AEC-Q100 Compliant

150 mA 10 V LDO Regulator for Automotive Applications

NO. EC-245-200219

OUTLINE

The RP171x is a LDO regulator featuring 150 mA output current. The RP171x offers the maximum input voltage of 10 V which makes it ideal for the use in car audio equipment, car navigation system and ETC system. The RP171x provides a supply current as low as Typ. 23 µA and achieves fast-response characteristics.

The RP171x offers an output voltage as low as 1.2 V. Compared to existing high-speed lines, the RP171x provides excellent output voltage accuracy and output voltage temperature coefficient

Internally, the RP171x consists of a fold-back protection circuit and a thermal shutdown circuit. A standby mode with ultra low supply current has been realized by a chip enable function.

The RP171x is available in a 5-pin SOT-23-5 package with high power dissipation.

FEATURES

- Input Voltage Range (Absolute Maximum Ratings) ····· 2.6 V to 10 V (12 V)
- Operating Temperature ····· −40°C to 105°C
- Supply Current ····· Typ. 23 µA (V_{IN} = V_{SET} +1.0 V)
- Standby Current ····· Typ. 0.1µA (V_{IN} = 10.0 V, CE = “L”)
- Output Voltage Range ····· 1.2 V/1.5 V/1.8 V/2.5 V/2.8 V/3.0 V/3.3 V/3.4 V/5.0 V/6.0 V
  * Contact our sales representatives for other voltages.
- Output Voltage Accuracy ····· ±1.0%
- Output Voltage Temperature Coefficient ····· Typ. ±80 ppm/°C
- Line Regulation ····· Typ. 0.02%/V
- Dropout Voltage ····· Typ. 0.4 V (I_{OUT} = 150 mA, V_{SET} = 2.8 V)
- Ripple Rejection ····· Typ. 70 dB (f = 1 kHz)
- Fold-back Protection Circuit ····· Typ. 40 mA
- Constant Slope Circuit (Soft-start Function)
- Thermal Shutdown Circuit ····· Stops at 165°C
- Auto-discharge Function ····· RP171xxxxD
- Package ····· SOT-23-5
- Ceramic Capacitor Compatible ····· 1.0 µF or more

APPLICATIONS

- Power supply for car audio equipment, car navigation system, ETC system, etc.
- Power supply for electronic control units such as EV inverter and battery charge control unit.

SELECTION GUIDE

The set output voltage, the auto-discharge function [1] and the automotive class are user-selectable options.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP171Nxx1∗-TR-#E	SOT-23-5	3,000 pcs	Yes	Yes

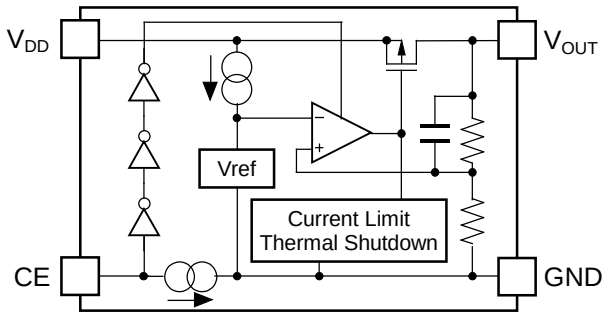
xx: Specify the set output voltage (V_{SET}) within the range of
1.2 V / 1.5 V / 1.8 V / 2.5 V / 2.8 V / 3.0 V / 3.3 V / 3.4 V / 5.0 V / 6.0 V
* Contact our sales representatives for other voltages.

∗: Select from (B) CE = Active-high without auto-discharge function or (D) CE = Active-high with Auto-discharge function.

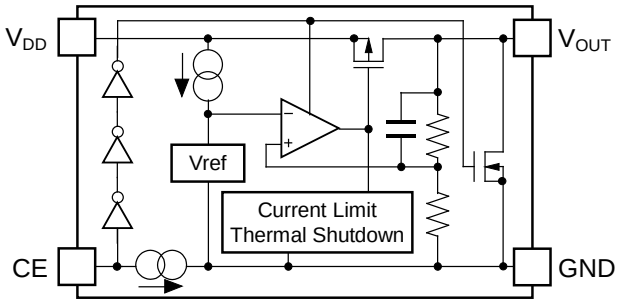
#: Select the quality class.

	Operating Temperature Range	Test Temperature
A	−40°C to 105°C	25°C, High
J	−40°C to 105°C	Low, 25°C, High

BLOCK DIAGRAM



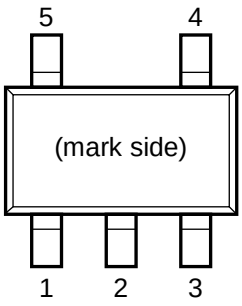
RP171xxxxB Block Diagram



RP171xxxxD Block Diagram

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

PIN DESCRIPTION



SOT-23-5 Pin Configuration

Pin No.	Symbol	Description
1	VDD	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin, Active-high
4	NC	No Connection
5	VOUT	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	12	V
V_{CE}	Input Voltage (CE Pin)	12	V
V_{OUT}	Output Voltage	−0.3 to V_{IN} +0.3	V
I_{OUT}	Output Current	330	mA
P_D	Power Dissipation (1) (SOT-23-5, JEDEC STD. 51-7)	830	mW
Tj	Junction Temperature	−40 to 150	°C
Tstg	Storage Temperature Range	−55 to 150	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause 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

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	2.6 to 10	V
Ta	Operating Temperature Range	−40 to 105	°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 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 conditions.

(1) Refer to *Power Dissipation* for detailed information.

ELECTRICAL CHARACTERISTICS

V_{IN} = V_{SET} + 1.0 V, I_{OUT} = 1 mA, unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at –40°C ≤ Ta ≤ 105°C.

RP171x (-AE) (Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	1.5 V < V_{SET}	Ta = 25°C	V_{SET} x 0.99		V_{SET} x 1.01	V
			−40°C ≤ Ta ≤ 105°C	[V_{SET} x0.965]		[V_{SET} x 1.03]	
		V_{SET} ≤ 1.5 V	Ta = 25°C	−15		15	mV
			−40°C ≤ Ta ≤ 105°C	[−53]		[45]	
I_{OUT}	Output Current			[150]			mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1 mA ≤ I_{OUT} ≤ 150 mA			5	[45]	mV
V_{DIF}	Dropout Voltage	I_{OUT} =150 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{SS}	Supply Current	I_{OUT} = 0 mA			23	[45]	µA
Istandby	Standby Current	V_{IN} = 10.0 V, V_{CE} = GND			0.1	[1.2]	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET} + 0.5 V ≤ V_{IN} ≤ 10.0 V Note: When V_{OUT} ≤ 2.1 V, 2.6 V ≤ V_{IN} ≤ 10.0 V			±0.02	[±0.25]	%/V
I_{SC}	Short Current Limit	V_{OUT} = 0 V			40		mA
I_{PD}	CE Pull-down Current				0.30		µA
V_{CEH}	CE Input Voltage “H”			[1.7]			V
V_{CEL}	CE Input Voltage “L”					[0.8]	V
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			110		°C
R_{LOW}	Auto-discharge Nch Tr. ON Resistance (RP171xxxxD)	V_{CE} = 0 V, V_{IN} = 7.0 V			250		Ω

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

V_{IN} = V_{SET} + 1.0 V, I_{OUT} = 1 mA, unless otherwise noted.

RP171x (-JE) (−40°C ≤ Ta ≤ 105°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	1.5 V < V_{SET}	Ta = 25°C	V_{SET} x 0.99		V_{SET} x 1.01	V
			−40°C ≤ Ta ≤ 105°C	V_{SET} x 0.965		V_{SET} x 1.03	
		V_{SET} ≤ 1.5 V	Ta = 25°C	−15		15	mV
			−40°C ≤ Ta ≤ 105°C	−53		45	
I_{OUT}	Output Current			150			mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1 mA ≤ I_{OUT} ≤ 150 mA			5	45	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 150 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{SS}	Supply Current	I_{OUT} = 0 mA			23	45	µA
Istandby	Standby Current	V_{IN} = 10.0 V, V_{CE} = GND			0.1	1.2	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET} + 0.5 V ≤ V_{IN} ≤ 10.0 V Note: When V_{OUT} ≤ 2.1 V, 2.6 V ≤ V_{IN} ≤ 10.0 V			±0.02	±0.25	%/V
I_{SC}	Short Current Limit	V_{OUT} = 0 V			40		mA
I_{PD}	CE Pull-down Current				0.30		µA
V_{CEH}	CE Input Voltage “H”			1.7			V
V_{CEL}	CE Input Voltage “L”					0.8	V
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			110		°C
R_{LOW}	Auto-discharge Nch Tr. ON Resistance (RP171xxxxD)	V_{CE} = 0 V, V_{IN} = 7.0 V			250		Ω

製品別電気的特性表

[ ]で示した値は、−40°C ≤ Ta ≤ 105°Cでの設計保証値です。

RP171xxxxB/D (-AE) (Ta = 25°C)

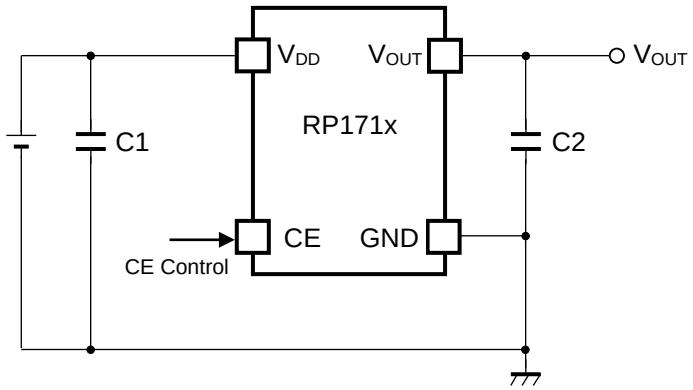
製品名	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 105°C)			V_{DIF} (V) (I_{OUT} = 150 mA)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
RP171x121x	1.185	1.200	1.215	[1.147]	1.200	[1.245]	−	[1.405]
RP171x151x	1.485	1.500	1.515	[1.447]	1.500	[1.545]	−	[1.105]
RP171x181x	1.782	1.800	1.818	[1.737]	1.800	[1.854]	−	[0.805]
RP171x251x	2.475	2.500	2.525	[2.413]	2.500	[2.575]	0.400	[0.600]
RP171x281x	2.772	2.800	2.828	[2.702]	2.800	[2.884]		
RP171x301x	2.970	3.000	3.030	[2.895]	3.000	[3.090]	0.300	[0.500]
RP171x331x	3.267	3.300	3.333	[3.185]	3.300	[3.399]		
RP171x341x	3.366	3.400	3.434	[3.281]	3.400	[3.502]		
RP171x501x	4.950	5.000	5.050	[4.825]	5.000	[5.150]	0.250	[0.420]
RP171x601x	5.940	6.000	6.060	[5.790]	6.000	[6.180]		

RP171xxxxB/D (-JE) (−40°C ≤ Ta ≤ 105°C)

製品名	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 105°C)			V_{DIF} (V) (I_{OUT} = 150 mA)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
RP171x121x	1.185	1.200	1.215	1.147	1.200	1.245	−	1.405
RP171x151x	1.485	1.500	1.515	1.447	1.500	1.545	−	1.105
RP171x181x	1.782	1.800	1.818	1.737	1.800	1.854	−	0.805
RP171x251x	2.475	2.500	2.525	2.413	2.500	2.575	0.400	0.600
RP171x281x	2.772	2.800	2.828	2.702	2.800	2.884		
RP171x301x	2.970	3.000	3.030	2.895	3.000	3.090	0.300	0.500
RP171x331x	3.267	3.300	3.333	3.185	3.300	3.399		
RP171x341x	3.366	3.400	3.434	3.281	3.400	3.502		
RP171x501x	4.950	5.000	5.050	4.825	5.000	5.150	0.250	0.420
RP171x601x	5.940	6.000	6.060	5.790	6.000	6.180		

APPLICATION INFORMATION

TYPICAL APPLICATION



RP171x Typical Application

External Components

Symbol	Description
C2 (C_{OUT})	1.0 µF, Ceramic Capacitor, MURATA GRM155B31A105KE15

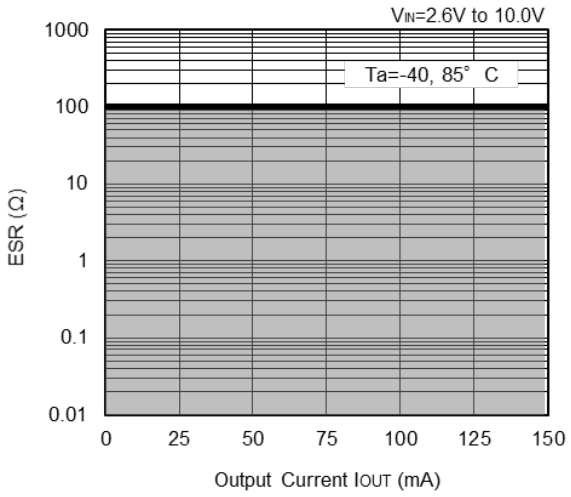
EQUIVALENT SERIES RESISTANCE (ESR) vs. OUTPUT CURRENT (I_{OUT})

Ceramic type output capacitor is recommended for the RP171x; however, the other output capacitors with low ESR also can be used. The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is under 40 µV (Avg.) are marked as the hatched area in the graph.

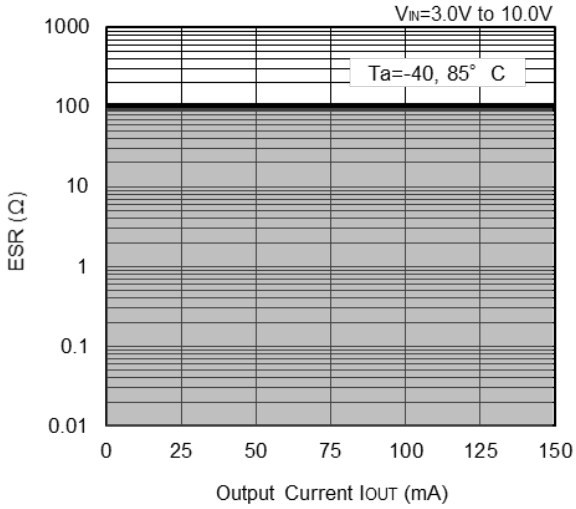
Measurement Conditions

Noise Frequency Band: 10 Hz to 2 MHz
Measurement Temperature: −40°C to 85°C
Hatched area: Noise level below 40 µV (Avg.).
C1, C2: Ceramic 1.0 µF (Murata, GRM155B31A105KE)

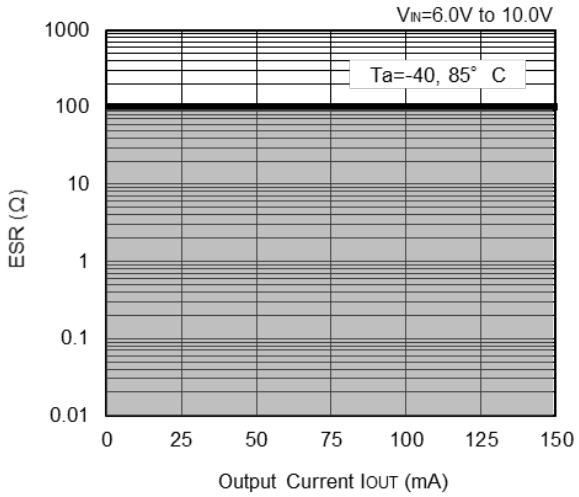
RP171x12xx



RP171x30xx



RP171x60xx



TECHNICAL NOTES

Phase Compensation

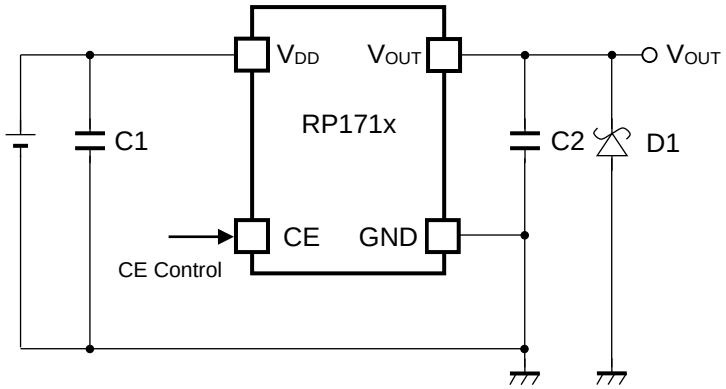
In the RP171x, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, use a 1.0 µF or more output capacitor (C2) with good frequency characteristics and proper ESR (Equivalent Series Resistance).

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

PCB Layout

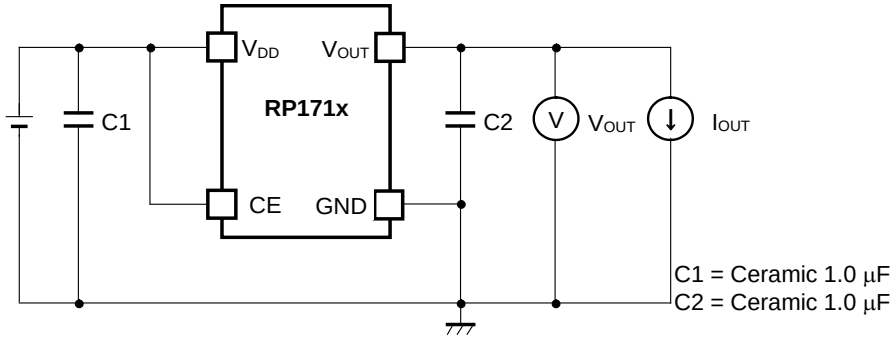
Ensure the V_{DD} and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. Connect a 1.0 µF or more output capacitor (C1) with suitable values between the V_{DD} and GND pins, and as close as possible to the pins.

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION

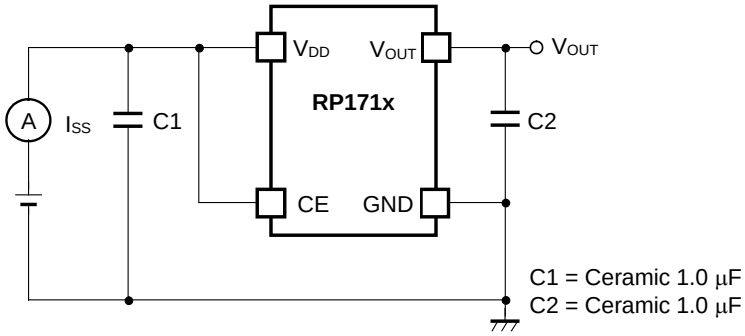


When a sudden surge of electrical current travels along the V_{OUT} pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor (C2) and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode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

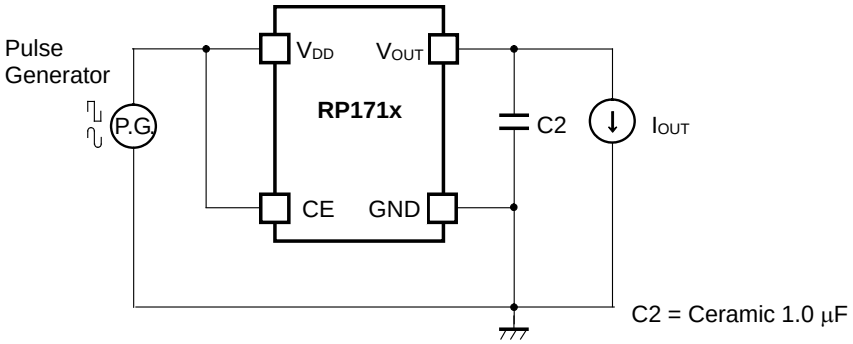
TEST CIRCUITS



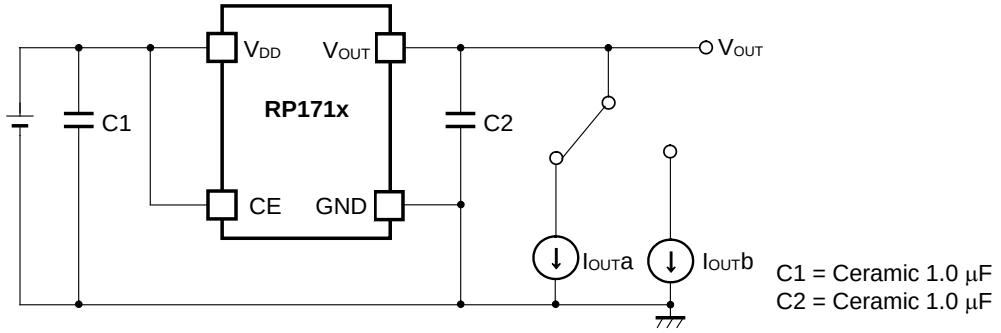
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection

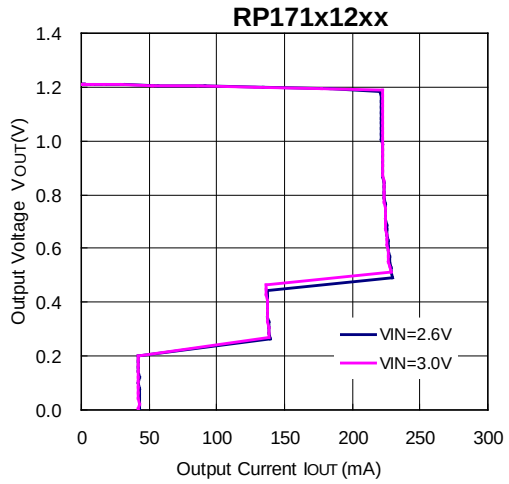


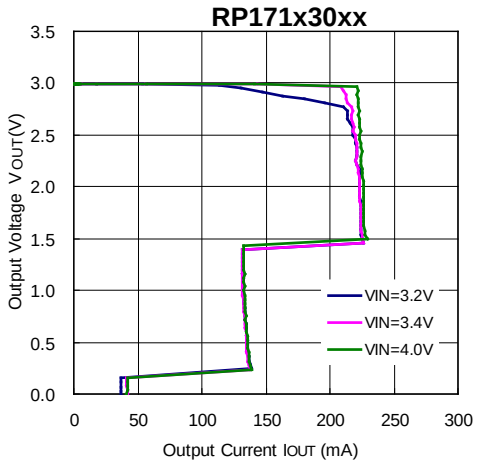
Test Circuit for Load Transient Response

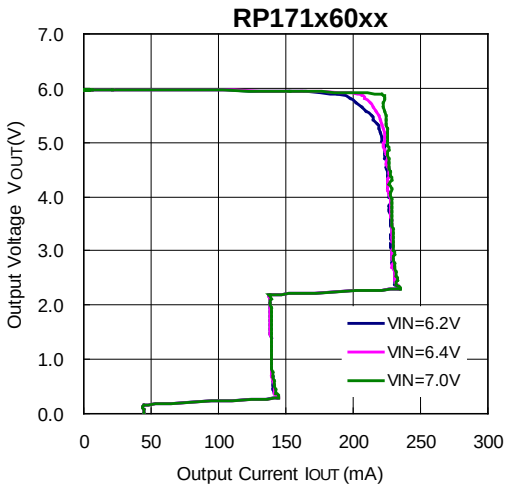
TYPICAL CHARACTERISTICS

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

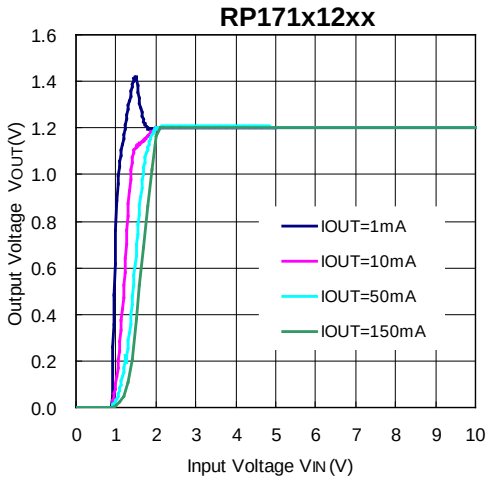
1) Output voltage vs. Output Current (Ta = 25°C)

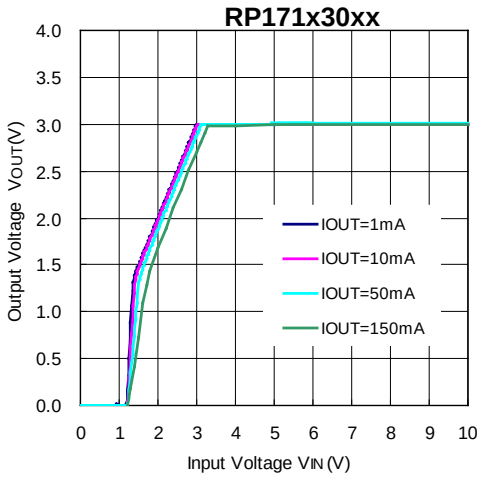




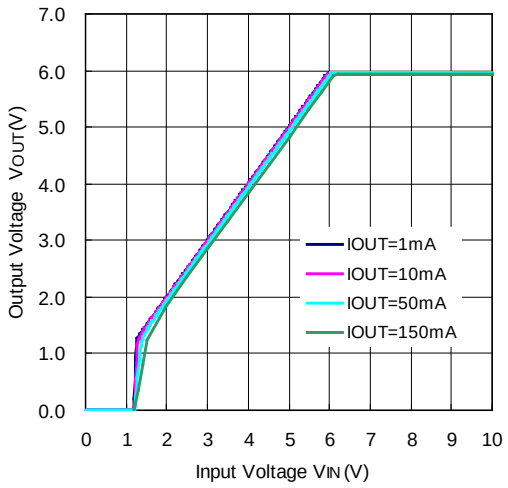


2) Output Voltage vs. Input Voltage (Ta = 25°C)



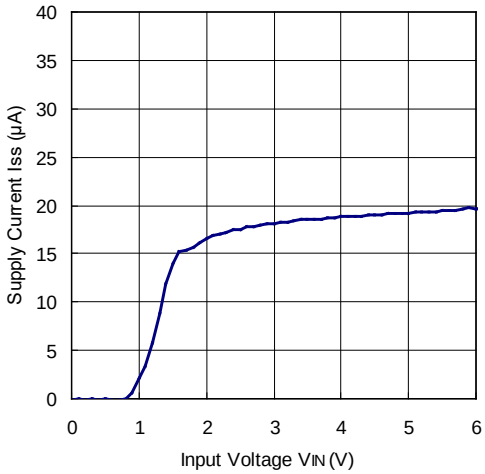


RP171x60xx

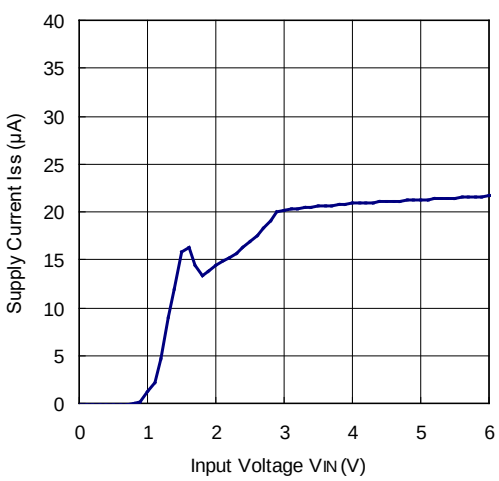


3) Supply Current vs. Input Voltage (Ta = 25°C)

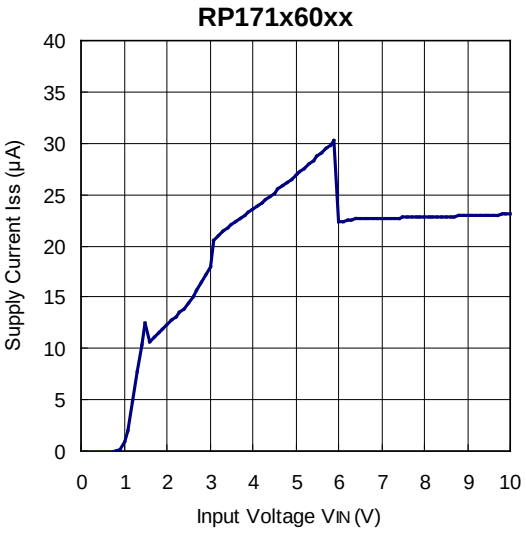
RP171x12xx



RP171x30xx

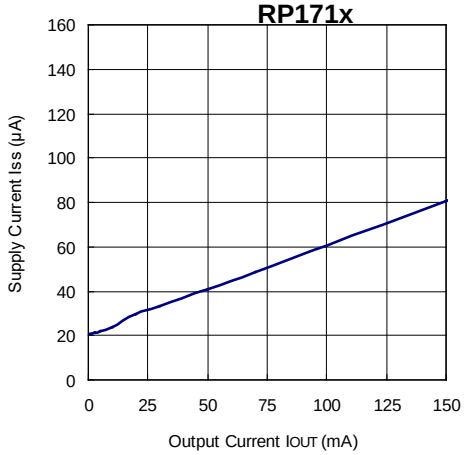


RP171x60xx



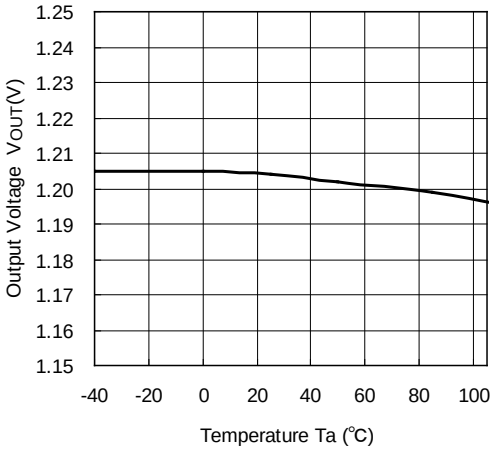
4) Supply Current vs. Output Current (Ta = 25°C)

RP171x

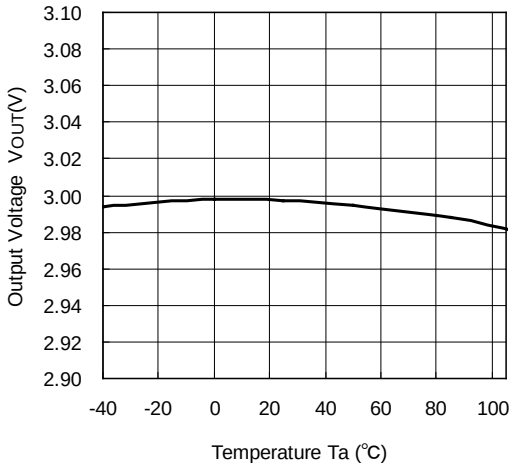


5) Output Voltage vs. Temperature

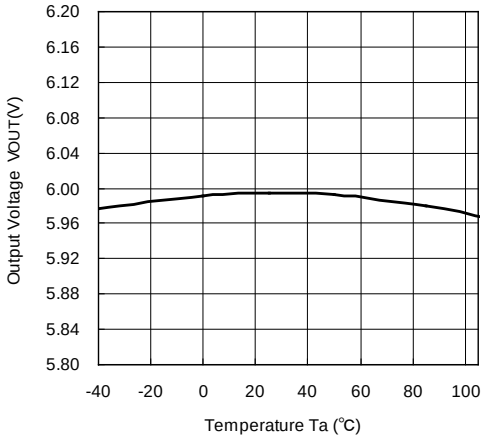
RP171x12xx



RP171x30xx

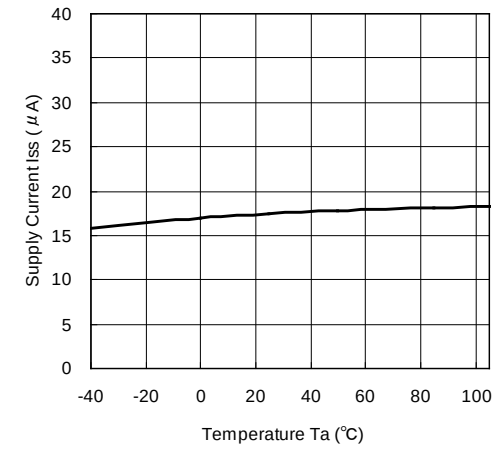


RP171x60xx

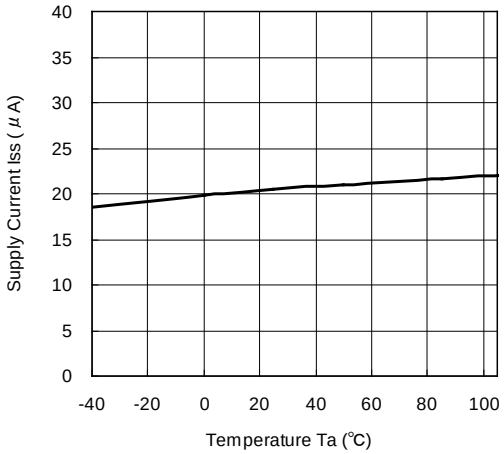


6) Supply Current vs. Temperature

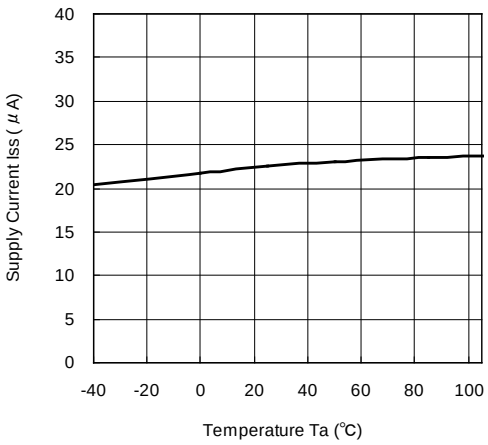
RP171x12xx



RP171x30xx

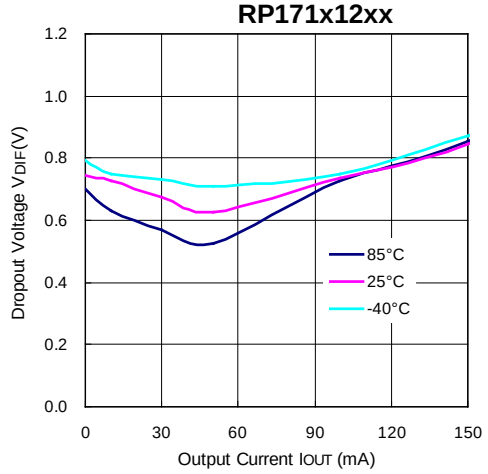


RP171x60xx

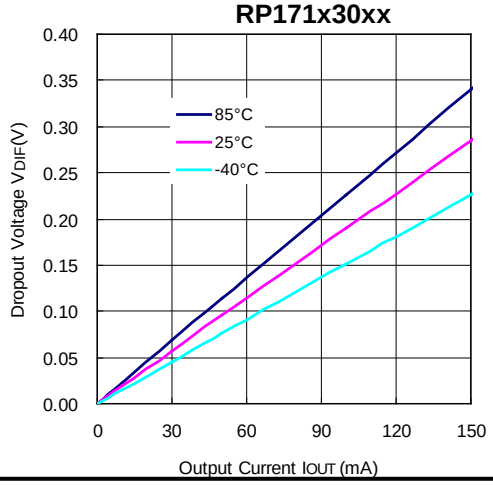


7) Dropout Voltage vs. Output Current

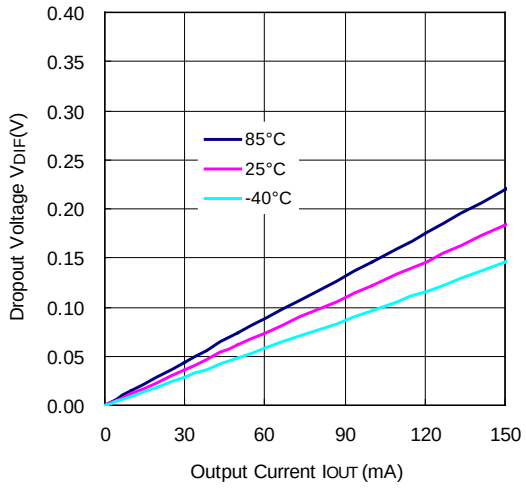
RP171x12xx



RP171x30xx

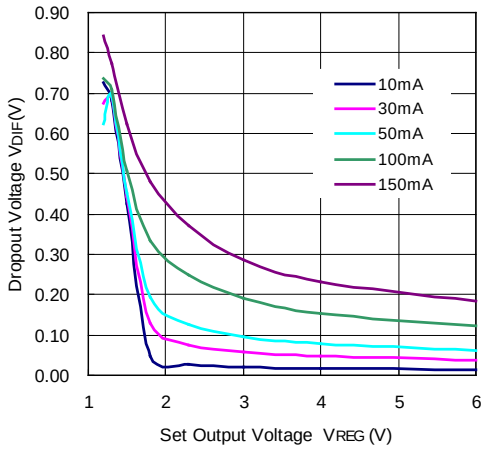


RP171x60xx



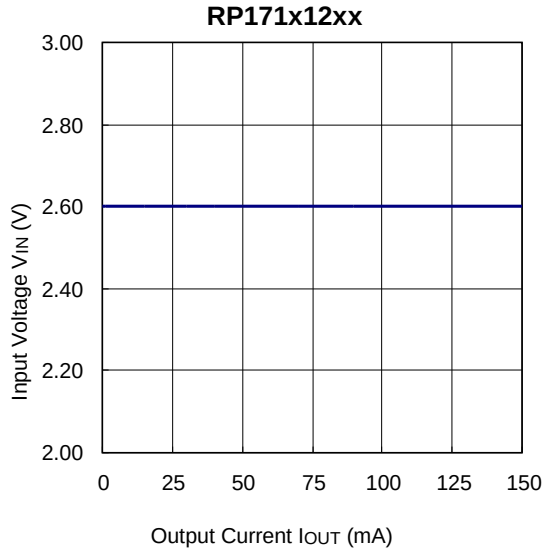
8) Dropout Voltage vs. Set Output Voltage (Ta = 25°C)

RP171x

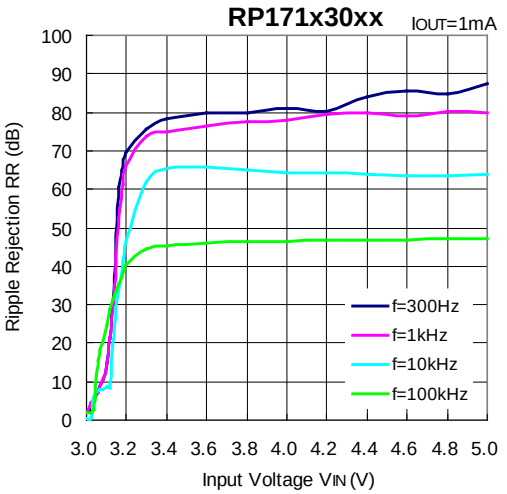


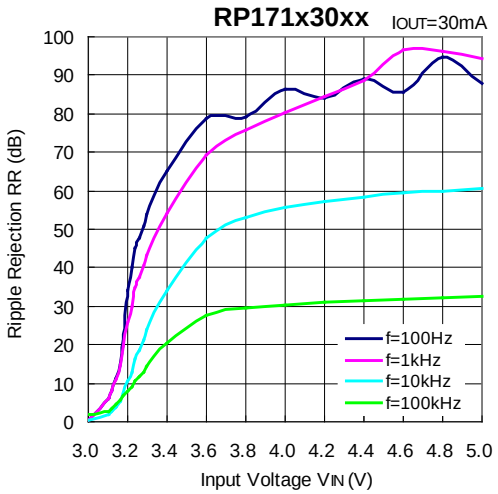
9) Minimum Operating Voltage

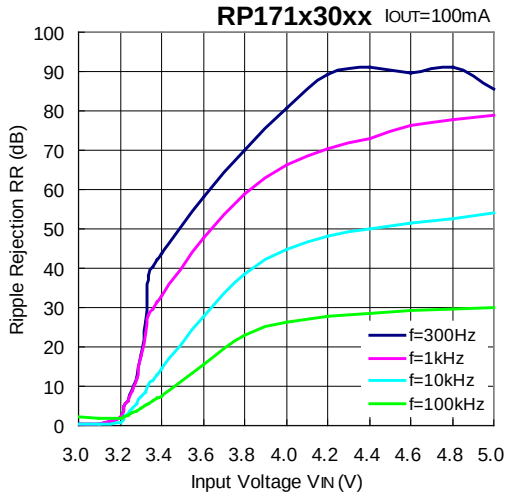
RP171x12xx



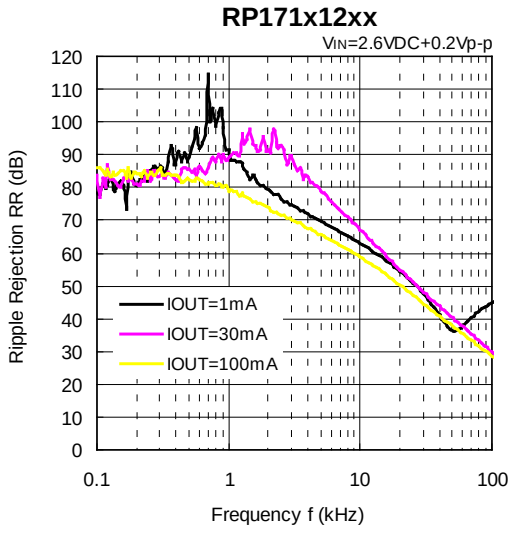
10) Ripple Rejection vs. Input Bias Voltage (C1 = none, C2 = Ceramic 1.0 µF, Ripple = 0.2 Vp-p, Ta = 25°C)

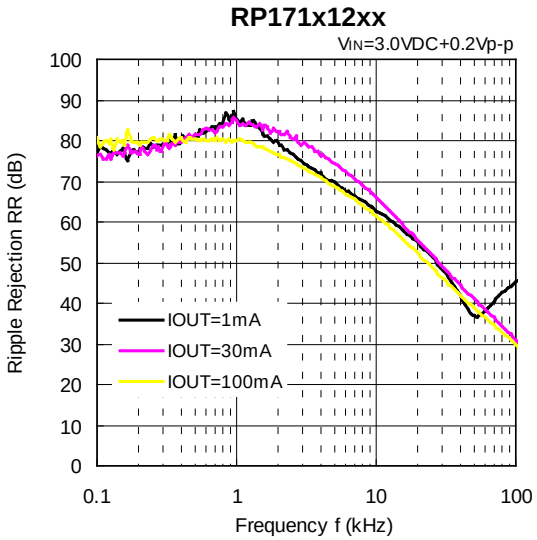




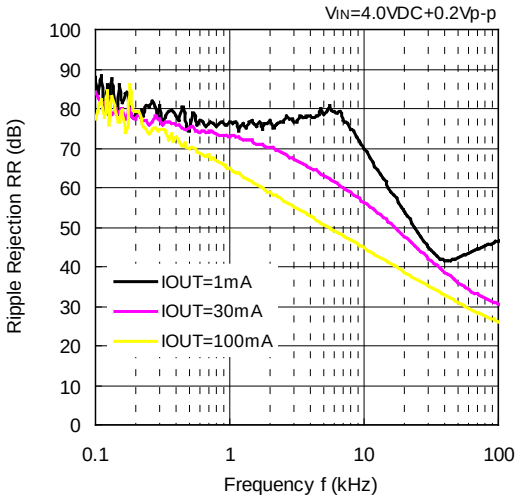


11) Ripple Rejection vs. Frequency (C1 = none, C2 = Ceramic 1.0 µF, Ta = 25°C)

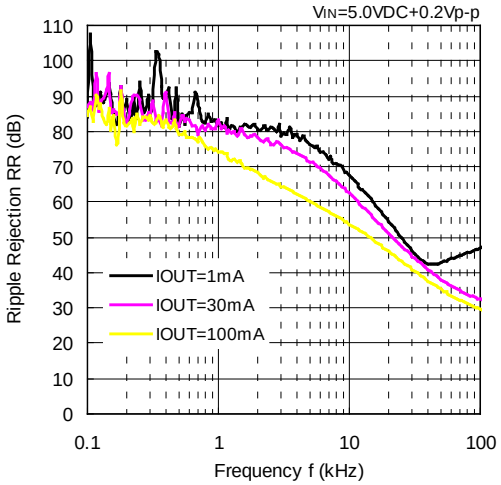




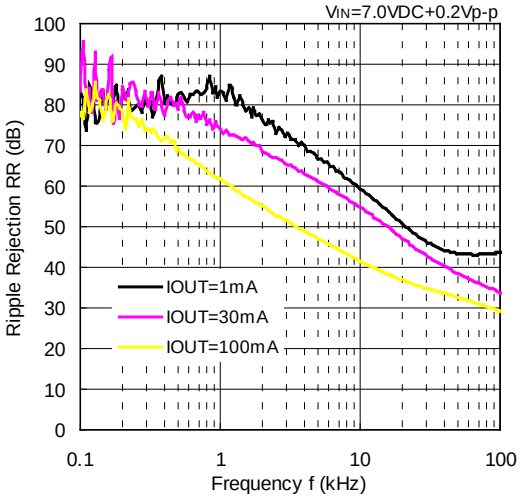
RP171x30xx



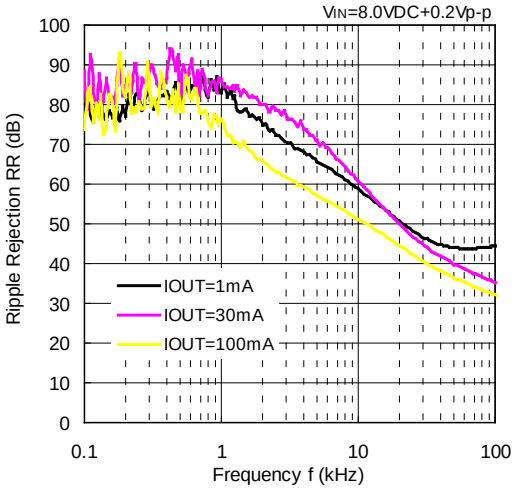
RP171x30xx



RP171x60xx

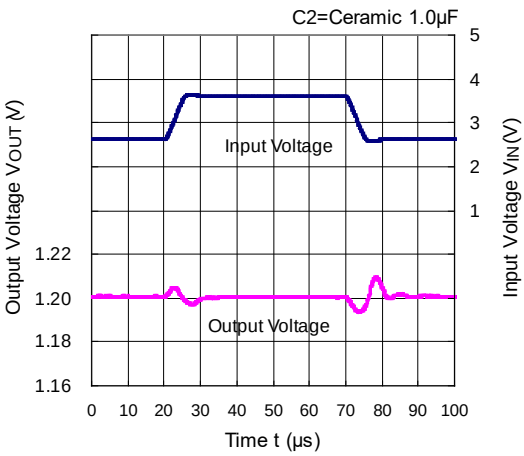


RP171x60xx

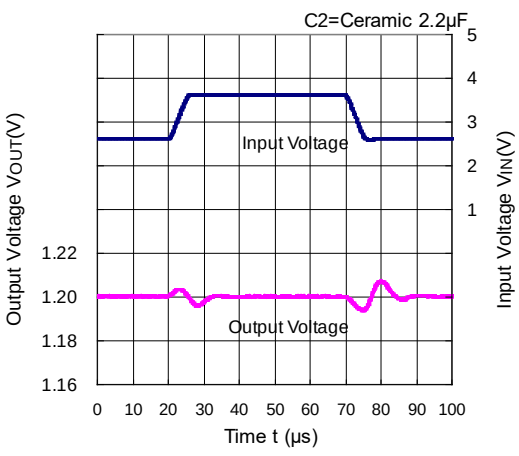


12) Input Transient Response (C1 = none, I_{OUT} = 30 mA, tr = tf = 5µs, Ta = 25°C)

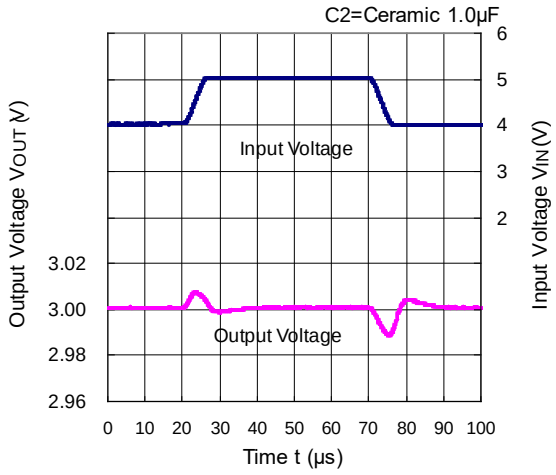
RP171x12xx



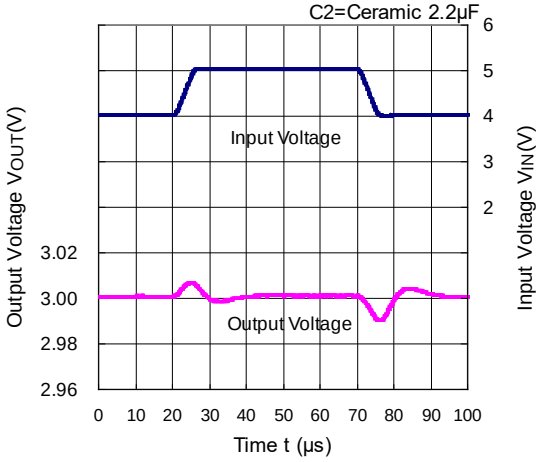
RP171x12xx



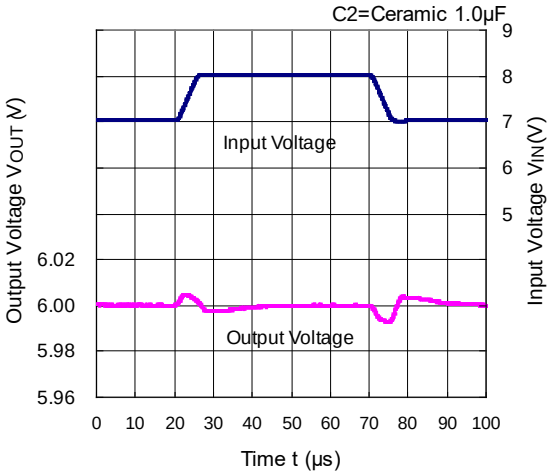
RP171x30xx



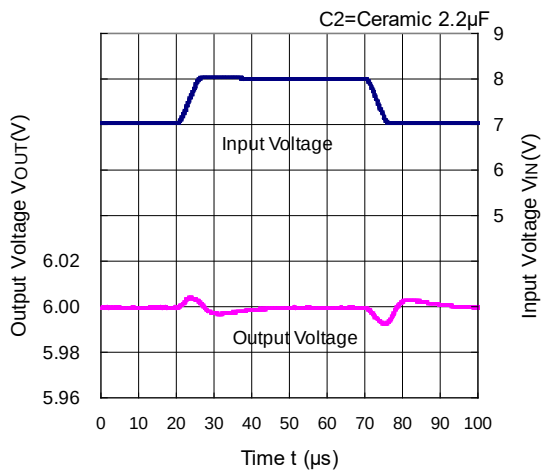
RP171x30xx



RP171x60xx

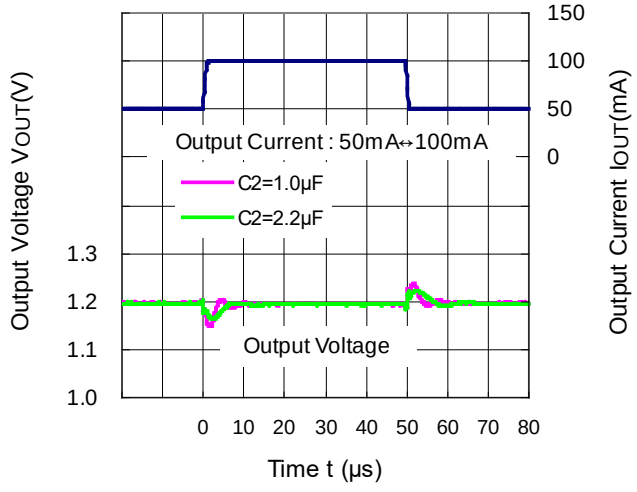


RP171x60xx

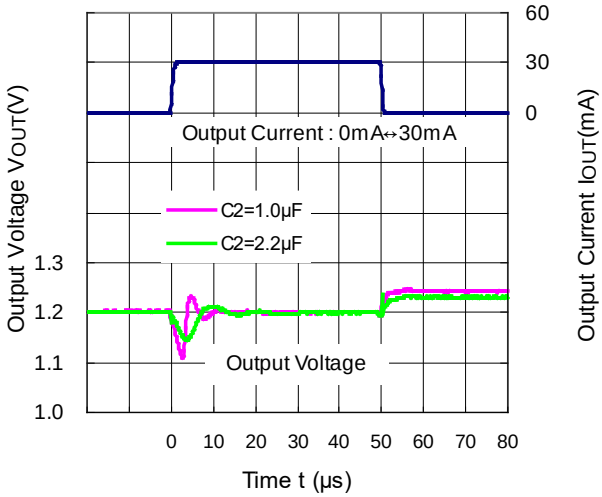


13) Load Transient Response (C1 = Ceramic 1.0 μF, tr = tf = 500 ns, Ta = 25°C)

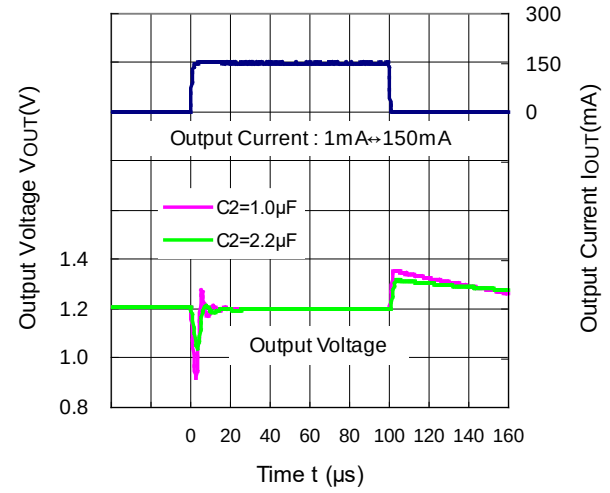
RP171x12xx



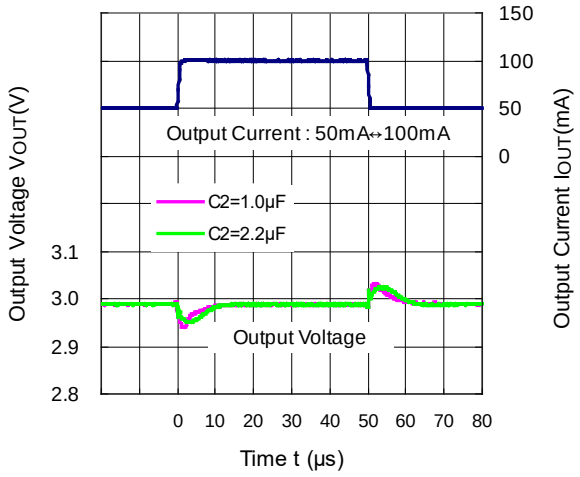
RP171x12xx



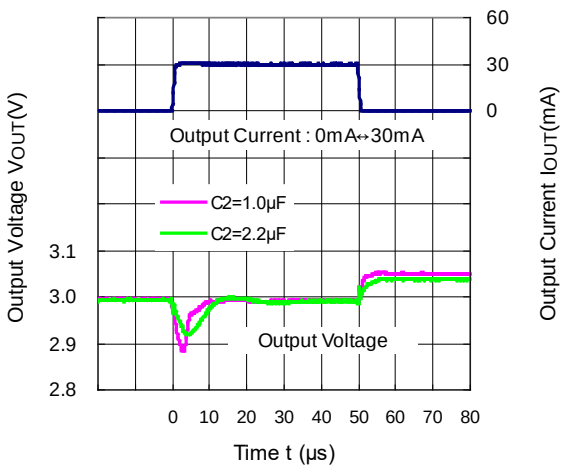
RP171x12xx



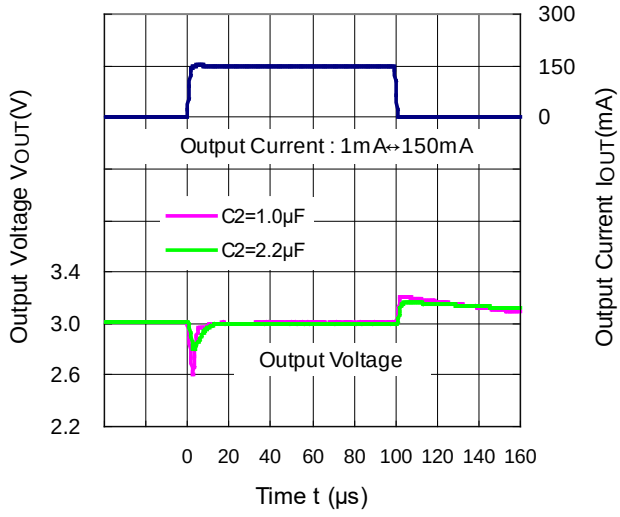
RP171x30xx



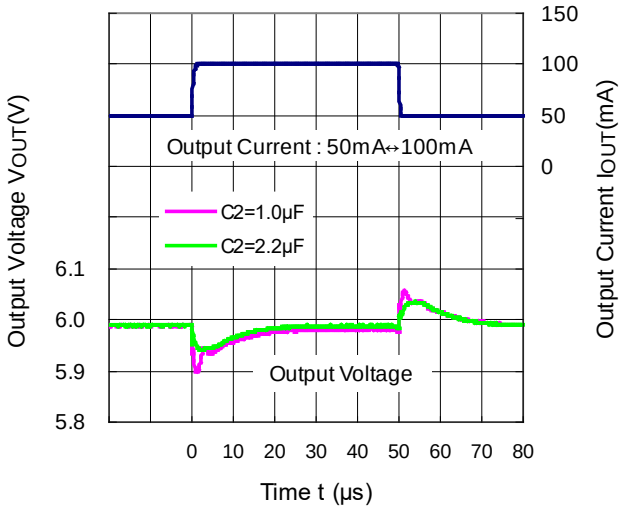
RP171x30xx



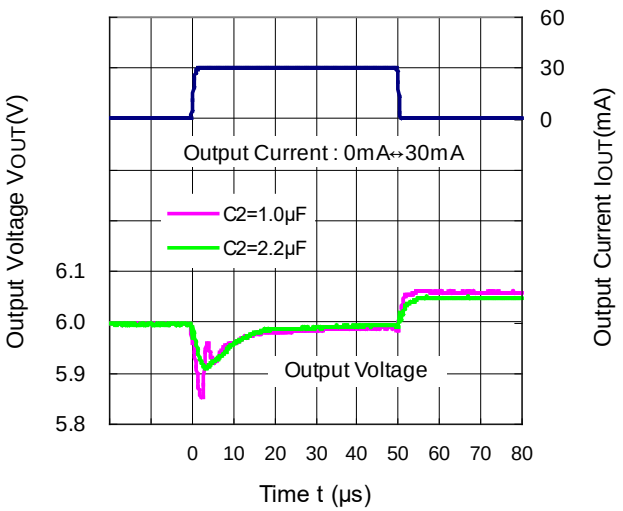
RP171x30xx



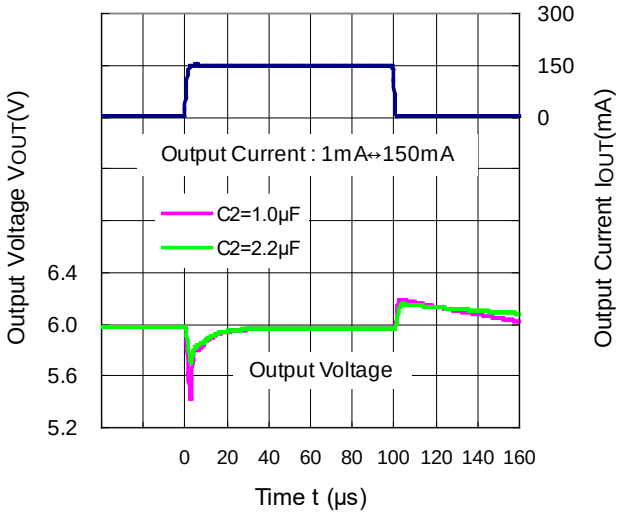
RP171x60xx



RP171x60xx

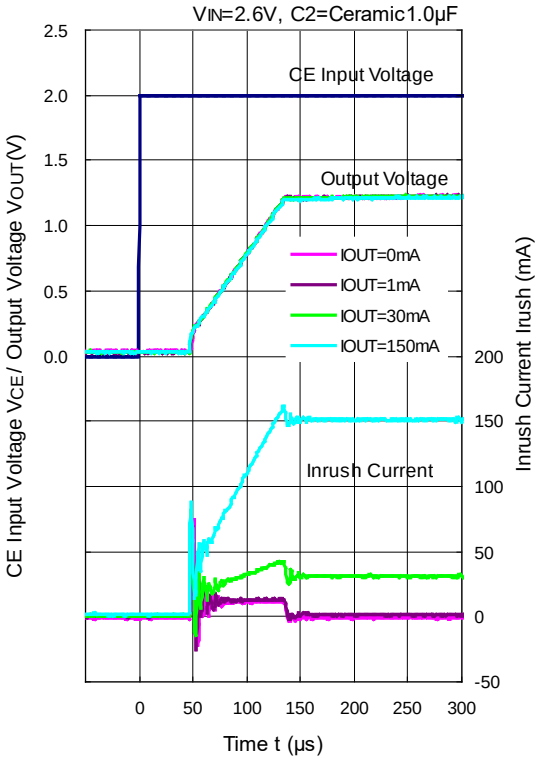


RP171x60xx

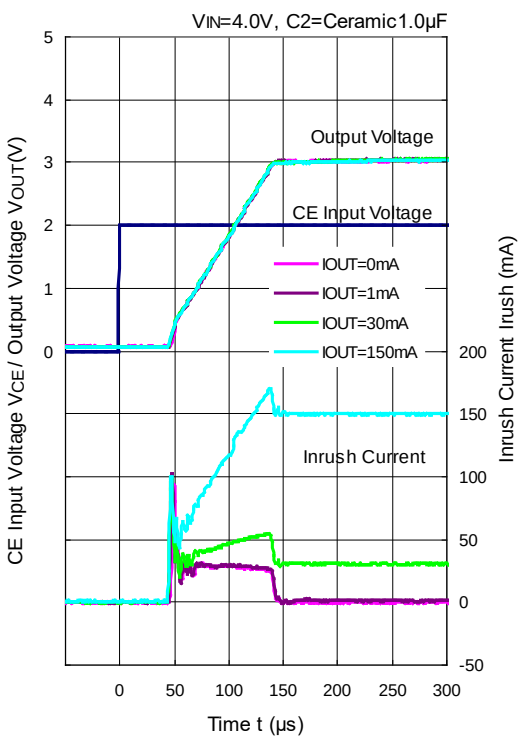


14) Turn On Speed with CE pin (C1 = Ceramic 1.0 µF, Ta = 25°C)

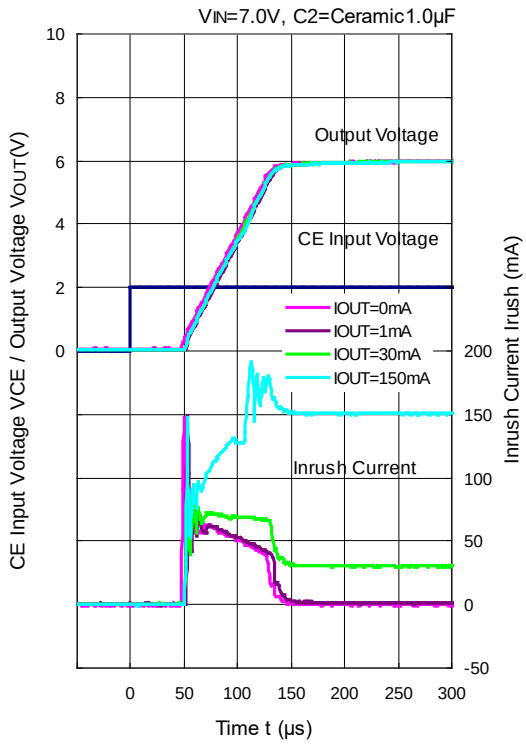
RP171x12xx



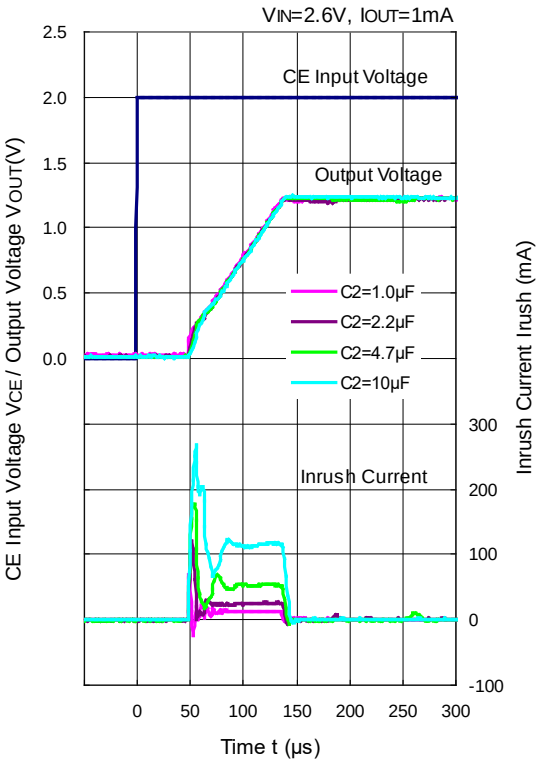
RP171x30xx



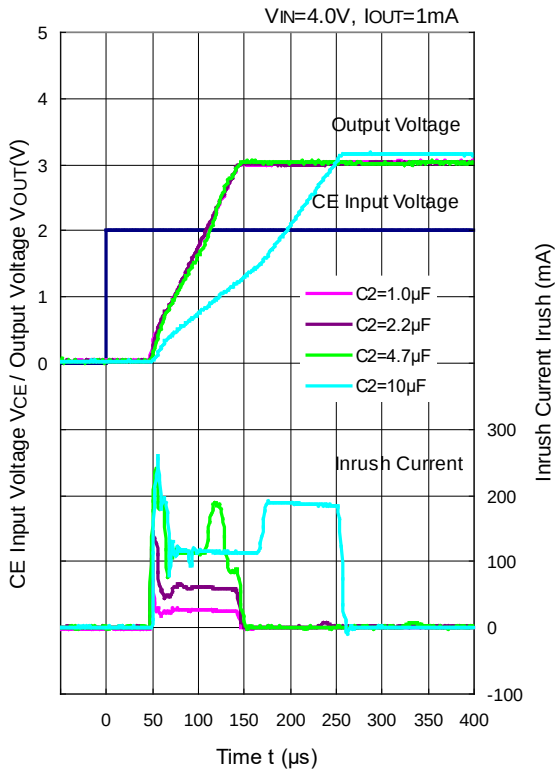
RP171x60xx



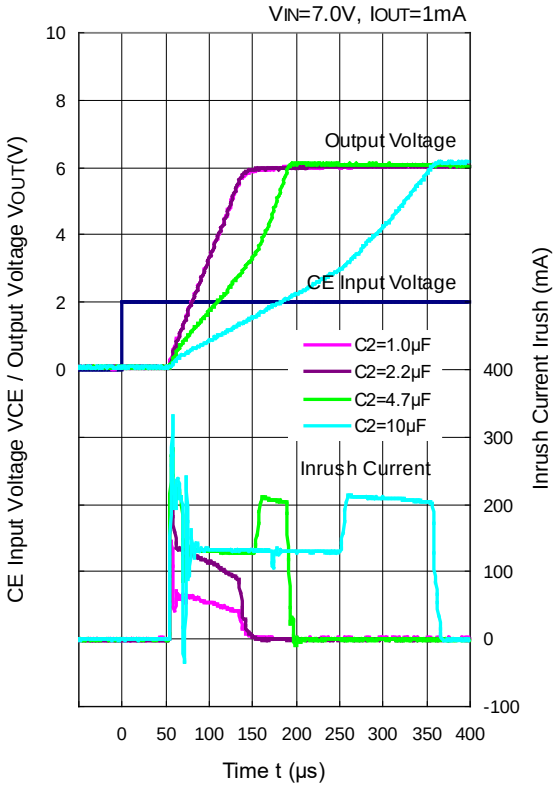
RP171x12xx



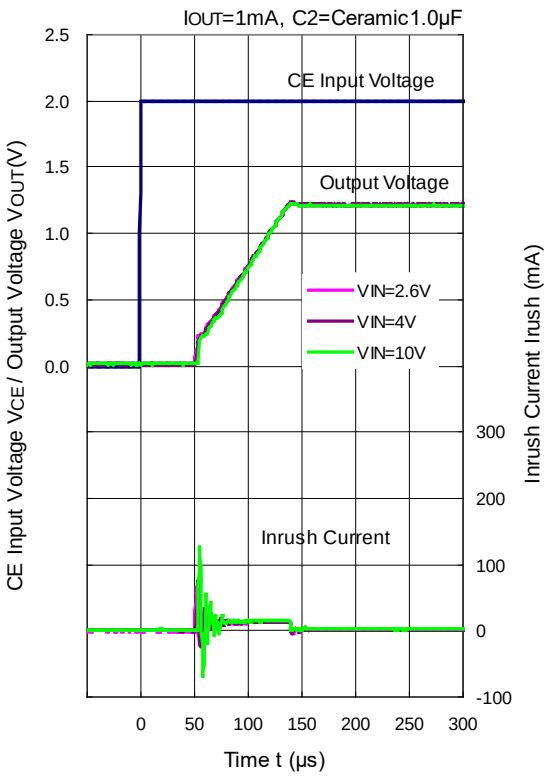
RP171x30xx



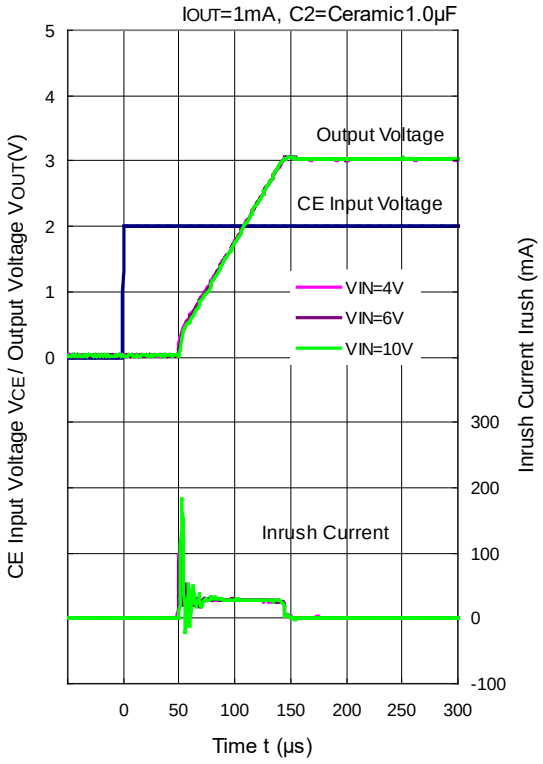
RP171x60xx



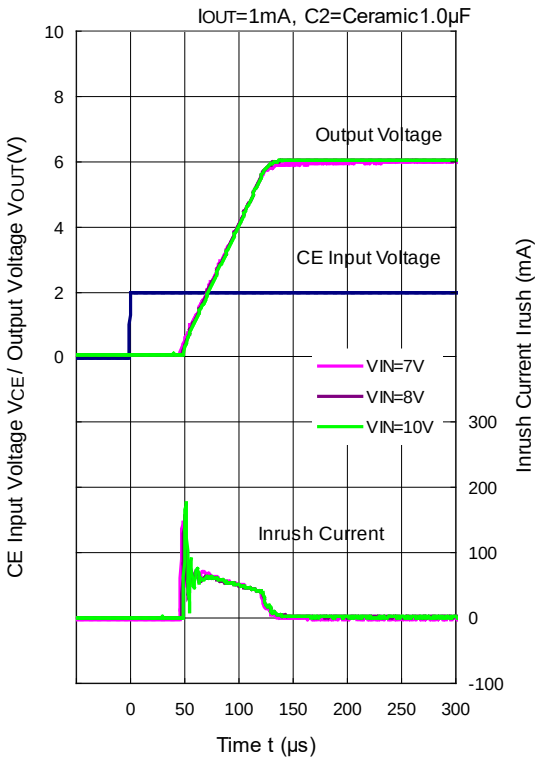
RP171x12xx



RP171x30xx

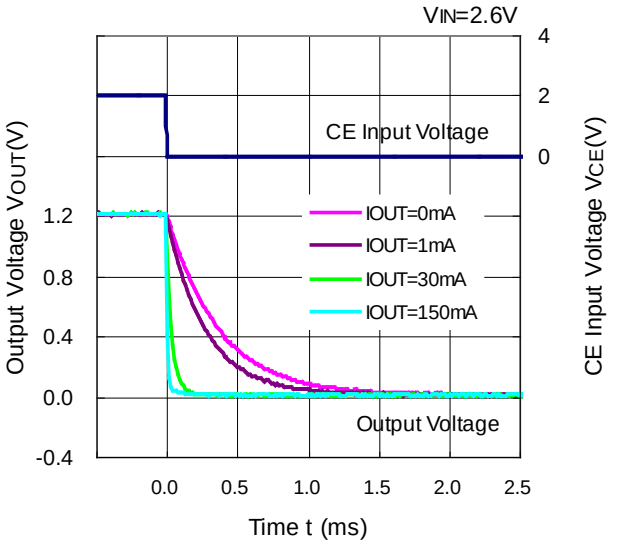


RP171x60xx

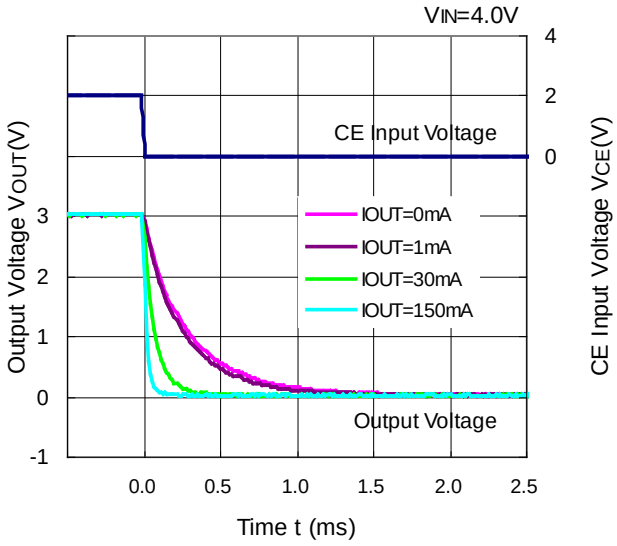


15) Turn Off Speed with CE pin (RP171xxxxD) (C1 = C2 = Ceramic 1.0 µF, Ta = 25°C)

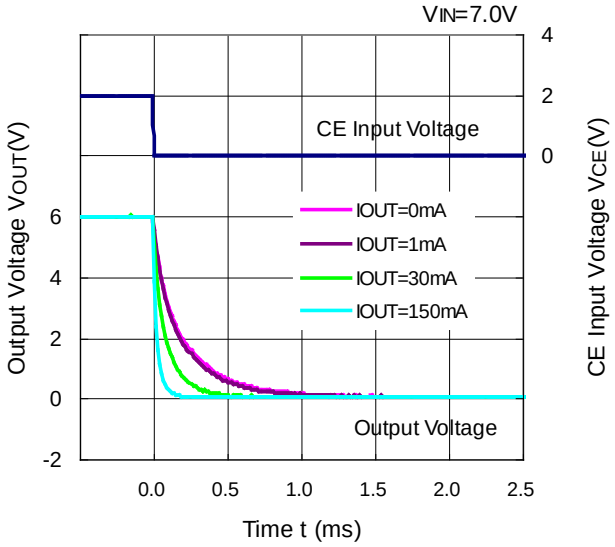
RP171x121D



RP171x301D



RP171x601D



Ver. A

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

Measurement Conditions

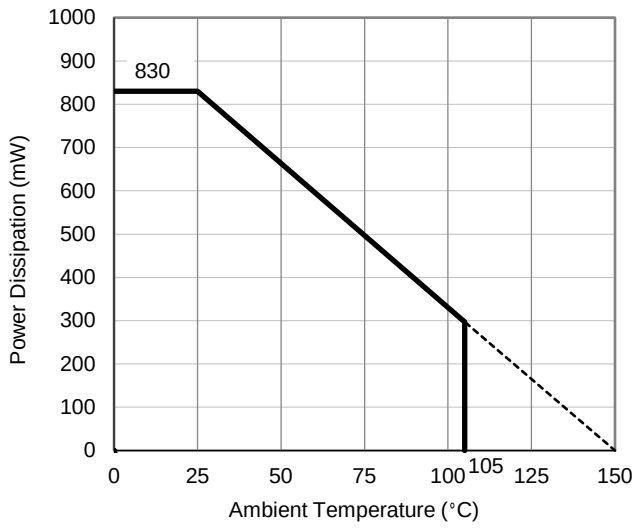
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx.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

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

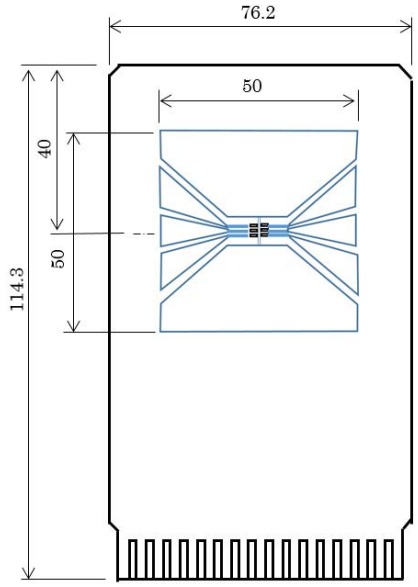
Item	Measurement Result
Power Dissipation	830 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

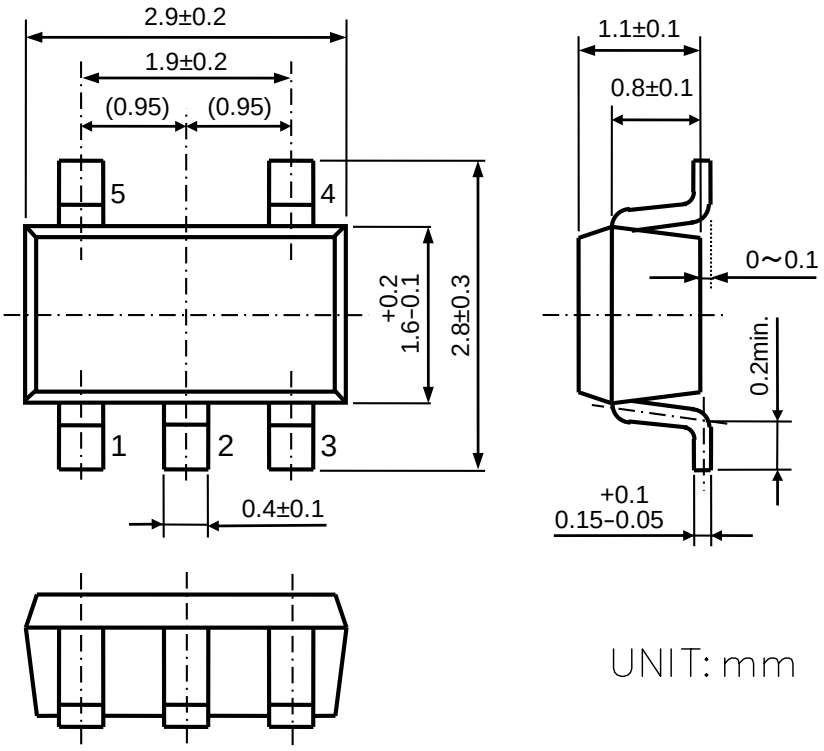
ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



SOT-23-5 Package Dimensions

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of our company.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our company's or any third party's intellectual property rights or any other rights.
5. The products in this document are designed for automotive applications. However, when using the products for automotive applications, please make sure to contact our sales representative in advance due to confirming the quality level.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI.
11. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

NISSHINBO

Nisshinbo Micro Devices Inc.

Official website
https://www.nisshinbo-microdevices.co.jp/en/

Purchase information
https://www.nisshinbo-microdevices.co.jp/en/buy/