RICOH

R1524x Series

AEC-Q100 Compliant

200 mA 36 V Input Ultra Low Supply Current VR for Automotive Applications

No. EC-332-190109

OUTLINE

The R1524x is an ultra-low supply current voltage regulator featuring 200 mA output current and 36 V input voltage. This device consists of an Output Short-circuit Protection Circuit, an Over-current Protection Circuit, and a Thermal Shutdown Circuit in addition to the basic regulator circuits. The operating temperature range is between −40°C to 125°C, and the maximum input voltage is 36 V. All these features allow this device to become an ideal power source for car accessories and ECUs.
The output voltages are internally fixed at either of the following: 1.8 V, 2.5 V, 2.8 V, 3.0 V, 3.3 V, 3.4 V, 5.0 V, 5.5 V, 6.0 V, 6.4 V, 7.5 V, 8.0 V, 8.5 V and 9.0 V. The output voltage accuracy is ±0.6%.
The packages for this device range from high-density mounting to ultra high wattage. The R1524x is offered in four packages; a 5-pin SOT-23-5, a 5-pin SOT-89-5, and a 6-pin HSOP-6J, and an 8-pin HSOP-8E package.

FEATURES

- Input Voltage Range (Maximum Rating) ············ 3.5 V to 36 V (50 V)
- Operating Temperature Range ························ –40°C to 125°C
- Supply Current·· Typ. 2.2 µA
- Standby Current··· Typ. 0.1 µA
- Dropout Voltage ··· Typ. 0.6 V (I_{OUT} = 200 mA, V_{OUT} = 5.0 V)
- Output Voltage Range ································· 1.8 V / 2.5 V / 2.8 V / 3.0 V / 3.3 V / 3.4V / 5.0 V / 5.5 V / 6.0 V / 6.4 V / 7.5 V / 8.0 V / 8.5 V / 9.0 V
  *Contact Ricoh sales representatives for other voltages.
- Output Voltage Accuracy······························· ±0.6% (Ta = 25°C)
- Output Voltage Temperature-Drift Coefficient ······· Typ. ±60 ppm/°C
- Line Regulation·· Typ. 0.01%/V (V_{SET} + 1 V ≤ V_{IN} ≤ 36 V)
- Built-in Output Short-circuit Protection Circuit ······ Typ. 80 mA
- Built-in Over-current Protection Circuit ··············· Typ. 350 mA
- Built-in Thermal Shutdown Circuit ····················· Thermal Shutdown Temperature: Typ. 160°C
- Ceramic capacitors are recommended
  to be used with this device ···························· C_{OUT} = 0.1 µF or more
- Packages ··· SOT-23-5, SOT-89-5, HSOP-6J, HSOP-8E

APPLICATIONS

- Power source for accessories such as car audios, car navigation systems, and ETC systems
- Power source for ECUs such as EV inverter and battery charge control unit

SELECTION GUIDE

The set output voltage, the package type, and the quality class are user-selectable.

Selection Guide

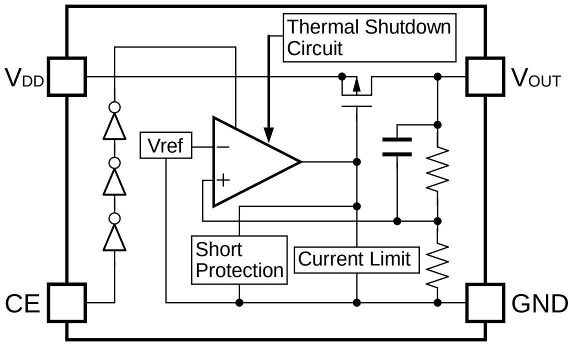
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1524NxxxB-TR-#E	SOT-23-5	3,000 pcs	Yes	Yes
R1524HxxxB-T1-#E	SOT-89-5	1,000 pcs	Yes	Yes
R1524SxxxB-E2-#E	HSOP-6J	1,000 pcs	Yes	Yes
R1524SxxxH-E2-#E	HSOP-8E	1,000 pcs	Yes	Yes

xxx: Specify the set output voltage (V_{SET})
1.8 V (018) / 2.5 V (025) / 2.8 V (028) / 3.0 V (030) / 3.3 V (033) / 3.4 V (034) / 5.0 V (050) / 5.5 V (055) / 6.0 V (060) / 6.4 V (064) / 7.5 V (075) / 8.0 V (080) / 8.5 V (085) / 9.0 V (090)
*Contact Ricoh sales representatives for other voltages.

: Quality Class

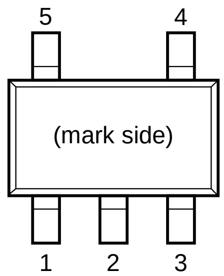
#	Operating Temperature Range	Test Temperature
A	−40°C to 125°C	25°C, High
K	−40°C to 125°C	Low, 25°C, High

BLOCK DIAGRAM

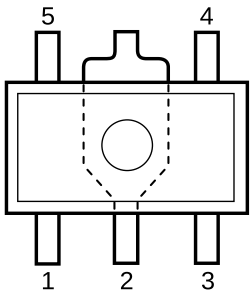


R1524x Block Diagram

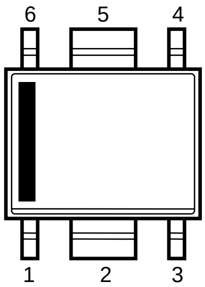
PIN DESCRIPTIONS



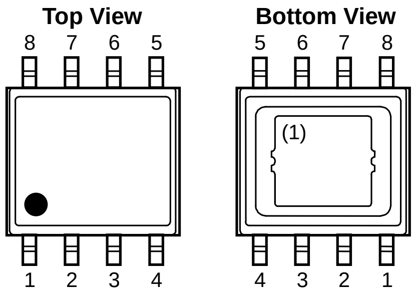
SOT-23-5 Pin Configuration



SOT-89-5 Pin Configuration



HSOP-6J Pin Configuration



HSOP-8E Pin Configuration

SOT-23-5 Pin Descriptions

Pin No.	Symbol	Description
1	GND(2)	Ground Pin
2	GND(2)	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	V_{OUT}	Output Pin
5	V_{DD}	Input Pin

SOT-89-5 Pin Descriptions

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND(2)	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	GND(2)	Ground Pin
5	V_{DD}	Input Pin

(1) The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left open.
(2) The GND pin must be wired together when it is mounted on board.

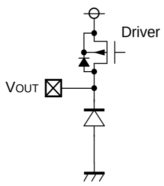
HSOP-6J Pin Descriptions

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND[1]	Ground Pin
3	CE	Chip Enable Pin (Active-high)
4	GND[1]	Ground Pin
5	GND[1]	Ground Pin
6	V_{DD}	Input Pin

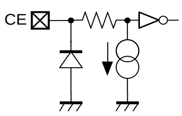
HSOP-8E Pin Descriptions

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	NC	No Connection
3	NC	No Connection
4	CE	Chip Enable Pin (Active-high)
5	GND	Ground Pin
6	NC	No Connection
7	NC	No Connection
8	V_{DD}	Input Pin

PIN EQUIVALENT CIRCUIT DIAGRAMS



V_{OUT} Pin



CE Pin

[1] The GND pin must be wired together when it is mounted on board.

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Item		Rating	Unit
V_{IN}	Input Voltage		−0.3 to 50	V
V_{IN}	Peak Input Voltage(1)		60	V
V_{CE}	Input Voltage (CE Pin)		−0.3 to 50	V
V_{OUT}	Output Voltage		−0.3 to V_{IN} + 0.3 ≤ 50	V
I_{OUT}	Output Current		300	mA
P_D	Power Dissipation(2) (JEDEC STD.51-7 Test Land Pattern)	SOT-23-5	830	mW
		SOT-89-5	3200	
		HSOP-6J	3400	
		HSOP-8E	3600	
Tj	Junction Temperature Range		−40 to 150	°C
Tstg	Storage Temperature Range		−55 to 150	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime 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.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	3.5 to 36	V
Ta	Operating Temperature Range	−40 to 125	°C

RECOMMENDED OPERATING CONDITIONS

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) Duration time: 200 ms
(2) Refer to *POWER DISSIPATION* for detailed information.

ELECTRICAL CHARACTERISTICS

$C_{IN} = C_{OUT} = 0.1$ μF, unless otherwise noted.

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 125°C.

R1524x (-AE) Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN} = 14 V I_{OUT} = 0 mA	V_{SET} ≤ 5.0 V		2.2	6.5	μA
			5.0 V < V_{SET}		2.5	6.8	
Istandby	Standby Current	V_{IN} = 36 V, V_{CE} = 0 V			0.1	1.0	μA
V_{OUT}	Output Voltage	V_{SET} + 1 V(1) ≤ V_{IN} ≤ 36 V, I_{OUT} = 1 mA	Ta = 25°C	×0.994		×1.006	V
			−40°C ≤ Ta ≤ 125°C	×0.984		×1.016	
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	V_{IN} = V_{SET} + 3.0 V 1 mA ≤ I_{OUT} ≤ 200 mA		Refer to the *Product-specific Electrical Characteristics*			
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET} + 1 V(1) ≤ V_{IN} ≤ 36 V, I_{OUT} = 1 mA	V_{SET} < 3.3 V	-20	5	20	mV
			3.3 V ≤ V_{SET}	-0.02	0.01	0.02	%/V
V_{DIF}	Dropout Voltage	I_{OUT} = 200 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{LIM}	Output Current Limit	V_{IN} = V_{SET} + 3.0 V		220	350	420	mA
I_{SC}	Short Current Limit	V_{IN} = 3.5 V, V_{OUT} = 0 V		60	80	110	mA
V_{CEH}	CE Pin Input Voltage, high	V_{IN} = V_{SET} + 1 V(1)		2.0		36	V
V_{CEL}	CE Pin Input Voltage, low	V_{IN} = 36 V		0		1.0	V
I_{PD}	CE Pull-down Current	V_{IN} = 36 V, V_{CE} = 2 V			0.2	0.6	μA
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			160		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			135		°C

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 25°C).

(1) V_{SET} ≤ 2.5 V, V_{IN} = 3.5 V

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 125°C.

R1524x (-AE) Product-specific Electrical Characteristics (Ta = 25°C)

Product Name	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 125°C)			$\Delta V_{OUT}/\Delta I_{OUT}$ (mV)			V_{DIF} (V)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
R1524x018x	1.7892	1.80	1.8108	1.7712	1.80	1.8288	-10	10	40	1.6	2.5
R1524x025x	2.4850	2.50	2.5150	2.4600	2.50	2.5400				1.2	2.2
R1524x028x	2.7832	2.80	2.8168	2.7552	2.80	2.8448					
R1524x030x	2.9820	3.00	3.0180	2.9520	3.00	3.0480					
R1524x033x	3.2802	3.30	3.3198	3.2472	3.30	3.3528				0.8	2.0
R1524x034x	3.3796	3.40	3.4204	3.3456	3.40	3.4544					
R1524x050x	4.9700	5.00	5.0300	4.9200	5.00	5.0800				0.6	1.2
R1524x055x	5.4670	5.50	5.5330	5.4120	5.50	5.5880	-18	18	72		
R1524x060x	5.9640	6.00	6.0360	5.9040	6.00	6.0960					
R1524x064x	6.3616	6.40	6.4384	6.2976	6.40	6.5024					
R1524x075x	7.4550	7.50	7.5450	7.3800	7.50	7.6200					
R1524x080x	7.9520	8.00	8.0480	7.8720	8.00	8.1280				0.5	1.3
R1524x085x	8.4490	8.50	8.5510	8.3640	8.50	8.6360					
R1524x090x	8.9460	9.00	9.0540	8.8560	9.00	9.1440					

C_{IN} = C_{OUT} = 0.1 μF, unless otherwise noted.

R1524x (-KE) Electrical Characteristics (−40°C ≤ Ta ≤ 125°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN} = 14 V I_{OUT} = 0 mA	V_{SET} ≤ 5.0 V		2.2	6.5	μA
			5.0 V < V_{SET}		2.5	6.8	
Istandby	Standby Current	V_{IN} = 36 V, V_{CE} = 0 V			0.1	1.0	μA
V_{OUT}	Output Voltage	V_{SET} + 1 V(1) ≤ V_{IN} ≤ 36 V, I_{OUT} = 1 mA	Ta = 25°C	×0.994		×1.006	V
			−40°C ≤ Ta ≤ 125°C	×0.984		×1.016	
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN} = V_{SET} + 3.0 V 1 mA ≤ I_{OUT} ≤ 200 mA		Refer to the *Product-specific Electrical Characteristics*			
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{SET} + 1 V(1) ≤ V_{IN} ≤ 36 V, I_{OUT} = 1 mA	V_{SET} < 3.3 V	-20	5	20	mV
			3.3 V ≤ V_{SET}	-0.02	0.01	0.02	%/V
V_{DIF}	Dropout Voltage	I_{OUT} = 200 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{LIM}	Output Current Limit	V_{IN} = V_{SET} + 3.0 V		220	350	420	mA
I_{SC}	Short Current Limit	V_{IN} = 3.5 V, V_{OUT} = 0 V		60	80	110	mA
V_{CEH}	CE Pin Input Voltage, high	V_{IN} = V_{SET} + 1 V(1)		2.0		36	V
V_{CEL}	CE Pin Input Voltage, low	V_{IN} = 36 V		0		1.0	V
I_{PD}	CE Pull-down Current	V_{IN} = 36 V, V_{CE} = 2 V			0.2	0.6	μA
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature		150	160		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		125	135		°C

(1) V_{SET} ≤ 2.5 V, V_{IN} = 3.5 V

R1524x (-KE) Product-specific Electrical Characteristics (−40°C ≤ Ta ≤ 125°C)

Product Name	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 125°C)			$\Delta V_{OUT}/\Delta I_{OUT}$ (mV)			V_{DIF} (V)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
R1524x018x	1.7892	1.80	1.8108	1.7712	1.80	1.8288	-10	10	40	1.6	2.5
R1524x025x	2.4850	2.50	2.5150	2.4600	2.50	2.5400				1.2	2.2
R1524x028x	2.7832	2.80	2.8168	2.7552	2.80	2.8448					
R1524x030x	2.9820	3.00	3.0180	2.9520	3.00	3.0480					
R1524x033x	3.2802	3.30	3.3198	3.2472	3.30	3.3528				0.8	2.0
R1524x034x	3.3796	3.40	3.4204	3.3456	3.40	3.4544					
R1524x050x	4.9700	5.00	5.0300	4.9200	5.00	5.0800				0.6	1.2
R1524x055x	5.4670	5.50	5.5330	5.4120	5.50	5.5880	-18	18	72		
R1524x060x	5.9640	6.00	6.0360	5.9040	6.00	6.0960					
R1524x064x	6.3616	6.40	6.4384	6.2976	6.40	6.5024					
R1524x075x	7.4550	7.50	7.5450	7.3800	7.50	7.6200					
R1524x080x	7.9520	8.00	8.0480	7.8720	8.00	8.1280				0.5	1.3
R1524x085x	8.4490	8.50	8.5510	8.3640	8.50	8.6360					
R1524x090x	8.9460	9.00	9.0540	8.8560	9.00	9.1440					

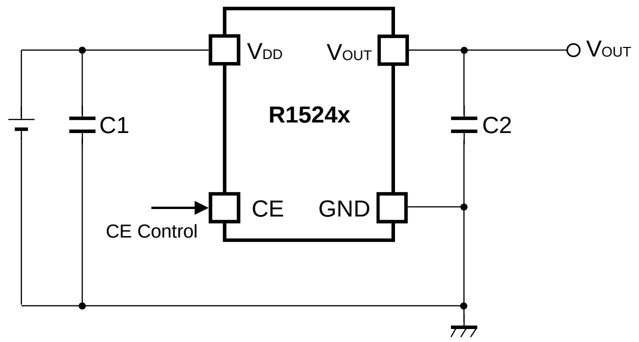
THEORY OF OPERATION

Thermal Shutdown

R1524x has a built-in thermal shutdown circuit, which stops the regulator operation if the junction temperature of this device increases to 160°C (Typ.) or higher. If the temperature drops to 135°C (Typ.) or lower, the regulator restarts the operation. Unless eliminating the overheating problem, the regulator turns on and off repeatedly and as a result, a pulse shaped output voltage is generated.

APPLICATION INFORMATION

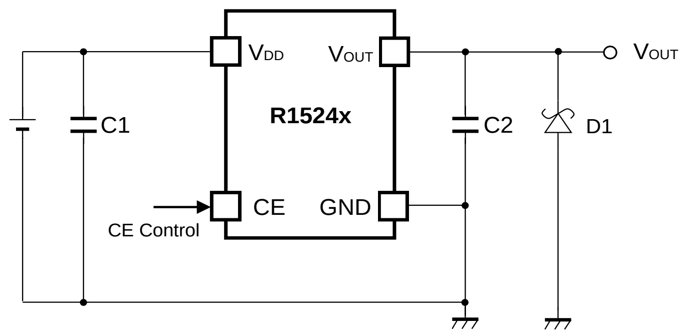
TYPICAL APPLICATIONS



C1 = Ceramic 0.1 µF
C2 = Ceramic 0.1 µF

R1524x Typical Applications

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



C1 = Ceramic 0.1 µF
C2 = Ceramic 0.1 µF

R1524x Typical Application for IC Chip Breakdown Prevention

When a sudden surge of electrical current travels along the V_{OUT} pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor (C2) and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode (D1) between the V_{OUT} pin and GND has the effect of preventing damage to them.

TECHNICAL NOTES

Phase Compensation

In the R1524x, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, make sure to use 0.1 μF or more of a capacitor (C2).

In case of using a tantalum type capacitor and the ESR (Equivalent Series Resistance) value of the capacitor is large, the output might be unstable. Evaluate the circuit including consideration of frequency characteristics.

Connect 0.1 μF or more of a capacitor (C1) between V_{DD} and GND, and as close as possible to the pins.

PCB Layout

For SOT-23-5 package type, wire the following GND pins together: No. 1 and No. 2

For SOT-89-5 package type, wire the following GND pins together: No. 2 and No. 4.

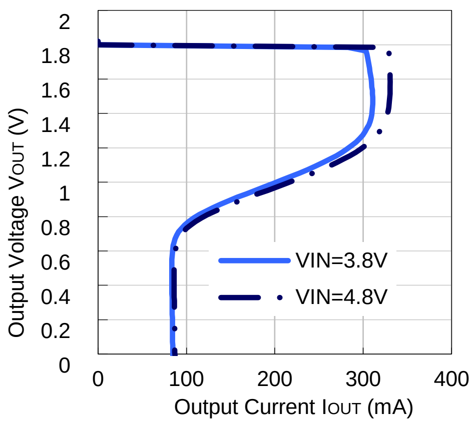
For HSOP-6J package type, wire the following GND pins together: No. 2, No. 4, and No. 5.

TYPICAL CHARACTERISTICS

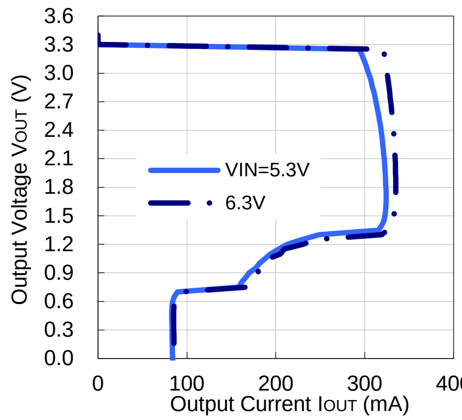
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs. Output Current (Ta = 25°C)

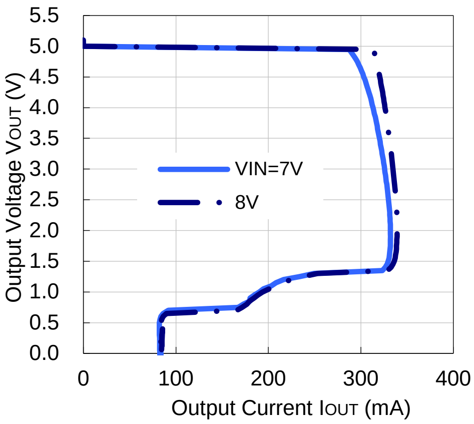
R1524x018B



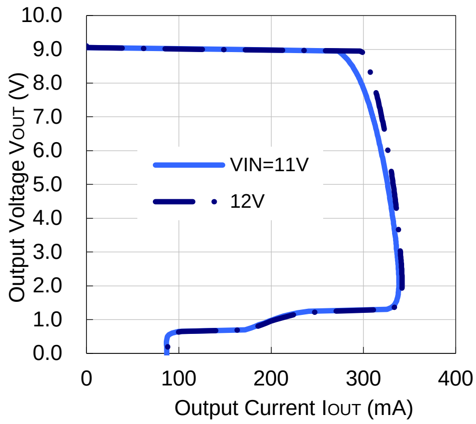
R1524x033B



R1524x050B

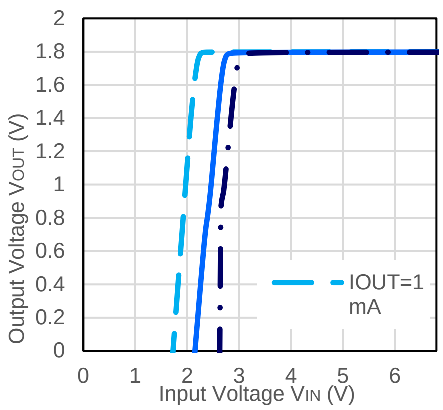


R1524x090B



2) Output Voltage vs. Input Voltage (Ta = 25°C)

R1524x018B



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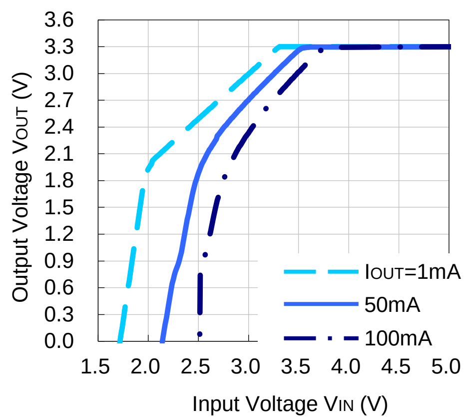

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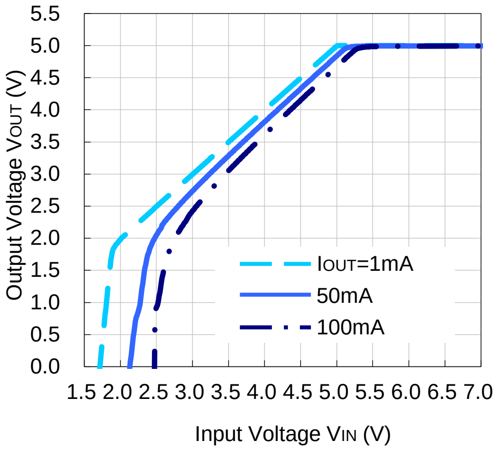
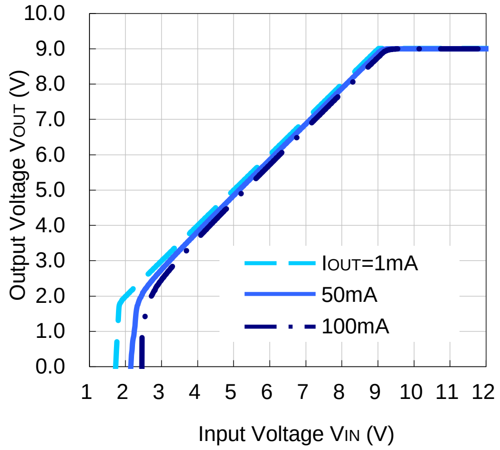
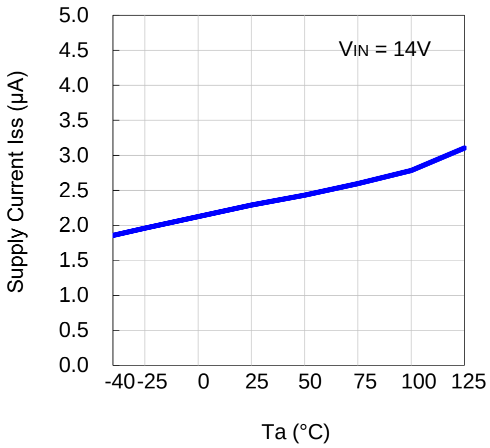


R1524x090B



3) Supply Current vs. Temperature

R1524x018B



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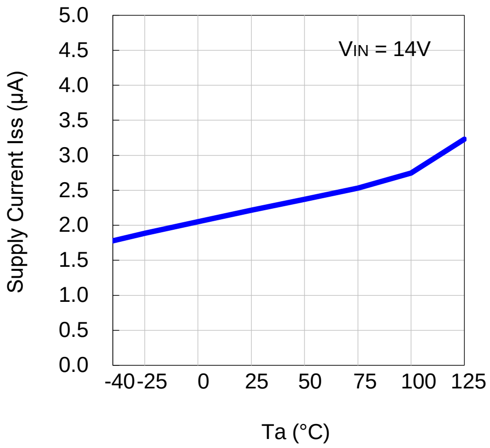

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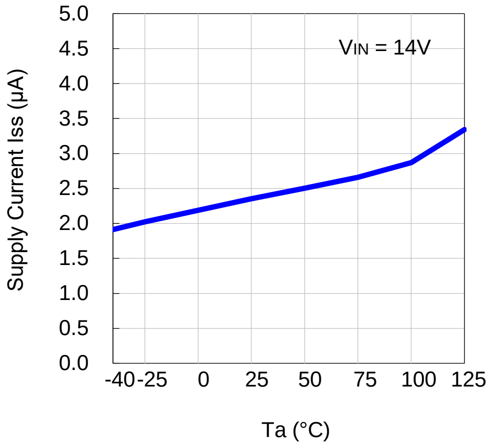
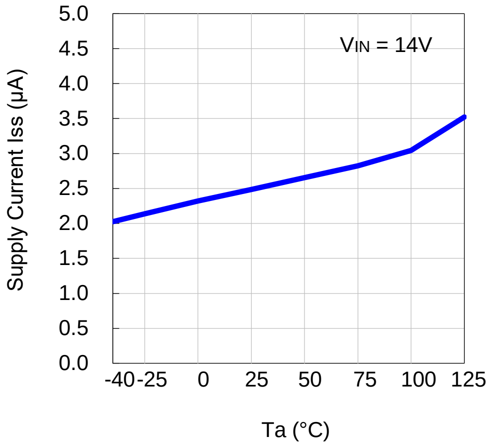
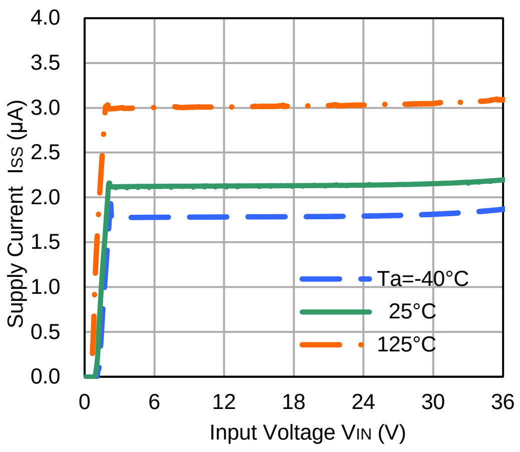


R1524x090B

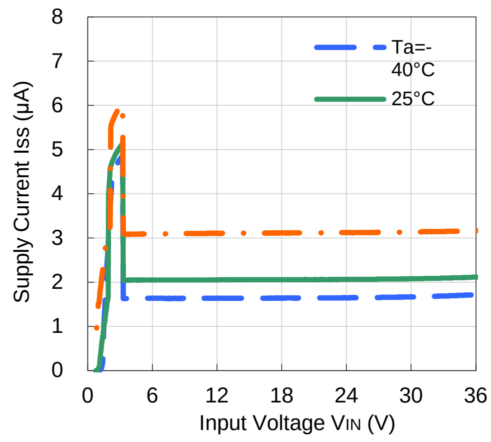


4) Supply Current vs. Input Voltage

R1524x018B

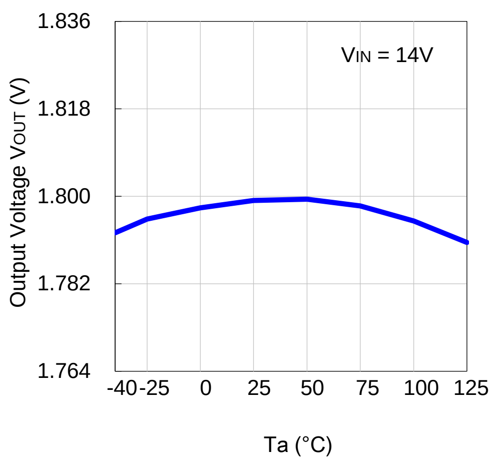


R1524x033B



5) Output Voltage vs. Temperature (I_{OUT} = 1mA)

R1524x018B



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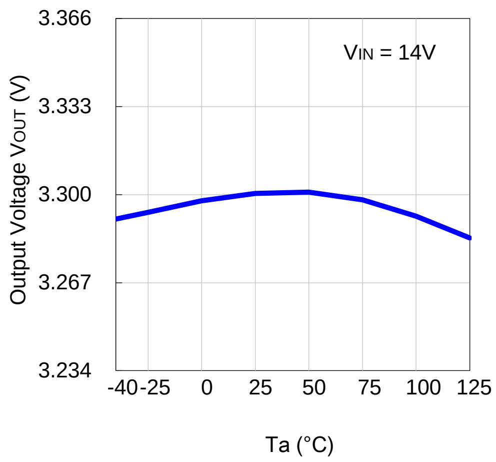
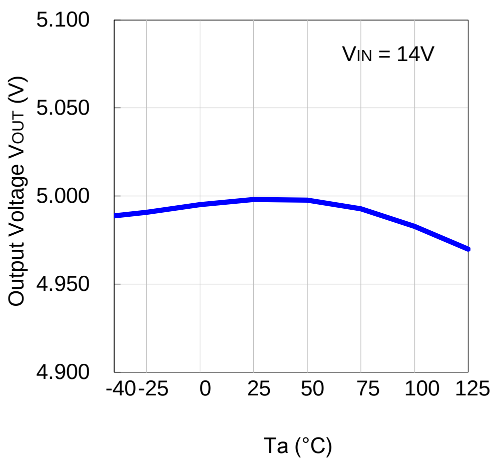


R1524x050B



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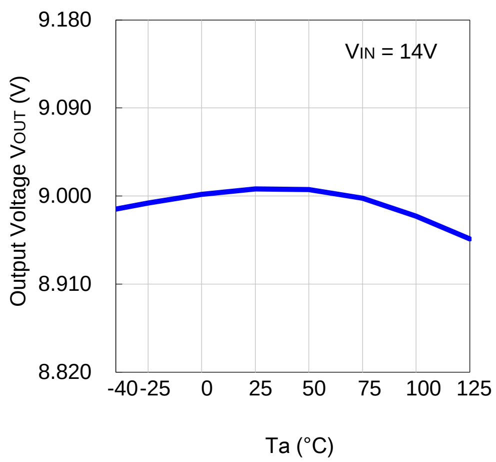
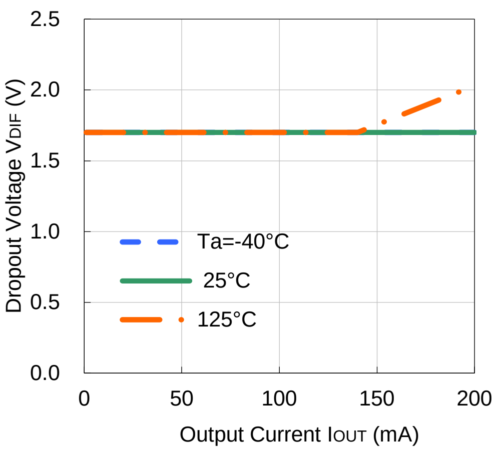


6) Dropout Voltage vs. Output Current

R1524x018B



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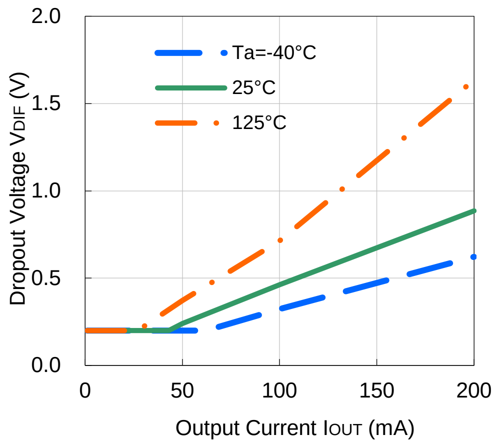

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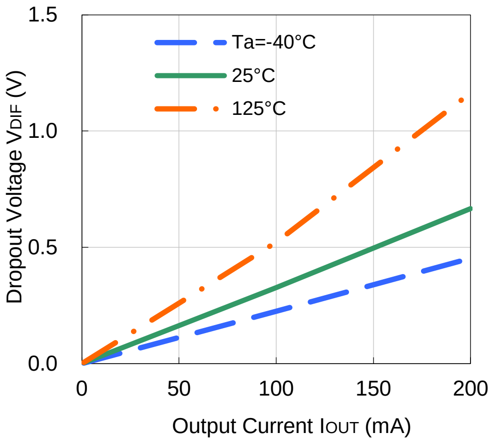

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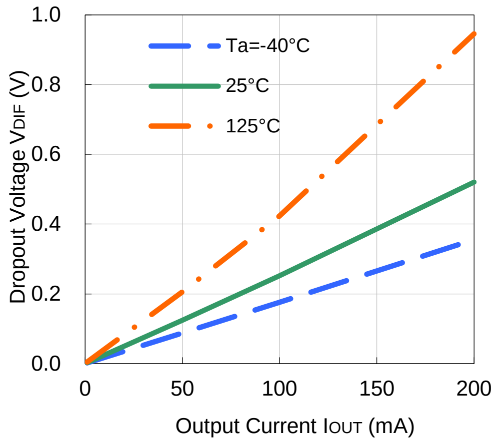
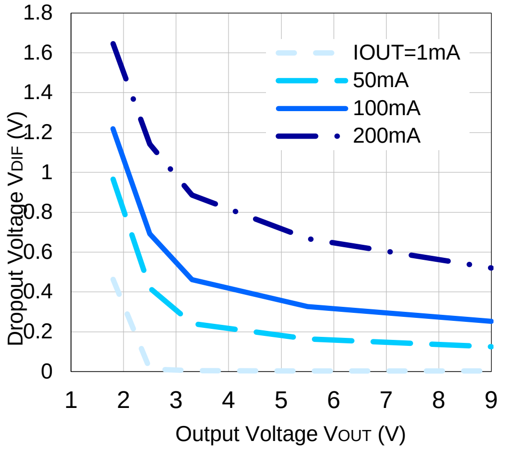
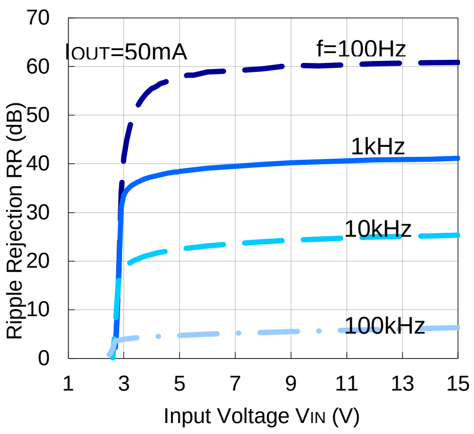


7) Dropout Voltage vs. Output Voltage (Ta = 25°C)



8) Ripple Rejection vs. Input Voltage (Ta = 25°C, Ripple = 0.2 Vpp)

R1524x018B



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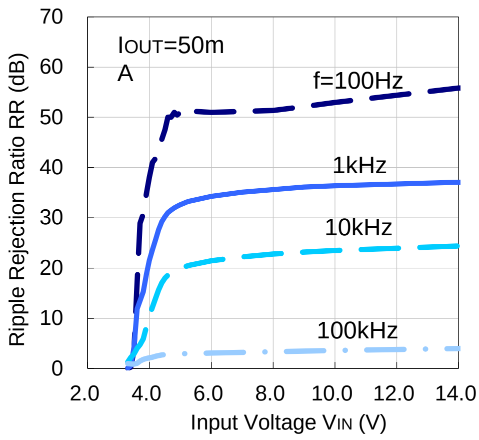

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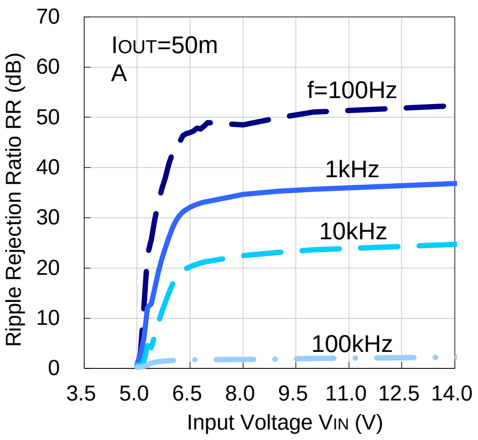
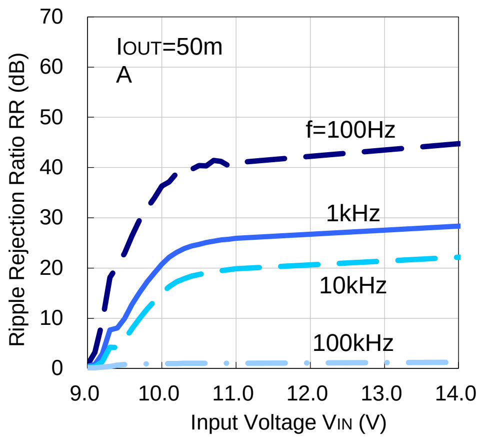
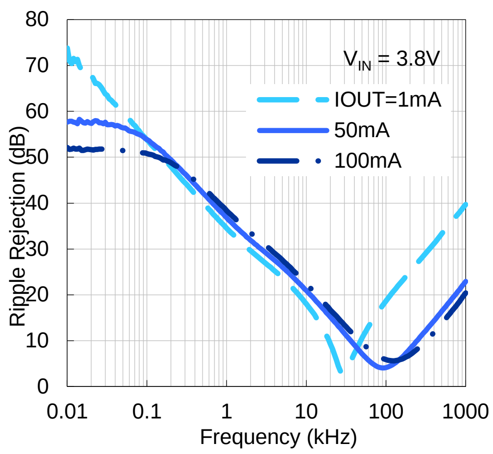


R1524x090B



9) Ripple Rejection vs. Frequency (Ta = 25°C, Ripple = 0.2 Vpp)

R1524x018B



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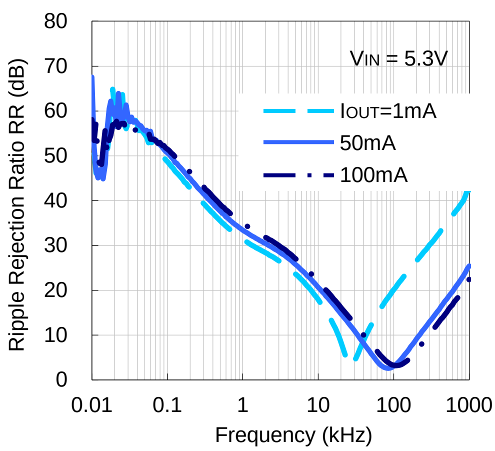

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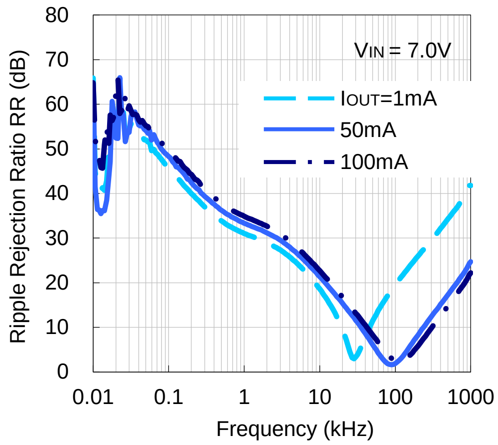

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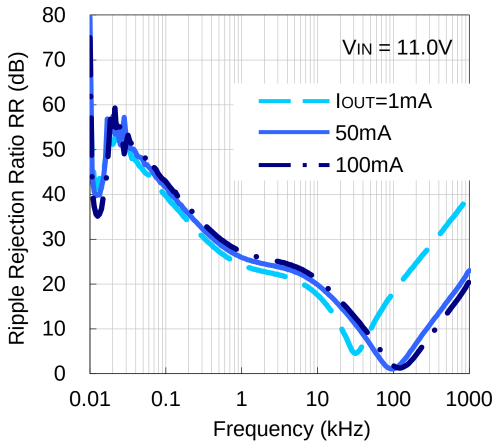
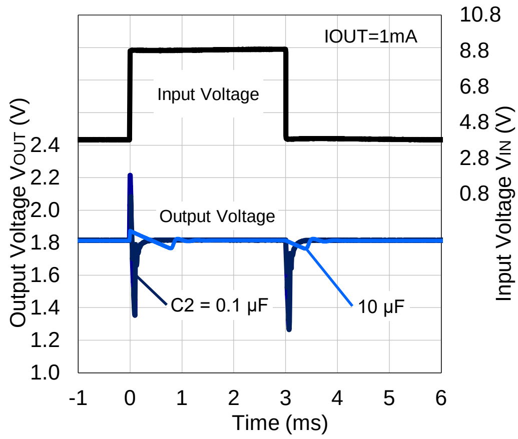


10) Input Transient Response (Ta = 25°C)

R1524x018B



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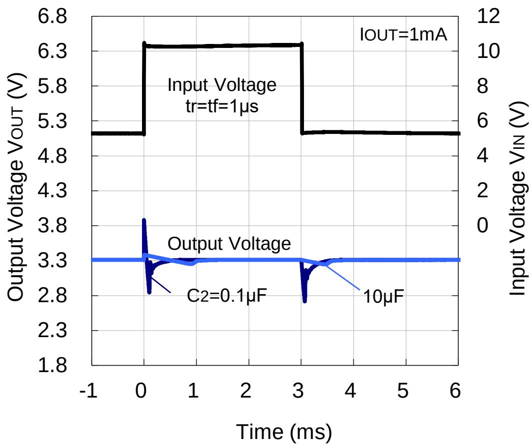

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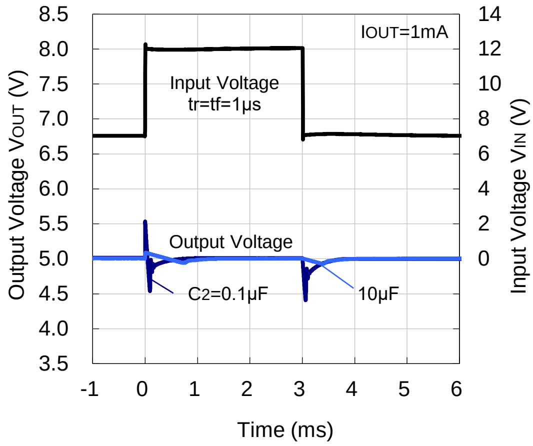
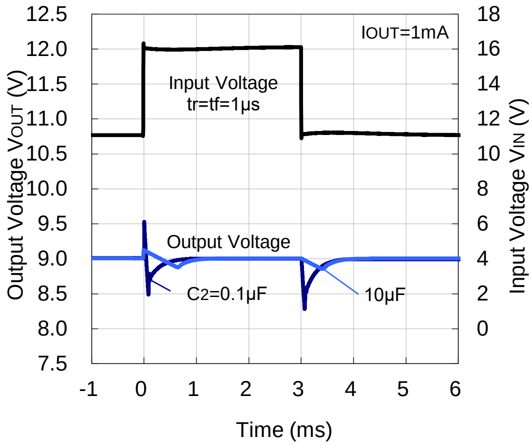
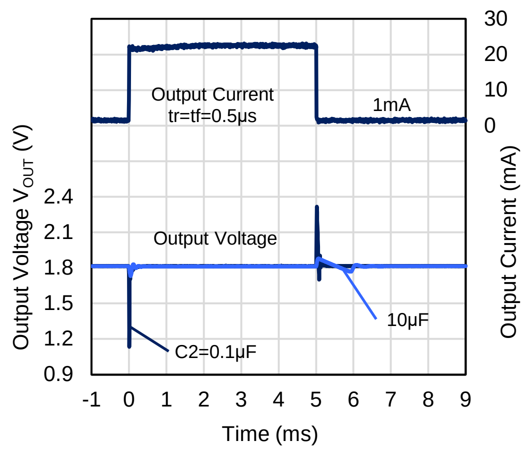


R1524x090B



11) Load Transient Response (Ta = 25°C)

R1524x018B



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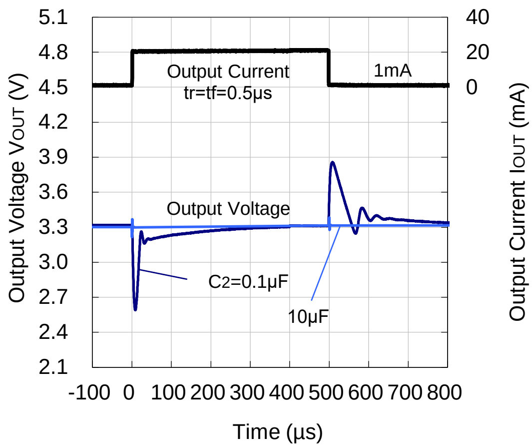

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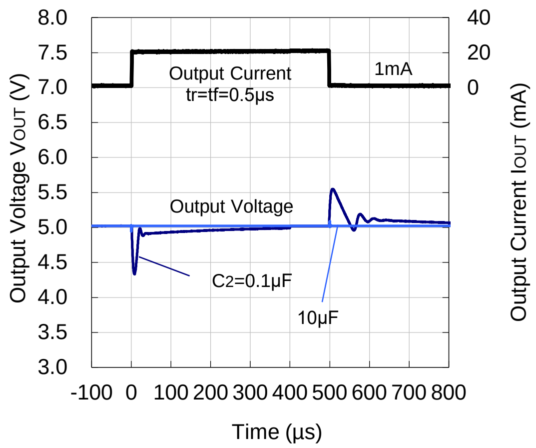

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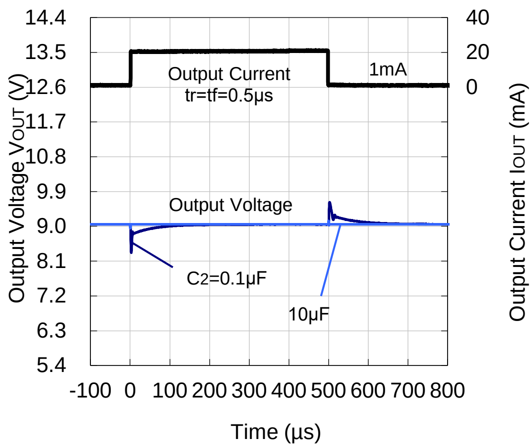
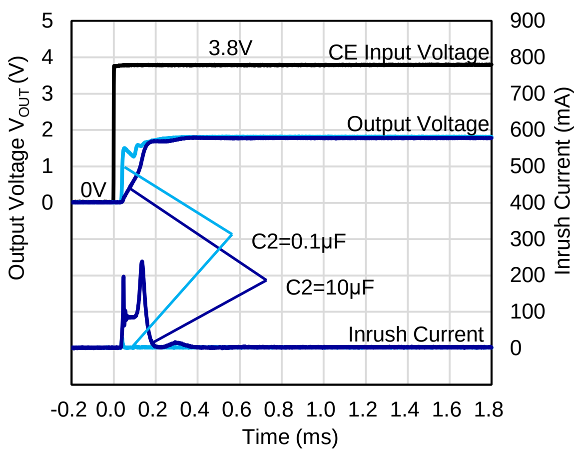
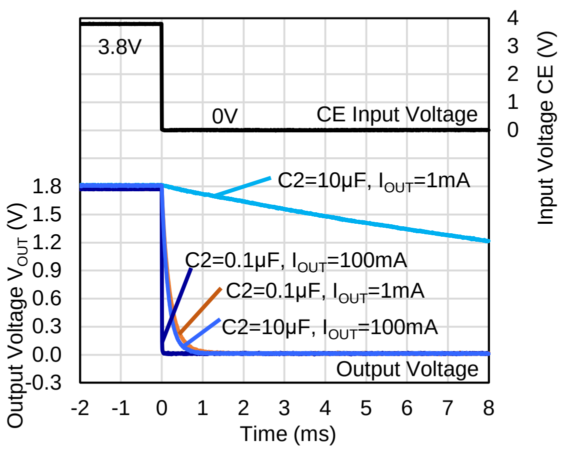


12) CE Transient Response (Ta = 25°C)

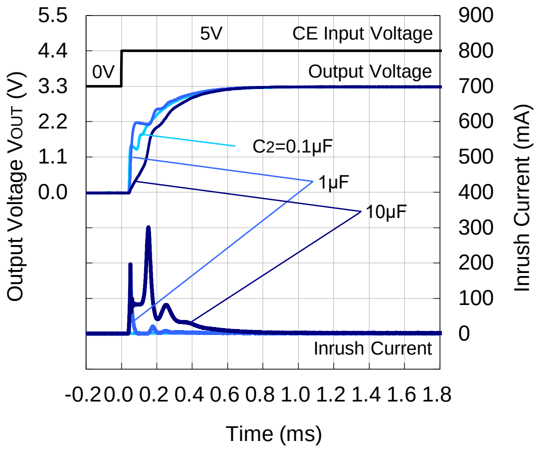
R1524x018B

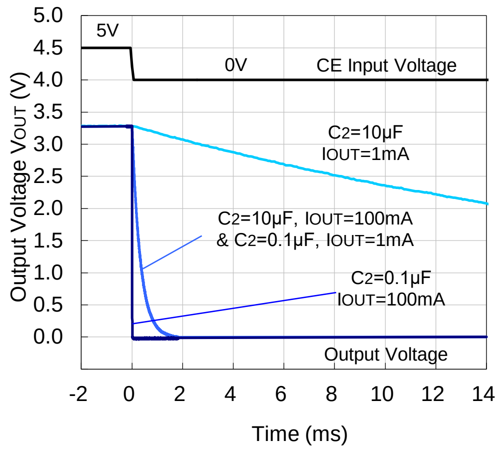




RICOH

R1524x033B





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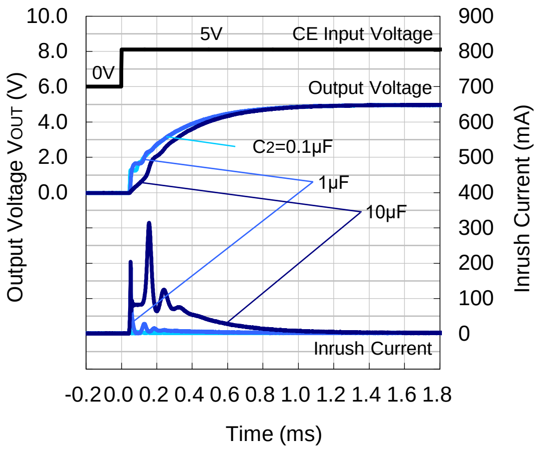

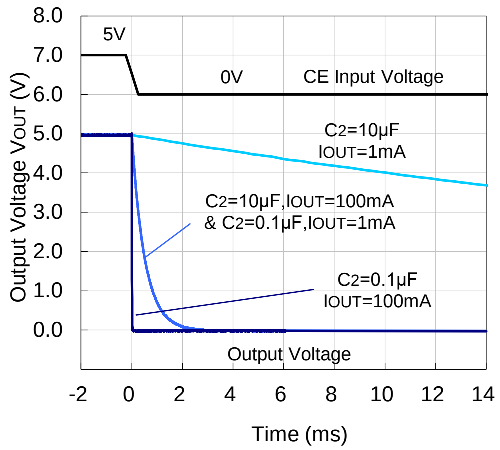

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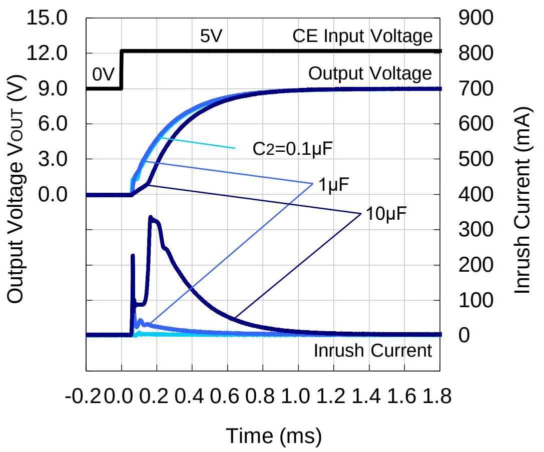
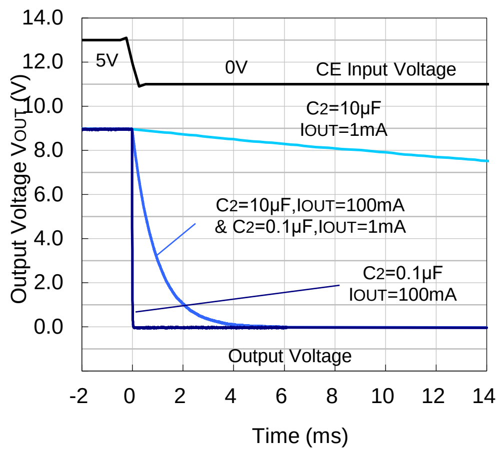
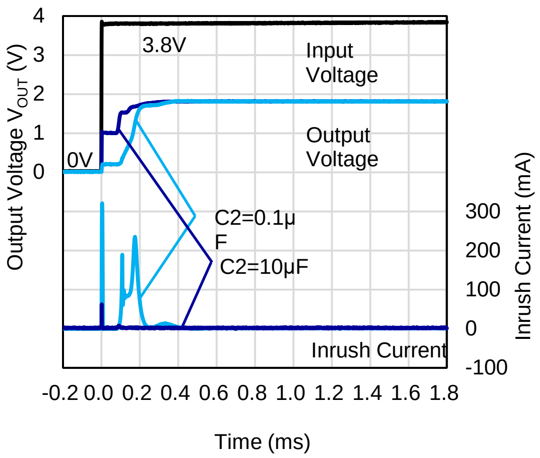




RICOH

13) Power-on Transient Response (Ta = 25°C, V_{CE} = 5 V)

R1524x018B



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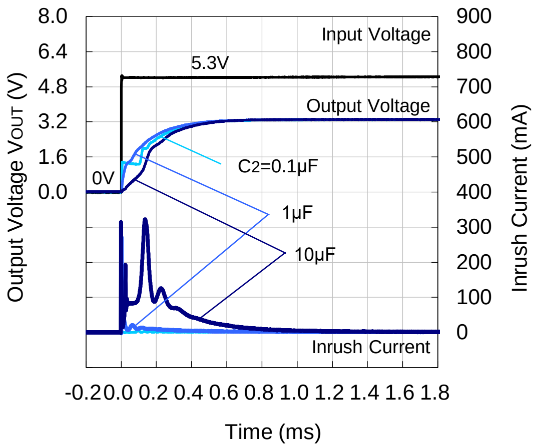

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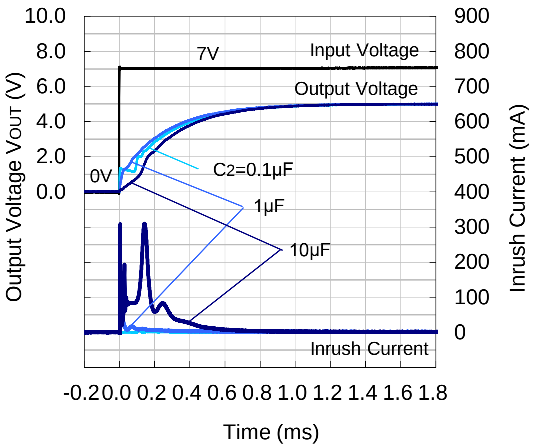

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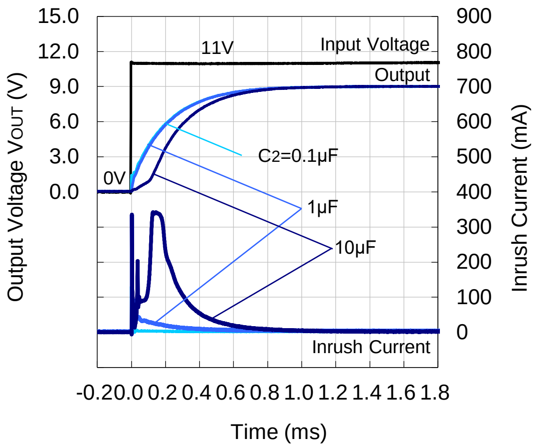
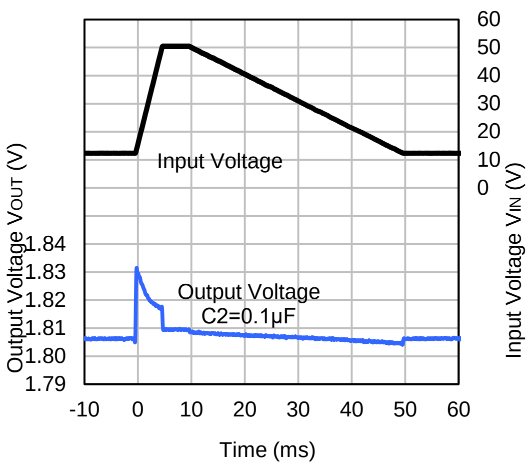


14) Load Dump (Ta = 25°C)

R1524x018B



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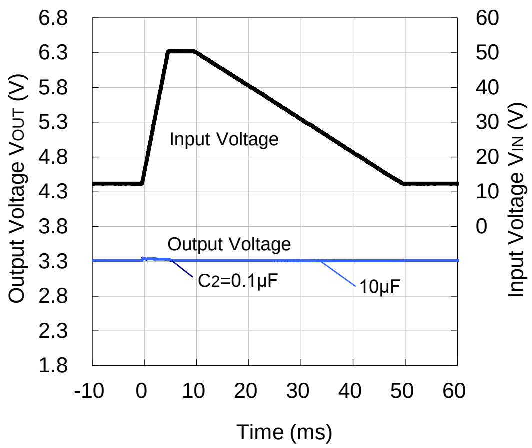
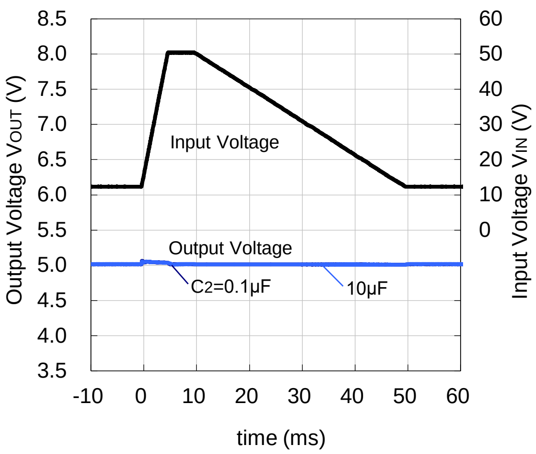


RICOH

R1524x050B



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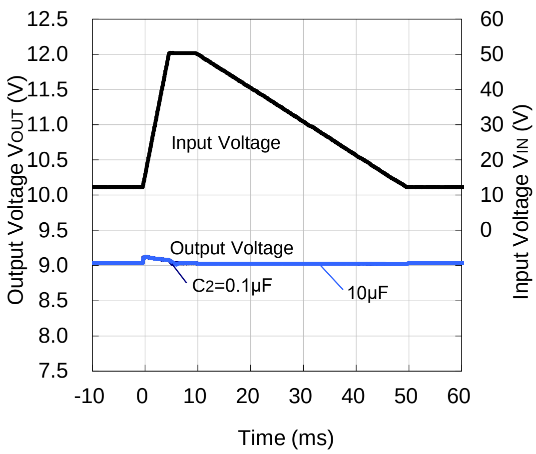
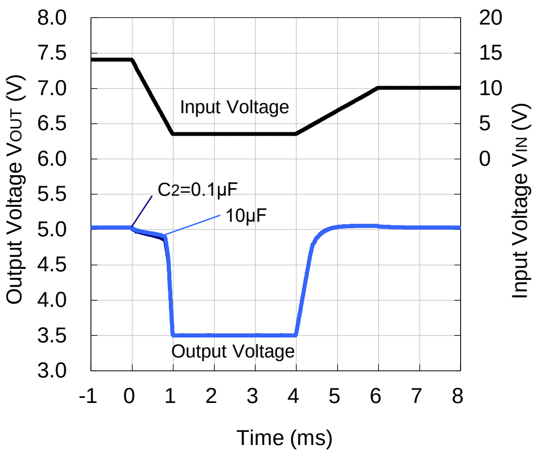
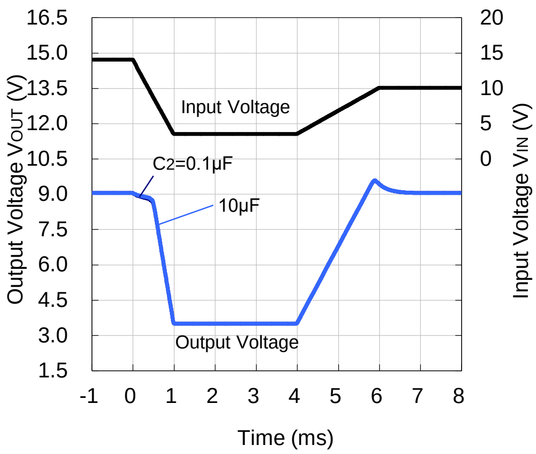


15) Cranking (Ta = 25°C)

R1524x050B



R1524x090B

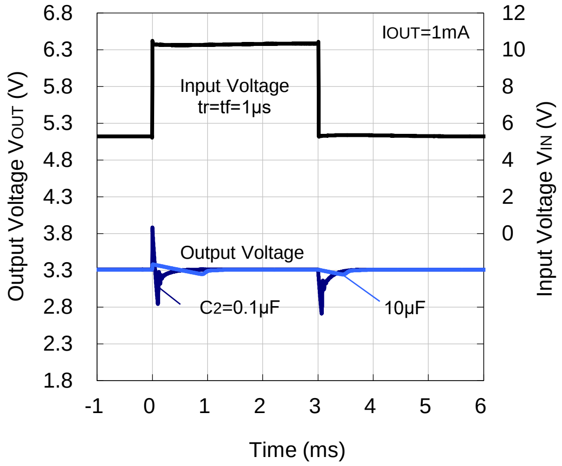


Input Transient/Load Transient vs. Output Capacity (C2)

R1524 performs a stable operation by using 0.1 µF of ceramic capacitor as the output capacitor. However, the variation of output voltage may not meet the demand of the system when input voltage and load current vary. In such cases, the variation of output voltage can be minimized significantly by using 10 µF or higher ceramic capacitor. When using an electrolytic capacitor for the output line, place the electrolytic capacitor outer side of the ceramic capacitor arranged close to the IC.

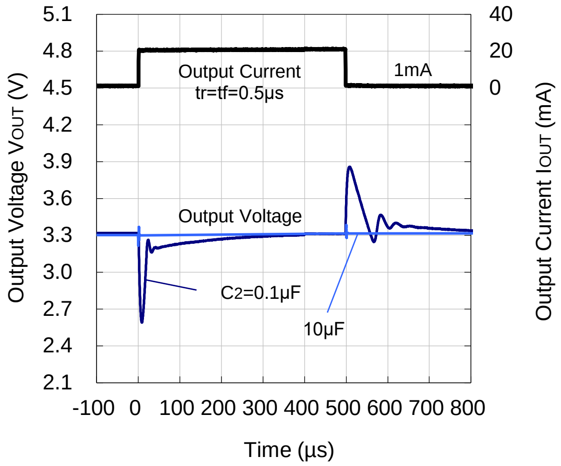
Input Transient Response

R1524x033B



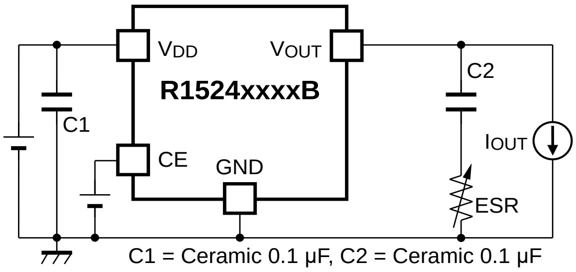
Load Transient Response

R1524x033B



ESR vs. Output Current

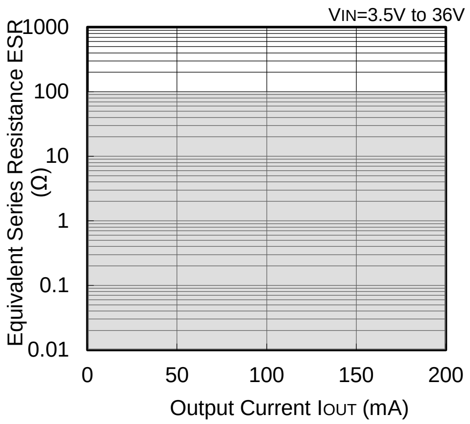
It is recommended that a ceramic type capacitor be used for this device. However, other types of capacitors having lower ESR can also be used. The relation between the output current (I_{OUT}) and the ESR of output capacitor is shown below.



C1 = Ceramic 0.1 μF, C2 = Ceramic 0.1 μF

Measurement Conditions
Frequency Band: 10 Hz to 2 MHz
Measurement Temperature: −40°C to 125°C
Hatched area: Noise level is 40 μV (average) or below
Ceramic Capacitors: C1 = 0.1 μF, C2 = 0.1 μF

R1524x018B



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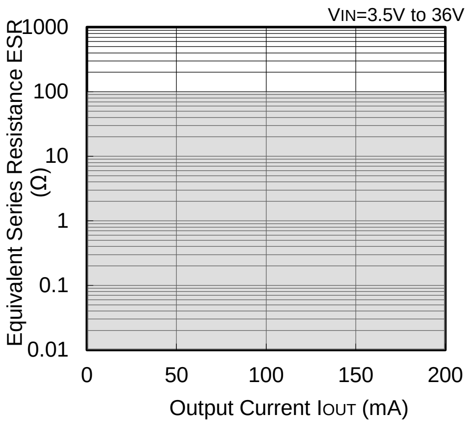
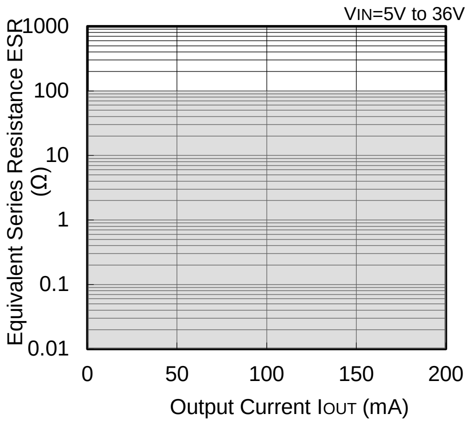
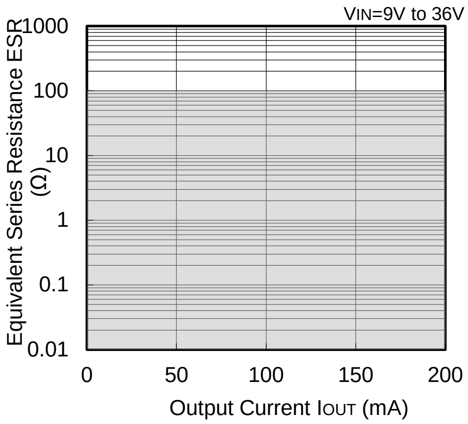


R1524x050B



R1524x090B



Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

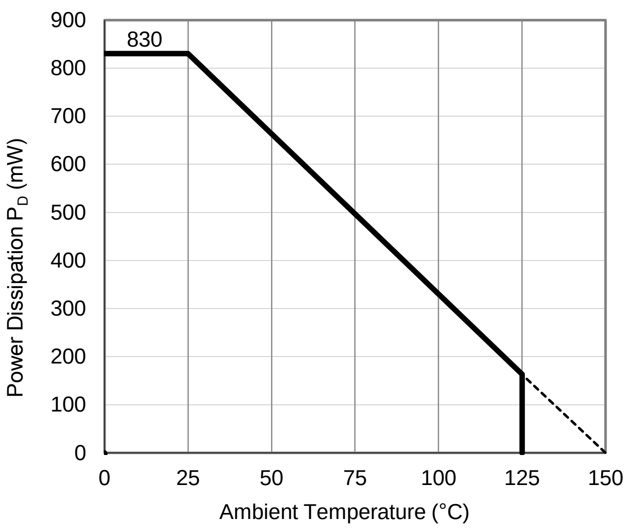
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 7 pcs

Measurement Result (Ta = 25°C, Tjmax = 150°C)

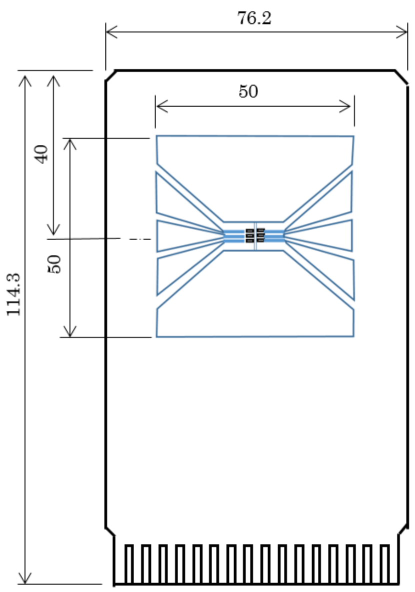
Item	Measurement Result
Power Dissipation	830 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

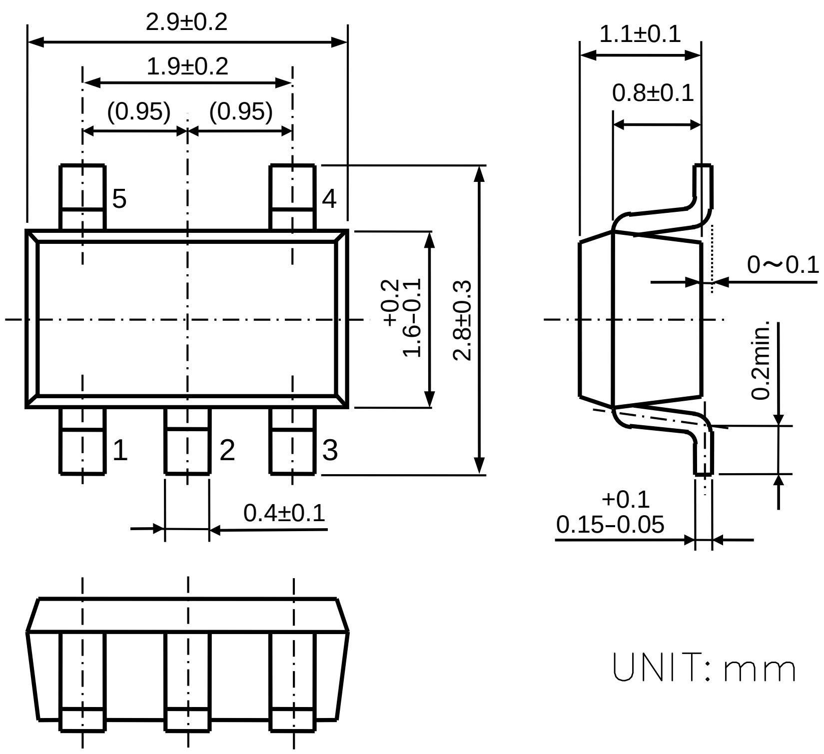


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

RICOH



SOT-23-5 Package Dimensions

Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

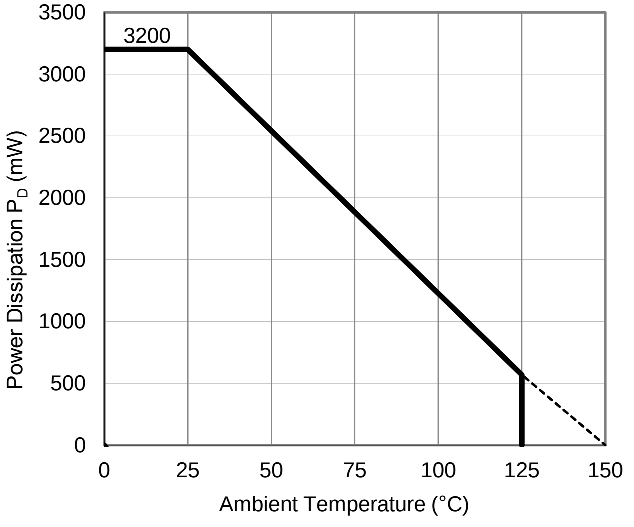
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 13 pcs

Measurement Result (Ta = 25°C, Tjmax = 150°C)

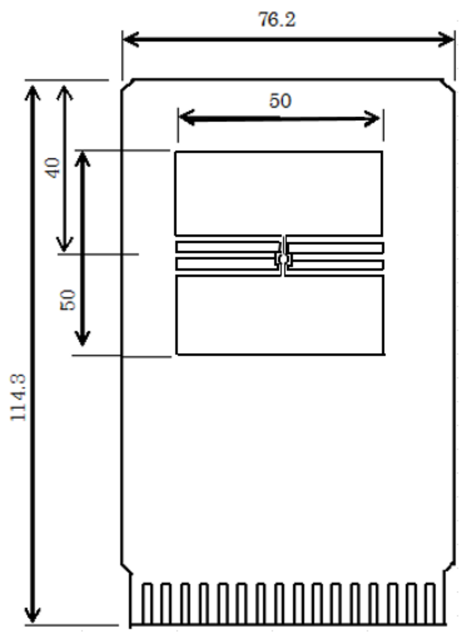
Item	Measurement Result
Power Dissipation	3200 mW
Thermal Resistance (θja)	θja = 38°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 13°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

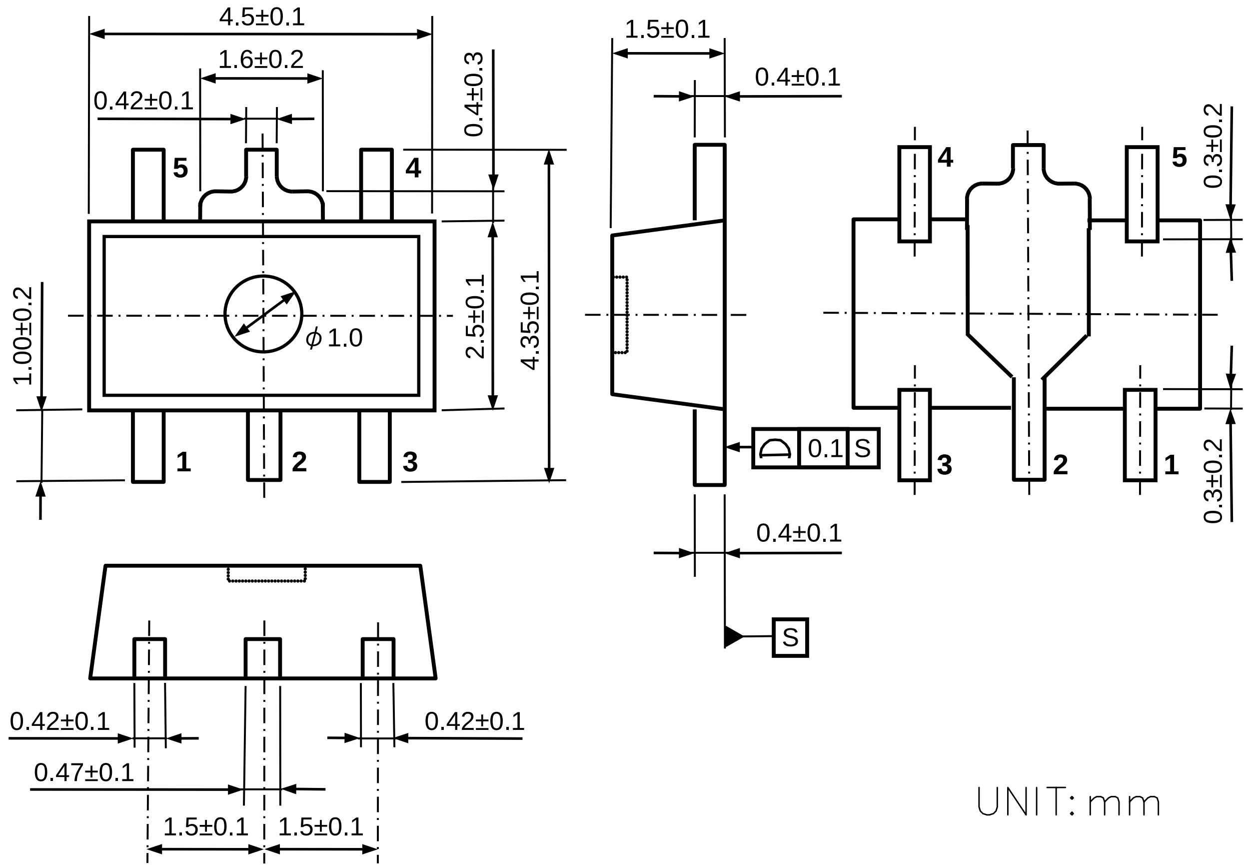


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

RICOH



SOT-89-5 Package Dimensions

Ver. A

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

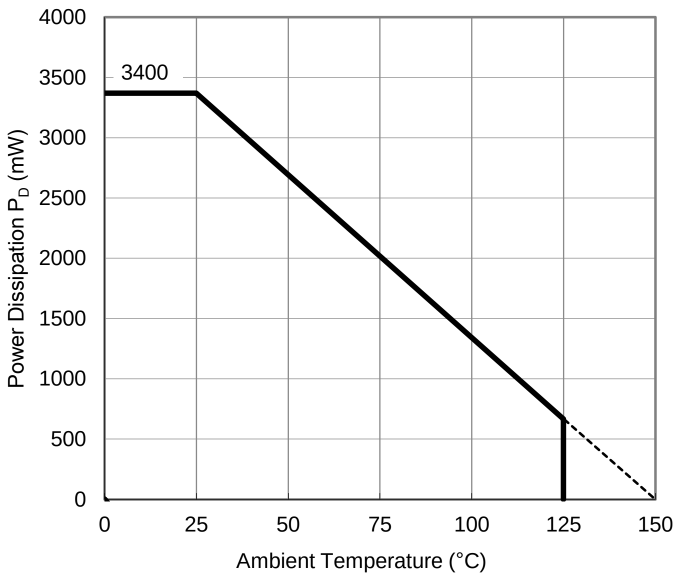
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 28 pcs

Measurement Result (Ta = 25°C, Tjmax = 150°C)

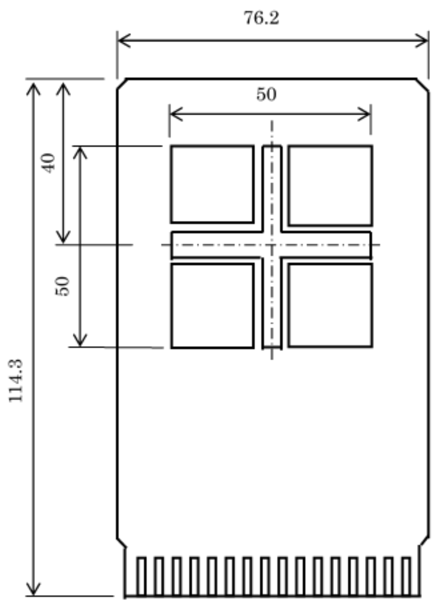
Item	Measurement Result
Power Dissipation	3400 mW
Thermal Resistance (θja)	θja = 37°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 7°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



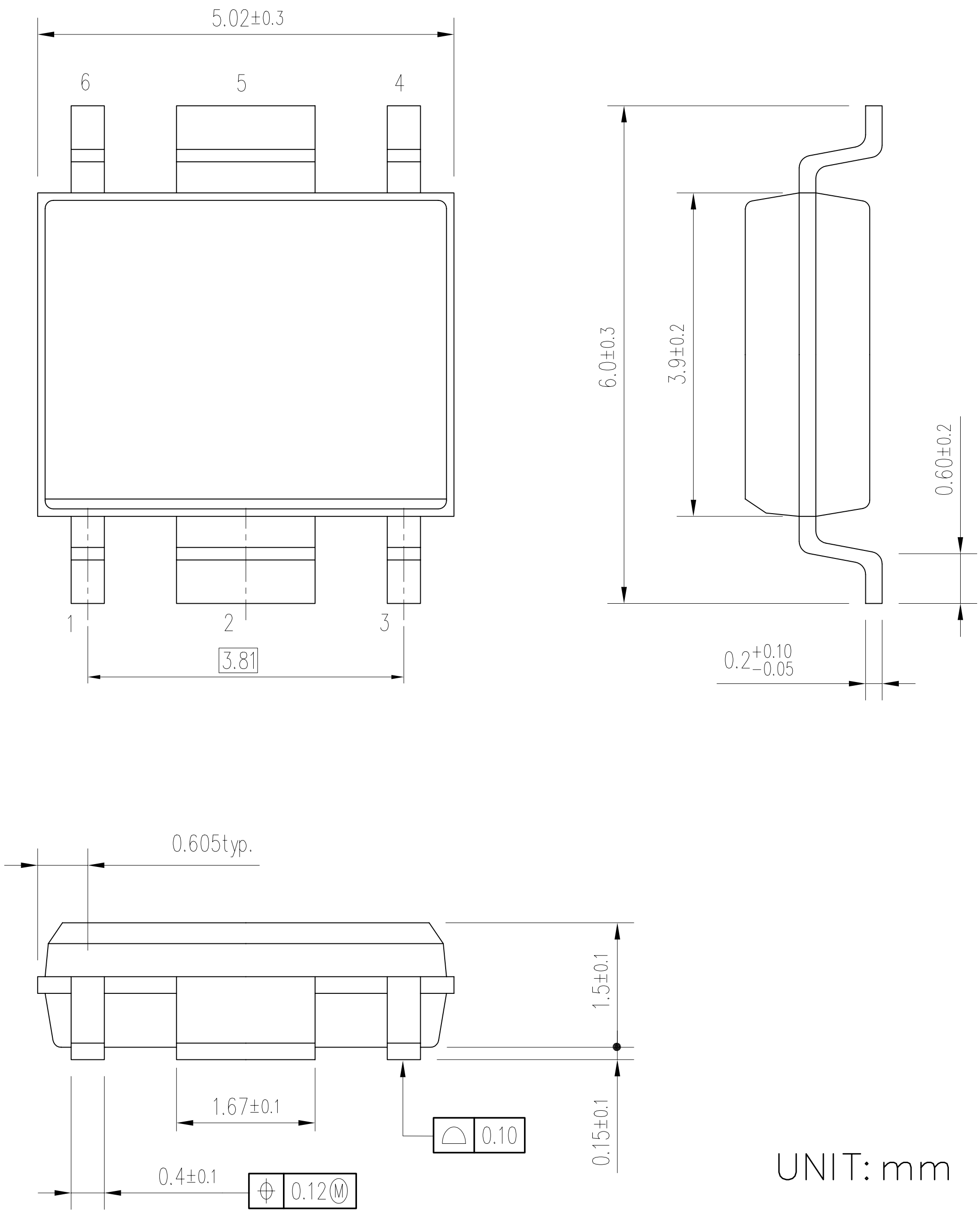
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

RICOH

Ver. A



HSOP-6J Package Dimensions

Ver. B

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

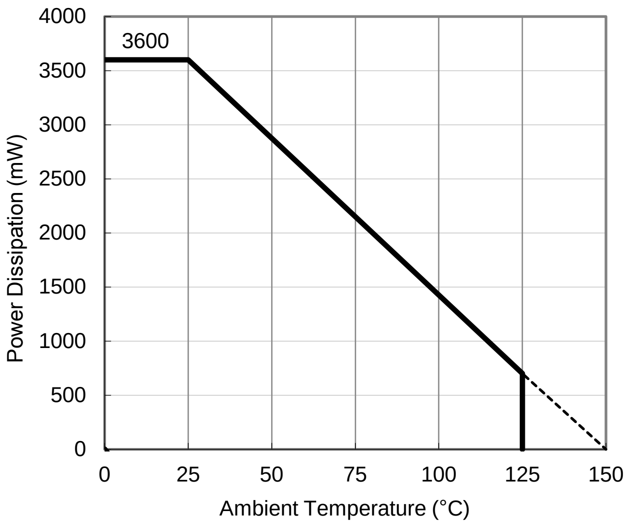
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 21 pcs

Measurement Result (Ta = 25°C, Tjmax = 150°C)

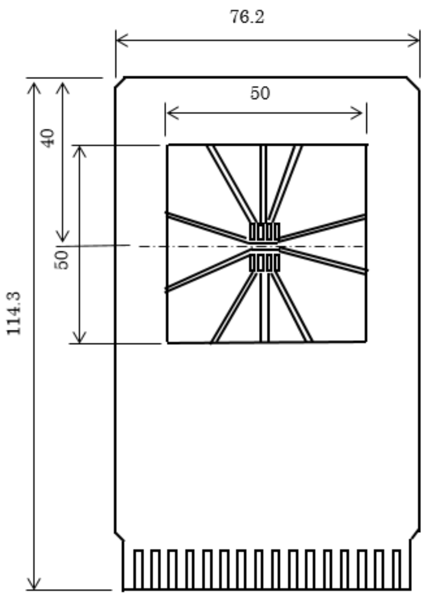
Item	Measurement Result
Power Dissipation	3600 mW
Thermal Resistance (θja)	θja = 34.5°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 10°C/W

θja: Junction-to-Ambient Thermal Resistance

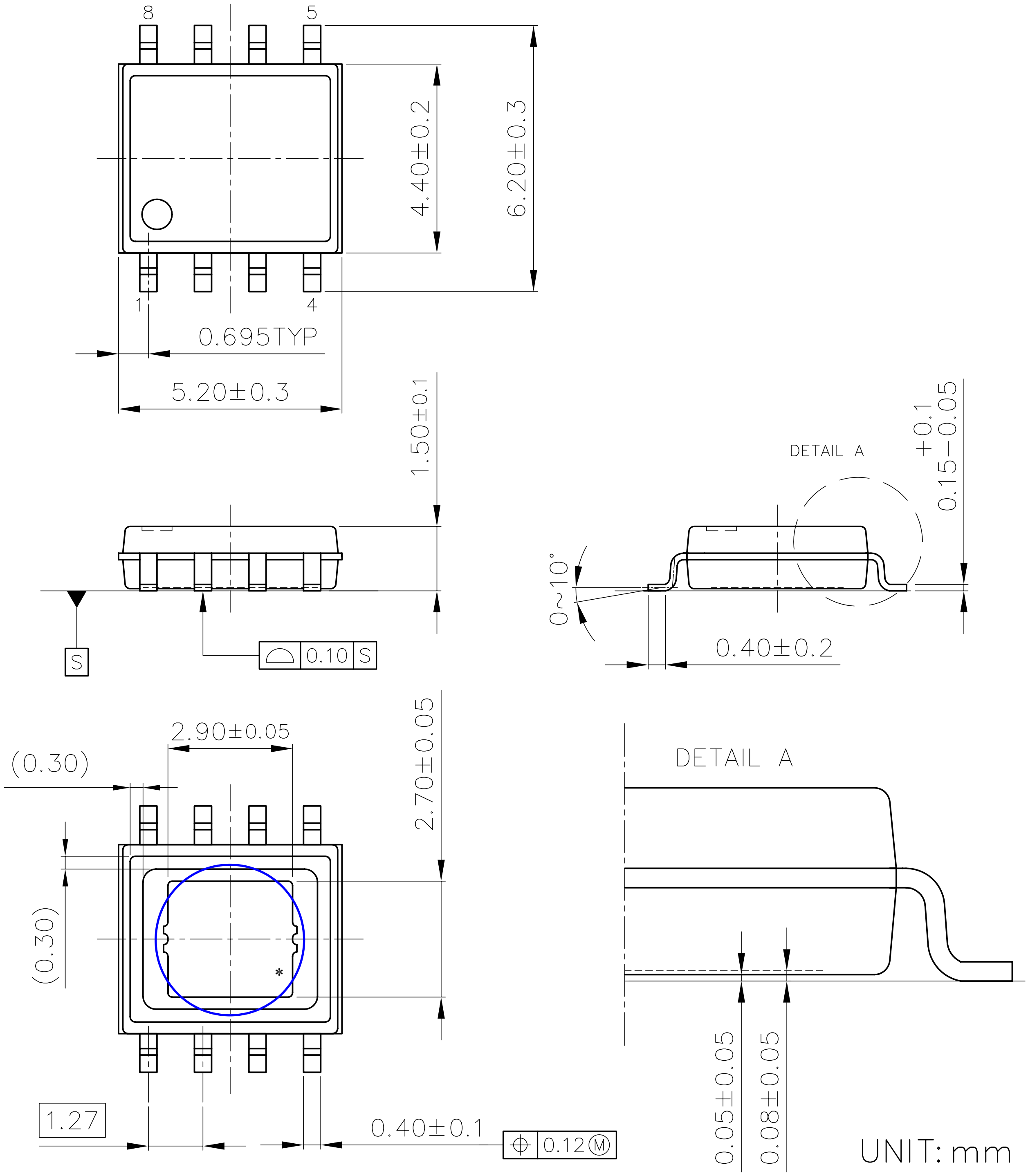
ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



HSOP-8E Package Dimensions

∗ The tab on the bottom of the package shown by blue circle is substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

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