36 V, 0.8% Accuracy, 300 mA, Voltage Regulator

NO.EA-321-190829

OUTLINE

The R1513S is a CMOS-based voltage regulator (VR) featuring 300 mA output current and 36 V input voltage. Internally, the R1513S consists of a fold-back protection circuit, a short current protection circuit and a thermal shutdown circuit in addition to the basic regulator circuit.

The performance is specified for 25°C with ±0.8% output voltage accuracy and for the −40°C to 125°C temperature range with ±1.0% output voltage accuracy. The operating temperature range is −40°C to 125°C and the maximum input voltage is 36 V. All these features allow the R1513S to become an ideal power source of electric home appliances.

The R1513S is available in 1.2 V, 1.5 V, 1.8 V, 3.3 V, 3.4 V and 5.0 V fixed output voltage options. By using external divider resistors, the output voltage can be set over a 1.2 V to 18.0 V range.

The R1513S is offered in a 6-pin HSOP-6J high wattage package.

FEATURES

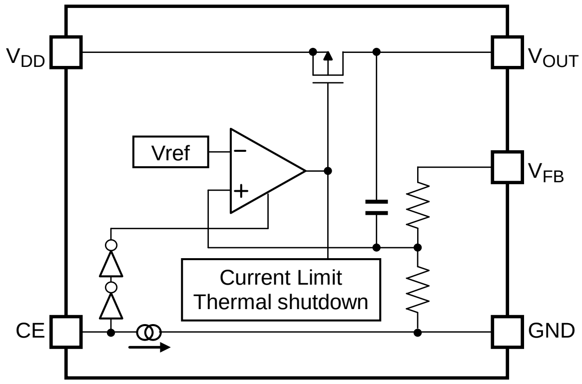
- Input Voltage (Maximum Ratings)················· 3.5 V to 36 V (50 V)
- Operating Temperature Range····················· −40°C to 125°C
- Supply Current ·· Typ. 75 μA
- Standby Current ······································ Typ. 0.1 μA
- Dropout Voltage ······································ Typ. 0.32 V (I_{OUT} = 300 mA, V_{OUT} = 5.0 V)
- Output Voltage Accuracy ···························· ±0.8% (Ta = 25°C)
  ±1.0% (−40°C to 125°C)
- Line Regulation ······································· Typ. 0.01%/V (V_{DD} = V_{OUT} + 1 V to 36 V)
- Package Type ·· HSOP-6J
- Output Voltage ·· 1.2 V / 1.5 V / 1.8 V / 3.3 V / 3.4 V / 5.0 V
- Short-current Protection Circuit···················· Current Limit Typ. 50 mA
- Fold-back Protection Circuit ························ Current Limit Typ. 450 mA
- Thermal Shutdown Circuit··························· Shutdown at Typ. 160°C
- Ripple Rejection ······································ Typ. 70 dB (f = 100 Hz)
- Ceramic Capacitor Compatible ···················· C1 = 1.0 μF or more, C2 = 4.7 μF or more

APPLICATIONS

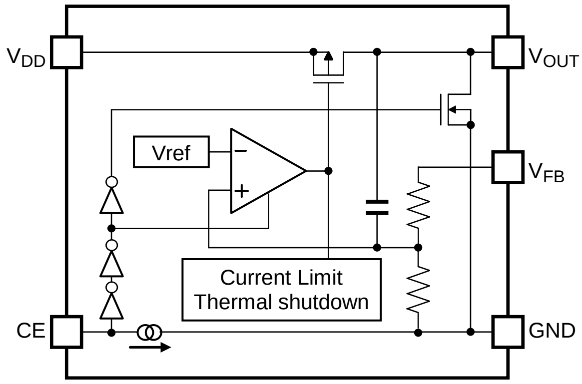
- Power source for home appliances such as refrigerators, rice cookers, and electric hot-water pot.
- Power source for notebook PCs, digital TVs, cordless phones, and private LAN system.
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, and projectors.

BLOCK DIAGRAM

R1513SxxxB Block Diagram



R1513SxxxD Block Diagram



SELECTION GUIDE

The set output voltage and the auto-discharge option[*1] are user-selectable options.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1513Sxx1∗-E2-FE	HSOP-6J	1,000 pcs	Yes	Yes

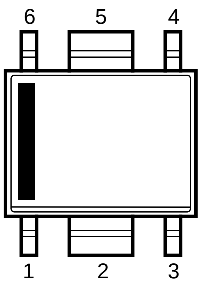
xx: Specify the set output voltage (V_{SET}) from below.

1.2 V (12) / 1.5 V (15) / 1.8 V (18) / 3.3 V (33) / 3.4 V (34) / 5.0 V (50)

∗: Specify the auto-discharge option.
B: Auto-discharge option not included
D: Auto-discharge option included

[*1] Auto-discharge function quickly lowers the output voltage to 0 V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

PIN DESCRIPTION



HSOP-6J Pin Configuration

HSOP-6J Pin Description

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

[*1] The GND pins must be wired together when they are 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}	CE Pin Input Voltage		−0.3 to 50	V
V_{FB}	V_{FB} Pin Input Voltage		−0.3 to V_{OUT} + 0.3 ≤ 50	V
V_{OUT}	Output Voltage		−0.3 ~ V_{IN} + 0.3 ≤ 50	V
P_D	Power Dissipation[*2]	Ultra High Wattage Land Pattern	3400	mW
		Standard Land Pattern	2100	
Ta	Operating Temperature Range		−40 to 125	°C
Tstg	Storage Temperature Range		−55 to 150	°C

[*1] Duration time = 200 ms

[*2] Refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage 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 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 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.

ELECTRICAL CHARACTERISTICS

C1 = 1.0 μF, C2 = 4.7 μF, V_{OUT} = $V_{FB,}$ V_{SET} = Set Output Voltage, unless otherwise noted.

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

R1513SxxxB/D Electrical Characteristics (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN} = 14 V, I_{OUT} = 0 mA			75	110	μA
Istandby	Standby Current	V_{IN} = 36 V, V_{CE} = 0 V			0.1	2.0	μA
V_{OUT}	Output Voltage	3.5 V ≤ V_{SET} +1 V ≤ V_{IN} ≤ 36 V, I_{OUT} = 1 mA	V_{SET} ≤ 1.8 V	−18		18	mV
			1.8 V < V_{SET}	×0.99		×1.01	V
		3.5 V ≤ V_{SET} +1 V ≤ V_{IN} ≤ 14 V, 1 mA ≤ I_{OUT} ≤ 50 mA	V_{SET} ≤ 1.8 V	−18		18	mV
			1.8 V < V_{SET}	×0.99		×1.01	V
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	3.5 V ≤ V_{SET} +1 V ≤ V_{IN} ≤ 36 V I_{OUT} = 1 mA		−0.02	0.01	0.02	%/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	3.5V ≤ V_{IN} = V_{SET} +1 V, 1 mA ≤ I_{OUT} ≤ 300 mA	V_{SET} ≤ 1.8 V	−5		5	mV
			V_{SET} = 3.3 V	−8		8	
			V_{SET} = 5.0 V	−12		12	
V_{DIF}	Dropout Voltage	I_{OUT} = 300 mA	V_{SET} = 1.2 V			2.30	V
			1.5V ≤ V_{SET}			2.00	
			1.8V ≤ V_{SET}			1.70	
			3.3V ≤ V_{SET}		0.39	0.74	
			5.0V ≤ V_{SET}		0.32	0.60	
I_{LIM}	Output Current Limit	V_{IN} = V_{SET} +1.5 V		300	450		mA
I_{SC}	Short Current Limit	V_{OUT} = 0 V		40	50		mA
R_{FB}	Feedback Resistance			1.0	2.4		MΩ
V_{CEH}	CE Input Voltage "H"			2.2		36	V
V_{CEL}	CE Input Voltage "L"			0		1.0	V
I_{PD}	CE Pull-down Current	V_{CE} = 5.0 V			0.2	0.6	μA
		V_{CE} = 36 V			0.5	1.3	
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature		150	160		°C
T_{TSR}	Thermnal Shutdown Released Temperature	Junction Temperature		125	135		°C
R_{LOW}	Low Output Nch Tr. ON Resistance (R1513SxxxD)	V_{IN} = 14.0 V, V_{CE} = 0 V		1.5	3.2	6.7	kΩ

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

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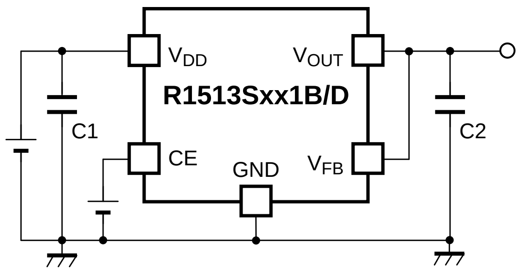
The specifications surrounded by ☐ are guaranteed by design engineering at –40°C ≤ Ta ≤ 125°C.

Product-specific Electrical Characteristics

(Ta = 25°C)

Product Name	V_{OUT} [V]			$\Delta V_{OUT}/\Delta I_{OUT}$ [mV]		V_{DIF} [V]	
	MIN.	TYP.	MAX.	MIN.	MAX.	TYP.	MAX.
R1513S121x	1.182	1.200	1.218	-5	5		2.30
R1513S151x	1.482	1.500	1.518	-5	5		2.00
R1513S181x	1.782	1.800	1.818	-5	5		1.70
R1513S331x	3.267	3.300	3.333	-8	8	0.39	0.74
R1513S341x	3.366	3.400	3.434	-8	8	0.39	0.74
R1513S501x	4.950	5.000	5.050	-12	12	0.32	0.60

TYPICAL APPLICATION



R1513S Typical Application

External Components List

Symbol	Description
C1	1.0 µF, Ceramic Capacitor
C2	4.7µF, Ceramic Capacitor

TECHNICAL NOTES

Phase Compensation

Phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, use a 4.7 µF or more output capacitor (C2) with good frequency characteristics and proper ESR (Equivalent Series Resistance). Connect a 1.0 µF or more input capacitor (C1) between the V_{DD} pin and the GND pin as close as possible to the pins.

In case of using a tantalum type capacitor with a large ESR, the output might become unstable. Evaluate your circuit including consideration of frequency characteristics.

Depending on the capacitor size, manufacturer, and part number, the bias characteristics and the temperature characteristics vary.

PCB Layout

Ensure the V_{DD} and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. No. 2 pin and No.5 pin must be wired together when mounting on board. Connect a capacitor with a suitable between the V_{DD} and GND pins, and as close as possible to the pins. The load regulation can be improved by short-circuiting V_{OUT} and V_{FB} close to the load device.

Thermal Shutdown Function

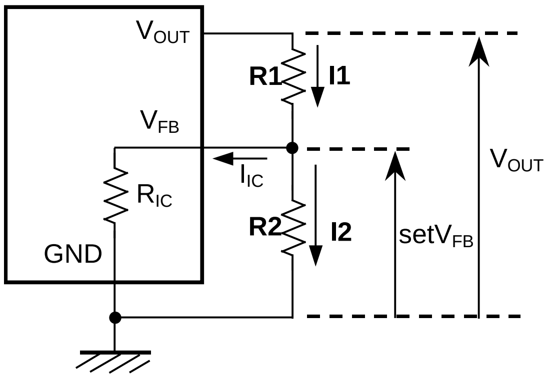
Thermal shutdown function detects overheating of the regulator and stops the regulator operation to protect the device from damage. Thermal shutdown circuit stops the regulator operation if the junction temperature becomes higher than 160°C (Typ.) and restarts the regulator operation if the junction temperature drops below 135°C (Typ.). The regulator repeats turning on and off and creates pulse waveform until the cause of the overheating is removed.

Adjustable Output Voltage Setting

Output voltage can be adjusted by using the external divider resistors (R1, R2). By using the following equation, the output voltage (V_{OUT}) can be determined. The voltage which is fixed inside the IC is described as V_{FB}.

$V_{OUT} = V_{FB}$ x ((R1 + R2) / R2)

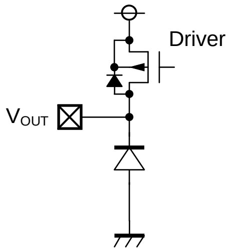
Recommended Output Voltage Range: 1.2 V ≤ V_{OUT} ≤ 18 V
$V_{FB} = V_{SET}$



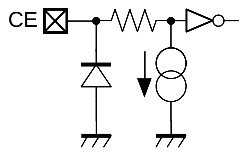
Output Voltage Adjustment Using External Divider Resistors (R1, R2)

The minimum resistance value for a resistor (R_{IC}) is 1 MΩ (Ta = 25°C, guaranteed by design). For better accuracy, setting R1 << R_{IC} reduces errors. The resistance value for a resistor (R2) should be set to 33 kΩ or lower. If the resistance values set for R1 and R2 are larger, the impedance of the V_{FB} pin becomes larger.
R_{IC} could be affected by temperature; therefore, evaluate the circuit taking the actual conditions of use into account when deciding the resistance values for R1 and R2.

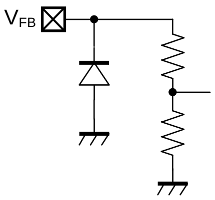
PIN EQUIVALENT CIRCUIT DIAGRAMS



V_{OUT} Pin Equivalent Circuit Diagrams



CE Pin Equivalent Circuit Diagrams



V_{FB} Pin Equivalent Circuit Diagrams

PACKAGE INFORMATION

POWER DISSIPATION (HSOP-6J)

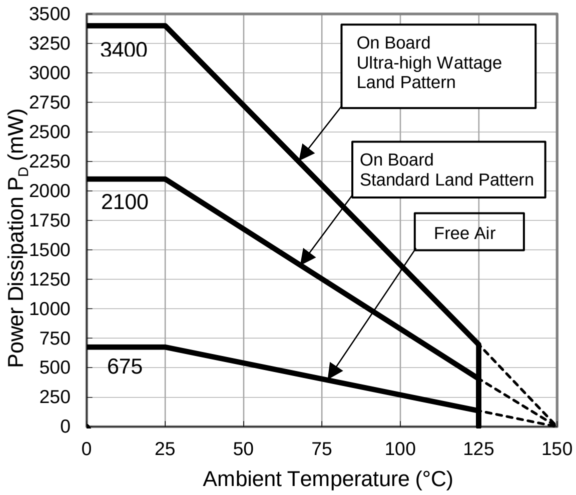
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

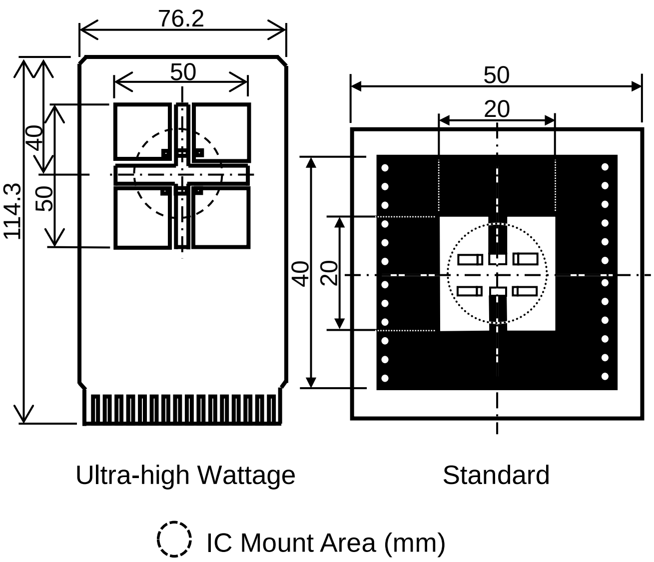
	Ultra-high Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-layer Board)	Glass Cloth Epoxy Plastic (Double-sided Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm	50 mm × 50 mm × 1.6 mm
Copper Ratio	96%	50%
Through-holes	ϕ 0.3 mm × 28 pcs	ϕ 0.5 mm × 24 pcs

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

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

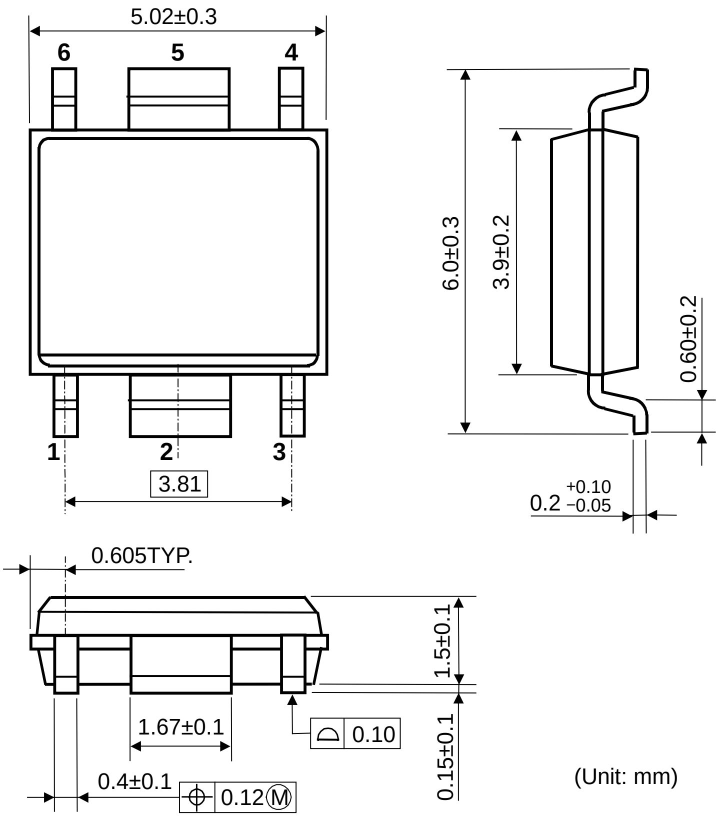


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (HSOP-6J)

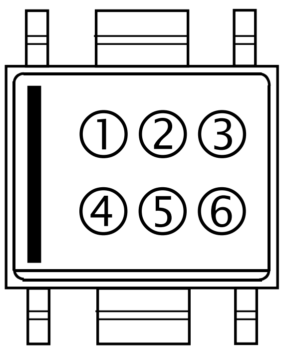


HSOP-6J Package Dimensions

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)

Mark Specification Table

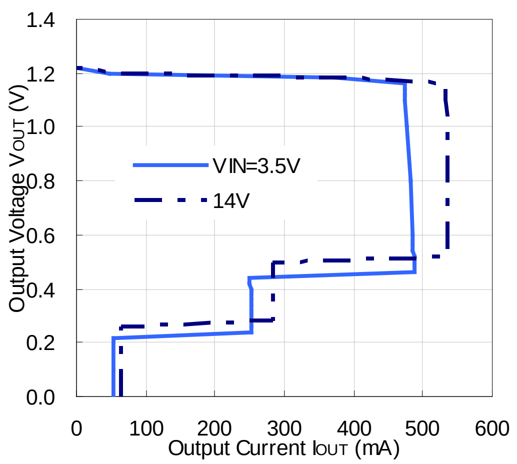
Product Name	①②③④
R1513S121B	Z 1 2 B
R1513S151B	Z 1 5 B
R1513S181B	Z 1 8 B
R1513S331B	Z 3 3 B
R1513S341B	Z 3 4 B
R1513S501B	Z 5 0 B
R1513S121D	Z 1 2 D
R1513S151D	Z 1 5 D
R1513S181D	Z 1 8 D
R1513S331D	Z 3 3 D
R1513S341D	Z 3 4 D
R1513S501D	Z 5 0 D

TYPICAL CHARACTERISTICS

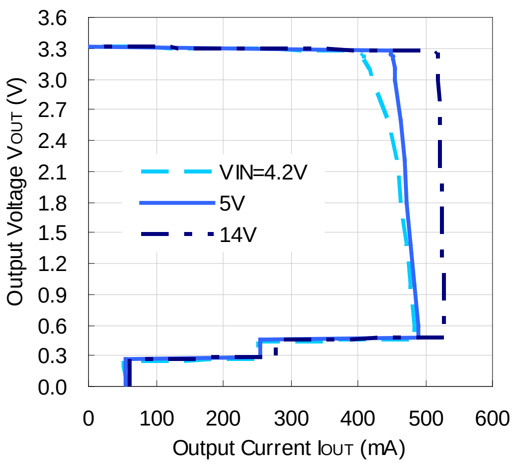
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

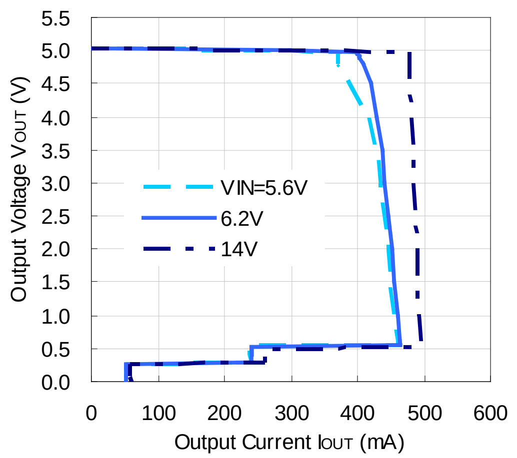
R1513S121B/D



R1513S331B/D

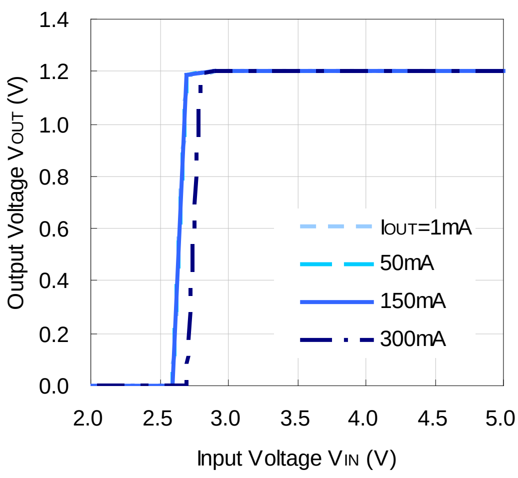


R1513S501B/D



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

R1513S121B/D



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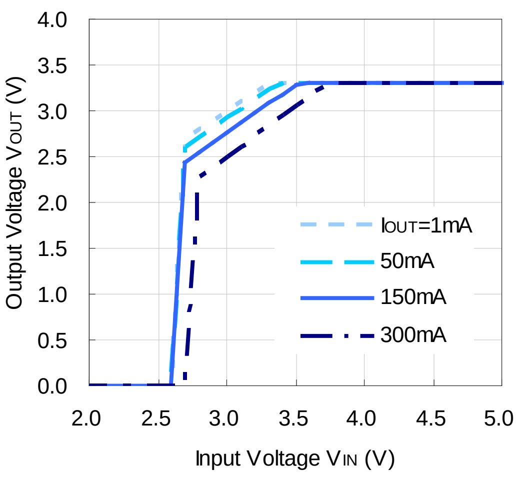
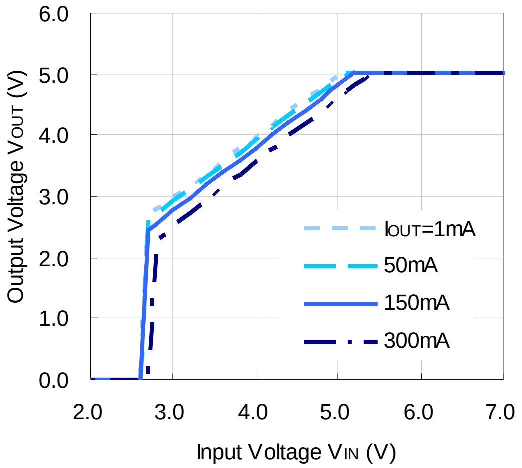
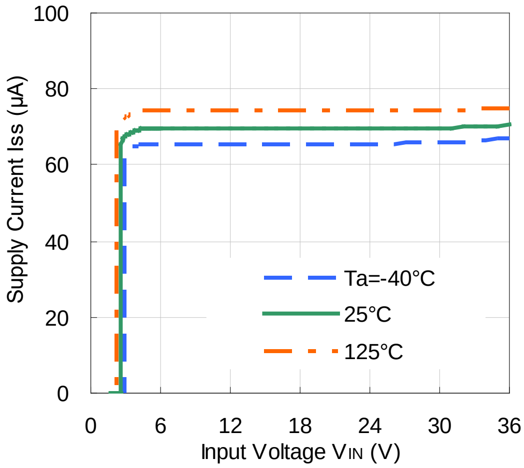


R1513S501B/D

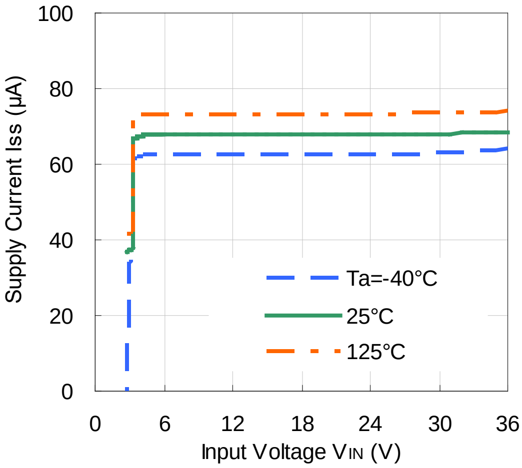


3) Supply Current vs. Input Voltage (Ta = 25°C)

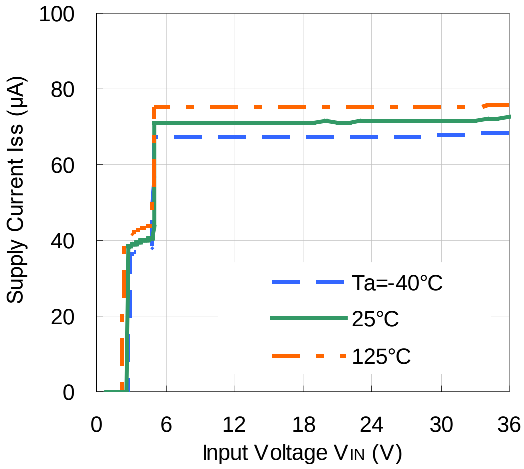
R1513S121B/D



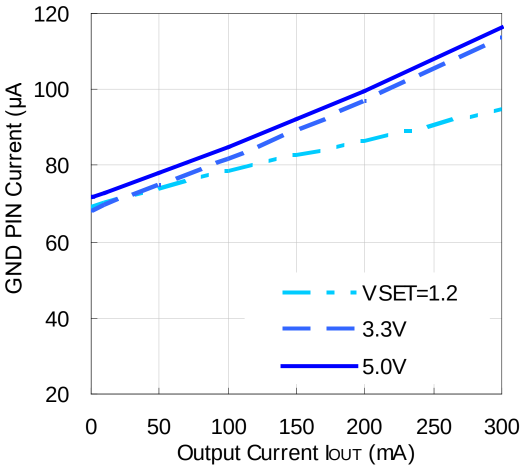
R1513S331B/D



R1513S501B/D

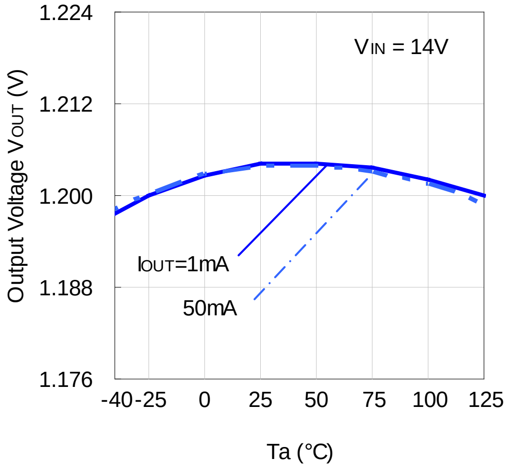


4) GND Pin Current vs. Output Current (Ta = 25°C)

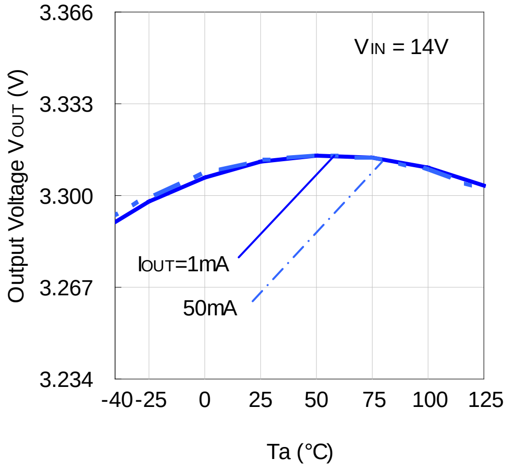


5) Output Voltage vs. Ambient Temperature

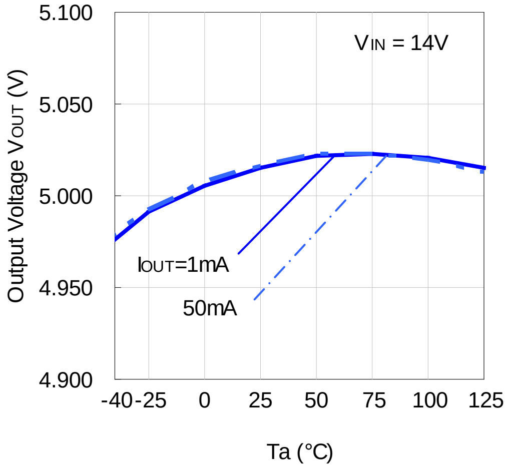
R1513S121B/D



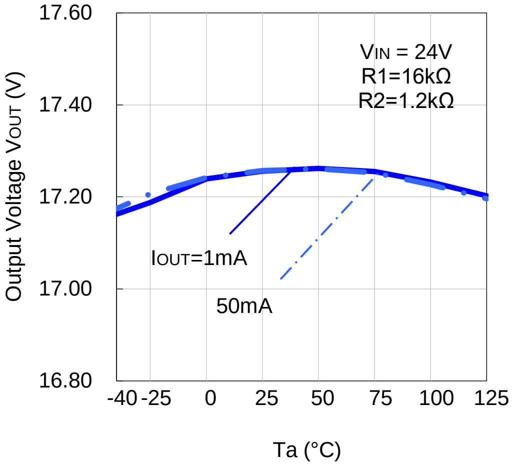
R1513S331B/D



R1513S501B/D

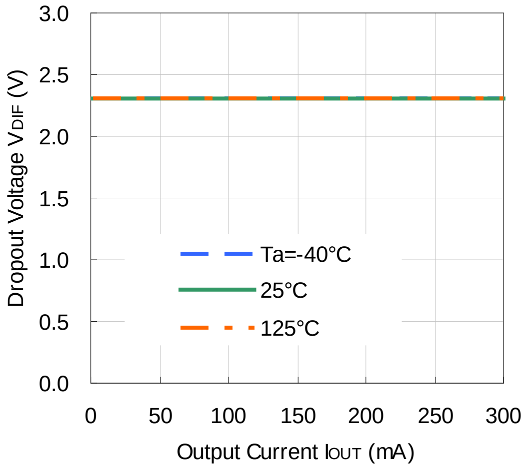


R1513S121B/D
(Output Voltage Adjusted to 17.2 V)

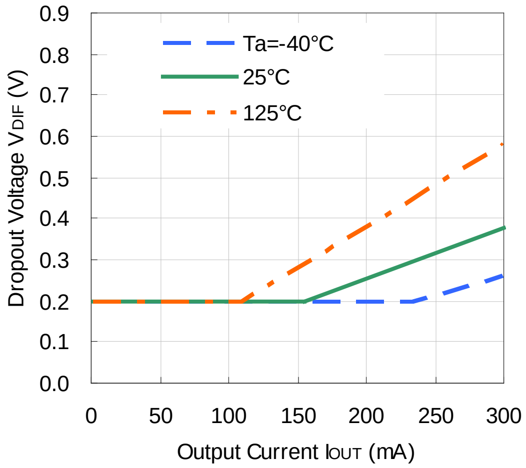


6) Dropout Voltage vs. Output Current

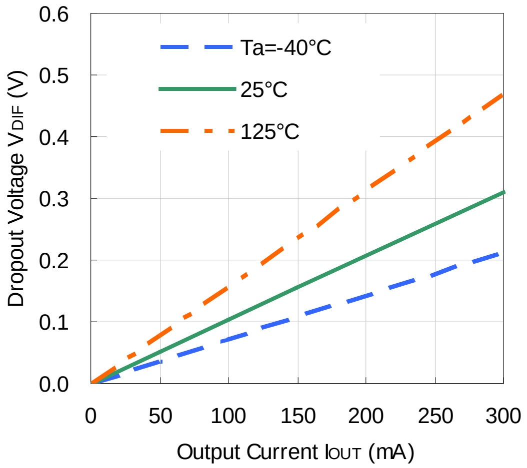
R1513S121B/D



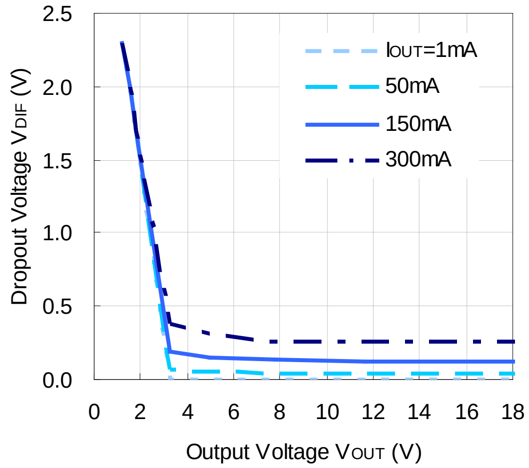
R1513S331B/D



R1513S501B/D

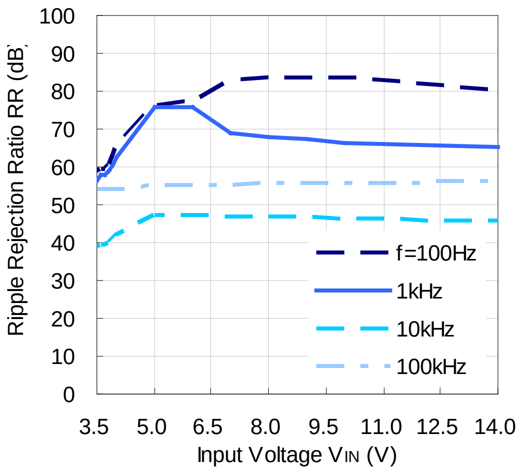


7) Dropout Voltage vs. Output Voltage (Ta = 25°C)

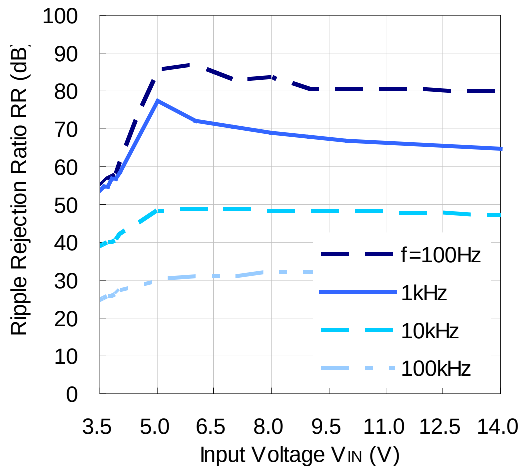


8) Ripple Rejection vs. Input Voltage (Ta = 25°C, Ripple = 0.5 Vpp)

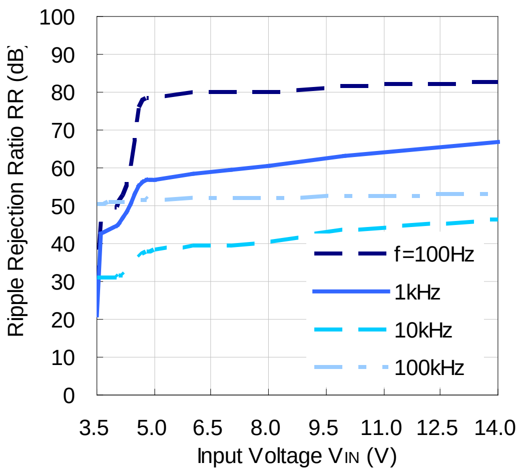
R1513S121B/D (I_{OUT} = 1 mA)



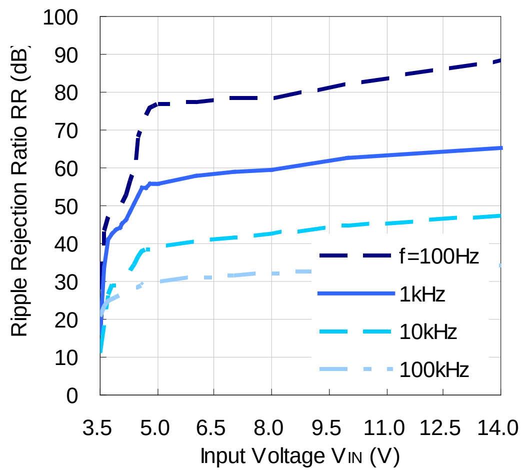
R1513S121B/D (I_{OUT} = 50 mA)



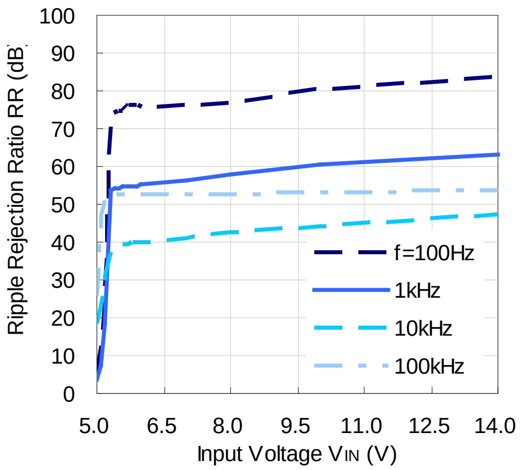
R1513S331B/D (I_{OUT} = 1 mA)



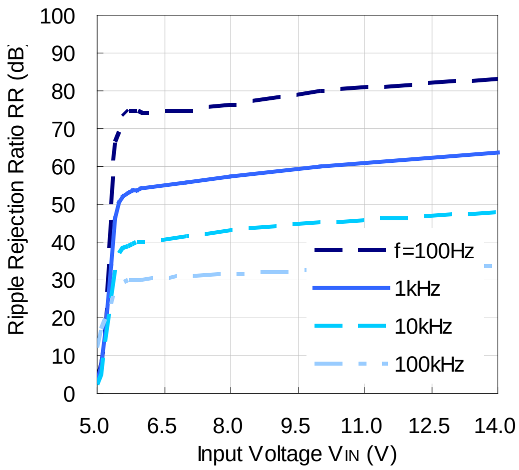
R1513S331B/D (I_{OUT} = 50 mA)



R1513S501B/D (I_{OUT} = 1 mA)

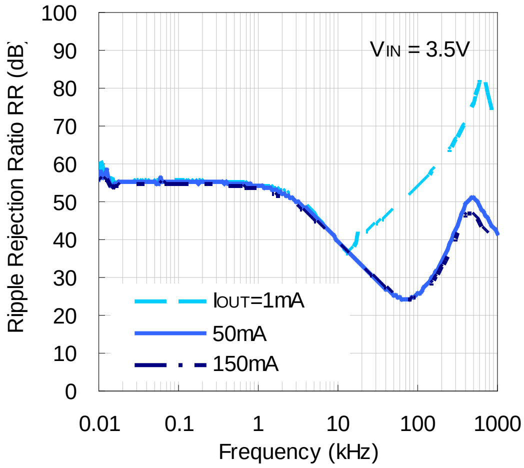


R1513S501B/D (I_{OUT} = 50 mA)

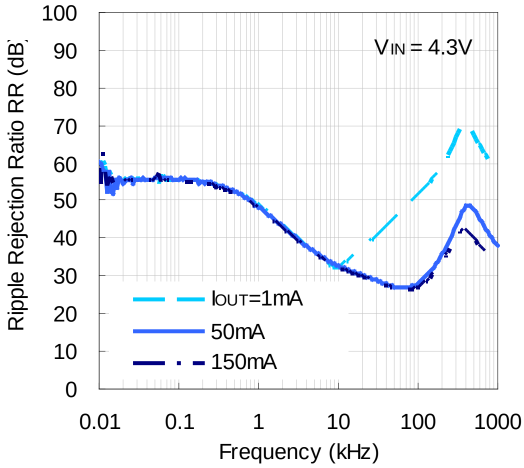


9) Ripple Rejection vs. Frequency (Ta = 25°C, Ripple = 0.5 Vpp)

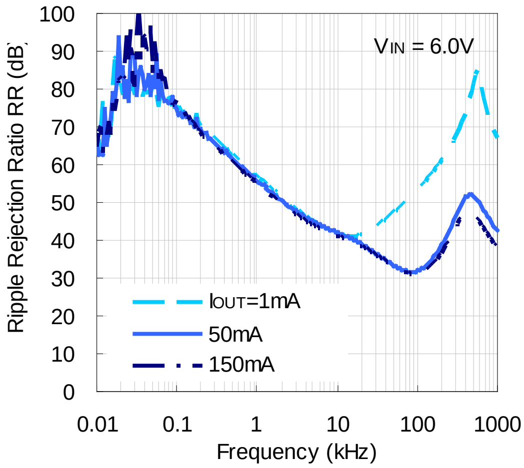
R1513S121B/D



R1513S331B/D

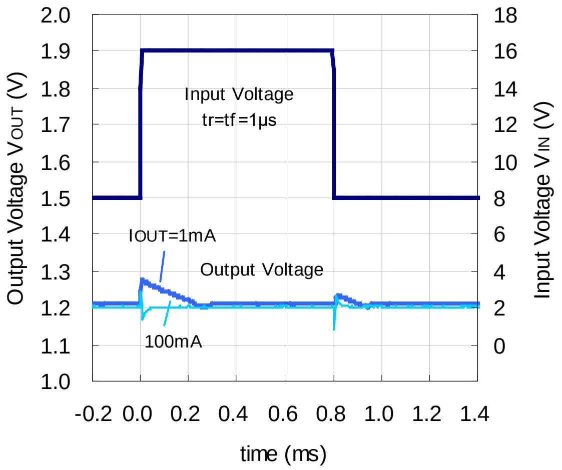


R1513S501B/D

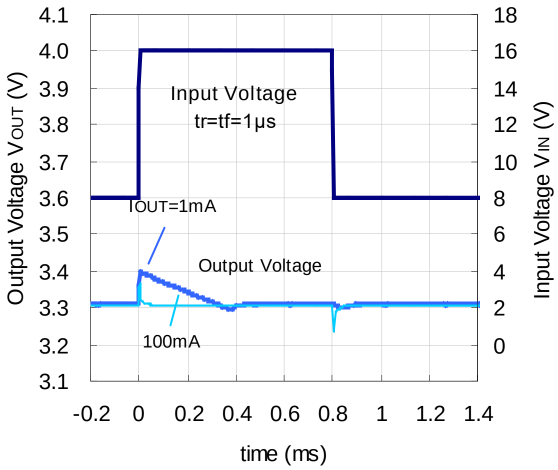


10) Input Transient Response (Ta = 25°C, C2 = 4.7μF)

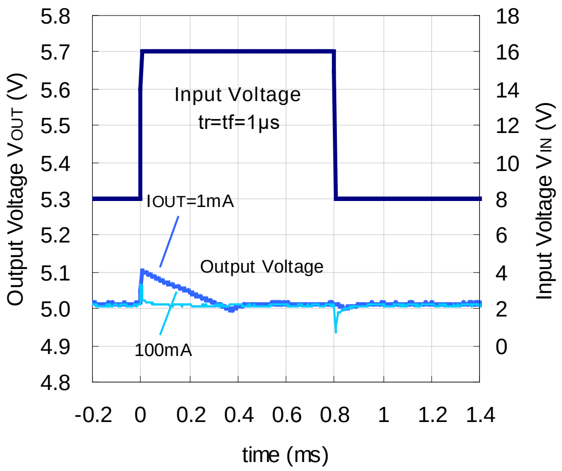
R1513S121B/D



R1513S331B/D

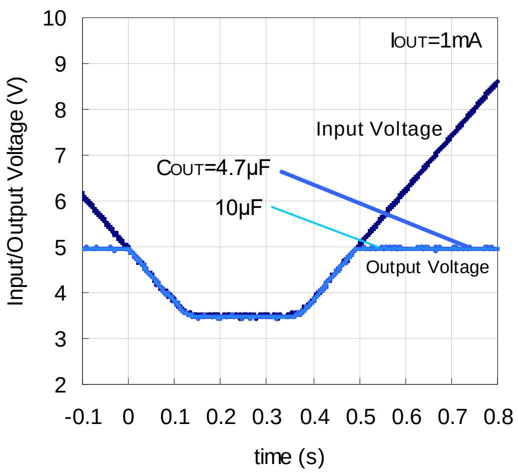


R1513S501B/D



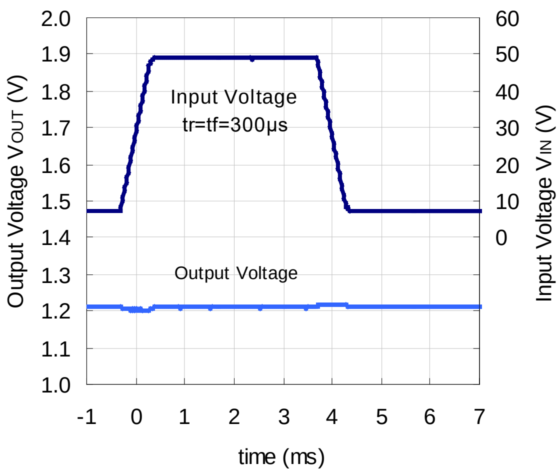
11) Cranking (Ta = −18°C)

R1513S501B/D

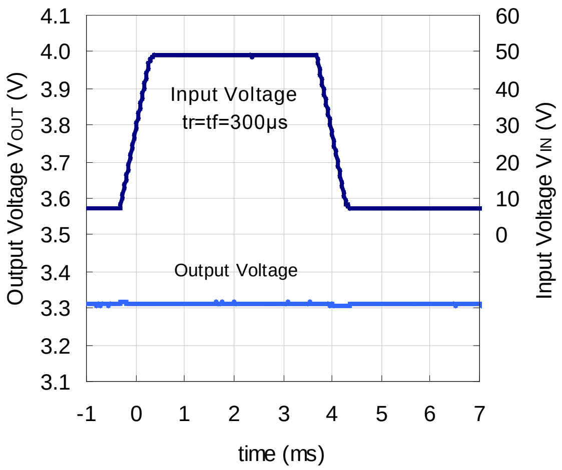


12) Load Dumping (Ta = 25°C, C2 = 4.7 μF)

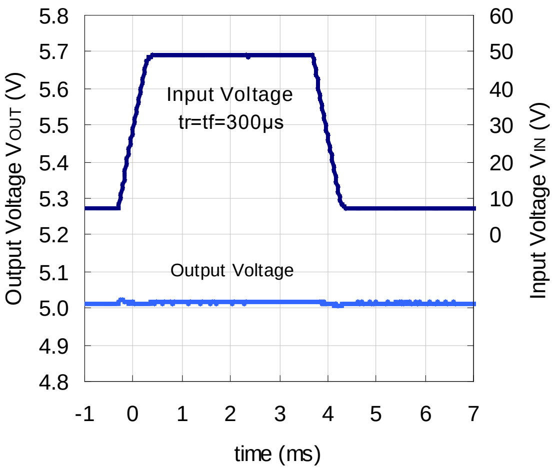
R1513S121B/D



R1513S331B/D

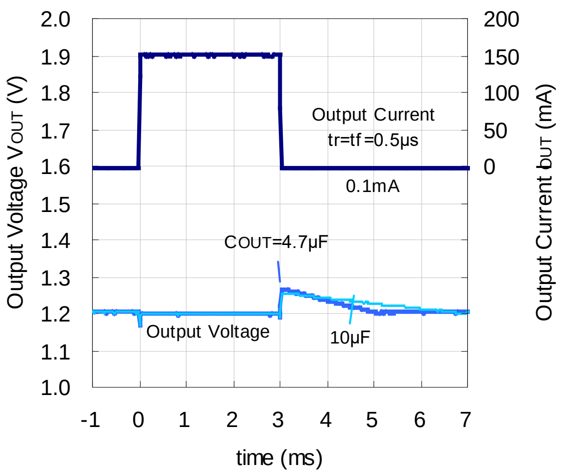


R1513S501B/D

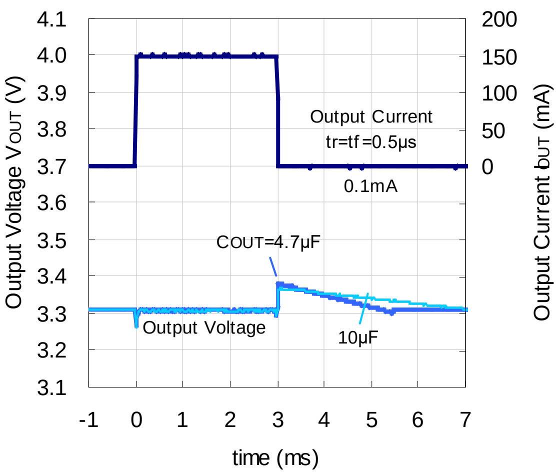


13) Load Transient Response (Ta = 25°C)

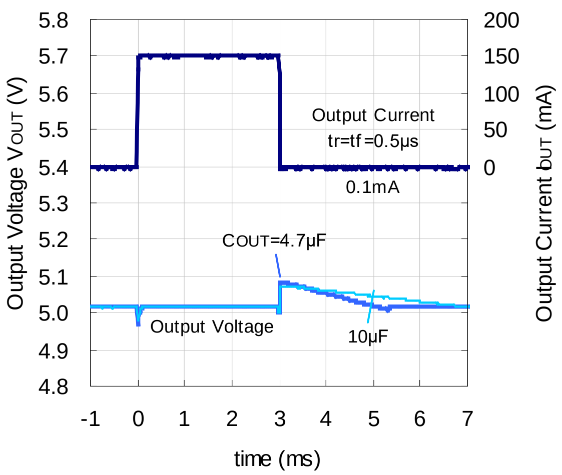
R1513S121B/D



R1513S331B/D

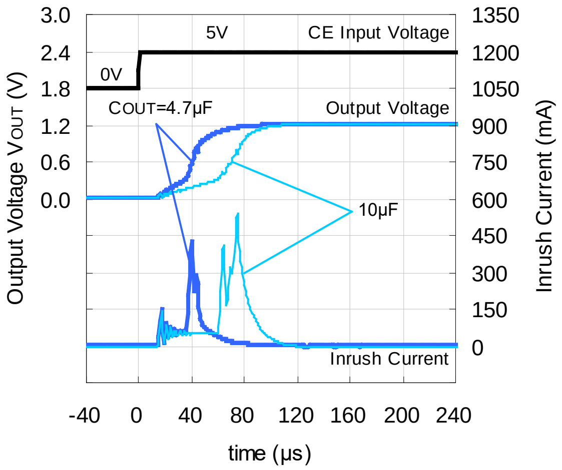


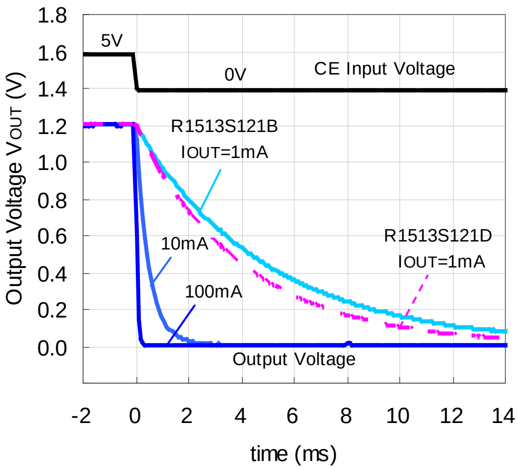
R1513S501B/D



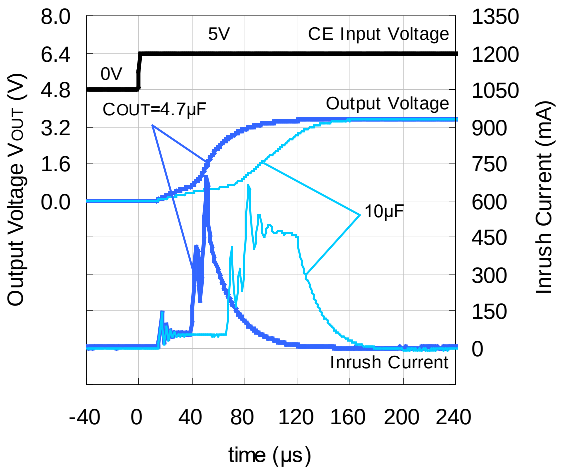
14) CE Transient Response (Ta = 25°C)

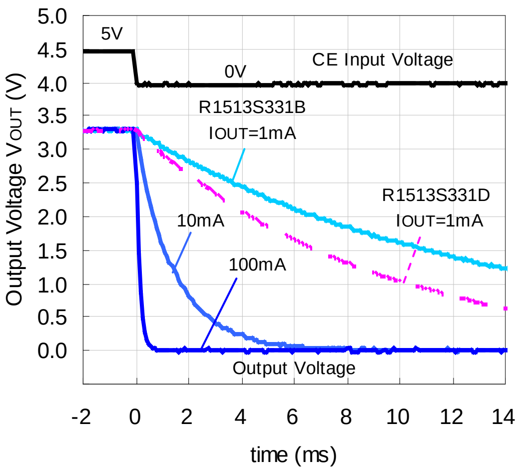
R1513S121B/D (V_{IN} = 3.5 V)



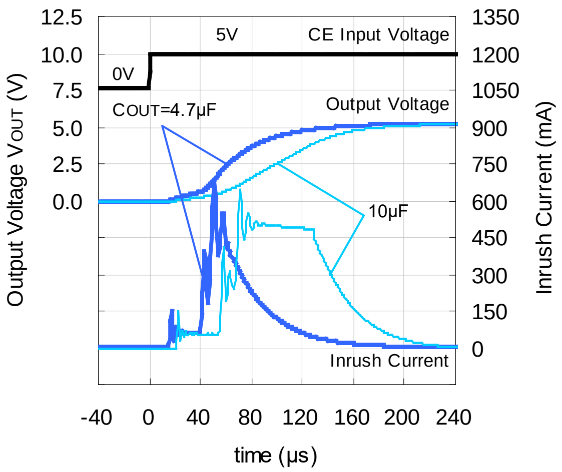


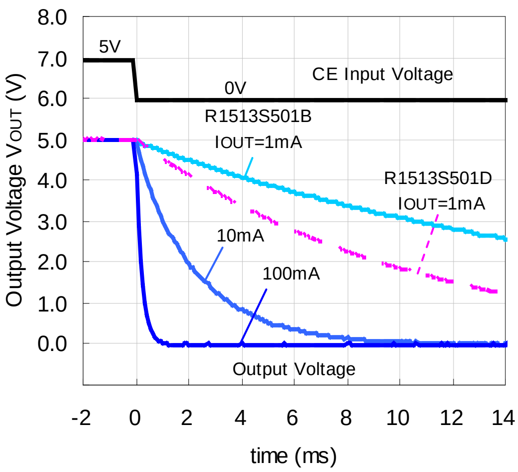
R1513S331B/D (V_{IN} = 4.3 V)





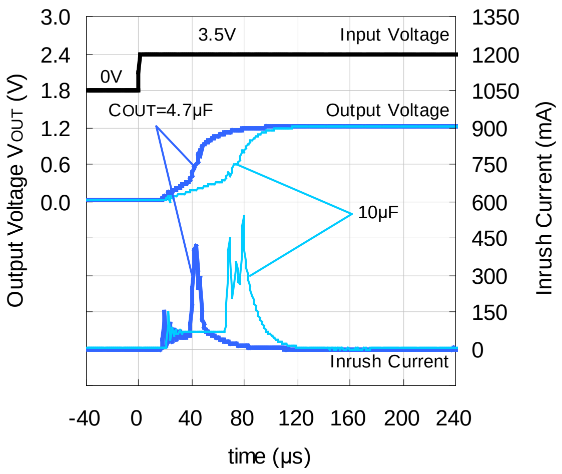
R1513S501B/D (V_{IN} = 6.0 V)



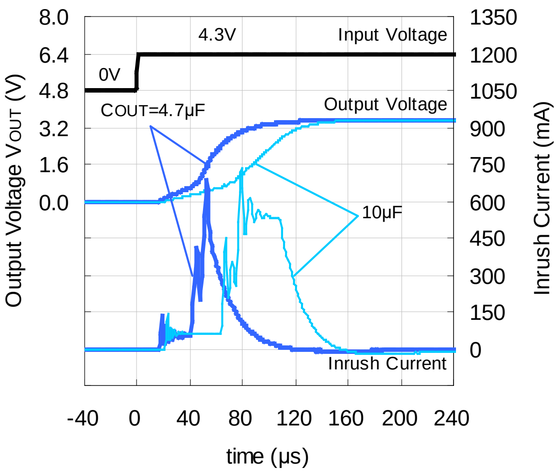


15) Power-on Transient Response (Ta = 25°C, V_{CE} = 5 V)

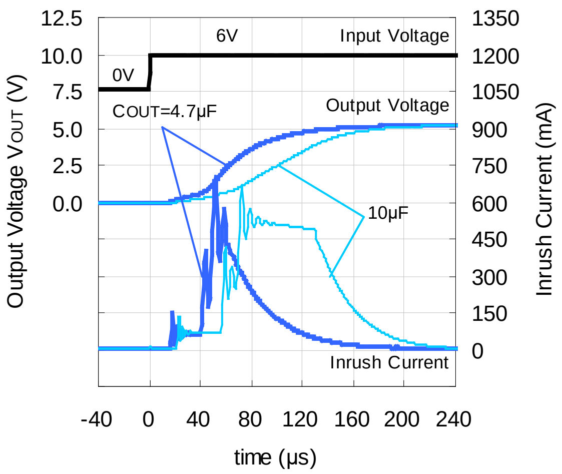
R1513S121B/D



R1513S331B/D

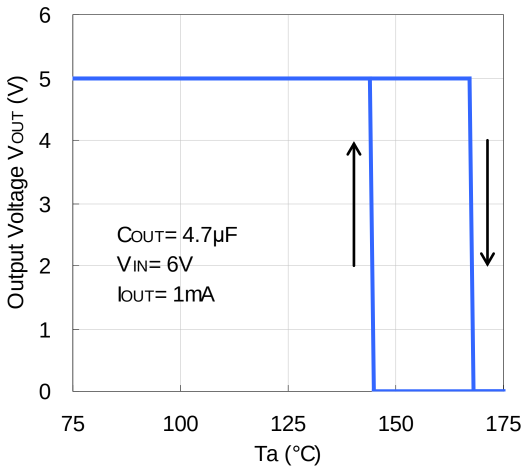


R1513S501B/D



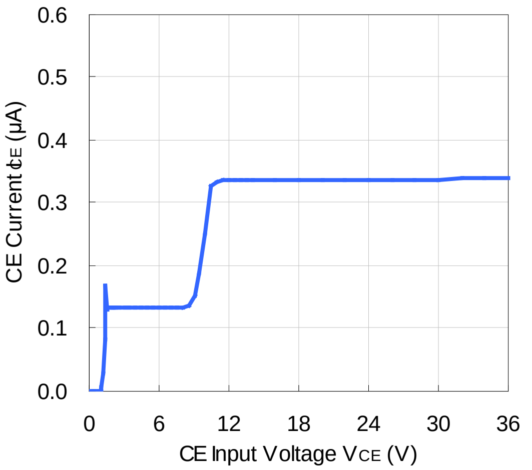
16) Thermal Shutdown

R1513S501B/D



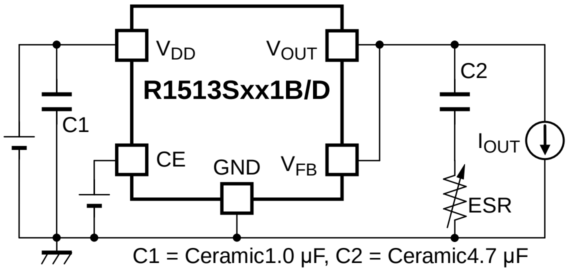
17) CE Pin Current vs. CE Pin Voltage (Ta = 25°C)

R1513Sxx1B/D

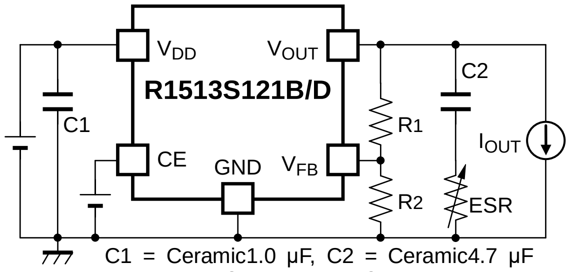


Equivalent Series Resistance (ESR) vs. Output Current

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 = Ceramic1.0 µF, C2 = Ceramic4.7 µF



C1 = Ceramic1.0 µF, C2 = Ceramic4.7 µF
R1 = 510 kΩ, R2 = 36 kΩ

Measurement Conditions

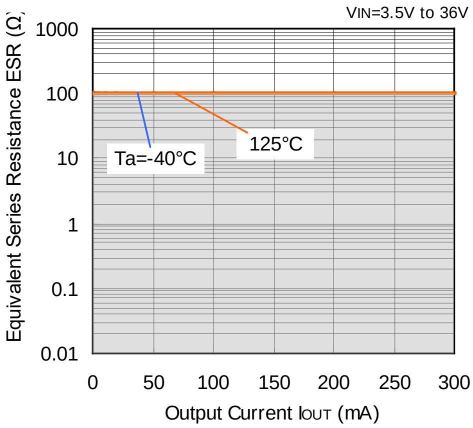
Frequency Band: 10 Hz to 2 MHz

Ambient Temperature: −40°C to 125°C

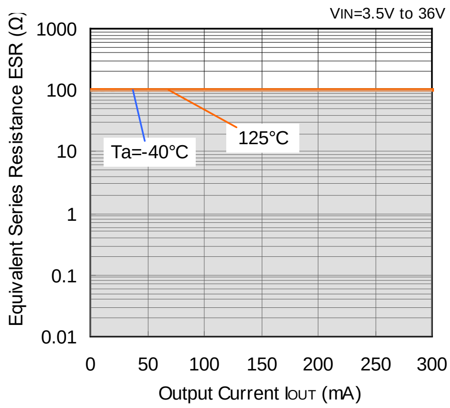
Hatched Area: Noise level below 40 µV (average)

Capacitor: C1 = 1.0 µF Ceramic Capacitor, C2 = 4.7 µF Ceramic Capacitor (CGA4J3X7R1C475K125AB)

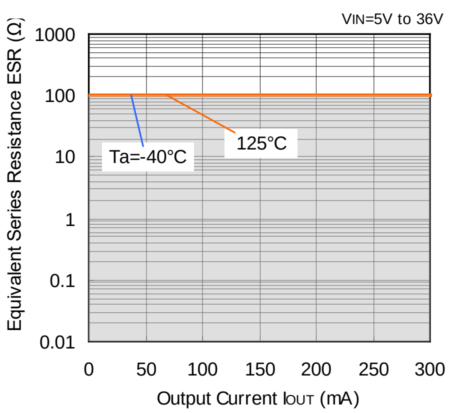
R1513S121B/D



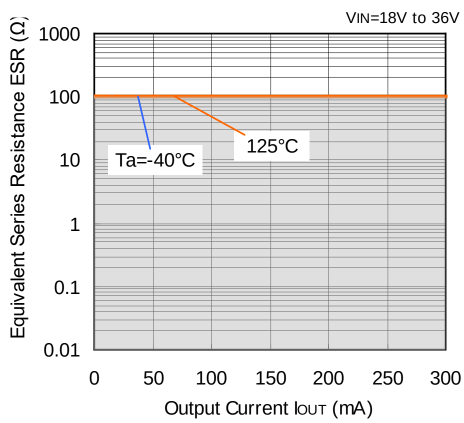
R1513S331B/D



R1513S501B/D



R1513S121B/D (V_{OUT} to 18.2 V)



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