20		μs
t <sub>d2</sub>		RST2				10	

**OPERATING EXPLANATION**



- ① The V<sub>CC</sub> rises up to 0.8V, then  $\overline{\text{Reset1}}$  and 2 generate Low output, and Rising up to 4.25V, charge of C<sub>1</sub> begins.
- ② The V<sub>CC</sub> rises up to 4.7V, then  $\overline{\text{Reset2}}$  generates high.
- ③, ④ The voltage at TC pin is 2V, then  $\overline{\text{Reset1}}$  generates high, when 4V, C<sub>1</sub> is discharged and  $\overline{\text{Reset1}}$  generates Low.
- ⑤ The voltage at TC pin falls to 2V, then  $\overline{\text{Reset1}}$  generates high, unless normal clock signal is entered to WD pin,  $\overline{\text{Reset1}}$  repeats this operation.
- ⑥, ⑦ Before the voltage at TC pin reaches 4V, if normal clock signal is entered to WD pin, Low  $\overline{\text{Reset1}}$  is cancelled.
- ⑧, ⑨ In the case of entrance of abnormal signal input, as the waveform of TC pin repeats charge and discharge of  $\overline{\text{Reset1}}$  alternatively from 2V to 4V, the  $\overline{\text{Reset1}}$  repeats high and Low output operation.
- ⑩ The V<sub>CC</sub> falls to 4.6V, then  $\overline{\text{Reset2}}$  generates Low, this detective voltage has a 100mV hysteresis.
- ⑪ When V<sub>CC</sub> goes down to 4.25V(V<sub>TH1</sub>), the status of TC pin is switched to discharge. When the potential at TC pin is detected being V<sub>TH3(H)</sub> or V<sub>TH3(L)</sub>, the status of  $\overline{\text{Reset1}}$  becomes "low".

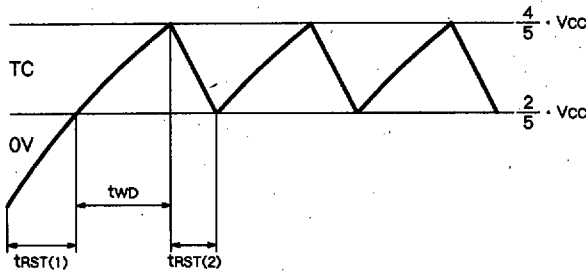
**WATCHDOG TIMER**

**TERMINOLOGY**

- $t_{RST1}$ : Time required for TC pin potential to rise from 0V to  $V_{TH3(L)}$  when  $V_{CC}$  is being applied.
- $t_{WD}$ : Time required for TC pin potential to rise from  $V_{TH3(L)}$  to  $V_{TH3(H)}$
- $t_{RST2}$ : Time required for TC pin potential to go down from  $V_{TH3(H)}$  to  $V_{TH3(L)}$

**1. Pin ② (TC Pin) Charge Time and Discharge Time**

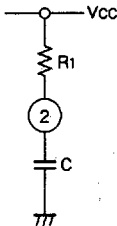
When input to WD pin is abnormal, TC pin output waveform is as shown below:



$$t_{RST(1)} = 0.51 \cdot C \cdot R_1$$

$$t_{WD} = 1.1 \cdot C \cdot R_1 \text{ (charge time)}$$

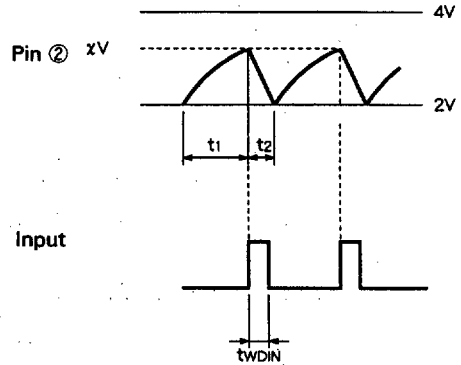
$$t_{RST(2)} = 1000 \cdot C \cdot \ln \frac{4 \cdot \frac{R_1}{1000} - 1}{2 \cdot \frac{R_1}{1000} - 3} \text{ (discharge time)}$$



Resistance  $R_1$ :  $10k\Omega \leq R_1 \leq 30k\Omega$   
 When  $R_1$  is  $10k\Omega$ ,  $t_{RST(2)}$  is  $830 \cdot C$ .

**2. Pin ① (WD Pin) Input Frequency, Input Pulse Width, Charge Time and Discharge Time**

When input to WD pin ① is normal, TC pin ② output waveform is as shown below: ( $V_{CC} = 5V$ )



$$t_1 = C \cdot R_1 \cdot \ln \frac{3}{5-x} \text{ (charge time)}$$

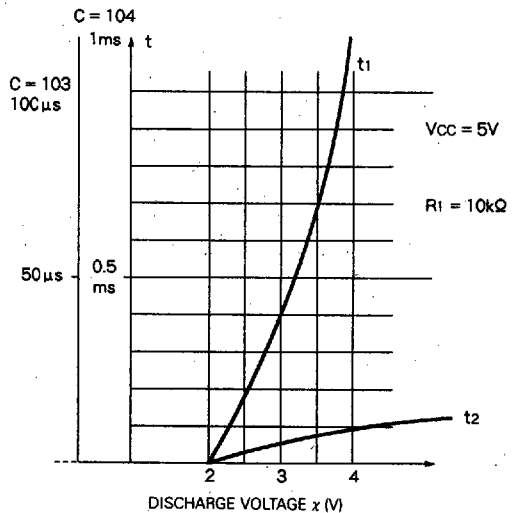
$$t_2 = 1000 \cdot C \cdot \ln \frac{\left(\frac{R_1}{1000} + 1\right) x - 5}{2 \cdot \frac{R_1}{1000} - 3} \text{ (discharge time)}$$

**PIN ① (WD PIN) INPUT REQUIREMENTS**

- (1) Connect capacitor between WD pin and voltage input. (Refer to Section 3.)
- (2) Input cycle: No more than  $t_{WD}$  (Discharge should start before voltage at WD pin reaches 4V.)

$$\frac{1}{1.1 \cdot C \cdot R_1} < f$$

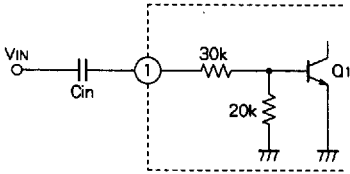
- (3) Input pulse width  $t_{WDIN}$ : No more than  $t_2$



**WATCHDOG TIMER**

**3. Relationship between Input Pulse Width and Input Capacitance  $C_{in}$**

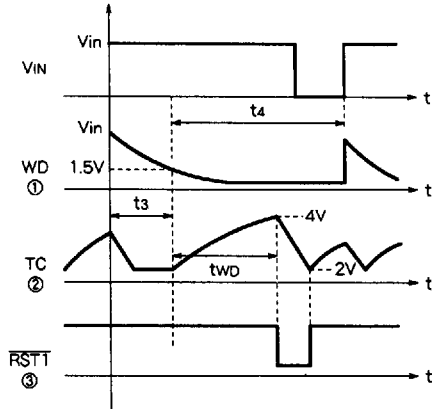
When input to pin ① is 1.5V or more, TC pin discharges electricity. Determine pulse width and input capacitance  $C_{in}$  with reference to the diagram shown on the right:



$Q_1$  is off when voltage at pin ① is 1.5V or less.

$$t_3 = C_{in} \cdot 5 \times 10^4 \cdot \ln \frac{V_{in}}{1.5}$$

$\overline{RSTT}$  is output when  $t_4$  is longer than  $t_{wo}$ .



$C_{in}$ : 10,000pF,  $t_3$ =0.6ms

$C_{in}$ : 1000pF,  $t_3$ =0.6 $\mu$ s

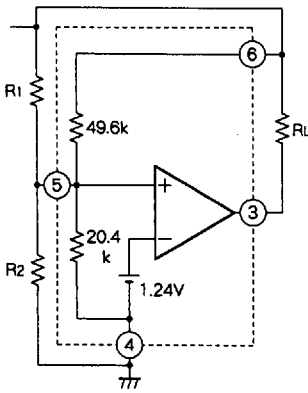
$C_{in}$ : 100pF,  $t_3$ =6 $\mu$ s

When  $t_3$  is too long, TC pin output waveform frequency changes as shown above. Set  $t_3$  to be sufficiently long to turn on  $Q_1$  [ $t_{WDIN}$  (3 $\mu$ s) or more] but not to exceed  $t_2$  (discharge time).

( $t_2$ : Discharge time during normal input)

**4.  $V_{CC}$  Detection Voltage Adjustment**

(1) Detection voltage 1 ( $V_{TH1}$ ) adjustment.



$V_{TH1}$ (V)	$R_1$ (k $\Omega$ )	$R_2$ (k $\Omega$ )	Detection voltage calculation formula
13	10	0.92	$V_{TH1} = \frac{R_{01} + R_{02}}{R_{02}} \times 1.24(V)$ $(R_{01} = R_1 // 49.6k\Omega)$ $(R_{02} = R_2 // 20.4k\Omega)$
10	10	1.25	
7	10	1.96	
5	10	3.17	
4.25	—	—	
4	10.90	5	
3.5	8.59	5	

To adjust detection voltage 1, determine external resistance with the following equations:

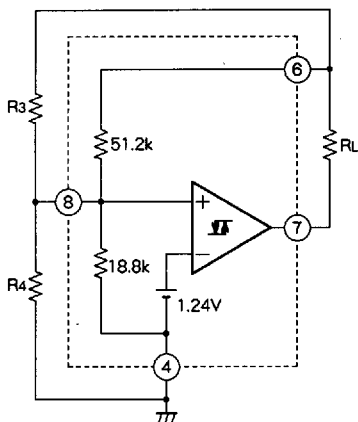
a.  $V_{TH1} > 4.25V$  ( $R_1 = 10k\Omega$ )

$$R_2 = \frac{1}{\frac{1}{R_0} - \frac{1}{20.4k}} \quad (R_0 = \frac{8.322k \times 1.24}{V_{TH1} - 1.24})$$

b.  $V_{TH1} < 4.25V$  ( $R_2 = 5k\Omega$ )

$$R_1 = \frac{1}{\frac{1}{R_0} - \frac{1}{49.6k}} \quad (R_0 = \frac{(V_{TH1} - 1.24)4.016k}{1.24})$$

**(2) Detection voltage 2 (V<sub>TH2(L)</sub>) adjustment**



V <sub>TH2(L)</sub> (V)	R <sub>3</sub> (kΩ)	R <sub>4</sub> (kΩ)	ΔV <sub>TH2</sub> (mV)	Detection voltage calculation formula
13	10	0.93	16.3	$V_{TH2(L)} = \frac{R_{03} + R_{04}}{R_{04}} \times 1.24 \text{ (V)}$ $(R_{03} = R_3 // 51.2 \text{ k}\Omega)$ $(R_{04} = R_4 // 18.8 \text{ k}\Omega)$
10	10	1.26	16.3	
7	10	1.99	16.3	
5	10	3.24	16.3	
4.6	—	—	100	
4	10.61	5	17.2	$\Delta V_{TH2} = \frac{R_{03}}{51.2 \text{ k}} \times 100 \text{ (mV)}$
3.5	8.38	5	14.1	

To adjust detection voltage 2, determine external resistances with the following equations:

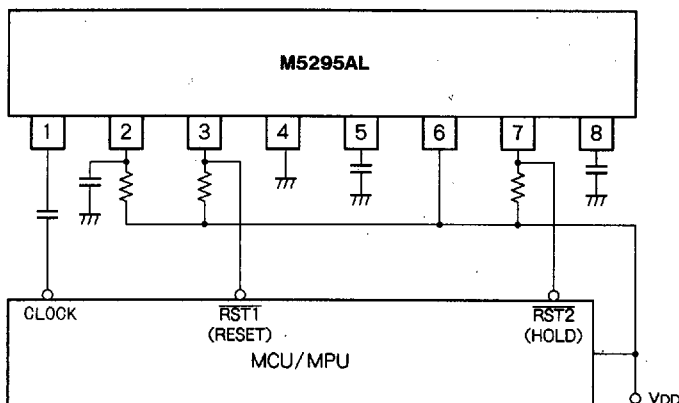
a. V<sub>TH2(L)</sub> > 4.6V (R<sub>3</sub> = 10kΩ)

$$R_4 = \frac{1}{\frac{1}{R_0} - \frac{1}{18.8 \text{ k}}} \quad (R_0 = \frac{8.37 \text{ k} \times 1.24}{V_{TH2(L)} - 1.24})$$

b. V<sub>TH2(L)</sub> < 4.6V (R<sub>4</sub> = 5kΩ)

$$R_3 = \frac{1}{\frac{1}{R_0} - \frac{1}{51.2 \text{ k}}} \quad (R_0 = \frac{(V_{TH2(L)} - 1.24) 3.95 \text{ k}}{1.24})$$

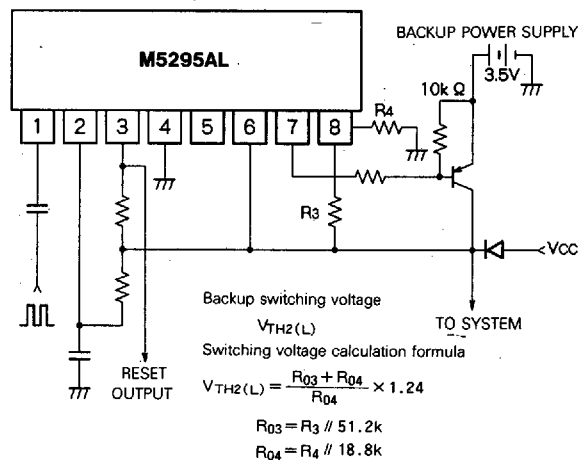
**APPLICATION EXAMPLE**



**OPERATION INSTRUCTIONS**

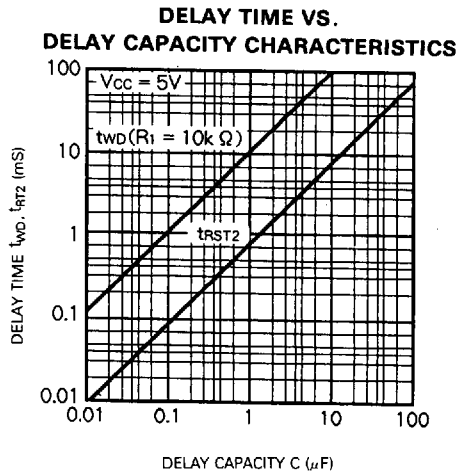
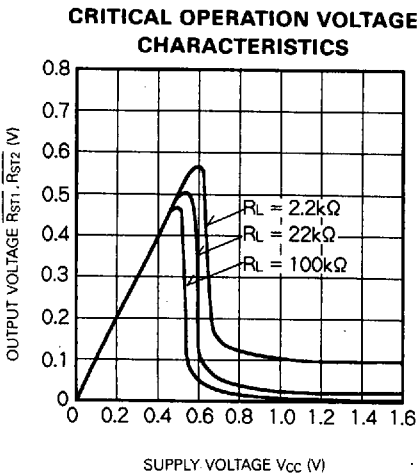
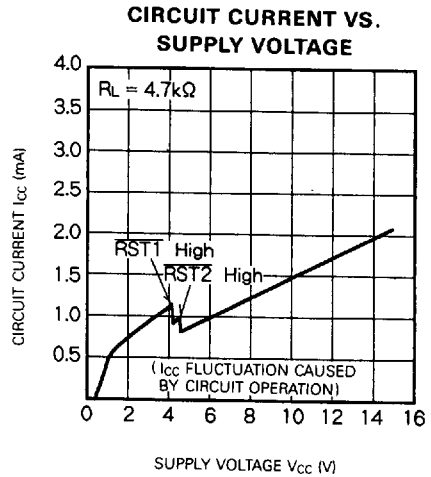
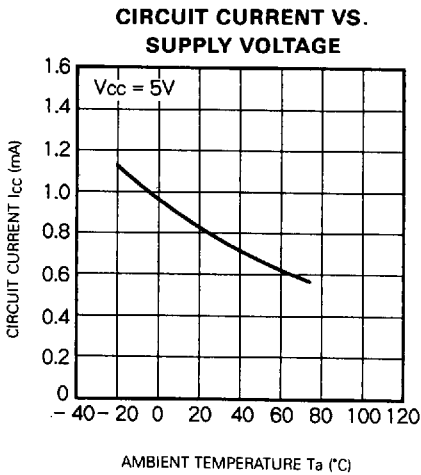
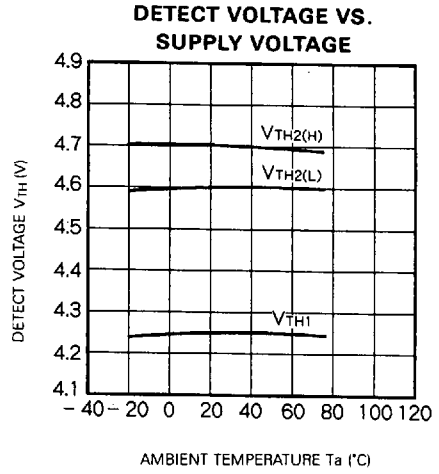
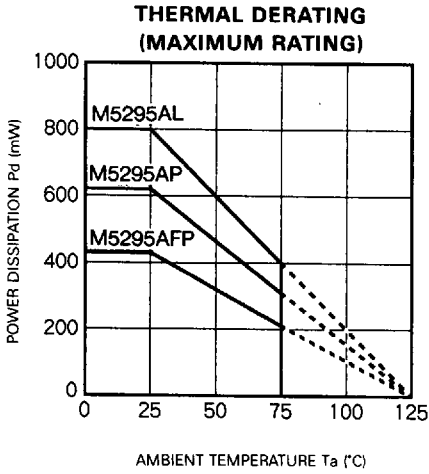
- When malfunction occurs due to noise or other related trouble, connect capacitance of approximately 1000 pF between pin ⑤ and GND as well as pin ③ and GND to stabilize operation
- To adjust detection voltage, add resistance of 15kΩ or less to both V<sub>CC</sub> and GND via adjusting pins. (Set detection voltage to no less than 3V.)
- Set t<sub>WD</sub> and t<sub>RST(2)</sub> as shown below:  
 $110 \mu\text{s} \leq t_{WD} \leq 1.1 \text{ s}$   
 $8.3 \mu\text{s} \leq t_{RST(2)} \leq 83 \text{ ms}$   
 $10 \text{ k}\Omega \leq R_1 \leq 30 \text{ k}\Omega$
- Input clock pulses to pin ① via capacitor. To determine capacitance, refer to "Relationship between Input Pulse Width and Input Capacitance C<sub>in</sub>".

**Example of Backup Circuit with M5295AL**



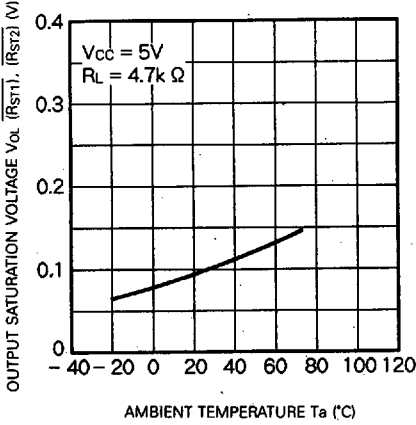
(Note) Set backup switching voltage to be more than or equal to backup supply voltage.

**TYPICAL CHARACTERISTICS**

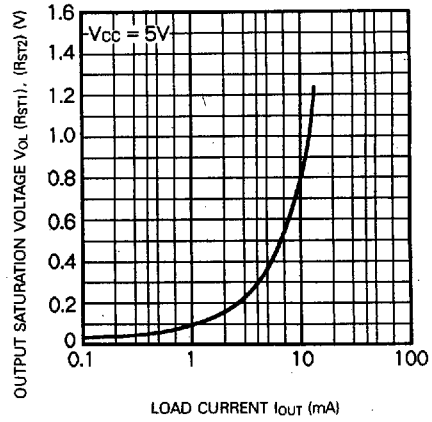


**WATCHDOG TIMER**

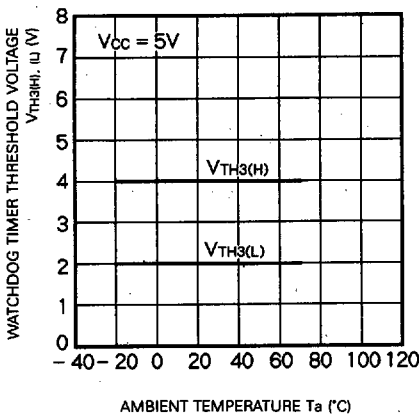
**OUTPUT SATURATION VOLTAGE VS. AMBIENT TEMPERATURE**



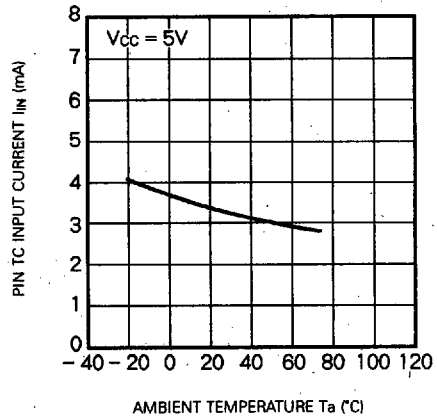
**OUTPUT SATURATION VOLTAGE VS. LOAD CURRENT**



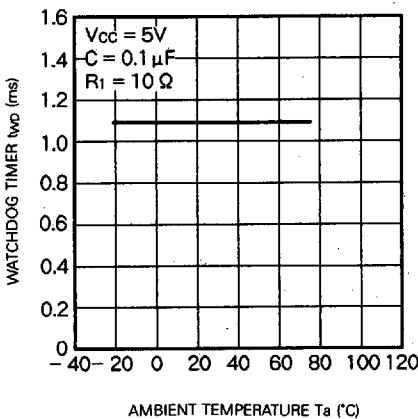
**WATCHDOG TIMER THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE**



**PIN TC INPUT CURRENT VS. AMBIENT TEMPERATURE**



**WATCHDOG TIMER VS. AMBIENT TEMPERATURE**



**RESET TIMER (2) VS. AMBIENT TEMPERATURE**

