RICOH R5520H SERIES

USB HIGH-SIDE POWER SWITCH

NO.EA-091-130827

OUTLINE

The R5520H is CMOS-based high-side MOSFET switch IC for Universal Serial Bus (USB) applications. Low ON Resistance (Typ.100mΩ) and low supply current (Typ.20μA at active mode) are realized in this IC.

An over-current limit circuit, thermal shutdown circuit, and an under voltage lockout circuit are built-in as protection circuits. Further, a delay circuit for flag signal after detecting over-current, is embedded to prevent miss-operation of error flag because of inrush current. The R5520H is ideal for applications of protection for USB power supply.

FEATURES

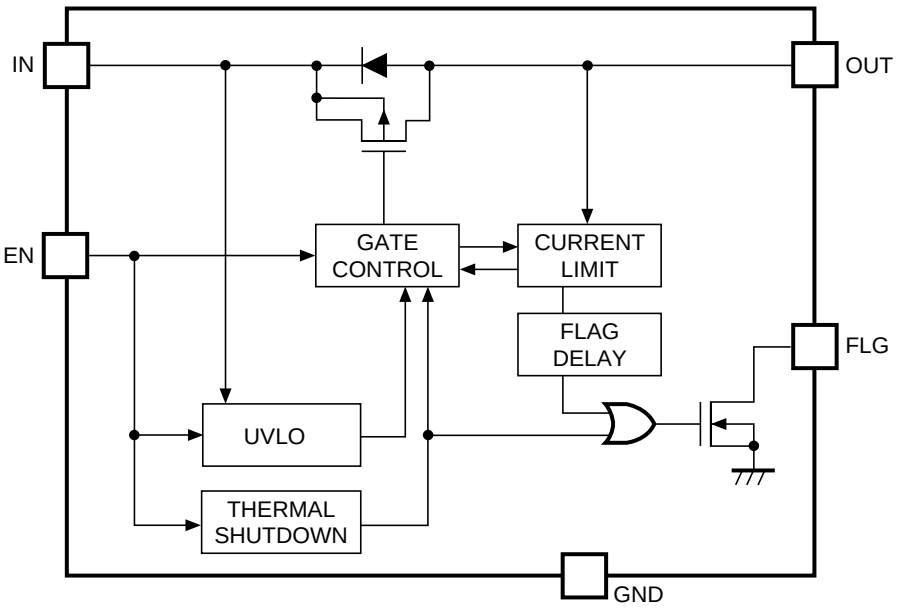
- Built-in P-channel MOSFET Switch
- Supply Current .....Typ. 20μA (at Active Mode)
- Switch ON Resistance .....Typ. 100mΩ
- Output Current.....Min. 500mA
- Flag Delay Time .....Typ. 10ms.
- Over- Current Limit / Short Circuit Protection
- Built-in Under Voltage Lockout (UVLO) Function
- Built-in Thermal Shutdown Protection
- Built-in Soft-start Function
- Package SOT-89-5

APPLICATIONS

- USB Peripherals
- Notebook PCs

BLOCK DIAGRAMS

R5520H001A/B



SELECTION GUIDE

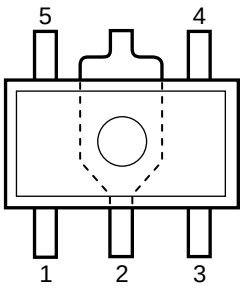
The logic of the enable pin for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5520H001∗-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes

∗ : Designation of the logic of the enable pin.
(A) "L" active
(B) "H" active

PIN DESCRIPTIONS

● **SOT-89-5**



Pin No	Symbol	Pin Description
1	EN	Enable Pin
2	GND	Ground Pin
3	FLG	FLG pin (Open Drain Output)
4	IN	Power Supply Pin
5	OUT	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.0	V
V_{EN}	Enable Pin Input Voltage	−0.3 to V_{IN}+0.3	V
V_{FLG}	Flag Voltage	−0.3 to 6.0	V
I_{FLG}	Flag Current	14	mA
V_{OUT}	Output Voltage	−0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	Internal Limited	
P_D	Power Dissipation[*1] (SOT-89-5)	900	mW
Ta	Operating Temperature Range	−40 to 85	°C
Tstg	Storage Temperature Range	−55 to 125	°C

[*1] For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.
The functional operation at or over these absolute maximum ratings is not assured.

ELECTRICAL CHARACTERISTICS

- **R5520H001A/B**

Ta=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage		4.0		5.5	V
I_{DD1}	Supply Current 1	Active *1, OUT=open		20	60	μA
I_{DD2}	Supply Current 2	OFF *2, OUT=open		0.5	5.0	μA
R_{ON}	Switch On Resistance	V_{IN}=5V, I_{OUT}=500mA		100	140	mΩ
		V_{IN}=4V, I_{OUT}=500mA		110	150	mΩ
t_{ON}	Output Turn-on Delay	R_L=10Ω		2	12	ms
t_{OFF}	Output Turn-off Delay	R_L=10Ω		5	20	μs
V_{UVLO}	UVLO Threshold	V_{IN}=increasing	2.1	2.4	2.7	V
		V_{IN}=decreasing		2.2		V
I_{TH}	Current Limit Threshold	Ramped Load		1.2	2.0	A
I_{LIM}	Short Current Limit	V_{OUT}=0V	0.50	0.75	1.00	A
t_{FD}	Over Current Flag Delay	From Over Current to FLG="L"	5	10	20	ms
T_{TS}	Thermal Shutdown Temperature Threshold	Tj=increasing		135		°C
		Tj=decreasing		125		
I_{EN}	Enable Pin Input Current			0.01	1.00	μA
V_{EN1}	Enable Pin Input Voltage 1	V_{EN}=increasing	2.4			V
V_{EN2}	Enable Pin Input Voltage 2	V_{EN}=decreasing			0.8	V
I_{LO}	Output Leakage Current			1	10	μA
V_{LF}	Flag "L" Output Voltage	I_{SINK}=1mA			0.4	V
I_{FOF}	Flag Off Current	V_{FLAG}=5.5V		0.05	2.00	μA

*1 EN=L (R5520H001A), EN=H (R5520H001B)

*2 EN=H (R5520H001A), EN=L (R5520H001B)

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

OPERATION

This explanation is based on the typical application.

・(1) There is a parasitic diode between source and drain of the switch transistor. (Refer to the block diagram.) Because of this, in both cases of enable and disable, if the voltage of OUT pin is higher than IN pin, current flows from OUT to IN.

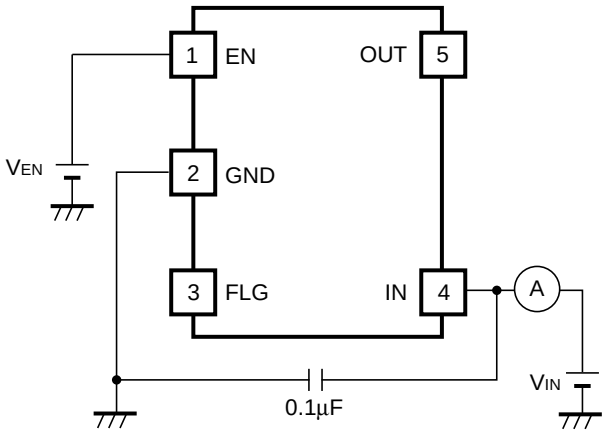
・(2) In case that OUT pin and GND is short, if over-current would continue, the temperature of the IC would increase drastically. If the temperature of the IC is beyond 135°C, the switch transistor turns off and the FLG pin level becomes "L". Then, when the temperature of the IC decreases equal or lower than 125°C, the switch transistor turns on and FLG becomes "H". Unless the abnormal situation of OUT pin is removed, the switch transistor repeats on and off.
Refer to the 21) over-current protection operation in the typical characteristics.

・(3) Over-current level is set internally in the IC. There are three types of response against over-current:
①Under the condition that OUT pin is short or large capacity is loaded, if the IC is enabled, the IC becomes constant current state. After the flag delay time passes, FLG becomes "L", that means over current state. Refer to the 20) current limit transient response of typical characteristics.
②While the switch transistor is on, if OUT pin is short or large capacity is loaded, until the current limit circuit responds, large transient current flows. After the transient current is beyond the over-current de-tector threshold and delay time of the flag passes, FLG becomes "L", that means over current state.
Refer to the 22), 23) over-current limit transient response of typical characteristics.
③In the case that load current gradually increases, the IC is not into the constant current state until the current is beyond over current limit. Once the level is beyond the over current detector threshold, load current is limited into over current limit level. Note that load current continuously flows until the load current is beyond the over-current detector threshold.

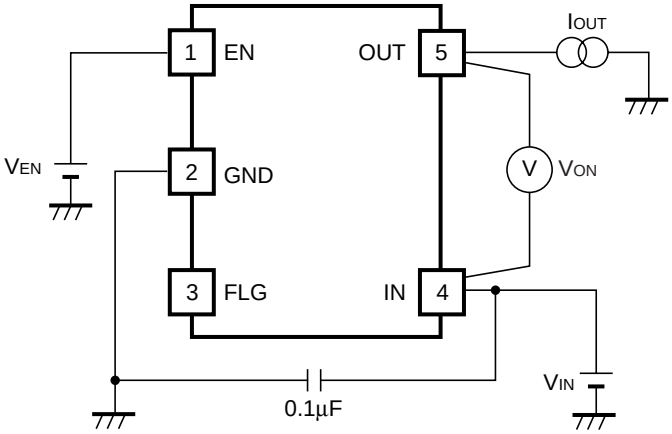
・(4) FLG pin is Nch Open drain output. If the over-current or over-temperature is detected, FLG becomes "L". If over-current is detected, FLG becomes "L" after the flag delay time t_{FD} passes. Therefore flag signal is not out with inrush current.

・(5) UVLO circuit prevents that the switch transistor turns on until the input voltage is beyond 2.4V. UVLO circuit can operate when the IC is enabled.

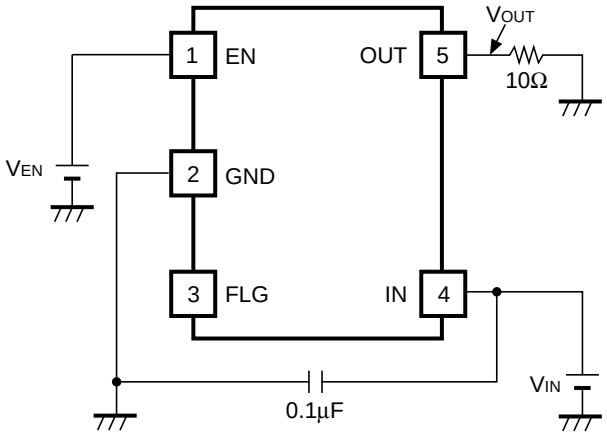
TEST CIRCUIT



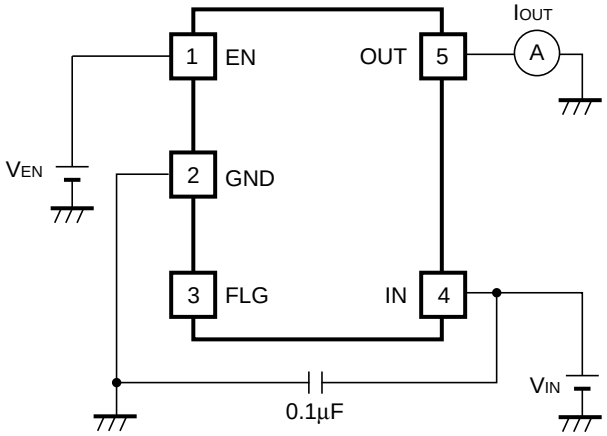
Supply Current Test Circuit



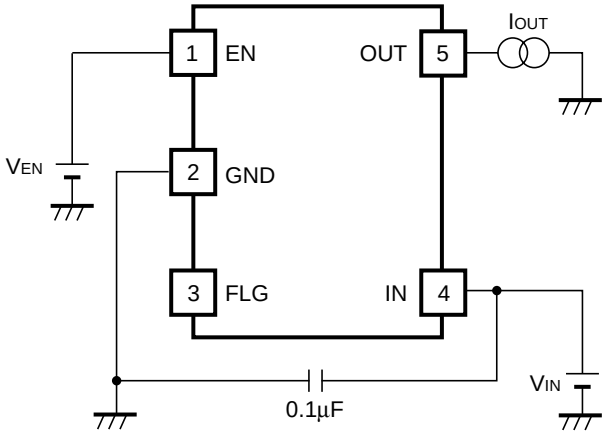
Switch On Resistance Test Circuit



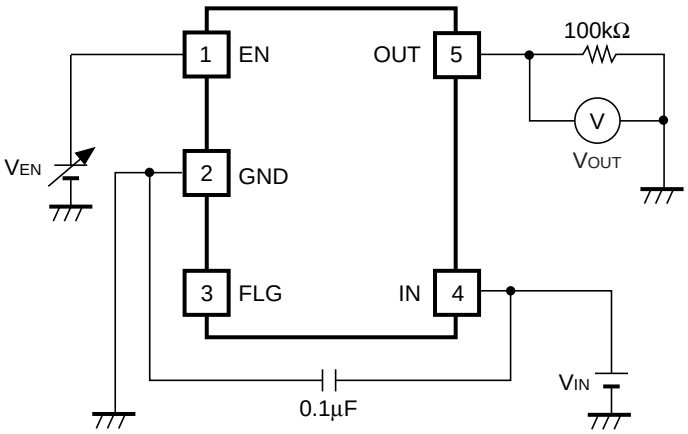
Output On Time Test Circuit



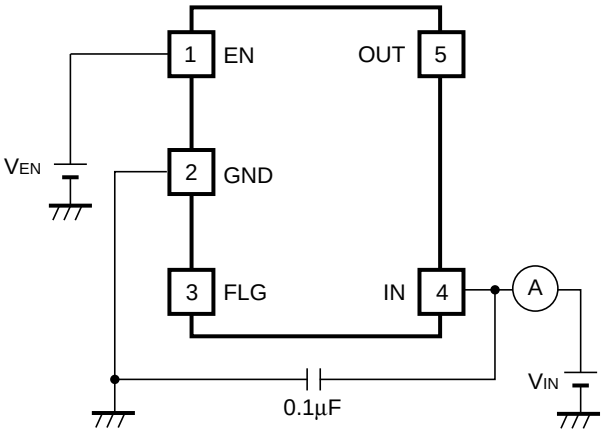
Over-current Limit Test Circuit



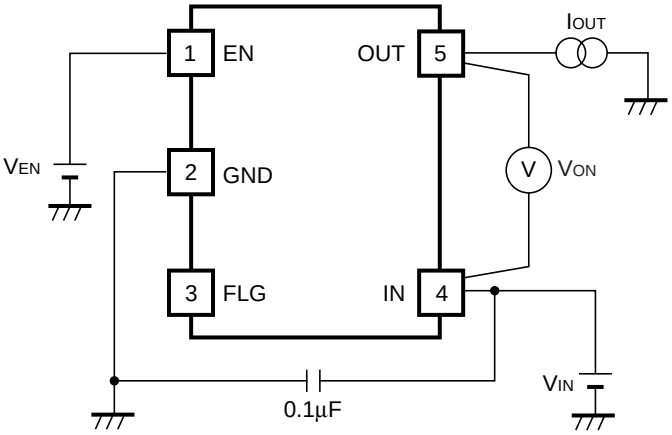
Over-current Threshold Test Circuit



Enable Input Voltage Test Circuit

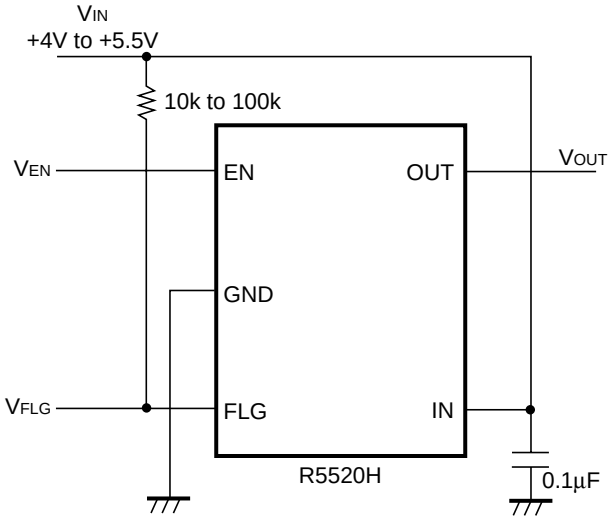


Flag Output Delay Time Test Circuit



UVLO Threshold Test Circuit

TYPICAL APPLICATION



R5520H001A/B

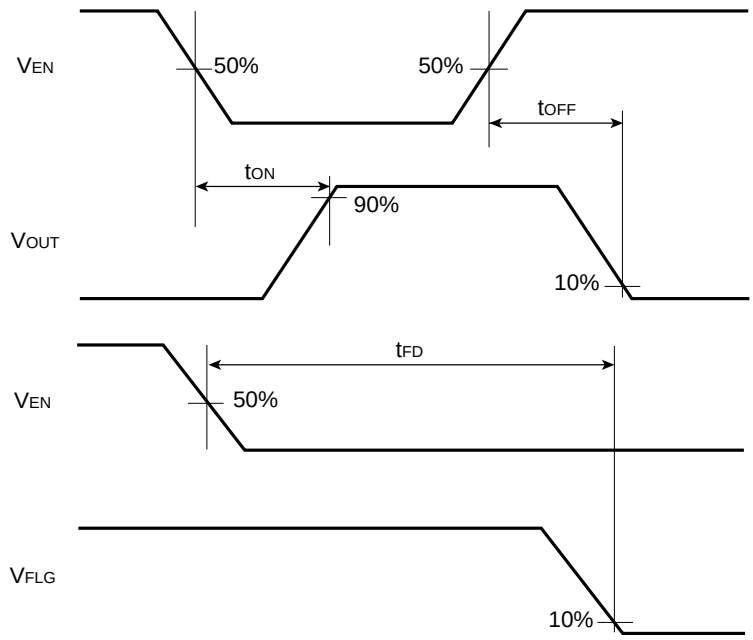
TECHNICAL NOTES

・Put a capacitance range from 0.1µF to 1µF bypass capacitor between IN pin and GND pin of the IC. Without a bypass capacitor, in case of output short, because of the high side inductance of IN pin, ringing may be generated and it might be a cause of an unstable operation.

・Recommended pull-up resistance value range of flag pin is from 10kΩ to 100kΩ.

TIMING CHART

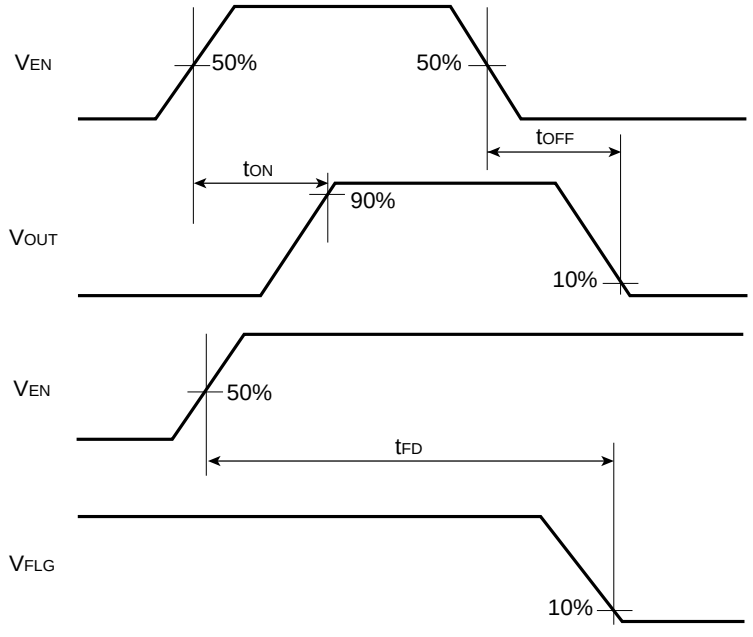
- **R5520H001A**



Output On Time/Output Off Time

FLG Output Delay Time

- **R5520H001B**



Output On Time/Output Off Time

FLG Output Delay Time

PACKAGE INFORMATION

POWER DISSIPATION (SOT-89-5)

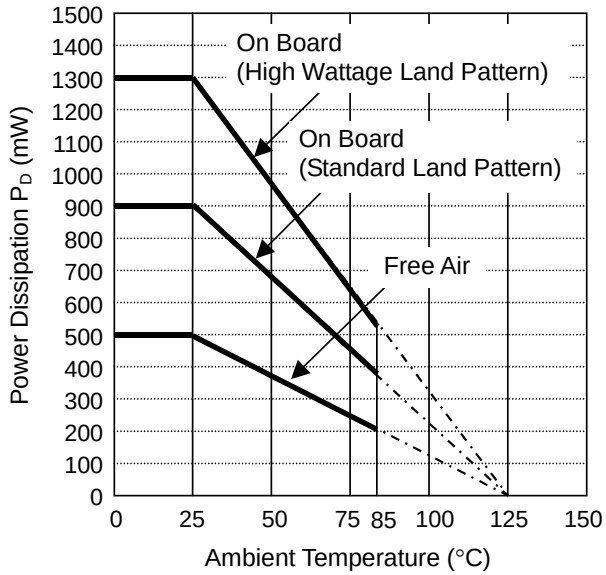
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

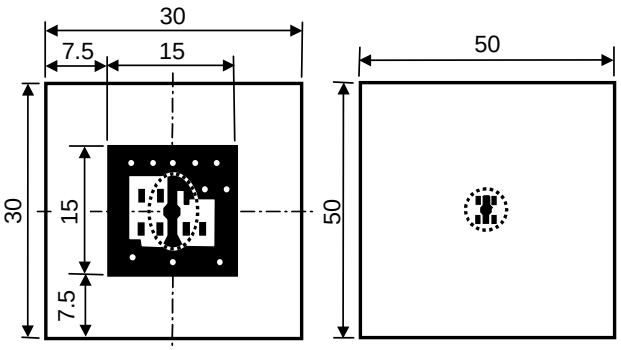
	High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)	Glass cloth epoxy plastic (Double sided)
Board Dimensions	30mm × 30mm × 1.6mm	50mm × 50mm × 1.6mm
Copper Ratio	Top side : Approx. 20% , Back side : Approx. 100%	Top side : Approx. 10% , Back side : Approx. 100%
Through-hole	ϕ0.85mm × 10pcs	-

Measurement Result (Ta=25°C, Tjmax=125°C)

	High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	1300mW	900mW	500mW
Thermal Resistance	77°C/W	111°C/W	200°C/W



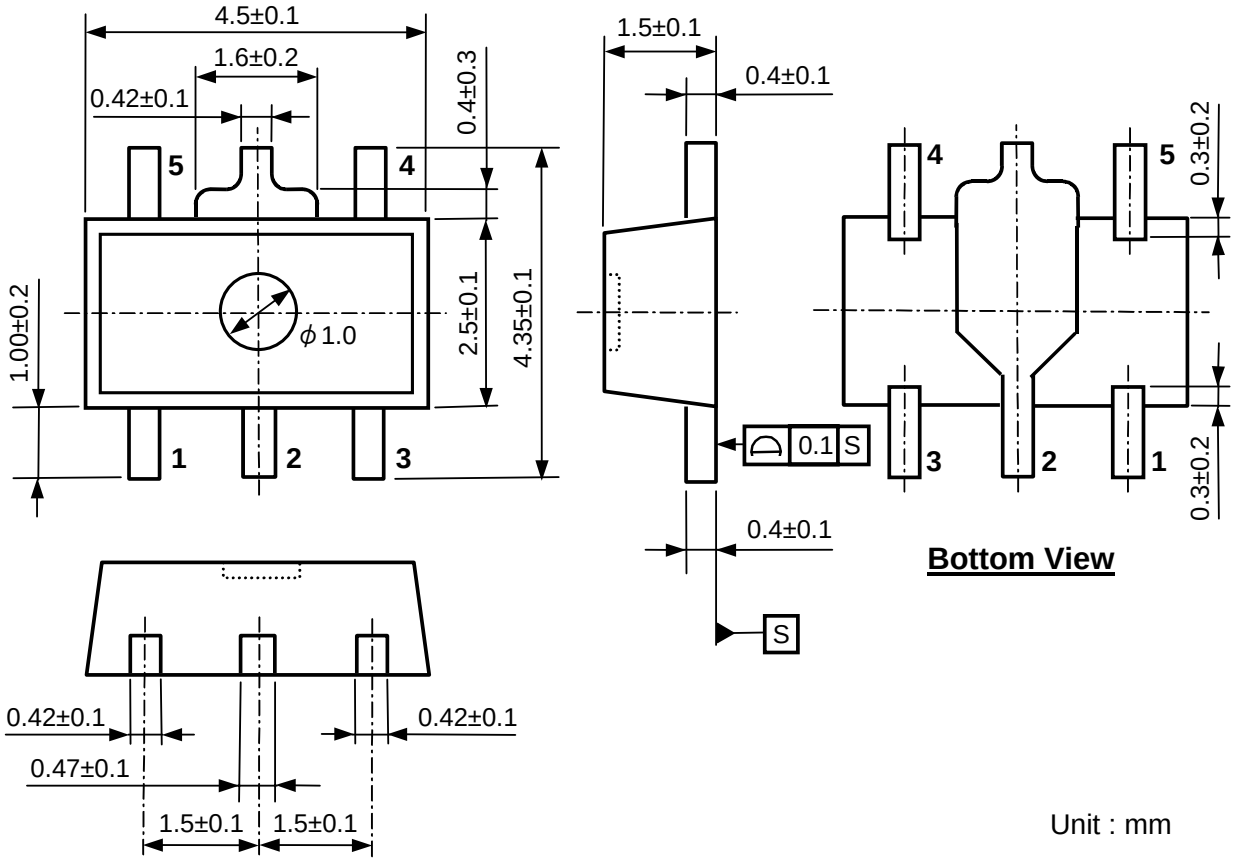
Power Dissipation



Measurement Board Pattern

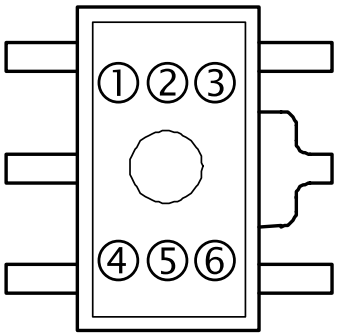
IC Mount Area (Unit : mm)

PACKAGE DIMENSIONS (SOT-89-5)



Unit : mm

MARK SPECIFICATION (SOT-89-5)



①②③④: Product Code …

Refer to *MARK SPECIFICATION TABLE (SOT-89-5)*

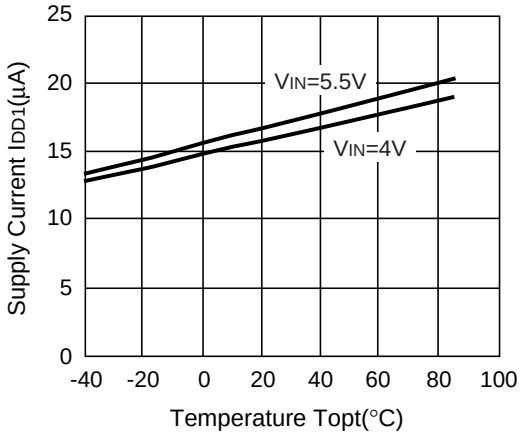
⑤⑥: Lot Number … Alphanumeric Serial Number

MARK SPECIFICATION TABLE (SOT-89-5)

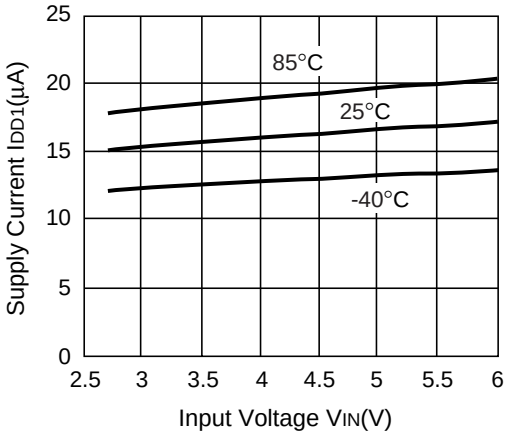
Product Name	①②③④
R5520H001A	F 0 1 A
R5520H001B	F 0 1 B

TYPICAL CHARACTERISTICS

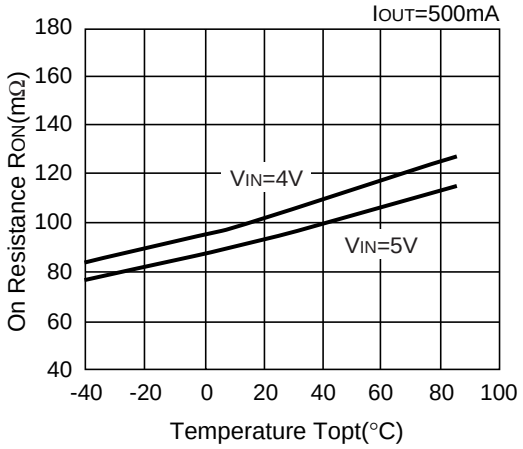
1) Supply Current vs. Temperature



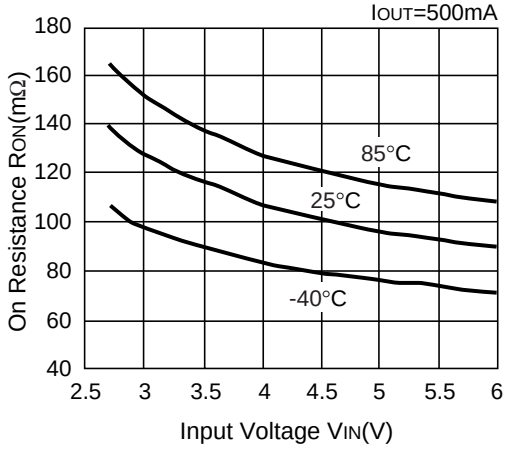
2) Supply Current vs. Input Voltage



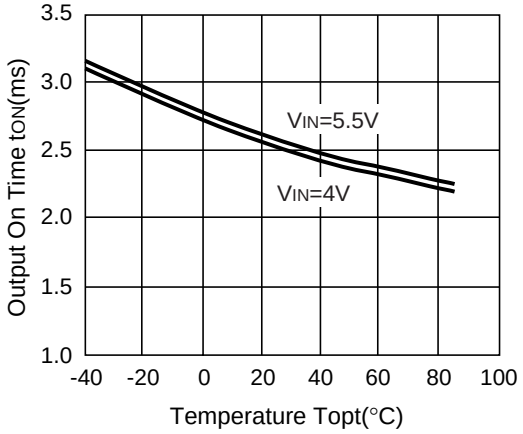
3) On Resistance vs. Temperature



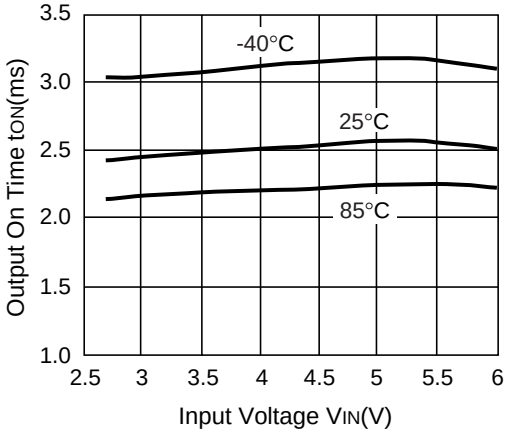
4) On Resistance vs. Input Voltage



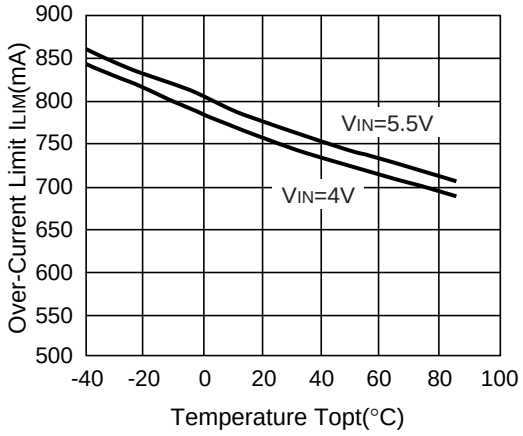
5) Output On Time vs. Temperature



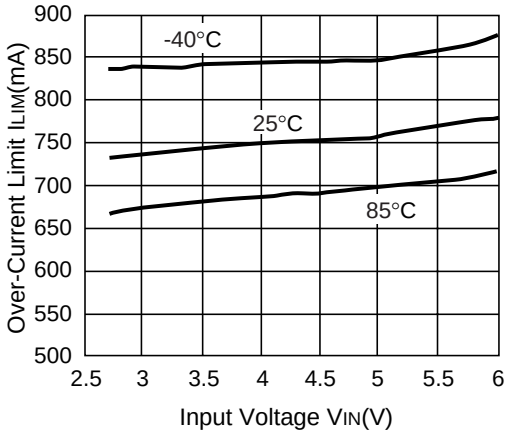
6) Output On Time vs. Input Voltage



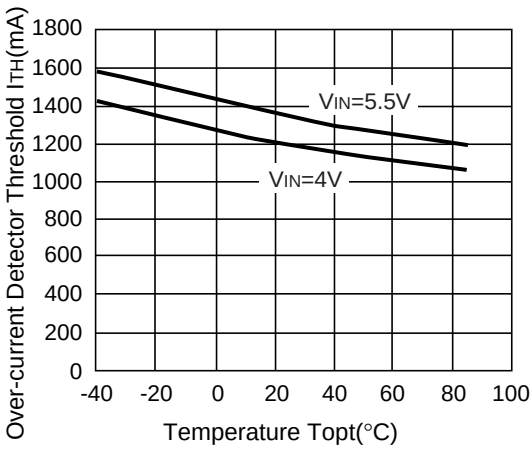
7) Over-current limit vs. Temperature



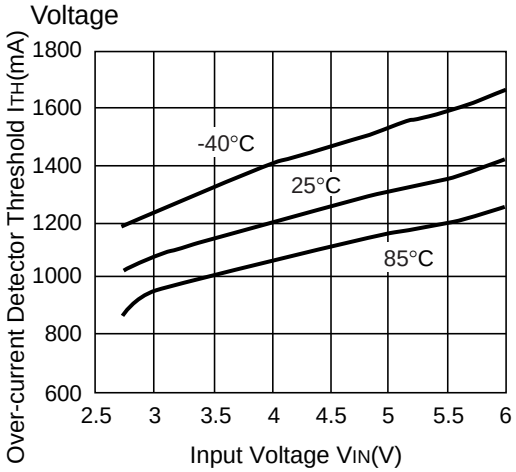
8) Over-current limit vs. Input Voltage



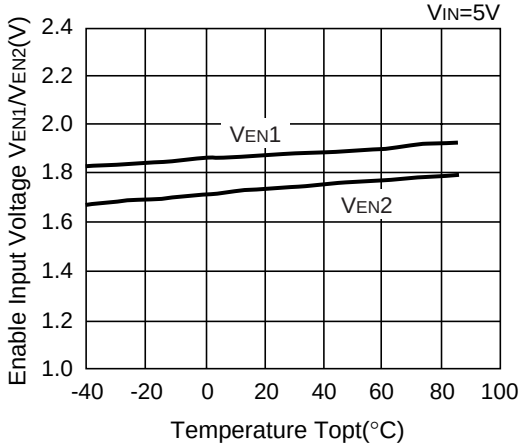
9) Over-current Detector Threshold vs. Temperature



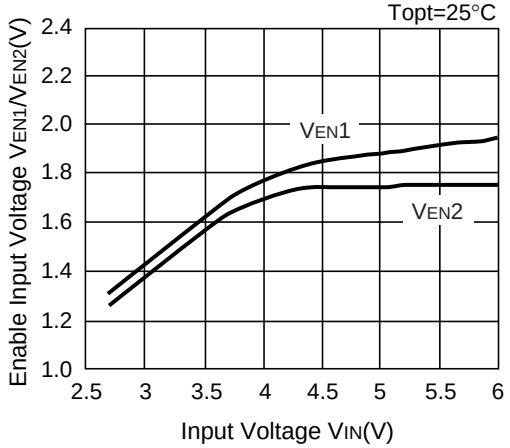
10) Over-current Detector Threshold vs. Input Voltage



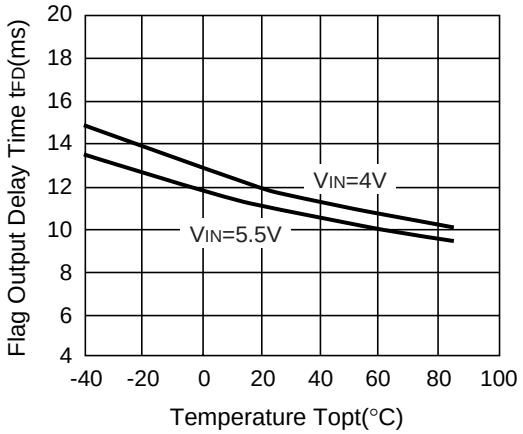
11) Enable Input Voltage vs. Temperature



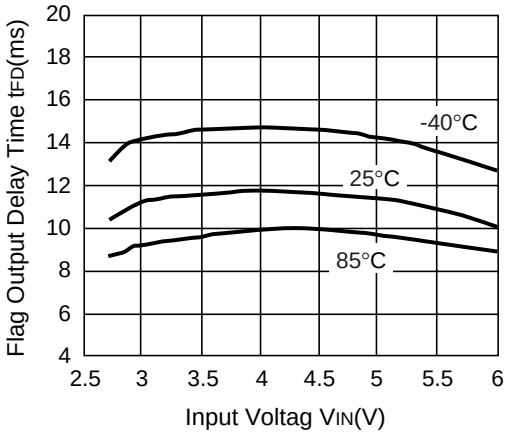
12) Enable Input Voltage vs. Input Voltage



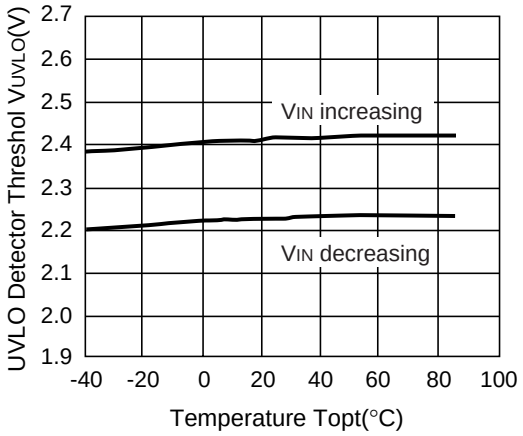
13) Flag Output Delay Time vs. Temperature



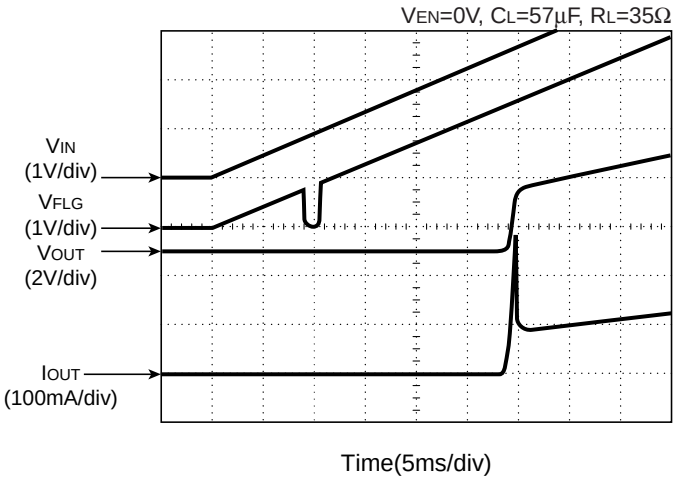
14) Flag Output Delay Time vs. Input Voltage



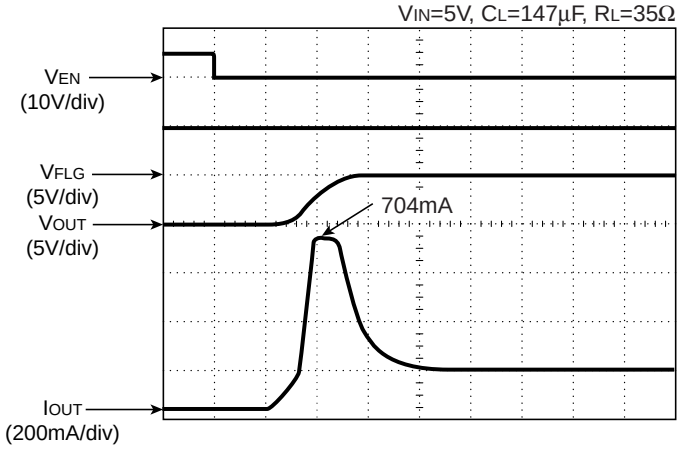
15) UVLO Threshold vs. Temperature



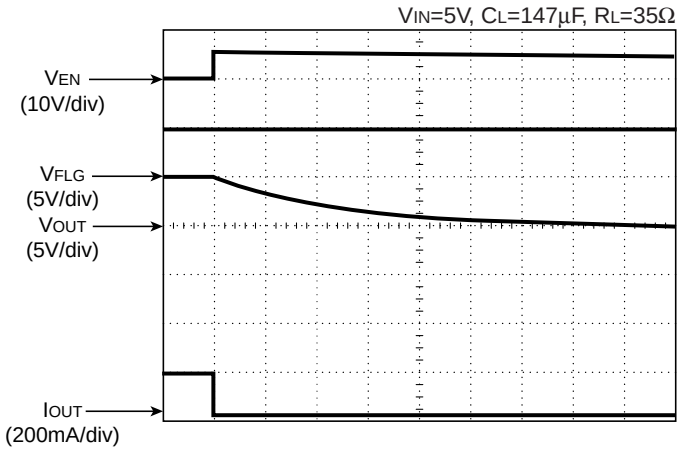
16) UVLO at V_{IN} increasing



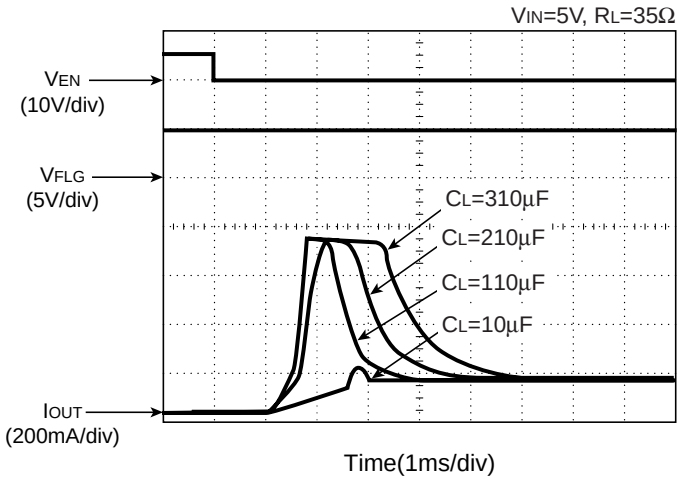
17) Turn-on response



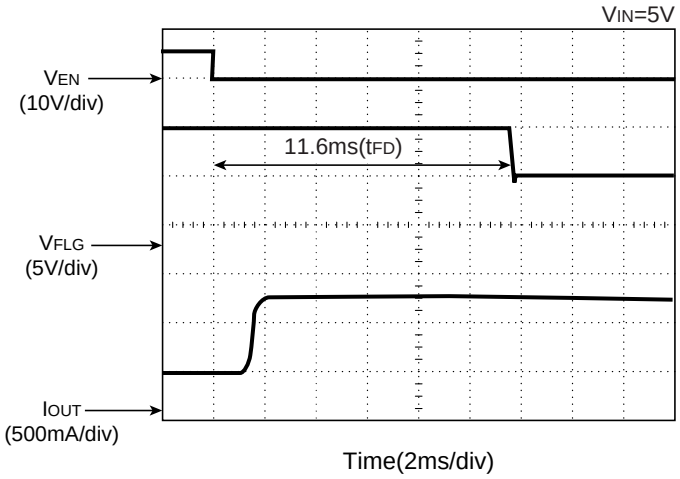
18) Turn off Response



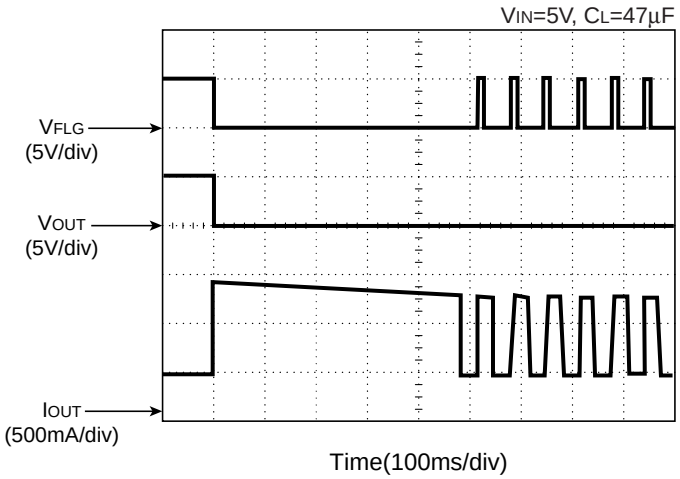
19) Inrush current



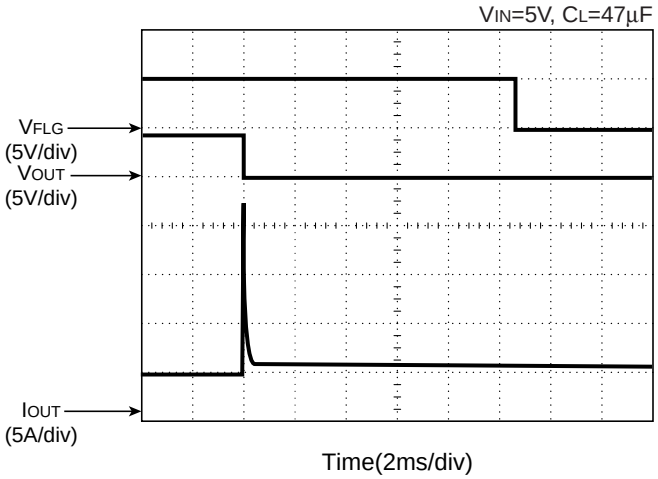
20) Current Limit Transient Response
(Case: Enable to Short)



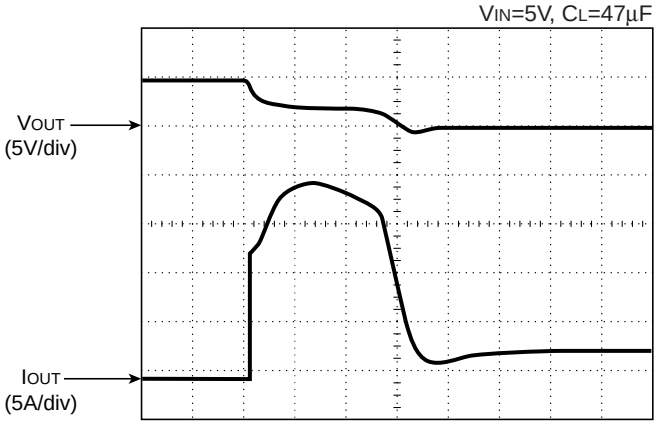
21) Thermal Shutdown



22) Current Limit Transient Response
(Case: Output short during enable)



23) Zoomed in 22)



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8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
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RoHS Compliant
Halogen Free

Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.
Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

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