RICOH

R5560Z Series

High-Current/Overvoltage Protection Switch IC with Voltage Suppressor

No. EA-328-170517

OUTLINE

The R5560Z is a CMOS-based high-current and overvoltage protection switch IC with voltage suppressor that uses an NMOS pass transistor to achieve ultra-low on resistance (Typ. 38 mΩ). The R5560Z consists of a soft-start circuit, a startup debounce circuit, an overvoltage lockout (OVLO) circuit, and a thermal shutdown circuit.

The OVLO threshold is adjustable with optional external resistors to any voltage between 4 V and 20 V. The internal OVLO threshold (preset to 6.8 V ±3%) is available when connecting the OVLO pin to GND.

An internal clamp can protect low-voltage systems from surges up to +80 V (The surge waveform is compliant with IEC 61000-4-5 Combination Wave.) without using a transient-voltage-suppression (TVS) diode.

The R5560Z is offered in a small and thin WLCSP-12-P2 (1.288 mm x 1.828 mm) package which achieves the smallest possible footprint solution on boards where area is limited.

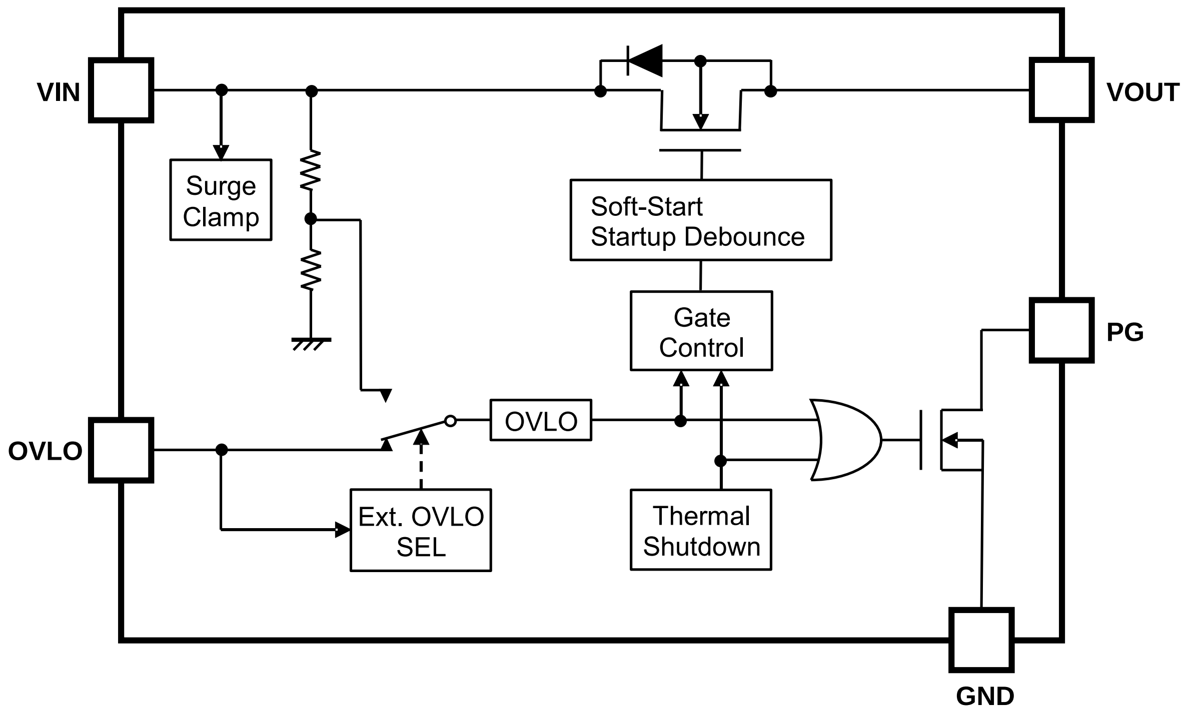
FEATURES

- Input Voltage Range (Maximum Rating) ·························· 2.5 V to 28 V (29 V)
- Surge Immunity ·························· 80 V
- Switch On Resistance ·························· Typ.38 mΩ
- Input Supply Current ·························· Typ. 19 µA
- Internal Fixed Preset OVLO Threshold ·························· 6.8 V±3%
- Adjustable OVLO Threshold with OVLO Pin
- Adjustable OVLO Threshold Range ·························· 4 V to 20 V
- Power Good (PG) Function
- Soft-start Function
- Internal Startup Debounce ·························· Typ.15 ms
- Thermal Shutdown Protection ·························· Typ.150°C
- Package ·························· WLCSP-12-P2

APPLICATIONS

- Smartphones
- Tablet PCs
- Mobile Internet Devices

BLOCK DIAGRAM



R5560Z Block Diagram

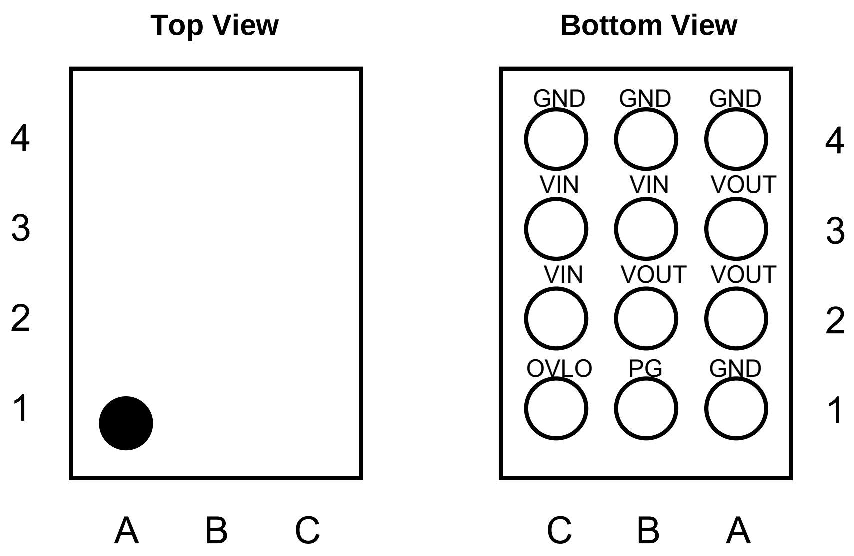
SELECTION GUIDE

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5560Zxx1A-TL-F	WLCSP-12-P2	5,000 pcs	Yes	Yes

xx: Designate the internal OVLO threshold.
01: 6.8 V

PIN DESCRIPTION



WLCSP-12-P2 Pin Configuration

WLCSP-12-P2 Pin Description

Pin No	Symbol	Pin Description
A1, A4, B4, C4	GND [1]	Ground pins.
A2, A3, B2	VOUT [2]	Output pins.
B1	PG	Power Good output pin. (Nch open drain) PG is driven low after input voltage is stable between minimum V_{IN} and V_{IN_OVLO} after startup debounce except during thermal shutdown operation.
B3, C2, C3	VIN [3]	Input pins.
C1	OVLO	External OVLO adjustment pin. Connect OVLO to GND when using the internal threshold. Connect a resistor-divider to OVLO to set a different OVLO threshold.

[1] Connect the pins that have the same symbols together: A1, A4, B4 and C4
[2] Connect the pins that have the same symbols together: A2, A3 and B2
[3] Connect the pins that have the same symbols together: B3, C2 and C3

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	−0.3 to 29	V
V_{OUT}	Output Voltage	−0.3 to V_{IN} + 0.3	V
V_{OVLO}	OVLO Pin Input Voltage	−0.3 to 24	V
V_{PG}	PG Pin Voltage	−0.3 to 6.5	V
I_{PG}	PG Pin Current	14	mA
I_{OUT}	Continuous Output Current	4.5	A
P_D	Power Dissipation (1)	1000	mW
Ta	Operating Temperature Range	−40 to 85	°C
Tstg	Storage Temerature	−55 to 125	°C

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 are not assured.

(1) Refer to *PACKAGE INFORMATION* for detailed information.

ELECTRICAL CHARACTERISTICS

V_{IN} = 2.5 V to 28 V, I_{OUT} = 1 mA, C_{IN} = 0.1 μF, unless otherwise noted. Typical values are V_{IN} = 5 V, Ta = 25°C.

The specifications surrounded by ☐ are guaranteed by design engineering at −40°C to 85°C.

R5560Z Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage			2.5		28	V
V_{IN_CLAMP}	Input Clamp Voltage	I_{IN} = 10 mA			33		V
I_{IN}	Input Supply Current	V_{IN} = 5 V, I_{OUT} = 0 mA			19	50	μA
I_{IN_OVLO}	OVLO Supply Current	V_{IN} = 5 V, V_{OUT} = 0 V, V_{OVLO} = 3 V			16	50	μA
R_{ON}	On Resistance	V_{IN} = 5 V, I_{OUT} = 1 A, Ta = 25°C			38	53	mΩ
V_{IN_OVLO}	Internal Fixed Preset OVLO Threshold	V_{OVLO} = 0 V	V_{IN} rising	6.6	6.8	7.0	V
			V_{IN} falling	6.5			V
V_{OVLO_SEL}	External OVLO Select Threshold			0.2	0.25	0.3	V
V_{OVLO_TH}	OVLO set Threshold			1.18	1.22	1.26	V
V_{IN_OVLO}	Adjustable OVLO Threshold Range (1)			4		20	V
I_{OVLO}	OVLO Input Leakage			−100		100	nA
V_{OL}	PG Output Low Voltage	I_{SINK} = 1 mA				0.4	V
V_{PG_LEAK}	PG Leakage Current	V_{IO} = 3.3 V		−1		1	μA
t_{DEB}	IN Debounce Time	2.5 V < V_{IN} < V_{IN_OVLO} to V_{OUT} = 10% of V_{IN}			15		ms
t_{ON}	Turn-On Time during Soft-Start	V_{IN} = 5 V, R_{LOAD} = 100 Ω, C_{OUT} = 100 uF, V_{OUT} = 10% of V_{IN} to 90% of V_{IN}			2		ms
t_{OFF}	Turn-Off Time	V_{IN} > V_{OVLO}, 2 V/μs to V_{OUT} = 80% of V_{IN}, R_{LOAD} = 100 Ω			2		μs
C_{OUT}	OUT Load Capacitance					1000	μF
T_{SHDN}	Thermal Shutdown				150		°C
T_{HYST}	Thermal Shutdown Hysteresis				20		°C

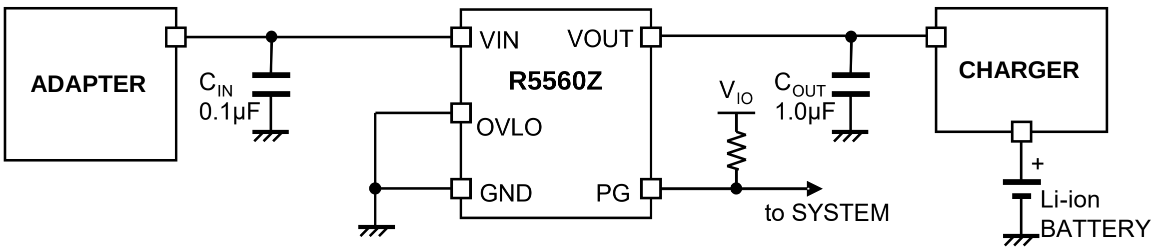
All test items listed under ELECTRICAL CHARACTERISTICS are done under the pulse load condition (Tj ≈ Ta = 25°C) except Adjustable OVLO Threshold Range, Turn-On Time during Soft-Start, Turn-Off Time and OUT Load Capacitance.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

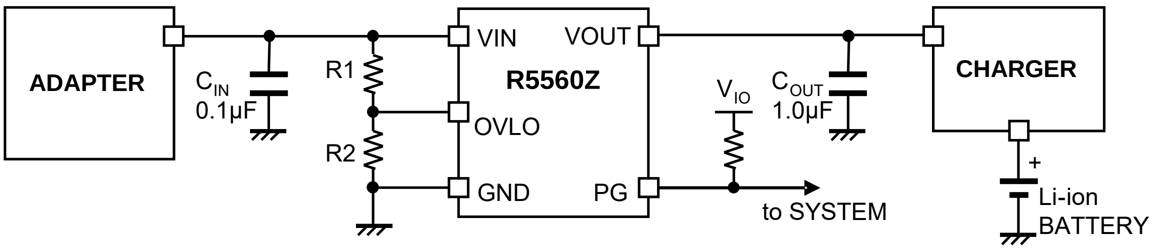
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic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

(1) Refer to *TECHNICAL NOTES* for details.

APPLICATION INFORMATION



Internal Fixed Preset OVLO Typical Application



External Adjustable OVLO Typical Application

TECHNICAL NOTES

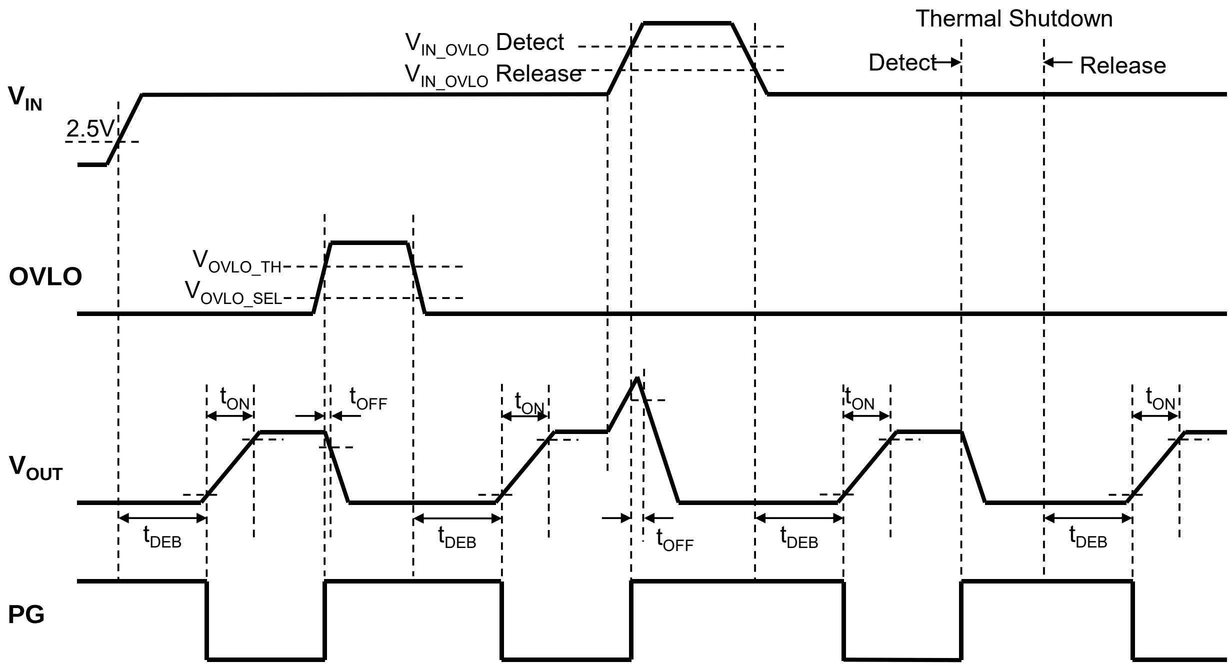
The performance of a power source circuit using this device is highly dependent on a peripheral circuit. A peripheral component or the device mounted on PCB should not exceed a rated voltage, a rated current or a rated power. When designing a peripheral circuit, please be fully aware of the following points.

- Set the OVLO pin input voltage to or below the external OVLO select threshold (Typ. 0.25 V) when using the internal fixed preset OVLO threshold (preset to 6.8 V ±3%). Connecting the OVLO pin to the GND pin without using R1 and R2 is recommended. Don't leave the OVLO pin the floating state.
- External resistors R1 and R2 are required in order to adjust the OVLO threshold. The formula to calculate the OVLO threshold is as follow. Adjustable OVLO threshold range is between 4 V and 20 V.

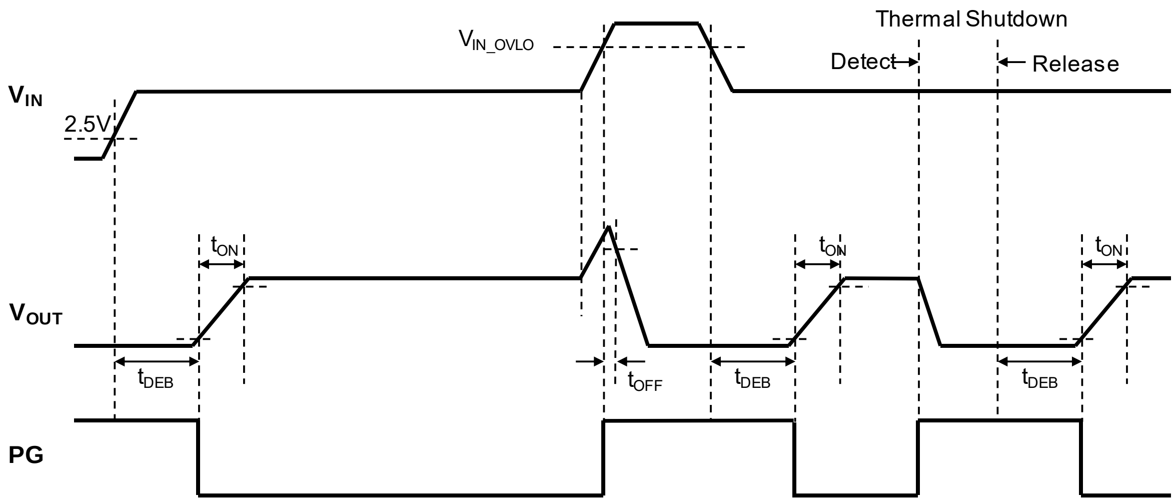
$$V_{IN\_OVLO} = V_{OVLO\_TH} \times \left(1 + \frac{R1}{R2}\right)$$

  The appropriate value for reducing current consumption is R1 = 1 MΩ.
- If the voltage at the V_{OUT} is larger than the V_{IN}, large currents may flow and can cause permanent damage to the device. The R5560Z is designed to control a current flow from V_{IN} to V_{OUT}.

TIMING CHART



Internal Fixed Preset OVLO Timing Chart

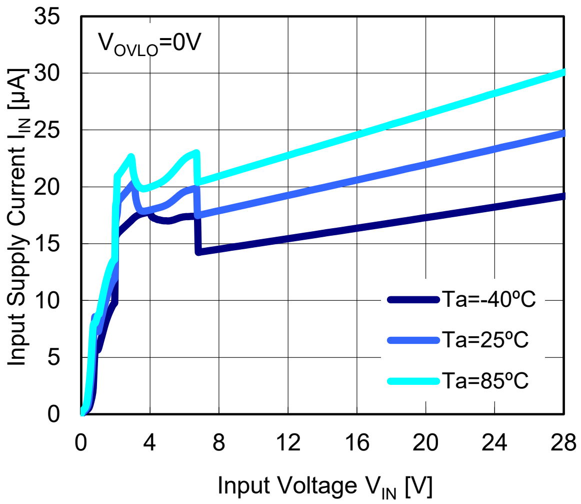


External Adjustable OVLO Timing Chart

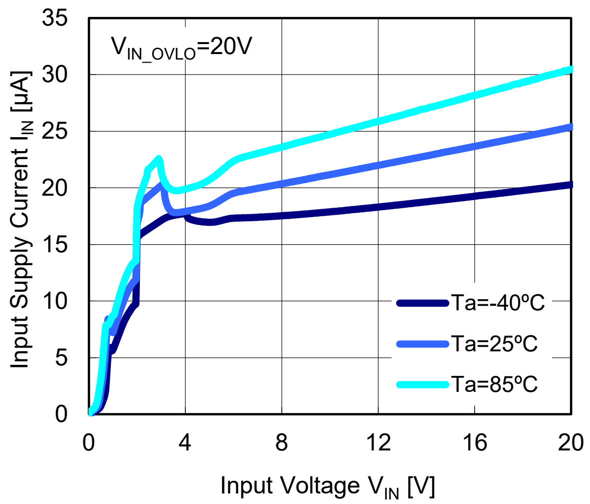
TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

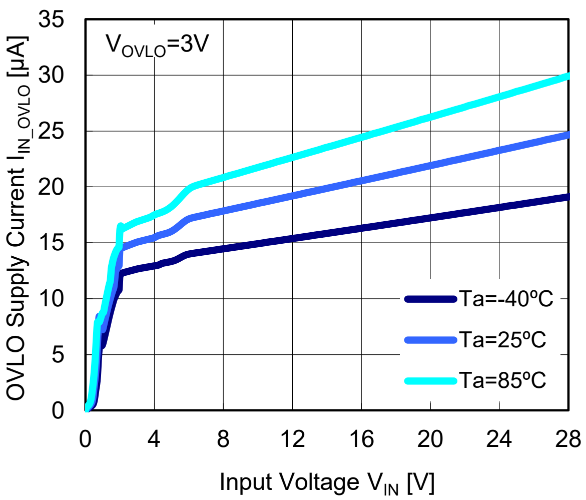
1) Input Supply Current vs. Input Voltage
(V_{IN_OVLO} = 6.8 V)



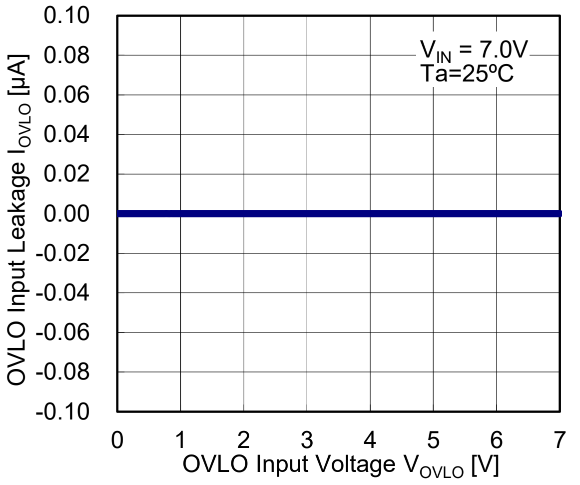
2) Input Supply Current vs. Input Voltage
(V_{IN_OVLO} = 20 V)



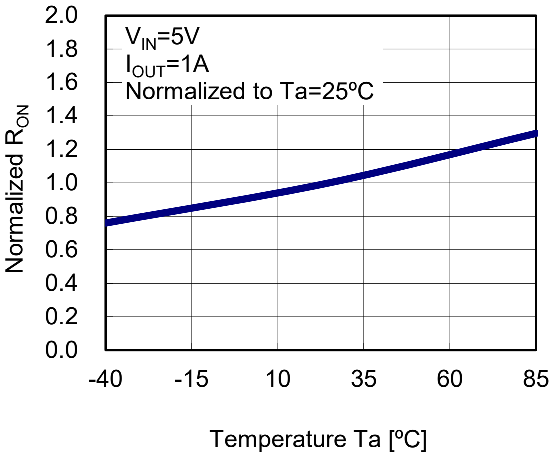
3) OVLO Supply Current vs. Input Voltage



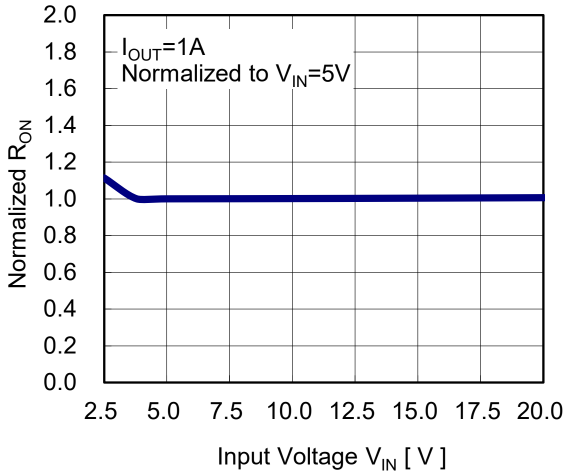
4) OVLO Input leakage vs. OVLO Input Voltage



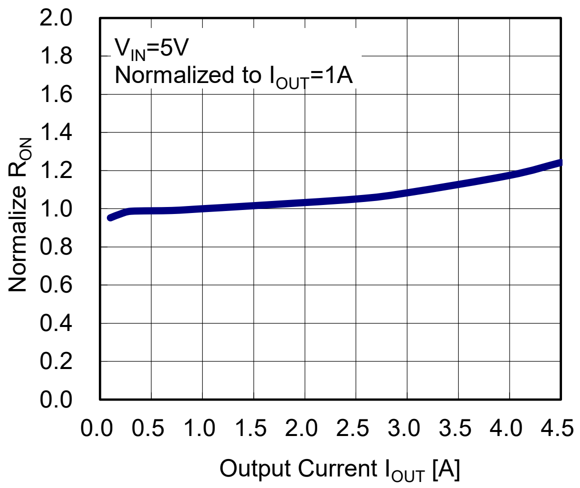
5) Normalized On Resistance vs. Temperature



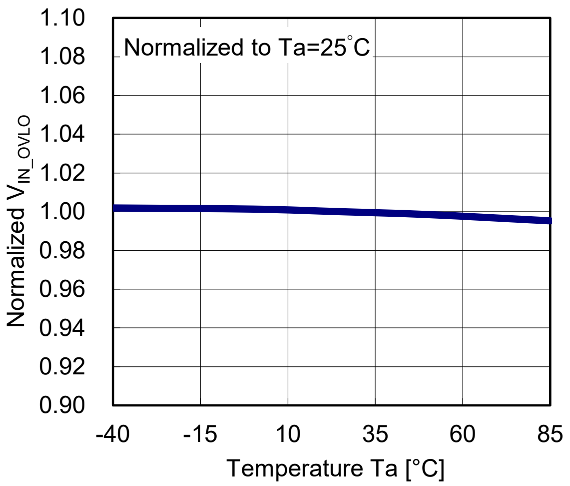
6) Normalized On Resistance vs. Input Voltage



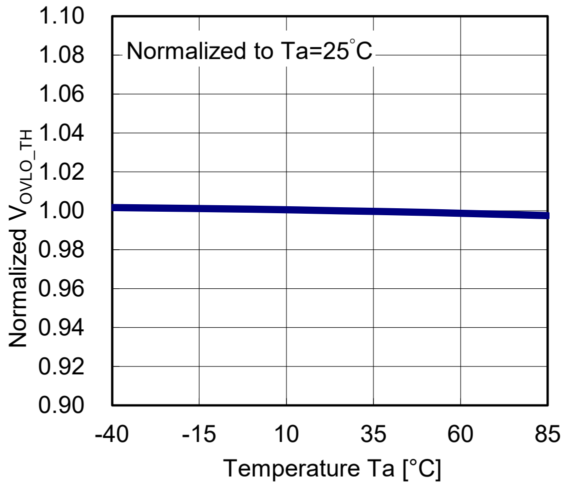
7) Normalized On Resistance vs. Output Current



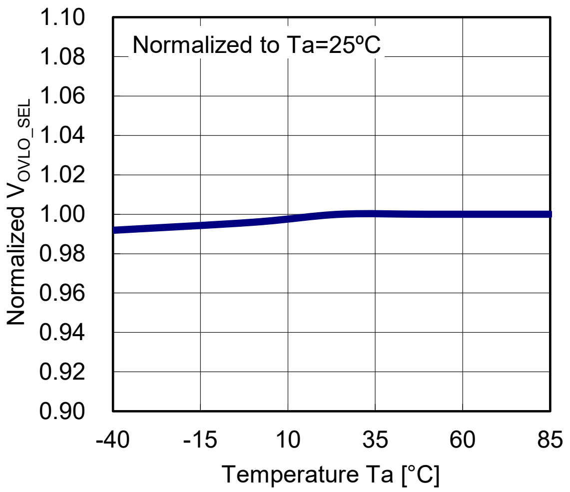
8) Normalized Internal Fixed Preset OVLO Threshold vs. Temperature



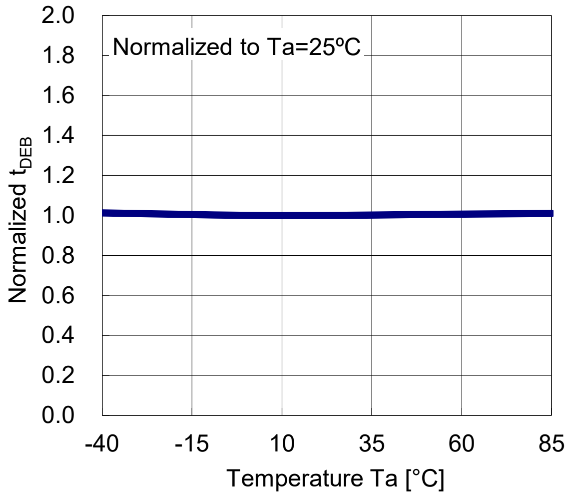
9) Normalized OVLO set Threshold vs. Temperature



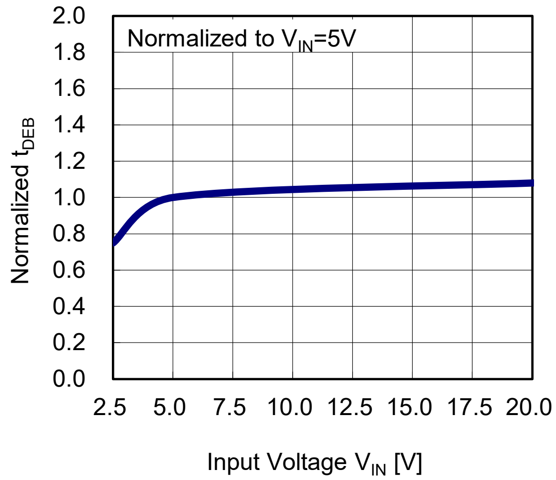
10) Normalized External OVLO Select Threshold vs. Temperature



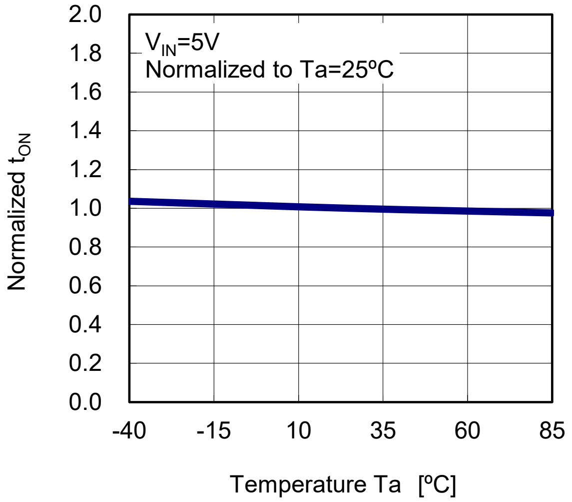
11) Normalized Debounce Time vs. Temperature



12) Normalized Debounce Time vs. Input Voltage



13) Normalized Turn On Time during Soft-Start vs. Temperature



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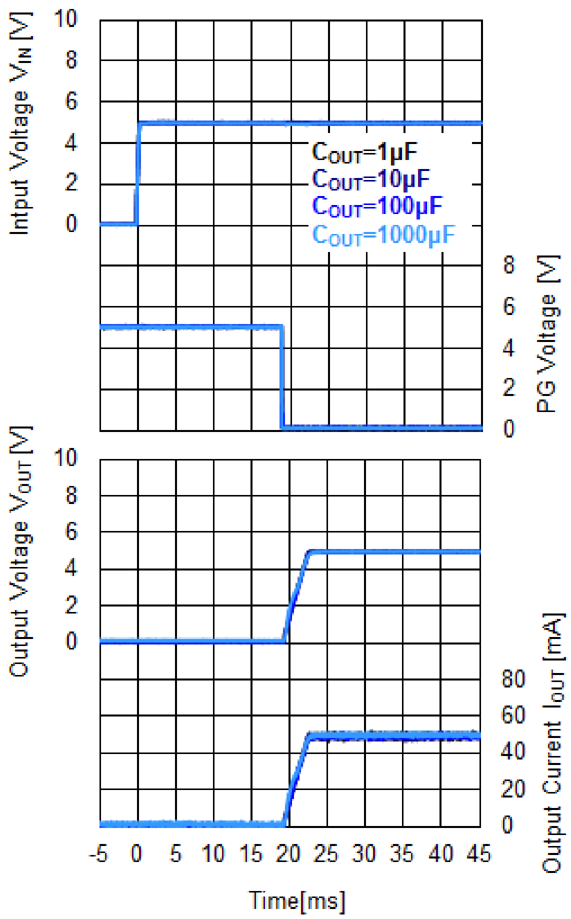
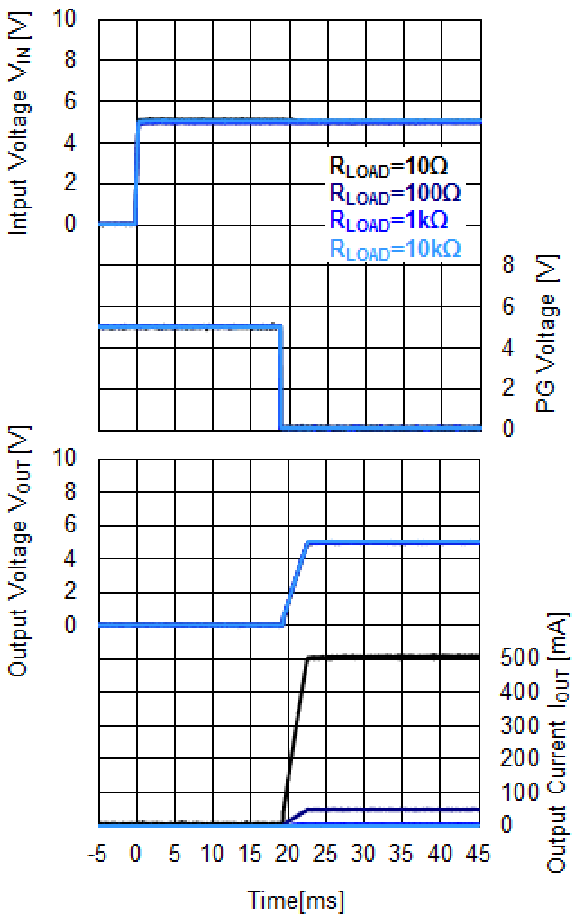
14) Power-Up Response (C_{OUT} dependence)

R_{LOAD} = 100 Ω, V_{IO} = 5.0 V, PG pull up resistance = 100 kΩ



15) Power-Up Response (R_{LOAD} dependence)

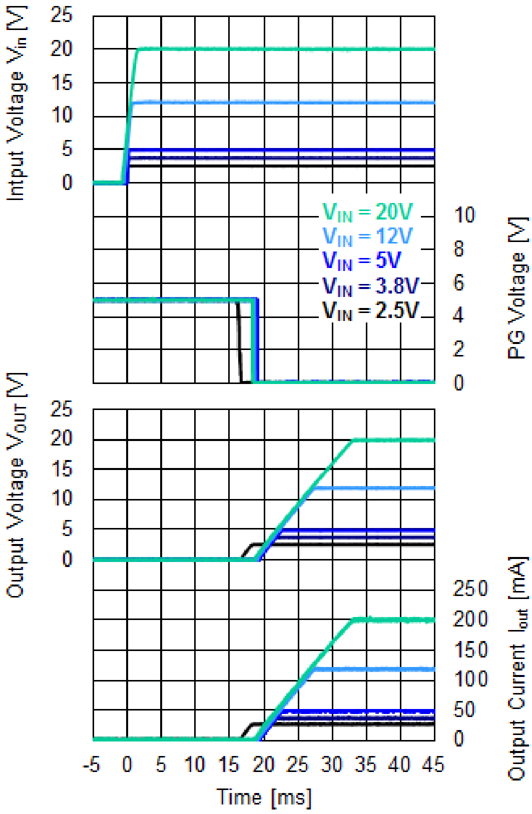
C_{OUT} = 1 μF, V_{IO} = 5.0 V, PG pull up resistance = 100 kΩ



16) Power-Up Response (V_{IN} dependence)

C_{OUT} = 1 μF, R_{LOAD} = 100 Ω, V_{IO} = 5.0 V,

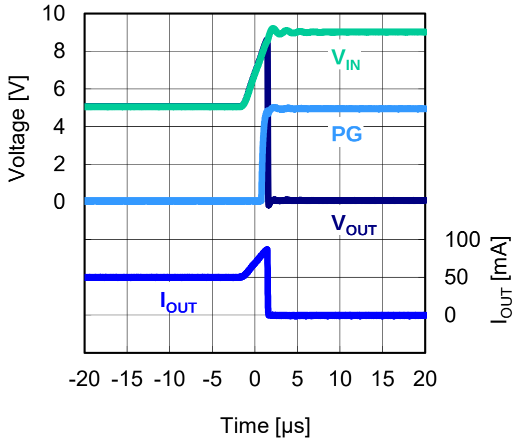
PG pull up resistance = 100 kΩ



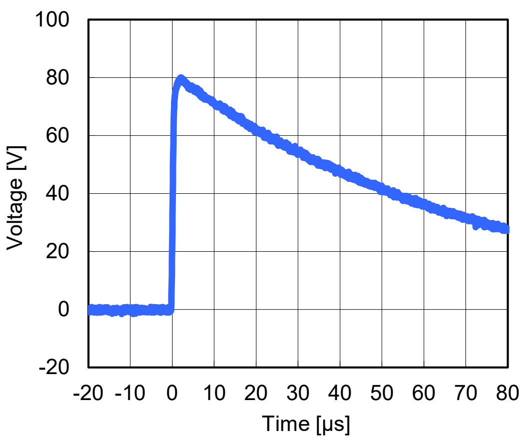
17) OVLO Response

V_{OVLO} = 0 V (V_{IN_OVLO} = 6.8 V),

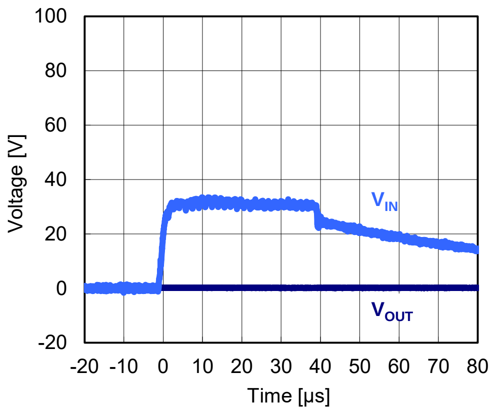
R_{LOAD} = 100 Ω, V_{IO} = 5.0 V, PG pull up resistance = 100 kΩ



18) Surge Suppression



80 V Surge Test Waveform



With 5560Z

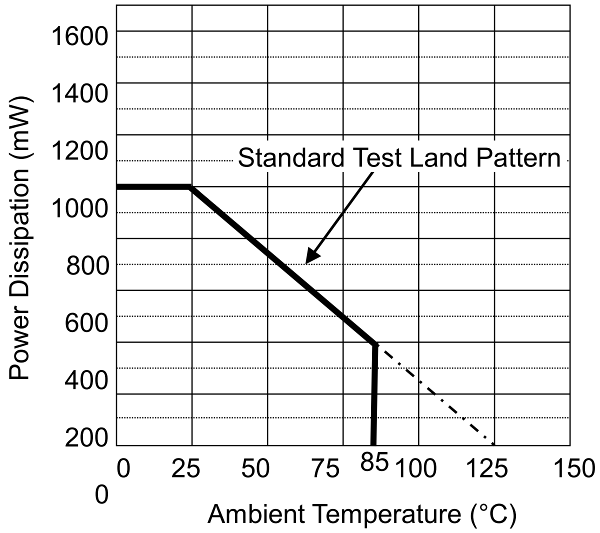
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

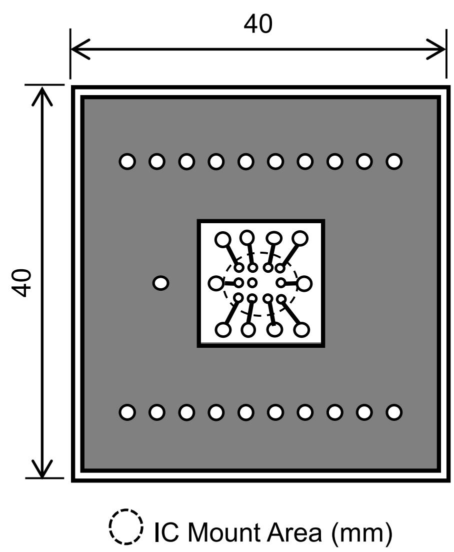
	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 80% Bottom Side: Approx. 90%
Through-holes	ϕ 0.6 mm × 31 pcs

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

	Standard Test Land Pattern
Power Dissipation	1000 mW
Thermal Resistance	θja = (125 − 25°C) / 1.0 W = 100°C/W

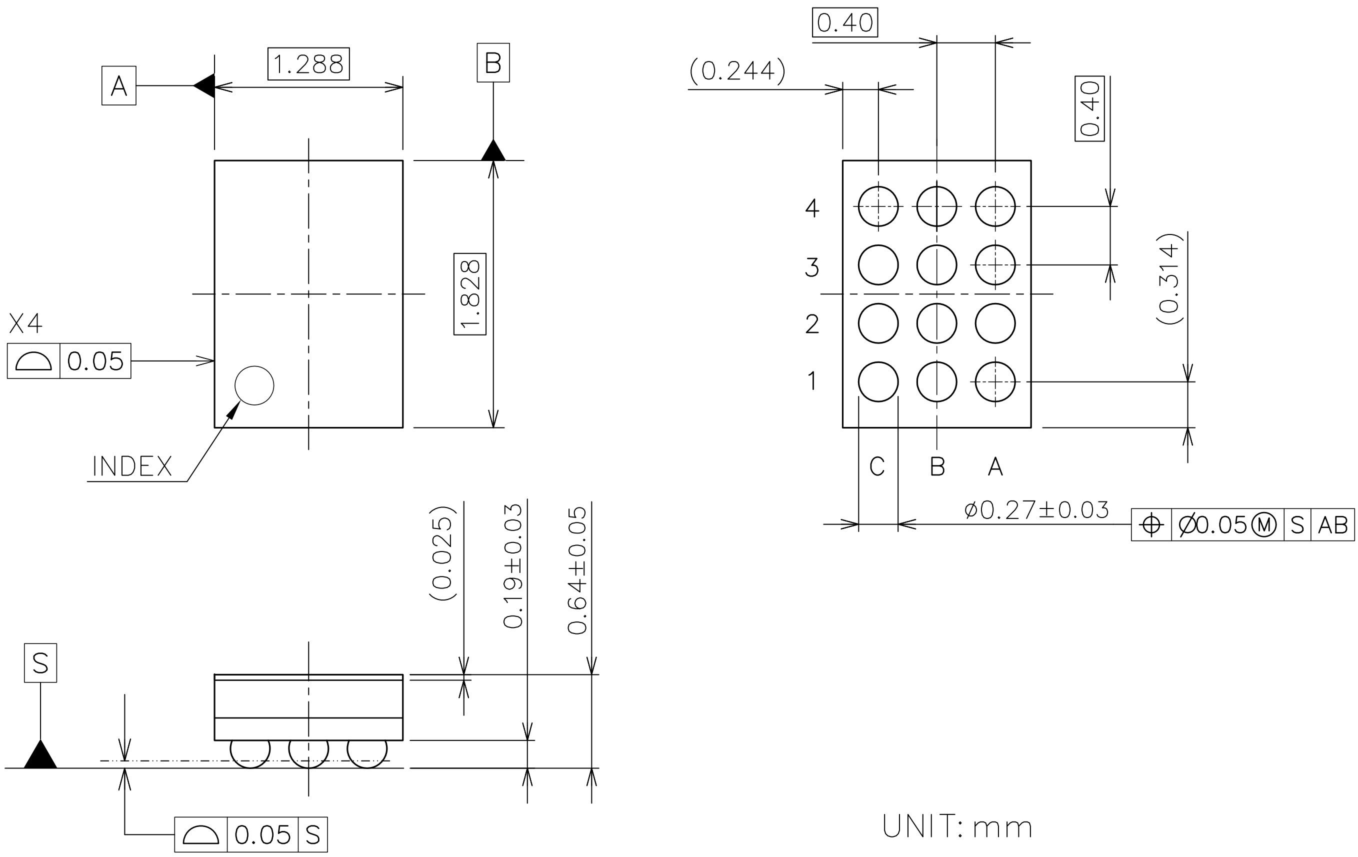


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

Ver. A



WLCSP-12-P2 Package Dimensions

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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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