To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

M5296FP

+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

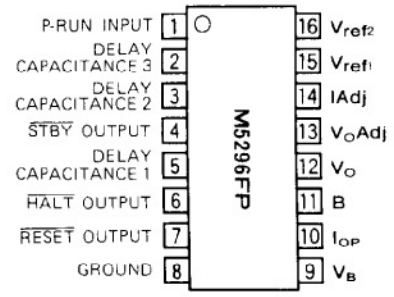
DESCRIPTION

The M5296FP is a watchdog timer semiconductor integrated circuits which incorporates a 5V constant-voltage power supply.

To check for system failure and assure safe system operations, the M5296FP has three sequential outputs ($\overline{HALT}$, $\overline{STBY}$, and $\overline{RESET}$) and a watchdog timer output which intermittently generates a reset pulse when pulse width or cycle abnormalities are found in the clock signal from the microcomputer. (The watchdog output terminal is shared by the watchdog timer output and sequential output $\overline{RESET}$.)

Further, each output retains the Low reset feature at supply voltages down to 0.8V, thereby preventing system malfunctioning upon power ON.

PIN CONFIGURATION (TOP VIEW)



Outline 16P2N-A

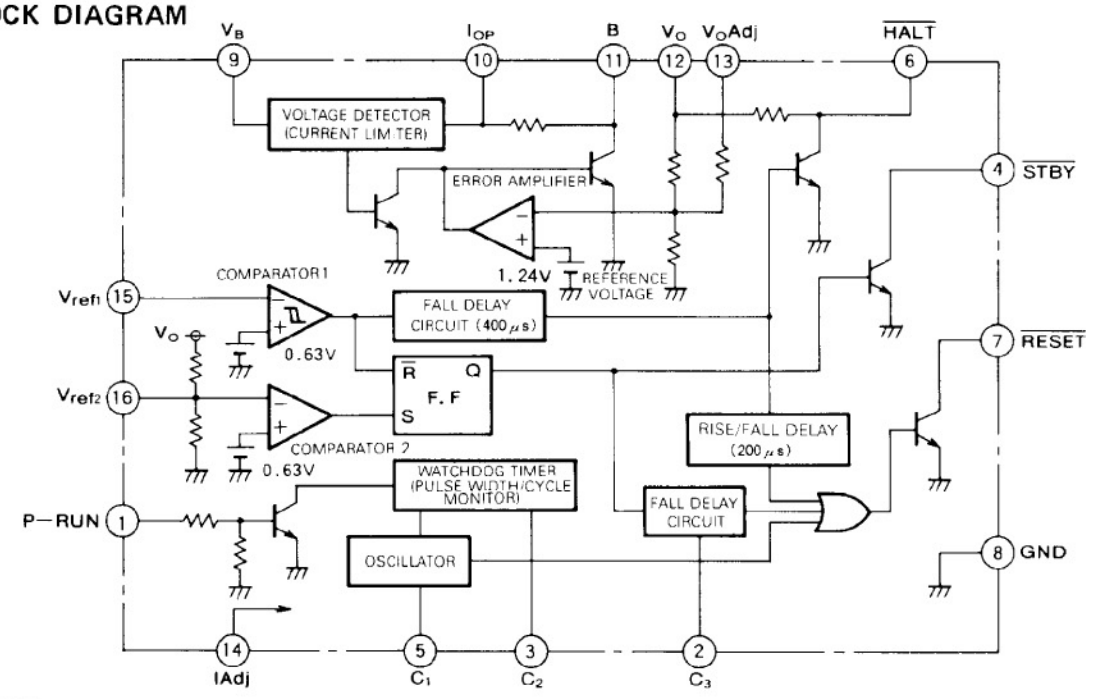
FEATURES

- Watchdog timer (clock pulse width and cycle are monitored at the same time).
- Power ON reset timer.
- Three outputs ($\overline{HALT}$ output for holding, $\overline{RESET}$ output for reset, and $\overline{STBY}$ output for return).
- Output voltage (can be fine-tuned with an external resistor) . . . . . 5V±0.25V
- Wide supply voltage range . . . . . 6V~40V
- The delay time can be set using an external capacitor (the setting can be varied from about 1msec to 1sec).
- Built-in overcurrent protection circuit (which can be set up with an external resistor).

APPLICATION

Home and industrial microcomputer systems.

BLOCK DIAGRAM



+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

ABSOLUTE MAXIMUM RATINGS (Ta=25℃ unless otherwise noted)

Symbol	Parameter	Test conditions	Rating	Unit
V_B	Supply voltage		40	V
V_{HALT}	$\overline{HALT}$ output breakdown voltage		V_O	V
V_{STBY}	$\overline{STBY}$ output breakdown voltage		16	V
V_{RESET}	$\overline{RESET}$ output breakdown voltage		16	V
I_{HALT}	$\overline{HALT}$ output current		10	mA
I_{STBY}	$\overline{STBY}$ output current		10	mA
I_{RESET}	$\overline{RESET}$ output current		10	mA
Pd	Internal power consumption		550	mW
K_θ	Thermal derating	Ta≧25℃	−5.5	mW/℃
Topr	Operating ambient temperature		−20 − +75	℃
Tstg	Storage temperature		−55 ~ +125	℃

ELECTRICAL CHARACTERISTICS (V_B=12V, I_O=50mA, C_I=22μF, C_O=100μF, Ta=25℃ unless otherwise noted)

Symbol	Parameter	Test conditions	Terminal	Rating Min	Rating Typ	Rating Max	Unit
I_B	Bias current		⑨		9	20	mA
V_O	Output voltage		⑫	4.75	5.0	5.25	V
V_{OM}		V_{OAdj}=0V, V_B=6~40V	⑫			6.0	V
Reg-IN	Input stability	V_B=6~40V	⑫		0.1	0.2	%/V
Reg-L	Load stability	I_O=1~500mA	⑫		40	200	mV
V_{ref1}	Reference voltage 1		⑮	0.56	0.63	0.68	V
V_{ref2}	Reference voltage 2		⑯	0.56	0.63	0.68	V
$\triangle V_{TH1}$	Threshold voltage hysteresis width	*1 V_{TH1}=4.35V	⑫	20	50	100	mV
V_{TH2}	Threshold voltage 2		⑫	2.6	3.0	3.4	V
VsatH	$\overline{HALT}$ output saturation voltage	I_{HALT}=2mA	⑥		0.2	0.4	V
VsatS	$\overline{STBY}$ output saturation voltage	I_{STBY}=5mA	④		0.2	0.4	V
VsatR	$\overline{RESET}$ output saturation voltage	I_{RESET}=5mA	⑦		0.2	0.4	V
V_{HALT}	$\overline{HALT}$ output H voltage		⑥	V_O−0.2	V_O−0.1	V_O	V
I_{LS}	$\overline{STBY}$ output leak current	V_{STBY}=5V	④			1	μA
I_{LR}	$\overline{RESET}$ output leak current	V_{RESET}=5V	⑦			1	μA
I_{HALT}	$\overline{HALT}$ output source current *2		⑥	0.5	1.0	2.0	mA
I_{IN-P}	P-RUN input current	V_{IN-P}=5V	①	130	200	300	μA
V_{IN-PH}	P-RUN H input voltage		①	2.0			V
V_{IN-PL}	P-RUN L input voltage		①			0.3	V
$t_{1(RW)}$	Watchdog reset pulse width	C_1=0.15μF	⑦	35	50	70	ms
$t_{2(HW)}$	Watchdog time	C_1=0.15μF, C_2=0.15μF	⑦	200	280	390	ms
$t_{3(R)}$	$\overline{RESET}$ output delay time	C_3=0.068μF	⑦	55	80	115	ms
$t_{4(H)}$	$\overline{RESET}$ output delay time		⑦	110	200	340	μs
$t_{5(H)}$	$\overline{HALT}$ output delay time *3		⑥	230	400	680	μs
$t_{6(PW)}$	P-RUN input minimum pulse width		①	230	400	680	μs
V_{BMIN}	V_B minimum operating voltage *4		⑨			2.0	V
V_{OMIN}	V_O minimum operating voltage *5		⑫		0.8	1.0	V
V_{IP}	Current limiter detection voltage *6		⑨ ⑩	85	130	200	mV

Note *1: V_{TH1} is the threshold voltage for V_{ref1}. It is to be set up by an external resistor. The setup must be such that $V_{TH1}>V_{TH2}$.
*2: A current that source when the $\overline{HALT}$ terminal is grounded in the HIGH $\overline{HALT}$ output mode (when V_O is normal).
*3: When Ta=−20 to +75℃, $t_{5(H)}>t_{4(R)}$.
*4: The V_B minimum operating voltage at which each function works.
*5: The V_O minimum operating voltage at which the HALT output, $\overline{RESET}$ output, and $\overline{STBY}$ output stay Low.
*6: In the overcurrent operation state, the current limiter works when the external resistor (Rs) voltage (voltage developed between terminals ⑨ and ⑩) drops 130 mV (TYP) or more.

Output peak current $I_{OP}=\frac{0.13}{Rs}$ [A]

+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

DEFINITION OF TERMS

$t_{1(RW)}$: Watchdog reset pulse width.
The width of an about 50% duty intermittent pulse that is generated from the $\overline{RESET}$ terminal when the clock signal input to the P-RUN terminal has a low input level, an insufficient pulse width, an excessively long period, or other problem.

Cycle $t = 2 \cdot t_{1(RW)}$

$t_{2(RW)}$: Watchdog time.
The time for clock signal monitoring or the maximum clock cycle during which clock signal normality is detected.

$t_{3(R)}$: $\overline{RESET}$ output delay time.
The delay time from the instant the $\overline{STBY}$ output is remove to the moment the $\overline{RESET}$ output is remove.

$t_{4(R)}$: $\overline{RESET}$ output delay time.
The time interval between $\overline{HALT}$ output fall/rise and $\overline{RESET}$ output fall/rise in cases where the $\overline{STBY}$ output is not generated (when V_O does not drop below V_{TH2}).

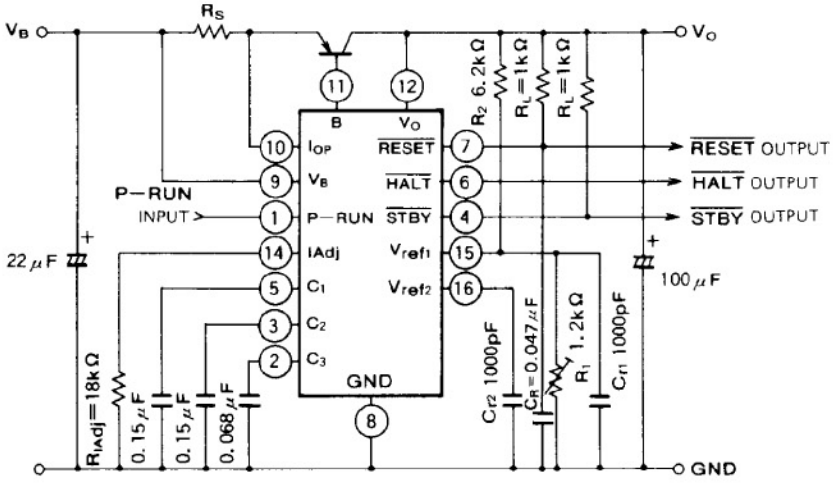
$t_{5(H)}$: $\overline{HALT}$ output delay time.
The time interval between the instant V_O is restored to the $V_{TH1} \pm \Delta V_{TH1}$ level and the instant the $\overline{HALT}$ output is remove.

$t_{6(PW)}$: P-RUN input minimum pulse width.
The minimum pulse width for clock signal normality detection.

V_{IN-PH} : P-RUN H input voltage.
The minimum input voltage for P-RUN terminal input clock signal High level detection.

V_{IN-PL} : The maximum input voltage for P-RUN terminal input clock signal Low level detection.

APPLICATION CIRCUIT EXAMPLE



C_I, C_O ····· Necessary for oscillation prevention and input/output stabilization. Be sure that these devices are used near the IC pins.

R_S ····· Required for current limiting setup. If the current limiting function is not to be exercised, short terminals ⑨ and ⑩.

R_{IAdj} ····· Resistor for delay time ($t_{1(RW)}$ to $t_{6(PW)}$) setup constant current determination. A standard setting of 18kΩ should be employed.

R_1, R_2 ····Resistor for threshold voltage V_{TH1} setup. For the setup procedure, see the later section entitled "PERIPHERAL CIRCUIT CONSTANT SETUP AND USAGE PRECAUTIONS."

C_1 ····· Necessary for watchdog reset pulse width setup. If the watchdog timer function is not to be used, ground terminal ⑤.

C_2 ····· Required for watchdog time setup. If the watchdog timer function is not to be used, ground terminal ③.

C_3 ····· Required for reset delay time setup for $\overline{STBY}$ output generation (V_{TH2} detection). When terminal ② is open, the delay time for $\overline{STBY}$ output is equal to that for $\overline{HALT}$ output.

$t_{3(R)} = t_{4(R)}$

R_L ····· As $\overline{STBY}$ and $\overline{RESET}$ are open-collector outputs, load resistor R_L is needed.

Cr_1, Cr_2 ·· Used when voltage detection terminals ⑮ and ⑯ are unstable due to power line noise or other factor.

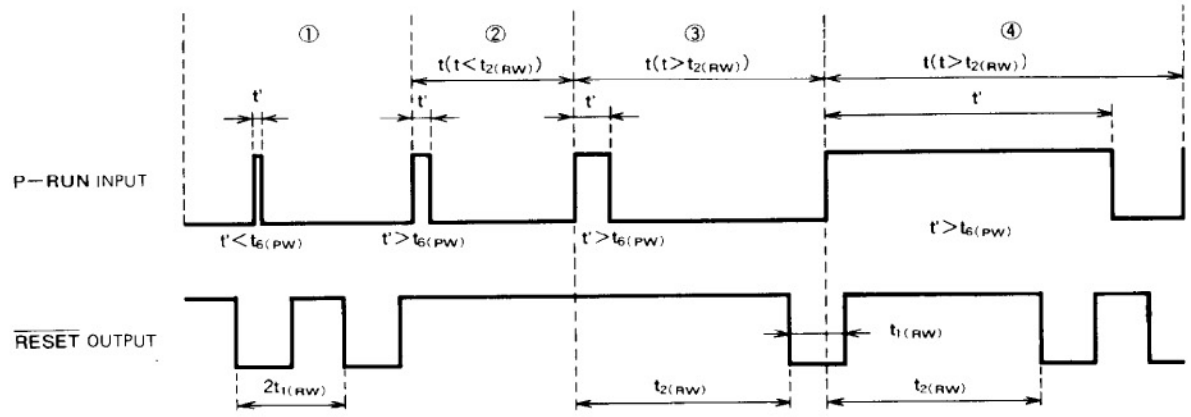
These devices are not needed when no such problems exist.

CR·····Necessary for $\overline{\text{RESET}}$ output chattering prevention. The setup must be such that $C_R \cdot R_L \geqq 4.0 \times 10^{-5}$ (F·Ω).

TIMING DIAGRAMS

1. Watchdog Timer

When the clock signal input is not give to the P-RUN input terminal or the entered signal has pulse widths (less than $t_{6(PW)}$) that are not to be detected as the clock signal, intermittent pulses (pulse width $t_{1(RW)}$ having a duty ratio of about 50% are outputted from the $\overline{\text{RESET}}$ terminal. When the entered clock signal has a pulse width of $t_{6(PW)}$ or more, the $\overline{\text{RESET}}$ intermittent operation stops and the signal goes High so that the watchdog timer (time setting: $t_{2(RW)}$ actuates. If no clock signal having a pulse width of $t_{6(PW)}$ or more is entered for a time period of $t_{2(RW)}$ after clock signal input, the $\overline{\text{RESET}}$ output starts an intermittent operation.



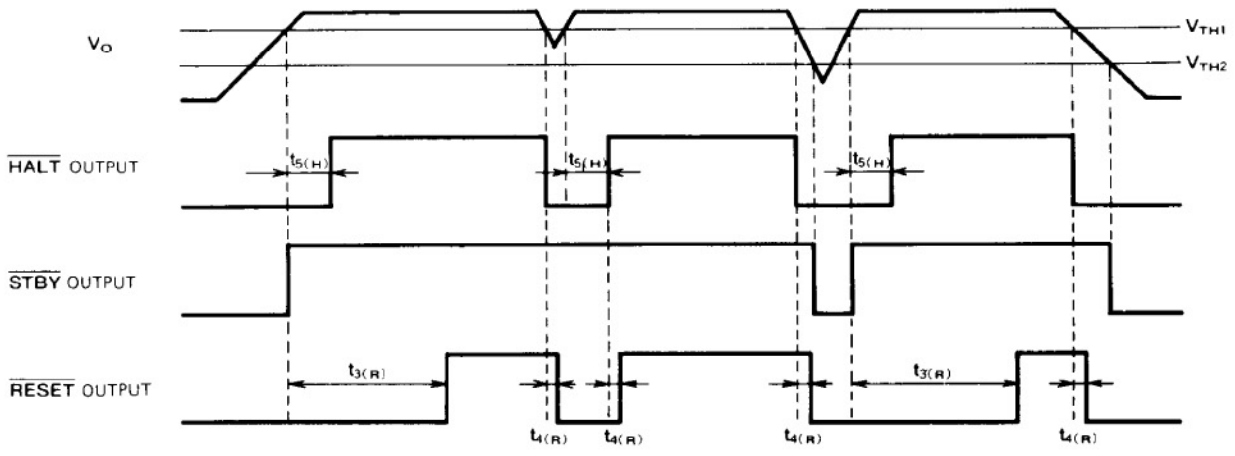
(1) The clock signal input is give to the P-RUN input terminal. However, as the pulse width is smaller than $t_{6(PW)}$, the clock signal input is not detected as a signal so that $\overline{\text{RESET}}$ generates intermittent pulsing.

(2) As the signal input has a pulse width of $t_{6(PW)}$ or more, the $\overline{\text{RESET}}$ intermittent operation stops and the High output is generated. Further, as the clock signal cycle is not longer than the watchdog time $t_{2(RW)}$, $\overline{\text{RESET}}$ keeps its High output.

(3) $\overline{\text{RESET}}$ maintains its High output by performing the same operations as indicated in paragraph (2) above. However, as the clock signal cycle is rendered longer than the watchdog time $t_{2(RW)}$, $\overline{\text{RESET}}$ starts an intermittent operation.

(4) The $\overline{\text{RESET}}$ intermittent operation starts $t_{2(RW)}$ after clock signal input due to the same operations as indicated in paragraph (3) above. Even if the clock signal input is fed while the $\overline{\text{RESET}}$ level is Low with intermittent operations performed, $\overline{\text{RESET}}$ does not immediately go High so that the Low pulse width ($t_{1(RW)}$ is assured.

VOLTAGE MONITORING TIMING DIAGRAM (P-RUN INPUT NORMALITY)



2. Voltage Monitoring Timing Diagram (P-RUN Input Normality)

$\overline{HALT}$ output

When V_O drops below the threshold voltage VTH_1, $\overline{HALT}$ generates a Low level. $\overline{HALT}$ is reset $t_{5(H)}$ after V_O is restored to the $VTH_1 \pm \Delta VTH_1$ level.

$\overline{STBY}$ output

When V_O drops below the threshold voltage VTH_2 ($VTH_2 < VTH_1$), $\overline{STBY}$ generates a Low level. When V_O is restored to the VTH_1 level, $\overline{STBY}$ is reset.

$\overline{RESET}$ output

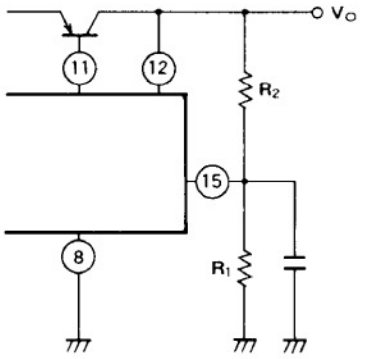
When the decreased V_O level is between VTH_2 and VTH_1 ($VTH_2 < V_O < VTH_1$), $\overline{RESET}$ output generation takes place $t_{4(R)}$ after $\overline{HALT}$ fall/rise. When V_O is lower than VTH_2, $\overline{RESET}$ rise occurs $t_{3(R)}$ after $\overline{STBY}$ rise.

However, $t_{3(R)} > t_{5(H)}$.

PERIPHERAL CIRCUIT CONSTANT SETUP AND USAGE PRECAUTIONS

1. Threshold Voltage Setup

As indicated in the timing diagram on the preceding page, the M5296FP checks for output voltage decrease on the basis of two preset values (threshold voltages 1 and 2 [V_{TH1} and V_{TH2}]). V_{TH1} can be set as desired with an external resistor (however, $V_{TH1} > V_{TH2}$). V_{TH2} is set to 3.0V Typ by the built-in resistor; however, it is possible to raise it slightly using the V_{ref2} terminal.



In the above circuit, V_{TH1} is calculated as follows.

$$V_{TH1} = 0.63 \times \frac{R_1 + R_2}{R_1} \quad (V)$$

For V_{TH1} detection purposes, hysteresis is provided to avoid operation instability which may be caused by noise ripple or other factor, and its value is as indicated below.

$$\Delta V_{TH1} \fallingdotseq 7 \times \frac{R_1 + R_2}{R_1} \quad (mV)$$

NOTE 1: V_{TH1} must be set up so that $V_{TH1} > V_{TH2}$.

NOTE 2: If malfunctioning occurs due to noise or other problem, connect an about 1000pF capacitor between terminals ⑮ and GND to assure stable operations.

2. Delay Time Setup

The M5296FP uses an external capacitor to set up three different delay times (watchdog reset pulse width $t_{1(RW)}$, watchdog time $t_{2(RW)}$, and $\overline{RESET}$ output delay time $t_{3(R)}$).

(1) $t_{1(RW)}$ Setup

When the clock signal input to the P-RUN terminal is abnormal, intermittent pulsing having a duty ratio of about 50% is generated from the $\overline{RESET}$ terminal.

The oscillation cycle $2 \cdot t_{1(RW)}$ is to be set up using C_1 as indicated below.

$$2 \cdot t_{1(RW)} = 6.72 \times 10^5 \times C_1 \ (s)$$

(2) $t_{2(RW)}$ Setup

The watchdog time $t_{2(RW)}$ is used for clock signal monitoring purposes. It denotes the clock signal cycle limit. If the clock signal cycle becomes longer than $t_{2(RW)}$, intermittent pulses preset by C_1 are generated from the $\overline{RESET}$ terminal. The value $t_{2(RW)}$ is to be set up by C_2.

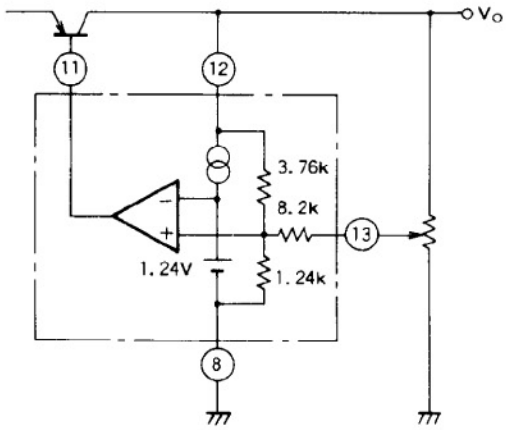
$$t_{2(RW)} = t_{1(RW)} + 1.53 \times 10^6 \times C_2 \ (s)$$

(3) $t_{3(R)}$ Setup

The RESET output delay time $t_{3(R)}$ refers to the elapsed time from the instant the $\overline{STBY}$ output is reset to the moment $\overline{RESET}$ output is reset. It is to be set up by C_3.

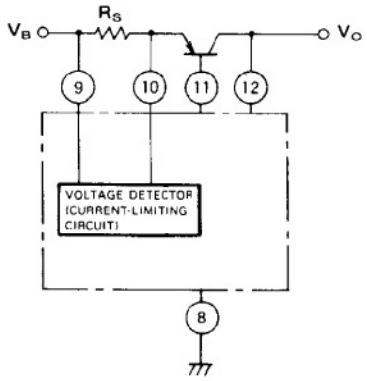
$$t_{3(R)} = 1.18 \times 10^6 \times C_3 \ (s)$$

3. Output Voltage V_O Adjustment



As shown above, the V_{OAdj} terminal permits output voltage fine adjustment. However, as a 8.2kΩ resistor is series-connected to the V_{OAdj} terminal, the approximate adjustment range is from -20% to +10%.

4. Overcurrent Protection Setup (I_O Peak Current Setup)



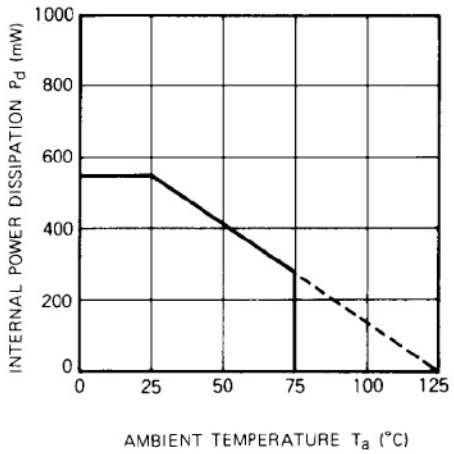
In the circuit shown at left, the load current flowing through the detection resistor R_S is detected as a voltage value (detection voltage: 130mV) for current limiting purposes.

$$I_{OP} \doteqdot \frac{130\,(mV)}{R_S\,(\Omega)}\,(mA)$$

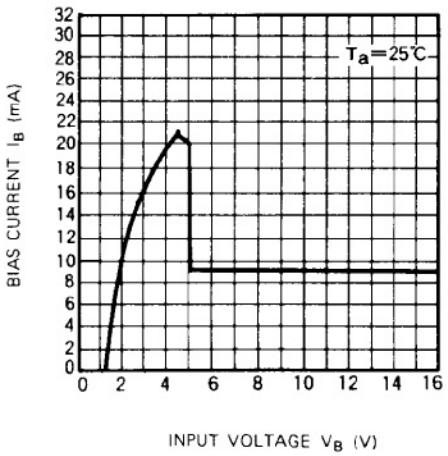
NOTE 3: The current flowing through R_S contains the IC bias current I_B. Therefore, the setup must be such that $I_B < 130/R_S$ (mA).

TYPICAL CHARACTERISTICS

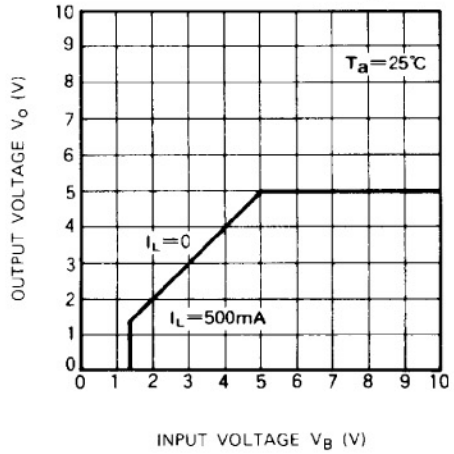
THERMAL DERATING (MAXIMUM RATING)



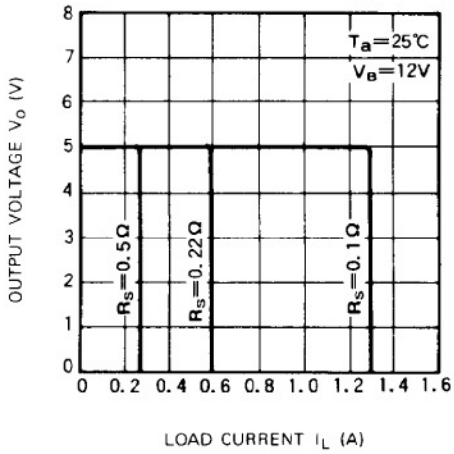
BIAS CURRENT VS. INPUT VOLTAGE



OUTPUT VOLTAGE (V_O) VS. INPUT VOLTAGE (V_B)

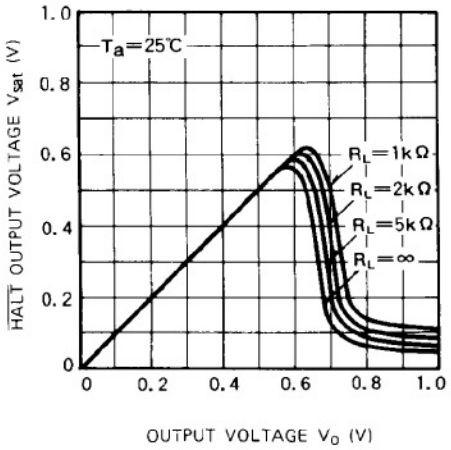


OUTPUT VOLTAGE (V_O) VS. LOAD CURRENT (I_L)

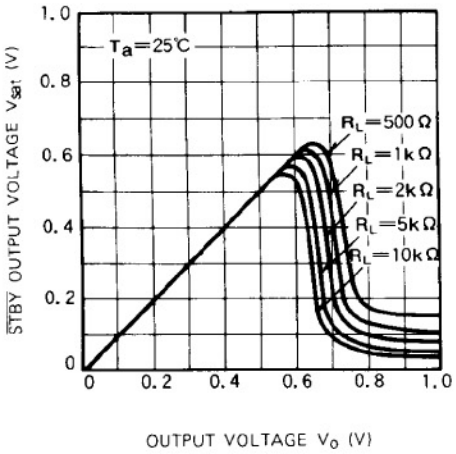


+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

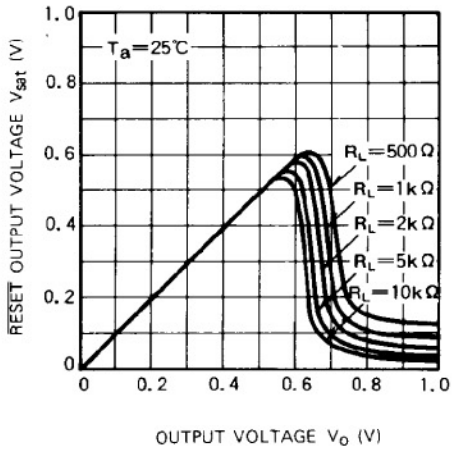
CRITICAL OPERATION VOLTAGE CHARACTERISTICS



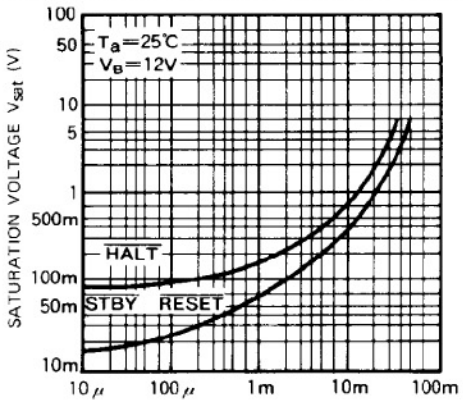
CRITICAL OPERATION VOLTAGE CHARACTERISTICS



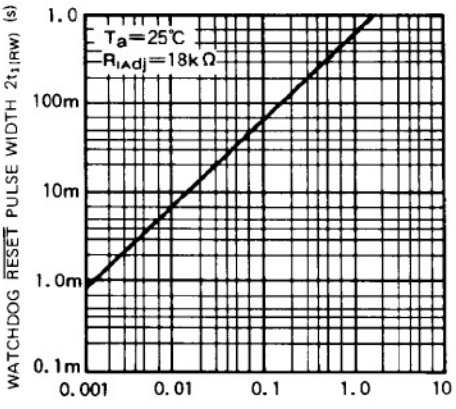
CRITICAL OPERATION VOLTAGE CHARACTERISTICS



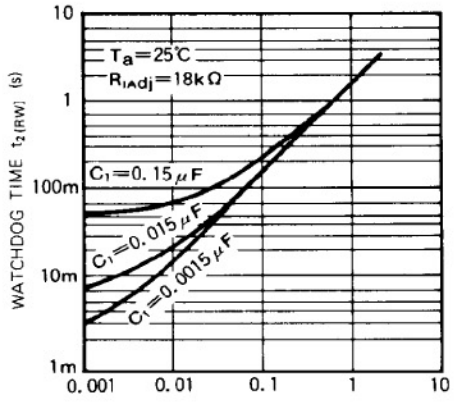
SATURATION VOLTAGE VS. SINK CURRENT



WATCHDOG RESET PULSE WIDTH VS. DELAY CAPACITANCE

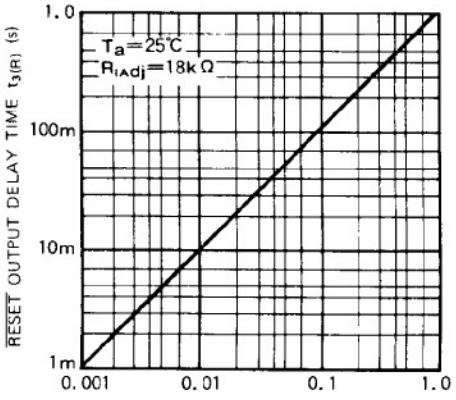


WATCHDOG TIME VS. DELAY CAPACITANCE

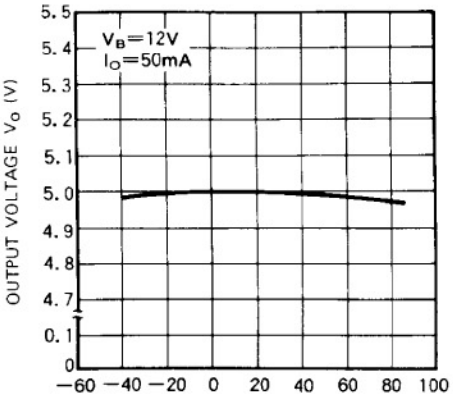


+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

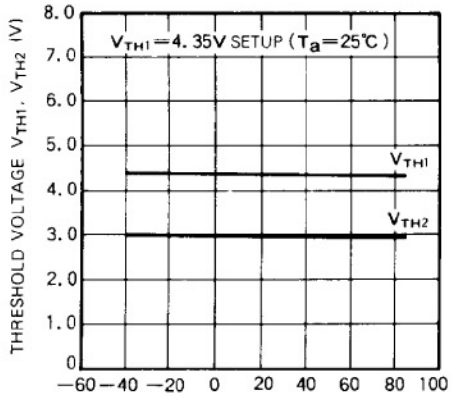
$\overline{\text{RESET}}$ OUTPUT DELAY TIME VS. DELAY CAPACITANCE



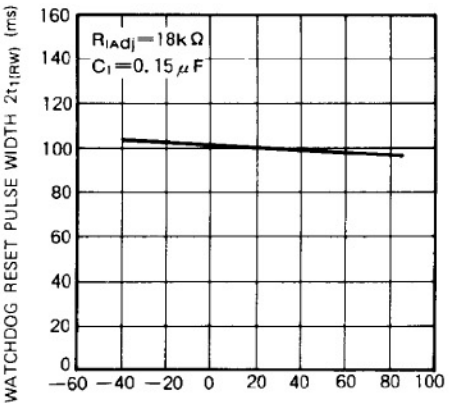
OUTPUT VOLTAGE VS. AMBIENT TEMPERATURE



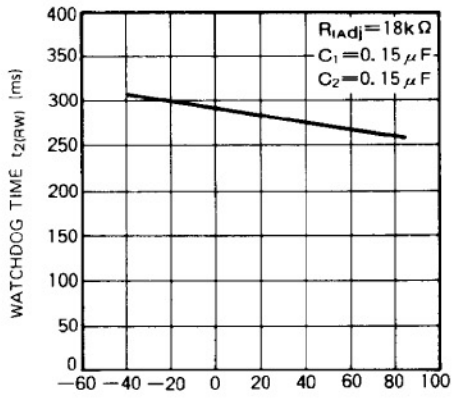
THRESHOLD VOLTAGE VS. AMBIENT TEMPERATURE



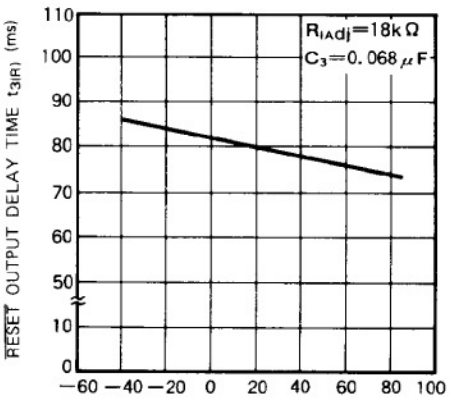
WATCHDOG RESET PULSE WIDTH VS. AMBIENT TEMPERATURE



WATCHDOG TIME VS. AMBIENT TEMPERATURE

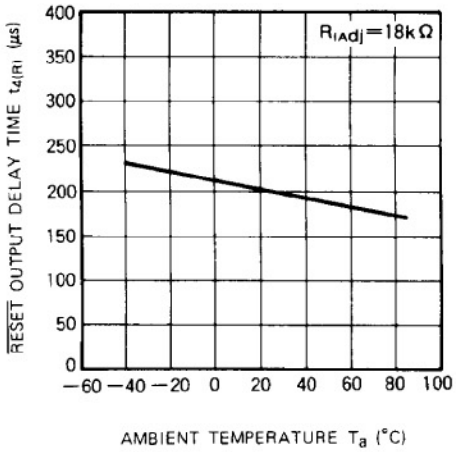


$\overline{\text{RESET}}$ OUTPUT DELAY TIME VS. AMBIENT TEMPERATURE

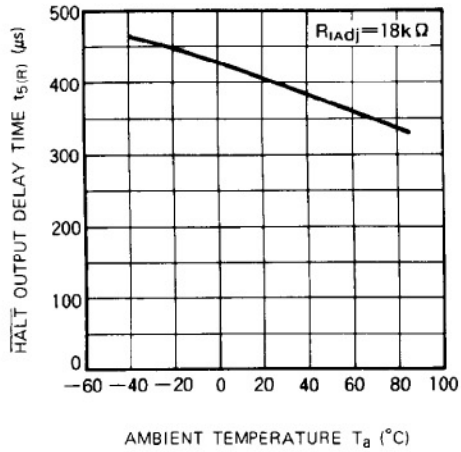


+5V CONSTANT-VOLTAGE POWER SUPPLY INCORPORATED WATCHDOG TIMER IC

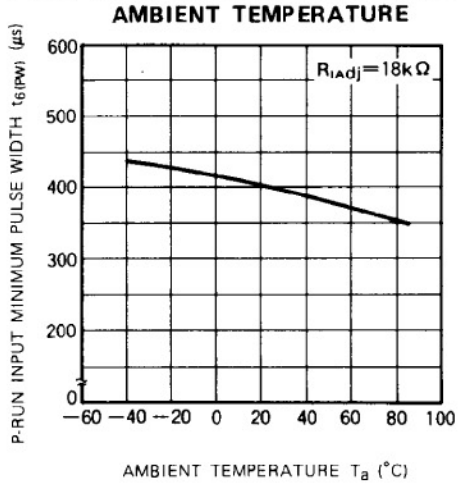
$\overline{\text{RESET}}$ OUTPUT DELAY TIME VS. AMBIENT TEMPERATURE



$\overline{\text{HALT}}$ OUTPUT DELAY TIME VS. AMBIENT TEMPERATURE



P-RUN INPUT MINIMUM PULSE WIDTH VS. AMBIENT TEMPERATURE



BIAS CURRENT VS. AMBIENT TEMPERATURE