150 mA 36 V Input LDO Regulator for Automotive Application

NO.EC-258-141222

OUTLINE

The R1516x Series are CMOS-based high-voltage resistant and low supply current voltage regulator ICs that provide the minimum 150mA of output voltage. Internally, the R1516x Series consists of a Foldback Protection Circuit, and a Thermal Shutdown Circuit in addition to the basic regulator circuits. The operating temperature range is between –40ºC to 105ºC, and the maximum input voltage is 36V. All these features allow this device to become an ideal power source for car accessories and ECUs.

The R1516x Series are available in fixed output voltage options between 1.8V and 6.2V in 0.1V steps. The output voltage accuracy is ±1%.

The R1516x Series are available in two types of packages: SOT-89-5 that is for high-density mounting and HSOP-6J that is for ultra high wattage.

FEATURES

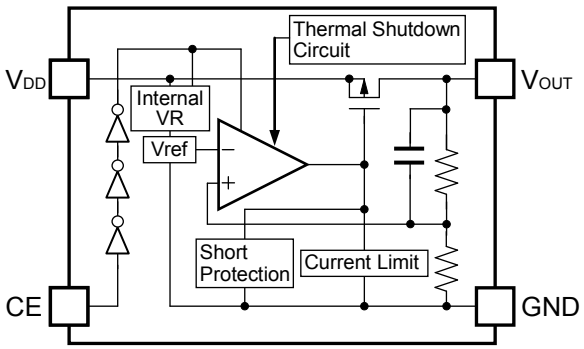
- Input Voltage Range (Maximum Rating) ····· 4V to 36V (50V)
- Supply Current ····· Typ. 29μA
- Standby Current ····· Typ. 0.1μA
- Output Voltage Temperature Coefficient ····· Typ. ±100ppm/ºC
- Output Current ····· Min. 150mA (V_{OUT}=5.0V, V_{IN}=8.0V)
- Line Regulation ····· Typ. 0.1%/V
- Output Voltage Accuracy ····· ±1% (V_{OUT} ≥ 3.2V, Ta=25ºC)
- Packages ····· SOT-89-5, HSOP-6J
- Output Voltage Range ····· 1.8V to 6.2V (0.1V steps)
- Built-in Foldback Protection Circuit ····· 50mA (Current at short mode)
- Built-in Thermal Shutdown Circuit ····· Stops at 160°C
- Operating Temperature ····· –40 to 105ºC

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

BLOCK DIAGRAMS

R1516xxxxB



SELECTION GUIDE

The output voltage and the package for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1516HxxxB-T1-#E	SOT-89-5	1,000pcs	Yes	Yes
R1516SxxxB-E2-#E	HSOP-6J	1,000pcs	Yes	Yes

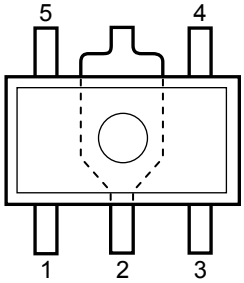
xxx : The output voltage can be designated in the range of 1.8V(018)to 6.2V(062)in 0.1V steps.

: Specify Automotive Class Code

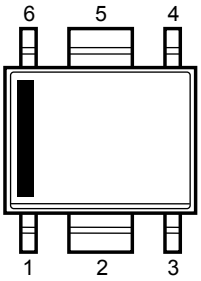
	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 105°C	25°C	High Temperature
J	-40°C to 105°C	25°C	High and Low Temperature

PIN DESCRIPTIONS

● **SOT-89-5**



● **HSOP-6J**



● **SOT-89-5**

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

∗) The GND pin must be wired together when it is mounted on board.

● **HSOP-6J**

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND*	Ground Pin
3	CE	Chip Enable Pin (“H” Active)
4	GND*	Ground Pin
5	GND*	Ground Pin
6	V_{DD}	Input Pin

∗) The GND pin must be wired together when it is mounted on board.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item			Rating	Unit
V_{IN}	Input Voltage			−0.3～50	V
V_{IN}	Peak Input Voltage*1			60	V
V_{CE}	Input Voltage (CE Pin)			−0.3～V_{IN}+0.3≦50	V
V_{OUT}	Output Voltage			−0.3～V_{IN}+0.3≦50	V
I_{OUT}	Output Current			250	mA
P_D	Power Dissipation *2	SOT-89-5	Standard Land Pattern	1120	mW
			High Wattage Land Pattern	1620	
		HSOP-6J	Standard Land Pattern	2100	
			Ultra High Wattage Land Pattern	3400	
Tj	Junction Temperature			−40 to 150	°C
Tstg	Storage Temperature Range			−55 to 150	°C

∗1) Duration time: 200ms
∗2) Refer to PACKAGE INFORMATION for detailed 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.

RECOMMENDED OPERATING RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	4 to 36	V
Ta	Operating Temperature Range	−40 to 105	°C

RECOMMENDED OPERATING RATINGS

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

ELECTRICAL CHARACTERISTICS

The specifications surrounded by ▭ are guaranteed by Design Engineering at - 40°C ≤ Ta ≤ 105ºC.

R1516xxxxB (Ta=25ºC)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage			4		36	V
I_{SS}	Supply Current	V_{IN}=V_{OUT}+3.0V, I_{OUT}=0mA			29	45	μA
Istandby	Standby Current	V_{IN}=36V, V_{CE}=0V			0.1	1.0	μA
V_{OUT}	Output Voltage	V_{IN}=V_{OUT}+3.0V I_{OUT}=1mA	V_{OUT} ≥ 3.2V	x0.99 x0.98		x1.01 x1.02	V
		V_{IN}=V_{OUT}+3.0V I_{OUT}=1mA	V_{OUT} < 3.2V	x0.985 x0.975		x1.015 x1.025	V
I_{LIM}	Output Current Limit	Please refer to Output Current Limit Specification Table.					mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	Please refer to Load Regulation Specification Table.					mV
ΔV_{OUT} /ΔV_{IN}	Line Regulation	I_{OUT}=1mA	V_{OUT}+1.5V ≤ V_{IN} ≤ 36V, (V_{OUT} ≥ 2.5V)		0.1	0.7	%
			4V ≤ V_{IN} ≤ 36V, (V_{OUT} < 2.5V)				
V_{DIF}	Dropout Voltage	Please refer to Dropout Voltage Secification Table.					V
ΔV_{OUT} /ΔTa	Output Voltage Temperature Coefficient	V_{IN}=V_{OUT}+3.0V, I_{OUT}=1mA -40ºC ≤ Ta ≤ 105ºC			±100		ppm/ºC
I_{SC}	Short Current Limit	V_{OUT}=0V			50		mA
V_{CEH}	CE Input Voltage "H"			1.3		V_{IN}	V
V_{CEL}	CE Input Voltage "L"			0		0.35	V
T_{TSD}	Thermal Shutdown Temparature	Junction Temeprature		150	160		ºC
T_{TSR}	Thermal Shutdown Released Temparature	Junction Temperature			125		ºC

For the other specifications, all test items are done under the pulse load condition (Tj≈Ta=25ºC)

Output Current Limit Specification Table (Ta=25ºC)

Output Voltage V_{OUT} (V)	Output Current Limit I_{LIM} (mA)	
	Conditions	Min.
1.8 ≤ V_{OUT} < 3.0	V_{IN}=V_{OUT}+5.0V	150
3.0 ≤ V_{OUT} < 5.0	V_{IN}=V_{OUT}+4.0V	
5.0 ≤ V_{OUT} ≤ 6.2	V_{IN}=V_{OUT}+3.0V	

Load Regulation Specification Table (Ta=25ºC)

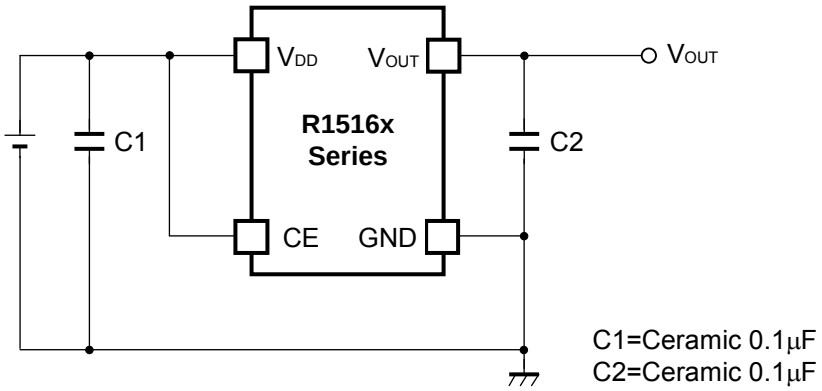
Outout Voltage V_{out} (V)	Load Regulation (mV)		
	Conditions	Typ.	Max.
1.8 ≤ V_{out} ≤ 3.0	V_{IN}=V_{OUT}+3.0V 1mA ≤ I_{OUT} ≤ 40mA	30 (V_{OUT}=3.0V)	70
3.0 < V_{out} ≤ 5.0		40 (V_{OUT}=5.0V)	105
5.0 < V_{out} ≤ 6.2		50 (V_{OUT}=6.2V)	125

The specifications surrounded by [ ] are guaranteed by Design Engineering at - 40°C ≤ Ta ≤ 105ºC

Dropout Voltage Specification Table (Ta=25ºC)

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)	
	Conditions	Max.
V_{OUT}=1.8	I_{OUT}=20mA	2.30
V_{OUT}=1.9		2.20
V_{OUT}=2.0		2.10
V_{OUT}=2.1		2.00
V_{OUT}=2.2		1.90
V_{OUT}=2.3		1.80
V_{OUT}=2.4		1.70
V_{OUT}=2.5		1.60
V_{OUT}=2.6		1.50
V_{OUT}=2.7		1.40
V_{OUT}=2.8		1.30
V_{OUT}=2.9		1.20
V_{OUT}=3.0		1.10
V_{OUT}=3.1		1.06
V_{OUT}=3.2		1.02
V_{OUT}=3.3		0.98
V_{OUT}=3.4		0.94
V_{OUT}=3.5		0.90
V_{OUT}=3.6		0.86
V_{OUT}=3.7		0.82
V_{OUT}=3.8		0.78
V_{OUT}=3.9		0.74
V_{OUT}=4.0		0.70
V_{OUT}=4.1		0.69
V_{OUT}=4.2		0.68
V_{OUT}=4.3		0.67
V_{OUT}=4.4		0.66
V_{OUT}=4.5		0.65
V_{OUT}=4.6		0.64
V_{OUT}=4.7		0.63
V_{OUT}=4.8		0.62
V_{OUT}=4.9		0.61
5.0 ≤ V_{OUT} ≤ 6.2		0.60

TYPICAL APPLICATION



TECHNICAL NOTES

When using the R1516x Series, please consider the following points.

Phase Compensation

The R1516x Series provide the constant-voltage without using C1 and C2 capacitors. However, if the input line is too long, C1 should be connected. To minimize the input voltage fluctuation and the transient output voltage fluctuation that is caused by the load fluctuation, C2 size should be increased. Please refer to the Basic Test Circuit below when connecting a 0.1μF to 20μF C1 capacitor from V_{DD} to GND, and also connecting a 0.1μF to 20μF C2 capacitor from V_{OUT} to GND. The C1 and C2 capacitors, V_{DD}, GND and V_{OUT} should be connected as close as possible to each other.

GND Wiring on Boards

For SOT-89-5 package, please connect the No.2 pin and the No.4 pin to the ground plane on the board.

For HSOP-6J package, please connect the No.2 pin, the No.4 pin and the No.5 pin to the ground plane on the board.

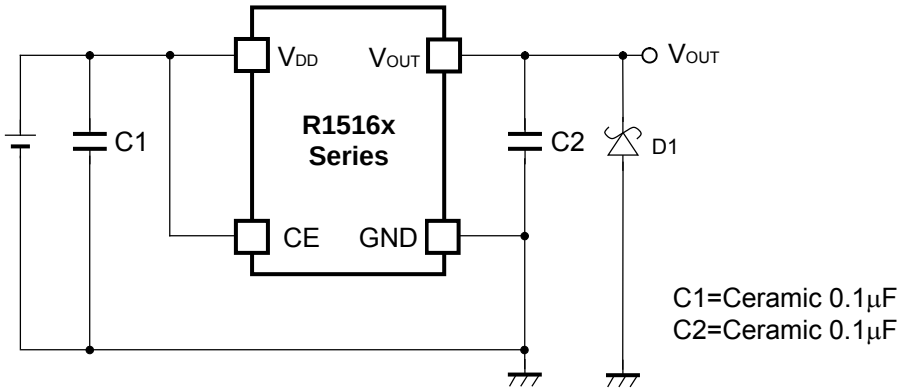
Thermal Shutdown

The thermal shutdown is included, which limits the junction temperature to a maximum 160ºC (Typ.). Under extreme conditions when the junction temperature begins to rise above 160ºC, the output is turned off, reducing the output current to zero. When the junction temperature drops below +125ºC (Typ.), the output is turned on again and the output current is restored to its nominal value. The output repeats turning on and off to form a pulse shaped output unless the causes of the temperature rise are removed.

Chip Enable (CE) Circuit

The electrical potential level of chip enable (CE) pin should not be set in between V_{CEH} and V_{CEL}. Using the electrical potentials in between V_{CEH} and V_{CEL} may cause the increase of supply current and may result in unstable output.

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.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-89-5)

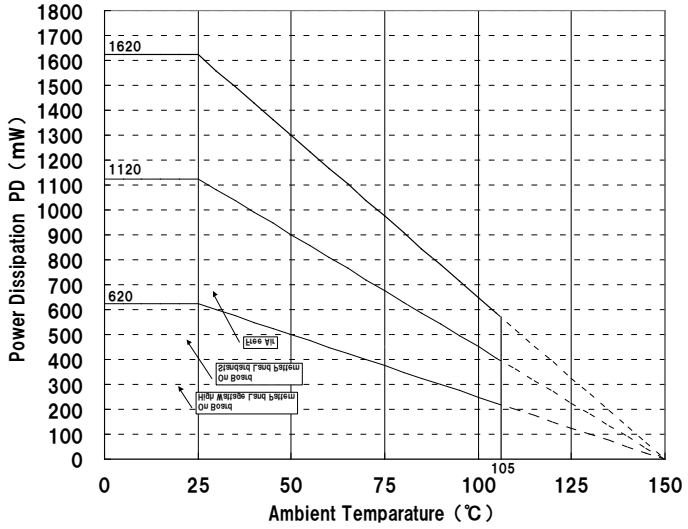
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

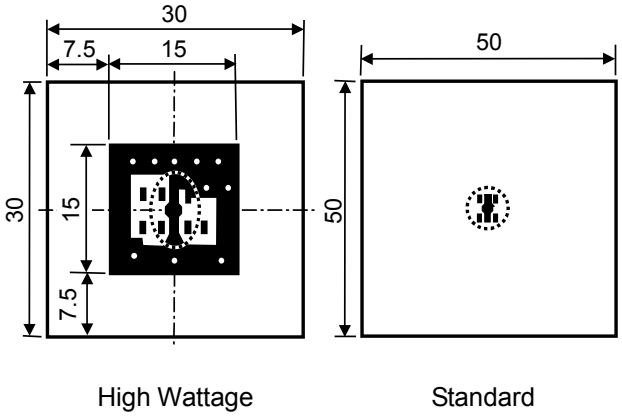
	High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)	Glass cloth epoxy plastic (Double sided)
Board Dimensions	30mm × 30mm × 1.6mm	50mm × 50mm × 1.6mm
Copper Ratio	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=150°C)

	High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	1620mW	1120mW	620mW
Thermal Resistance	77°C/W	111°C/W	200°C/W



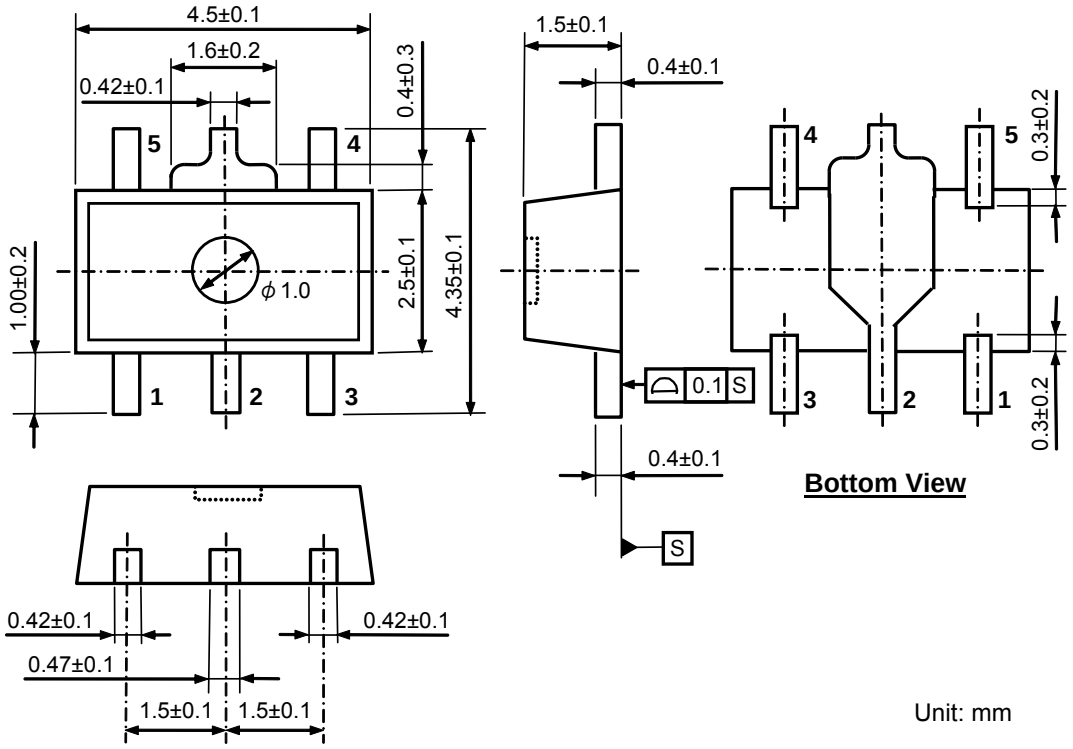
Power Dissipation



Measurement Board Pattern

IC Mount Area (Unit : mm)

PACKAGE DIMENSIONS (SOT-89-5)

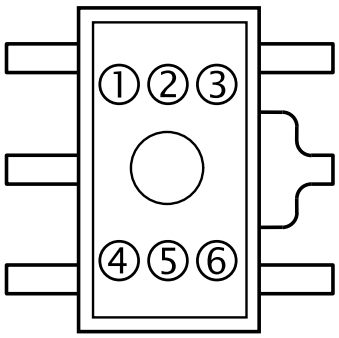


SOT-89-5 Package Dimensions

MARK SPECIFICATION (SOT-89-5)

①②③④: Product Code … **Refer to *MARK SPECIFICATION TABLE (SOT-89-5)***

⑤⑥: Lot Number … Alphanumeric Serial Number



SOT-89-5 Mark Specification

MARK SPECIFICATION TABLE (SOT-89-5)

R1516HxxxB

Product Name	① ② ③ ④	V_{SET}
R1516H018B	B 0 1 8	1.8 V
R1516H019B	B 0 1 9	1.9 V
R1516H020B	B 0 2 0	2.0 V
R1516H021B	B 0 2 1	2.1 V
R1516H022B	B 0 2 2	2.2 V
R1516H023B	B 0 2 3	2.3 V
R1516H024B	B 0 2 4	2.4 V
R1516H025B	B 0 2 5	2.5 V
R1516H026B	B 0 2 6	2.6 V
R1516H027B	B 0 2 7	2.7 V
R1516H028B	B 0 2 8	2.8 V
R1516H029B	B 0 2 9	2.9 V
R1516H030B	B 0 3 0	3.0 V
R1516H031B	B 0 3 1	3.1 V
R1516H032B	B 0 3 2	3.2 V
R1516H033B	B 0 3 3	3.3 V
R1516H034B	B 0 3 4	3.4 V
R1516H035B	B 0 3 5	3.5 V
R1516H036B	B 0 3 6	3.6 V
R1516H037B	B 0 3 7	3.7 V
R1516H038B	B 0 3 8	3.8 V
R1516H039B	B 0 3 9	3.9 V
R1516H040B	B 0 4 0	4.0 V
R1516H041B	B 0 4 1	4.1 V
R1516H042B	B 0 4 2	4.2 V
R1516H043B	B 0 4 3	4.3 V
R1516H044B	B 0 4 4	4.4 V
R1516H045B	B 0 4 5	4.5 V
R1516H046B	B 0 4 6	4.6 V
R1516H047B	B 0 4 7	4.7 V
R1516H048B	B 0 4 8	4.8 V
R1516H049B	B 0 4 9	4.9 V
R1516H050B	B 0 5 0	5.0 V
R1516H051B	B 0 5 1	5.1 V
R1516H052B	B 0 5 2	5.2 V
R1516H053B	B 0 5 3	5.3 V
R1516H054B	B 0 5 4	5.4 V
R1516H055B	B 0 5 5	5.5 V
R1516H056B	B 0 5 6	5.6 V
R1516H057B	B 0 5 7	5.7 V
R1516H058B	B 0 5 8	5.8 V
R1516H059B	B 0 5 9	5.9 V
R1516H060B	B 0 6 0	6.0 V
R1516H061B	B 0 6 1	6.1 V
R1516H062B	B 0 6 2	6.2 V

POWER DISSIPATION (HSOP-6J)

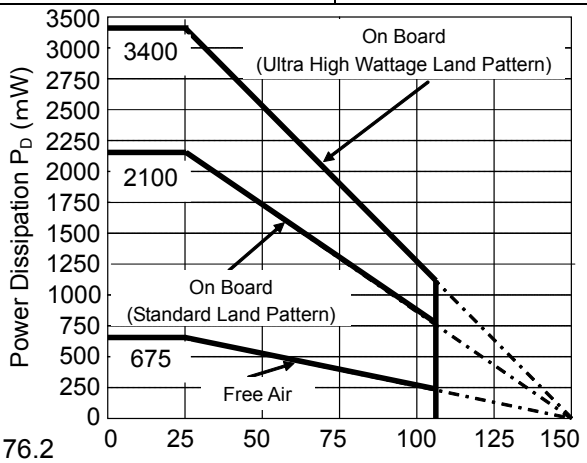
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

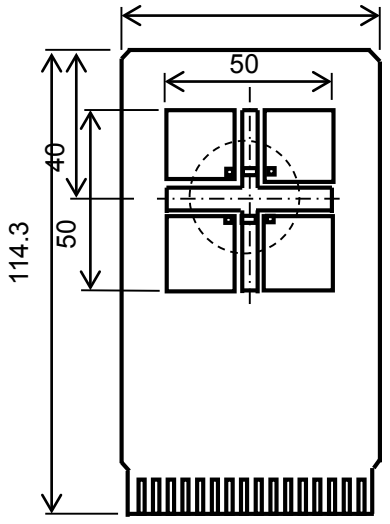
	Ultra High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (4Layers)	Glass cloth epoxy plastic (Double Layers)
Board Dimensions	76.2mm × 114.3mm × 0.8mm	50mm × 50mm × 1.6mm
Copper Ratio	96%	50%
Through-hole	ϕ0.3mm × 28pcs	ϕ0.5mm × 24pcs

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

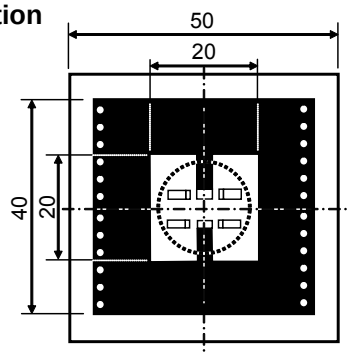
	Ultra High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	3400mW	2100mW	675mW
Thermal Resistance	37°C/W	59°C/W	185°C/W



Power Dissipation

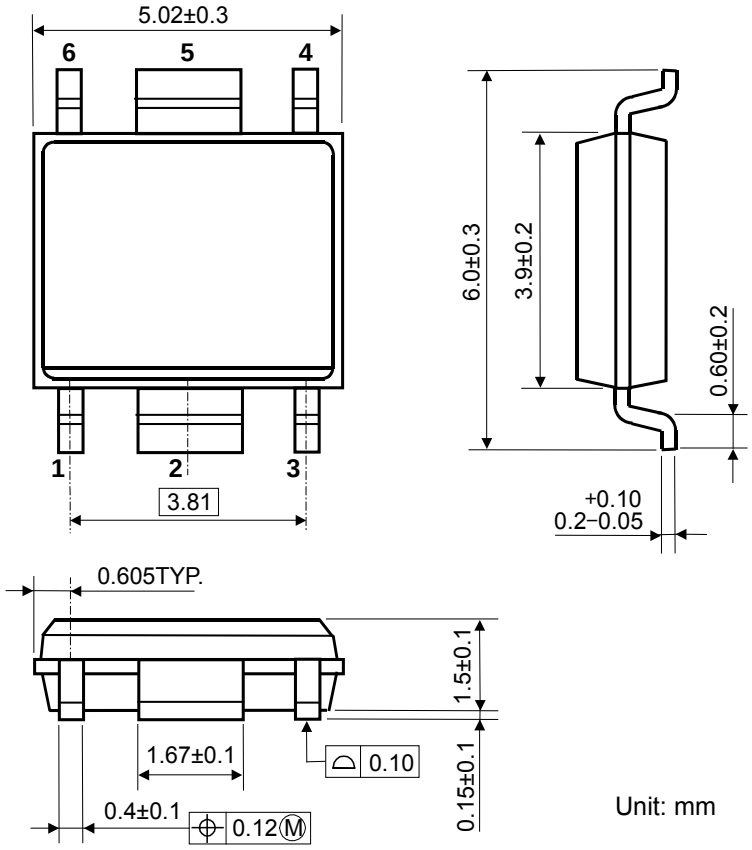


Ultra High Wattage Land Pattern
IC mount area (Unit:mm)



Measerament Bord Pattern
IC mount area(Unit:mm)

PACKAGE DIMENSIONS (HSOP-6J)

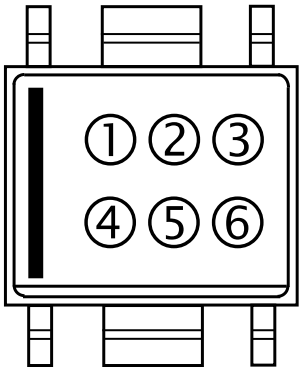


HSOP-6J Package Dimensions

MARK SPECIFICATION (HSOP-6J)

①②③④: Product Code … **Refer to *MARK SPECIFICATION TABLE (*HSOP-6J*)***

⑤⑥: Lot Number … Alphanumeric Serial Number



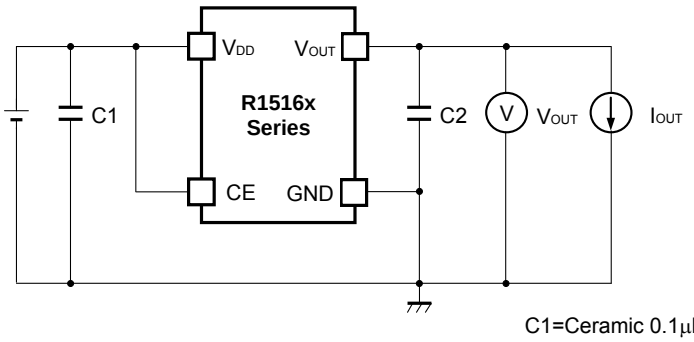
HSOP-6J Mark Specification

MARK SPECIFICATION TABLE (HSOP-6J)

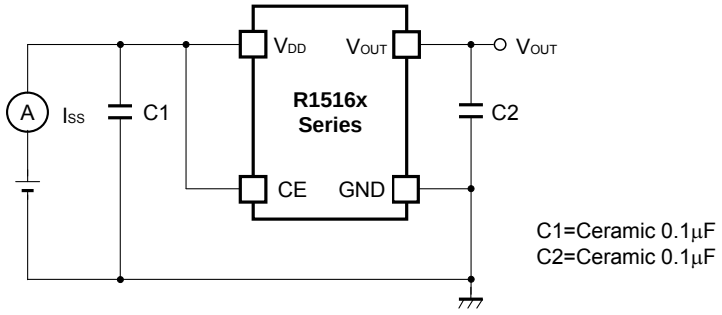
R1516SxxxB

Product Name	①	②	③	④	V_{SET}
R1516S018B	P	0	1	8	1.8 V
R1516S019B	P	0	1	9	1.9 V
R1516S020B	P	0	2	0	2.0 V
R1516S021B	P	0	2	1	2.1 V
R1516S022B	P	0	2	2	2.2 V
R1516S023B	P	0	2	3	2.3 V
R1516S024B	P	0	2	4	2.4 V
R1516S025B	P	0	2	5	2.5 V
R1516S026B	P	0	2	6	2.6 V
R1516S027B	P	0	2	7	2.7 V
R1516S028B	P	0	2	8	2.8 V
R1516S029B	P	0	2	9	2.9 V
R1516S030B	P	0	3	0	3.0 V
R1516S031B	P	0	3	1	3.1 V
R1516S032B	P	0	3	2	3.2 V
R1516S033B	P	0	3	3	3.3 V
R1516S034B	P	0	3	4	3.4 V
R1516S035B	P	0	3	5	3.5 V
R1516S036B	P	0	3	6	3.6 V
R1516S037B	P	0	3	7	3.7 V
R1516S038B	P	0	3	8	3.8 V
R1516S039B	P	0	3	9	3.9 V
R1516S040B	P	0	4	0	4.0 V
R1516S041B	P	0	4	1	4.1 V
R1516S042B	P	0	4	2	4.2 V
R1516S043B	P	0	4	3	4.3 V
R1516S044B	P	0	4	4	4.4 V
R1516S045B	P	0	4	5	4.5 V
R1516S046B	P	0	4	6	4.6 V
R1516S047B	P	0	4	7	4.7 V
R1516S048B	P	0	4	8	4.8 V
R1516S049B	P	0	4	9	4.9 V
R1516S050B	P	0	5	0	5.0 V
R1516S051B	P	0	5	1	5.1 V
R1516S052B	P	0	5	2	5.2 V
R1516S053B	P	0	5	3	5.3 V
R1516S054B	P	0	5	4	5.4 V
R1516S055B	P	0	5	5	5.5 V
R1516S056B	P	0	5	6	5.6 V
R1516S057B	P	0	5	7	5.7 V
R1516S058B	P	0	5	8	5.8 V
R1516S059B	P	0	5	9	5.9 V
R1516S060B	P	0	6	0	6.0 V
R1516S061B	P	0	6	1	6.1 V
R1516S062B	P	0	6	2	6.2 V

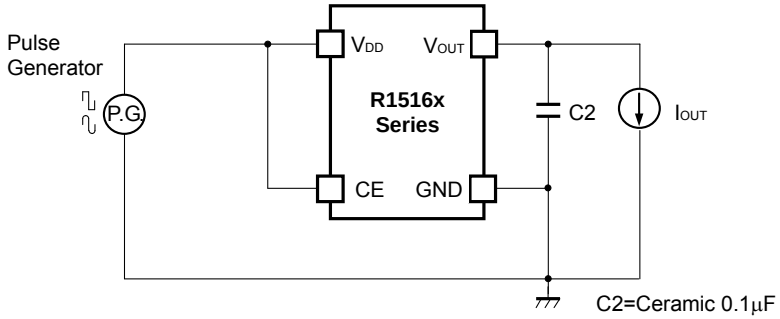
TEST CIRCUITS



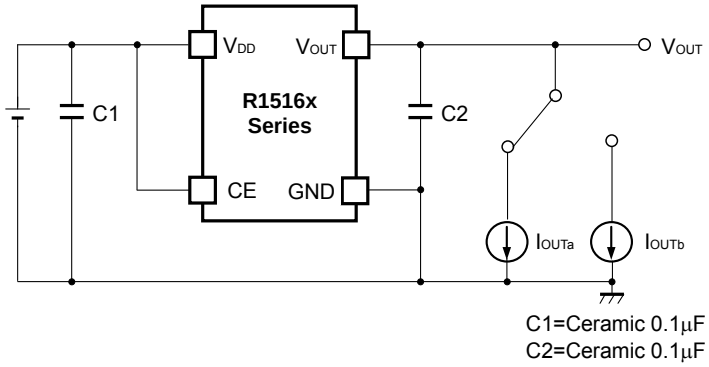
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Line Transient Response



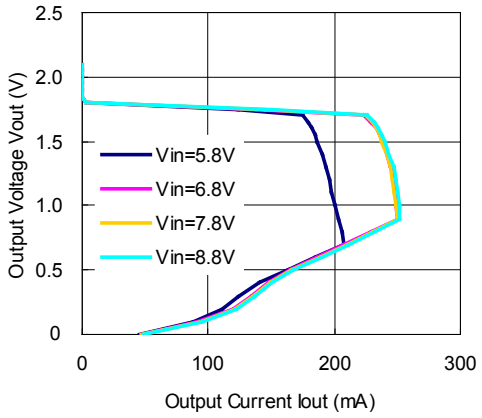
Test Circuit for Load Transient Response

Typical Characteristics

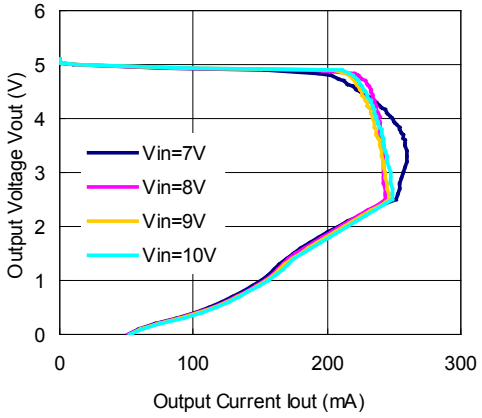
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs. Output Current (C1=0.1µF, C2=0.1µF, Ta=25°C)

R1516x018x

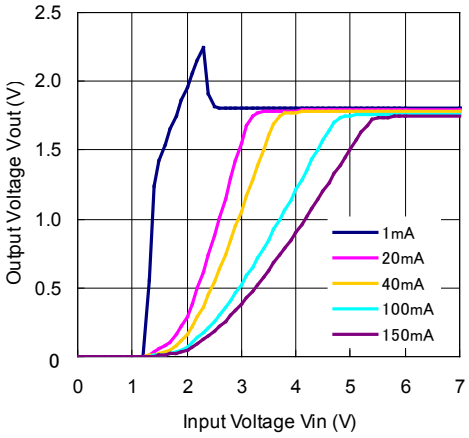


R1516x050x

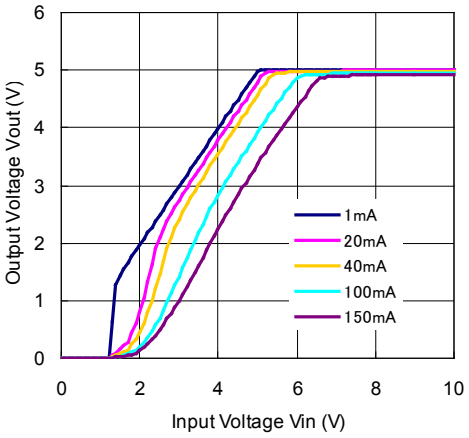


2) Output Voltage vs. Input Voltage (C1=0.1µF, C2=0.1µF, Ta=25°C)

R1516x018x

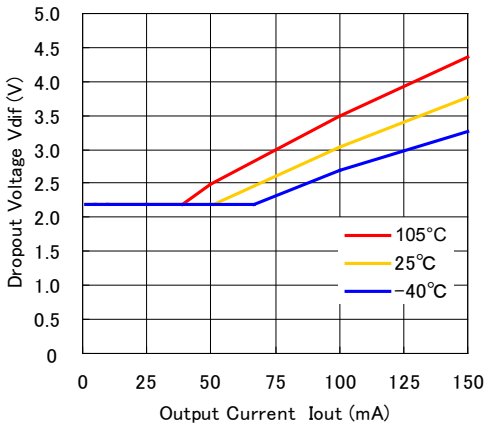


R1516x050x

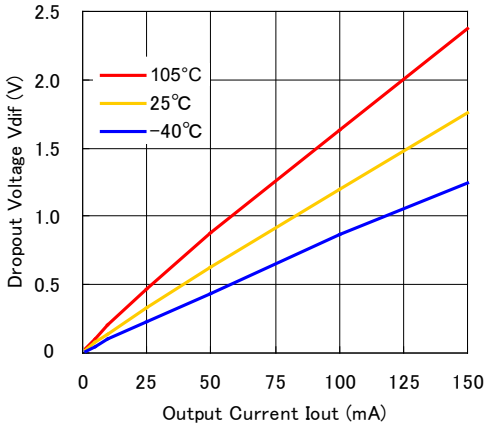


3) Dropout Voltage vs. Output Voltage (C1=0.1µF, C2=0.1µF, Ta=25°C)

R1516x018x

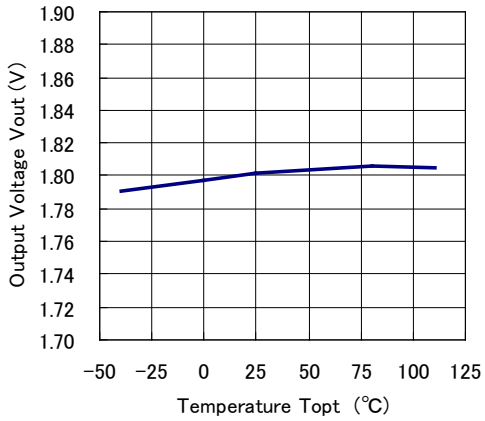


R1516x050x

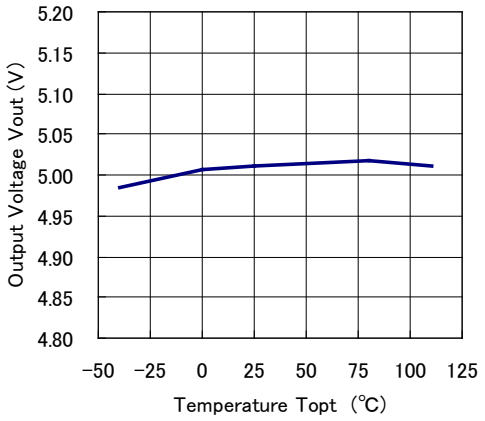


4) Output Voltage vs. Temperature (C1=0.1μF, C2=0.1μF)

R1516x018x

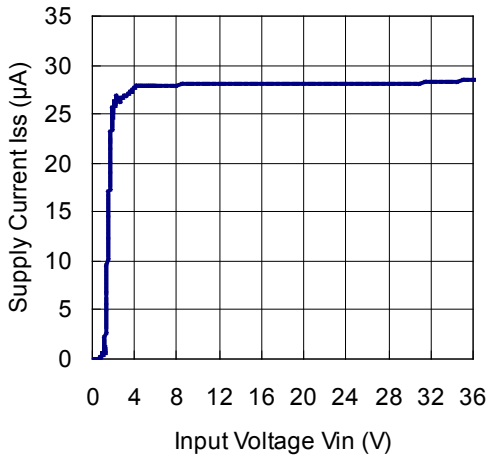


R1516x050x

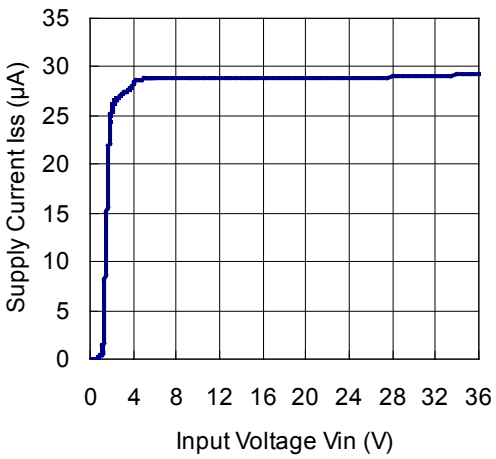


5) Supply Current vs. Input Voltage (C1=0.1μF, C2=0.1μF, Ta=25°C)

R1516x018x

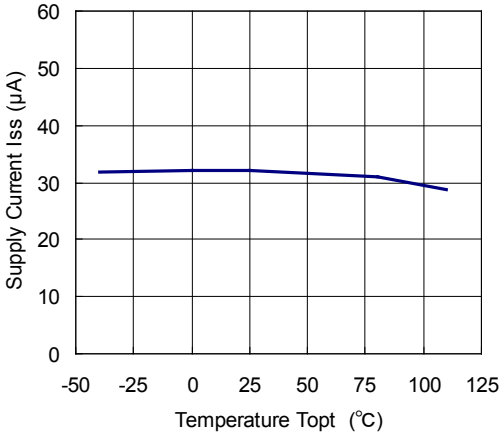


R1516x050x

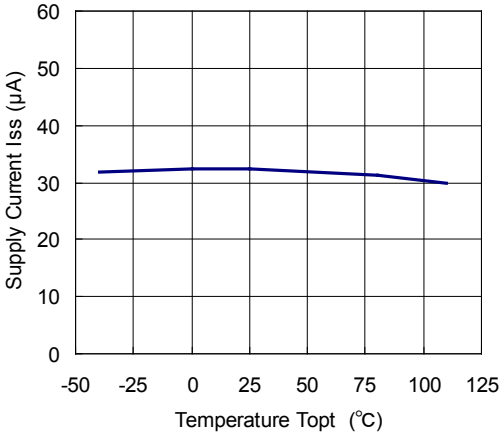


6) Supply Current vs. Temperature (C1=0.1μF, C2=0.1μF)

R1516x018x

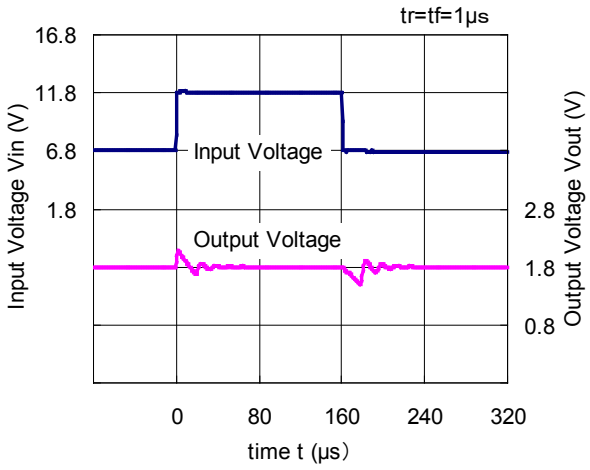


R1516x050x



7) Input Transient Response (C1=none, C2=Ceramic 0.1µF, I_{OUT}=1mA, Ta=25°C)

R1516x018x



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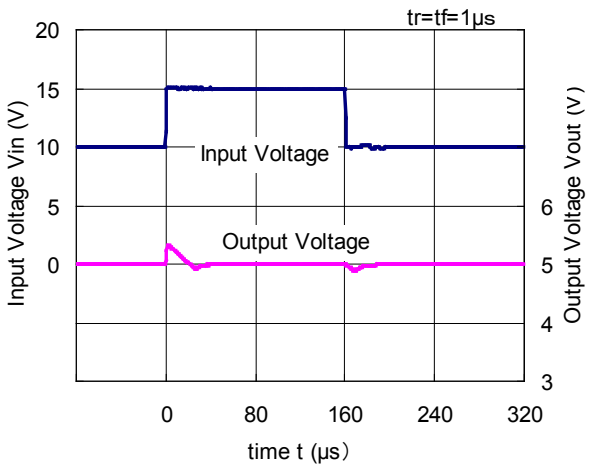

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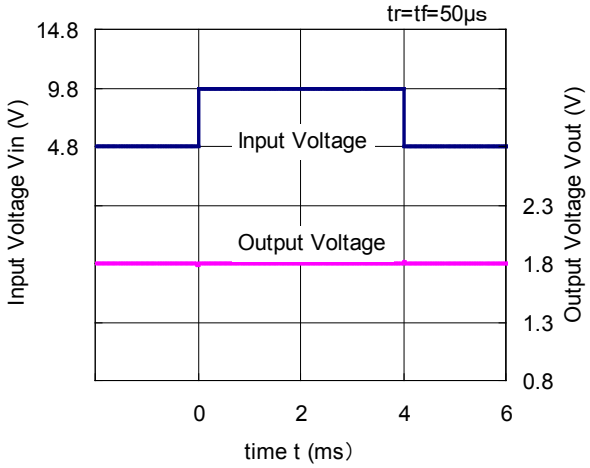

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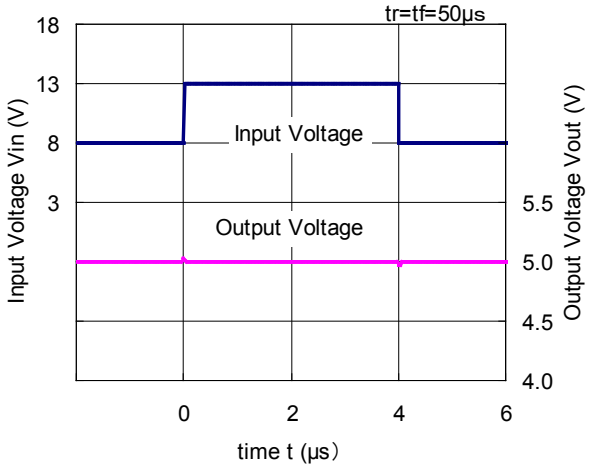
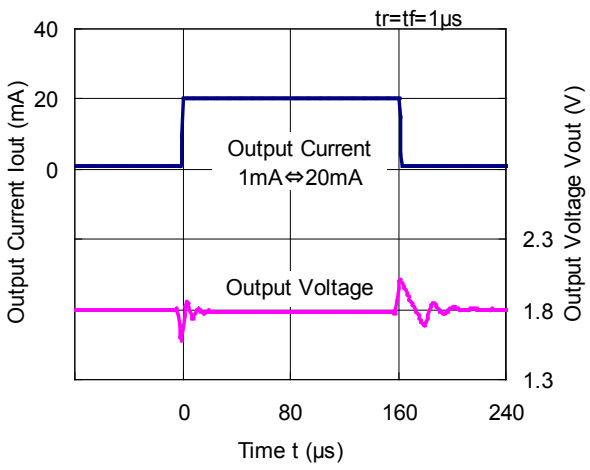


8) Load Transient Response (C_1=Ceramic 0.1µF, C_2=Ceramic 0.1µF, Ta=25°C)

R1516x018x



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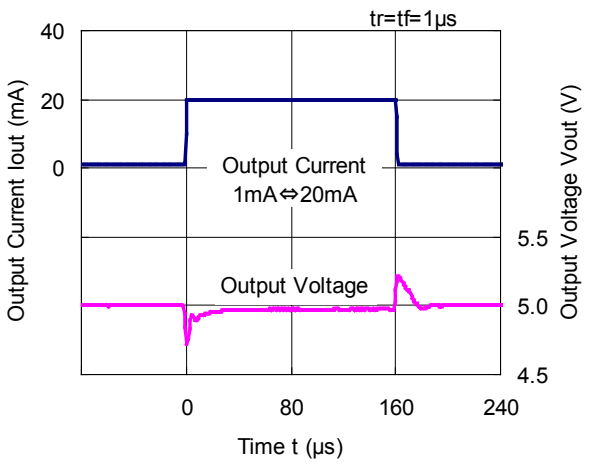

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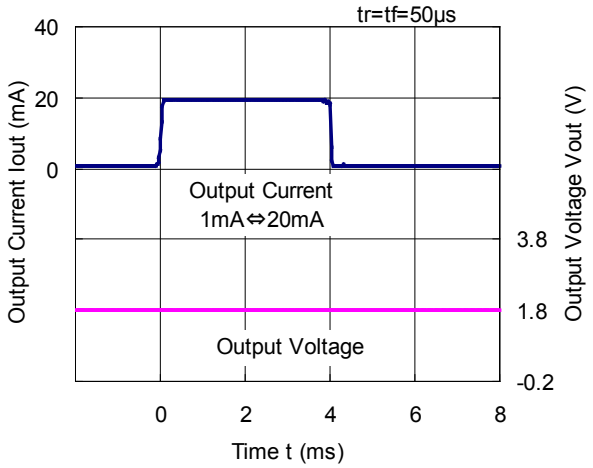

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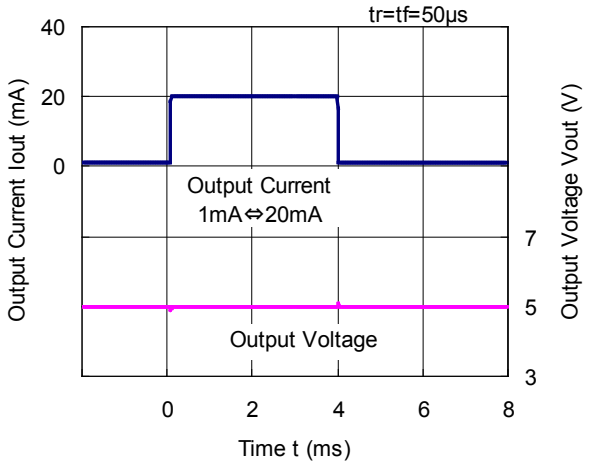

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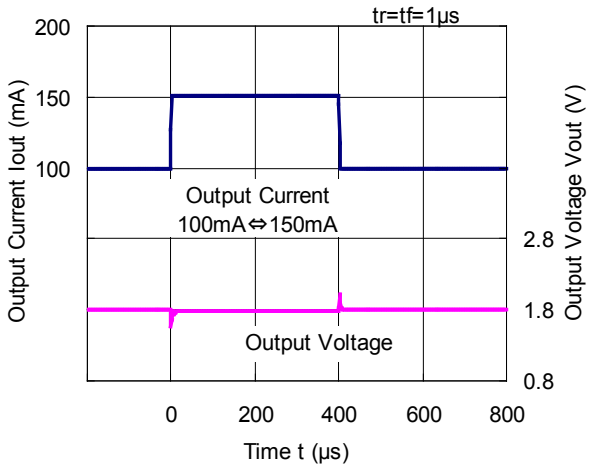

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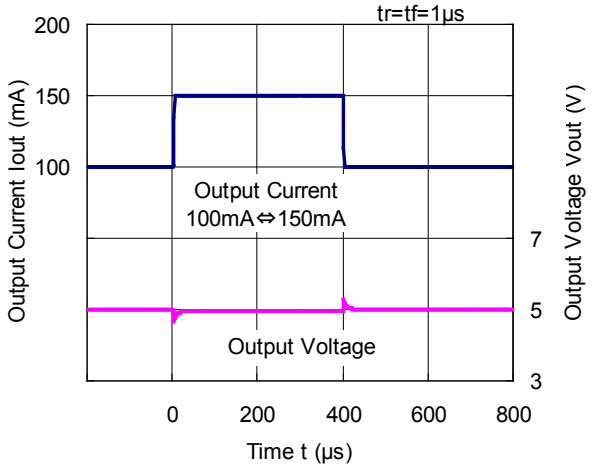
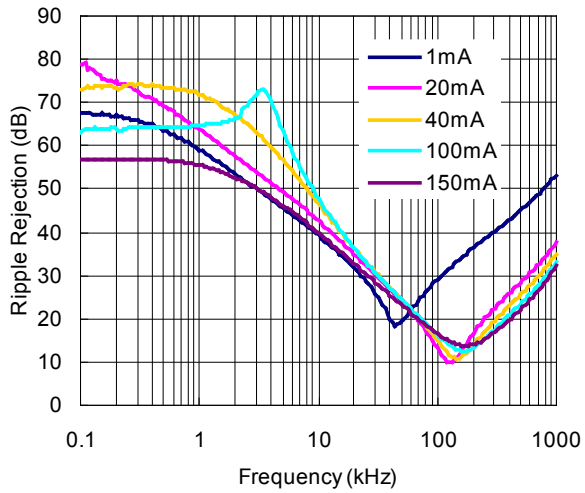
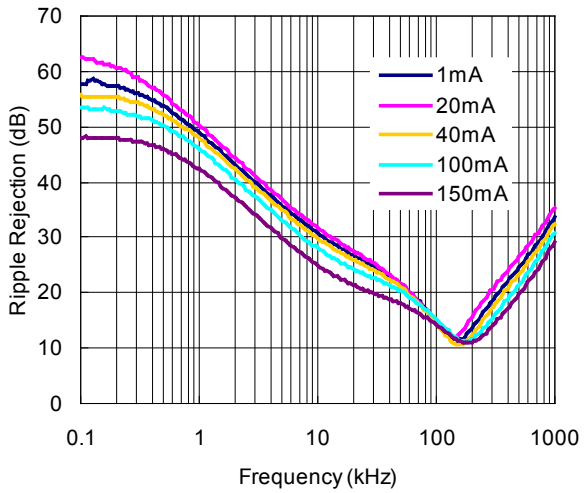


9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 0.1µF, Ripple=0.5Vp-p, Ta=25°C)

R1516x018x

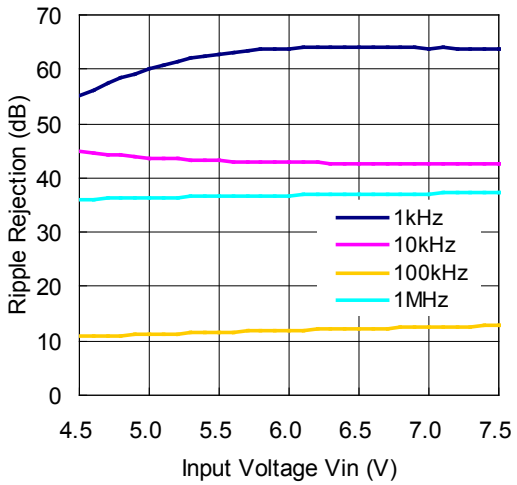


R1516x050x

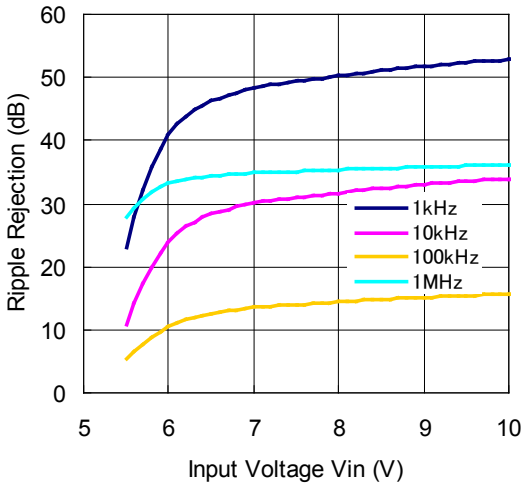


10) Ripple Rejection vs. Input Voltage (C1=none, C2=Ceramic 0.1µF, I_{OUT}=20mA, Ripple=0.5Vp-p, Ta=25°C)

R1516x018x



R1516x050x



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8. Quality Warranty

    8-1. Quality Warranty Period

    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.

    8-2. Quality Warranty Remedies

    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.

    8-3. Remedies after Quality Warranty Period

    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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