High-Voltage Hysteresis Selectable Temperature Switch

General Description

The RT9726 is a temperature switch with wide input voltage range. The over-temperature threshold point is generated by a negative temperature coefficient (NTC) thermistor and a setting resistor. The RT9726 provides an active-low, open-drain logic output. $\overline{OT}$ goes LOW when the NTC pin voltage is lower than 50% of the REF voltage threshold. The RT9726 provides the selectable hysteresis mode that can be set by the EN pin Input voltage. The IC is available in SC-70-6 package.

Ordering Information

RT9726 □□

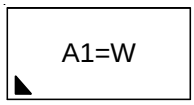
- Package Type
  - U6 : SC-70-6
- Lead Plating System
  - G : Green (Halogen Free and Pb Free)

Note :

Richtek products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Marking Information



A1= : Product Code

W : Date code

Features

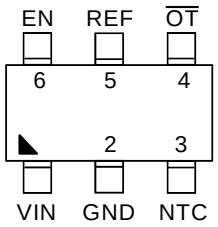
- **Wide Input Voltage Range : 4.75V to 25V**
- **0.5μA Shutdown Current**
- **2 Selectable Hysteresis Threshold**
- **Reference Output for Thermal Threshold Setting**
- **Open-drain Logic Output**
- **RoHS Compliant and Halogen Free**

Applications

- Notebook Temperature Monitoring
- Microprocessor Thermal Management
- Temperature Control
- Fan Control
- Electronic System Protection

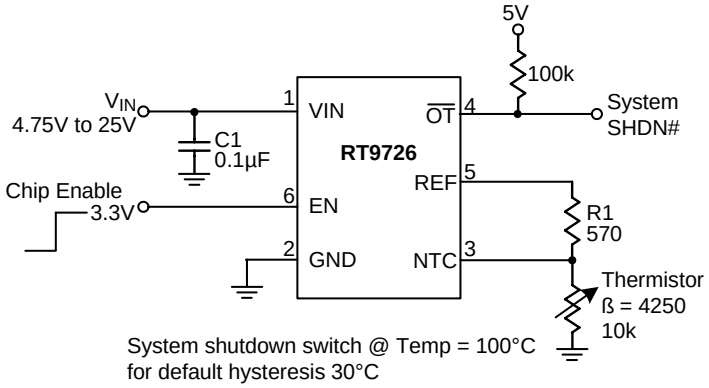
Pin Configurations

(TOP VIEW)



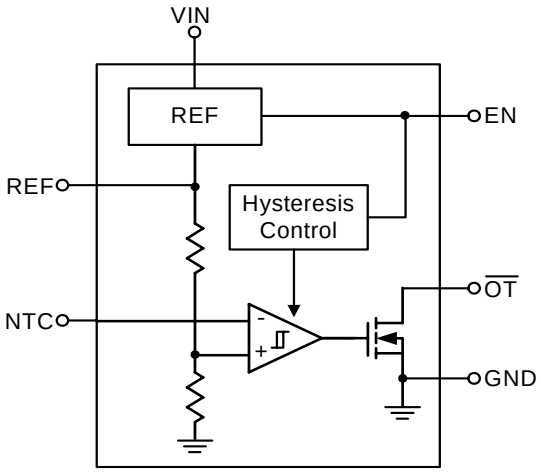
SC-70-6

Typical Application Circuit



System shutdown switch @ Temp = 100°C
for default hysteresis 30°C

Function Block Diagram



Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VIN	High Voltage Power Supply Input. This pin should be bypassed with a 0.1μF capacitor to ground.
2	GND	Ground pin. Tie the ground pin close to temperature sensing thermistor.
3	NTC	This pin should connect a thermistor resistor to ground. The NTC pin will sense the external thermistor cross voltage and provide typical 50%REF over-temperature threshold for $\overline{OT}$ pin.
4	$\overline{OT}$	Open-drain and active-low output. $\overline{OT}$ will go LOW when NTC pin is lower than typical 50%REF over-temperature threshold.
5	REF	Reference Output. This pin should connect with a resistor to NTC pin to set the over-temperature threshold.
6	EN	Chip Enable (Active High). This pin can be used for the over-temperature threshold hysteresis setting.

Absolute Maximum Ratings (Note 1)

- VIN to GND ---------- –0.3V to 28V
- NTC, $\overline{OT}$, REF, EN to GND ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  SC-70-6 ---------- 0.3W
- Package Thermal Resistance (Note 2)
  SC-70-6, θ_{JA} ---------- 333°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 4)

- Supply Input Voltage, V_{IN} ---------- 4.75V to 25V
- Junction Temperature Range ---------- –40°C to 125°C

Electrical Characteristics

(No load on REF, V_{IN} = 7V, V_{EN} = 5V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Supply						
VIN Shutdown Current	I_{VIN}	V_{IN} = 4.75V to 25V, EN = GND	--	--	3	μA
VIN Quiescent Current	I_Q	V_{IN} = 4.75V to 25V, EN = 5V, No Load On REF	--	100	150	μA
REF Output						
REF Output Voltage	REF	No External Load	1.978	2	2.022	V
REF Output Current	I_{REF}	In 1% REF Drop	--	--	2	mA
Logic Output						
$\overline{OT}$ Output Low Voltage		$\overline{OT}$ Sink Current = 4mA	--	--	0.2	V
Temperature Threshold Configure						
Over-Temperature Threshold	NTC/REF	$\overline{OT}$ = High	47.5	50	52.5	%
Over-Temperature Recovery Threshold	NTC/REF	Mode = Hyst1, $\overline{OT}$ = Low	62.5	65	67.5	%
		Mode = Hyst2, $\overline{OT}$ = Low	70	72.5	75	%
EN Input Voltage	EN	Shutdown	--	--	0.4	V
		Set Hyst1 Mode	1.2	--	2.4	V
		Set Hyst2 Mode	2.9	--	--	V

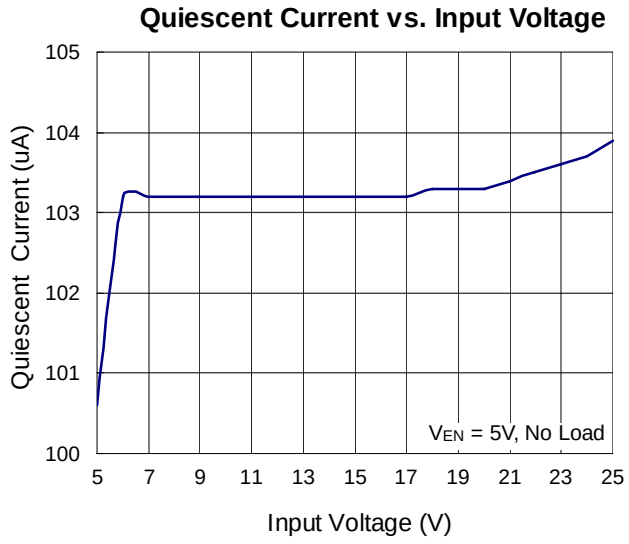
Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

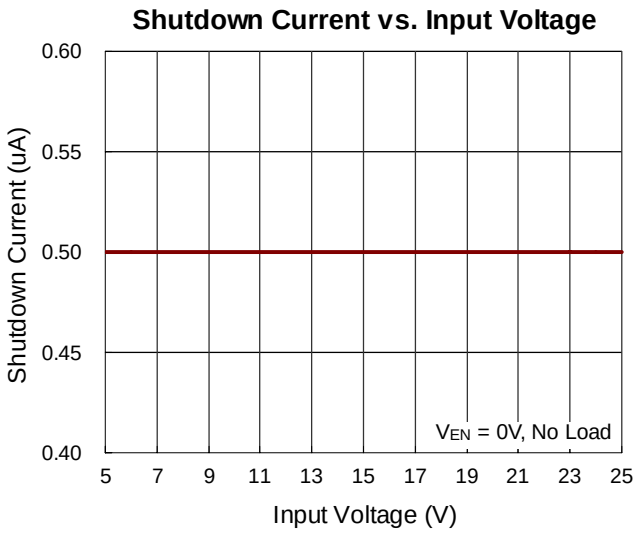
Note 2. θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

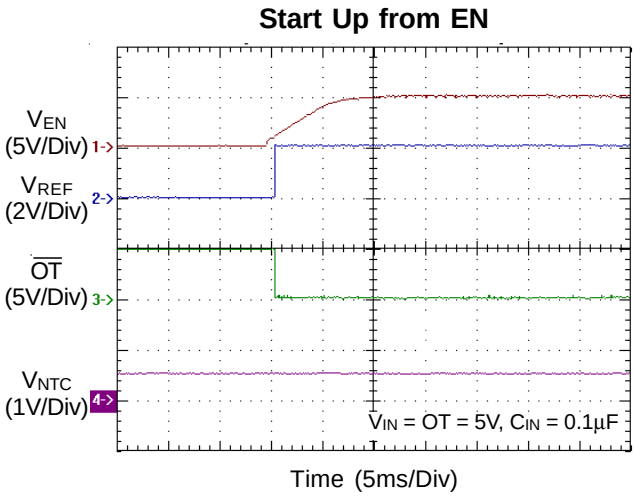
Note 3. Devices are ESD sensitive. Handling precaution is recommended.

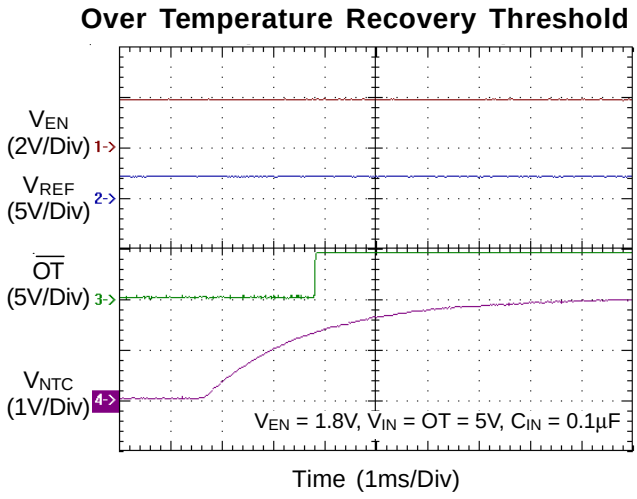
Note 4. The device is not guaranteed to function outside its operating conditions.

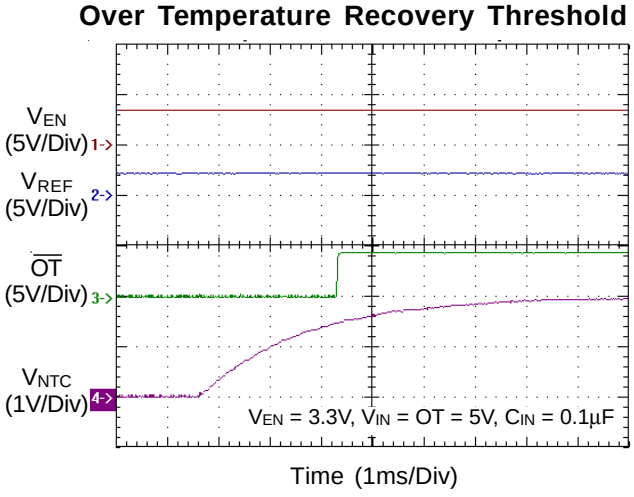
Typical Operating Characteristics











Application Information

The RT9726 is a temperature switch with wide input voltage range from 4.75V to 25V. It provides an accurate reference output voltage. By adding a negative temperature coefficient (NTC) thermistor from NTC pin to GND and a resistor from REF to NTC pin, a temperature-dependent voltage can be achieved. When the NTC pin voltage is lower than 50% of the REF voltage threshold, the $\overline{OT}$ pin goes low. The RT9726 provides a selectable hysteresis mode that can be set by controlling the EN pin voltage.

Over Temperature Threshold Setting

The $\overline{OT}$ pin state is an open-drain logic output. As shown in Table 1, the $\overline{OT}$ pin will go low and shut down the RT9726 when $V_{NTC} \leq 50\%$ of V_{REF}. When $V_{NTC} > 50\%$ of V_{REF}, the $\overline{OT}$ pin will be pulled high by the external resistor.

Table 1. NTC Over Temperature Threshold

NTC Pin Voltage	$\overline{OT}$ Pin State
> 50% V_{REF}	Pulled High
≤ 50% V_{REF}	Low

Over Temperature Recovery Threshold

The RT9726 supports two temperature recovery thresholds as shown in the Table 2. It is set by EN pin voltage. For example, set EN pin voltage at 3.3V then $\overline{OT}$ pin will be released if V_{NTC} rises to above 70% of the V_{REF}.

Table 2. Recovery Mode and NTC Recovery Threshold Voltage

Recovery Mode	EN Input Voltage	NTC Pin Recovery Threshold Voltage (min.)	Recovery Temperature Threshold (1)
Hyst 1	V_{EN} = 1.2V to 2.4V	62.5% V_{REF}	−20°C
Hyst 2	V_{EN} = 2.9V to 5.5V	70% V_{REF}	−30°C

Note 1 : Thermistor β = 4250 and temperature threshold is set at 100°C.

POR and Shutdown

Power-on reset (POR) occurs when input voltage rises above 3.9V (typical), the $\overline{OT}$ pin will be released when V_{NTC} is higher then 50% V_{REF}.

By setting the EN pin voltage below 0.4V, the REF pin voltage goes low and then the RT9726 will be shut down.

Design Example

Figure 1. shows the typical fan control application circuit. When the NTC pin voltage is lower than 50% of V_{REF}, the $\overline{OT}$ will go low to turn on the fan.

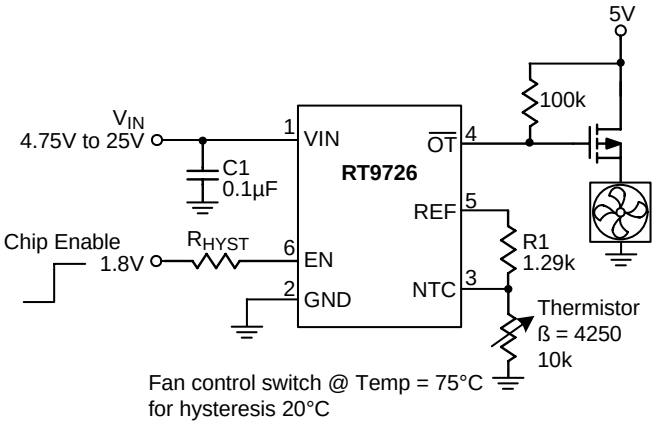


Figure 1. Fan Control Application

$$R_{T1} = R_{T2} \times e^{\beta\left(\frac{1}{T1}-\frac{1}{T2}\right)}$$

R_{T1} : The resistance of NTC thermistor at T1 (°k)

R_{T2} : The resistance of NTC thermistor at T2 (°k)

β : The coefficient of NTC thermistor

If the thermal shut-down threshold is set at 75°C and R_{T2} = 10kΩ (under 25°C) with β = 4250, R1 can be calculated by using the equation as follows :

$$R1 = R_{(T1 = 75^{\circ}C)} = 10k \times e^{4250\times\left(\frac{1}{273.15+75}-\frac{1}{273.15+25}\right)}$$

$$= 1.29k\Omega$$

Thermal Considerations

For continuous operation, do not exceed absolute maximum operation junction temperature. The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surroundings airflow and temperature difference between junction to ambient. The maximum power dissipation can be calculated by following formula :

$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$

Where $T_{J(MAX)}$ is the maximum operation junction temperature, T_A is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance.

For recommended operating conditions specification of the RT9726, the maximum junction temperature is 125°C and T_A is the maximum ambient temperature. The junction to ambient thermal resistance θ_{JA} is layout dependent. For SC-70-6 packages, the thermal resistance θ_{JA} is 333°C /W on the standard JEDEC 51-3 single layer thermal test board. The maximum power dissipation at T_A = 25°C can be calculated by following formula :

$P_{D(MAX)}$ = (125°C – 25°C) / (333°C / W) = 0.3W for SC-70-6 package

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{JA}. For RT9726 package, the Figure 2 of derating curves allows the designer to see the effect of rising ambient temperature on the maximum power dissipation allowed.

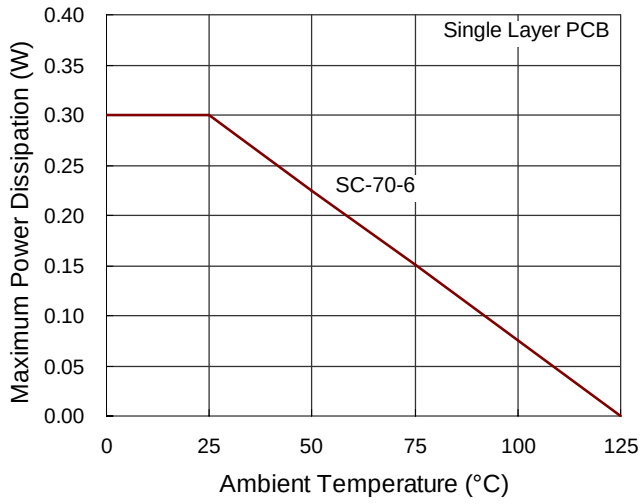


Figure 2. Derating Curves for RT9726 Package

Layout Considerations

For best performance of the RT9726, the input capacitor should be placed as close to the VIN pin and ground plane as possible to reduce noise coupling.

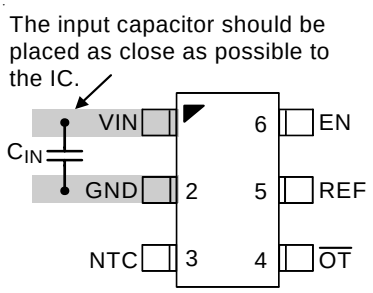
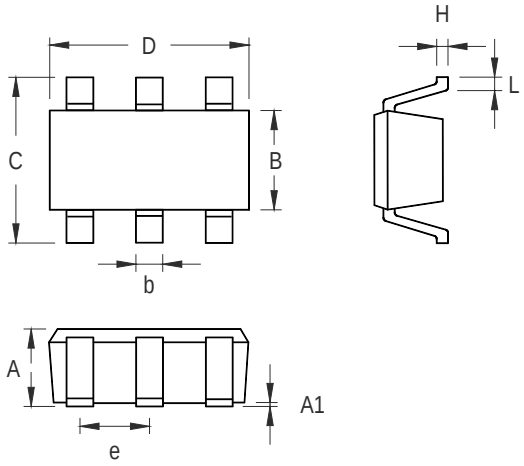


Figure 3. PCB Layout Guide

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.031	0.044
A1	0.000	0.100	0.000	0.004
B	1.150	1.350	0.045	0.054
b	0.150	0.400	0.006	0.016
C	1.800	2.450	0.071	0.096
D	1.800	2.250	0.071	0.089
e	0.650		0.026	
H	0.080	0.260	0.003	0.010
L	0.210	0.460	0.008	0.018

SC-70-6 Surface Mount Package

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