Portable Power Management 300mA Dual LDO Regulator

General Description

The RT9011 is a dual channel, low noise, and low dropout regulator sourcing up to 300mA at each channel. The range of output voltage is from 1.2V to 3.6V by operating from 2.5V to 5.5V input.

The RT9011 offers 2% accuracy, extremely low dropout voltage (240mV @ 300mA), and extremely low ground current, only 27μA per LDO. The shutdown current is near zero current which is suitable for battery-power devices. Other features include current limiting, over temperature, output short circuit protection.

The RT9011 is short circuit thermal folded back protected. The IC lowers its OTP trip point from 165°C to 110°C when output short circuit occurs (VOUT < 0.4V) providing maximum safety to end users.

The RT9011 can operate stably with very small ceramic output capacitors, reducing required board space and component cost. The RT9011 is available in fixed output voltages in the TSOT-23-6, WDFN-8L 2x2, WDFN-10L 3x3, WDFN-8L 3x3 and WDFN-6L 1.6x1.6 packages.

Ordering Information

RT9011-□□□□

- Package Type
  - J6 : TSOT-23-6
  - QW : WDFN-8L 2x2 (W-Type)
  - QWA : WDFN-10L 3x3 (W-Type)
  - QWB : WDFN-8L 3x3 (W-Type)
  - QWC : WDFN-6L 1.6x1.6 (W-Type)
- Lead Plating System
  - P : Pb Free
  - G : Green (Halogen Free and Pb Free)
- Output Voltage : VOUT1/VOUT2
  - VOUT2 > VOUT1 is Recommended

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.

Features

- **Wide Operating Voltage Ranges : 2.5V to 5.5V**
- **Low-Noise for RF Application**
- **No Noise Bypass Capacitor Required**
- **Fast Response in Line/Load Transient**
- **TTL-Logic-Controlled Shutdown Input**
- **Low Temperature Coefficient**
- **Dual LDO Outputs (300mA/300mA)**
- **Ultra-low Quiescent Current 27μA/LDO**
- **High Output Accuracy 2%**
- **Short Circuit Protection**
- **Thermal Shutdown Protection**
- **Current Limit Protection**
- **Short Circuit Thermal Folded Back Protection**
- **Tiny TSOT-23-6 and 6-Lead/8-Lead/10-Lead WDFN Packages**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

- CDMA/GSM Cellular Handsets
- Battery-Powered Equipment
- Laptop, Palmtops, Notebook Computers
- Hand-Held Instruments
- PCMCIA Cards
- Portable Information Appliances

Marking Information

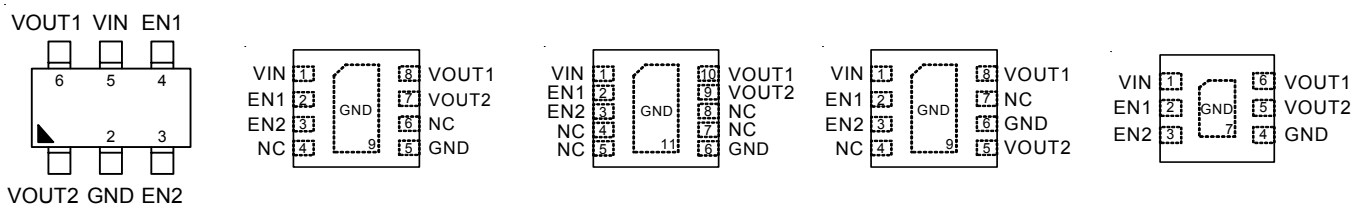
For marking information, contact our sales representative directly or through a Richtek distributor located in your area.

Available Voltage Version

Code	Voltage	Code	Voltage	Code	Voltage
A	3.5	B	1.3	C	1.2
D	1.85	E	2.1	F	1.5
G	1.8	H	2	J	2.5
K	2.6	L	2.7	M	2.8
N	2.85	P	3	Q	3.1
R	3.2	S	3.3	T	2.65
V	2.9	W	1.6	X	3.15
Y	1.9				

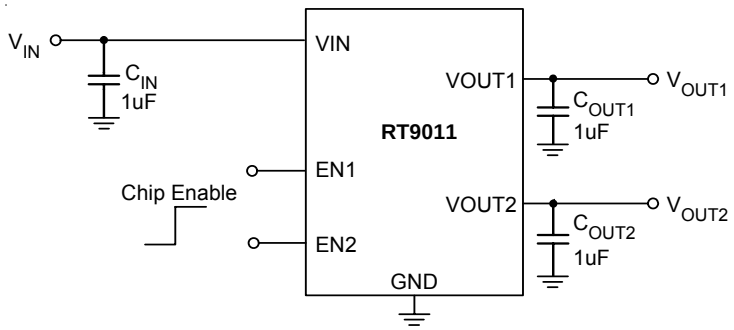
Pin Configurations

(TOP VIEW)



TSOT-23-6 WDFN-8L 2x2 WDFN-10L 3x3 WDFN-8L 3x3 WDFN-6L 1.6x1.6

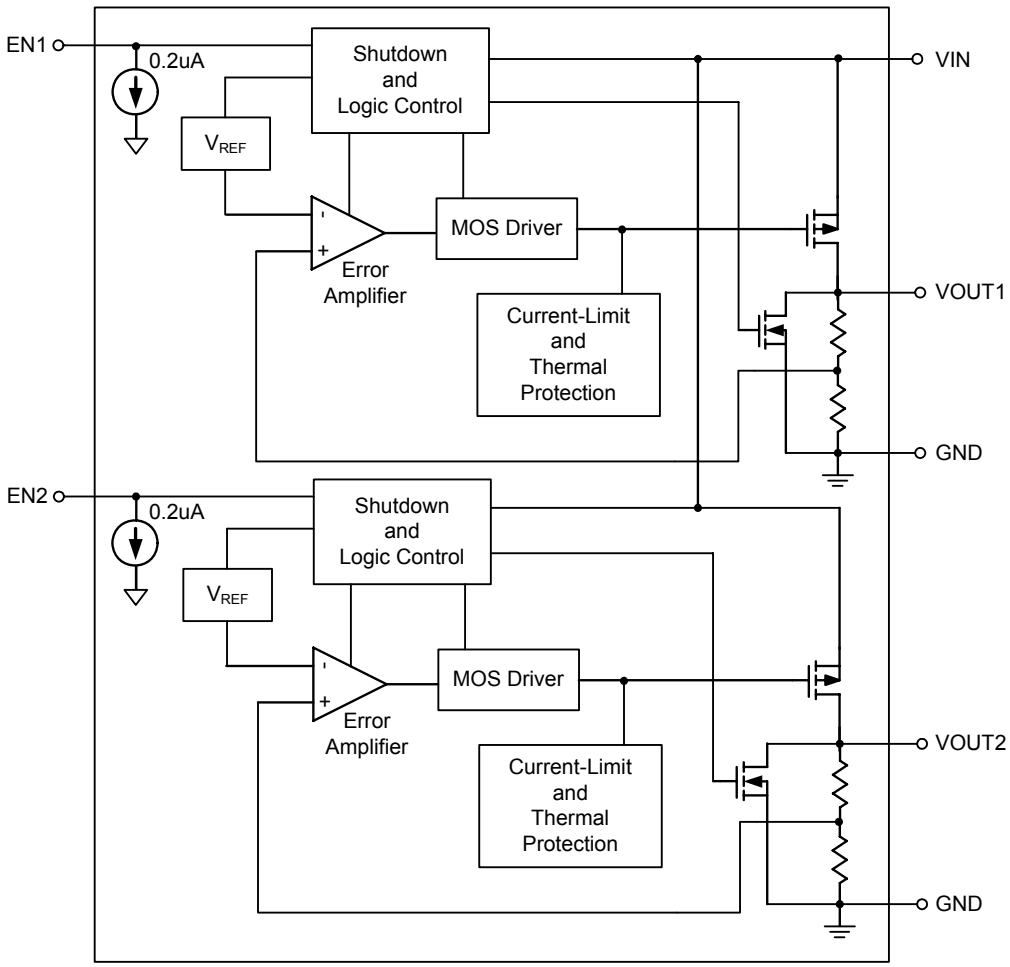
Typical Application Circuit



Functional Pin Description

Pin No.					Pin Name	Pin Function
TSOT-23-6	WDFN-8L 2x2	WDFN-10L 3x3	WDFN-8L 3x3	WDFN-6L 1.6x1.6		
5	1	1	1	1	VIN	Supply Input.
4	2	2	2	2	EN1	Chip Enable1 (Active High).
3	3	3	3	3	EN2	Chip Enable2 (Active High).
2	5, Exposed Pad (9)	6, Exposed Pad (11)	6, Exposed Pad (9)	4, Exposed Pad (7)	GND	Common Ground. The exposed pad must be soldered to a large PCB and connected to GND for maximum power dissipation.
1	7	9	5	5	VOUT2	Channel 2 Output Voltage.
6	8	10	8	6	VOUT1	Channel 1 Output Voltage.
--	4, 6	4, 5, 7, 8	4, 7	--	NC	No Internal Connection.

Function Block Diagram



Absolute Maximum Ratings (Note 1)

- Supply Input Voltage ---------- –0.3V to 7V
- Other I/O Pin Voltages ---------- –0.3V to 7V
- Power Dissipation, P_D @ T_A = 25°C
  - TSOT-23-6 ---------- 0.455W
  - WDFN-8L 2x2 ---------- 0.606W
  - WDFN-10L 3x3 ---------- 0.926W
  - WDFN-8L 3x3 ---------- 0.926W
  - WDFN-6L 1.6x1.6 ---------- 0.571W
- Package Thermal Resistance (Note 2)
  - TSOT-23-6, θ_{JA} ---------- 220°C/W
  - WDFN-8L 2x2, θ_{JA} ---------- 165°C/W
  - WDFN-10L 3x3, θ_{JA} ---------- 108°C/W
  - WDFN-8L 3x3, θ_{JA} ---------- 108°C/W
  - WDFN-6L 1.6x1.6, θ_{JA} ---------- 175°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°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 ---------- 2.5V to 5.5V
- Enable Input Voltage ---------- 0V to 5.5V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = V_{OUT} + 1V, V_{EN} = V_{IN}, C_{IN} = C_{OUT} = 1µF, T_A = –40°C to 85°C, unless otherwise specified.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage		V_{IN} = 2.5V to 5.5V	2.5	--	5.5	V
Dropout Voltage (Note 5)	V_{DROP}	I_{OUT} = 300mA	–	240	330	mV
Output voltage range	V_{OUT}		1.2	--	3.6	V
V_{OUT} Accuracy	ΔV	I_{OUT} = 1mA to 300mA	–3	--	+3	%
Line Regulation	ΔV_{LINE}	V_{IN} = (V_{OUT} + 0.3V) to 5.5V or V_{IN} > 2.5V, whichever is larger	–	--	0.2	%/V
Load Regulation	ΔV_{LOAD}	1mA < I_{OUT}< 300mA	–	--	0.6	%
Current Limit		R_{LOAD} = 1Ω	330	450	700	mA
Quiescent Current	I_Q	V_{EN} > 1.5V	–	58	80	µA
Shutdown Current	I_{Q_SD}	V_{EN} < 0.4V	–	--	1	µA
EN Threshold	V_{IH}	V_{IN} = 2.5V to 5.5V, Power On	1.5	--	–	V
	V_{IL}	V_{IN} = 2.5V to 5.5V, Shutdown	–	--	0.4	

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Voltage TC			--	100	--	ppm/°C
V_{OUT} Discharge Resistance in Shutdown (Note 6)		V_{IN} = 5V, EN1 = EN2 = GND	--	3	--	kΩ
EN Pull Low Current	I_{EN}		–	0.2	–	μA
Thermal Shutdown	T_{SD}		--	170	--	°C
Thermal Shutdown Hysteresis	ΔT_{SD}		--	40	--	°C
PSRR V_{IN} = V_{OUT} + 1V, C_{OUT} = 2.2μF I_{LOAD} = 50mA	PSRR	f = 100Hz	–	70	–	dB
		f = 1kHz	--	70	--	
		f = 10kHz	--	70	--	
		f = 100kHz	–	54	–	
		f = 200kHz	--	45	--	
		f = 300kHz	--	38	--	
Output Voltage Noise		C_{OUT1} = C_{OUT2} = 10uF, 10Hz to 100kHz, I_{OUT1} = I_{OUT2} = 1mA	--	100	--	uVrms

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 recommended.

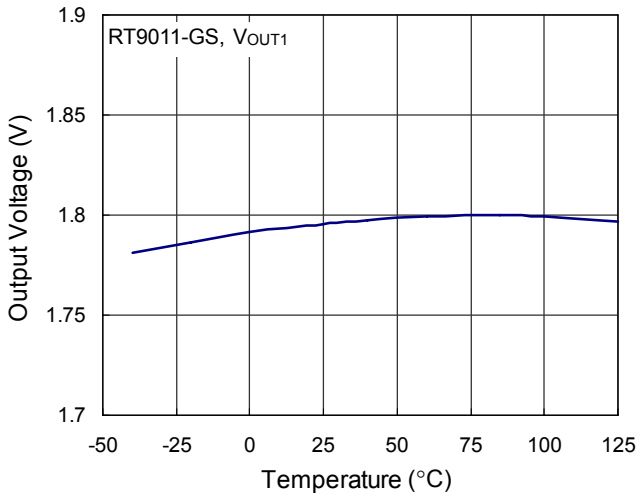
Note 4. The device is not guaranteed to function outside its operating conditions.

Note 5. The dropout voltage is defined as V_{IN} -V_{OUT}, which is measured when V_{OUT} is $V_{OUT(NORMAL)}$ – 100mV.

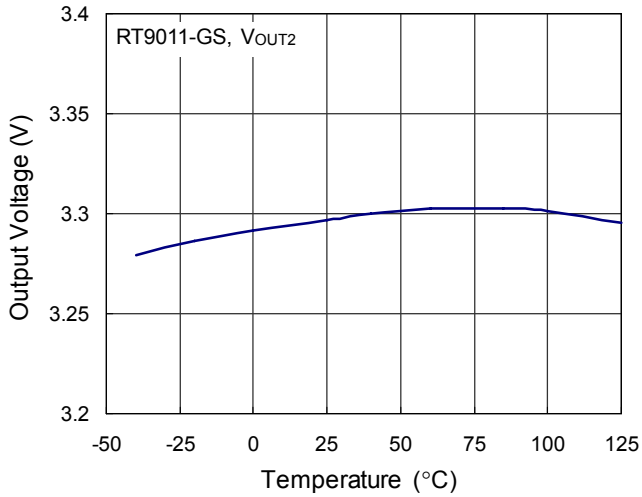
Note 6. It is guaranteed by design.

Typical Operating Characteristics

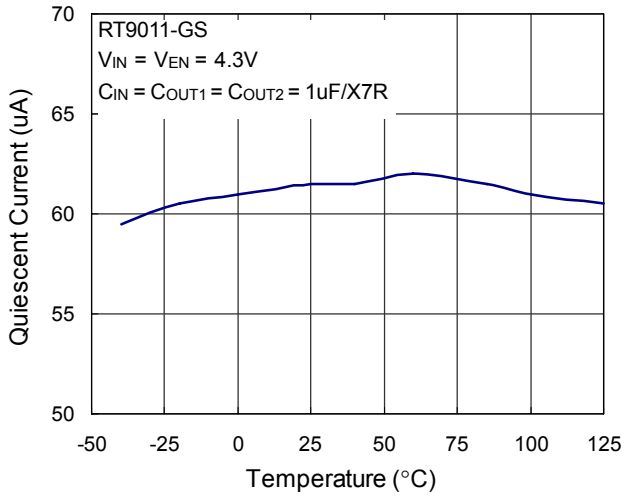
Output Voltage vs. Temperature



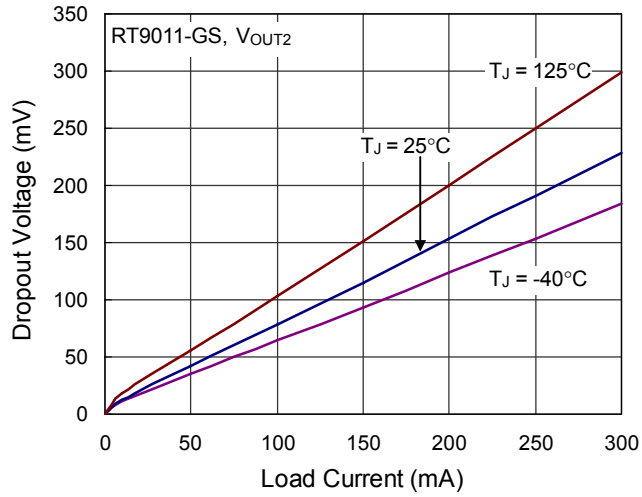
Output Voltage vs. Temperature



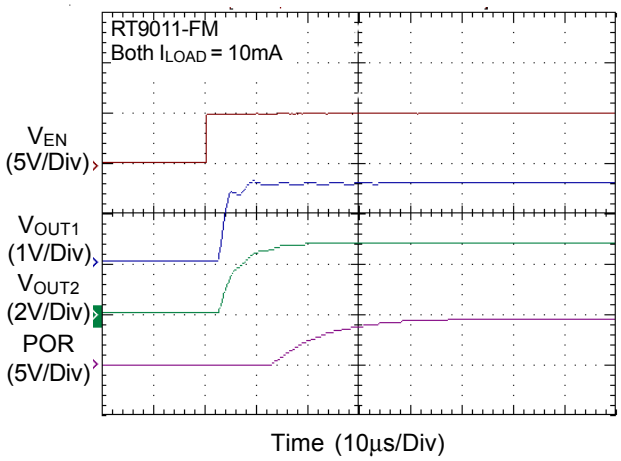
Quiescent Current vs. Temperature



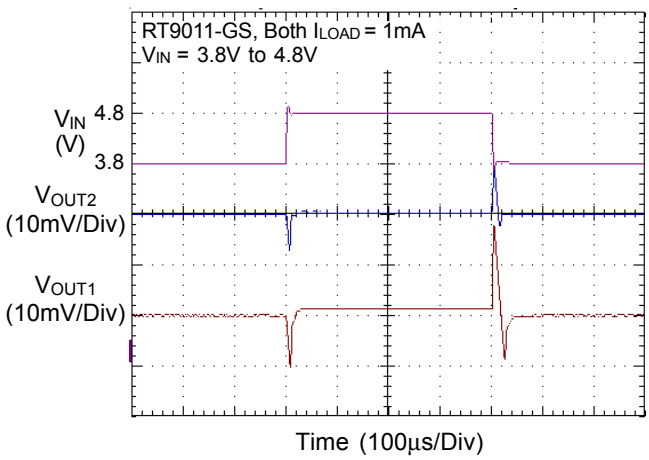
Dropout Voltage vs. Load Current



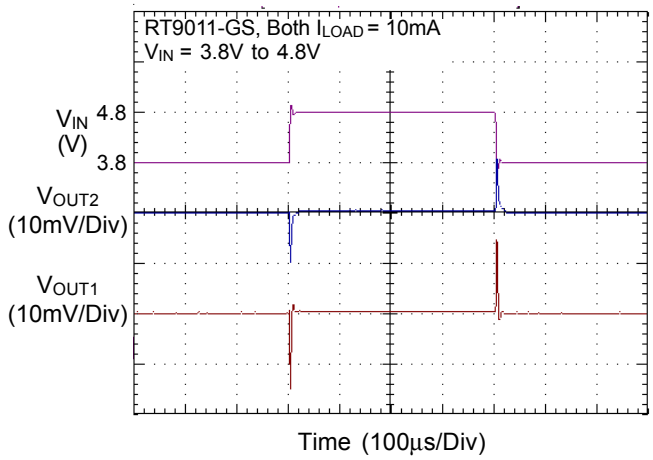
Power-On



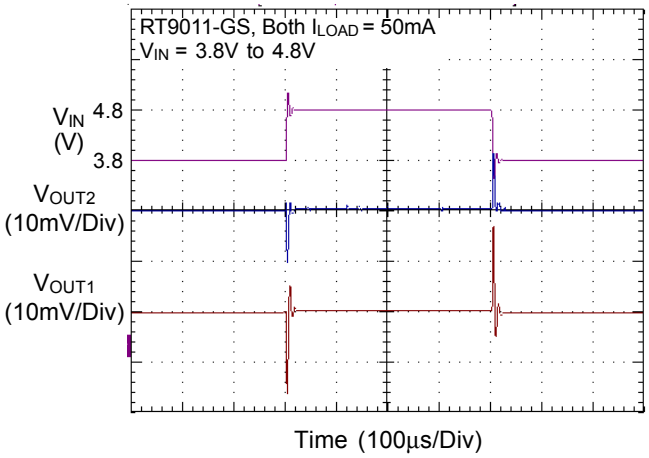
Line Transient Response



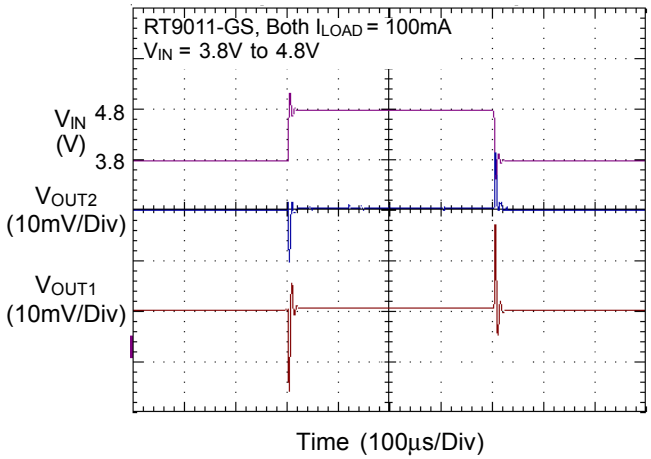
Line Transient Response



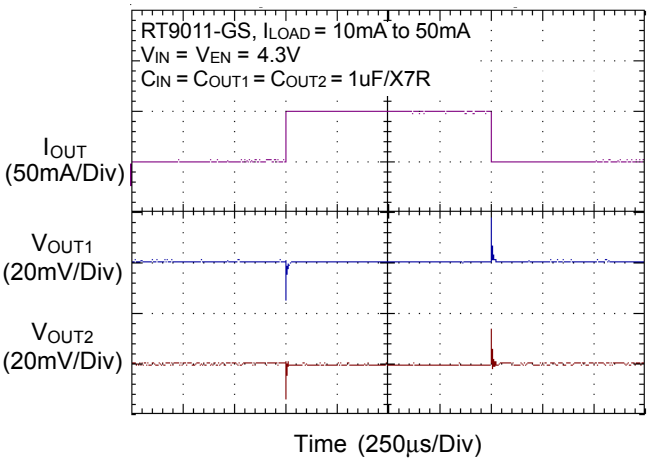
Line Transient Response



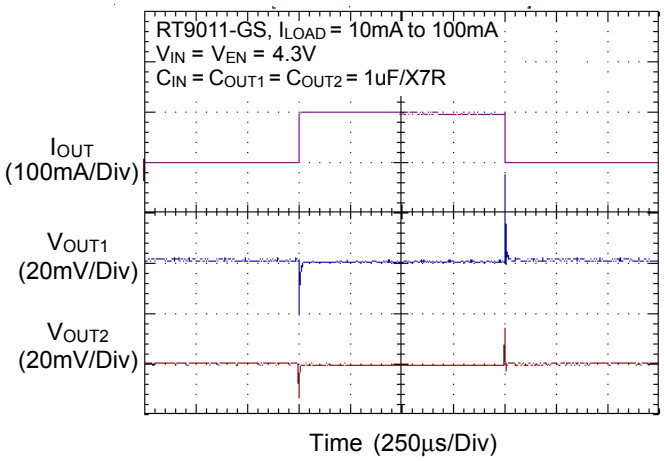
Line Transient Response



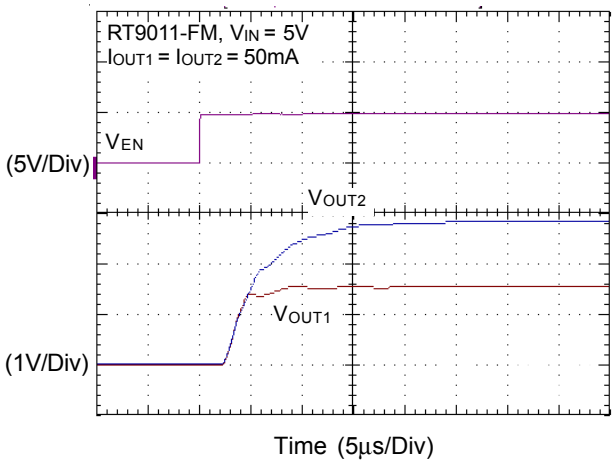
Load Transient Response



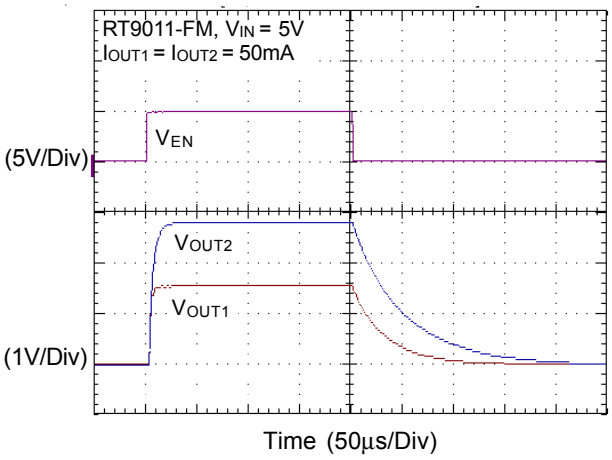
Load Transient Response



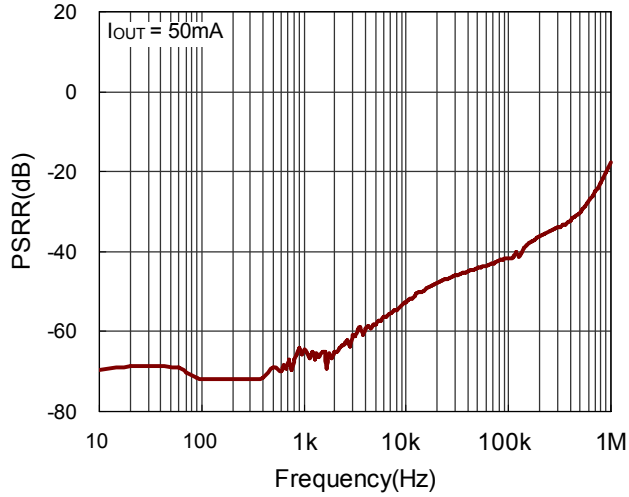
Start Up



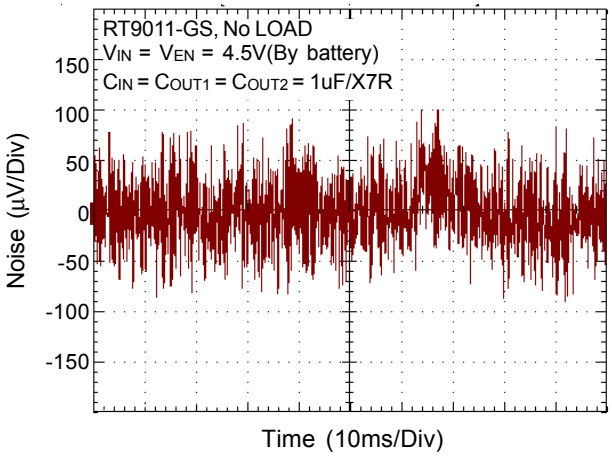
EN Pin Shutdown Response



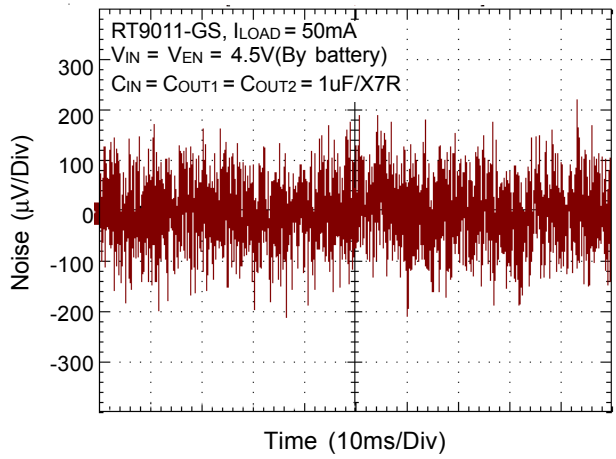
PSRR



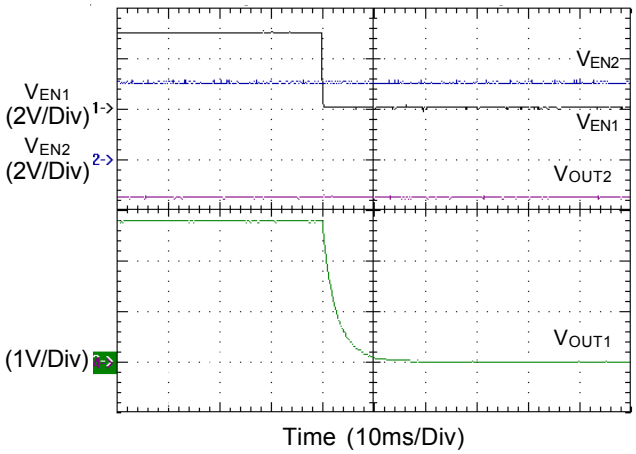
Noise



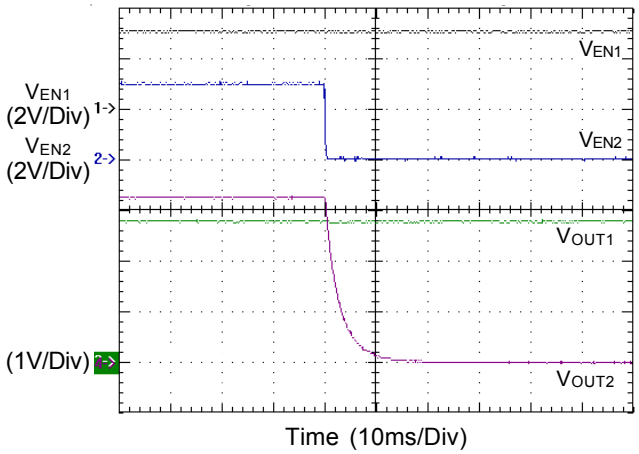
Noise



EN1 Pin Response



EN2 Pin Response



Applications Information

Like any low-dropout regulator, the external capacitors used with the RT9011 must be carefully selected for regulator stability and performance. Using a capacitor whose value is > 1μF on the RT9011 input and the amount of capacitance can be increased without limit. The input capacitor must be located a distance of not more than 0.5 inch from the input pin of the IC and returned to a clean analog ground. Any good quality ceramic or tantalum can be used for this capacitor. The capacitor with larger value and lower ESR (equivalent series resistance) provides better PSRR and line-transient response.

The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDOs application. The RT9011 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1μF with ESR is > 20mΩ on the RT9011 output ensures stability. The RT9011 still works well with output capacitor of other types due to the wide stable ESR range. Figure 1. shows the curves of allowable ESR range as a function of load current for various output capacitor values. Output capacitor of larger capacitance can reduce noise and improve load transient response, stability, and PSRR. The output capacitor should be located not more than 0.5 inch from the VOUT pin of the RT9011 and returned to a clean analog ground.

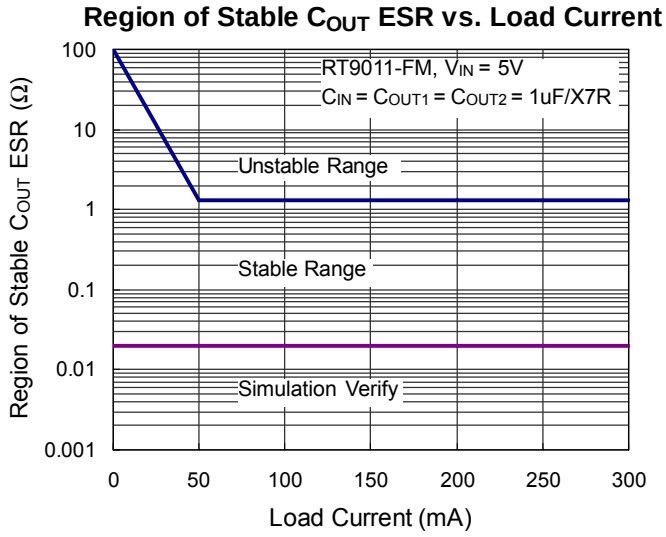


Figure 1. Stable Cout ESR Range

Thermal Considerations

Thermal protection limits power dissipation in RT9011. When the operation junction temperature exceeds 170°C, the OTP circuit starts the thermal shutdown function and turns the pass element off. The pass element turns on again after the junction temperature cools by 40°C. RT9011 lowers its OTP trip level from 170°C to 110°C when output short circuit occurs (V_{OUT} < 0.4V) as shown in Figure 2. It limits IC case temperature under 100°C and provides maximum safety to customer while output short circuit occurring.

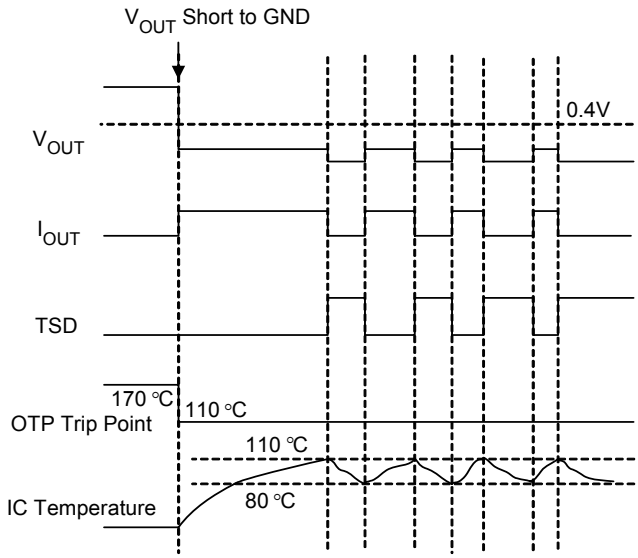


Figure 2. Short Circuit Thermal Folded Back Protection when Output Short Circuit Occurs (Patent)

For continuous operation, do not exceed absolute maximum operation junction temperature 125°C. The power dissipation definition in device is :

$$P_D = (V_{IN}-V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q$$

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 RT9011, the maximum junction temperature is 125°C. The junction to ambient thermal resistance (θ_{JA} is layout dependent) for TSOT-23-6 is 220°C/W, WDFN-8L 2x2 is 165°C/W, WDFN-10L 3x3 is 108°C/W, WDFN-8L 3x3 is 108°C/W and WDFN-8L 1.6x1.6 is 175°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) / (220°C/W) = 0.455W for TSOT-23-6 packages

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

$P_{D(MAX)}$ = (125°C – 25°C) / (108°C/W) = 0.926W for WDFN-10L 3x3 packages

$P_{D(MAX)}$ = (125°C – 25°C) / (108°C/W) = 0.926W for WDFN-8L 3x3 packages

$P_{D(MAX)}$ = (125°C – 25°C) / (175°C/W) = 0.571W for WDFN-6L 1.6x1.6 packages

The maximum power dissipation depends on operating ambient temperature for fixed $T_{J(MAX)}$ and thermal resistance θ_{JA}. For RT9011 packages, the Figure 3 of de-rating curves allows the designer to see the effect of rising ambient temperature on the maximum power allowed.

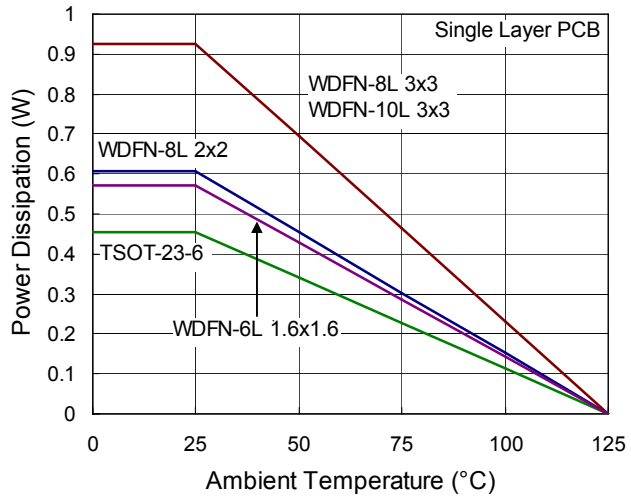
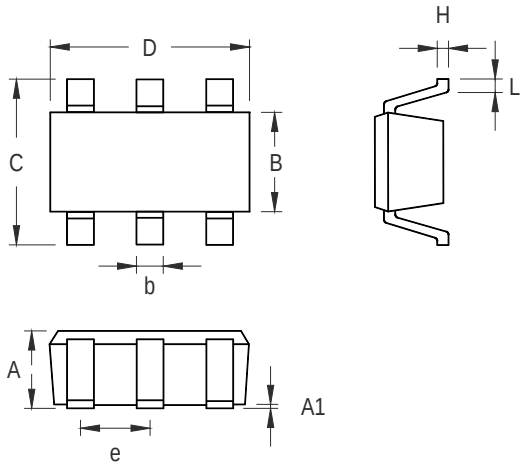


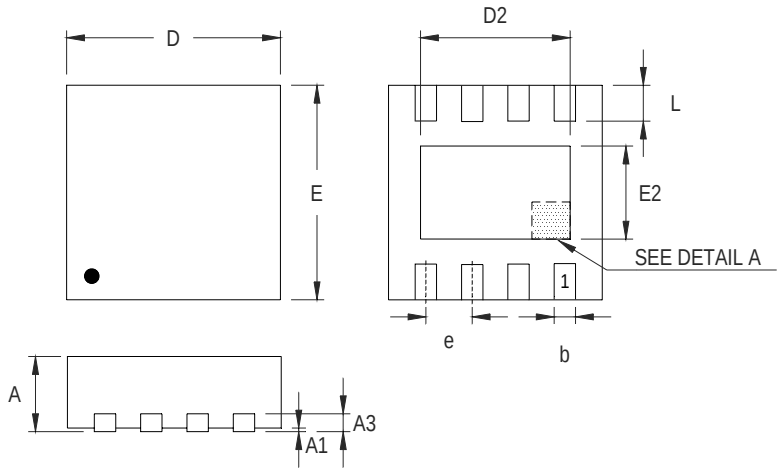
Figure 3. Derating Curves for RT9011 Packages

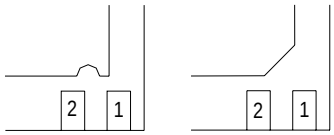
Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	1.000	0.028	0.039
A1	0.000	0.100	0.000	0.004
B	1.397	1.803	0.055	0.071
b	0.300	0.559	0.012	0.022
C	2.591	3.000	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

TSOT-23-6 Surface Mount Package





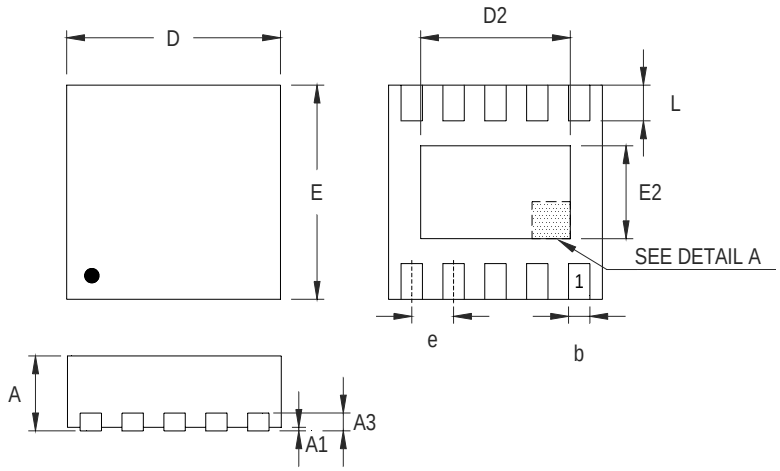
DETAIL A

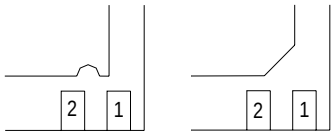
Pin #1 ID and Tie Bar Mark Options

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





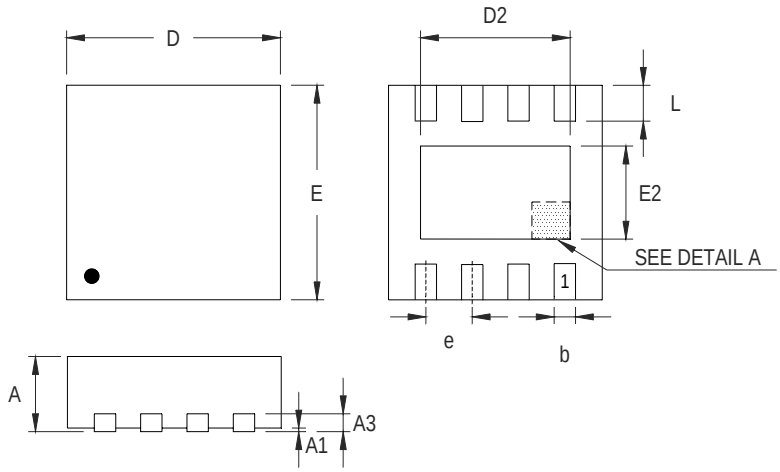
DETAIL A

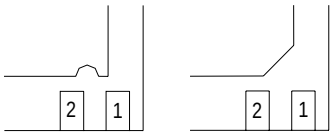
Pin #1 ID and Tie Bar Mark Options

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	0.180	0.300	0.007	0.012
D	2.950	3.050	0.116	0.120
D2	2.300	2.650	0.091	0.104
E	2.950	3.050	0.116	0.120
E2	1.500	1.750	0.059	0.069
e	0.500		0.020	
L	0.350	0.450	0.014	0.018

W-Type 10L DFN 3x3 Package





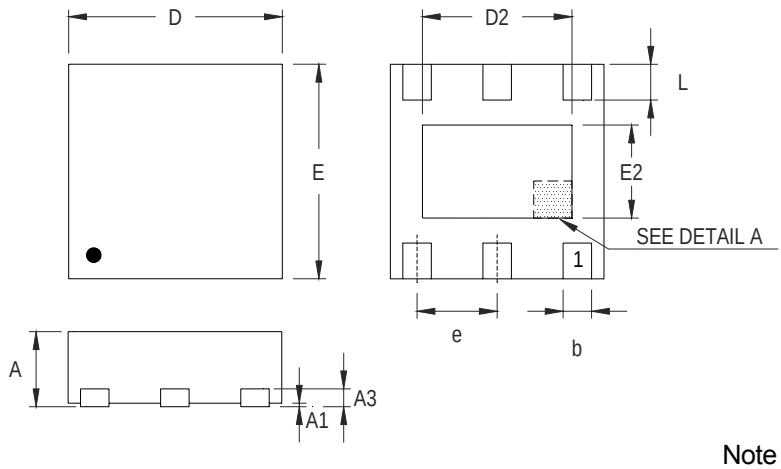
DETAIL A

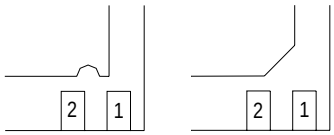
Pin #1 ID and Tie Bar Mark Options

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	2.950	3.050	0.116	0.120
D2	2.100	2.350	0.083	0.093
E	2.950	3.050	0.116	0.120
E2	1.350	1.600	0.053	0.063
e	0.650		0.026	
L	0.425	0.525	0.017	0.021

W-Type 8L DFN 3x3 Package





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	1.550	1.650	0.061	0.065
D2	0.950	1.050	0.037	0.041
E	1.550	1.650	0.061	0.065
E2	0.550	0.650	0.022	0.026
e	0.500		0.020	
L	0.190	0.290	0.007	0.011

W-Type 6L DFN 1.6x1.6 Package

Richtek Technology Corporation
Headquarter
5F, No. 20, Taiyuen Street, Chupei City
Hsinchu, Taiwan, R.O.C.
Tel: (8863)5526789 Fax: (8863)5526611

Richtek Technology Corporation
Taipei Office (Marketing)
5F, No. 95, Minchiuan Road, Hsintien City
Taipei County, Taiwan, R.O.C.
Tel: (8862)86672399 Fax: (8862)86672377
Email: marketing@richtek.com

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