RICHTEK® **RT9718**

Overvoltage Protection IC

1 General Description

The RT9718 is an integrated circuit optimized to protect low voltage system from abnormally high input voltages (up to 30V). The IC monitors the input voltage, battery voltage, and charging current to ensure all three parameters operate within the normal range. When the input voltage exceeds a certain Overvoltage Protection (OVP) threshold voltage level, the IC will turn off the power MOSFET within 1μs to remove the power before any damage occurs. The RT9718 can also provide a voltage output in the absence of battery.

The current in the power MOSFET is limited to prevent the battery from being charged with excessive current. The current limit can be programmed by an external resistor connected between the ILIM and GND pins. The Overcurrent Protection (OCP) function includes a 4-bit binary counter that accumulates during an OCP event. If the total count reaches 16 consecutive times, the power MOSFET is turned off permanently unless the input power is recycled.

The IC also monitors the battery voltage. If the battery voltage exceeds 4.35V and lasts for more than 180μs blinking time, the RT9718 will turn off the MOSFET. The internal logic control will permanently turn off the power MOSFET when the battery overvoltage event occurs 16 consecutive times.

The RT9718 is available in a WDFN package. The recommended junction temperature range is –40°C to 125°C, and the ambient temperature range is –40°C to 85°C.

2 Marking Information

For marking information, contact our sales representative directly or through a Richtek distributor located in your area.

3 Features

- **Fully Integrated Protection Functions**
  - **Programmable OCP**
  - **Input OVP**
  - **Battery OVP**
- **Withstand High Input Voltage up to 30V**
- **Overvoltage Turn-Off Time Less than 1μs**
- **High Accuracy Protection Thresholds**
- **Over-Temperature Protection**
- **High Immunity of False Triggering Under Transients**
- **Warning Indication Output**
- **Enable Input**
- **Thermal Enhanced WDFN Package**

4 Applications

- Cellular Phones
- Digital Cameras
- Smartphones
- Portable Instruments

5 Ordering Information

RT9718□□□

Package Type(1)
QW: WDFN-8L 2x2 (W-Type)

Lead Plating System
G: Richtek Green Policy Compliant(2)

OVP
A: 6.80V
B: 5.85V
C: 6.25V
D: 7.20V

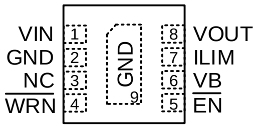
Note 1.

- Marked with (1) indicated: Compatible with the current requirements of IPC/JEDEC J-STD-020.
- Marked with (2) indicated: Richtek products are Richtek Green Policy compliant.

Table of Contents

6 Pin Configuration

(TOP VIEW)

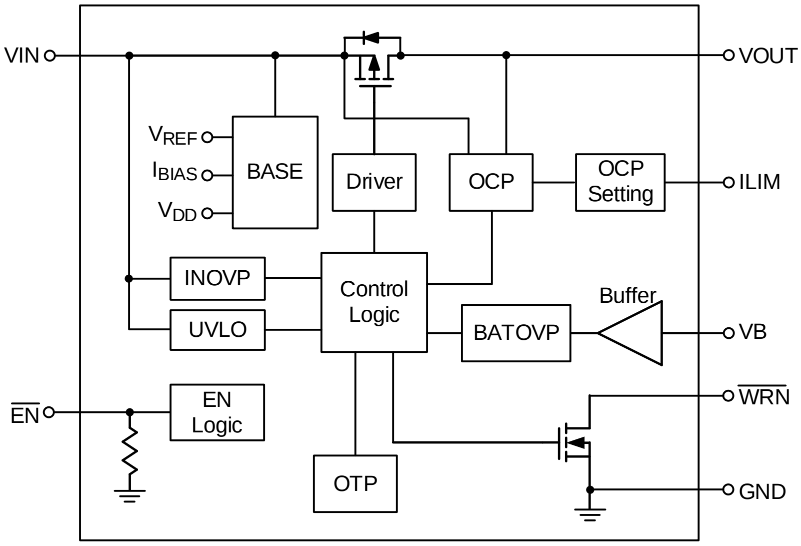


WDFN-8L 2x2

7 Functional Pin Description

Pin No.	Pin Name	Pin Function
1	VIN	Input power source. The VIN can withstand input voltages up to 30V.
2	GND	Analog ground.
3	NC	No internal connection.
4	$\overline{WRN}$	This is an open-drain logic output that turns low when any protection event occurs.
5	$\overline{EN}$	Chip enable (active low). To enable the IC, pull this pin low or leave it floating. To disable the IC, force this pin to a high state.
6	VB	Battery voltage monitoring input. This pin is connected to the positive terminal of the battery pack via an isolation resistor.
7	ILIM	Overcurrent Protection (OCP) threshold setting pin. To set the OCP threshold, connect a resistor between this pin and ground (GND).
8	VOUT	Output through the power MOSFET.
9 (Expose Pad)	GND	The exposed pad should be soldered to a large area on the PCB and connected to the ground (GND) to ensure maximum thermal dissipation.

8 Functional Block Diagram



9 Absolute Maximum Ratings

(Note 2)

- Supply Input Voltage, V_{IN} ---------- –0.3V to 30V
- VOUT, VB ---------- –0.3V to 7V
- Other Pins ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  WDFN-8L 2x2 ---------- 0.606W
- Package Thermal Resistance (Note 3)
  WDFN-8L 2x2, θ_{JA} ---------- 165°C/W
- WDFN-8L 2x2, θ_{JA} ---------- 20°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10sec.) ---------- 260°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 4)
  HBM (Human Body Model) ---------- 2kV

Note 2. Stresses beyond those listed under ”Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Note 3. θ_{JA} is simulated under natural convection (still air) at T_A = 25°C with the component mounted on a low effective-thermal-conductivity single-layer test board on a JEDEC 51-3 thermal measurement standard. θ_{JC} is simulated at the bottom of the package.

Note 4. Devices are ESD sensitive. Handling precautions are recommended.

10 Recommended Operating Conditions

(Note 5)

- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Note 5. The device is not guaranteed to function outside its operating conditions.

11 Electrical Characteristics

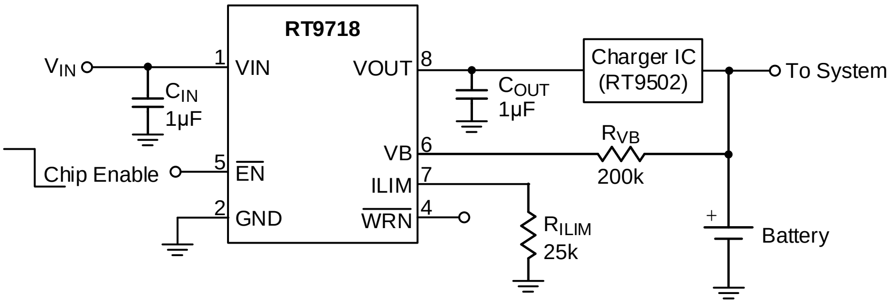
(V_{IN} = 5V, T_A = 25°C, unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Power-On Reset						
Operation Voltage	V_{IN}	RT9718A	4	--	6.5	V
		RT9718B	4	--	5.5	
		RT9718C	4	--	5.9	
		RT9718D	4	--	6.9	
Power-On Reset Voltage	V_{POR}	V_{POR} rising	2.5	2.7	2.9	V
Power-On Reset Deglitch Time	$t_{DEGLITCH\_POR}$		--	8	--	ms

Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Undervoltage-Lockout Falling Threshold	V_{UVLO_F}	V_{UVLO} falling		2.45	--	2.75	V
Quiescent Current	I_Q	$\overline{EN}$ = 0V		--	500	600	μA
Shutdown Current	I_{SHDN}	$\overline{EN}$ = 5V		--	65	95	μA
Protections							
VIN Overvoltage Protection Threshold	V_{IN_OVP}	V_{IN} rising	RT9718A	6.6	6.8	7	V
			RT9718B	5.6	5.85	6	
			RT9718C	6.05	6.25	6.45	
			RT9718D	7	7.2	7.4	
VIN Overvoltage Protection Hysteresis	$V_{IN\_OVP\_HYS}$			--	60	100	mV
VIN Overvoltage Protection Propagation Delay Time	$t_{DLY\_VIN\_OVP\_PD}$	V_{OUT} = V_{IN} x 80%		--	--	1	μs
VIN Overvoltage Protection Recovery Delay Time	$t_{DLY\_VIN\_OVP\_RD}$			--	8	--	ms
Overcurrent Protection Threshold	I_{OCP}	As R_{ILIM} = 25kΩ		0.93	1	1.07	A
Overcurrent Protection Blanking Time	t_{BLK_OCP}			--	180	--	μs
Overcurrent Protection Recover Delay Time	$t_{DLY\_OCP\_RD}$			--	64	--	ms
VB Overvoltage Protection Rising Threshold	$V_{VB\_OVP\_R}$	VB rising		4.3	4.35	4.4	V
VB Overvoltage Protection Hysteresis	$V_{VB\_OVP\_HYS}$	Hysteresis		--	30	--	mV
VB Overvoltage Protection Falling Threshold	$V_{VB\_OVP\_F}$			4.225	--	--	V
VB Overvoltage Protection Blanking Time	$t_{BLK\_VB\_OVP}$			--	180	--	μs
VB Overvoltage Protection Recover Delay Time	$t_{DLY\_VB\_OVP\_RD}$			--	8	--	ms
The VB Pin Leakage Current	I_{LK_VB}	V_{VB} = 4.4V		--	--	20	nA
Over-Temperature Protection Threshold	T_{OTP}	Rising		--	140	--	°C
Over-Temperature Protection Hysteresis	T_{OTP_HYS}	Hysteresis		--	20	--	°C
Over-Temperature Protection Recover Delay Time	$t_{DLY\_OTP\_RD}$			--	8	--	ms
Over-Temperature Protection Soft-Start Time	t_{SS_OTP}			--	8	--	ms
Logic							
$\overline{EN}$ Input Voltage Logic-High	V_{IH_EN}			1.5	--	--	V
$\overline{EN}$ Input Voltage Logic-Low	V_{IL_EN}			--	--	0.4	V

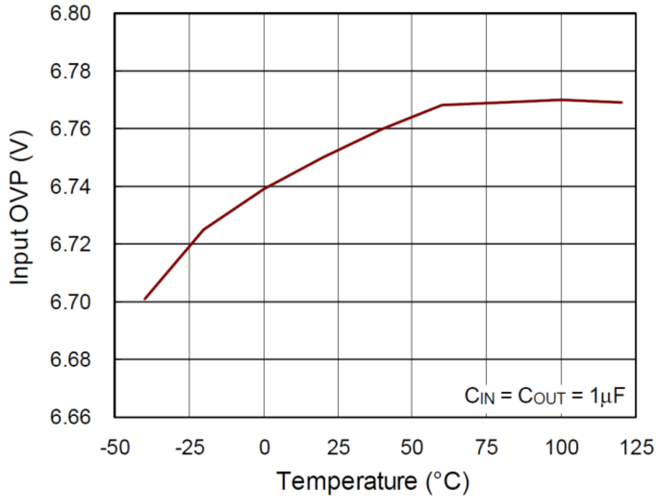
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
$\overline{EN}$ Internal Pull-Down Resistor	R_{PD_EN}		100	200	400	kΩ
$\overline{WRN}$ Output Voltage Logic-Low	V_{OH_WRN}	Sink 5mA	--	0.35	0.8	V
$\overline{WRN}$ Output Logic-High Leakage Current	I_{LK_WRN}		--	--	1	μA
Power MOSFET						
On-Resistance	R_{ON}	I_{OUT} = 500mA, 4.3V < V_{IN} < 6.5V	--	200	300	mΩ

12 Typical Application Circuit

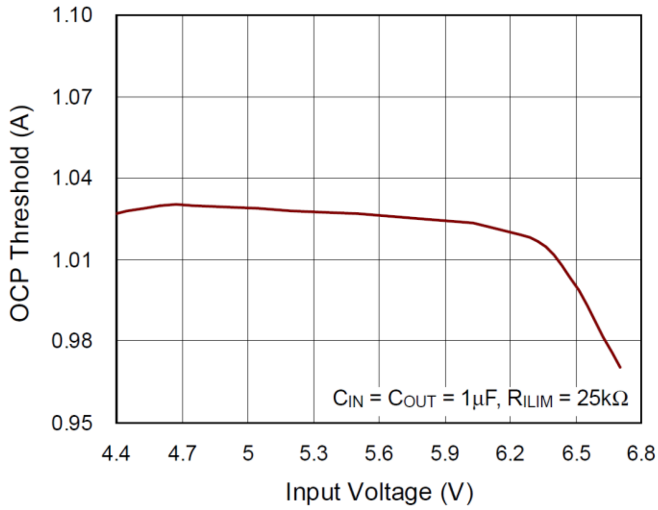


13 Typical Operating Characteristics

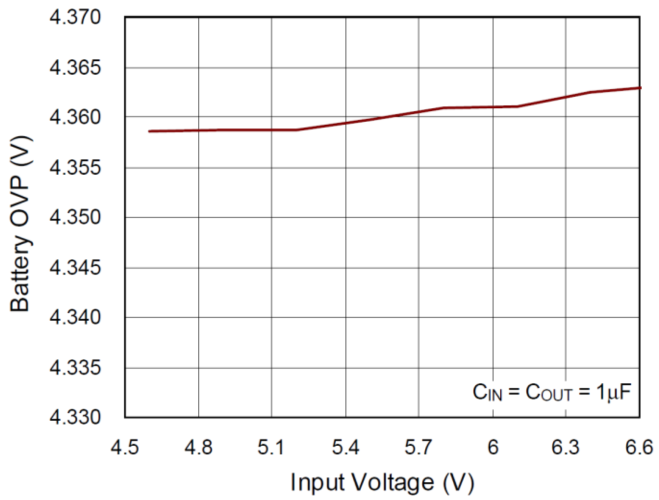
Input OVP vs. Temperature



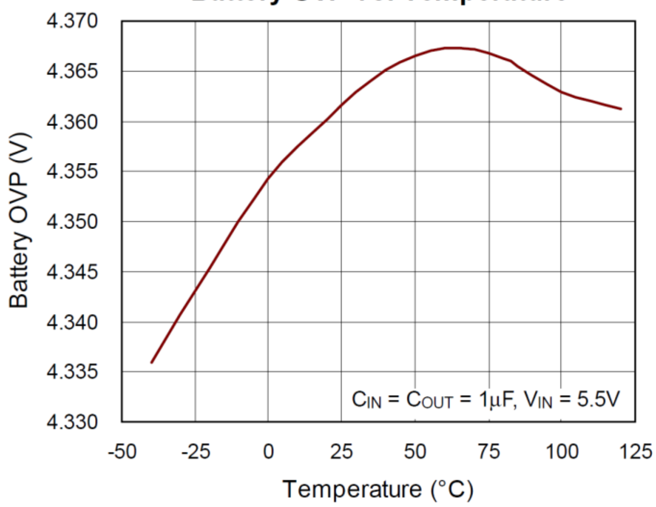
OCP Threshold vs. Input Voltage



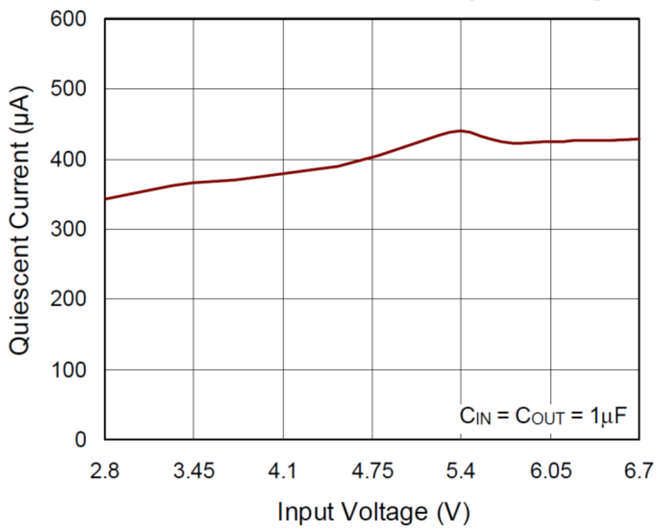
Battery OVP vs. Input Voltage



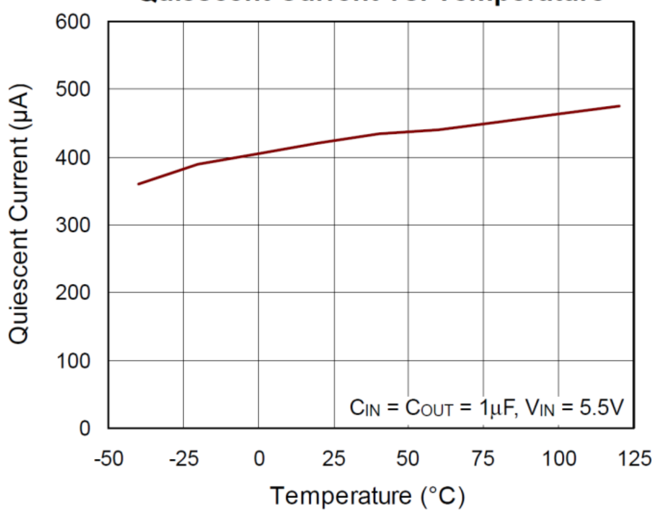
Battery OVP vs. Temperature



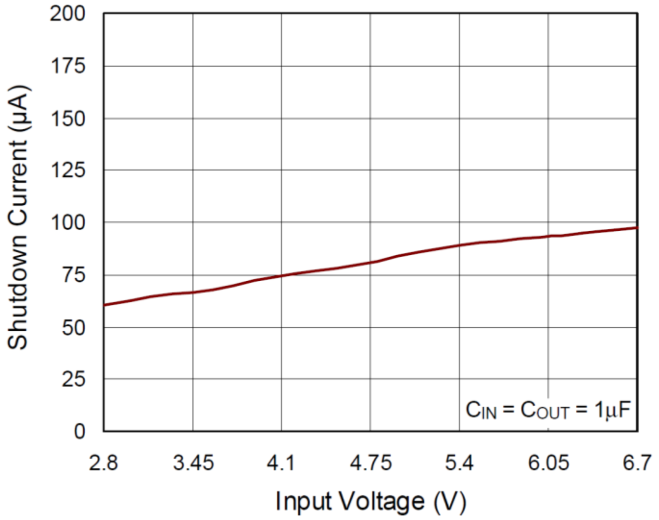
Quiescent Current vs. Input Voltage



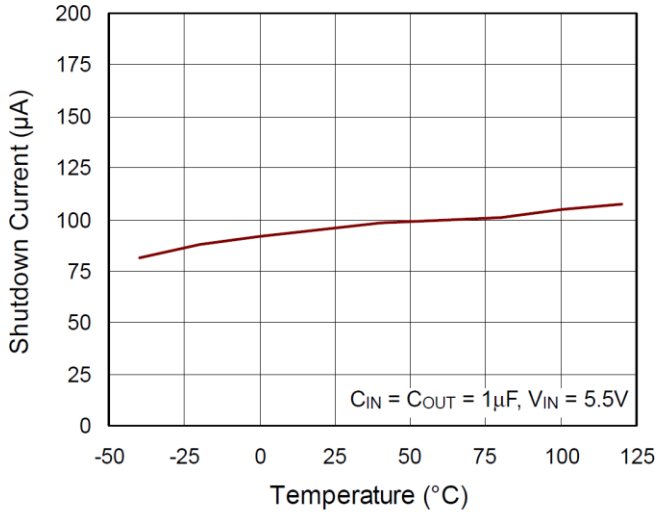
Quiescent Current vs. Temperature



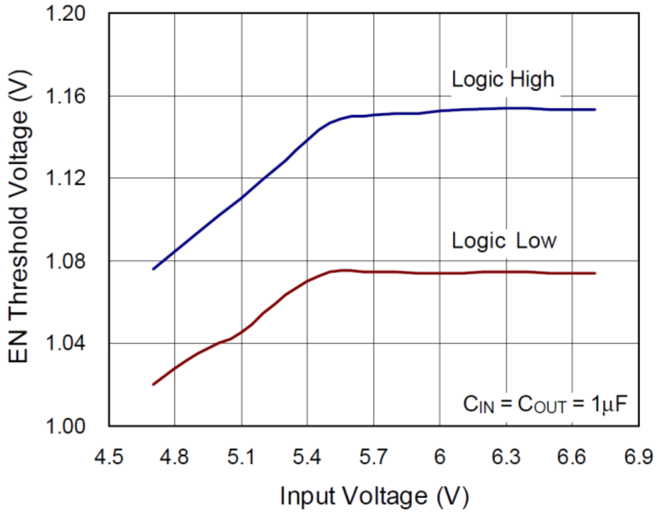
Shutdown Current vs. Input Voltage



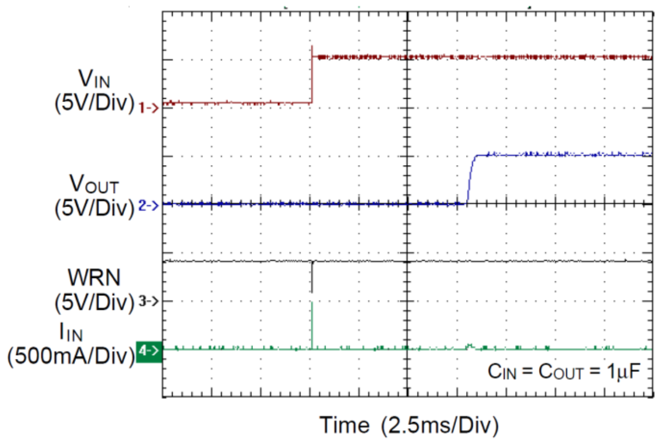
Shutdown Current vs. Temperature



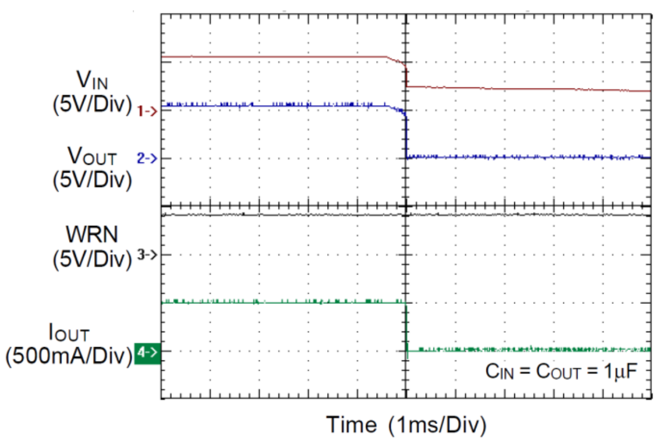
EN Threshold Voltage vs. Input Voltage



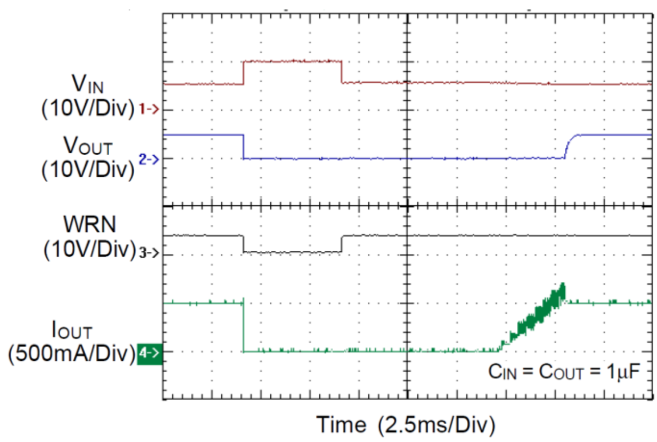
Power On



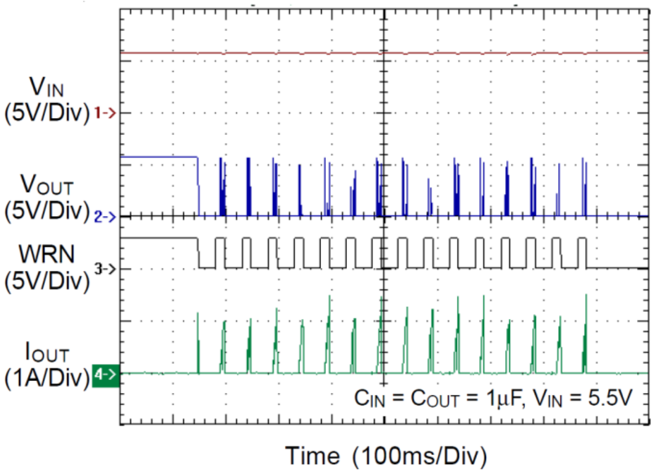
Power Off



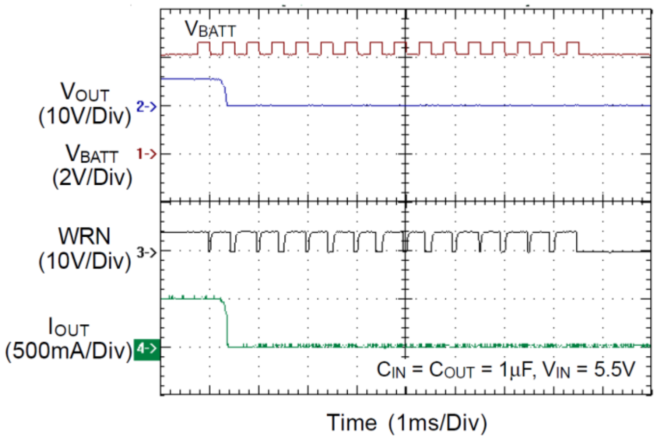
Input OVP



OCP



Battery OVP



14 Application Information

(Note 6)

14.1 Power Up

The RT9718 features a power-on reset (POR) threshold of 2.7V with a built-in hysteresis of 100mV. Before the input voltage reaches this POR threshold, the RT9718 remains off. Once the input voltage exceeds the POR threshold, the RT9718 will initiate a delay of 8ms, after which the soft-start process is activated. The 8ms delay allows any transients at the input to settle during a hot insertion of the power supply before the IC begins operation.

During the soft-start transition, the RT9718 gradually turns on the internal MOSFET to minimize the inrush current.

14.2 Enable Control

The RT9718 features an enable (EN) input. When the $\overline{EN}$ pin is pulled to a logic high (> 1.5V), the RT9718 will be shut down. When the $\overline{EN}$ pin is pulled to a logic low (< 0.4V), the RT9718 will be powered on. The $\overline{EN}$ pin includes an internal pull-down resistor, which mean leaving the $\overline{EN}$ pin floating will enable the IC.

14.3 Warning Indication Output

The $\overline{WRN}$ pin is an open-drain output that signals LOW when any protection event occurs, including Input Overvoltage Protection (OVP), Output Overcurrent Protection (OCP), and Battery OVP. Once the protection events are cleared, the $\overline{WRN}$ pin signals HIGH.

14.4 Over-Temperature Protection (OTP)

The RT9718 monitors its internal temperature to prevent thermal failures. The chip turns off the MOSFET when the internal temperature reaches 140°C. The IC will resume operation once the internal temperature has cooled down by 20°C.

14.5 Input Overvoltage Protection

The RT9718 monitors the input voltage to prevent system failures due to excessive input voltage. The input Overvoltage Protection (OVP) threshold of the RT9718 is set by an internal resistor. When the input voltage exceeds the threshold, the RT9718 outputs a logic signal to turn off the internal MOSFET within 1μs, protecting the electronics in the handheld system from high voltage damage. The hysteresis for the input OVP threshold is 100mV. Once the input voltage returns to normal operating rage, the RT9718 re-enables the MOSFET.

14.6 Battery Overvoltage Protection

The battery Overvoltage Protection (OVP) threshold voltage is typically set at 4.35V, and the RT9718 includes a built-in 180μs blanking time to prevent transient voltage from triggering the battery OVP. If the OVP condition persists after 180μs, the internal MOSFET will be turned off and the $\overline{WRN}$ pin will output a LOW signal. The battery OVP threshold features a built-in hysteresis of 30mV. Additionally, the control logic incorporates a 4-bit binary counter. Should the battery overvoltage event occurs 16 consecutive times, the MOSFET will be permanently turned off unless the input power or the enable pin is reset.

14.7 R_{VB} Selection

The RT9718 monitors the battery voltage through the VB pin. The RT9718 will be turned off when the battery voltage exceeds the 4.35V battery Overvoltage Protection (OVP) threshold. The VB pin should be connected to the positive terminal of the battery pack via an isolation resistor (R_{VB}), which is a critical component. The R_{VB} affects various parameters, such as the battery OVP threshold accuracy and leakage current at the VB pin. Generally, reducing the value of R_{VB} decreases the battery OVP threshold error, but this also increases the leakage current at the VB pin. Therefore, finding a balance between the battery OVP threshold accuracy and the VB pin leakage current is essential. A resistance value ranging from 200kΩ to 1MΩ is permissible for R_{VB}.

14.8 Overcurrent Protection (OCP)

The RT9718 monitors the output current to prevent the output shorts or charging the battery with excessive current. The Overcurrent Protection (OCP) threshold can be set via the ILIM pin. The RT9718 features a built-in 180μs delay time to prevent transient noise from triggering the OCP. If the OCP condition persists for 180μs, the internal MOSFET will be turned off, and the $\overline{\text{WRN}}$ pin will output a LOW signal. If the OCP event occurs 16 consecutive times, the internal MOSFET will be permanently turned off unless the input power is recycled or the enable pin is toggled.

The OCP threshold can be set by the resistor connected between the ILIM pin and GND. The OCP threshold can be calculated using the following equation:

$$I_{OCP} = \frac{25000}{R_{ILIM}}$$

14.9 Capacitor Selection

To achieve optimal performance with the RT9718, selecting appropriate peripheral capacitors is crucial. These capacitors influence parameters such as the input inrush current and input overshoot voltage. Generally, increasing the input capacitance C_{IN} is necessary to reduce the input overshoot voltage. However, this also results in an increase in the input inrush current. There are two scenarios that can lead to the input overshoot voltage: the first is when the AC adapter is hot-plugged, and the second is when the RT9718 experiences a step-down change. The cable between the AC adapter output and the handheld system input possesses parasitic inductance, which contributes to the input overshoot voltage. Typically, the input overshoot voltage ranges from 1.5 to 2 times the input voltage. It is recommended to use a capacitance of 1μF for both C_{IN} and C_{OUT}, with a rated voltage that is higher than 1.5 to 2 times the operating voltage.

14.10 Thermal Considerations

Thermal protection limits power dissipation in the RT9718. When the operation junction temperature exceeds 140°C, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass elements turn on again after the junction temperature cools by 20°C.

The junction temperature should never exceed the absolute maximum junction temperature $T_{J(MAX)}$, listed under Absolute Maximum Ratings, to avoid permanent damage to the device. The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction and ambient temperatures. The maximum power dissipation can be calculated using the following formula:

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

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

For continuous operation, the maximum operating junction temperature indicated under Recommended Operating Conditions is 125°C. The junction-to-ambient thermal resistance, θ_{JA}, is highly package dependent. For a WDFN-8L 2x2 package, the thermal resistance, θ_{JA}, is 165°C/W on a standard JEDEC 51-3 low effective-thermal-conductivity single-layer test board. The maximum power dissipation at T_A = 25°C can be calculated as below:

$P_{D(MAX)}$ = (125°C - 25°C) / (165°C/W) = 0.606W for a WDFN-8L 2x2 package.

The maximum power dissipation depends on the operating ambient temperature for the fixed $T_{J(MAX)}$ and the thermal resistance, θ_{JA}. The derating curve in Figure 1 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

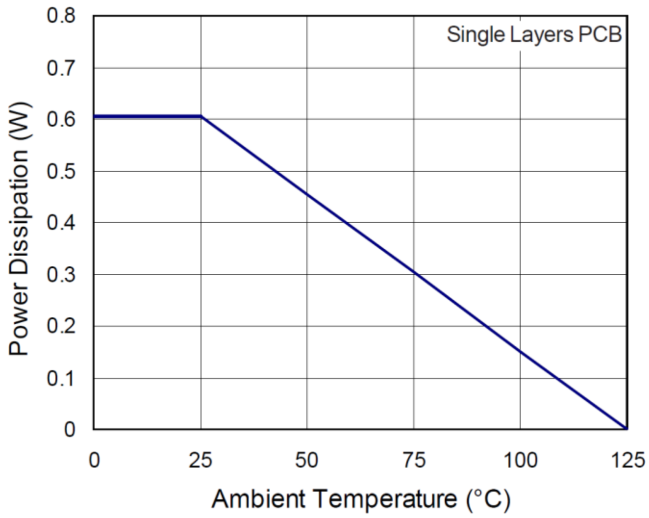


Figure 1. Derating Curve of Maximum Power Dissipation

14.11 Layout Considerations

For best performance of the RT9718 series, the following guidelines should be strictly adhered to:

- Input and output capacitors must be placed close to the IC and connected to ground plane to minimize noise coupling.
- The GND and exposed pad should be connected to a robust ground plane to serve a heat sink.
- Main current traces should be kept as short and as wide as possible to reduce resistance and improve current handling.

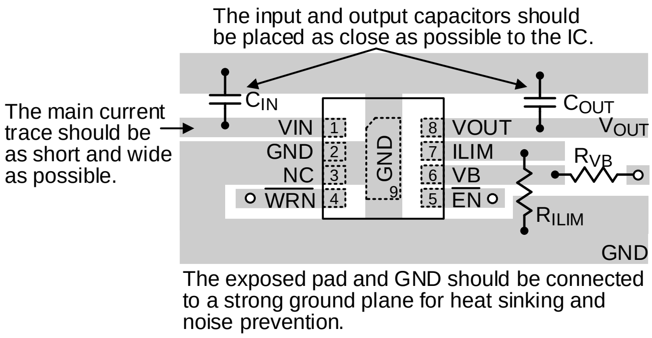
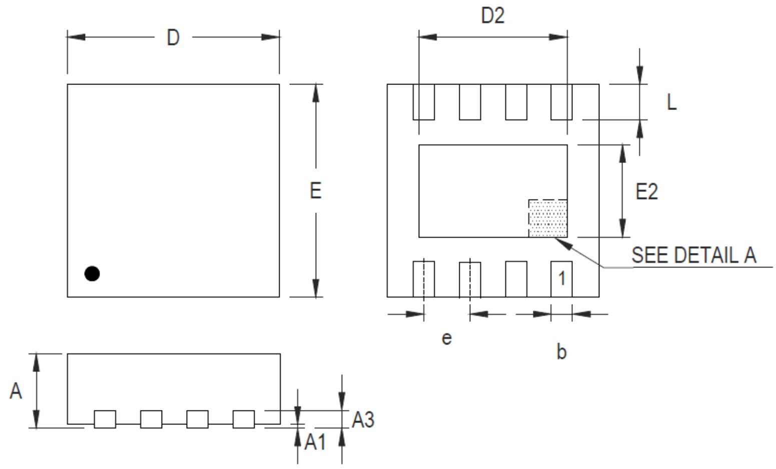
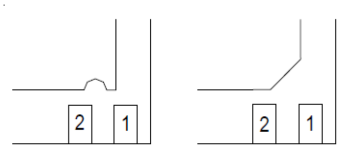


Figure 2. PCB Layout Guide

Note 6. The information provided in this section is for reference only. The customer is solely responsible for designing, validating, and testing any applications incorporating Richtek's product(s). The customer is also responsible for applicable standards and any safety, security, or other requirements.

15 Outline Dimension





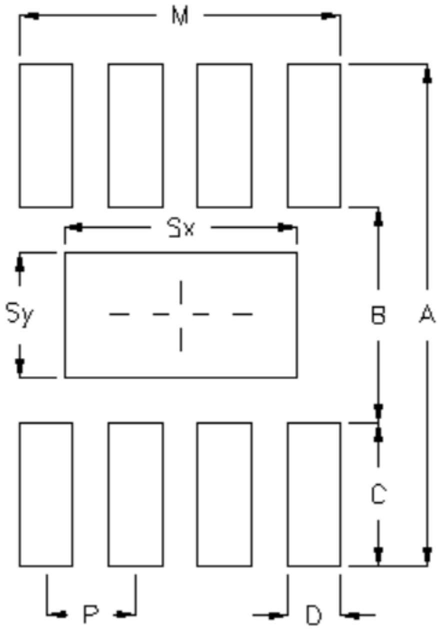
DETAIL A
Pin #1 ID and Tie Bar Mark Options

Note : The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A3	0.175	0.250	0.007	0.010
b	0.200	0.300	0.008	0.012
D	1.950	2.050	0.077	0.081
D2	1.000	1.250	0.039	0.049
E	1.950	2.050	0.077	0.081
E2	0.400	0.650	0.016	0.026
e	0.500		0.020	
L	0.300	0.400	0.012	0.016

W-Type 8L DFN 2x2 Package

16 Footprint Information

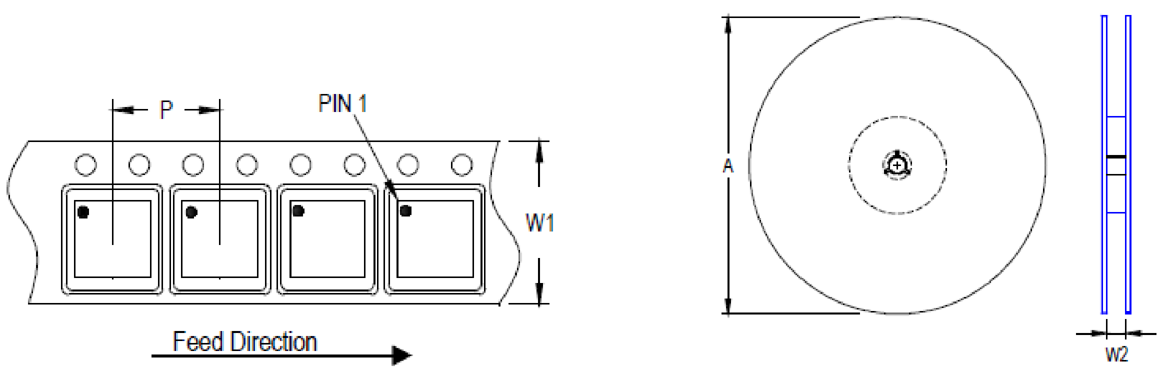


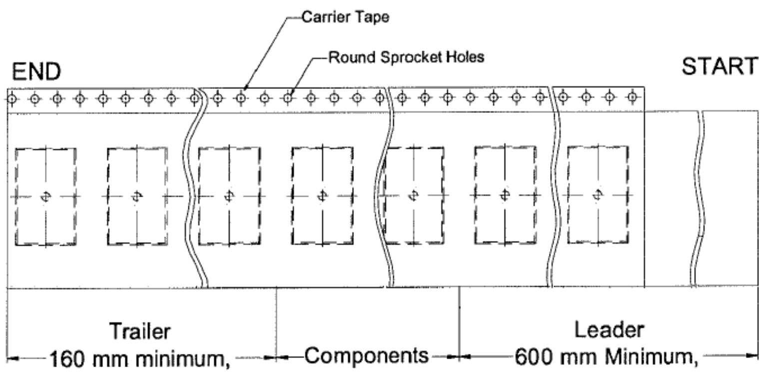
Package	Number of Pin	Footprint Dimension (mm)								Tolerance
		P	A	B	C	D	Sx	Sy	M	
V/W/U/XDFN2*2-8	8	0.50	2.80	1.20	0.80	0.30	1.30	0.70	1.80	±0.05

17 Packing Information

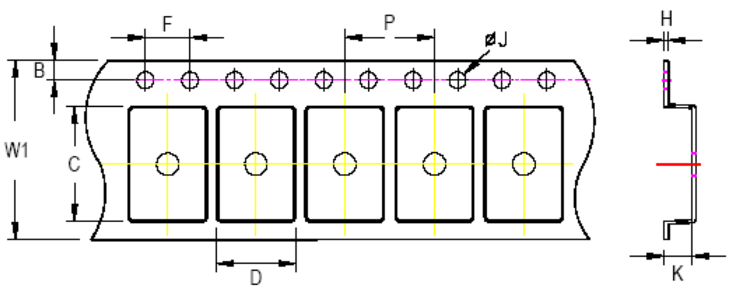
17.1 Tape and Reel Data

17.1.1 2500 Units per Reel





Package Type	Tape Size (W1) (mm)	Pocket Pitch (P) (mm)	Reel Size (A)		Units per Reel	Trailer (mm)	Leader (mm)	Reel Width (W2) Min/Max (mm)
			(mm)	(in)				
(V, W) QFN/DFN 2x2	8	4	180	7	2,500	160	600	8.4/9.9

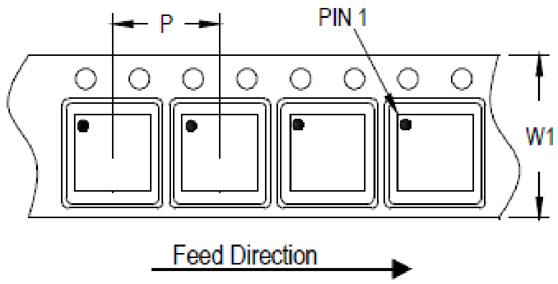


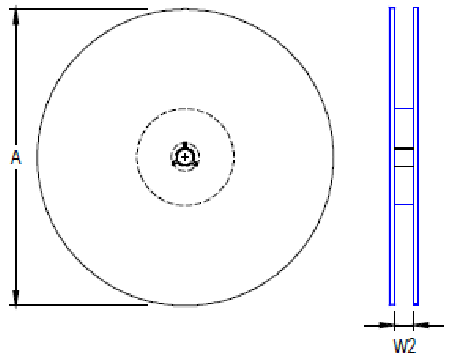
C, D, and K are determined by component size. The clearance between the components and the cavity is as follows:

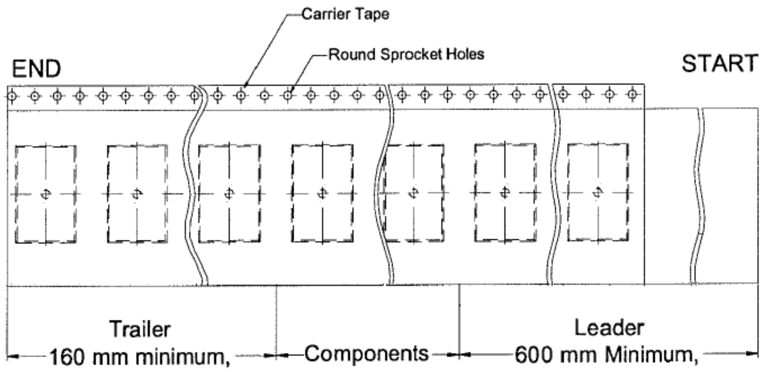
- For 8mm carrier tape: 0.5mm max.

Tape Size	W1	P		B		F		ØJ		K		H
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Max
8mm	8.3mm	3.9mm	4.1mm	1.65mm	1.85mm	3.9mm	4.1mm	1.5mm	1.6mm	1.0mm	1.3mm	0.6mm

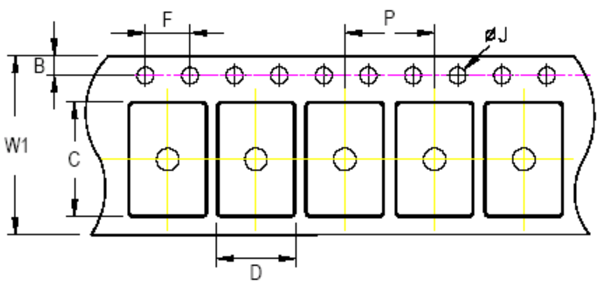
17.1.2 3000 Units per Reel

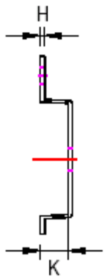






Package Type	Tape Size (W1) (mm)	Pocket Pitch (P) (mm)	Reel Size (A)		Units per Reel	Trailer (mm)	Leader (mm)	Reel Width (W2) Min/Max (mm)
			(mm)	(in)				
(V, W) QFN/DFN 2x2	8	4	180	7	3,000	160	600	8.4/9.9





C, D and K are determined by component size. The clearance between the components and the cavity is as follows:

- For 8mm carrier tape: 0.5mm max.

Tape Size	W1	P		B		F		ØJ		K		H
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Max
8mm	8.3mm	3.9mm	4.1mm	1.65mm	1.85mm	3.9mm	4.1mm	1.5mm	1.6mm	1.0mm	1.3mm	0.6mm

17.2 Tape and Reel Packing

17.2.1 2500 Units per Reel

Step	Photo/Description	Step	Photo/Description
1	 Reel 7”	4	 3 reels per inner box **Box A**
2	 HIC & Desiccant (1 Unit) inside	5	 12 inner boxes per outer box
3	 Caution label is on backside of Al bag	6	 Outer box **Carton A**

Container / Package	Reel		Box			Carton		
	Size	Units	Item	Reels	Units	Item	Boxes	Unit
(V, W) QFN & DFN 2x2	7”	3,000	Box A	3	9,000	Carton A	12	108,000
			Box E	1	3,000	For Combined or Partial Reel.		

17.2.2 3000 Units per Reel

Step	Photo/Description	Step	Photo/Description
1	 Reel 7”	4	 3 reels per inner box **Box A**
2	 HIC & Desiccant (1 Unit) inside	5	 12 inner boxes per outer box
3	 Caution label is on backside of Al bag	6	 Outer box **Carton A**

Container / Package	Reel		Box			Carton		
	Size	Units	Item	Reels	Units	Item	Boxes	Unit
(V, W) QFN & DFN 2x2	7”	2,500	Box A	3	7,500	Carton A	12	90,000
			Box E	1	2,500	For Combined or Partial Reel.		

17.3 Packing Material Anti-ESD Property

Surface Resistance	Aluminum Bag	Reel	Cover tape	Carrier tape	Tube	Protection Band
Ω/cm^2	**10^4 to 10^{11}**	**10^4 to 10^{11}**	**10^4 to 10^{11}**	**10^4 to 10^{11}**	**10^4 to 10^{11}**	**10^4 to 10^{11}**

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18 Datasheet Revision History

Version	Date	Description	Item
05	2024/11/5	Modify	*General Description on page 1* - Added the description of temperature *Ordering Information on page 1* - Updated description - Added note *Electrical Characteristics on page 4, 5, 6* - Updated the parameter and symbol *Application Information on page 13* - Added declaration *Footprint Information on page 15* - Updated information *Packing Information on page 16, 17, 18* - Updated information