

1 A 36V Input Low Supply Current LDO for Automotive Applications

NO.EC-329-190212

OUTLINE

R1518x is a CMOS-based LDO that specifically designed for automotive applications featuring 1 A output current and 36 V input voltage. In addition to a conventional regulator circuit, R1518x consists of a constant slope circuit as a soft-start function, a fold-back protection circuit, a short current limit circuit, and a thermal shutdown circuit. Besides the low supply current by CMOS, the operating temperature is -40°C to 125°C and the maximum input voltage is 36 V, the R1518x is very suitable for power source of car accessories.

R1518x is available in R1518xxxB/D/E/F with the internally fixed output voltage, and R1518xxxD/F with the auto-discharge function at standby.

R1518x001C can adjust the output voltage with an external resistor. R1518xxxB/C/D internally fixes the soft-start time at 120 μs (Typ). R1518Jxx1E/F can adjust the soft-start time with an external capacitor.

R1518x is available in two packages for ultra high wattage: HSOP-6J and TO-252-5-P2.

FEATURES

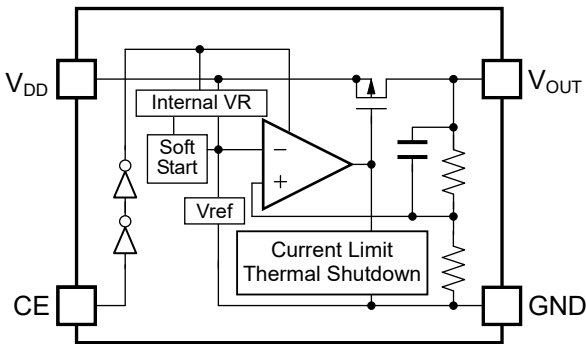
- Input Voltage Range (Maximum Rating) 3.5 V to 36.0 V (50.0V)
- Operating Temperature range -40°C to 125°C
- Supply Current Typ. 18 μA
- Standby Current Typ. 0.1 μA
- Dropout Voltage Typ. 0.7 V ($I_{\text{OUT}} = 1 \text{ A}$, $V_{\text{OUT}} = 5.0 \text{ V}$)
- Output Voltage Accuracy $\pm 0.8\%$ ($V_{\text{OUT}} \leq 5.0 \text{ V}$)
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 60 \text{ ppm}/^{\circ}\text{C}$ ($-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$)
- Line Regulation Typ. 0.01%/V
- Packages HSOP-6J, TO-252-5-P2
- Output Voltage Range R1518xxxB/D/E/F: 2.5 V/2.8 V/3.0 V/3.3 V/3.4 V/5.0 V/
6.0 V/8.0 V/8.5 V/9.0 V
*Contact Ricoh sales representatives for other voltages.
R1518x001C: Adjustable from 2.5 V to 12.0 V
with external resistor
Feedback Voltage: 2.5 V
- Built-in Short Current Limit Circuit Typ. 150 mA
- Built-in Fold-Back Protection Circuit Min. 1.1 A
- Built-in Thermal Shutdown Circuit Typ. 160°C
- Built-in Soft-start Circuit R1518xxxB/C/D: Typ. 120 μs
R1518Jxx1E/F: Time adjustable
- Ceramic Capacitors can be used R1518xxxB/D/E/F: 0.1 μF or more
R1518x001C: 1.0 μF or more

APPLICATIONS

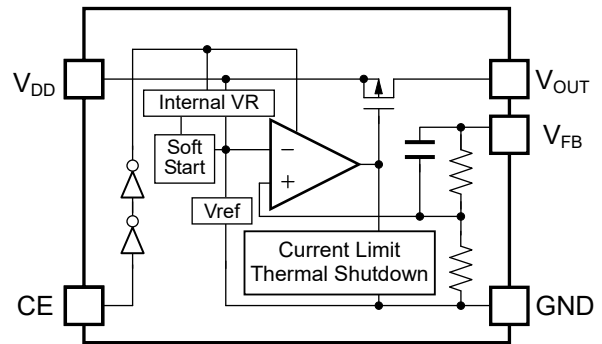
- Power source for car accessories including car audio equipment, car navigation system, and ETC system.
- Power source for control units including EV inverter and charge control.

BLOCK DIAGRAMS

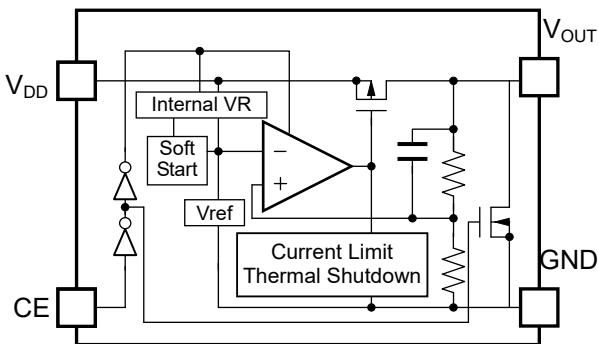
R1518xxxxB



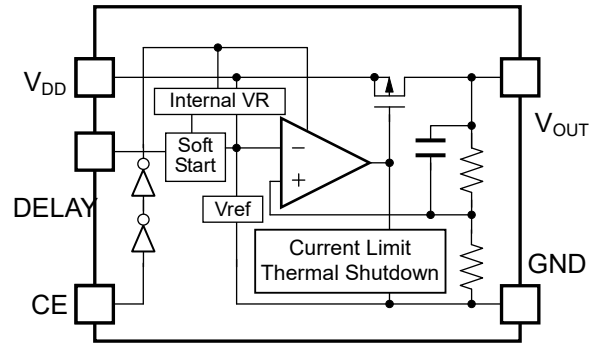
R1518x001C



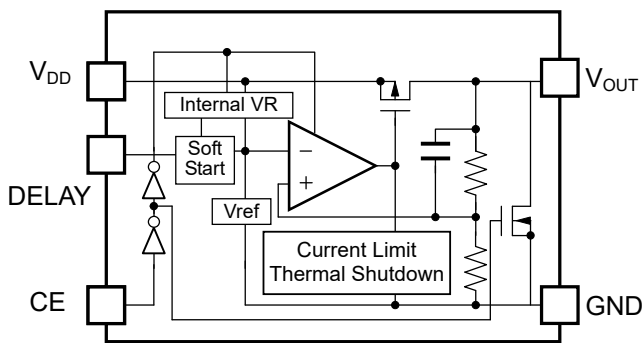
R1518xxxxD



R1518Jxx1E



R1518Jxx1F



SELECTION GUIDE

The output voltage, version, and package type for this device can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1518Sxx2*-E2-#E	HSOP-6J	1,000 pcs	Yes	Yes
R1518S001C-E2-#E				
R1518Jxx1*-T1-#E	TO-252-5-P2	3,000 pcs	Yes	Yes
R1518J001C-T1-#E				

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

2.5 V (25) / 2.8 V (28) / 3.0 V (30) / 3.3 V (33) / 3.4 V (34) / 5.0 V (50) / 6.0 V (60) /
8.0 V (80) / 8.5 V (85) / 9.0 V (90)

Note: Contact Ricoh sales representatives for other voltages.

Adjustable output voltage setting type is fixed to (00)

Note: For R1518S001C-E2-#E and R1518J001C-T1-#E (No auto-discharge function)

* : Specify the version with desired functions

B: No auto-discharge function

D: Auto-discharge function

E: No auto-discharge function / Adjustable soft-start time setting

F: Auto-discharge function / Adjustable soft-start time setting

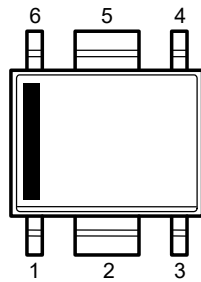
Note: R1518Sxx2*-E2-#E can provide R1518Sxx2B/D only.

: Specify Automotive Class Code

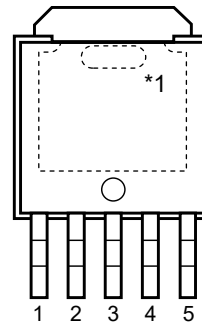
	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 125°C	25°C	High temperature
K	-40°C to 125°C	-40°C to 125°C	High and low temperature

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

PIN DESCRIPTION



HSOP-6J



TO-252-5-P2

HSOP-6J

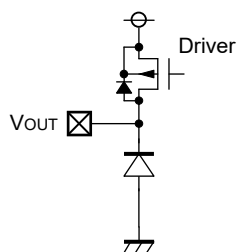
Pin No.	Symbol	Description	
1	V _{DD}	Input Pin	
2	GND	Ground Pin	
3	GND	Ground Pin	R1518Sxx2B/D
	V _{FB}	Feedback Pin	R1518S001C
4	CE	Chip Enable Pin, Active-high	
5	GND	Ground Pin	
6	V _{OUT}	Output Pin	

TO-252-5-P2

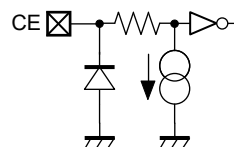
Pin No.	Symbol	Description	
1	V _{DD}	Input Pin	
2	NC	No Connection	R1518Jxx1B/D
	V _{FB}	Feedback Pin	R1518J001C
	DELAY	Adjustable Soft-start Time Pin	R1518Jxx1E/F
3	GND	Ground Pin	
4	CE	Chip Enable Pin, Active-high	
5	V _{OUT}	Output Pin	

*1 The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). The tab is recommended to connect to the ground plane on the board. Otherwise it may be left floating.

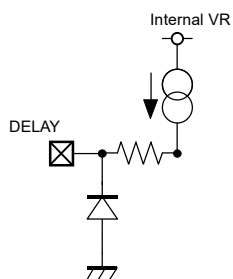
PIN EQUIVALENT CIRCUIT DIAGRAMS



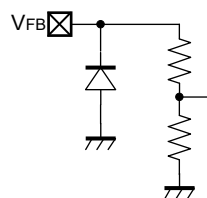
V_{OUT} Pin



CE Pin



**DELAY Pin
(R1518Jxx1E/F)**



**V_{FB} Pin
(R1518x001C)**

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 _{FB}	Input Voltage (V _{FB} Pin)	-0.3 to 50	V	
V _{OUT}	Output Voltage	-0.3 to V _{IN} + 0.3 ≤ 50	V	
P _D	Power Dissipation * ² (JEDEC STD.51)	HSOP-6J	3400	mW
		TO-252-5-P2	4800	
T _j	Junction Temperature	-40 to 150	°C	
T _{stg}	Storage Temperature Range	-55 to 150	°C	

*¹ Duration time = 200 ms

*² Refer to *POWER DISSIPATION* 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 CONDITIONS

Symbol	Item	Rating	Unit
V _{IN}	Input Voltage	3.5 to 36	V
T _a	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.

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{SET} + 1.0\text{ V}$, $I_{OUT} = 1\text{ mA}$, $C_{IN} = C_{OUT} = 0.1\text{ }\mu\text{F}$, unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$.

R1518xxxxB/D (-AE)

($T_a = 25^{\circ}\text{C}$)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V_{OUT}	Output Voltage	$T_a = 25^{\circ}\text{C}$	$V_{SET} \leq 5.0\text{ V}$	$\times 0.992$		$\times 1.008$	V
			$V_{SET} > 5.0\text{ V}$	$\times 0.99$		$\times 1.01$	V
		$-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$	$V_{SET} \leq 5.0\text{ V}$	$\times 0.982$		$\times 1.018$	V
			$V_{SET} > 5.0\text{ V}$	$\times 0.98$		$\times 1.02$	V
$\Delta V_{OUT} / \Delta I_{OUT}$	Load Regulation	$V_{IN} = V_{SET} + 2.0\text{ V}$ $1\text{ mA} \leq I_{OUT} \leq 250\text{ mA}$	-15	3	25	mV	
		$V_{IN} = V_{SET} + 2.0\text{ V}$ $1\text{ mA} \leq I_{OUT} \leq 1\text{ A}$	-60	10	60	mV	
V_{DIF}	Dropout Voltage	$I_{OUT} = 1\text{ A}$	Refer to the <i>Product-specific Electrical Characteristics</i>				
I_{SS}	Supply Current	$I_{OUT} = 0\text{ mA}$		18	36	μA	
$I_{standby}$	Standby Current	$V_{CE} = 0\text{ V}$		0.1	2.0	μA	
$\Delta V_{OUT} / \Delta V_{IN}$	Line Regulation	$V_{SET} + 0.5\text{ V} \leq V_{IN} \leq 36\text{ V}$, if $V_{IN} \leq 3.5\text{ V}$		0.01	0.02	%/V	
I_{LIM}	Output Current Limit	$V_{IN} = V_{SET} + 2.0\text{ V}$	1.1	1.8	2.5	A	
I_{SC}	Short Current Limit	$V_{OUT} = 0\text{ V}$	110	180	250	mA	
I_{PD}	CE Pull-down Current	$V_{CE} = 5\text{ V}$		0.2	0.6	μA	
		$V_{CE} = 36\text{ V}$		0.5	1.3	μA	
t_{D1}	Soft-start Time 1			120		μs	
V_{CEH}	CE Input Voltage "H"		2.2		36	V	
V_{CEL}	CE Input Voltage "L"		0		1.0	V	
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		$^{\circ}\text{C}$	
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		$^{\circ}\text{C}$	
R_{LOW}	Low Output Nch Tr. ON Resistance (R1518xxxxD)	$V_{IN} = 14.0\text{ V}$, $V_{CE} = 0\text{ V}$	1.0	3.2	5.0	k Ω	

All test items listed under Electrical Characteristics are done under the pulse load condition ($T_j \approx T_a = 25^{\circ}\text{C}$) except for Soft-start Time 1.

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 $V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = 0.1 \mu\text{F}$, $C_{OUT} = 1.0 \mu\text{F}$, unless otherwise noted.The specifications surrounded by are guaranteed by design engineering at $-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$.**R1518x001C (-AE)**

(Ta = 25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{FB}	Feedback Voltage	T _a = 25°C	2.480		2.520	V
		-40°C ≤ T _a ≤ 125°C	2.455		2.545	V
ΔV _{OUT} / ΔI _{OUT}	Load Regulation	V _{IN} = V _{SET} + 2.0 V 1 mA ≤ I _{OUT} ≤ 250 mA	-10	3	10	mV
		V _{IN} = V _{SET} + 2.0 V 1 mA ≤ I _{OUT} ≤ 1 A	-25	5	35	mV
V _{DIF}	Dropout Voltage	V _{SET} = V _{FB} , I _{OUT} = 1 A		1.0	1.8	V
I _{SS}	Supply Current	I _{OUT} = 0 mA		18	36	μA
I _{standby}	Standby Current	V _{CE} = 0 V		0.1	2.0	μA
ΔV _{OUT} / ΔV _{IN}	Line Regulation	V _{SET} = V _{FB} , 3.5 V ≤ V _{IN} ≤ 36 V		0.01	0.02	%/V
I _{LIM}	Output Current Limit	V _{IN} = V _{SET} + 2.0 V	1.1	1.8	2.5	A
I _{SC}	Short Current Limit	V _{OUT} = V _{FB} = 0 V	110	180	250	mA
I _{PD}	CE Pull-down Current	V _{CE} = 5 V		0.2	0.6	μA
		V _{CE} = 36 V		0.5	1.3	μA
t _{D1}	Soft-start Time 1			120		μs
V _{CEH}	CE Input Voltage "H"		2.2		36	V
V _{CEL}	CE Input Voltage "L"		0		1.0	V
T _{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		°C
T _{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		°C

All test items listed under Electrical Characteristics are done under the pulse load condition (T_j ≈ T_a = 25°C) except for Soft-start Time 1.

$V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$, unless otherwise noted.

The specifications surrounded by are guaranteed by design engineering at $-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$.

R1518Jxx1E/F (-AE)

(Ta = 25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V_{OUT}	Output Voltage	$T_a = 25^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	$\times 0.992$		$\times 1.008$	V
			$V_{SET} > 5.0 \text{ V}$	$\times 0.99$		$\times 1.01$	V
		$-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	×0.982		×1.018	V
			$V_{SET} > 5.0 \text{ V}$	×0.98		×1.02	V
$\Delta V_{OUT} / \Delta I_{OUT}$	Load Regulation	$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$	-15	3	25	mV	
		$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$	-60	10	60	mV	
V_{DIF}	Dropout Voltage	$I_{OUT} = 1 \text{ A}$	Refer to the <i>Product-specific Electrical Characteristics</i>				
I_{SS}	Supply Current	$I_{OUT} = 0 \text{ mA}$		18	36	μA	
Istandby	Standby Current	$V_{CE} = 0 \text{ V}$		0.1	2.0	μA	
$\Delta V_{OUT} / \Delta V_{IN}$	Line Regulation	$V_{SET} + 0.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$, if $V_{IN} \leq 3.5 \text{ V}$		0.01	0.02	%/V	
I_{LIM}	Output Current Limit	$V_{IN} = V_{SET} + 2.0 \text{ V}$	1.1	1.8	2.5	A	
I_{SC}	Short Current Limit	$V_{OUT} = 0 \text{ V}$	110	180	250	mA	
I_{PD}	CE Pull-down Current	$V_{CE} = 5 \text{ V}$		0.2	0.6	μA	
		$V_{CE} = 36 \text{ V}$		0.5	1.3	μA	
I_{DELAY}	DELAY Current	DELAY = GND	1.5	2.5	3.5	μA	
t_{D1}	Soft-start Time 1	DELAY = OPEN		26		μs	
t_{D2}	Soft-start Time 2	DELAY = $0.001 \mu\text{F}$	210	290	415	μs	
V_{CEH}	CE Input Voltage "H"		2.2		36	V	
V_{CEL}	CE Input Voltage "L"		0		1.0	V	
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		$^\circ\text{C}$	
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		$^\circ\text{C}$	
R_{LOW}	Low Output Nch Tr. ON Resistance (R1518Jxx1F)	$V_{IN} = 14.0 \text{ V}$, $V_{CE} = 0 \text{ V}$	1.0	3.2	5.0	k Ω	

All test items listed under Electrical Characteristics are done under the pulse load condition ($T_j \approx T_a = 25^\circ\text{C}$) except for Soft-start Time 1 and Soft-start Time 2.

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The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$.**R1518Jxx1B/D/E/F (-AE), R1518Sxx2B/D (-AE) Product-specific Electrical Characteristics** (Ta = 25°C)

Product Name	V _{OUT} [V] (Ta = 25°C)			V _{OUT} [V] (-40°C ≤ Ta ≤ 125°C)			V _{DIF} [V]	
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Max.
R1518x25xx	2.480	2.500	2.520	2.455	2.500	2.545	1.00	1.80
R1518x28xx	2.778	2.800	2.822	2.750	2.800	2.850		
R1518x30xx	2.976	3.000	3.024	2.946	3.000	3.054		
R1518x33xx	3.274	3.300	3.326	3.241	3.300	3.359	0.90	1.60
R1518x34xx	3.373	3.400	3.427	3.339	3.400	3.461		
R1518x50xx	4.960	5.000	5.040	4.910	5.000	5.090	0.70	1.30
R1518x60xx	5.940	6.000	6.060	5.880	6.000	6.120		
R1518x80xx	7.920	8.000	8.080	7.840	8.000	8.160		
R1518x85xx	8.415	8.500	8.585	8.330	8.500	8.670	0.65	1.10
R1518x90xx	8.910	9.000	9.090	8.820	9.000	9.180		

$V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$, unless otherwise noted.

R1518xxxxB/D (-KE)

($-40 \leq T_a \leq 125^\circ\text{C}$)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V_{OUT}	Output Voltage	$T_a = 25^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	$\times 0.992$		$\times 1.008$	V
			$V_{SET} > 5.0 \text{ V}$	$\times 0.99$		$\times 1.01$	V
		$-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	$\times 0.982$		$\times 1.018$	V
			$V_{SET} > 5.0 \text{ V}$	$\times 0.98$		$\times 1.02$	V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$	-15	3	25	mV	
		$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$	-60	10	60	mV	
V_{DIF}	Dropout Voltage	$I_{OUT} = 1 \text{ A}$	Refer to the <i>Product-specific Electrical Characteristics</i>				
I_{SS}	Supply Current	$I_{OUT} = 0 \text{ mA}$		18	36	μA	
Istandby	Standby Current	$V_{CE} = 0 \text{ V}$		0.1	2.0	μA	
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$V_{SET} + 0.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$, if $V_{IN} \leq 3.5 \text{ V}$		0.01	0.02	%/V	
I_{LIM}	Output Current Limit	$V_{IN} = V_{SET} + 2.0 \text{ V}$	1.1	1.8	2.5	A	
I_{SC}	Short Current Limit	$V_{OUT} = 0 \text{ V}$	110	180	250	mA	
I_{PD}	CE Pull-down Current	$V_{CE} = 5 \text{ V}$		0.2	0.6	μA	
		$V_{CE} = 36 \text{ V}$		0.5	1.3	μA	
V_{CEH}	CE Input Voltage "H"		2.2		36	V	
V_{CEL}	CE Input Voltage "L"		0		1.0	V	
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		$^\circ\text{C}$	
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		$^\circ\text{C}$	
R_{LOW}	Low Output Nch Tr. ON Resistance (R1518xxxxD)	$V_{IN} = 14.0 \text{ V}$, $V_{CE} = 0 \text{ V}$	1.0	3.2	5.0	k Ω	

R1518x

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 $V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = 0.1 \text{ } \mu\text{F}$, $C_{OUT} = 1.0 \text{ } \mu\text{F}$, unless otherwise noted.**R1518x001C (-KE)**($-40 \leq T_a \leq 125^\circ\text{C}$)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{FB}	Feedback Voltage	$T_a = 25^\circ\text{C}$	2.480		2.520	V
		$-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$	2.455		2.545	V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$	-10	3	10	mV
		$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$	-25	5	35	mV
V_{DIF}	Dropout Voltage	$V_{SET} = V_{FB}$, $I_{OUT} = 1 \text{ A}$		1.0	1.8	V
I_{SS}	Supply Current	$I_{OUT} = 0 \text{ mA}$		18	36	μA
Istandby	Standby Current	$V_{CE} = 0 \text{ V}$		0.1	2.0	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$V_{SET} = V_{FB}$, $3.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$		0.01	0.02	%/V
I_{LIM}	Output Current Limit	$V_{IN} = V_{SET} + 2.0 \text{ V}$	1.1	1.8	2.5	A
I_{SC}	Short Current Limit	$V_{OUT} = V_{FB} = 0 \text{ V}$	110	180	250	mA
I_{PD}	CE Pull-down Current	$V_{CE} = 5 \text{ V}$		0.2	0.6	μA
		$V_{CE} = 36 \text{ V}$		0.5	1.3	μA
V_{CEH}	CE Input Voltage "H"		2.2		36	V
V_{CEL}	CE Input Voltage "L"		0		1.0	V
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		$^\circ\text{C}$
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		$^\circ\text{C}$

$V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$, unless otherwise noted.

R1518Jxx1E/F (-KE)

($-40 \leq T_a \leq 125^\circ\text{C}$)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V_{OUT}	Output Voltage	$T_a = 25^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	$\times 0.992$		$\times 1.008$	V
			$V_{SET} > 5.0 \text{ V}$	$\times 0.99$		$\times 1.01$	V
		$-40^\circ\text{C} \leq T_a \leq 125^\circ\text{C}$	$V_{SET} \leq 5.0 \text{ V}$	$\times 0.982$		$\times 1.018$	V
			$V_{SET} > 5.0 \text{ V}$	$\times 0.98$		$\times 1.02$	V
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$	-15	3	25	mV	
		$V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$	-60	10	60	mV	
V_{DIF}	Dropout Voltage	$I_{OUT} = 1 \text{ A}$	Refer to the <i>Product-specific Electrical Characteristics</i>				
I_{SS}	Supply Current	$I_{OUT} = 0 \text{ mA}$		18	36	μA	
Istandby	Standby Current	$V_{CE} = 0 \text{ V}$		0.1	2.0	μA	
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	$V_{SET} + 0.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$, if $V_{IN} \leq 3.5 \text{ V}$		0.01	0.02	%/V	
V_{IN}	Input Voltage		3.5		36	V	
I_{LIM}	Output Current Limit	$V_{IN} = V_{SET} + 2.0 \text{ V}$	1.1	1.8	2.5	A	
I_{SC}	Short Current Limit	$V_{OUT} = 0 \text{ V}$	110	180	250	mA	
I_{PD}	CE Pull-down Current	$V_{CE} = 5 \text{ V}$		0.2	0.6	μA	
		$V_{CE} = 36 \text{ V}$		0.5	1.3	μA	
I_{DELAY}	DELAY Current	DELAY = GND	1.5	2.5	3.5	μA	
V_{CEH}	CE Input Voltage "H"		2.2		36	V	
V_{CEL}	CE Input Voltage "L"		0		1.0	V	
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature	150	160		$^\circ\text{C}$	
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature	125	135		$^\circ\text{C}$	
R_{LOW}	Low Output Nch Tr. ON Resistance (R1518Jxx1F)	$V_{IN} = 14.0 \text{ V}$, $V_{CE} = 0 \text{ V}$	1.0	3.2	5.0	k Ω	

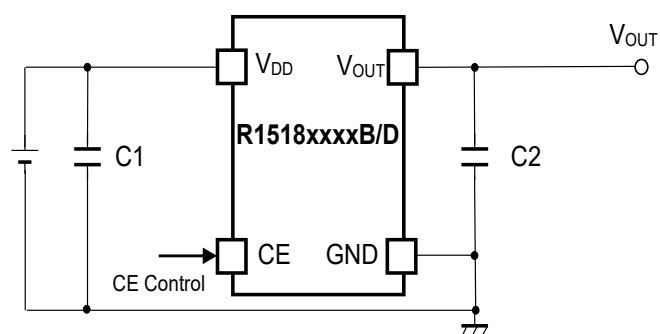
R1518xNO.EC-329-190212

R1518Jxx1B/D/E/F (-KE), R1518Sxx2B/D (-KE) Product-specific Electrical Characteristics

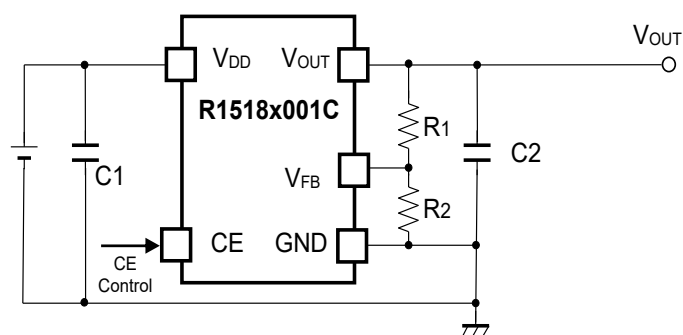
(-40 ≤ Ta ≤ 125°C)

Product Name	V _{OUT} [V] (Ta = 25°C)			V _{OUT} [V] (-40°C ≤ Ta ≤ 125°C)			V _{DIF} [V]	
	Min.	Typ.	Max.	Min.	Typ.	Max.	Typ.	Max.
R1518x25xx	2.480	2.500	2.520	2.455	2.500	2.545	1.00	1.80
R1518x28xx	2.778	2.800	2.822	2.750	2.800	2.850		
R1518x30xx	2.976	3.000	3.024	2.946	3.000	3.054		
R1518x33xx	3.274	3.300	3.326	3.241	3.300	3.359	0.90	1.60
R1518x34xx	3.373	3.400	3.427	3.339	3.400	3.461		
R1518x50xx	4.960	5.000	5.040	4.910	5.000	5.090	0.70	1.30
R1518x60xx	5.940	6.000	6.060	5.880	6.000	6.120		
R1518x80xx	7.920	8.000	8.080	7.840	8.000	8.160		
R1518x85xx	8.415	8.500	8.585	8.330	8.500	8.670	0.65	1.10
R1518x90xx	8.910	9.000	9.090	8.820	9.000	9.180		

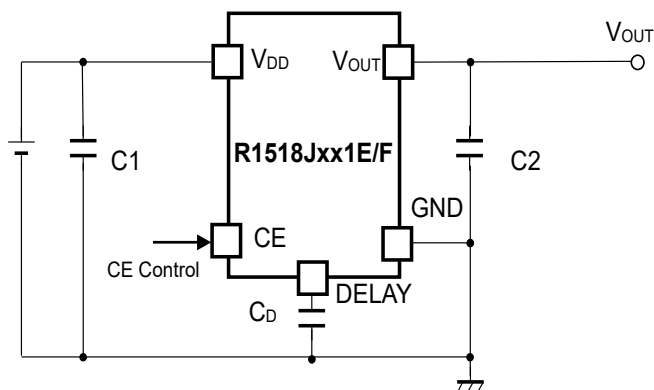
TYPICAL APPLICATION



R1518xxxxB/D Typical Application



R1518x001C Typical Application



R1518Jxx1E/F Typical Application

External Components :

Symbol	Description
R1518xxxxB//D/E/F	
C1	0.1 μ F (Ceramic)
C2	0.1 μ F (Ceramic)
R1518x001C	
C1	0.1 μ F (Ceramic)
C2	1.0 μ F (Ceramic)

TECHNICAL NOTES

Phase Compensation

In LDO regulators, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, use 0.1 μF or more (R1518xxxxB/D/E/F), 1.0 μF or more (R1518x001C) of the capacitor C2. When using a tantalum type capacitor and the ESR (Equivalent Series Resistance) value is large, the output might be unstable. Evaluate the circuit including consideration of frequency characteristics.

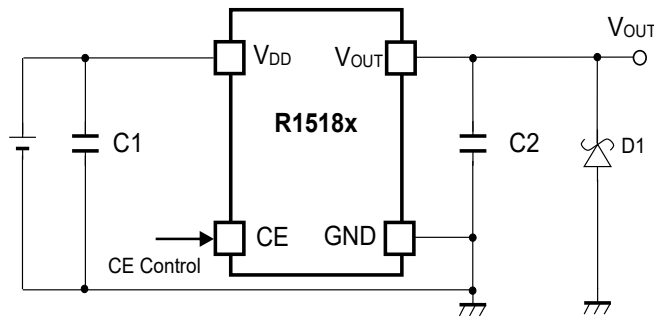
For the externally adjustable output voltage type (R1518x001C), use 10 k Ω or lower resistance R2.

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

In addition, connect the capacitor C2 between V_{OUT} and GND, and as close as possible to the pins.

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.

OPERATION DESCRIPTION

Thermal Shutdown Function

Thermal shutdown function is included in this device. If the junction temperature is more than or equal to 160°C (Typ.), the operation of the regulator would stop. After that, when the junction temperature is less than or equal to 135°C (Typ.), the operation of the regulator would restart. Unless the cause of rising temperature is removed, the regulator repeats on and off, and output waveform would be like consecutive pulses.

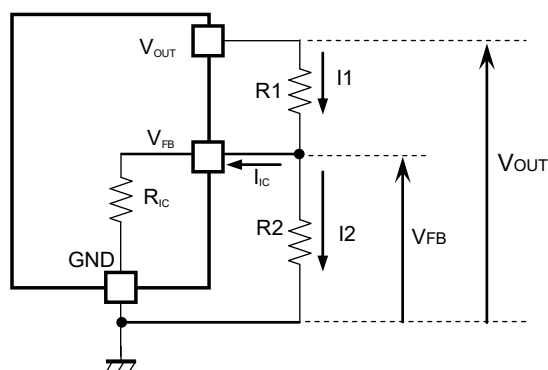
Adjustable Output Voltage Setting (R1518x001C)

The output voltage of R1518x001C 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} .

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

Recommended Range: $2.5 \text{ V} \leq V_{OUT} \leq 12.0 \text{ V}$

$V_{FB} = 2.5 \text{ V}$



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

R_{IC} of the R1518x001C is approximately Typ. 1.35 M Ω ($T_a=25^\circ\text{C}$, guaranteed by design engineering). For better accuracy, setting $R1 \ll R_{IC}$ reduces errors. The resistance value for R2 should be set to 10 k Ω or lower. It is easily affected by noises when setting the value of R1 and R2 larger, which makes the impedance of V_{FB} pin larger.

R_{IC} could be affected by the temperature, therefore evaluate the circuit taking the actual conditions of use into account when deciding the resistance values for R1 and R2.

Soft-start Function

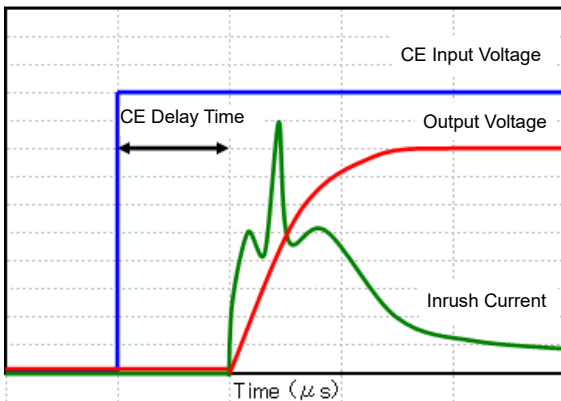
R1518x is equipped with a constant slope circuit, which achieves a soft-start function. This circuit allows the output voltage to start up gradually when the CE is turned on. The constant slope circuit minimizes the inrush current at the start-up and also prevents the overshoot of the output voltage. For R1518xxxxB/C/D, the capacitor to create the start-up slope is built in this device that does not require any external components. The start-up time and the start-up slope angle are fixed inside the device. As for R1518Jxx1E/F, the soft-start time is adjustable by inserting the external capacitor to DELAY pin. By using the following equation, the relation between the soft-start time t_D [s] and DELAY pin capacitor C_D [F] is determined.

$$t_D = ((C_D + 90 \times 10^{-12}) / I_{\text{DELAY}}) \times 0.73$$

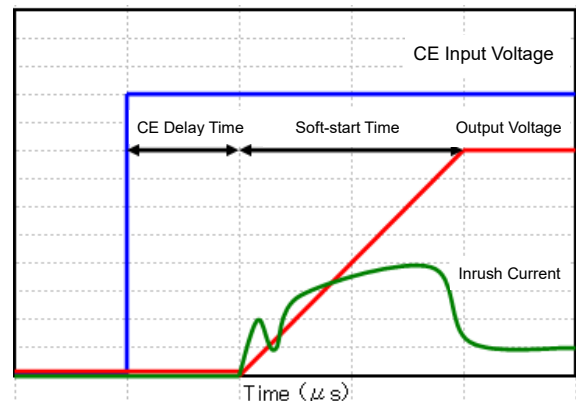
When the capacitor C_D of R1518Jxx1E/F is not used, use the DELAY pin as OPEN. At that time, $C_D = 0$ in the above equation, therefore the start-up time is about 26 μs . However, be sure to consider approximately 50 μs of CE delay time.

Conventional Inrush Current Limit Circuit

(Diagrammatic sketch)

**Constant Slope Circuit**

(Diagrammatic sketch)

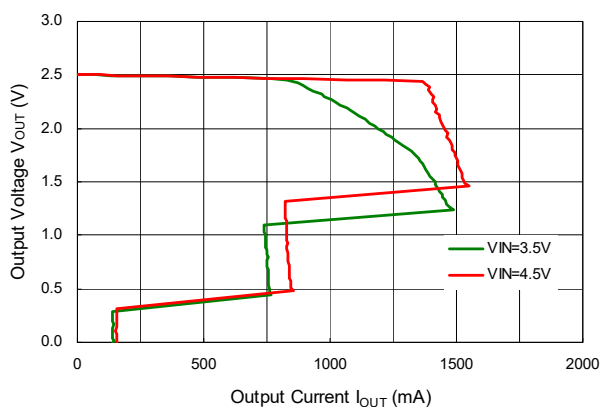


TYPICAL CHARACTERISTICS

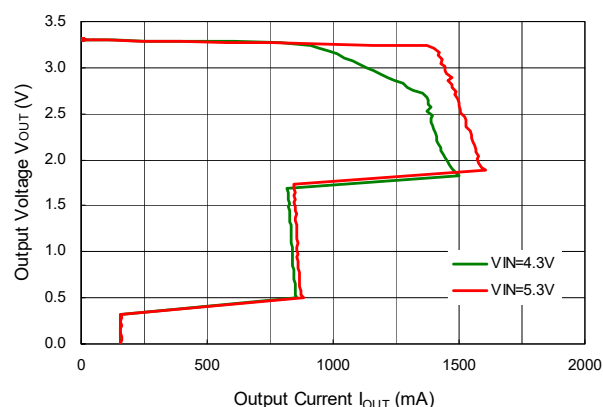
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

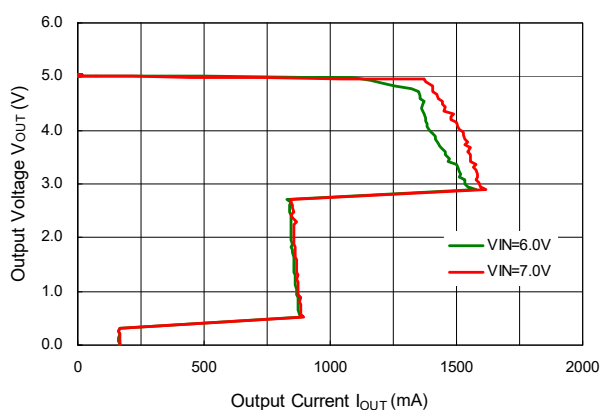
R1518x25xx, R1518x001C



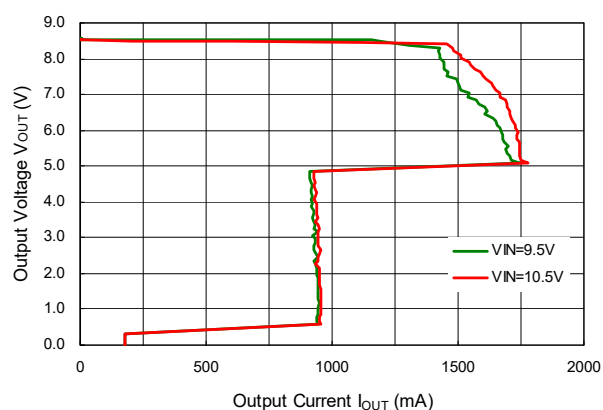
R1518x33xx



R1518x50xx

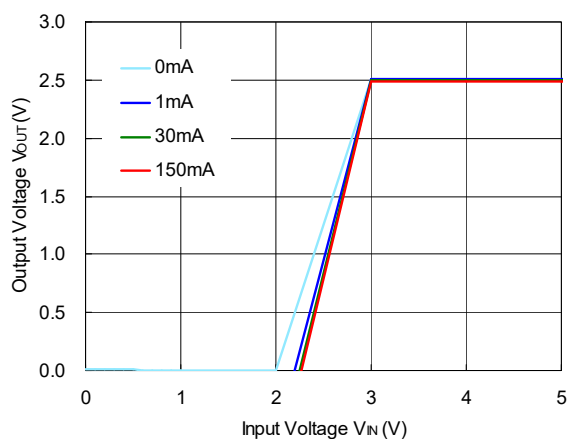


R1518x85xx

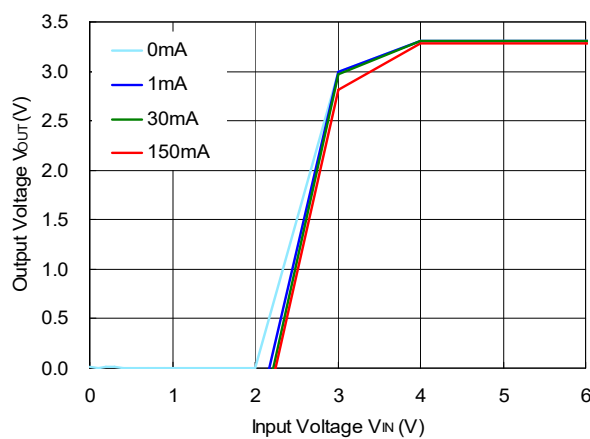


2) Output Voltage vs. Input Voltage (Ta = 25°C)

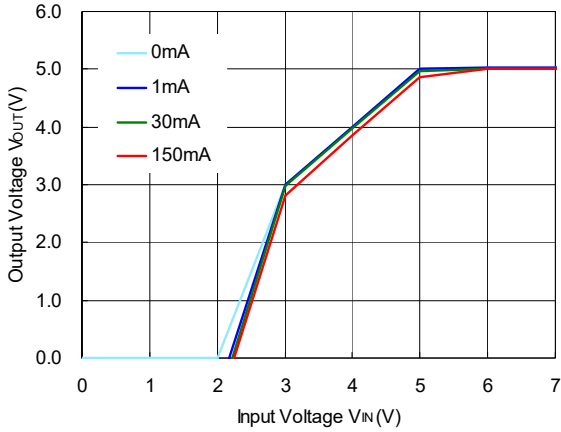
R1518x25xx



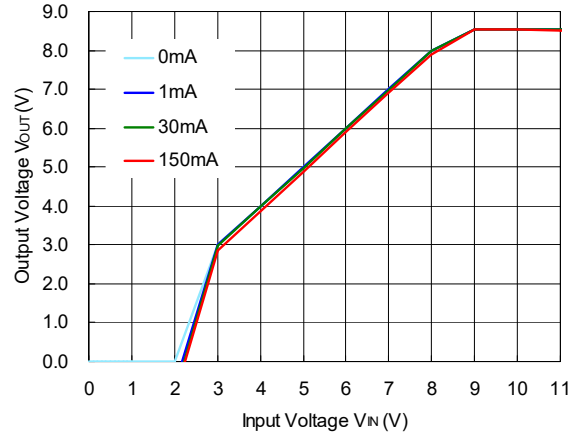
R1518x33xx



R1518x50xx

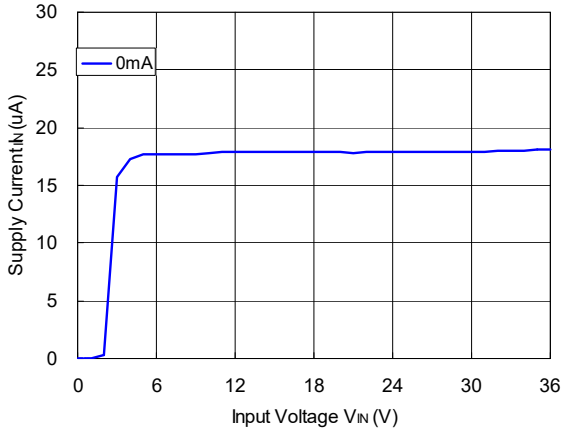


R1518x85xx

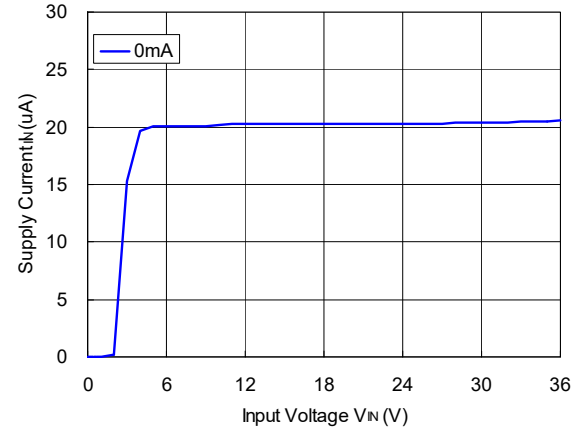


3) Supply Current vs. Input Voltage

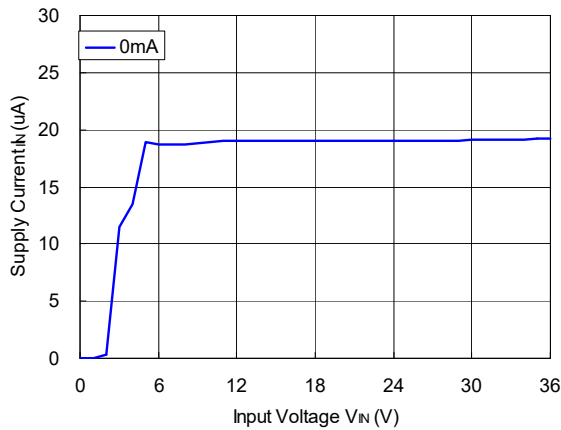
R1518x25xx, R1518x001C



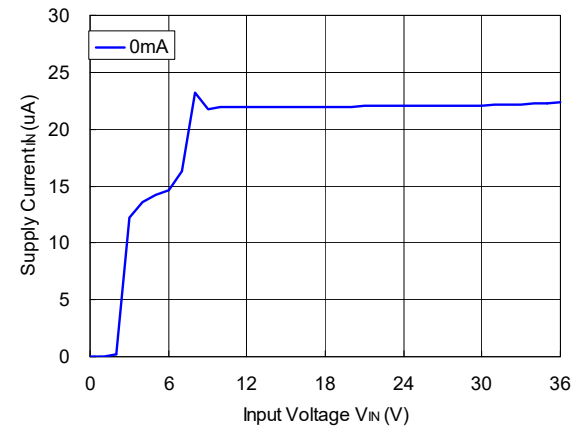
R1518x33xx



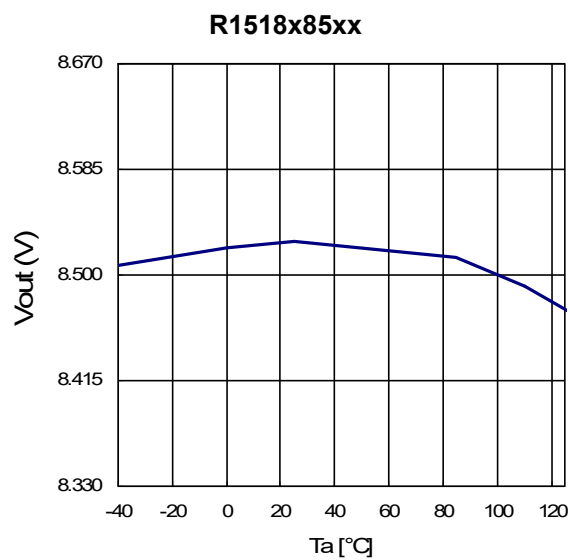
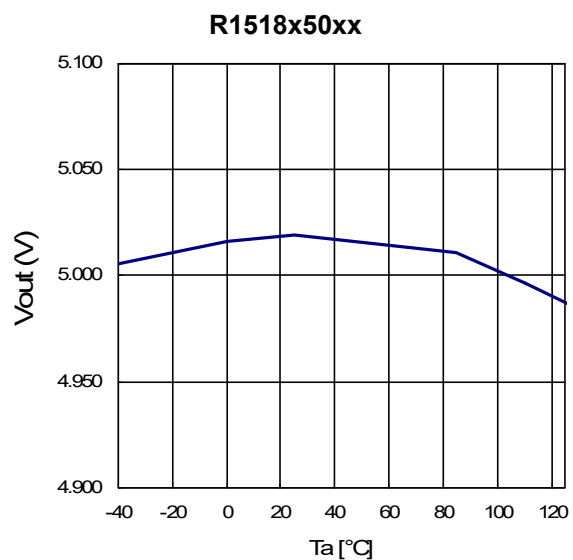
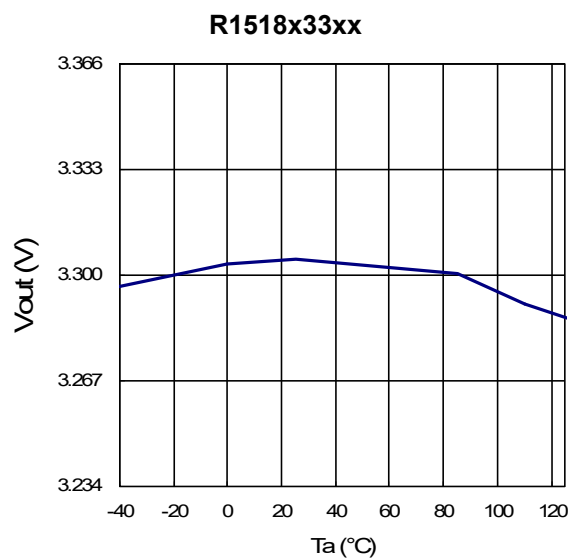
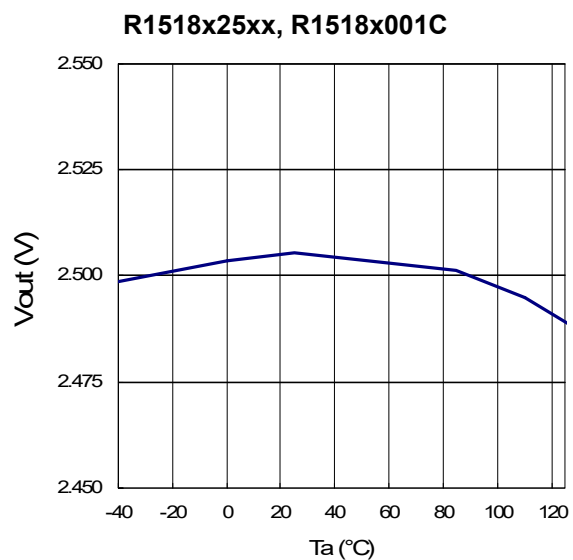
R1518x50xx



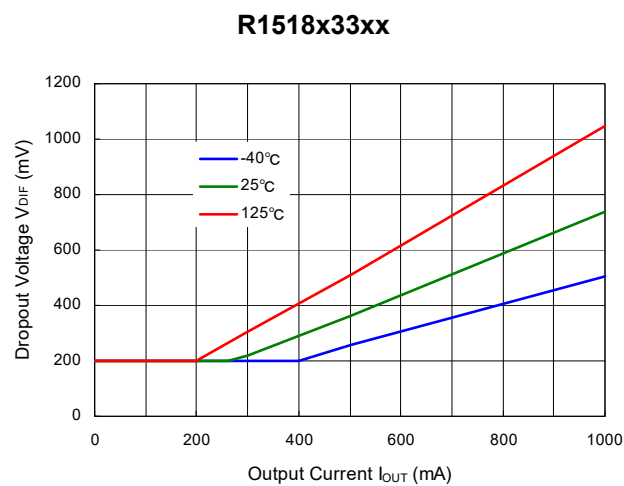
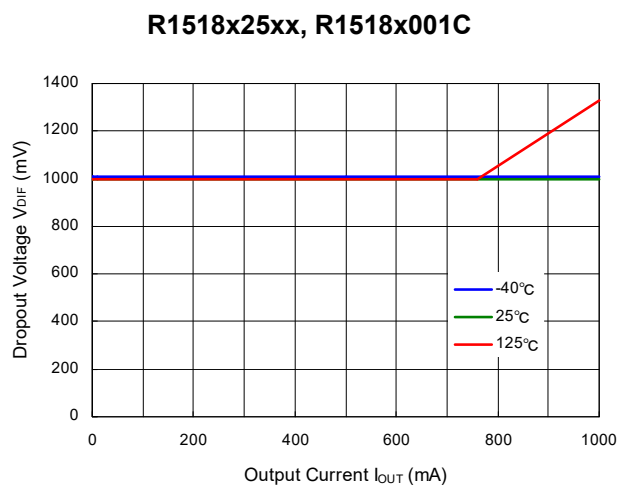
R1518x85xx



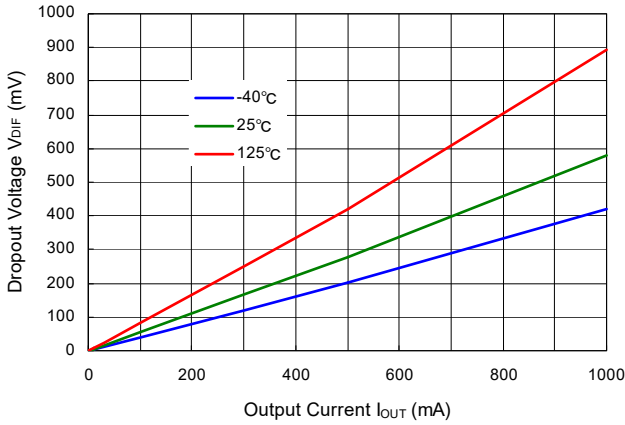
4) Output Voltage vs. Operating Temperature



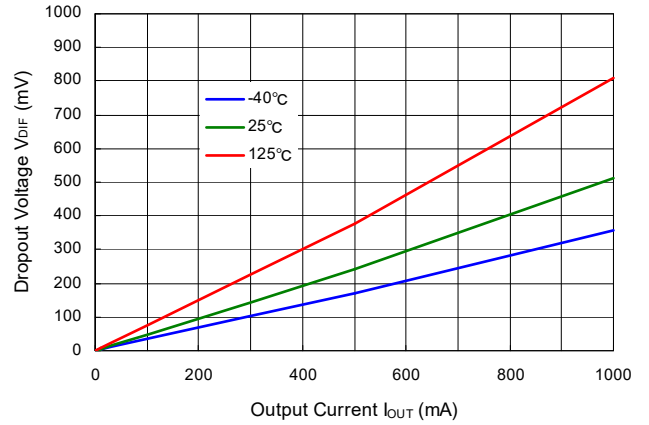
5) Dropout Voltage vs. Output Current



R1518x50xx

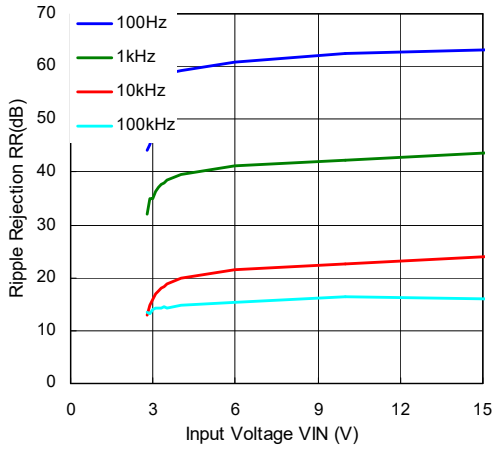


R1518x85xx

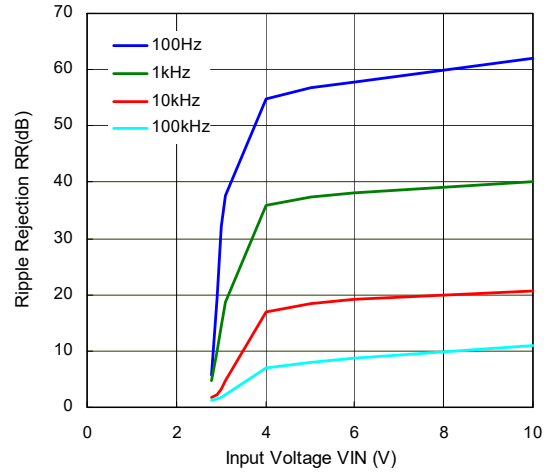


6) Ripple Rejection vs. Input Voltage (Ta = 25°C, Ripple = 0.5 Vpp)

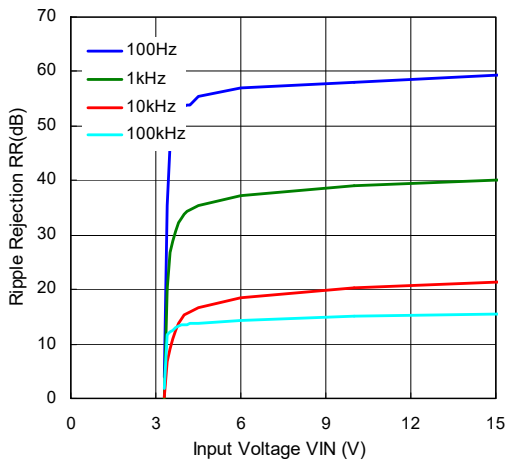
R1518x25xx, R1518x001C (I_{OUT} = 1 mA)



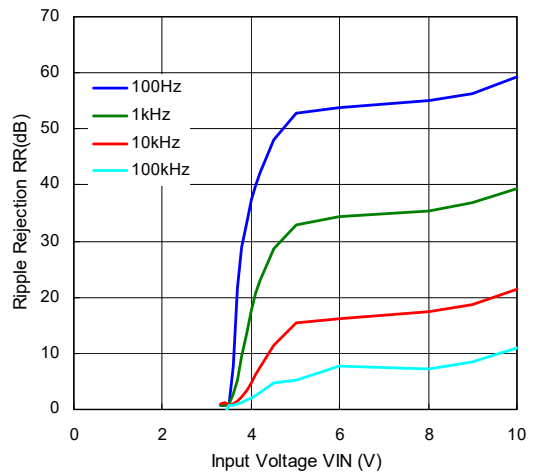
R1518x25xx, R1518x001C (I_{OUT} = 300 mA)



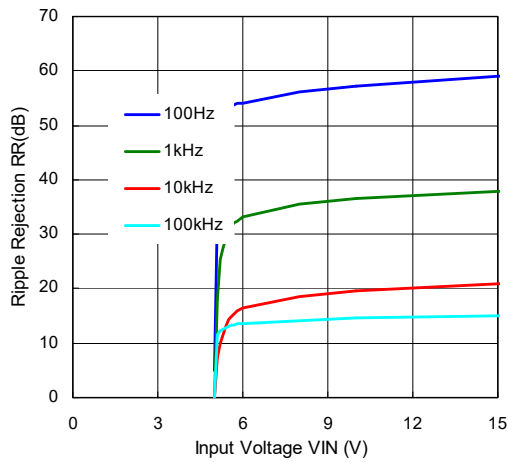
R1518x33xx (I_{OUT} = 1 mA)



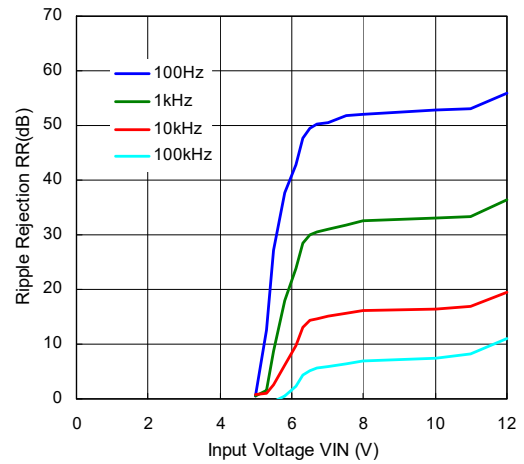
R1518x33xx (I_{OUT} = 300 mA)



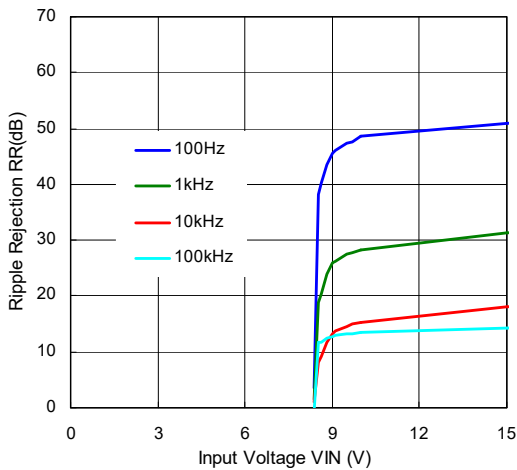
R1518x50xx (I_{OUT} = 1 mA)



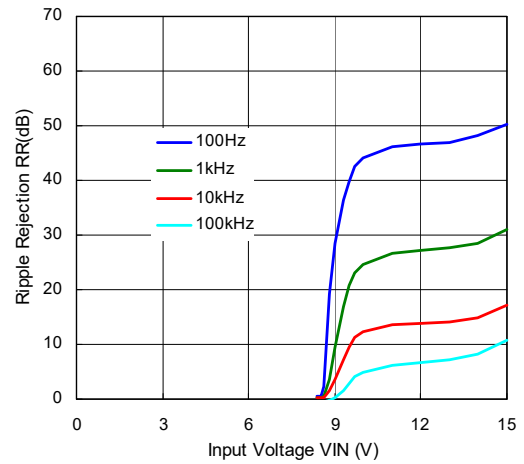
R1518x50xx (I_{OUT} = 300 mA)



R1518x85xx (I_{OUT} = 1 mA)

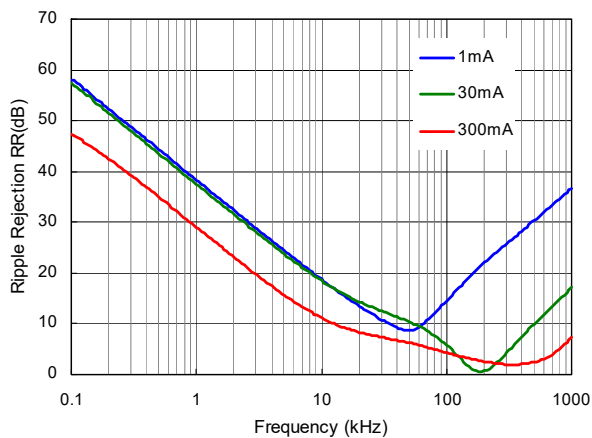


R1518x85xx (I_{OUT} = 300 mA)

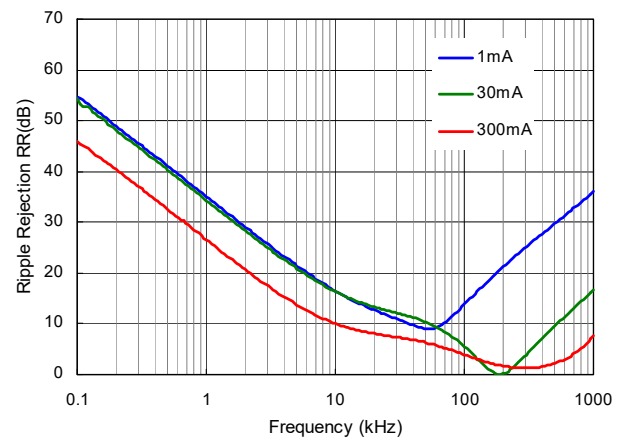


7) Ripple Rejection vs. Frequency (Ta = 25°C, Ripple = 0.5 Vpp)

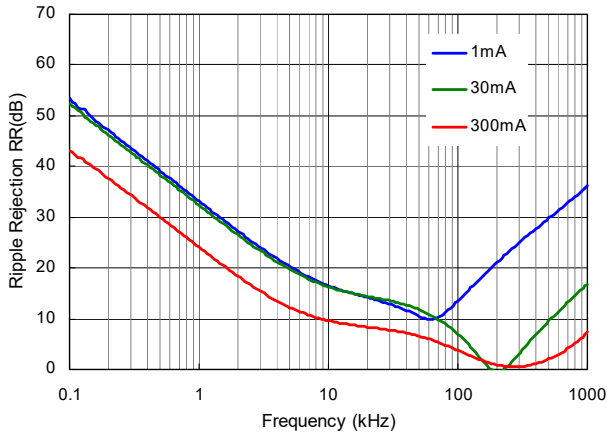
R1518x25xx, R1518x001C



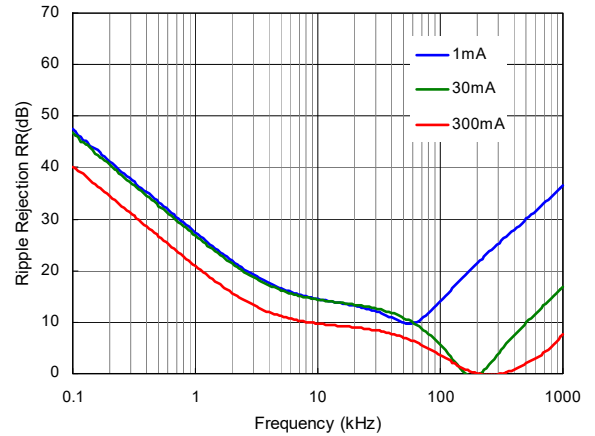
R1518x33xx



R1518x50xx

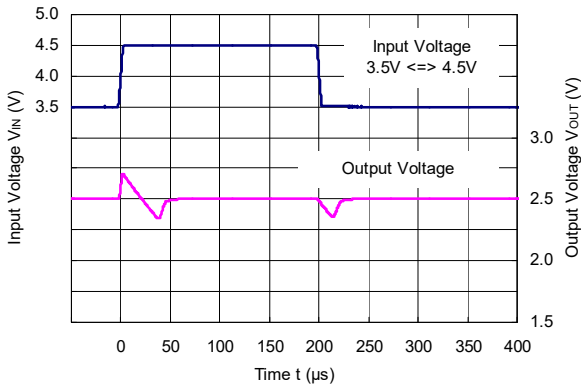


R1518x85xx

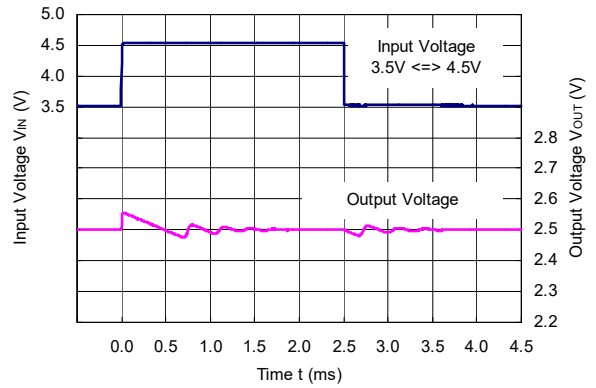


8) Input Transient Response ($T_a = 25^\circ\text{C}$, $I_{OUT} = 1\text{ mA}$, $t_r = t_f = 5\ \mu\text{s}$)

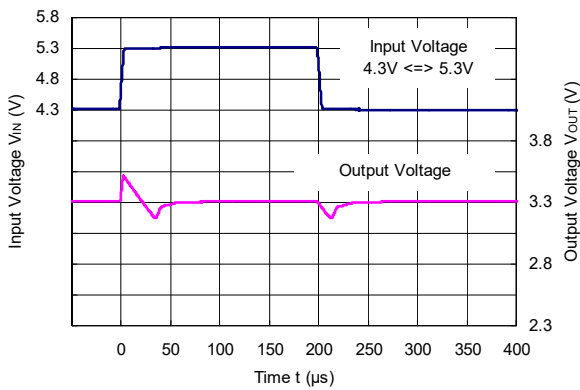
R1518x25xx, R1518x001C ($C_2 = 0.1\ \mu\text{F}$)



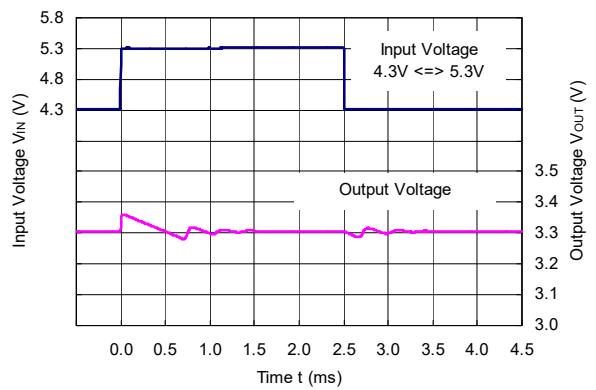
R1518x25xx, R1518x001C ($C_2 = 10\ \mu\text{F}$)



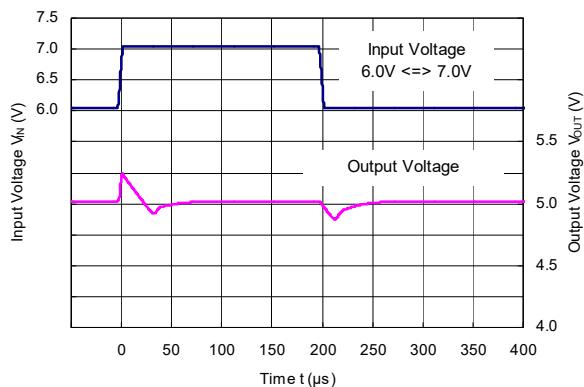
R1518x33xx ($C_2 = 0.1\ \mu\text{F}$)



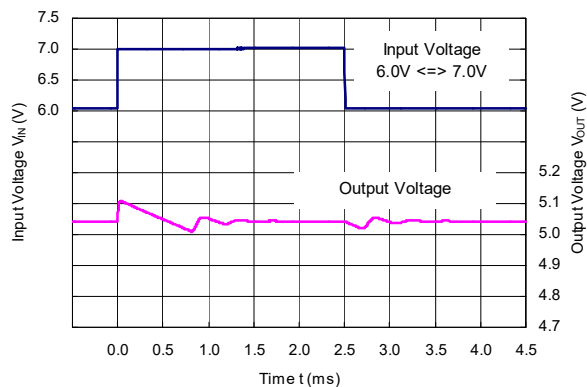
R1518x33xx ($C_2 = 10\ \mu\text{F}$)



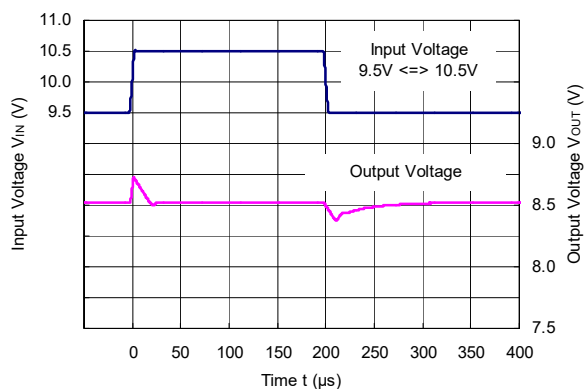
R1518x50xx (C2 = 0.1 μ F)



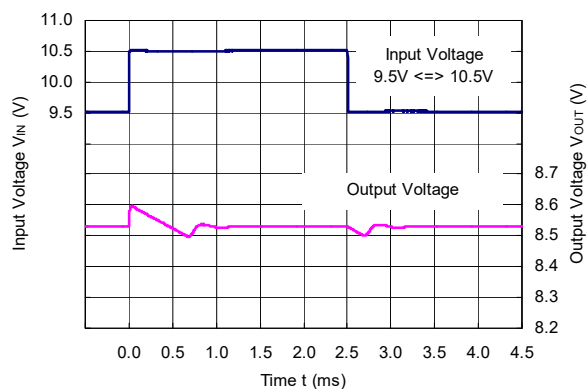
R1518x50xx (C2 = 10 μ F)



R1518x85xx (C2 = 0.1 μ F)

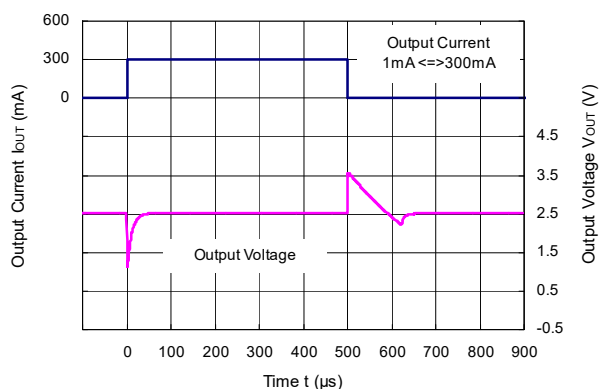


R1518x85xx (C2 = 10 μ F)

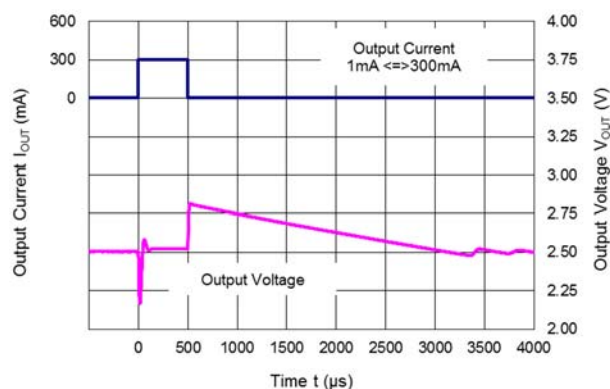


9) Load Transient Response ($T_a = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 1.0\text{V}$, $t_r = t_f = 0.5\ \mu\text{s}$)

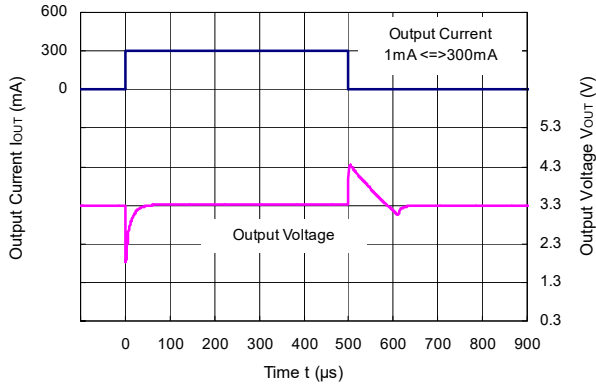
R1518x25xx, R1518x001C (C2 = 0.1 μ F)



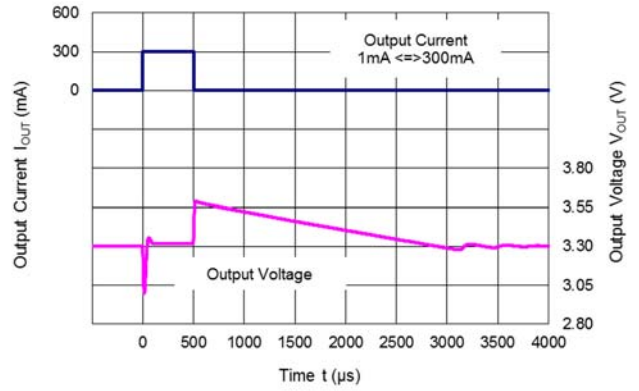
R1518x25xx, R1518x001C (C2 = 10 μ F)



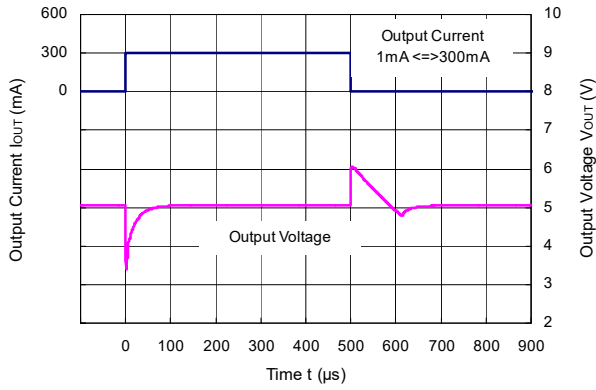
R1518x33xx (C2 = 0.1 μ F)



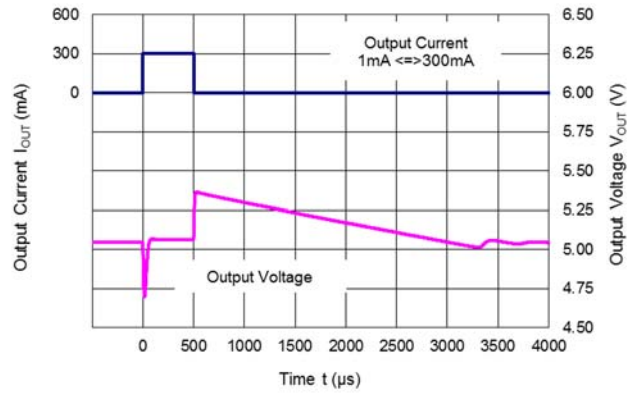
R1518x33xx (C2 = 10 μ F)



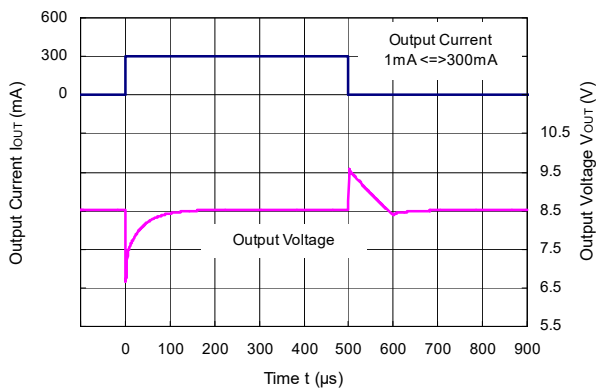
R1518x50xx (C2 = 0.1 μ F)



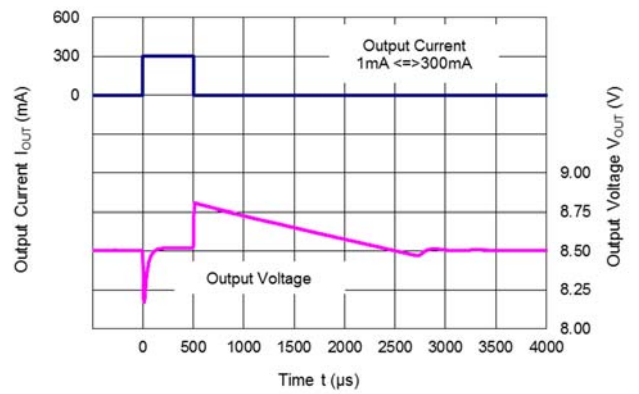
R1518x50xx (C2 = 10 μ F)

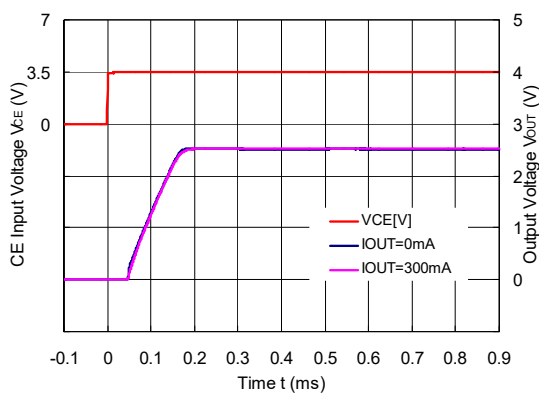
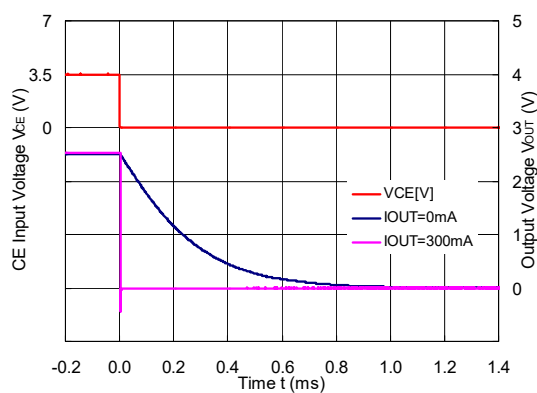
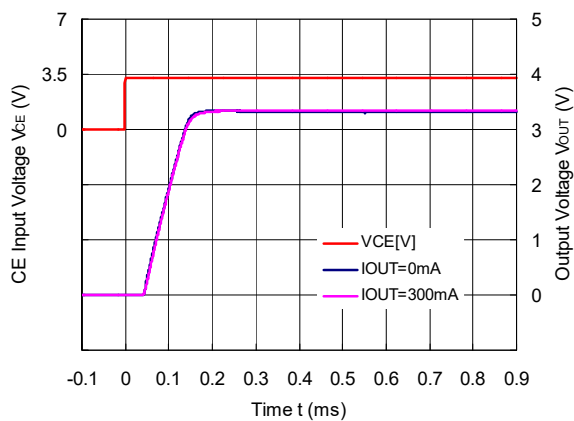
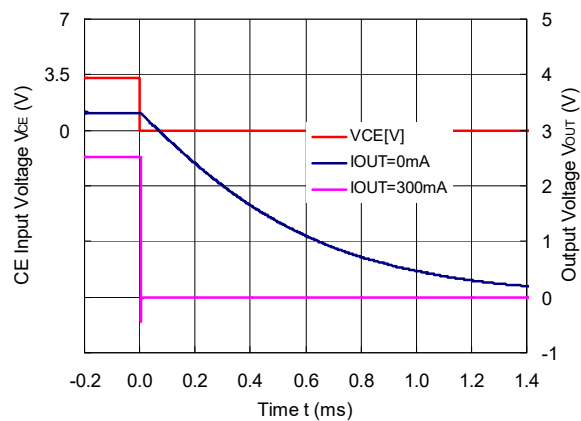
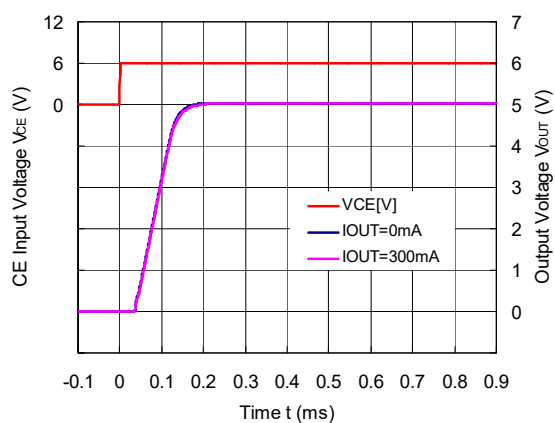
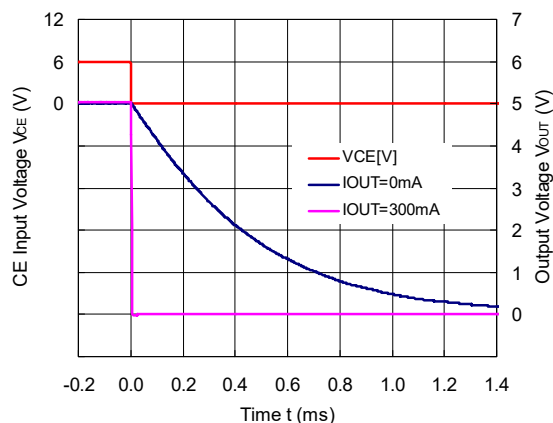


R1518x85xx (C2 = 0.1 μ F)

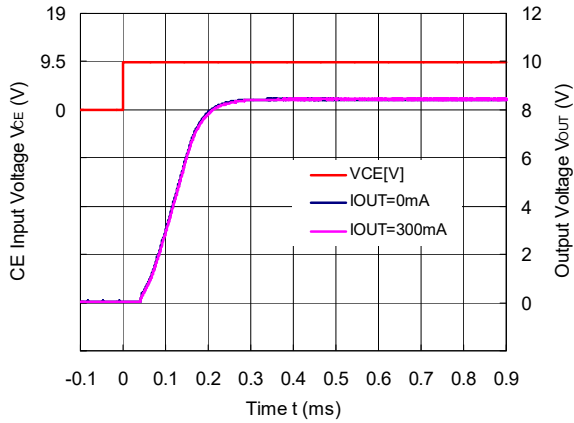


R1518x85xx (C2 = 10 μ F)

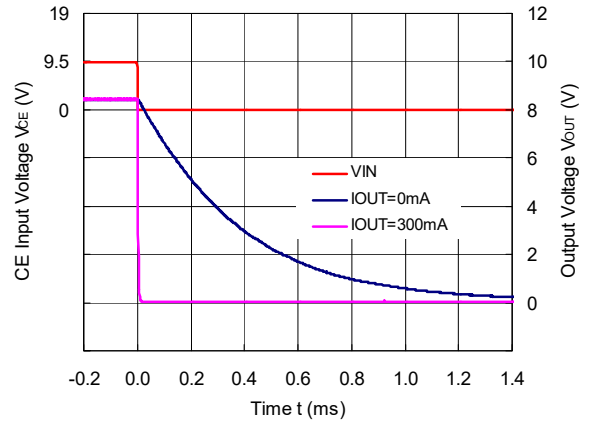


10) CE Transient Response ($T_a = 25^\circ\text{C}$)R1518x25xB/D, R1518x001C ($C_2 = 0.1 \mu\text{F}$)R1518x25xD ($C_2 = 0.1 \mu\text{F}$)R1518x33xB/D ($C_2 = 0.1 \mu\text{F}$)R1518x33xD ($C_2 = 0.1 \mu\text{F}$)R1518x50xB/D ($C_2 = 0.1 \mu\text{F}$)R1518x50xD ($C_2 = 0.1 \mu\text{F}$)

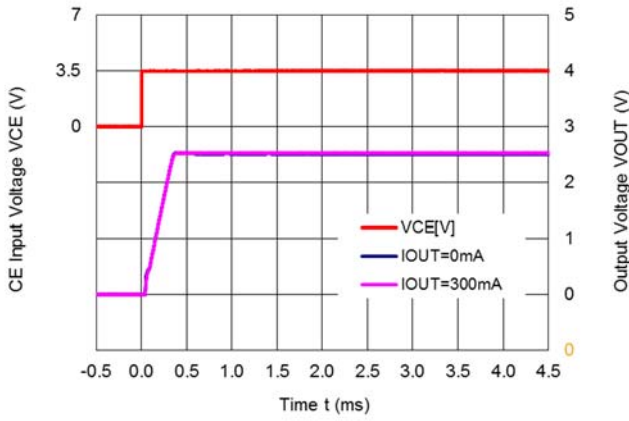
R1518x85xB/D (C2 = 0.1 μF)



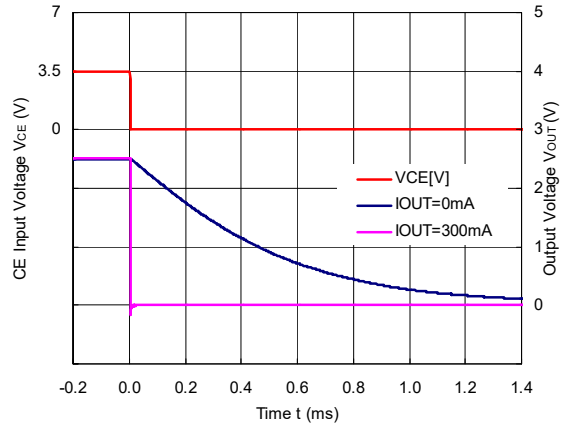
R1518x85xD (C2 = 0.1 μF)



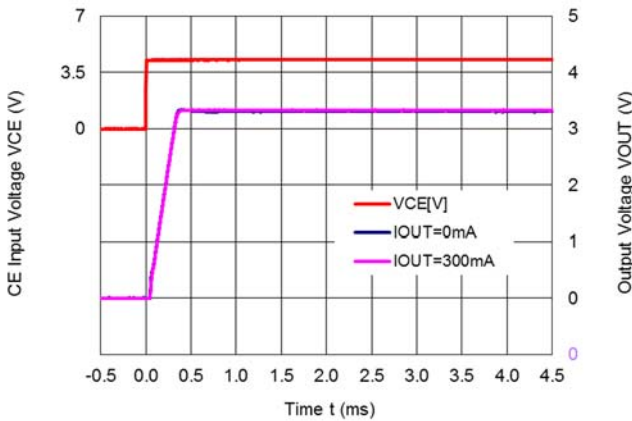
R1518J251E/F (C2 = 0.1 μF, C_D = 1 nF)



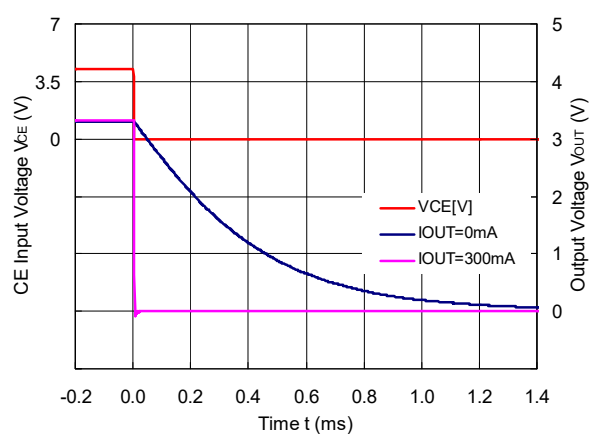
R1518x25xF (C2 = 0.1 μF, C_D = 1 nF)



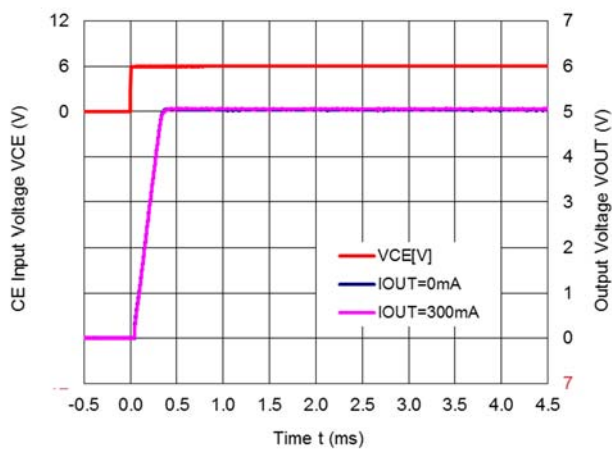
R1518J331E/F (C2 = 0.1 μF, C_D = 1 nF)



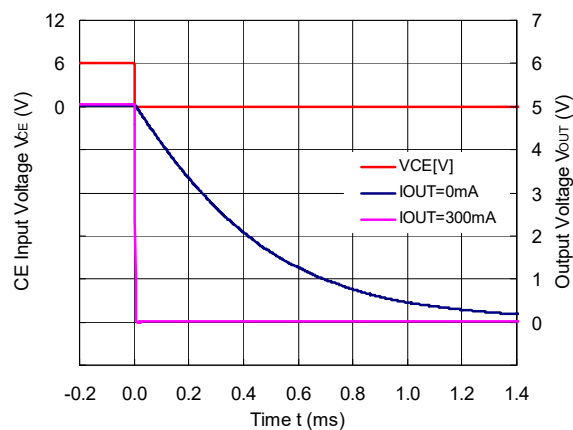
R1518x33xF (C2 = 0.1 μF, C_D = 1 nF)



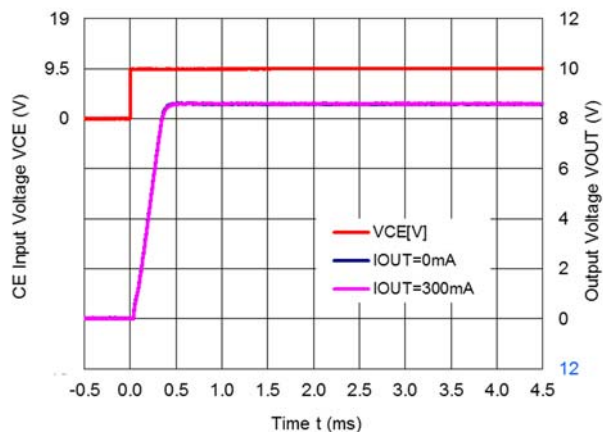
R1518J501E/F (C2 = 0.1 μ F, C_D = 1 nF)



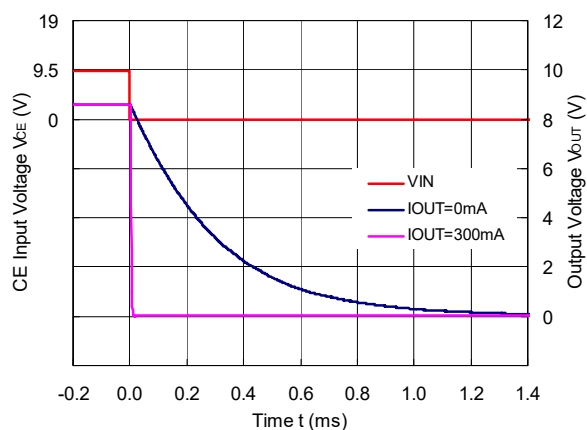
R1518x50xF (C2 = 0.1 μ F, C_D = 1 nF)



R1518J851E/F (C2 = 0.1 μ F, C_D = 1 nF)

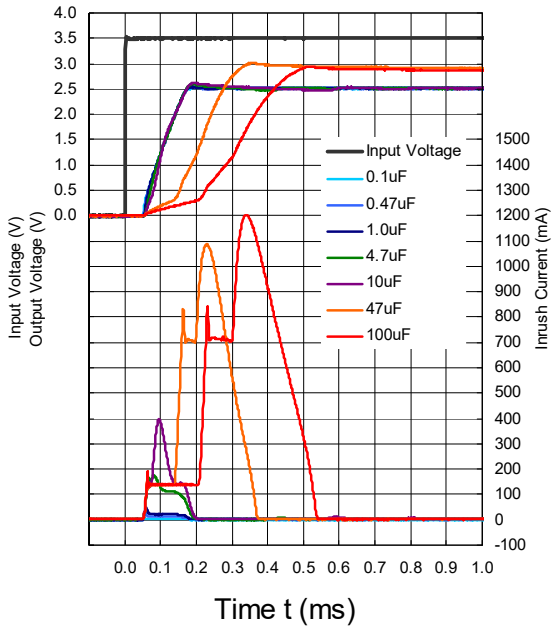


R1518x85xF (C2 = 0.1 μ F, C_D = 1 nF)

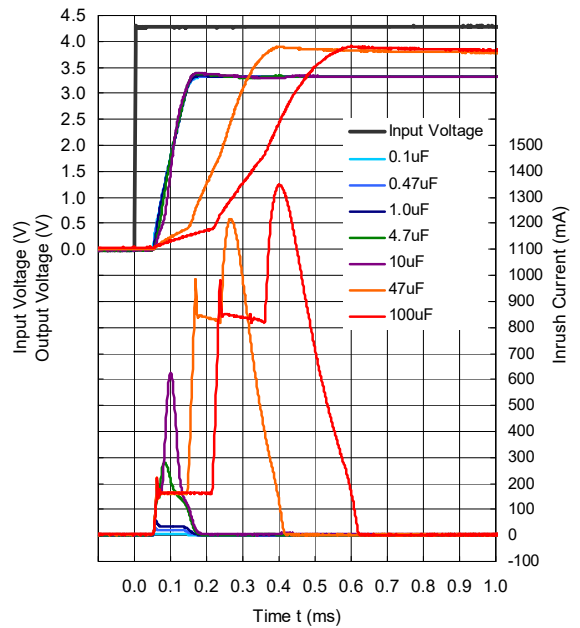


11) Inrush Current Prevention Circuit (Ta = 25°C, I_{OUT} = 1 mA)

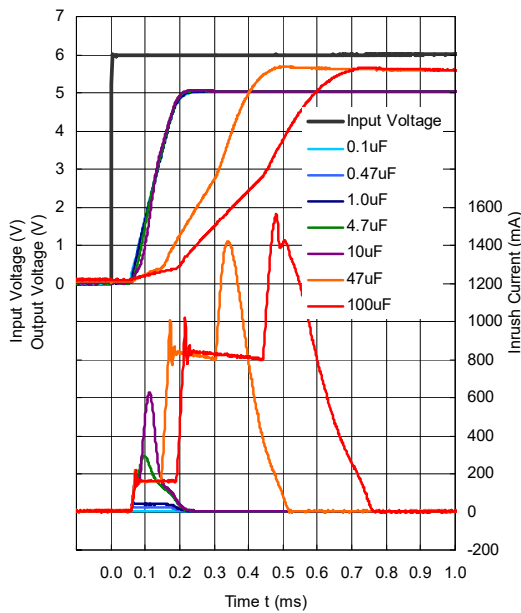
R1518x25xB/D, R1518x001C



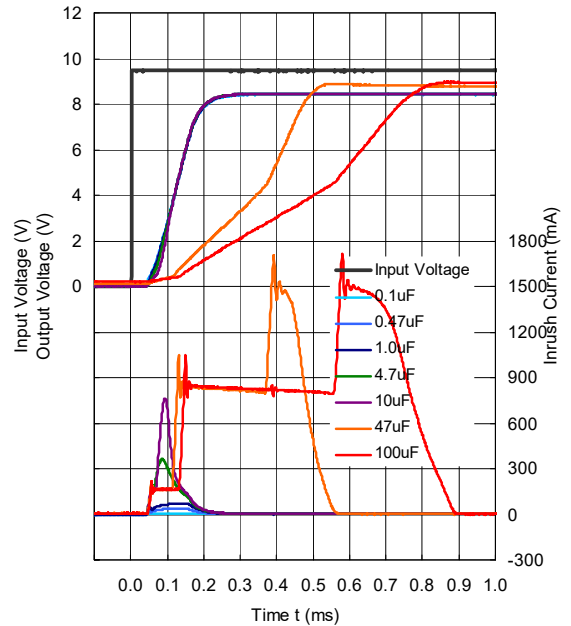
R1518x33xB/D



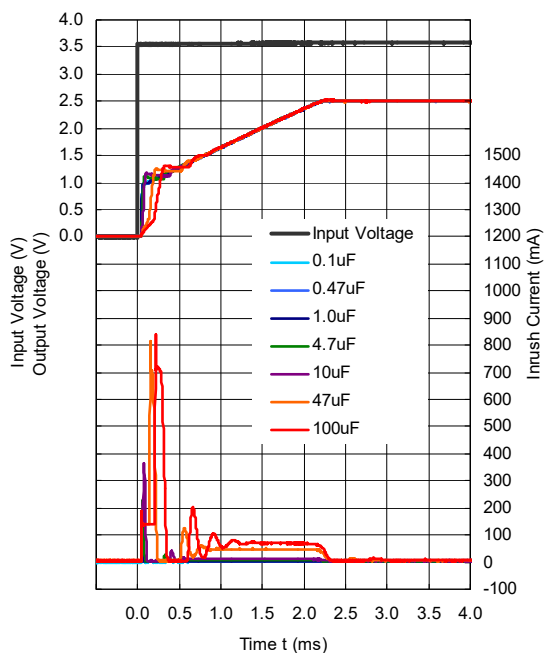
R1518x50xB/D



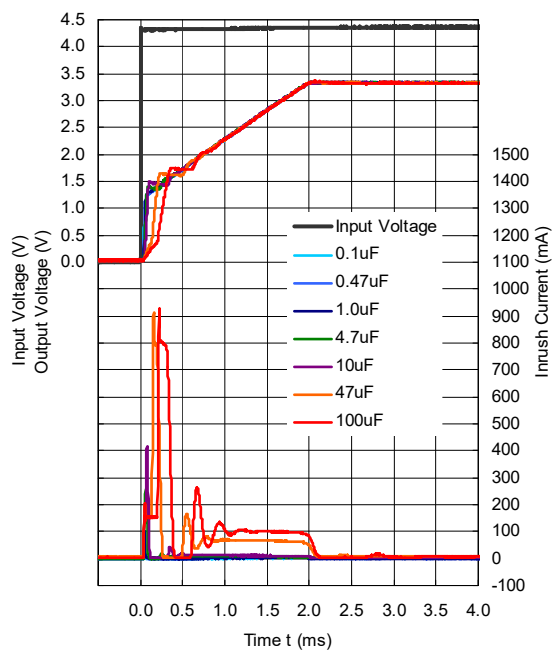
R1518x85xB/D



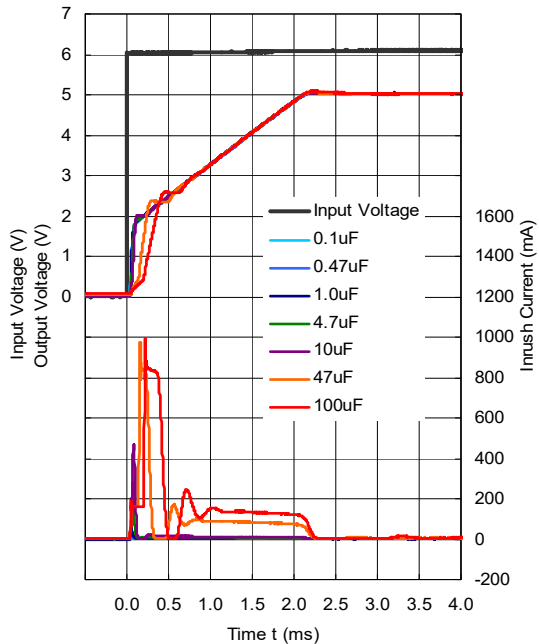
R1518J251E/F ($C_D = 10 \text{ nF}$)



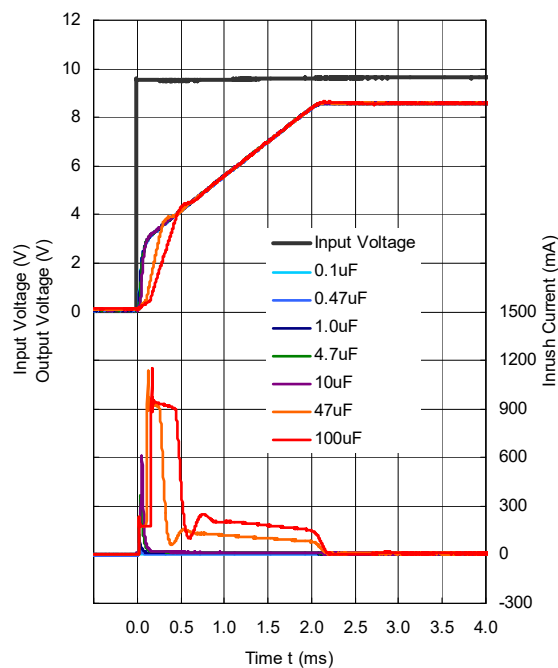
R1518J331E/F ($C_D = 10 \text{ nF}$)



R1518J501E/F ($C_D = 10 \text{ nF}$)

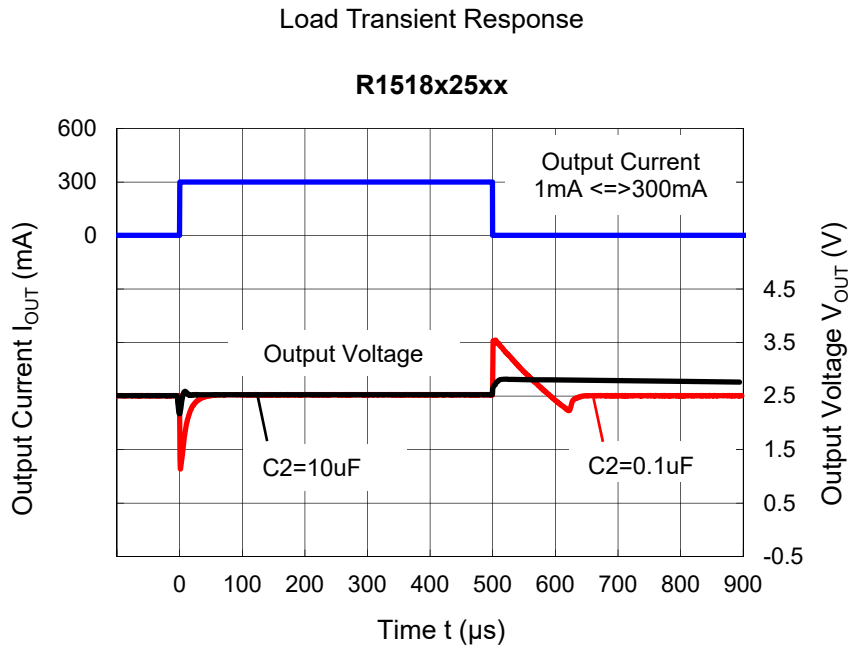


R1518J851E/F ($C_D = 10 \text{ nF}$)



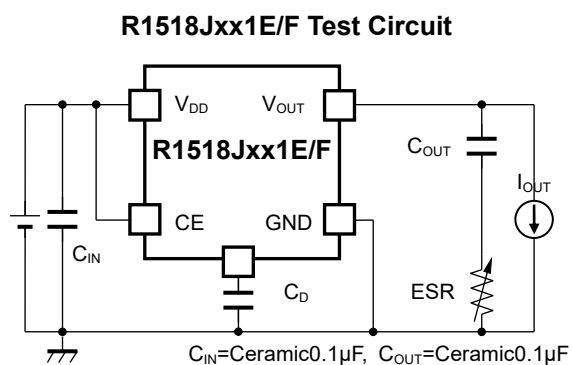
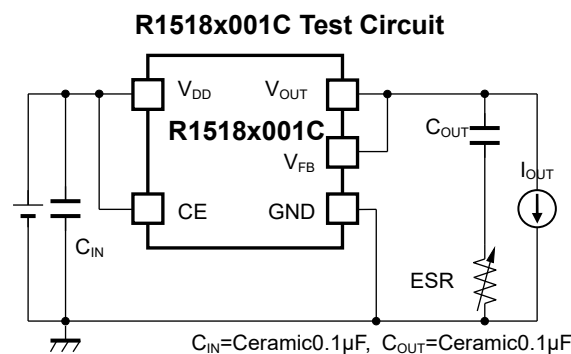
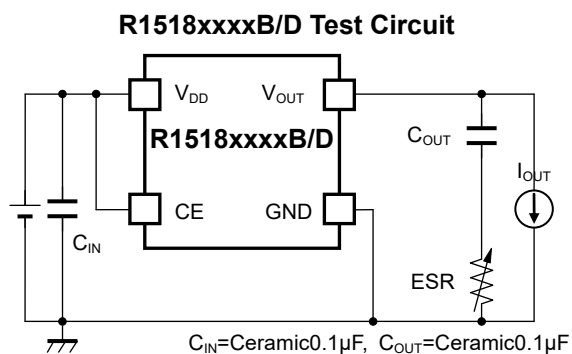
Load Transient vs. Output Capacity (C2)

R1518 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 a high-capacity electrolytic capacitor for the output line, place the electrolytic capacitor a few centimeters apart from the IC after arranging the ceramic capacitor close to the IC.



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.



Measurement conditions

Frequency Band: 10 Hz to 2 MHz

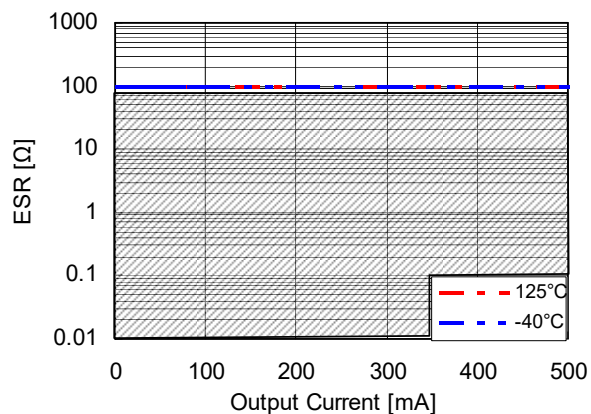
Measurement Temperature: -40°C to 125°C

Hatched area: Noise level is $40\mu\text{V}$ (average) or below

Capacitor: $C_1 = \text{Ceramic } 0.1\mu\text{F}$, $C_2 = 0.1\mu\text{F}$

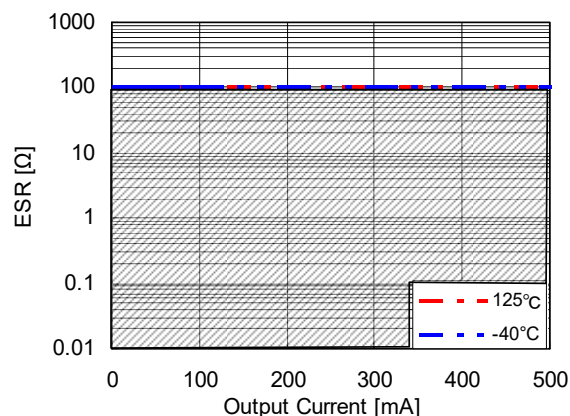
R1518x25xx Output Current I_{OUT} vs. ESR

$V_{IN} = 2.5\text{V to } 36\text{V}$



R1518x85xx Output Current I_{OUT} vs. ESR

$V_{IN} = 8.5\text{V to } 36\text{V}$



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

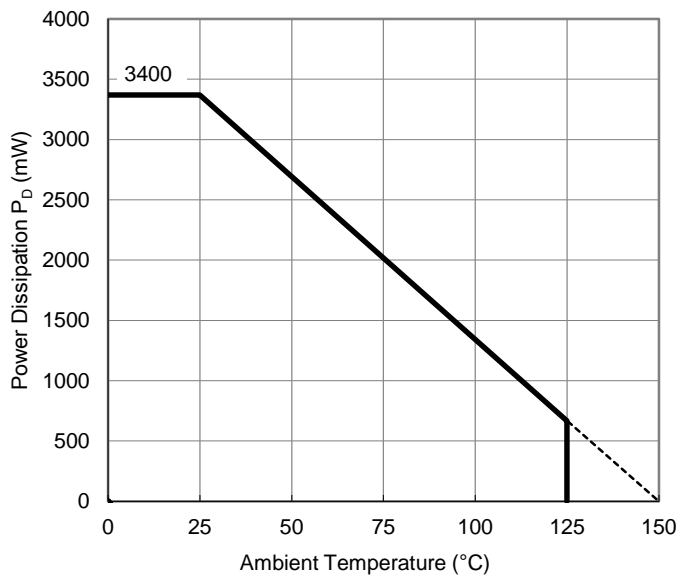
Measurement Result

(Ta = 25°C, Tjmax = 150°C)

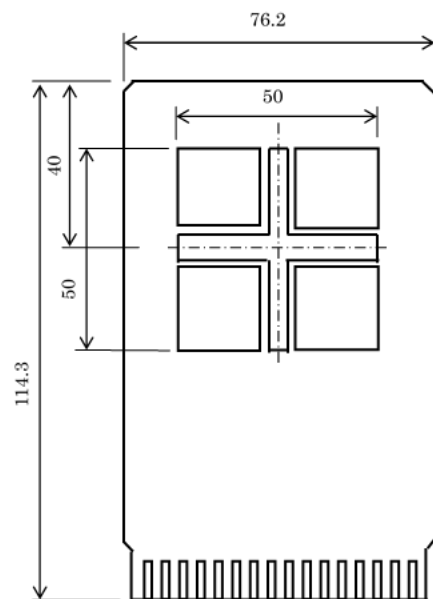
Item	Measurement Result
Power Dissipation	3400 mW
Thermal Resistance (θ_{ja})	$\theta_{ja} = 37^{\circ}\text{C/W}$
Thermal Characterization Parameter (ψ_{jt})	$\psi_{jt} = 7^{\circ}\text{C/W}$

θ_{ja} : Junction-to-Ambient Thermal Resistance

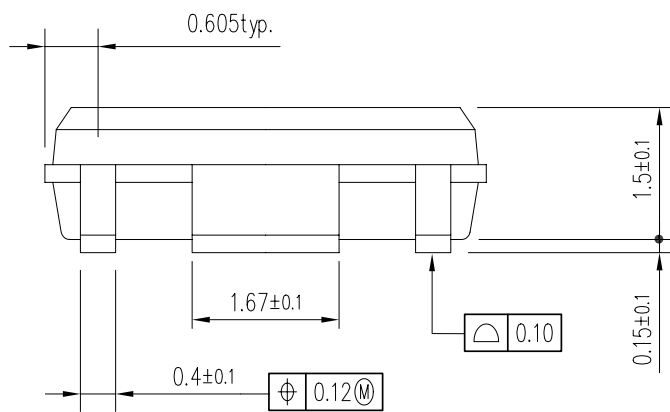
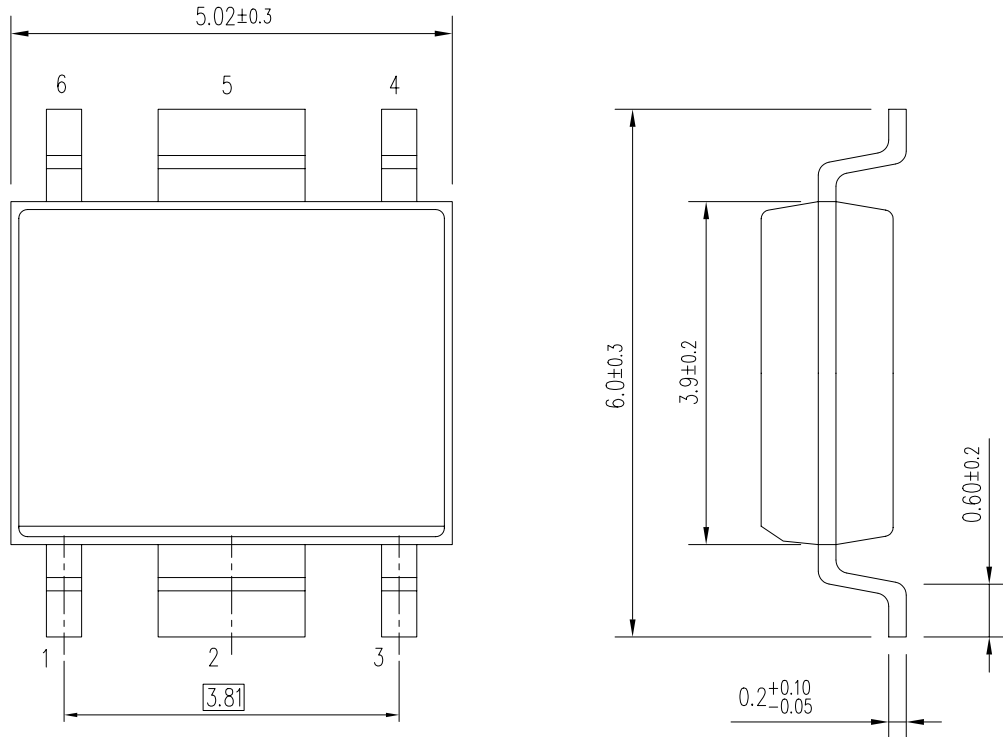
ψ_{jt} : Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



UNIT: mm

HSOP-6J Package Dimensions

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

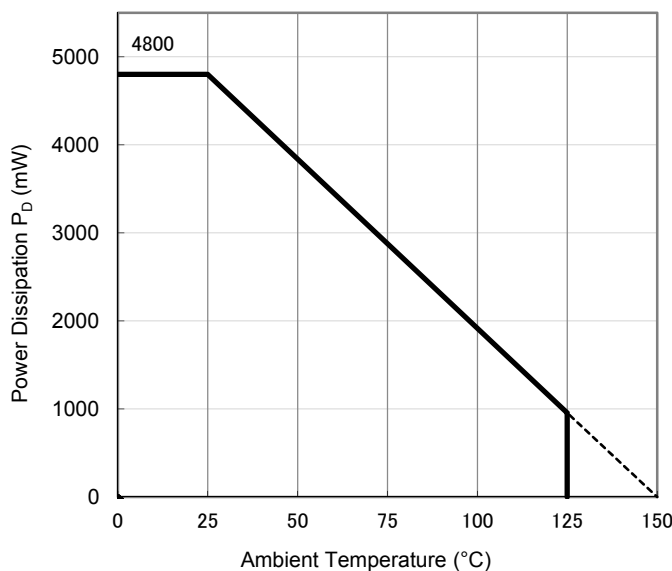
Measurement Result

(Ta = 25°C, Tjmax = 150°C)

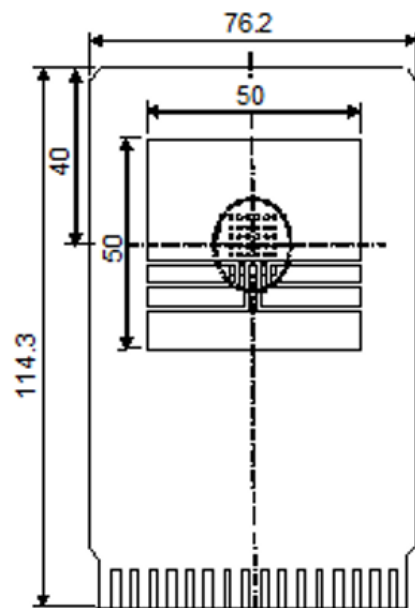
Item	Measurement Result
Power Dissipation	4800 mW
Thermal Resistance (θ_{ja})	$\theta_{ja} = 26^\circ\text{C/W}$
Thermal Characterization Parameter (ψ_{jt})	$\psi_{jt} = 7^\circ\text{C/W}$

θ_{ja} : Junction-to-Ambient Thermal Resistance

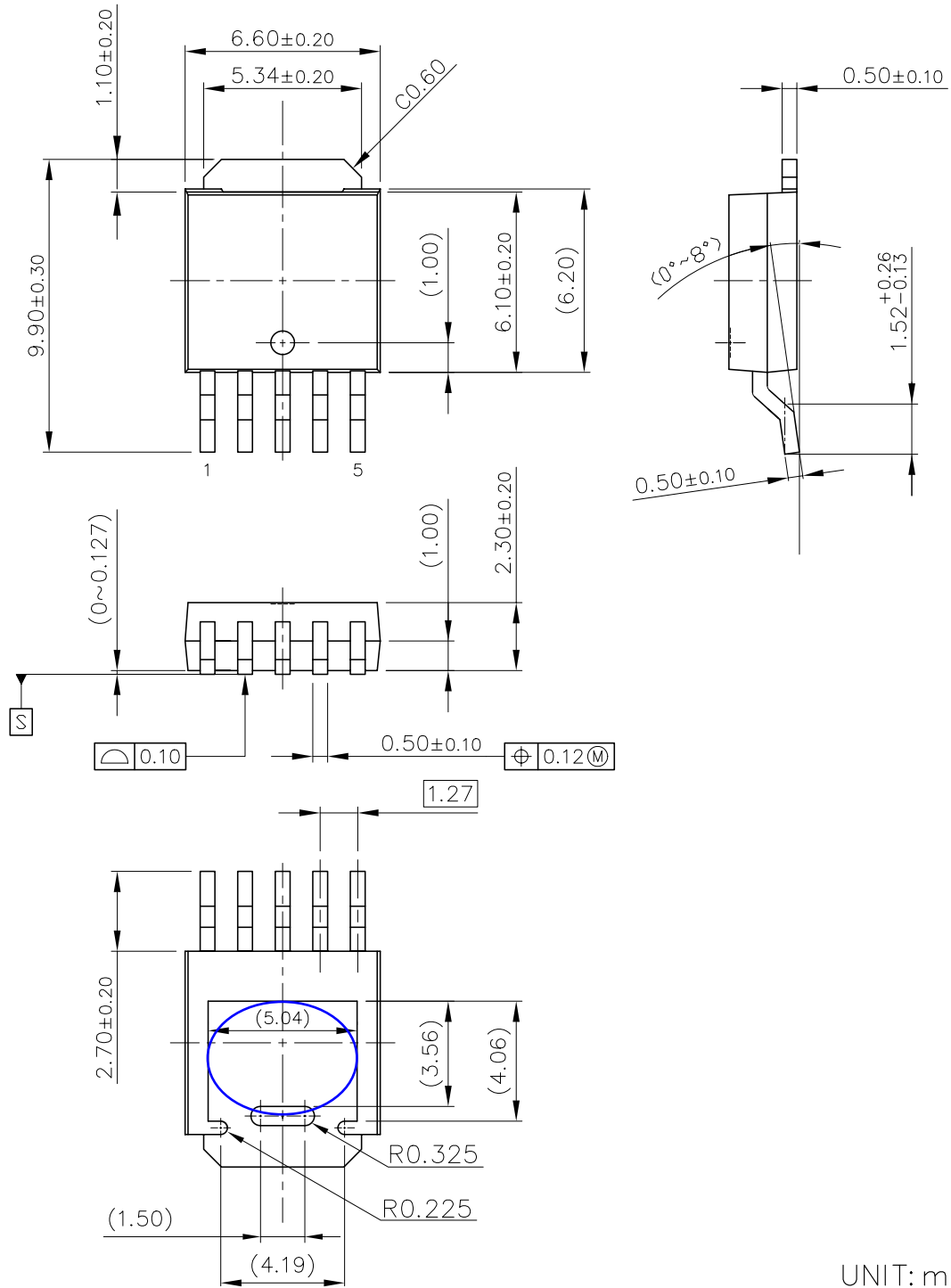
ψ_{jt} : Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



UNIT: mm

TO-252-5-P2 Package Dimensions

* The tab on the bottom of the package shown by blue circle is a 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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