

Outline

The R5480 is a high voltage tolerance CMOS-based protection IC for over-charge/discharge and over-current of rechargeable one-cell Lithium-ion (Li+)/Lithium polymer battery. The R5480 can detect over-charge/discharge of Li+ one-cell and excess load current and charge current, further, include a short circuit protector for preventing large external short circuit current. The R5480 consists of four voltage detectors, a reference unit, a delay circuit, a short circuit detector, an oscillator, a counter, and a logic circuit.

When the R5480 detects over-charge or over-charge current, the output of COUT pin switches to "L" level, of the charger's negative pin level after the internal fixed delay time. When the R5480 detects over-discharge or excess discharge current, the output of DOUT pin switches to "L" level after the internal fixed delay time.

After detecting over-charge or excess charge current, the R5480 can be reset and the output of COUT becomes "H" after the charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold.

However, depending on the characteristics of external components such as MOSFETs, release conditions may be not enough just removing a charger from the battery pack. In that case, a kind of load must be set to release the over-charge detect.

If a charger is continuously connected to the battery pack, even if the cell voltage becomes lower than over-charge detector threshold, over-charge state is not released.

After detecting over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than over-discharge detector threshold, the R5480 is released and the voltage of DOUT pin becomes "H". If the battery is discharged to 0V, recharge current is not acceptable. Once after detecting excess discharge-current or short circuit, the R5480 is released and DOUT level becomes "H" with detaching a battery pack from a load system. After detecting over-discharge, supply current is kept extremely low by halting internal circuits' operation.

When the output of COUT is "H", by setting the V- pin between -3.0V and the delay shortening mode voltage (Typ. -2.0V), the output delay can be shortened. Especially, the delay time of over charge detector can be reduced into approximately 1/100. Thus, testing time of protector circuit board can be reduced. Output type of COUT and DOUT is CMOS.

■ FEATURES

- Manufactured with High Voltage Tolerant ProcessAbsolute Maximum Rating 30V
- Low supply currentSupply current (At normal mode) TYP.4.0μA
 - Standby current MAX 0.1μA
- High accuracy detector threshold.....Over-charge detector ±20mV
 - Over-discharge detector ±35mV
 - Excess discharge-current detector ±15%
 - Excess charge-current detector ±15%
- Variety of detector thresholdOver-charge detector threshold 4.1V~4.5V step of 0.005V
 - Over-discharge detector threshold 2.1V ~ 3.0V step of 0.005V
 - Excess discharge-current threshold 0.030V ~ 0.048V step of 0.001V
 - Excess charge-current threshold -0.030V~-0.020V step of 0.001V
- Internal fixed Output delay timeOver-charge detector Output Delay 1.0s
 - Over-discharge detector Output Delay 20ms
 - Excess discharge-current detector Output Delay 12ms
 - Excess charge-current detector Output Delay 16ms
 - Short Circuit detector Output Delay 250μs
- Output Delay Time Shortening Function At C_{OUT} is "H", if V₋ level is set at -2.0V, the Output Delay time of detect the over-charge and over-discharge can be reduced. (Delay Time for over-charge becomes about 1/100 of normal state.)
- Conditions for release over-charge detector..... Latch type
- Conditions for release over-discharge detector..... Latch type
- 0V-battery charge optionunacceptable
- Ultra Small packageDFN(PLP)1414-6

■ APPLICATIONS

- Li+ / Li Polymer protector of over-charge, over-discharge, excess-current for battery pack
- High precision protectors for smart-phones and any other gadgets using on board Li+ / Li Polymer battery

Absolute Maximum Ratings

Ta=25°C, Vss=0V

Item	Symbol	Ratings	Unit
Supply Voltage	VDD	-0.3 to 12	V
Input Voltage			
V- pin Voltage	V-	VDD-30 to VDD+0.3	V
RSENS pin Voltage	VRSENS	Vss-0.3 to VDD+0.3	V
Output Voltage			
COUT pin Voltage	VCOUT	VDD-30 to VDD+0.3	V
DOUT pin Voltage	VDOUT	Vss-0.3 to VDD+0.3	V
Power Dissipation	PD	150	mW
Operating Temperature	Ta	-40 to 85	°C
Storage Temperature	Tstg	-55 to 125	°C

*Note: Exposure to the condition exceeded Absolute Maximum Ratings may cause the permanent damages and affects the reliability and safety of both device and systems using the device. The functional operations cannot be guaranteed beyond specified values in the recommended conditions.

Electrical Characteristics

Unless otherwise provided, Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V _{DD1}	V _{DD} - V _{SS}	1.5		5.0	V
Maximum Operating Voltage for Inhibition of Charger	V _{nochg}	Voltage Defined as V _{DD} -V _{SS} , V _{DD} -V ₋ =4V	0.4	0.7	1.0	V
Over-charge Threshold Voltage	V _{DET1}	R1=330Ω	V _{DET1} -0.020	V _{DET1}	V _{DET1} +0.020	V
Output Delay of Over-charge	t _{VDET1}	V _{DD} =3.6V→4.5V	0.7	1.0	1.3	s
Release Delay for VD1	t _{VREL1}	V _{DD} =4V, V ₋ =0V→1V	11	16	21	ms
Over-discharge Threshold	V _{DET2}	Detect falling edge of supply voltage	V _{DET2} -0.035	V _{DET2}	V _{DET2} +0.035	V
Output Delay of Over-discharge	t _{VDET2}	V _{DD} =3.6V→2.0V	14	20	26	ms
Release Delay for VD2	t _{VREL2}	V _{DD} =3V, V ₋ =3V→0V	0.7	1.2	1.7	ms
Excess discharge-current threshold	V _{DET3}	Detect rising edge of 'Rsens' pin voltage V ₋ = V _{RSENS}	V _{DET3} ×0.85	V _{DET3}	V _{DET3} ×1.15	V
Output delay of excess discharge-current	t _{VDET3}	V _{DD} =3.0V, V _{RSENS} =0V to 0.4V V ₋ = V _{RSENS}	8	12	16	ms
Output delay of release from excess discharge-current	t _{VREL3}	V _{DD} =3.0V, V ₋ =3V to 0V V ₋ = V _{RSENS}	0.7	1.2	1.7	ms
Short Protection Voltage (R5480KxxxCG)	V _{short}	V _{DD} =3.0V, V _{RSENS} =V ₋	0.41	0.50	0.59	V
Short Protection Voltage (R5480KxxxCL)	V _{short}	V _{DD} =3.0V, V _{RSENS} =V ₋	0.135	0.18	0.225	V
Delay Time for Short Protection	t _{short}	V _{DD} =3.0V, V _{RSENS} =0V to 3V V ₋ = V _{RSENS}	180	250	425	μs
Reset Resistance for Excess Current Protection	R _{short}	V _{DD} =3.6V, V ₋ =1.0V	20	45	70	kΩ
Excess charge-current threshold	V _{DET4}	Detect falling edge of 'Rsens' pin voltage V ₋ = V _{RSENS}	V _{DET4} ×0.85	V _{DET4}	V _{DET4} ×1.15	V
Output delay of excess charge-current	t _{VDET4}	V _{DD} =3.0V, V _{RSENS} =0V to -0.3V V ₋ = V _{RSENS}	11	16	21	ms
Output delay of release from excess charge-current	t _{VREL4}	V _{DD} =3.0V, V ₋ =-1V to 0V V ₋ = V _{RSENS}	0.7	1.2	1.7	ms
Delay Time Shortening Mode Voltage	V _{DS}	V _{DD} =3.6V	-2.6	-2.0	-1.4	V
Nch ON-Voltage of C _{OUT}	V _{oL1}	I _{oL} =50μA, V _{DD} =4.5V		0.4	0.5	V
Pch ON-Voltage of C _{OUT}	V _{oH1}	I _{oH} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Nch ON-Voltage of D _{OUT}	V _{oL2}	I _{oL} =50μA, V _{DD} =2.0V		0.2	0.5	V
Pch ON-Voltage of D _{OUT}	V _{oH2}	I _{oH} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Supply Current	I _{DD}	V _{DD} =3.9V, V ₋ =0V		4.0	8.0	μA
Standby Current	I _{standby}	V _{DD} =2.0V			0.1	μA

- 'Note1' Considering of variation in process parameters, we compensate for this characteristic related to temperature by laser-trim, however, this specification is guaranteed by design, not mass production tested.

Electrical Characteristics

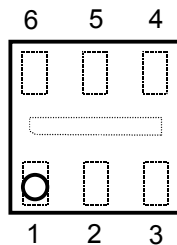
Ta=-20°C~+60°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V _{DD1}	V _{DD} - V _{SS}	1.5		5.0	V
Maximum Operating Voltage for Inhibition of Charger	V _{nochg}	Voltage Defined as V _{DD} -V _{SS} , V _{DD} -V ₋ =4V	0.27	0.7	1.1	V
Over-charge Threshold Voltage	V _{DET1}	R1=330Ω	V _{DET1} -0.025	V _{DET1}	V _{DET1} +0.025	V
Output Delay of Over-charge	t _{VDET1}	V _{DD} =3.6V→4.5V	0.67	1.0	1.55	s
Release Delay for VD1	t _{VREL1}	V _{DD} =4V, V ₋ =0V→1V	10.7	16	24.8	ms
Over-discharge Threshold	V _{DET2}	Detect falling edge of supply voltage	V _{DET2} -0.040	V _{DET2}	V _{DET2} +0.040	V
Output Delay of Over-discharge	t _{VDET2}	V _{DD} =3.6V→2.0V	13.4	20	31	ms
Release Delay for VD2	t _{VREL2}	V _{DD} =3V, V ₋ =3V→0V	0.65	1.2	1.86	ms
Excess discharge-current threshold	V _{DET3}	Detect rising edge of 'Rsens' pin voltage V ₋ = V _{RSSENS}	V _{DET3} × 0.83	V _{DET3}	V _{DET3} × 1.17	V
Output delay of excess discharge-current	t _{VDET3}	V _{DD} =3.0V, V _{RSSENS} =0V to 0.4V V ₋ = V _{RSSENS}	7.5	12	18.6	ms
Output delay of release from excess discharge-current	t _{VREL3}	V _{DD} =3.0V, V ₋ =3V to 0V V ₋ = V _{RSSENS}	0.65	1.2	1.86	ms
Short Protection Voltage (R5480KxxxCG)	V _{short}	V _{DD} =3.0V, V _{RSSENS} =V ₋	0.40	0.50	0.60	V
Short Protection Voltage (R5480KxxxCL)	V _{short}	V _{DD} =3.0V, V _{RSSENS} =V ₋	0.130	0.18	0.230	V
Delay Time for Short Protection	t _{short}	V _{DD} =3.0V, V _{RSSENS} =0V to 3V V ₋ = V _{RSSENS}	160	250	490	μs
Reset Resistance for Excess Current Protection	R _{short}	V _{DD} =3.6V, V ₋ = 1.0V	17.3	45	73.3	kΩ
Excess charge-current threshold	V _{DET4}	Detect falling edge of 'Rsens' pin voltage V ₋ = V _{RSSENS}	V _{DET4} × 0.83	V _{DET4}	V _{DET4} × 1.17	V
Output delay of excess charge-current	t _{VDET4}	V _{DD} =3.0V, V _{RSSENS} =0V to -0.3V V ₋ = V _{RSSENS}	10.7	16	24.8	ms
Output delay of release from excess charge-current	t _{VREL4}	V _{DD} =3.0V, V ₋ =-1V to 0V V ₋ = V _{RSSENS}	0.65	1.2	1.86	ms
Delay Time Shortening Mode Voltage	V _D S	V _{DD} =3.6V	-2.7	-2.0	-1.2	V
Nch ON-Voltage of C _{OUT}	V _{oL1}	I _{oL} =50μA, V _{DD} =4.5V		0.4	0.5	V
Pch ON-Voltage of C _{OUT}	V _{oH1}	I _{oH} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Nch ON-Voltage of D _{OUT}	V _{oL2}	I _{oL} =50μA, V _{DD} =2.0V		0.2	0.5	V
Pch ON-Voltage of D _{OUT}	V _{oH2}	I _{oH} =-50μA, V _{DD} =3.9V	3.4	3.7		V
Supply Current	I _{DD}	V _{DD} =3.9V, V ₋ = 0V		4.0	8.7	μA
Standby Current	I _{standby}	V _{DD} =2.0V			0.12	μA

Note: All of these specifications are guaranteed by design, not tested in mass production.

PIN CONFIGURATIONS

R5480K : DFN(PLP)1414-6



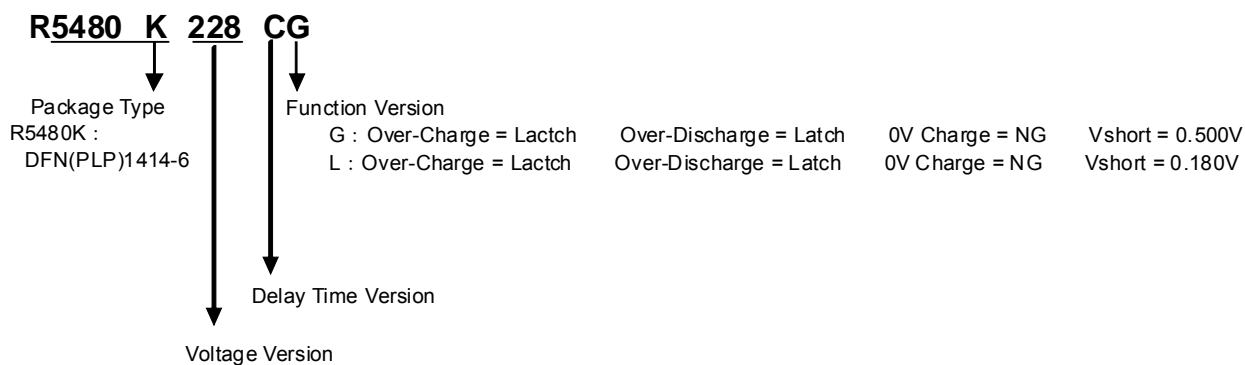
PIN DESCRIPTION

Pin No.	Symbol	Description
1	V _{SS}	V _{SS} pin. Ground pin for the IC
2	V _{DD}	Power supply pin, the substrate voltage level of the IC.
3	R _{SENS}	Input of overcurrent detection
4	V ₋	Pin for charger negative input
5	C _{OUT}	Output of over-charge detection, CMOS output
6	D _{OUT}	Output of over-discharge detection, CMOS output

SELECTION GUIDE

In the R5480 Series, input threshold of over-charge, over-discharge, excess discharge current, and the package and taping can be designated.

Part Number is designated as follows:



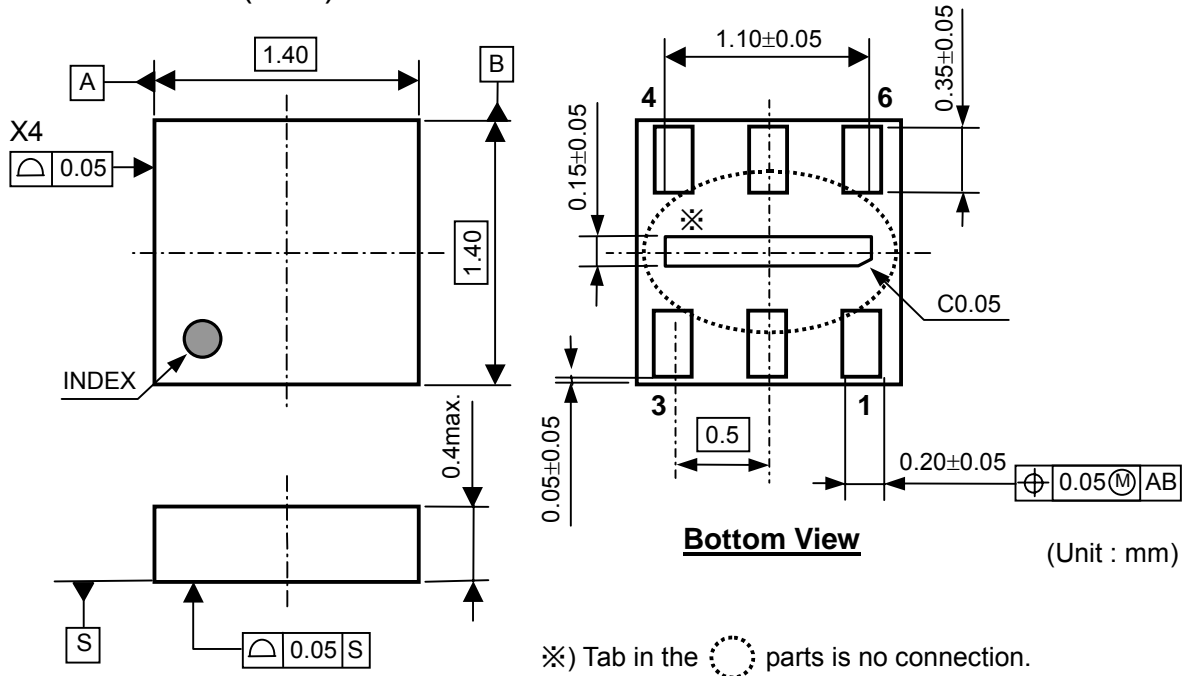
Code	Return from Over-Charge	Return from Over-Discharge	tVdet1 (s)	tVdet2 (ms)	tVdet3 (ms)	tVdet4 (ms)	tShort (μs)	0V Charge
R5480x xxx CG	Latch	Latch	1	20	12	16	250	NG
R5480x xxx CL	Latch	Latch	1	20	12	16	250	NG

R5480K Series : DFN(PLP)1414-6

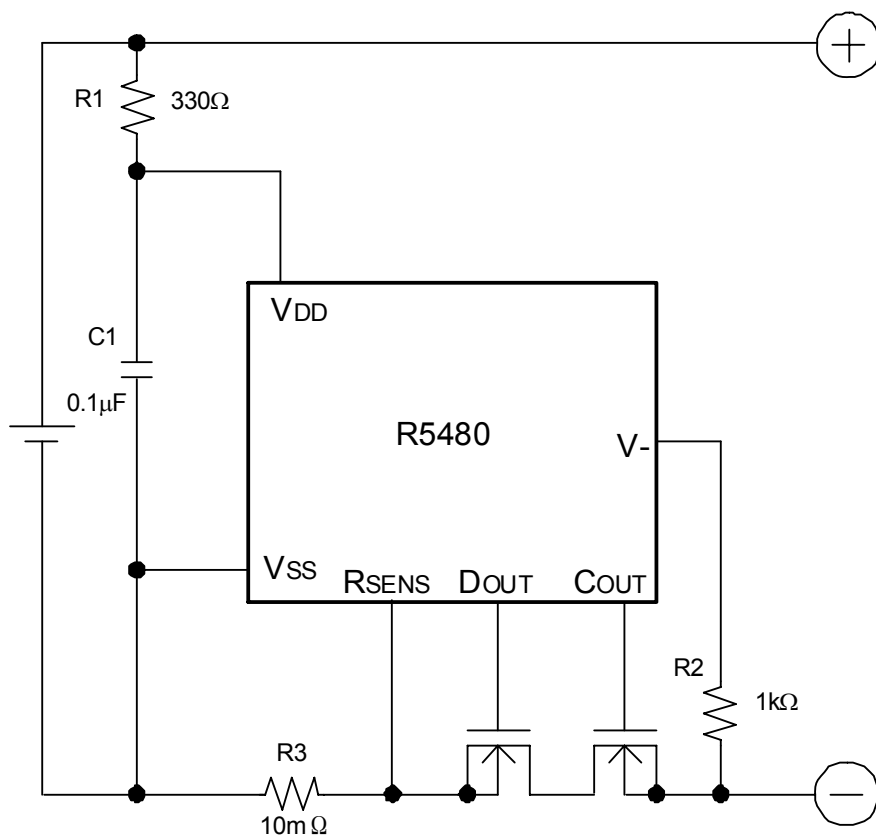
Code	VDET1 (V)	VREL1 (V)	VDET2 (V)	VREL2 (V)	VDET3 (V)	VDET4 (V)	Vshort (V)	tVdet1 (s)	tVdet2 (ms)	tVdet3 (ms)	tVdet4 (ms)	tShort (μ s)	0V Charge
R5480K228CG	4.405	-	2.400	-	0.032	-0.020	0.500	1	20	12	16	250	NG
R5480K240CG	4.280	-	2.800	-	0.032	-0.020	0.500	1	20	12	16	250	NG
R5480K241CG	4.405	-	2.400	-	0.042	-0.020	0.500	1	20	12	16	250	NG
R5480K247CG	4.425	-	2.400	-	0.032	-0.020	0.500	1	20	12	16	250	NG
R5480K257CL	4.425	-	2.400	-	0.034	-0.022	0.180	1	20	12	16	250	NG
R5480K260CL	4.280	-	2.400	-	0.032	-0.030	0.180	1	20	12	16	250	NG
R5480K261CL	4.280	-	2.700	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K262CL	4.405	-	2.400	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K266CL	4.475	-	2.800	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K267CL	4.475	-	2.400	-	0.034	-0.022	0.180	1	20	12	16	250	NG
R5480K275CL	4.230	-	2.800	-	0.048	-0.030	0.180	1	20	12	16	250	NG
R5480K277CL	4.425	-	2.800	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K278CL	4.425	-	2.800	-	0.034	-0.022	0.180	1	20	12	16	250	NG
R5480K283CL	4.280	-	2.800	-	0.030	-0.020	0.180	1	20	12	16	250	NG
R5480K284CL	4.425	-	2.400	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K285CL	4.280	-	2.400	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K286CL	4.405	-	2.800	-	0.040	-0.030	0.180	1	20	12	16	250	NG
R5480K287CL	4.280	-	2.600	-	0.048	-0.030	0.180	1	20	12	16	250	NG

Package Dimensions

R5480K : DFN(PLP)1414-6



Technical Notes



*R1 and C1 stabilize a supply voltage to the R5480. A recommended R1 value is equal or less than 1k Ω . A large value of R1 makes detection voltage shift higher because of the conduction current flowed in the R5480.

Further, to stabilize the operation of R5480, use the C1 with the value of 0.01 μ F or more.

*R1 and R2 can operate as a current limit against setting cell reverse direction or applying excess charge voltage to the R5480. While small value of R1 and R2 may cause over power dissipation rating of the R5480, therefore a total of "R1+R2" should be 1k Ω or more. Besides, if a large value of R2 is set, release from over-discharge by connecting a charger might not be possible. Recommended R2 value is equal or less than 10k Ω .

R3 is a resistor for sensing an excess current. If the resistance value is too large, power loss becomes also large. By the excess current, if the R3 is not appropriate, the power loss may be beyond the power dissipation of R3. Choose an appropriate R3 according to the cell specification.

The typical application circuit diagram is just an example. This circuit performance largely depends on the PCB layout and external components. In the actual application, fully evaluation is necessary.

Over-voltage and the over current beyond the absolute maximum rating should not be forced to the protection IC and external components.

Although the short protection circuit is built in the IC, if the positive terminal and the negative terminal of the battery pack are short, during the delay time of short limit detector, large current flows through the FET. Select an appropriate FET with large enough current capacity to prevent the IC from burning damage.

We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to humans or damages to property resulting from such failure, users should be careful enough to incorporate safe measures in design, such as redundancy, fire-containment, and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.

If the positive terminal and the negative terminal of the battery pack are short, even though the short protection circuit is built in the IC, during the delay time until detecting the short circuit, a large current may flow through the FET. Select an FET with large enough current capacity in order to endure the large current during the delay time.

Sense resistance and on resistance of the MOSFET selection guideline

Short mode is detected by the current base or the relation between VDD at short and total on resistance of external MOSFETs for Cout and Dout.

If short must be detected by the current base determined by Vshort and R3, the next formula must be true, otherwise, the short current limit becomes $(VDD^* - 0.9)/(R3 + R_{ss}(on))$

$$\frac{VDD^* - 0.9}{R3 + R_{ss}(on)} \geq \frac{V_{short}}{R3}$$

*Vshort = 0.5V (CG version) , 0.18V(CL version)

*R3 = External current sense Resistance(Ω)

*Rss(on) = external MOSFETs' total ON Resistance(Ω)

VDD = VDD level at short mode. If VDD goes down by the short current, the lowest level is VDD*.

Notes: in case of the short mode is specified at short current determined by the relation between R3 and Vshort value,

ex. 1

As the Rsense, in case that the 10m Ω is selected as R3 and if the VDD becomes 3.0V, to detect short at 50A with Vshort=0.5V, the Rss(on) must be 32m Ω or lower.

Otherwise, according to the Rss(on), short current limit is lower than expected.

ex. 2

As the Rsense, in case the 20m Ω is selected as R3 and if the VDD becomes 3.0V, to detect short at 25A with Vshort=0.5V, the Rss(on) must be 64m Ω or lower.



1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, firecontainment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.



For the conservation of the global environment, Ricoh is advancing the decrease of the negative environmental impact material.
After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive. Basically after Apr. 1, 2012, we will ship out the Power Management ICs of the Halogen Free products only. (RicoH Halogen Free products are also Antimony Free.)

RICOH RICOH COMPANY, LTD. Electronic Devices Company

<http://www.ricoh.com/LSI/>

RICOH COMPANY, LTD.

Electronic Devices Company

● Higashi-Shinagawa Office (International Sales)

3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.

● Semiconductor Support Centre

"Nieuw Kronenburg" Prof. W.H. Keesomlaan 1, 1183 DJ, Amstelveen, The Netherlands
P.O.Box 114, 1180 AC Amstelveen
Phone: +31-20-5474-309 Fax: +31-20-5474-791

RICOH ELECTRONIC DEVICES KOREA Co., Ltd.

11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd.

Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH COMPANY, LTD.

Electronic Devices Company

● Taipei office

Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623