300 mA 10 V Input LDO Regulator for Industrial Applications

NO. EA-341-160613

OUTLINE

The RP170x Series are LDO regulators featuring 300 mA output current that are developed with CMOS process technology. Because of the 10 V maximum input voltage, RP170x can be used in the industrial equipments such as FAs and smart meters. The supply current is Typ. 23 μA though an excellent response characteristics. The output voltage range from 1.2 V is possible. The output voltage accuracy and temperature-drift coefficient of output voltage of the RP170x Series are excellent.

RP170x has a fold-back protection circuit and a thermal shutdown circuit. Moreover, a standby mode with ultra low supply current can be realized with the chip enable function.

SOT-23-5 and SOT-89-5 with high power dissipation packages are available.

This is a high-reliability semiconductor device for industrial applications (-Y) that has passed both the screening at high temperature and the reliability test with extended hours. This line of products operate in a wide temperature range from low temperature to high temperature to support harsh environment applications.

FEATURES

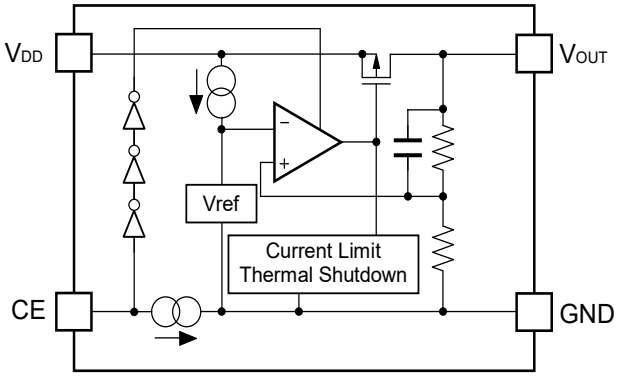
- Input Voltage Range (Maximum Rating) .....2.6 V to 10.0 V (12 V)
- Operating Temperature.....−50°C to 105°C
- Supply Current.....Typ. 23 μA
- Standby Mode .....Typ. 0.1 μA
- Dropout Voltage.....Typ. 0.20 V (I_{OUT} = 100 mA, V_{OUT} = 3.0 V)
  .....Typ. 0.77 V (I_{OUT} = 300 mA, V_{OUT} = 2.8 V)
- Ripple Rejection .....Typ. 70 dB (f = 1 kHz)
- Temperature-Drift Coefficient of Output Voltage .....Typ. ±80 ppm/°C
- Line Regulation.....Typ. 0.02%/V
- Output Voltage Accuracy .....±1.0%
- Packages.....SOT-23-5, SOT-89-5
- 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.
- Built-in Fold Back Protection Circuit ..... Typ. 40mA (Current at short mode)
- Built-in Thermal Shutdown Circuit ..... Shutdown Temperature at 165°C
- Built-in Constant Slope Circuit (Soft-start Function)
- Ceramic capacitors are recommended to be used with this IC.....1.0 μF or more

APPLICATIONS

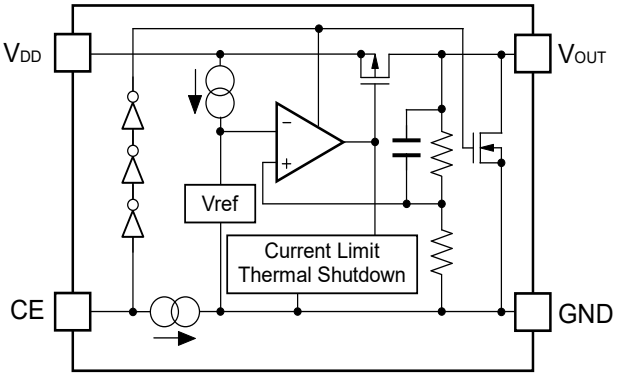
- Industrial equipments such as FAs and smart meters
- Equipments used under high-temperature conditions such as surveillance camera and vending machine
- Equipments accompanied by self-heating such as motor and lighting

BLOCK DIAGRAMS

RP170xxxxB



RP170xxxxD



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP170Nxx1∗-TR-YE	SOT-23-5	3,000 pcs	Yes	Yes
RP170Hxx1∗-T1-YE	SOT-89-5	1,000 pcs	Yes	Yes

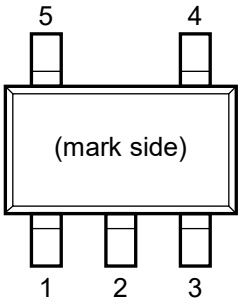
xx: Specify the set output voltage (V_{SET})
1.2 V (12) / 1.5 V (15) / 1.8 V (18) / 2.5 V (25) / 2.8 V (28) / 3.0 V (30) / 3.3 V (33) /
3.4 V (34) / 5.0 V (50) / 6.0 V (60)
Contact our sales representatives for other voltages.

∗ : The auto discharge functions at off state are as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

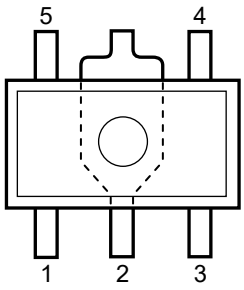
Auto-discharge function quickly lowers the output voltage to 0 V by releasing the electrical charge accumulated in the external capacitor when the chip enable signal is switched from the active mode to the standby mode.

PIN DESCRIPTIONS

● **SOT-23-5**



● **SOT-89-5**



● **SOT-23-5**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	V_{OUT}	Output Pin

● **SOT-89-5**

Pin No	Symbol	Pin Description
1	V_{OUT}	Output Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	V_{DD}	Input 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 (SOT-23-5)*	Standard Land Pattern	525	mW
	Power Dissipation (SOT-89-5)*	High Wattage Land Pattern	1620	
		Standard Land Pattern	1120	
Tj	Junction Temperature		−50 to 150	°C
Tstg	Storage Temperature Range		−55 to 150	°C

* Please refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	2.6 to 10	V
Ta	Operating Temperature Range	−50 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 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 V, I_{OUT} = 1 mA, unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at –50°C ≤ Ta ≤ 105°C.

RP170xxxxB/D (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
			−50°C ≤ Ta ≤ 105°C	[V_{SET} x 0.965]		[V_{SET} x 1.03]	
		V_{SET} ≤ 1.5V	Ta = 25°C	−15		15	mV
			−50°C ≤ Ta ≤ 105°C	[−53]		[45]	
I_{OUT}	Output Current			[300]			mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1 mA ≤ I_{OUT} ≤ 300 mA			10	[80]	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 300 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{SS}	Supply Current	I_{OUT} = 0 mA			23	[45]	µA
Istandby	Supply Current (Standby Mode)	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 (When V_{SET} ≤ 2.1 V, 2.6 V ≤ V_{IN} ≤ 10.0 V)			±0.02	[±0.25]	%/V
I_{SC}	Short Current Limit	V_{OUT} = 0V			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}	Nch On Resistance for Auto Discharge (D Version Only)	V_{CE} = 0 V V_{IN} = 7.0 V			250		Ω

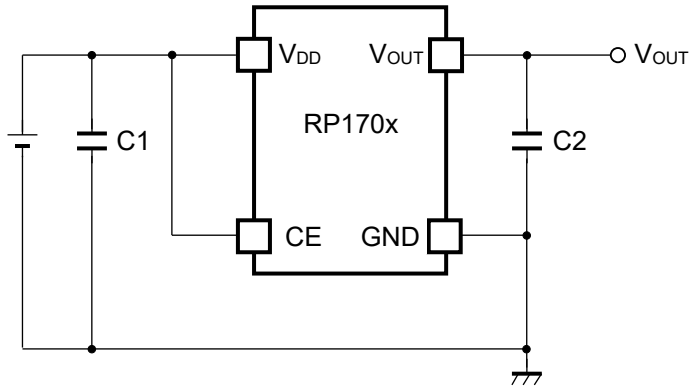
All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 25°C).

V_{IN} = V_{SET} + 1 V, I_{OUT} = 1 mA, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at –50°C ≤ Ta ≤ 105°C.

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

Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = –50 to 105°C)			V_{DIF} [V]	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
RP170x121x	1.185	1.200	1.215	1.147	1.200	1.245	1.400	1.925
RP170x151x	1.485	1.500	1.515	1.447	1.500	1.545	1.200	1.655
RP170x181x	1.782	1.800	1.818	1.737	1.800	1.854	0.980	1.305
RP170x251x	2.475	2.500	2.525	2.413	2.500	2.575	0.770	1.185
RP170x281x	2.772	2.800	2.828	2.702	2.800	2.884		
RP170x301x	2.970	3.000	3.030	2.895	3.000	3.090	0.600	0.995
RP170x331x	3.267	3.300	3.333	3.185	3.300	3.399		
RP170x341x	3.366	3.400	3.434	3.281	3.400	3.502		
RP170x501x	4.950	5.000	5.050	4.825	5.000	5.150	0.500	0.875
RP170x601x	5.940	6.000	6.060	5.790	6.000	6.180		

TYPICAL APPLICATION



External Components:

Symbol	Description
C2	Ceramic 1.0 µF (MURATA GRM155B31A105KE15)

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 1.0 µF or more and good ESR (Equivalent Series Resistance).

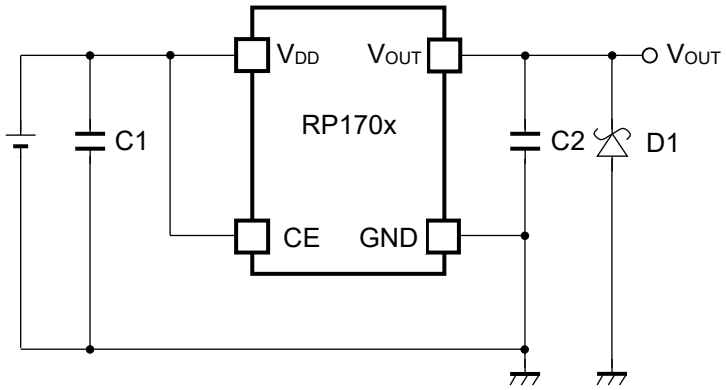
(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0 µF or more between V_{DD} and GND, and as close as possible to the pins.

Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



External Components:

Symbol	Description
C2	1.0 µF (Ceramic), MURATA, GRM155B31A105KE15

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

PACKAGE INFORMATION

POWER DISSIPATION (SOT-23-5)

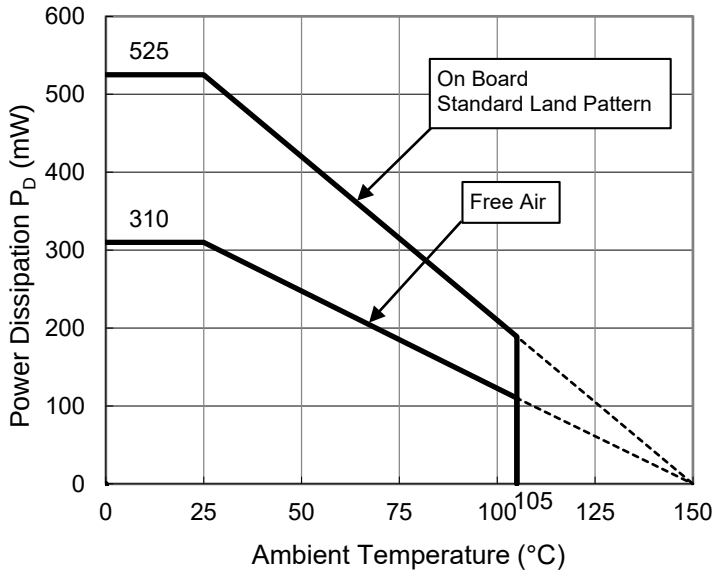
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

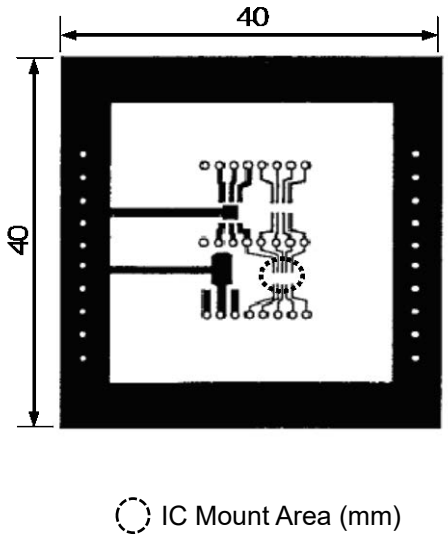
	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.5 mm × 44 pcs

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

	Standard Test Land Pattern	Free Air
Power Dissipation	525 mW	310 mW
Thermal Resistance	θja = (150 − 25°C) / 0.525 W = 238°C/W	400°C/W

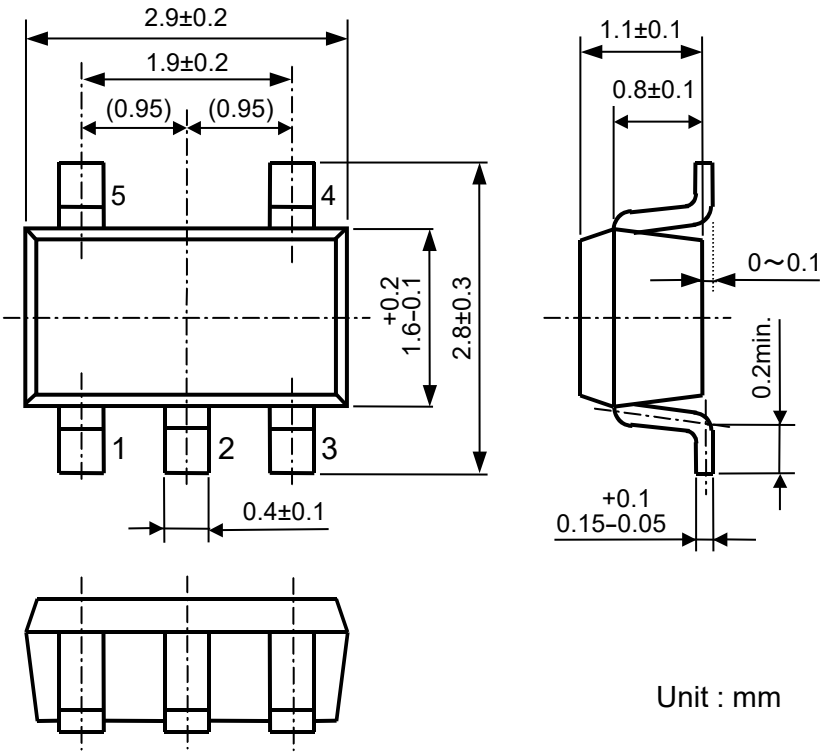


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (SOT-23-5)



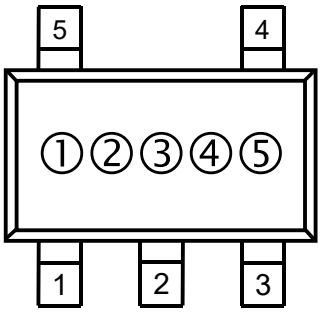
Unit : mm

SOT-23-5 Package Dimensions

MARK SPECIFICATION (SOT-23-5)

①②③: Product Code … **Refer to *MARK SPECIFICATION TABLE (SOT-23-5).***

④⑤: Lot Number … Alphanumeric Serial Number



SOT-23-5 Mark Specification

MARK SPECIFICATION TABLE (SOT-23-5)

RP170Nxx1B

Product Name	①	②	③	V_{SET}
RP170N121B	F	A	A	1.2 V
RP170N151B	F	A	E	1.5 V
RP170N181B	F	A	H	1.8 V
RP170N251B	F	A	R	2.5 V
RP170N281B	F	A	U	2.8 V
RP170N301B	F	A	X	3.0 V
RP170N331B	G	A	A	3.3 V
RP170N341B	G	A	B	3.4 V
RP170N501B	G	A	T	5.0 V
RP170N601B	H	A	D	6.0 V

RP170Nxx1D

Product Name	①	②	③	V_{SET}
RP170N121D	F	B	A	1.2 V
RP170N151D	F	B	E	1.5 V
RP170N181D	F	B	H	1.8 V
RP170N251D	F	B	R	2.5 V
RP170N281D	F	B	U	2.8 V
RP170N301D	F	B	X	3.0 V
RP170N331D	G	B	A	3.3 V
RP170N341D	G	B	B	3.4 V
RP170N501D	G	B	T	5.0 V
RP170N601D	H	B	D	6.0 V

POWER DISSIPATION (SOT-89-5)

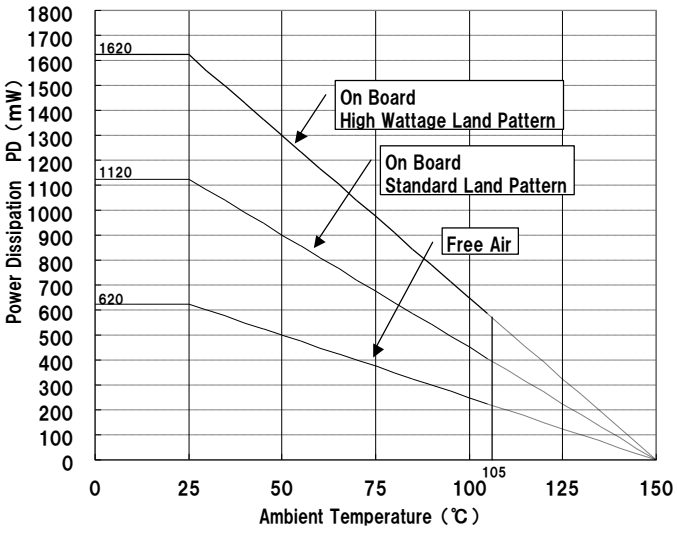
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

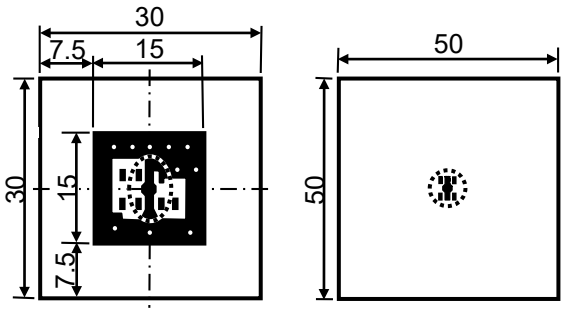
	High Wattage Test Land Pattern	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-sided Board)	Glass Cloth Epoxy Plastic (Double-sided Board)
Board Dimensions	30 mm × 30 mm × 1.6 mm	50 mm × 50 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 20% Bottom Side: Approx. 100%	Top Side: Approx. 10% Bottom Side: Approx. 100%
Through-holes	ϕ 0.85 mm × 10 pcs	-

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

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



Power Dissipation vs. Ambient Temperature

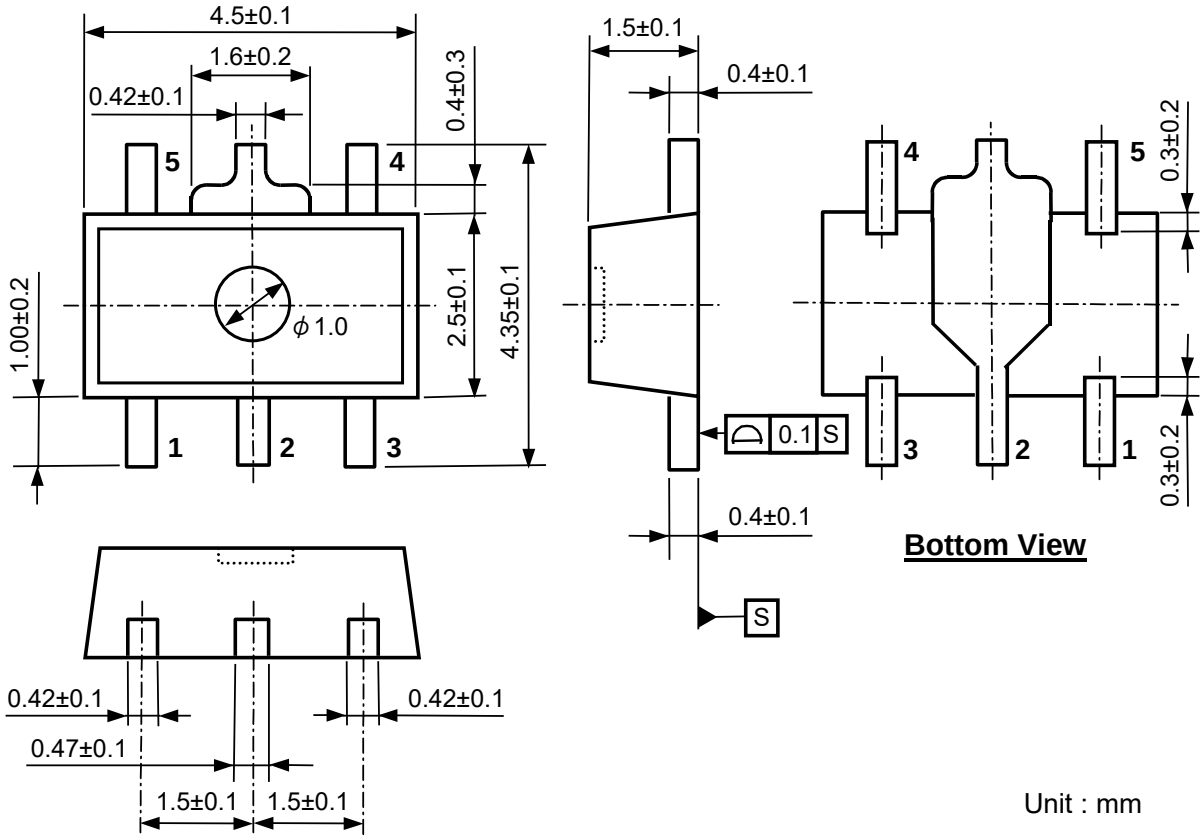


High Wattage **Standard**

IC Mount Area (mm)

Measurement Board Pattern

PACKAGE DIMENSIONS (SOT-89-5)

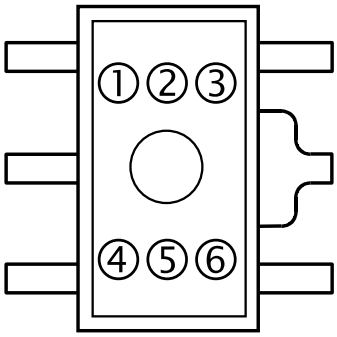


Unit : mm

MARK SPECIFICATION (SOT-89-5)

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

⑤⑥: Lot Number … Alphanumeric Serial Number



MARK SPECIFICATION TABLE (SOT-89-5)

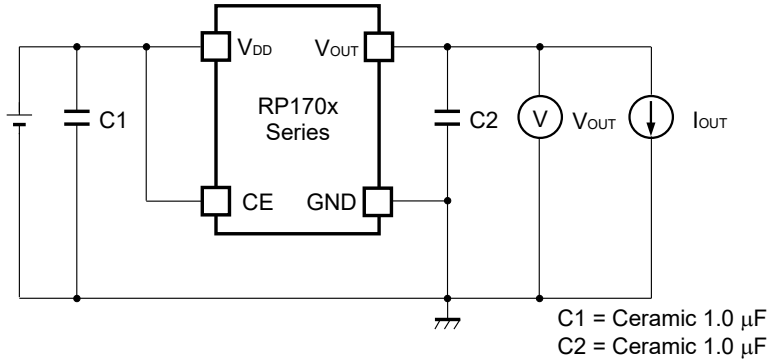
RP170Hxx1B

Product Name	①	②	③	④	V_{SET}
RP170H121B	Y	1	2	B	1.2 V
RP170H151B	Y	1	5	B	1.5 V
RP170H181B	Y	1	8	B	1.8 V
RP170H251B	Y	2	5	B	2.5 V
RP170H281B	Y	2	8	B	2.8 V
RP170H301B	Y	3	0	B	3.0 V
RP170H331B	Y	3	3	B	3.3 V
RP170H341B	Y	3	4	B	3.4 V
RP170H501B	Y	5	0	B	5.0 V
RP170H601B	Y	6	0	B	6.0 V

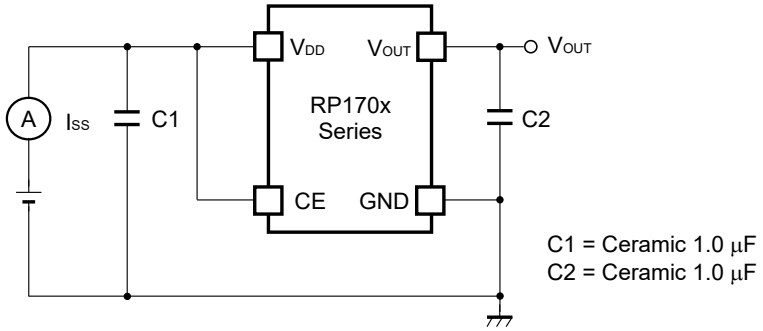
RP170Hxx1D

Product Name	①	②	③	④	V_{SET}
RP170H121D	Y	1	2	D	1.2 V
RP170H151D	Y	1	5	D	1.5 V
RP170H181D	Y	1	8	D	1.8 V
RP170H251D	Y	2	5	D	2.5 V
RP170H281D	Y	2	8	D	2.8 V
RP170H301D	Y	3	0	D	3.0 V
RP170H331D	Y	3	3	D	3.3 V
RP170H341D	Y	3	4	D	3.4 V
RP170H501D	Y	5	0	D	5.0 V
RP170H601D	Y	6	0	D	6.0 V

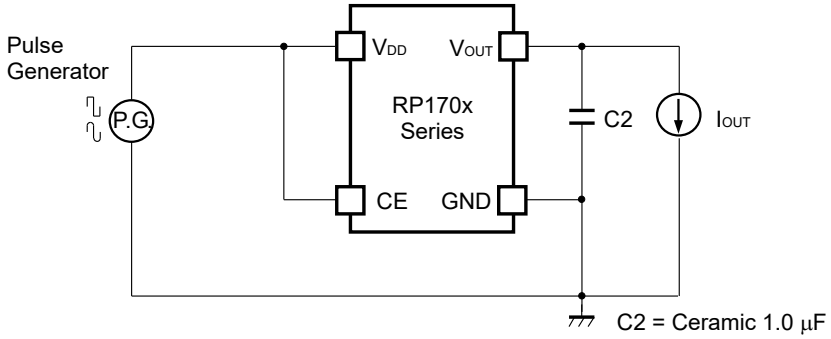
TEST CIRCUITS



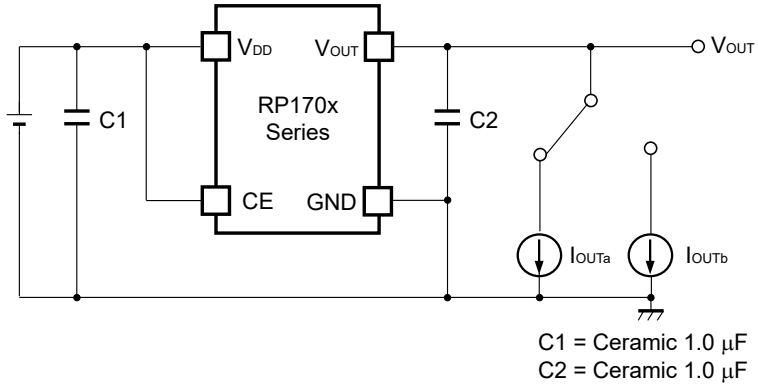
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection



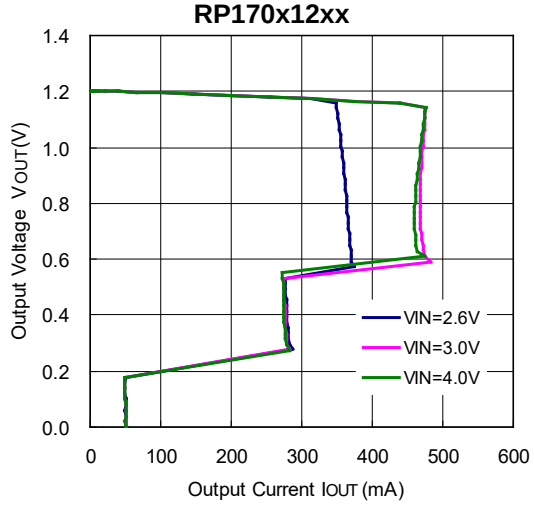
Test Circuit for Load Transient Response

TYPICAL CHARACTERISTICS

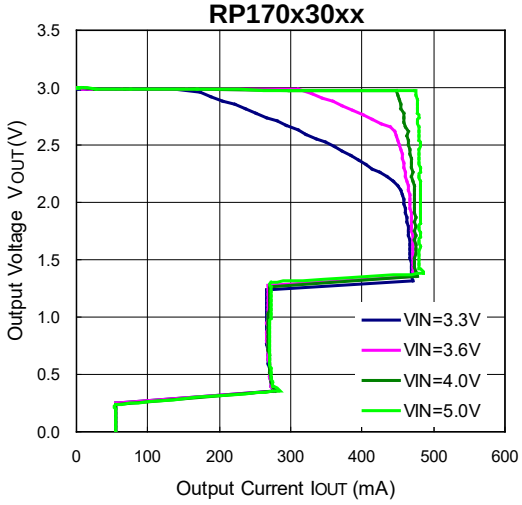
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

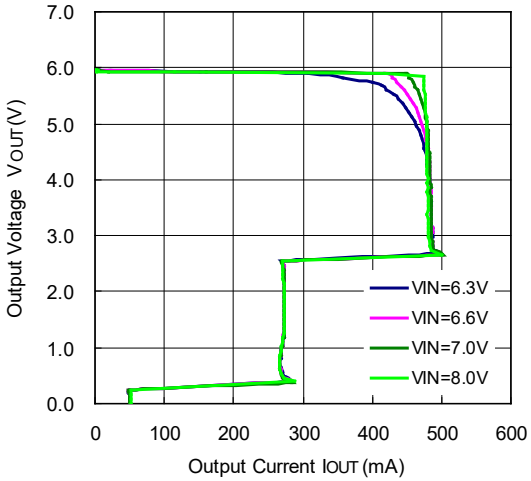
RP170x12xx



RP170x30xx

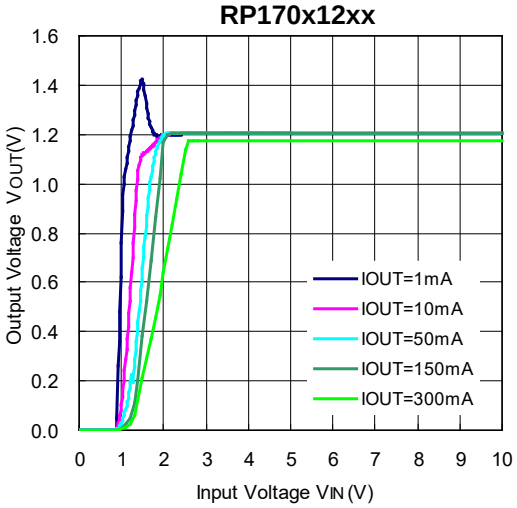


RP170x60xx

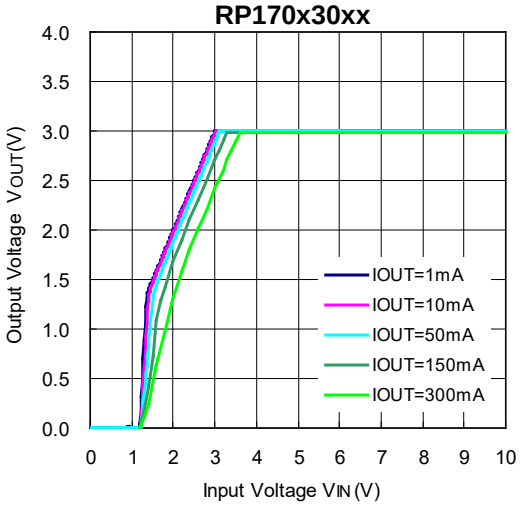


2) Output Voltage vs. Input Voltage (Ta = 25°C)

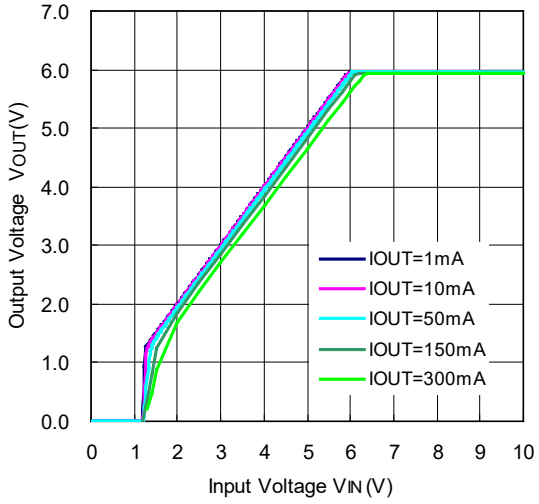
RP170x12xx



RP170x30xx

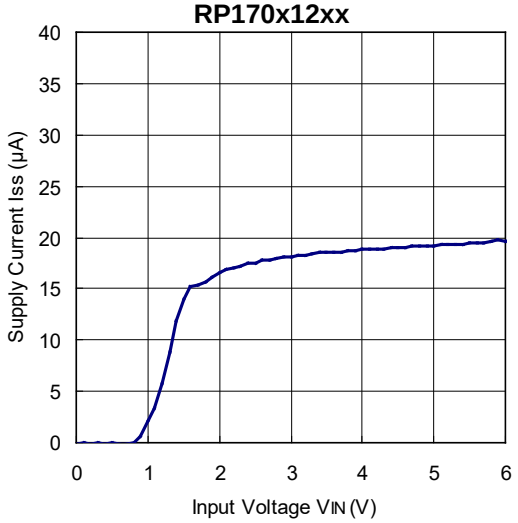


RP170x60xx

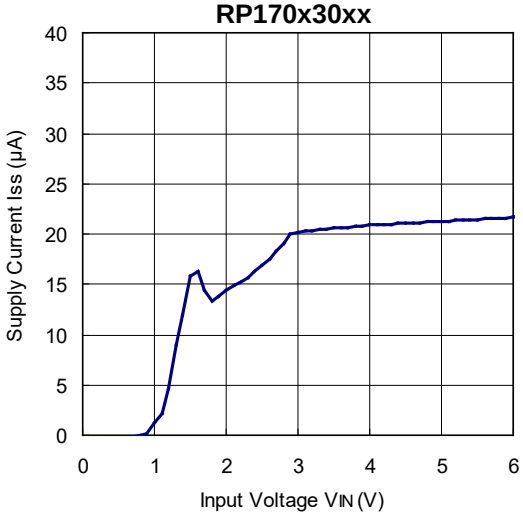


3) Supply Current vs. Input Voltage (Ta = 25°C)

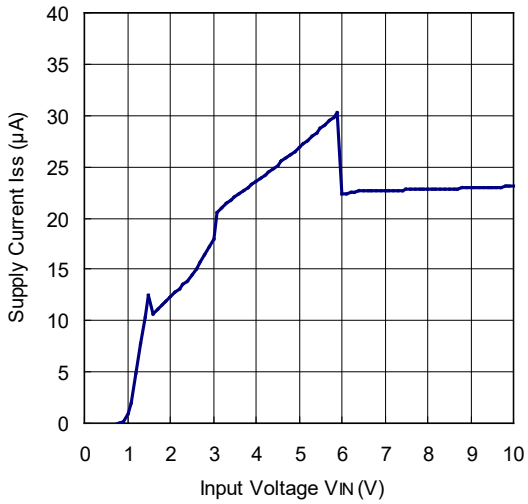
RP170x12xx



RP170x30xx

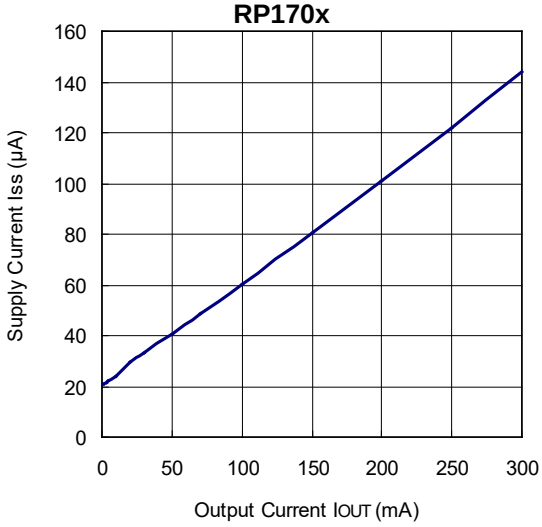


RP170x60xx



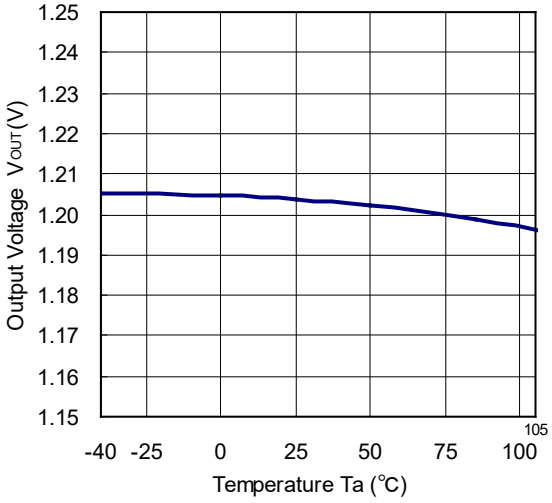
4) Supply Current vs. Output Current (Ta = 25°C)

RP170x

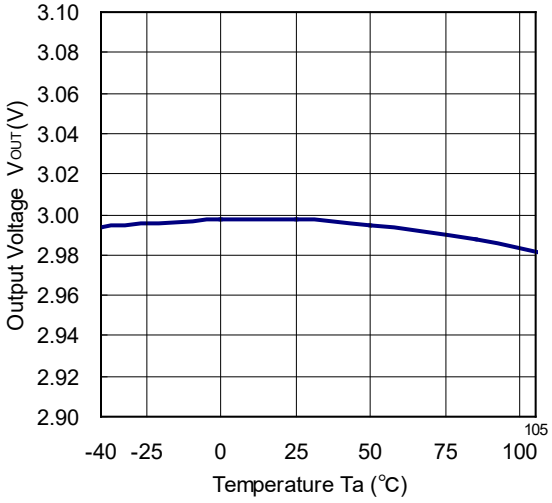


5) Output Voltage vs. Temperature

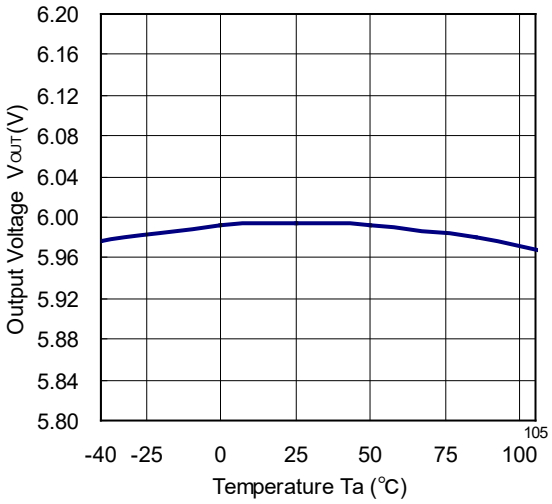
RP170x12xx



RP170x30xx

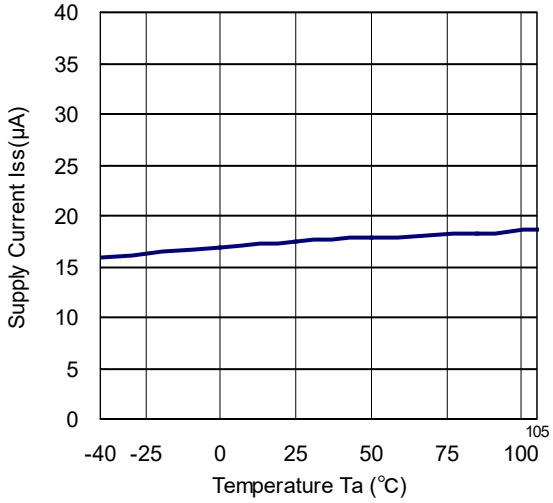


RP170x60xx

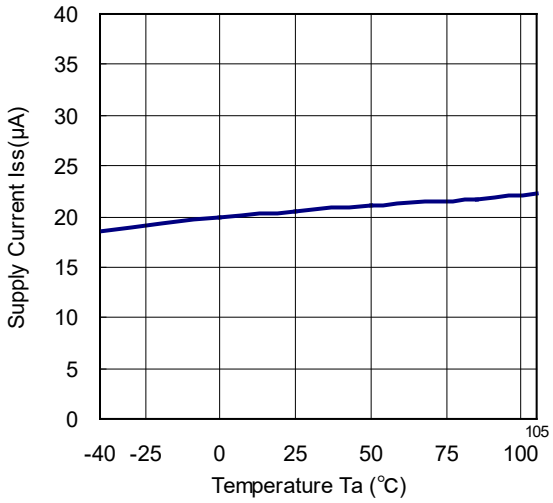


6) Supply Current vs. Temperature

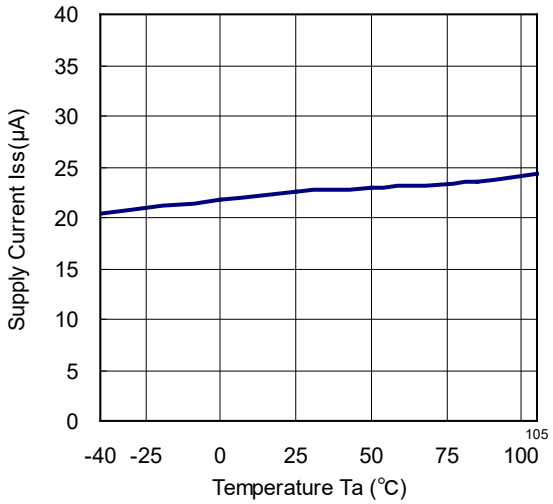
RP170x12xx



RP170x30xx

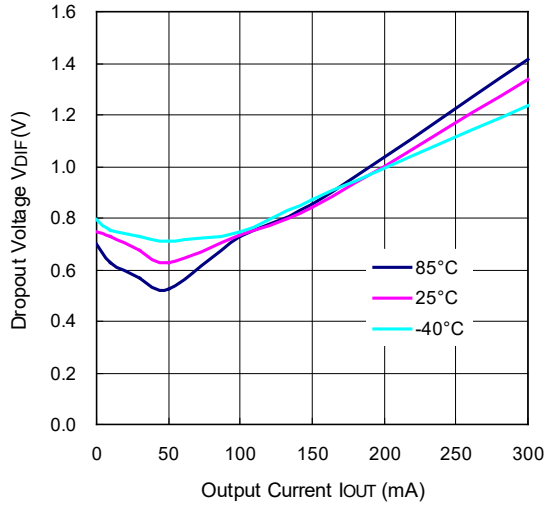


RP170x60xx

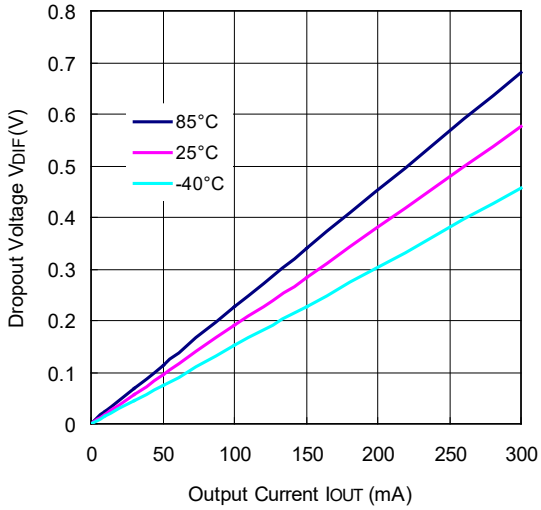


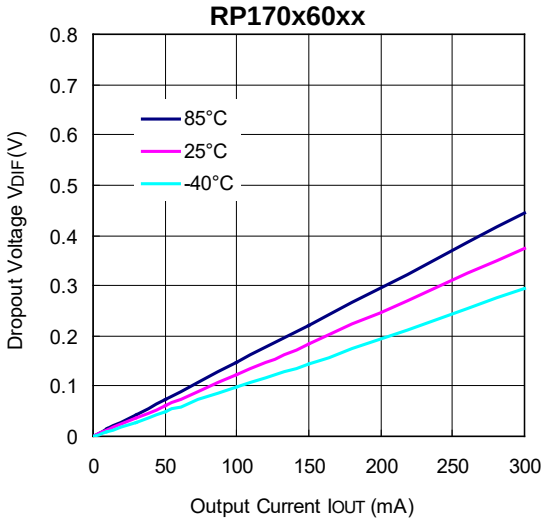
7) Dropout Voltage vs. Output Current

RP170x12xx

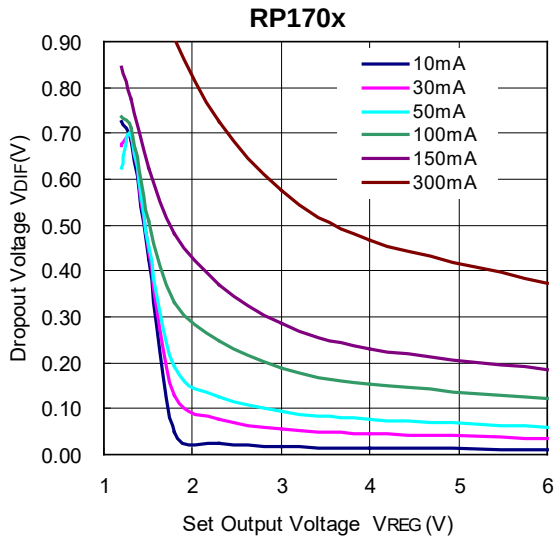


RP170x30xx

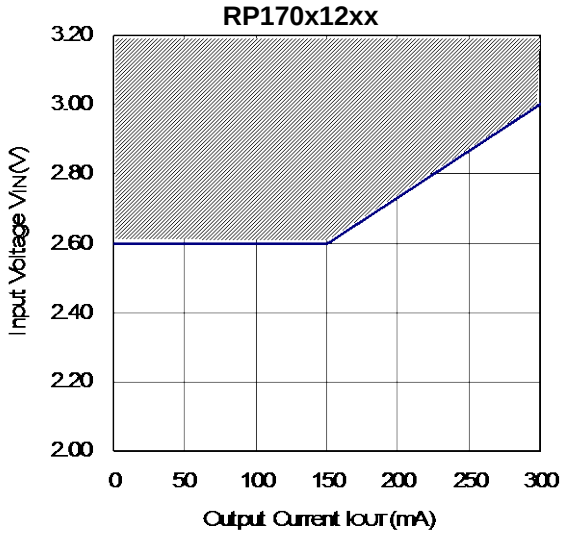




8) Dropout Voltage vs. Set Output Voltage (Ta = 25°C)

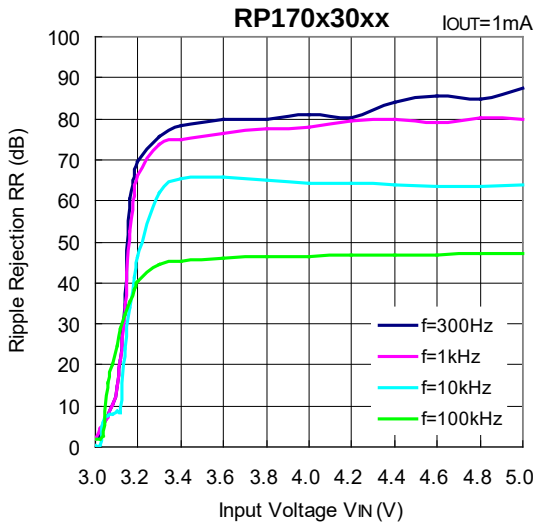


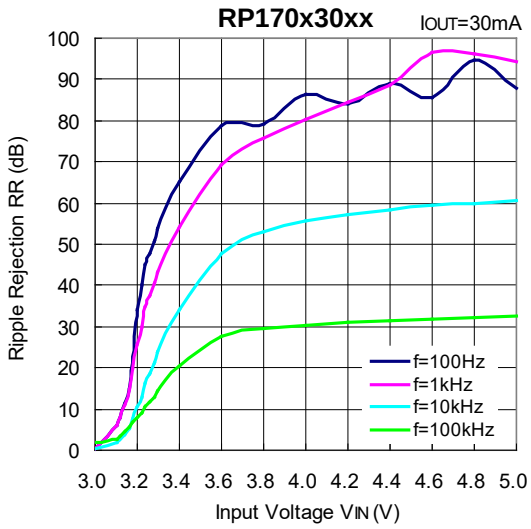
9) Minimum Operating Voltage

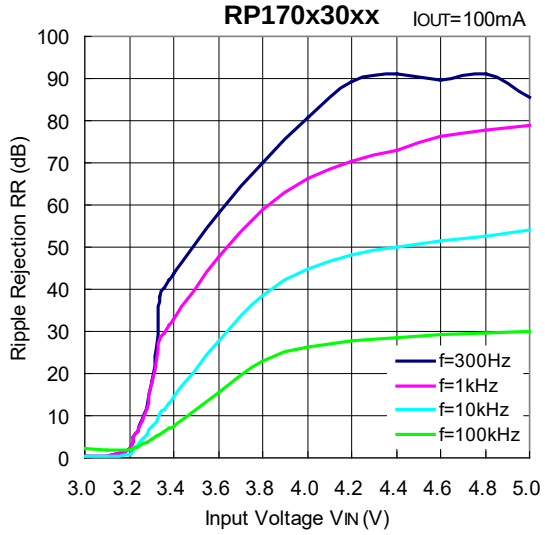


Hatched area is available for 1.2 V output

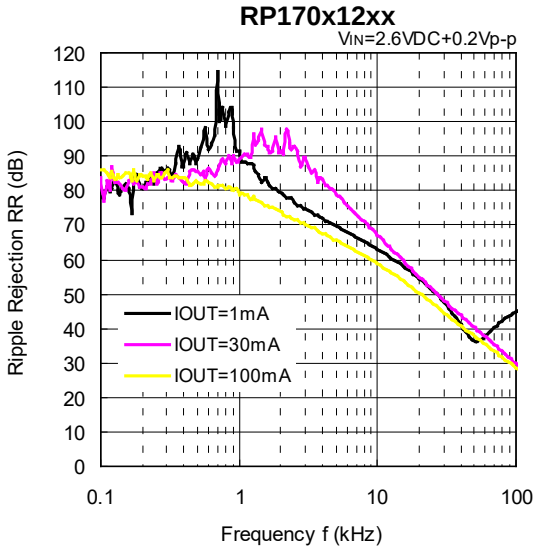
10) Ripple Rejection vs. Input Bias Voltage (C1 = none, C2 = Ceramic 1.0 µF, Ripple = 0.2 Vp-p, Ta = 25°C)

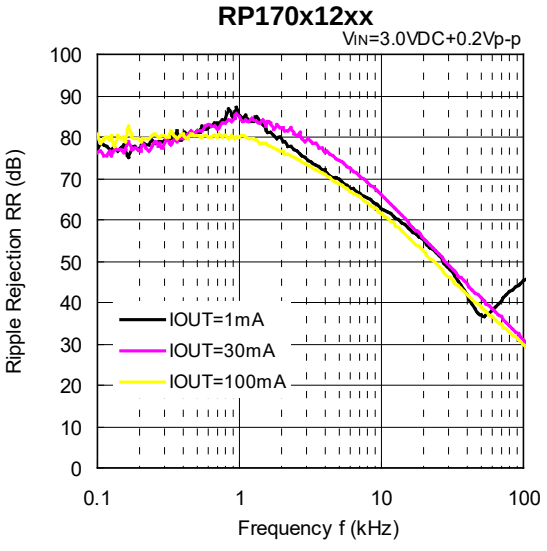




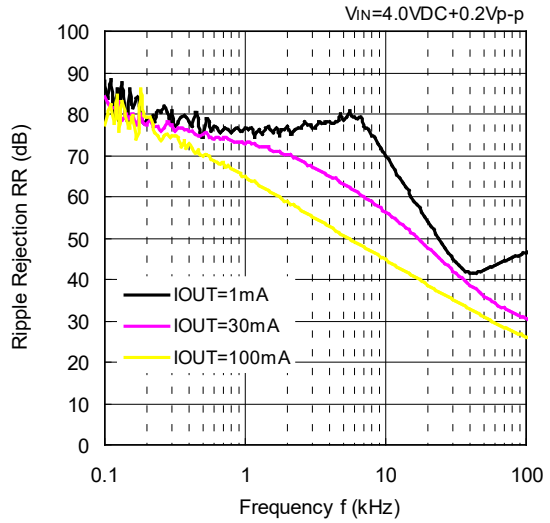


11) Ripple Rejection vs. Frequency (C1 = none, C2 = Ceramic 1.0 µF, Ta = 25°C)

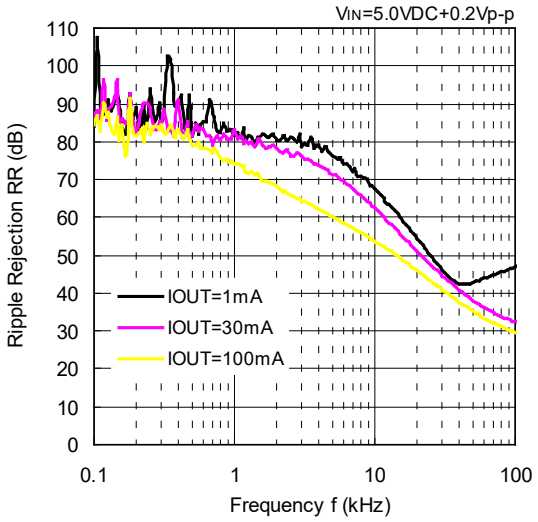




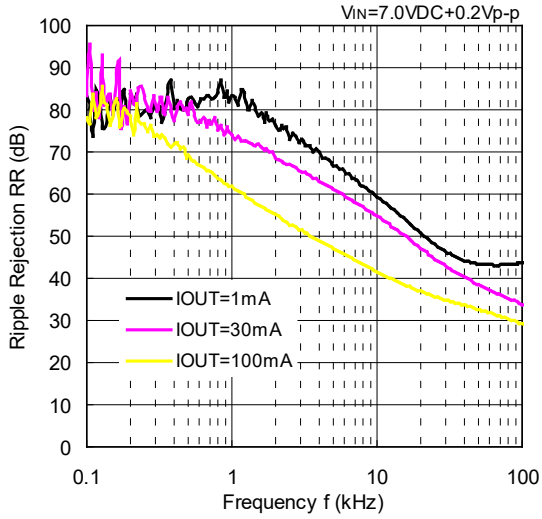
RP170x30xx



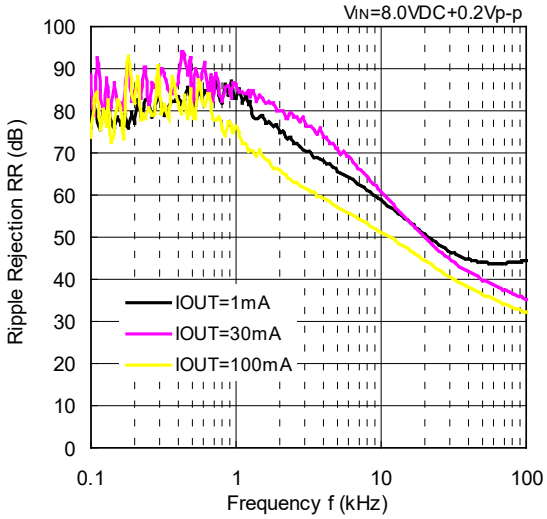
RP170x30xx



RP170x60xx

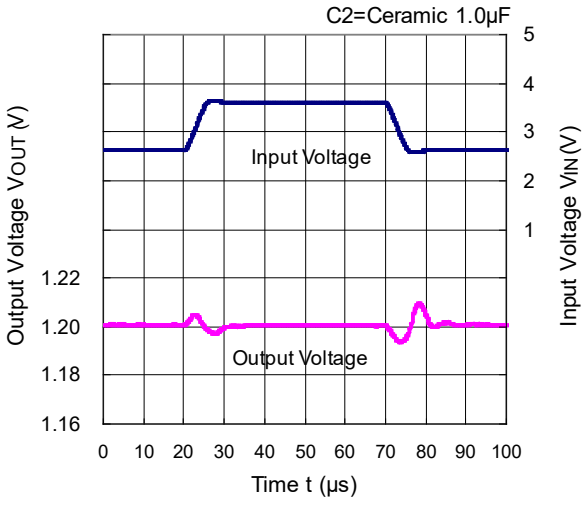


RP170x60xx

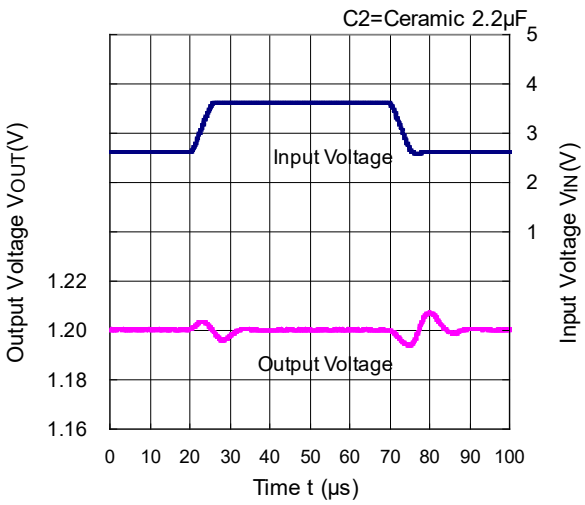


12) Input Transient Response (C1 = none, I_{OUT} = 30 mA, tr = tf = 5 µs, Ta = 25°C)

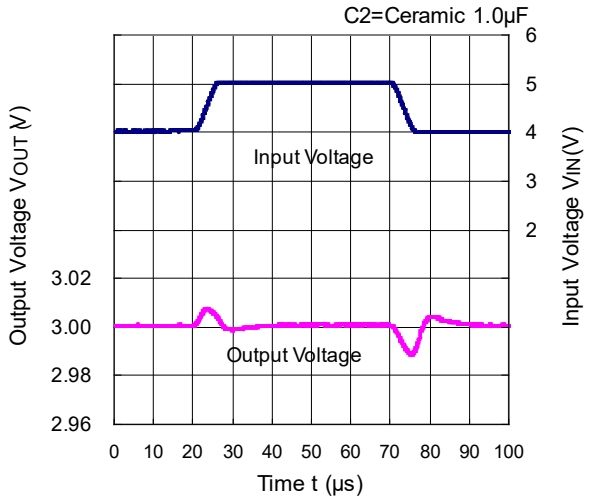
RP170x12xx



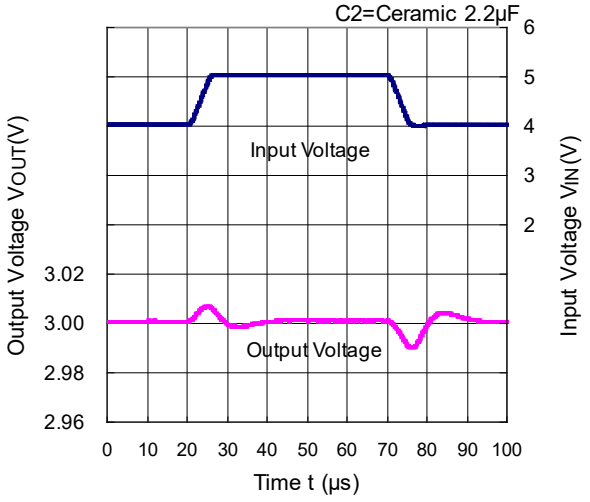
RP170x12xx



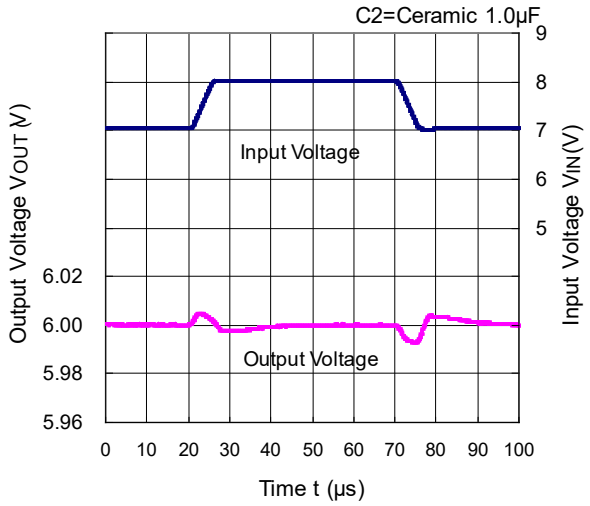
RP170x30xx



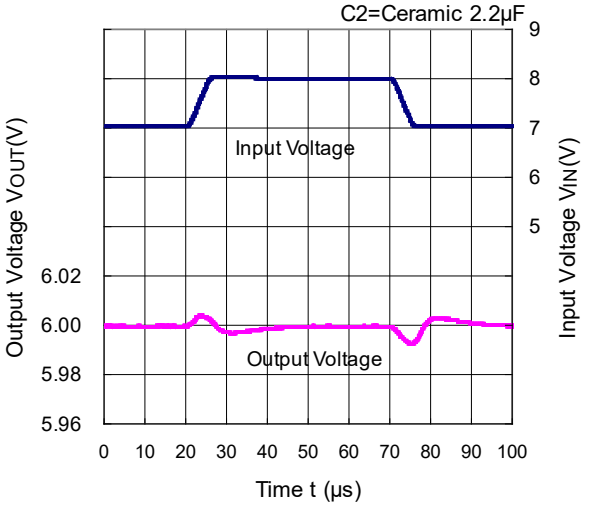
RP170x30xx



RP170x60xx

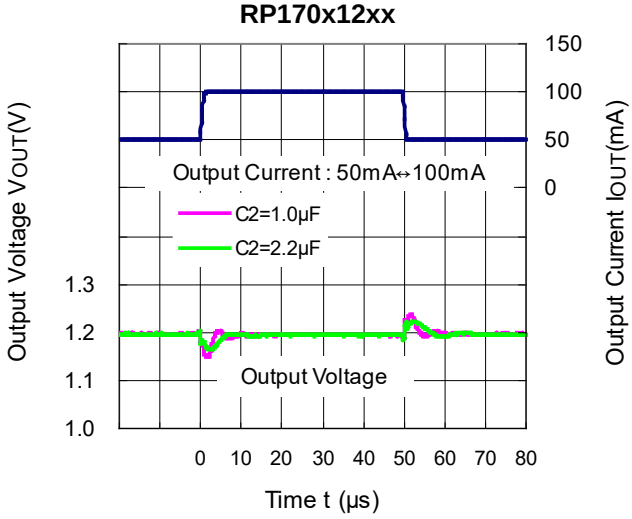


RP170x60xx

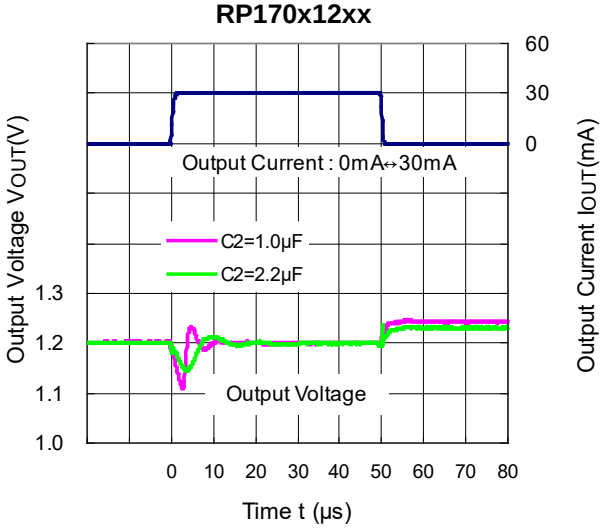


13) Load Transient Response (C1 = Ceramic 1.0 µF, tr = tf = 500 ns, Ta = 25°C)

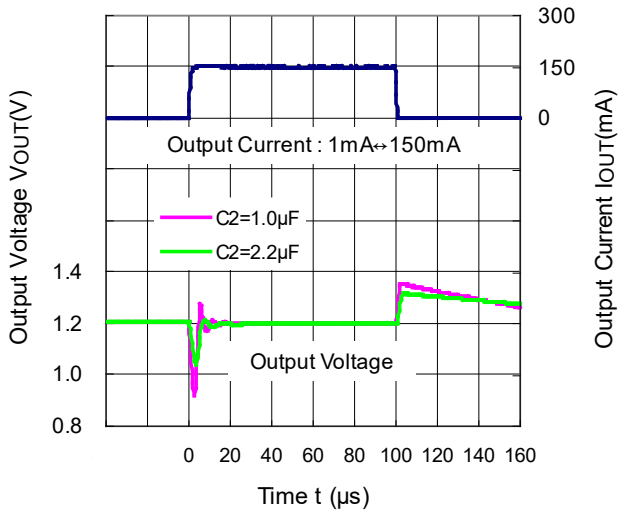
RP170x12xx



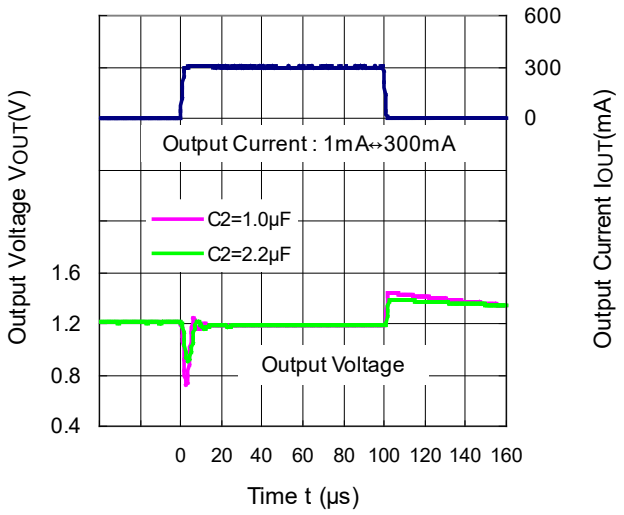
RP170x12xx



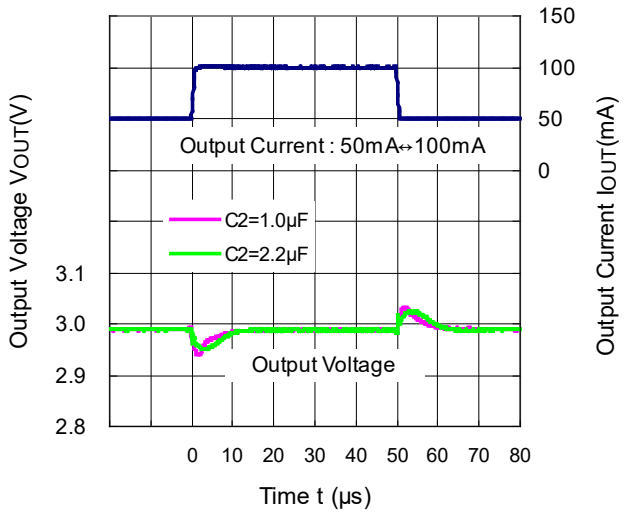
RP170x12xx



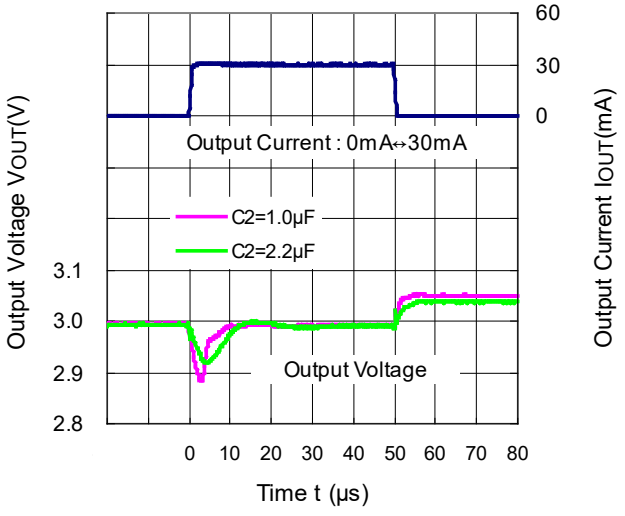
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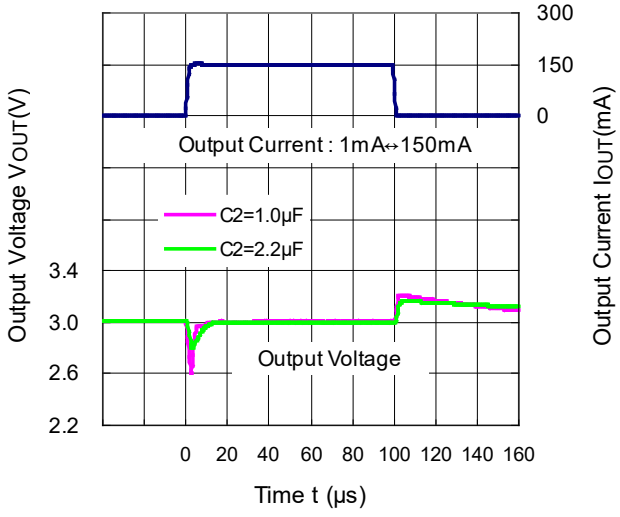
RP170x30xx



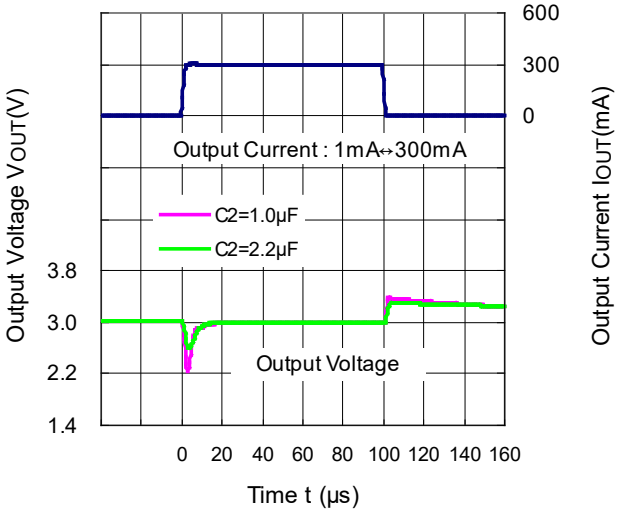
RP170x30xx



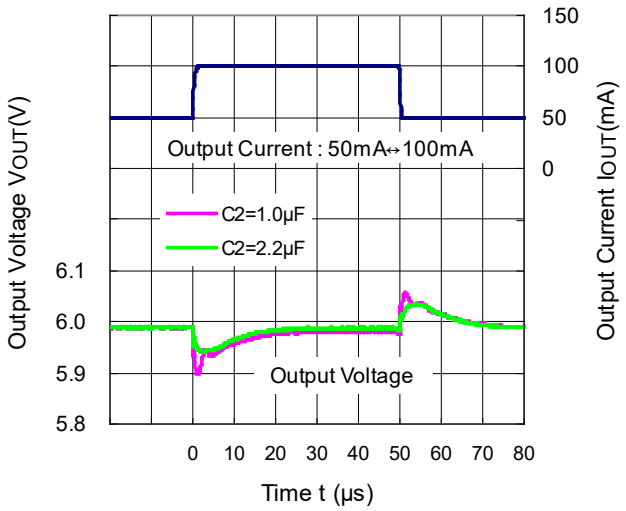
RP170x30xx



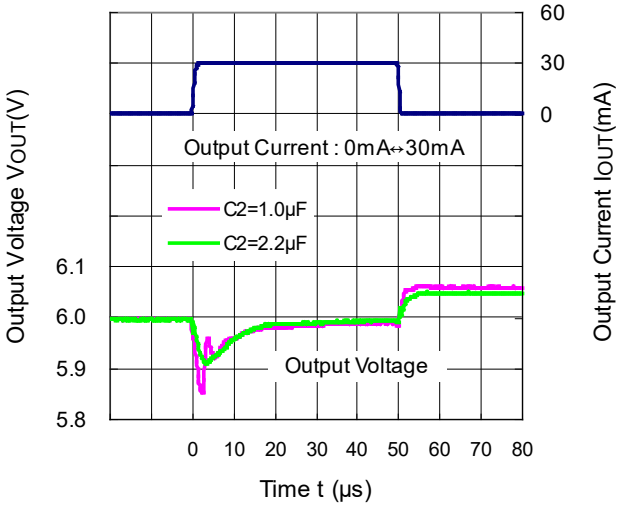
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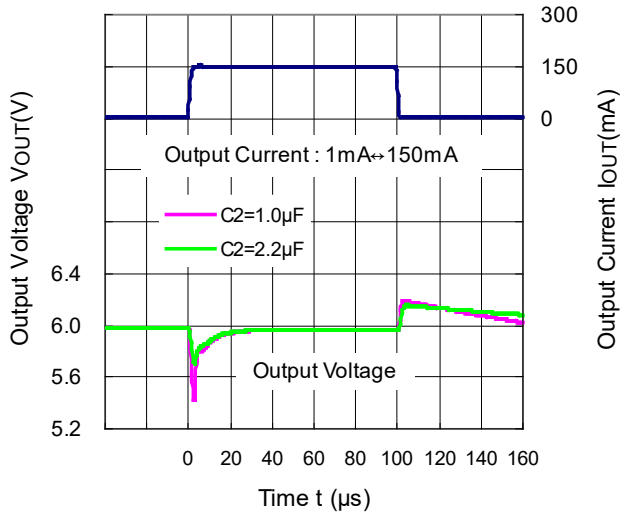
RP170x60xx



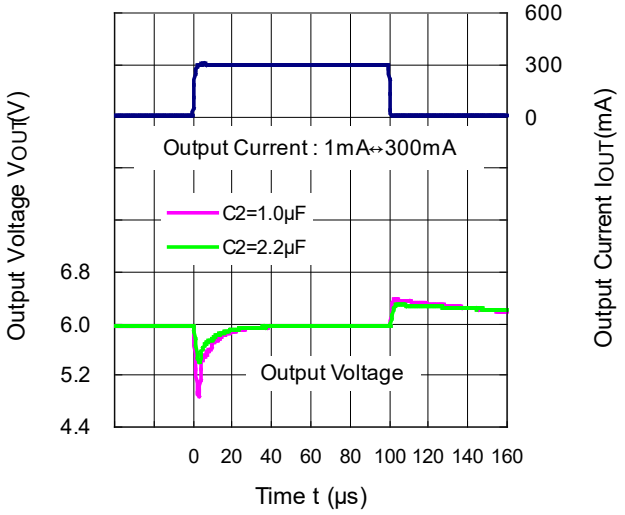
RP170x60xx



RP170x60xx

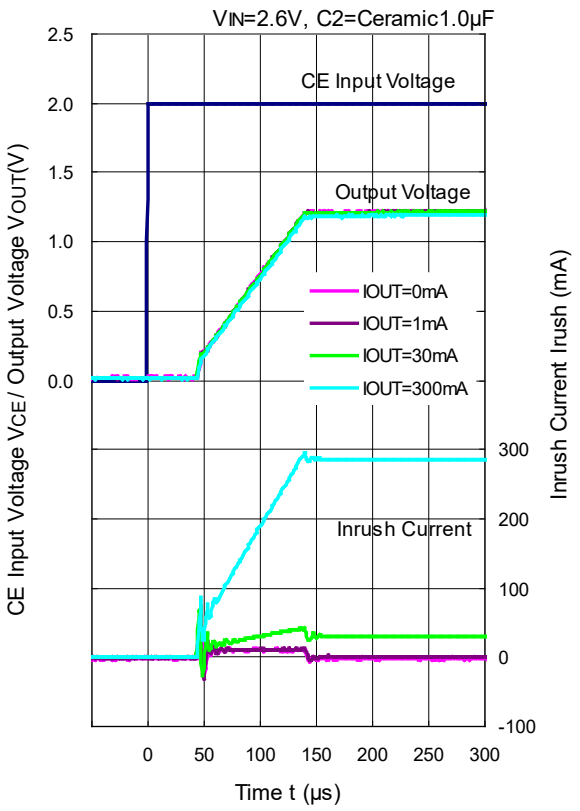


RP170x60xx

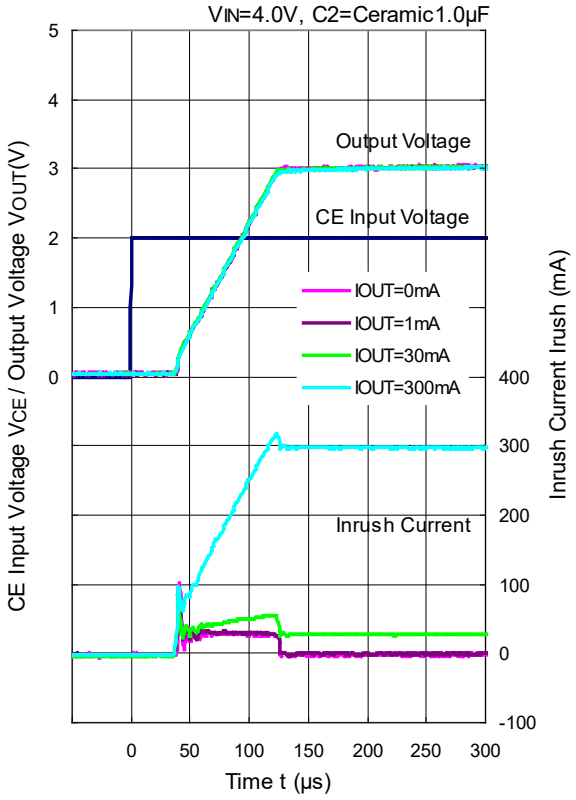


14) Turn On Speed with CE pin (C1 = Ceramic 1.0 µF, Ta = 25°C)

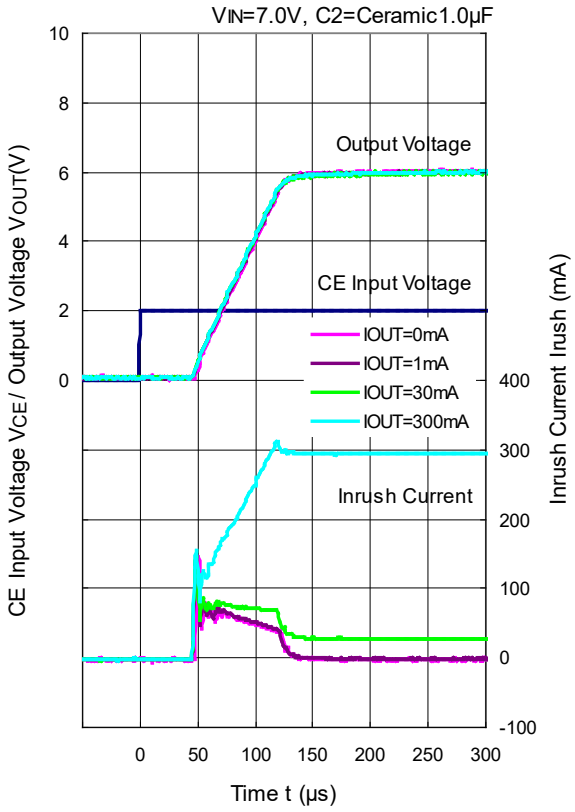
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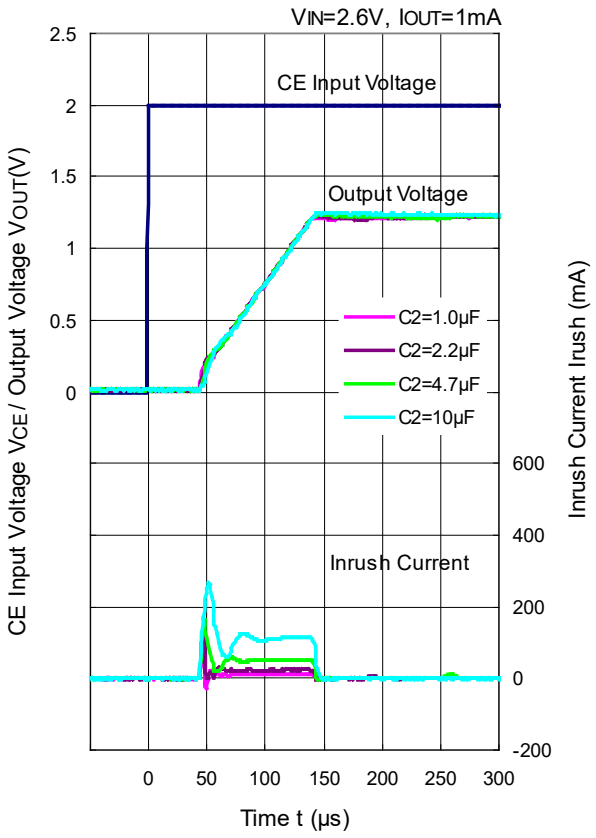
RP170x30xx



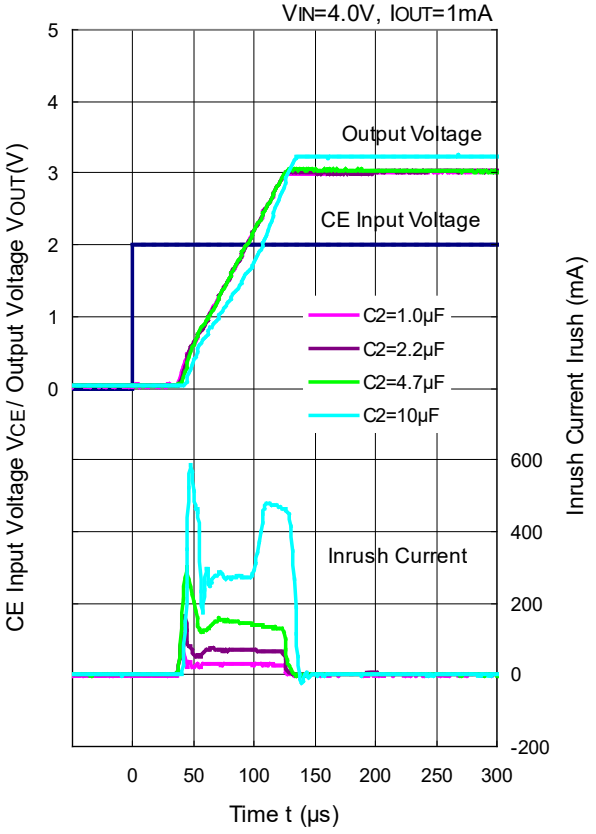
RP170x60xx



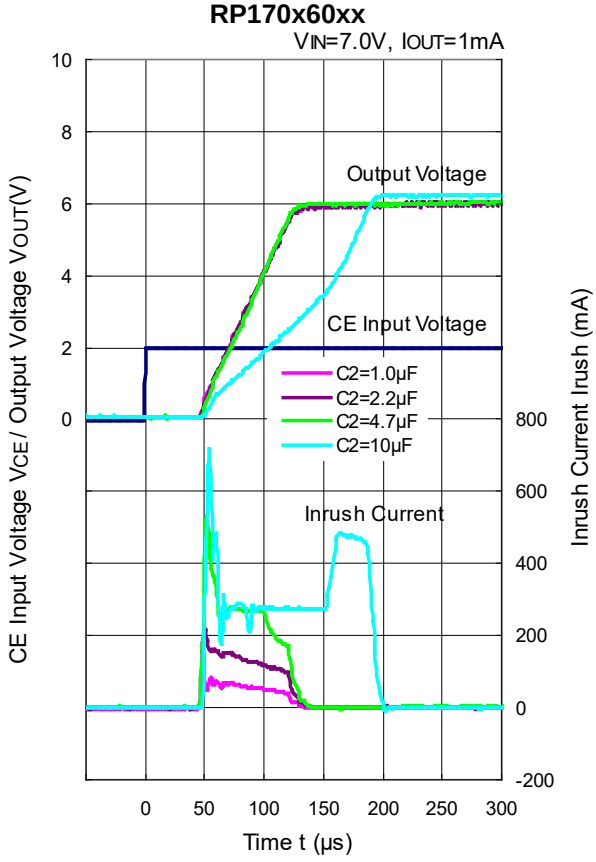
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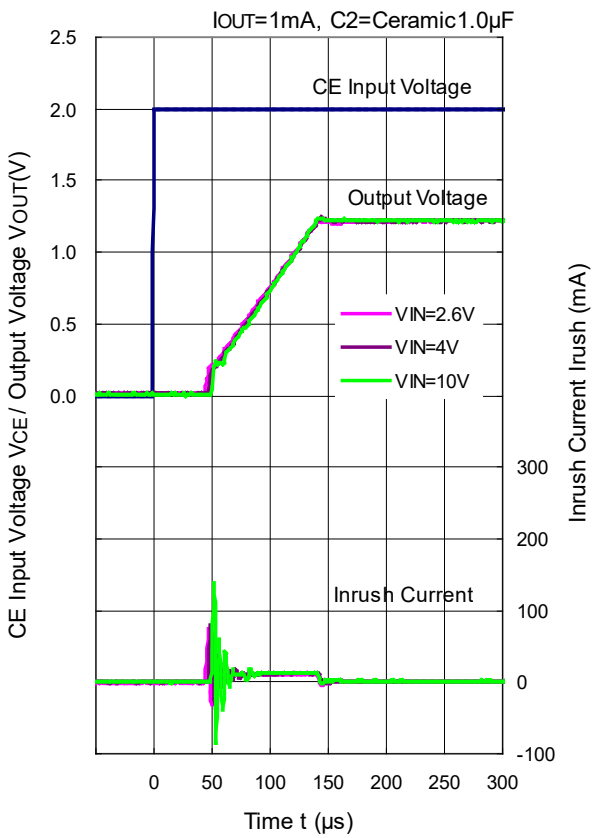
RP170x30xx



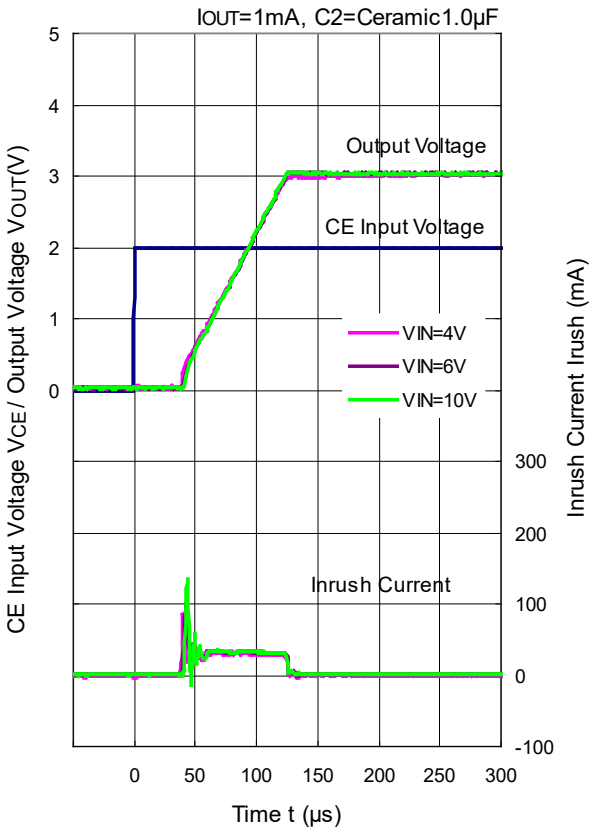
RP170x60xx



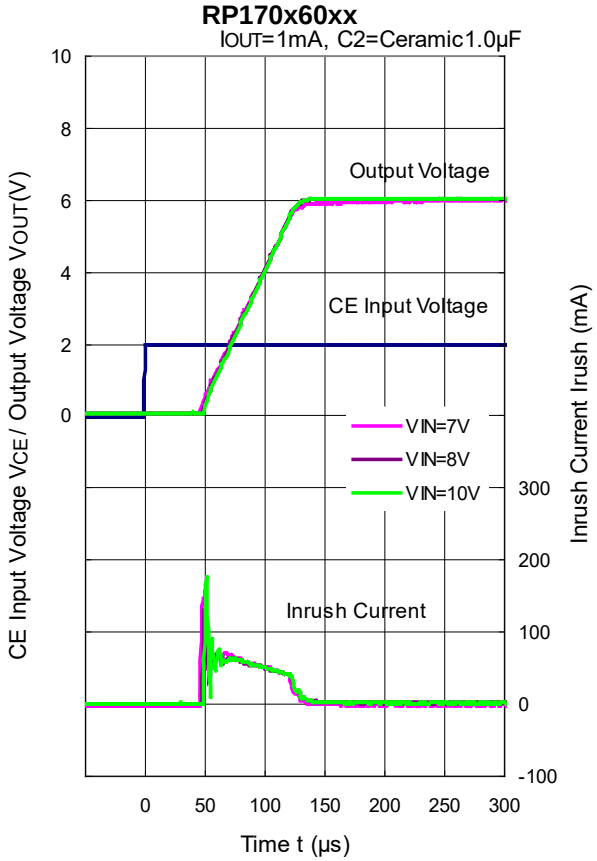
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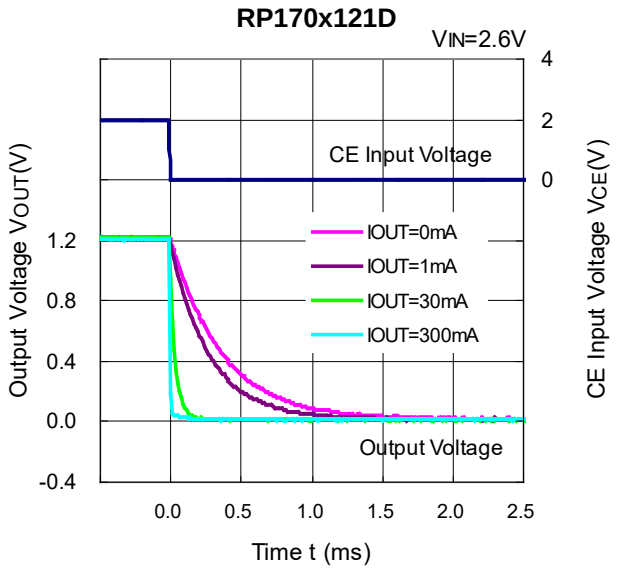
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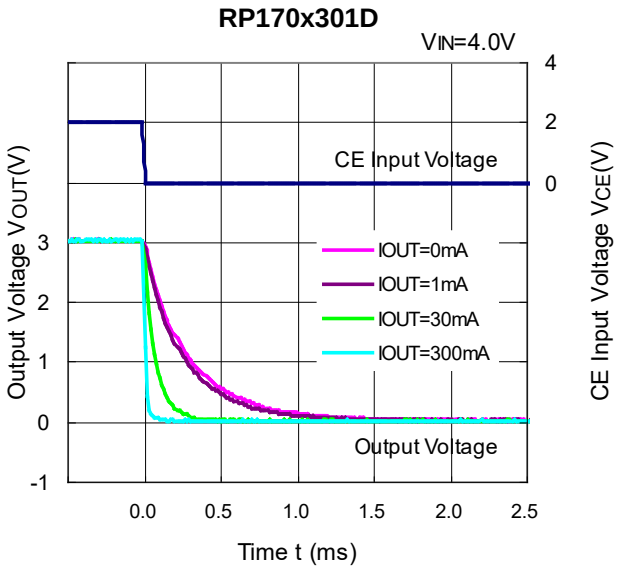


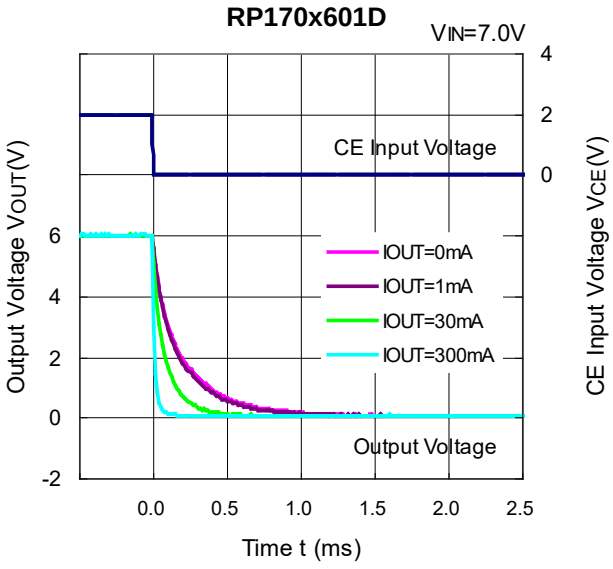
RP170x60xx



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







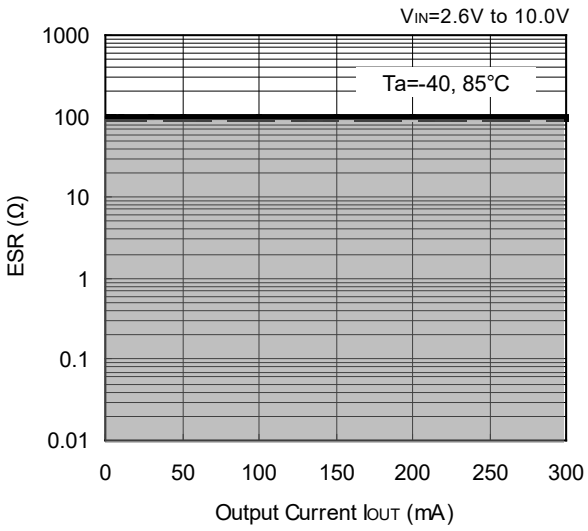
ESR vs. Output Current

Ceramic type output capacitor is recommended for this series; 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.

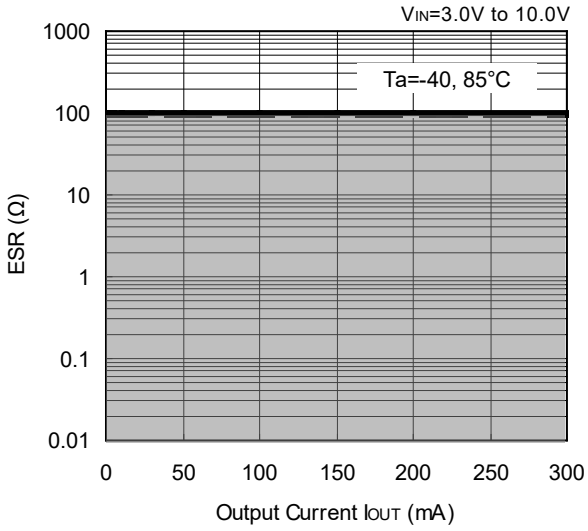
Measurement conditions

Frequency Band : 10 Hz to 2 MHz
Temperature : −40°C to 85°C
C1, C2 : Ceramic 1.0 μF (Murata GRM155B31A105KE)

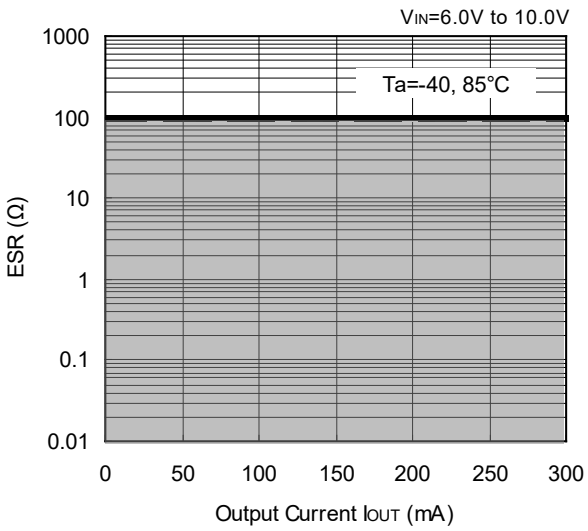
RP170x12xx



RP170x30xx



RP170x60xx



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