300mA 10V INPUT LDO REGULATOR

No.EA-205-200219

OUTLINE

The RP170x is LDO regulator featuring 300mA output current. Because of the 10V maximum input voltage, RP170x can be used in 2 cell lithium-ion battery powered portable appliances and besides a portable equipment. The supply current is Typ. 23μA though an excellent response characteristics.
The output voltage range from 1.2V 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.
SC-88A, SOT-23-5 and SOT-89-5 with high power dissipation packages are available.

FEATURES

- Supply Current ····· Typ. 23μA
- Standby Mode ····· Typ. 0.1μA
- Dropout Voltage ····· Typ. 0.20V (I_{OUT}=100mA, V_{OUT}=3.0V)
  Typ. 0.77V (I_{OUT}=300mA, V_{OUT}=2.8V)
- Ripple Rejection····· Typ. 70dB (f=1kHz)
- Temperature-Drift Coefficient of Output Voltage····· Typ. ±80ppm/°C
- Line Regulation····· Typ. 0.02%/V
- Output Voltage Accuracy·····±1.0%
- Packages ····· SC-88A, SOT-23-5, SOT-89-5
- Input Voltage Range ····· 2.6V to 10.0V
- Output Voltage Range ····· 1.2V to 6.5V (0.1V steps)
  (For other voltages, please refer to
  MARK INFORMATIONS.)
- 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····· 1.0μF or more

APPLICATIONS

- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.
- Power source for home appliances.

SELECTION GUIDE

The output voltage, auto discharge[1] function, and package for the ICs can be selected at the user's request.

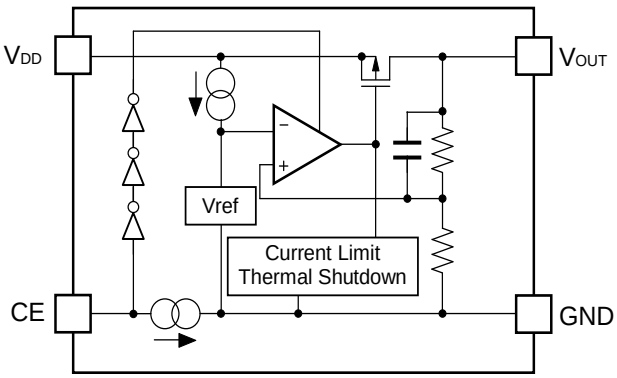
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP170Qxx2∗-TR-FE	SC-88A	3,000 pcs	Yes	Yes
RP170Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
RP170Hxx1∗-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.2V(12) to 6.5V(65) in 0.1V steps.
The voltage in 0.05 V step is shown as follows.
Example 1.25 V: RP170x12x∗5

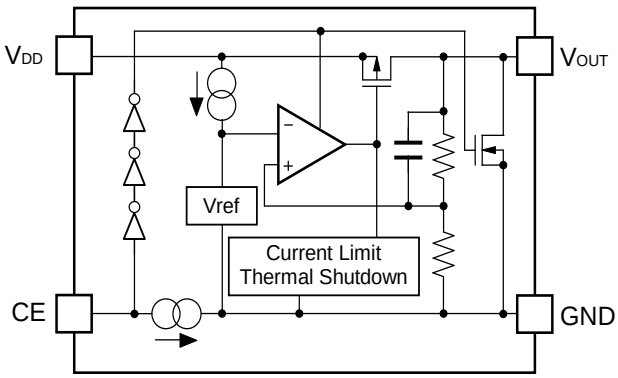
∗ : The auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

BLOCK DIAGRAMS

RP170xxxxB



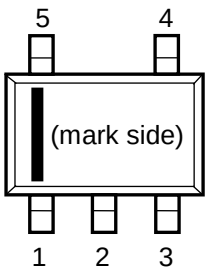
RP170xxxxD



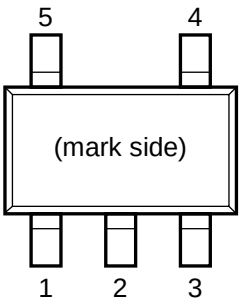
[1]Auto-discharge function quickly lowers the output voltage to 0V by releasing the electrical charge accumulated in the external capacitor when the chip enable signal is switched from the active mode to the standby mode.

PIN CONFIGURATIONS

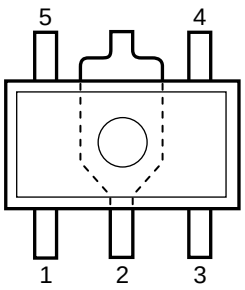
● **SC-88A**



● **SOT-23-5**



● **SOT-89-5**



PIN DESCRIPTIONS

● **SC-88A**

Pin No	Symbol	Pin Description
1	CE	Chip Enable Pin ("H" Active)
2	NC	No Connection
3	GND	Ground Pin
4	VOUT	Output Pin
5	VDD	Input Pin

● **SOT-23-5**

Pin No	Symbol	Pin Description
1	VDD	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	VOUT	Output Pin

● **SOT-89-5**

Pin No	Symbol	Pin Description
1	VOUT	Output Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	NC	No Connection
5	VDD	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 (1)	SC-88A (Our Standard Test Land Pattern)	380	mW
		SOT-23-5 (JEDEC STD. 51-7)	660	
		SOT-89-5 (JEDEC STD. 51-7)	2600	
T_j	Junction Temperature Range		−40 to 125	°C
T_{stg}	Storage Temperature Range		−55 to 125	°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.

RECCOMENDED OPERATING CONDITIONS

Symbol	Parameter	Rating	Unit
V_{IN}	Input Voltage	2.6 to 10	V
Ta	Operating Temperature Range	−40 to 85	°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

RP170xxxxB/D

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

☐ values indicate −40°C ≤ Ta ≤ 85°C, unless otherwise noted. Ta=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Ta=25°C	V_{OUT} > 1.5V	×0.99		×1.01	V
			V_{OUT} ≤ 1.5V	−15		+15	mV
		−40°C ≤ Ta ≤ 85°C	V_{OUT} > 1.5V	☐×0.974		☐×1.023	V
			V_{OUT} ≤ 1.5V	☐−40		☐+35	mV
I_{OUT}	Output Current			☐300			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	0.1mA ≤ I_{OUT} ≤ 300mA			10	☐70	mV
V_{DIF}	Dropout Voltage	I_{OUT}=300mA	1.2V ≤ V_{OUT} < 1.3V		1.400	☐1.800	V
			1.3V ≤ V_{OUT} < 1.5V		1.350	☐1.750	
			1.5V ≤ V_{OUT} < 1.8V		1.200	☐1.550	
			1.8V ≤ V_{OUT} < 2.3V		0.980	☐1.300	
			2.3V ≤ V_{OUT} < 3.0V		0.770	☐1.080	
			3.0V ≤ V_{OUT} < 4.0V		0.600	☐0.850	
			4.0V ≤ V_{OUT} ≤ 6.5V		0.500	☐0.750	
I_{SS}	Supply Current	I_{OUT}=0mA			23	☐40	μA
$I_{standby}$	Standby Current	V_{IN}=10.0V, V_{CE}=GND			0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 10.0V (In case that V_{OUT} ≤ 2.1V, 2.6V ≤ V_{IN} ≤ 10.0V)			0.02	☐0.2	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.2Vp-p, I_{OUT}=30mA (In case that V_{OUT} < 2.0V, V_{IN}=3.0V)			70		dB
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
en	Output Noise	BW=10Hz to 100kHz			100		μVrms
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN}=7.0V V_{CE}=0V			250		Ω

All of unit are tested and specified under load conditions such that Tj≈Ta=25°C except for Output Noise, Ripple Rejection and Thermal Shutdown.

Product-specific Electrical Characteristics

The specifications surrounded by ☐ are guaranteed by design engineering at –40°C ≤ Ta ≤ 85°C.

RP170xxxxB/D (Ta = 25°C)

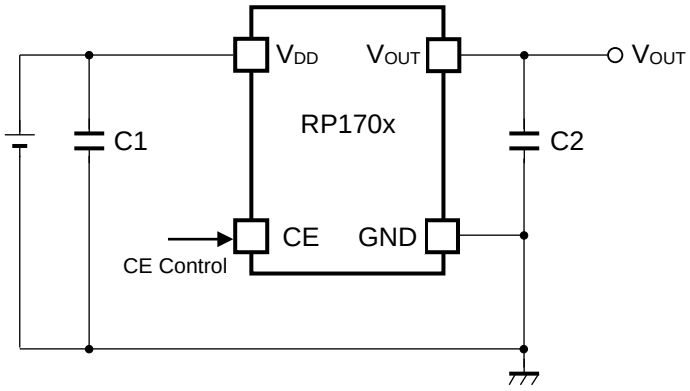
Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = –40 to 85°C)			V_{DIF} [V]	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
RP170x12xx	1.185	1.2	1.215	1.160	1.2	1.235	1.400	1.800
RP170x12xx5	1.235	1.25	1.265	1.210	1.25	1.285		
RP170x13xx	1.285	1.3	1.315	1.260	1.3	1.335	1.350	1.750
RP170x14xx	1.385	1.4	1.415	1.360	1.4	1.435		
RP170x15xx	1.485	1.5	1.515	1.460	1.5	1.535	1.200	1.550
RP170x16xx	1.584	1.6	1.616	1.558	1.6	1.637		
RP170x17xx	1.683	1.7	1.717	1.656	1.7	1.739		
RP170x18xx	1.782	1.8	1.818	1.753	1.8	1.841	0.980	1.300
RP170x18xx5	1.832	1.85	1.869	1.802	1.85	1.893		
RP170x19xx	1.881	1.9	1.919	1.851	1.9	1.944		
RP170x20xx	1.980	2.0	2.020	1.948	2.0	2.046		
RP170x21xx	2.079	2.1	2.121	2.045	2.1	2.148		
RP170x22xx	2.178	2.2	2.222	2.143	2.2	2.251		
RP170x23xx	2.277	2.3	2.323	2.240	2.3	2.353	0.770	1.080
RP170x24xx	2.376	2.4	2.424	2.338	2.4	2.455		
RP170x25xx	2.475	2.5	2.525	2.435	2.5	2.558		
RP170x26xx	2.574	2.6	2.626	2.532	2.6	2.660		
RP170x27xx	2.673	2.7	2.727	2.630	2.7	2.762		
RP170x28xx	2.772	2.8	2.828	2.727	2.8	2.864		
RP170x28xx5	2.822	2.85	2.879	2.776	2.85	2.916		
RP170x29xx	2.871	2.9	2.929	2.825	2.9	2.967		
RP170x30xx	2.970	3.0	3.030	2.922	3.0	3.069	0.600	0.850
RP170x31xx	3.069	3.1	3.131	3.019	3.1	3.171		
RP170x32xx	3.168	3.2	3.232	3.117	3.2	3.274		
RP170x33xx	3.267	3.3	3.333	3.214	3.3	3.376		
RP170x34xx	3.366	3.4	3.434	3.312	3.4	3.478		
RP170x35xx	3.465	3.5	3.535	3.409	3.5	3.581		
RP170x36xx	3.564	3.6	3.636	3.506	3.6	3.683		
RP170x37xx	3.663	3.7	3.737	3.604	3.7	3.785		
RP170x38xx	3.762	3.8	3.838	3.701	3.8	3.887		
RP170x39xx	3.861	3.9	3.939	3.799	3.9	3.990		

The specifications surrounded by ☐ are guaranteed by design engineering at –40°C ≤ Ta ≤ 85°C.

RP170xxxxB/D (Ta = 25°C)

Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = –40 to 85°C)			V_{DIF} [V]	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
RP170x40xx	3.960	4.0	4.040	3.896	4.0	4.092	0.500	0.750
RP170x41xx	4.059	4.1	4.141	3.993	4.1	4.194		
RP170x42xx	4.158	4.2	4.242	4.091	4.2	4.297		
RP170x43xx	4.257	4.3	4.343	4.188	4.3	4.399		
RP170x44xx	4.356	4.4	4.444	4.286	4.4	4.501		
RP170x45xx	4.455	4.5	4.545	4.383	4.5	4.604		
RP170x46xx	4.554	4.6	4.646	4.480	4.6	4.706		
RP170x47xx	4.653	4.7	4.747	4.578	4.7	4.808		
RP170x48xx	4.752	4.8	4.848	4.675	4.8	4.910		
RP170x49xx	4.851	4.9	4.949	4.773	4.9	5.013		
RP170x50xx	4.950	5.0	5.050	4.870	5.0	5.115		
RP170x51xx	5.049	5.1	5.151	4.967	5.1	5.217		
RP170x52xx	5.148	5.2	5.252	5.065	5.2	5.320		
RP170x53xx	5.247	5.3	5.353	5.162	5.3	5.422		
RP170x54xx	5.346	5.4	5.454	5.260	5.4	5.524		
RP170x55xx	5.445	5.5	5.555	5.357	5.5	5.627		
RP170x56xx	5.544	5.6	5.656	5.454	5.6	5.729		
RP170x57xx	5.643	5.7	5.757	5.552	5.7	5.831		
RP170x58xx	5.742	5.8	5.858	5.649	5.8	5.933		
RP170x59xx	5.841	5.9	5.959	5.747	5.9	6.036		
RP170x60xx	5.940	6.0	6.060	5.844	6.0	6.138		
RP170x61xx	6.039	6.1	6.161	5.941	6.1	6.240		
RP170x62xx	6.138	6.2	6.262	6.039	6.2	6.343		
RP170x63xx	6.237	6.3	6.363	6.136	6.3	6.445		
RP170x64xx	6.336	6.4	6.464	6.234	6.4	6.547		
RP170x65xx	6.435	6.5	6.565	6.331	6.5	6.650		

TYPICAL APPLICATION



(External Components)
C2 1.0μF MURATA: GRM155B31A105KE15

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 1.0μF 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 1.0μF or more between V_{DD} and GND pin, 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.

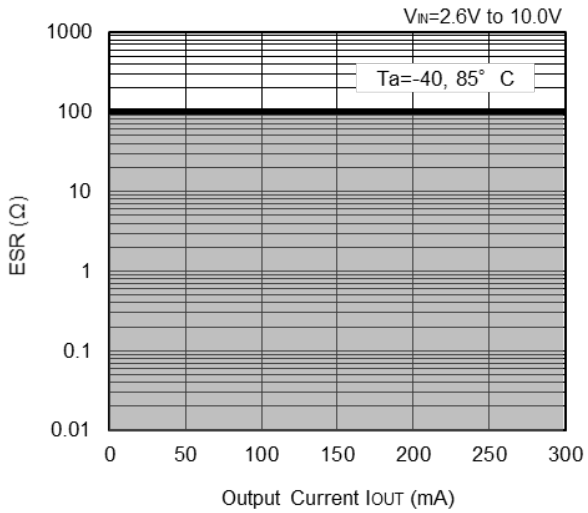
ESR vs. Output Current

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 40μV (Avg.) are marked as the hatched area in the graph.

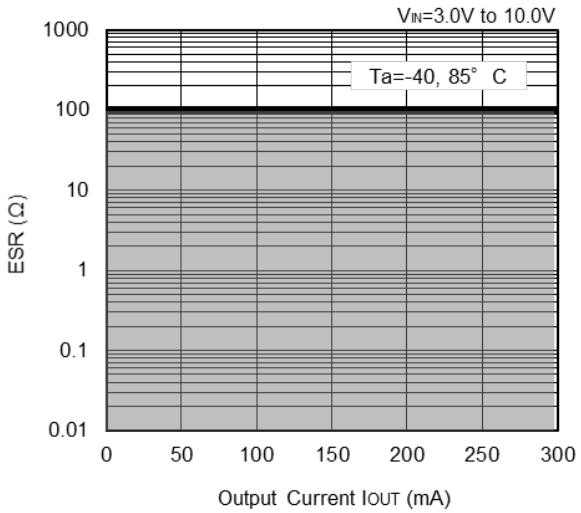
Measurement conditions

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

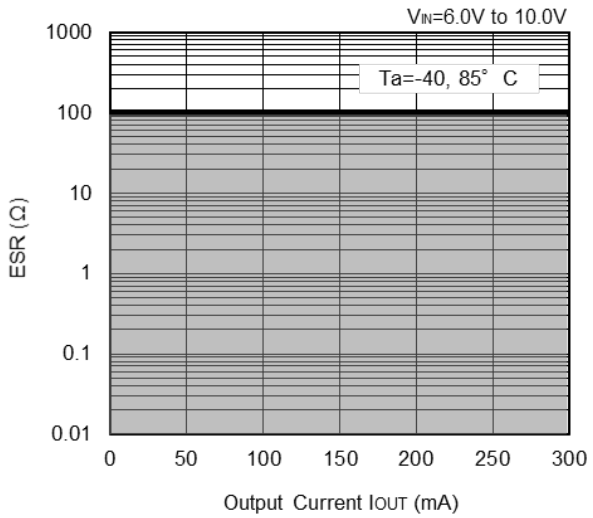
RP170x12xx



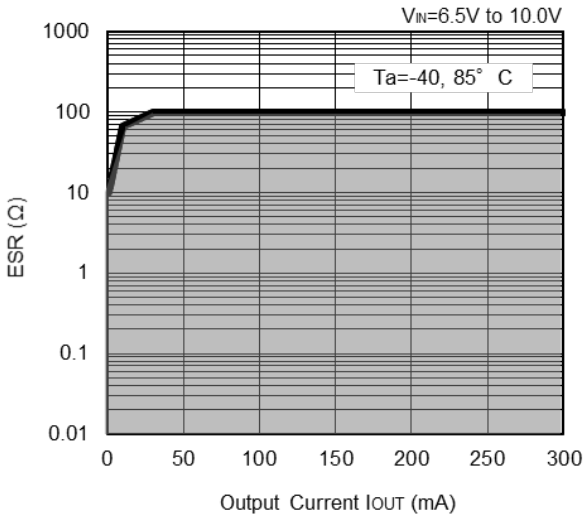
RP170x30xx



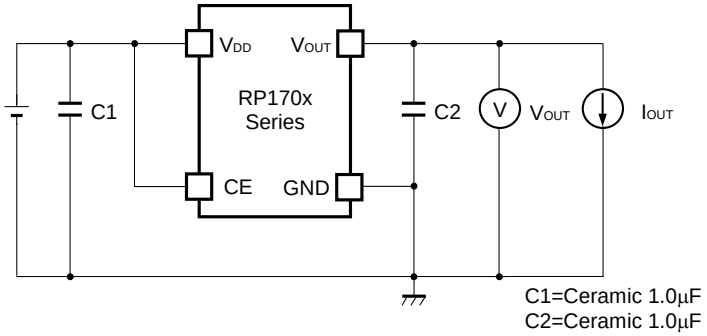
RP170x60xx



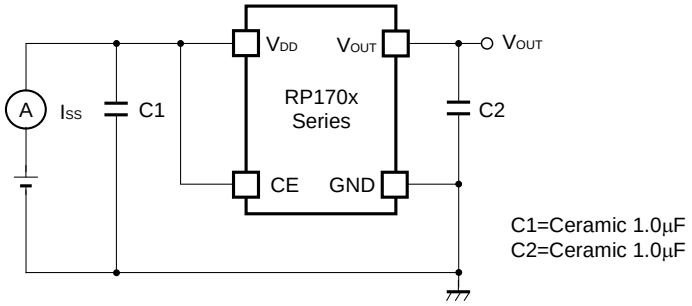
RP170x65xx



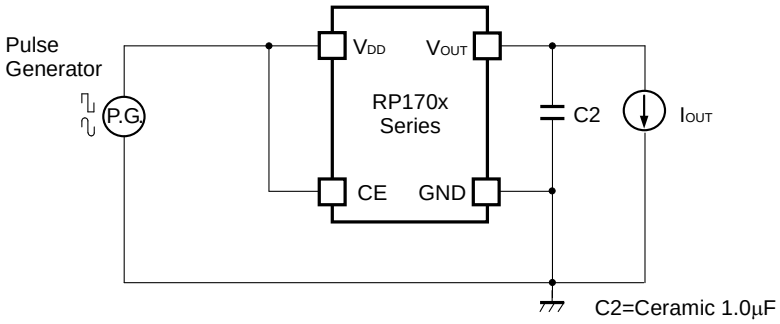
TEST CIRCUITS



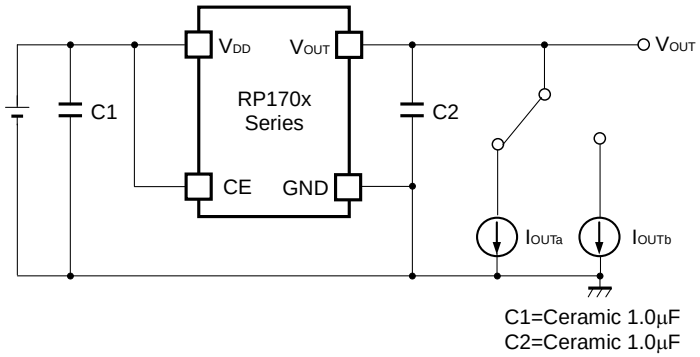
Basic Test Circuit



Test Circuit for Supply Current



Test Circuit for Ripple Rejection



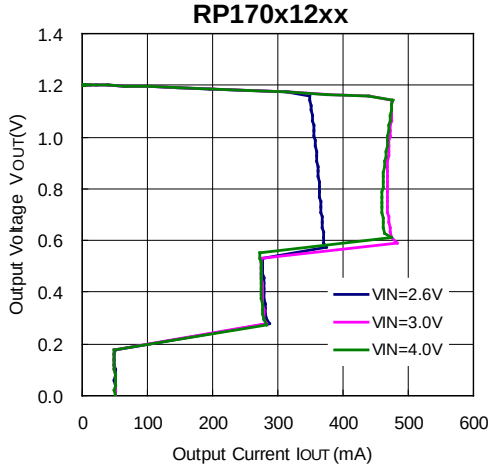
Test Circuit for Load Transient Response

TYPICAL CHARACTERISTICS

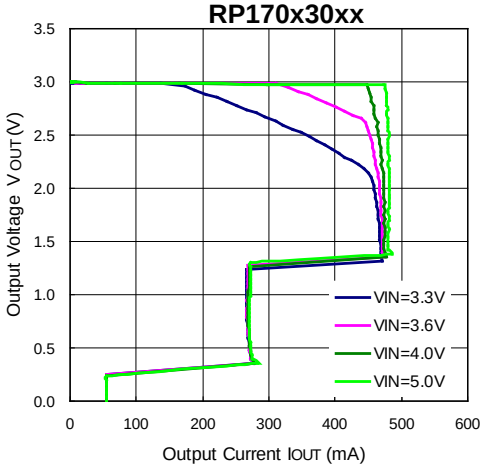
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

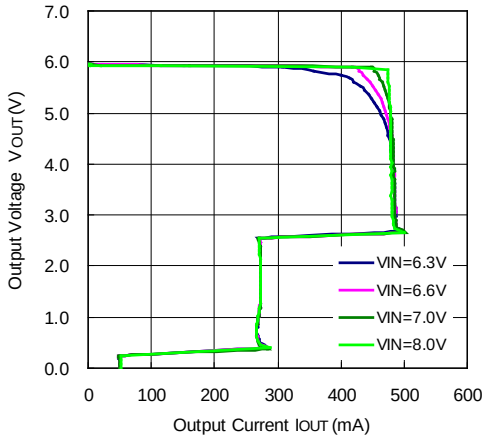
RP170x12xx



RP170x30xx

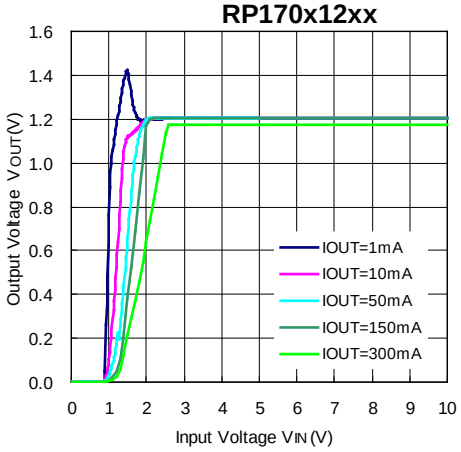


RP170x60xx

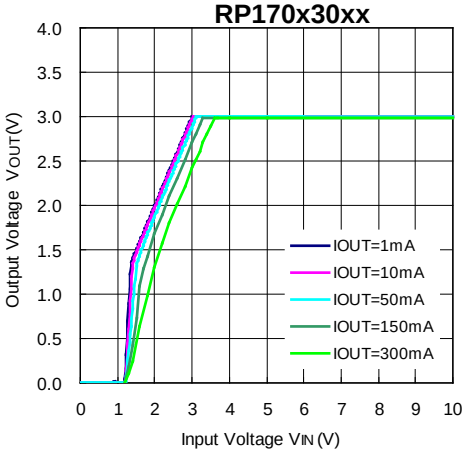


2) Output Voltage vs. Input Voltage (Ta=25°C)

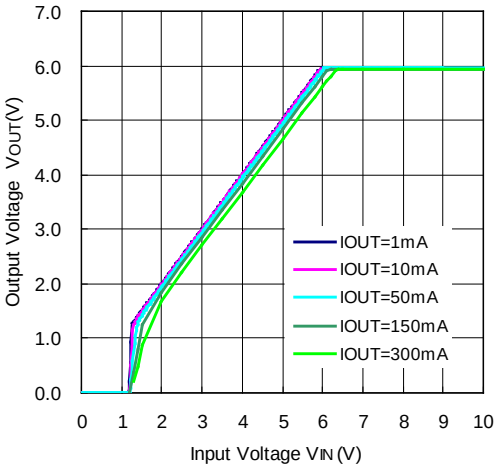
RP170x12xx



RP170x30xx

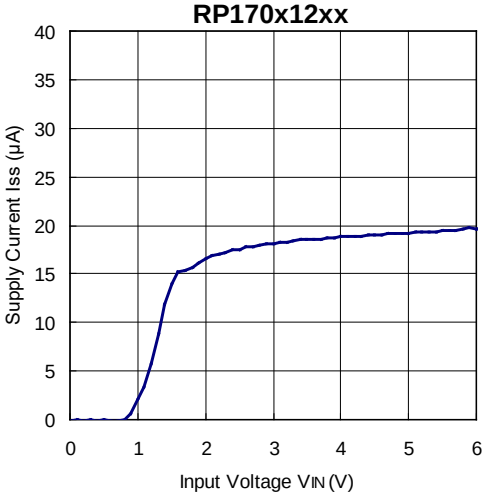


RP170x60xx

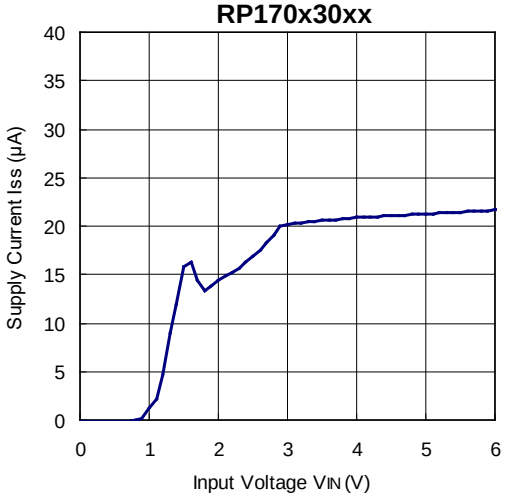


3) Supply Current vs. Input Voltage (Ta=25°C)

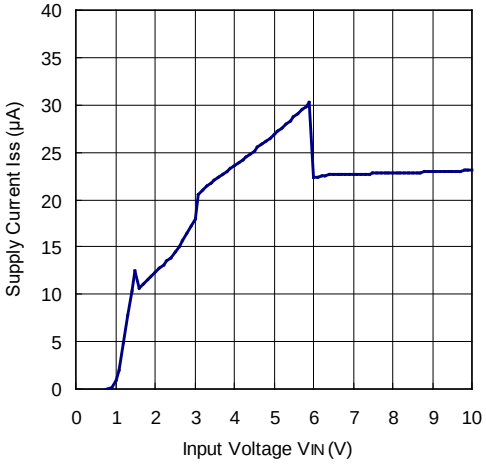
RP170x12xx



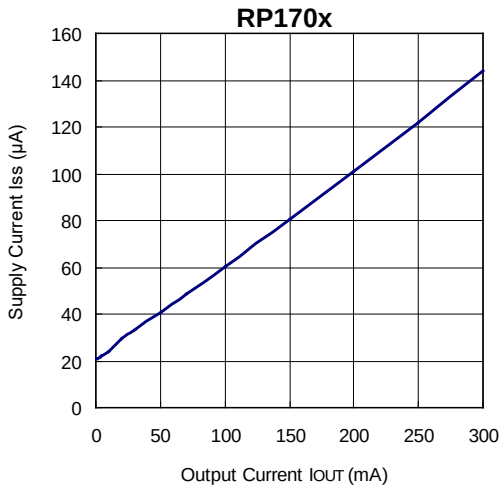
RP170x30xx



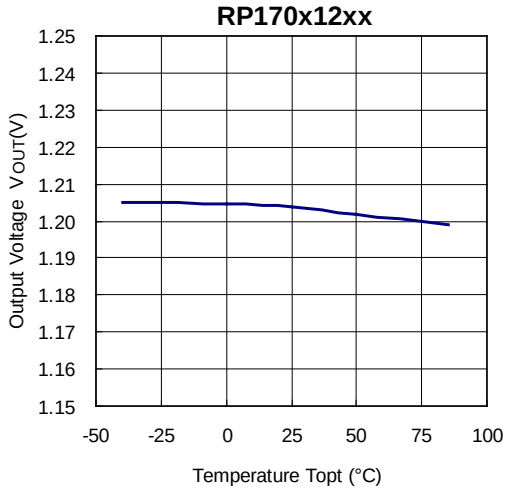
RP170x60xx

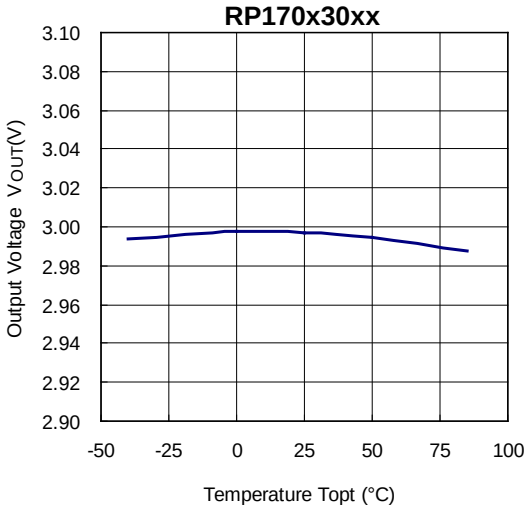


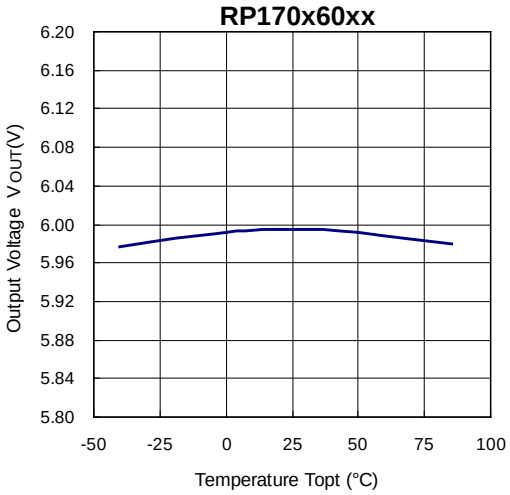
4) Supply Current vs. Output Current (Ta=25°C)



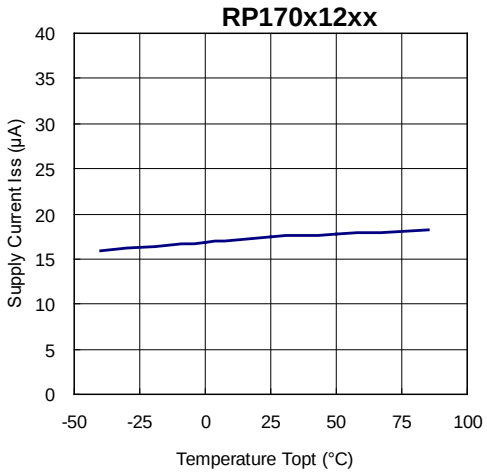
5) Output Voltage vs. Temperature

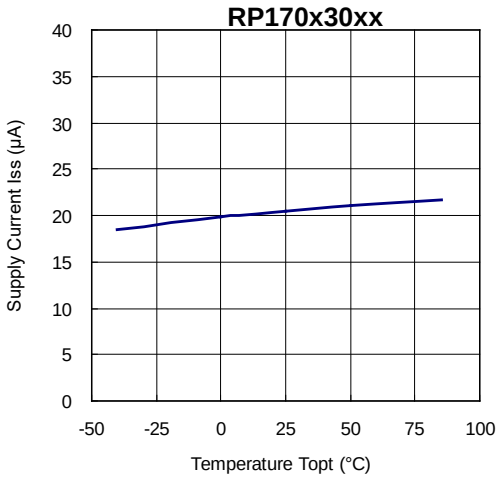


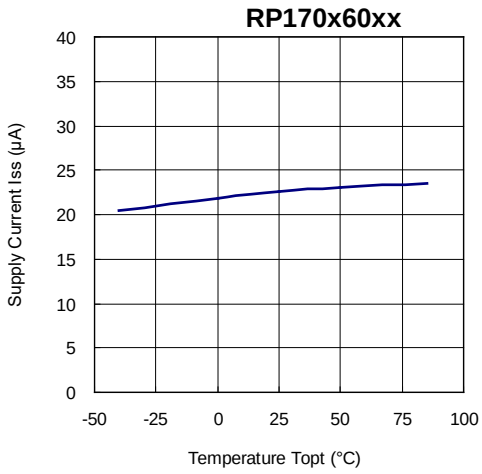




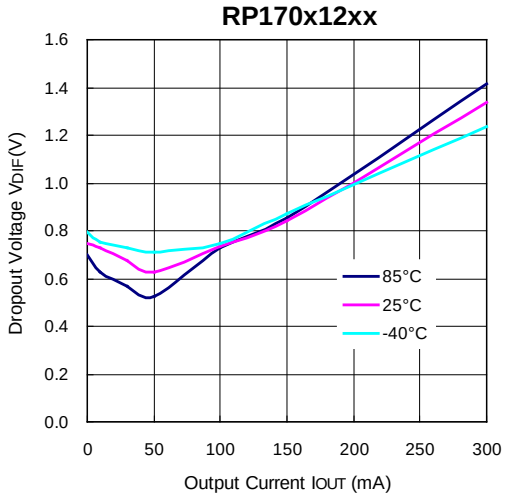
6) Supply Current vs. Temperature

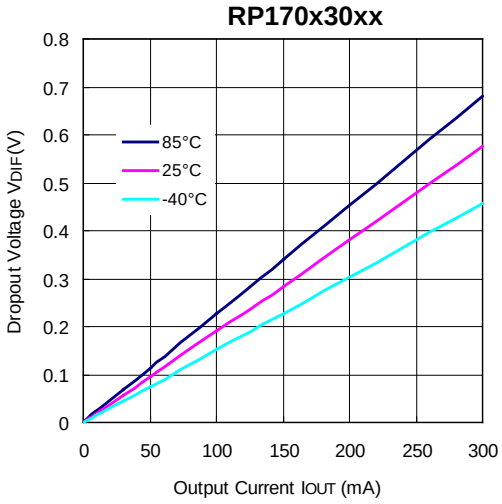


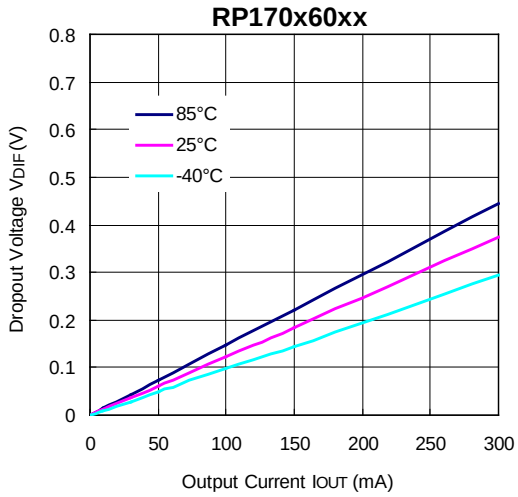




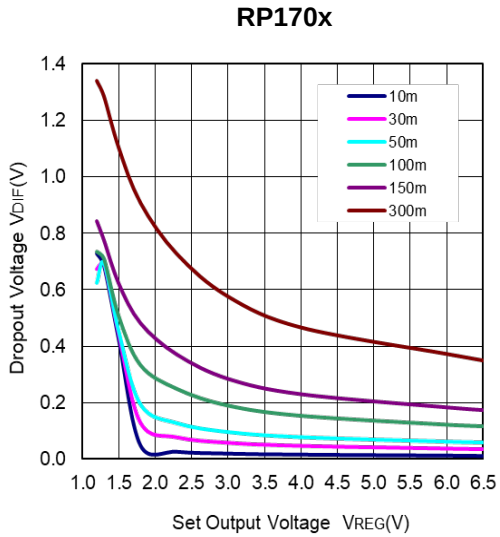
7) Dropout Voltage vs. Output Current



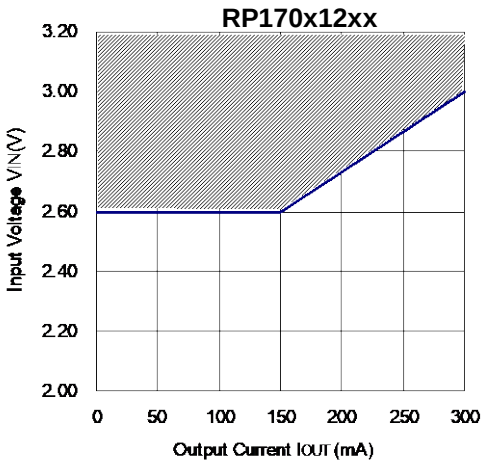




8) Dropout Voltage vs. Set Output Voltage (Ta=25°C)

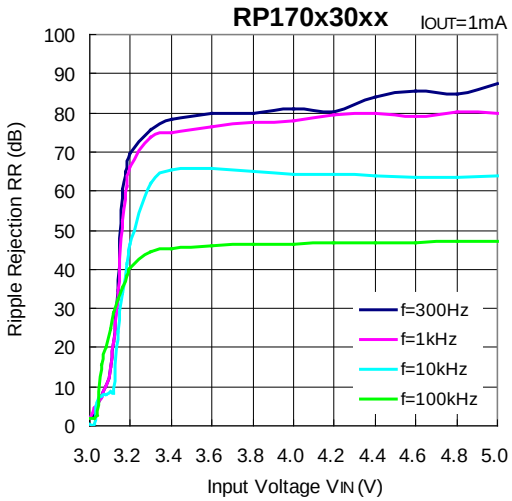


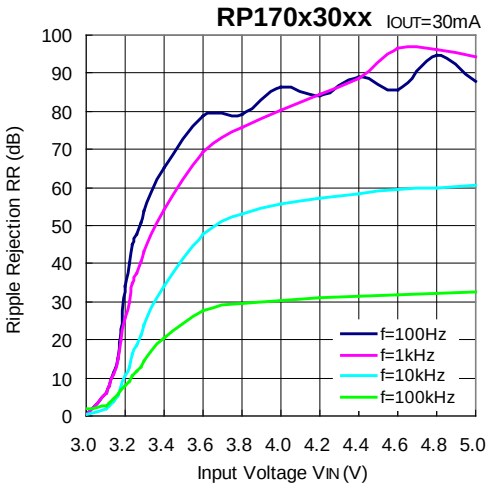
9) Minimum Operating Voltage

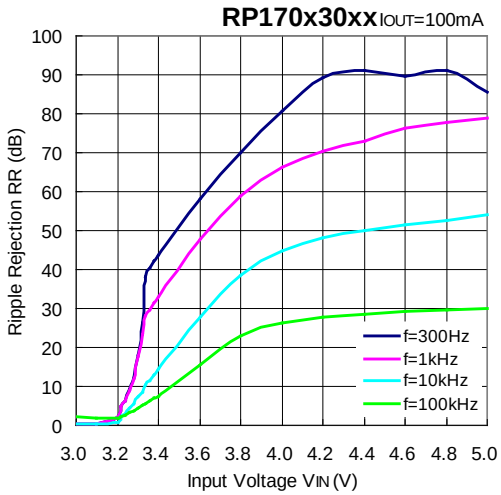


Hatched area is available
for 1.2V output

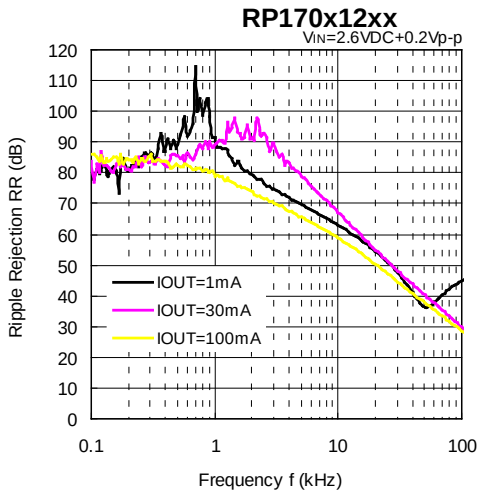
10) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 1.0µF, Ripple=0.2Vp-p, Ta=25°C)

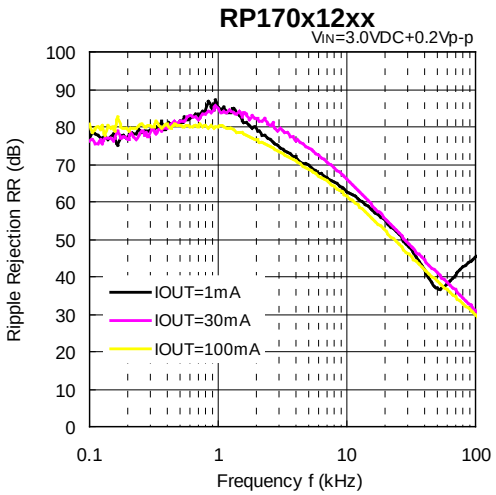






11) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 1.0µF, Ta=25°C)





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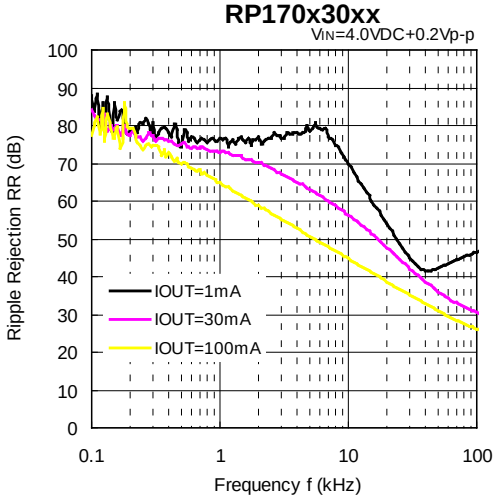
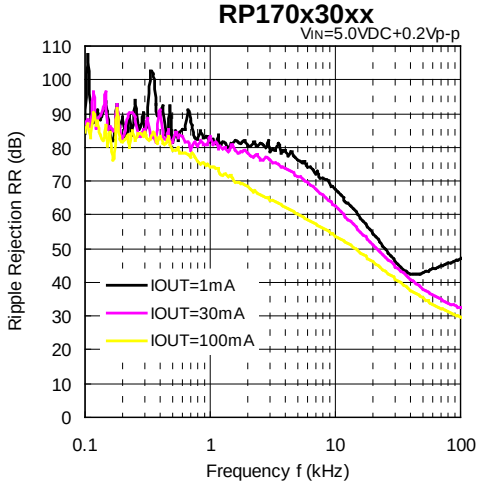
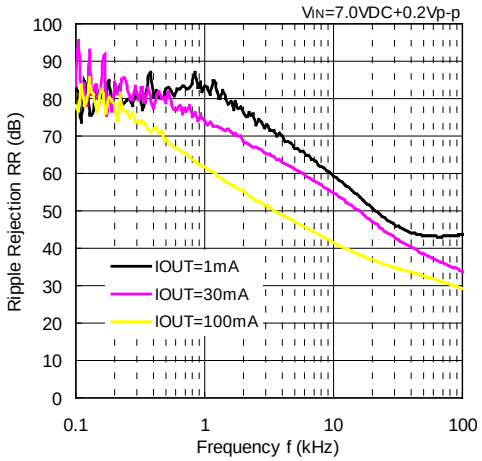


RP170x30xx



RP170x60xx



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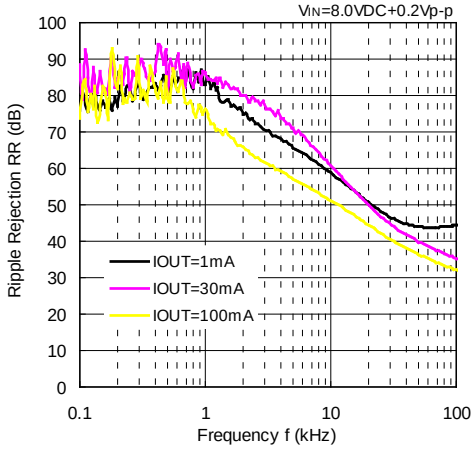
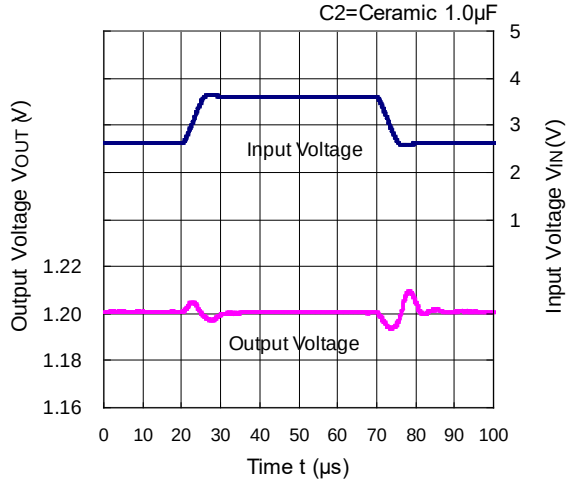
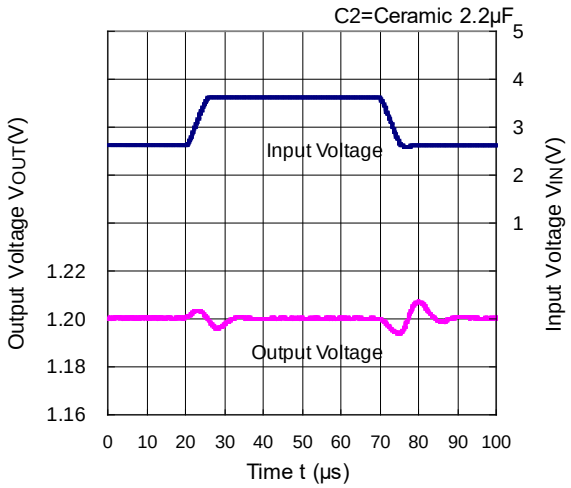


12) Input Transient Response (C1=none, I_{OUT}=30mA, tr=tf=5µs, Ta=25°C)

RP170x12xx



RP170x12xx



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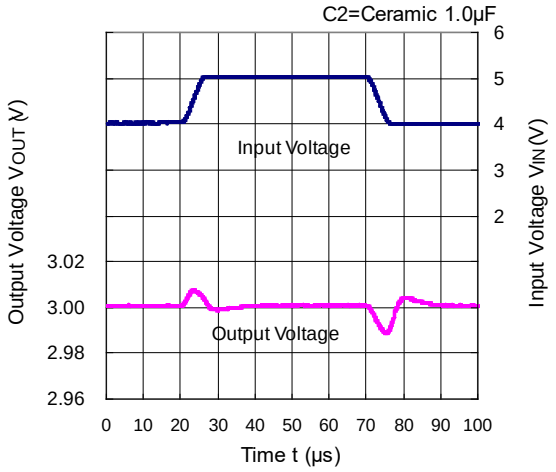

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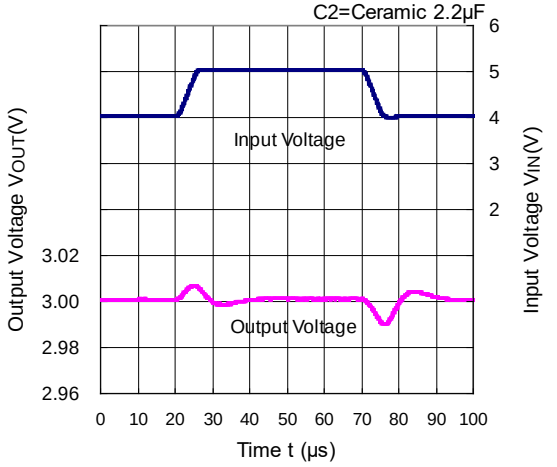

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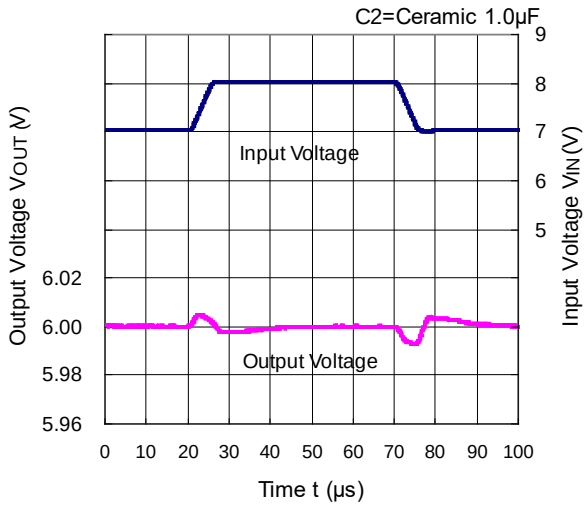
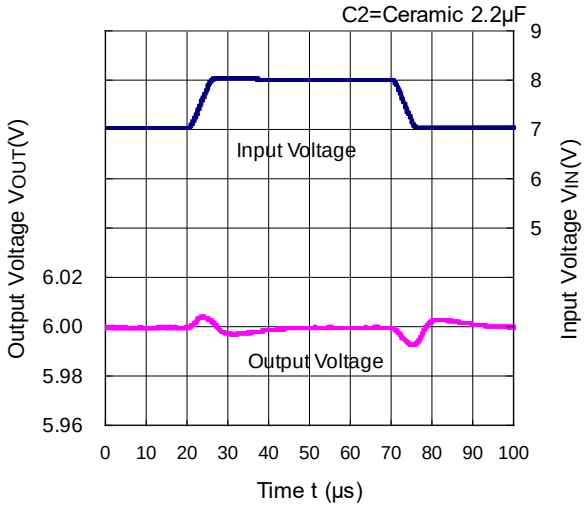
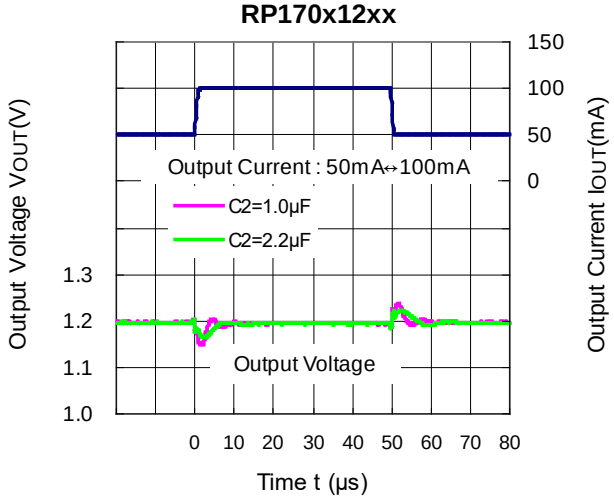


RP170x60xx



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

RP170x12xx



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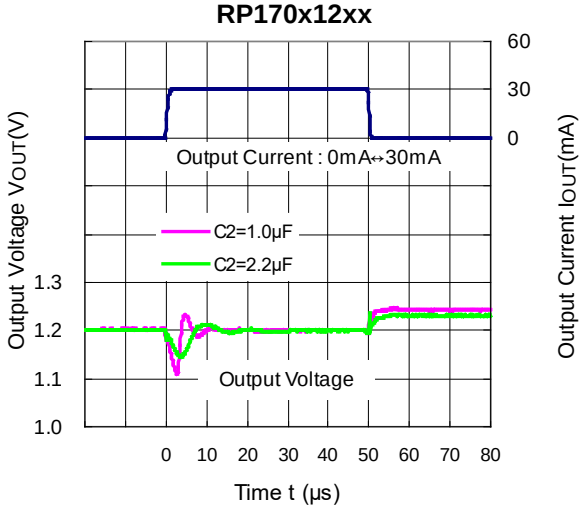

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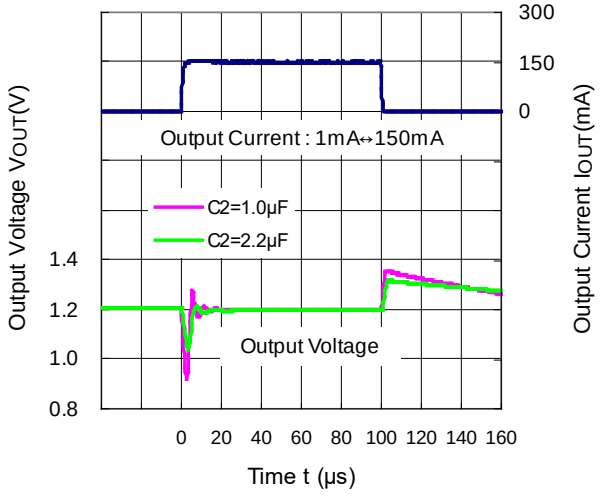

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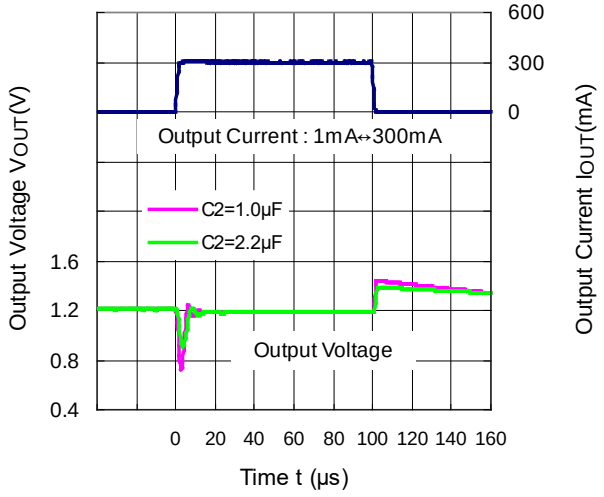

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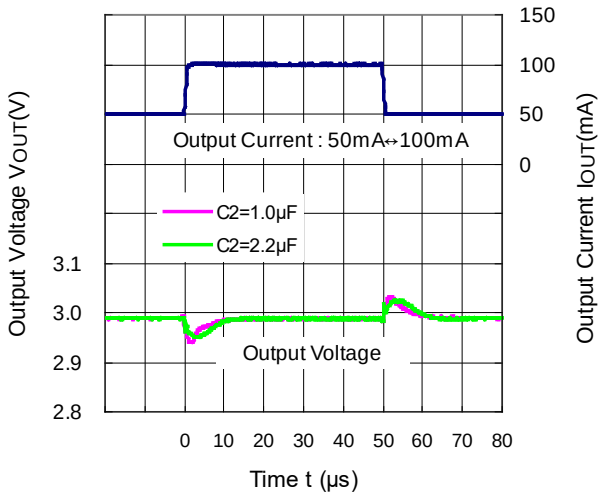

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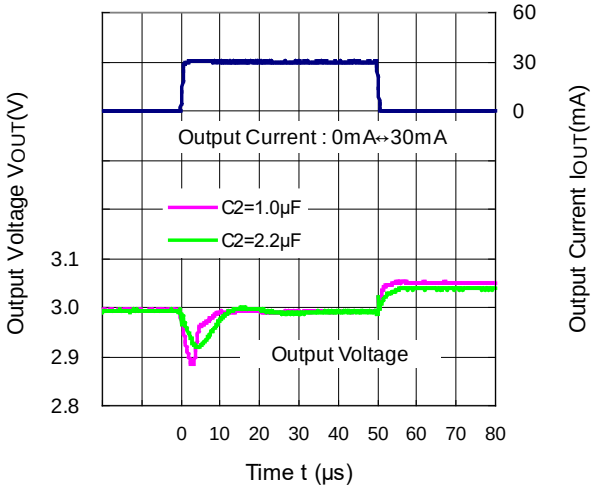

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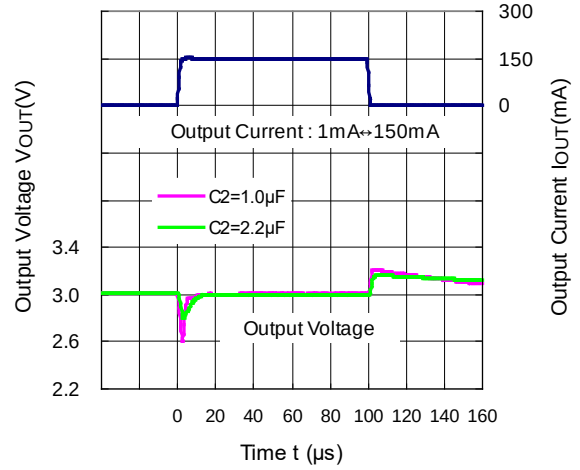

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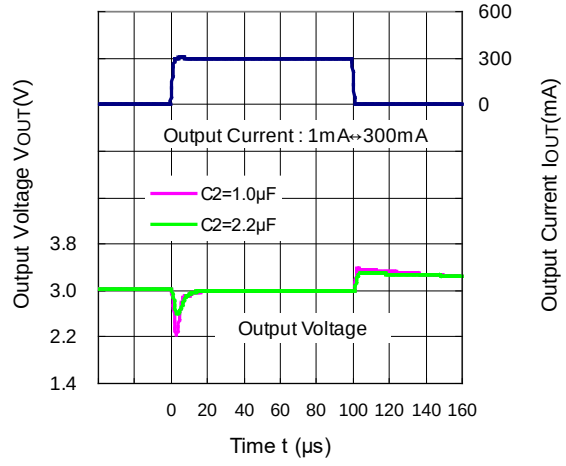

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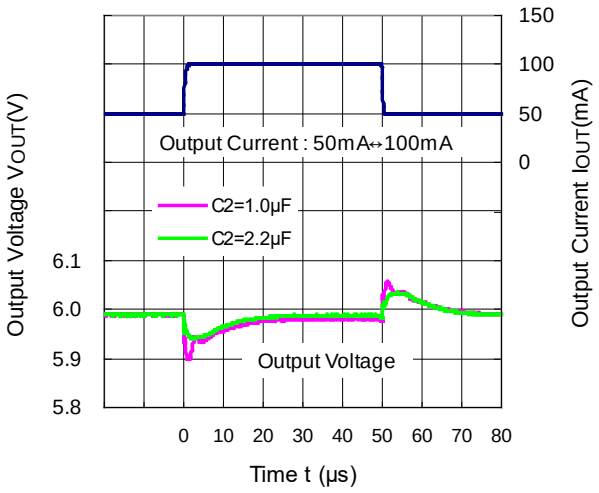

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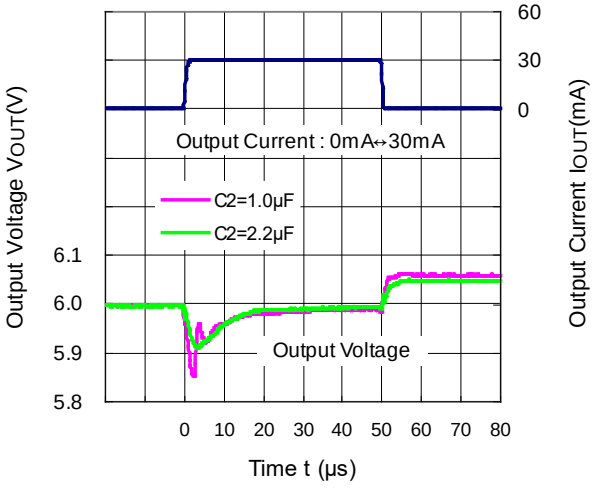

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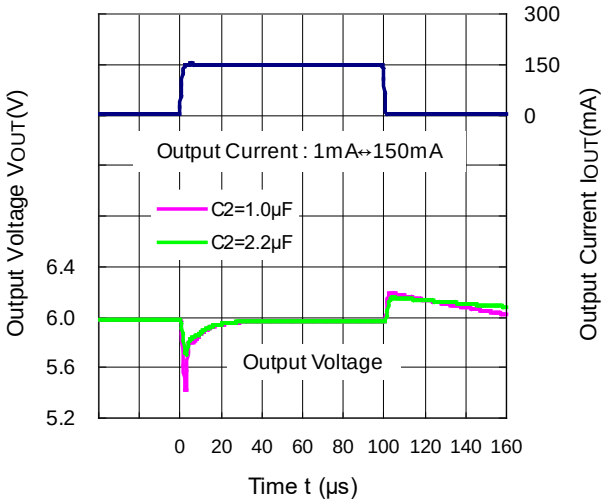

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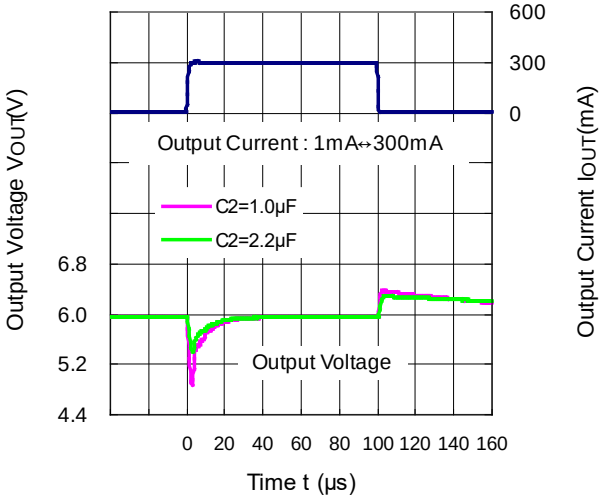
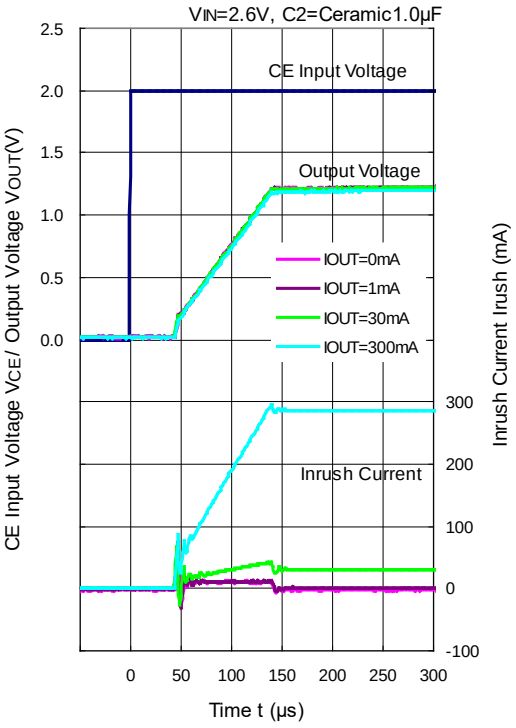


14) Turn On Speed with CE pin (C1=Ceramic 1.0µF, Ta=25°C)

RP170x12xx



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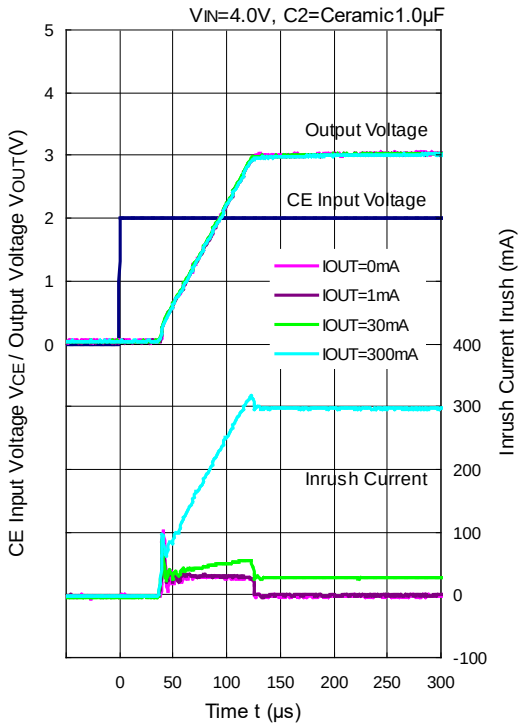

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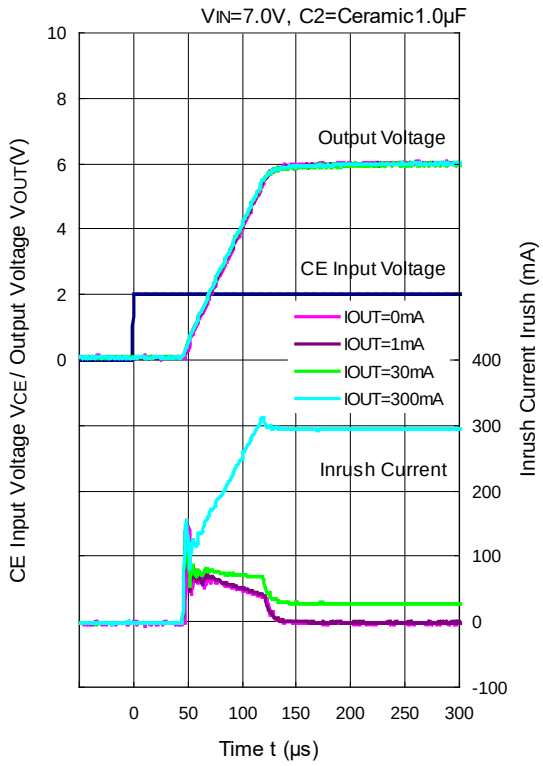
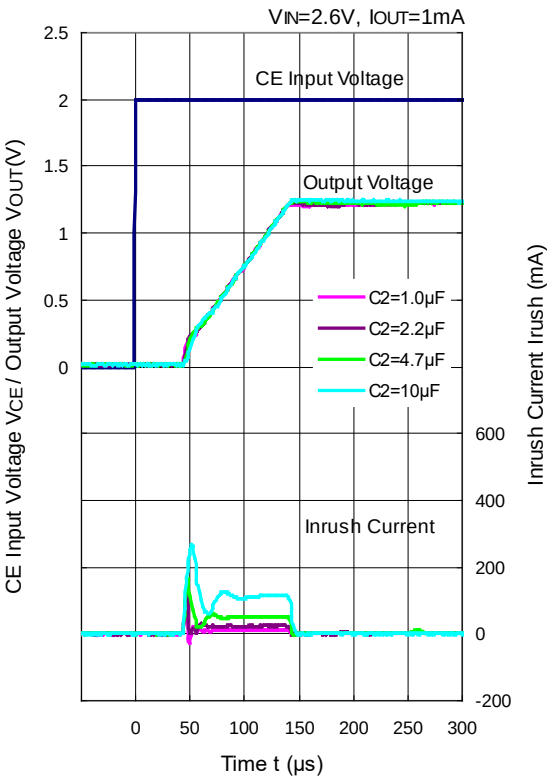
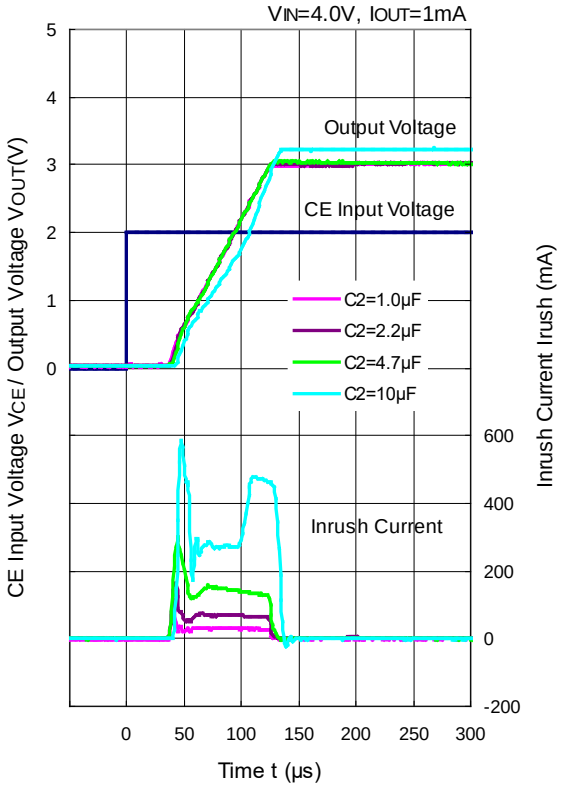


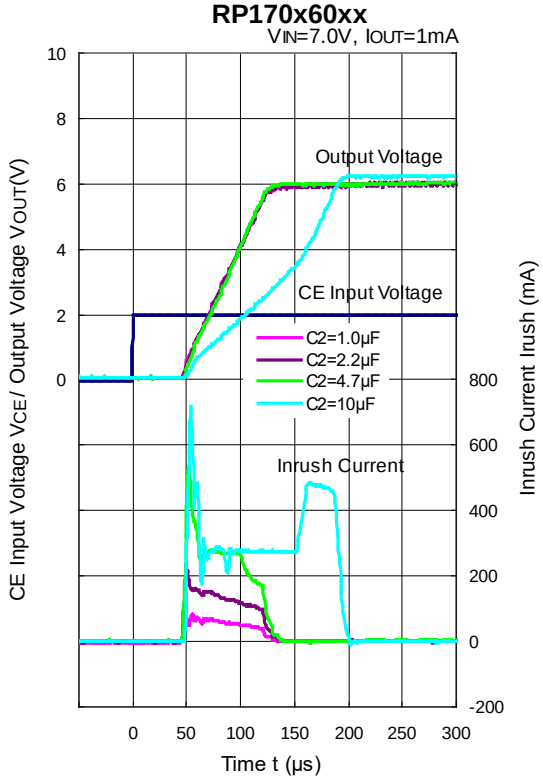
RP170x12xx



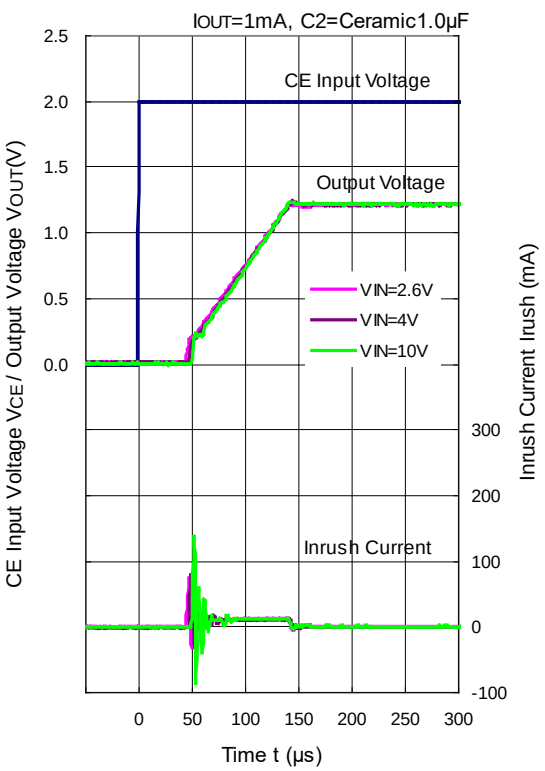
RP170x30xx

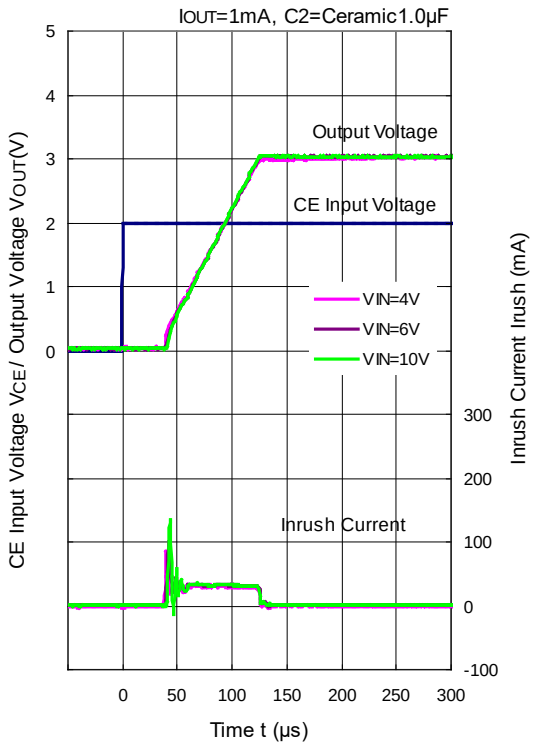


RP170x60xx



RP170x12xx RP170x30xx





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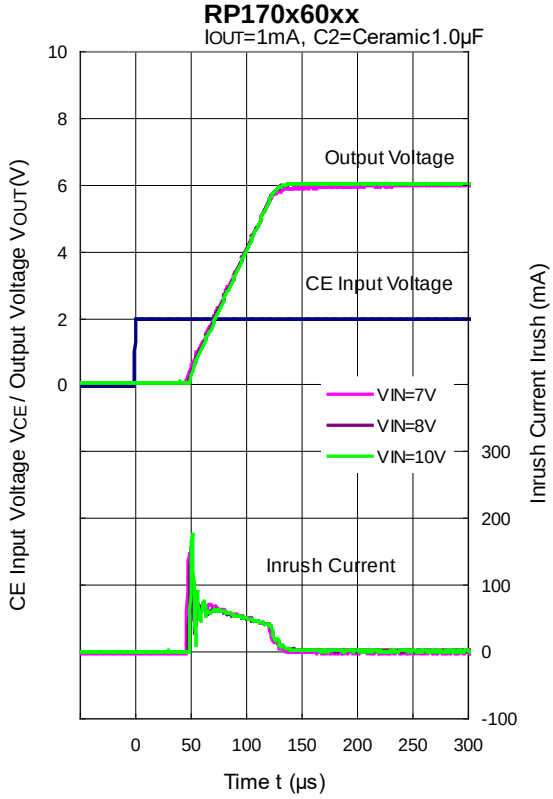
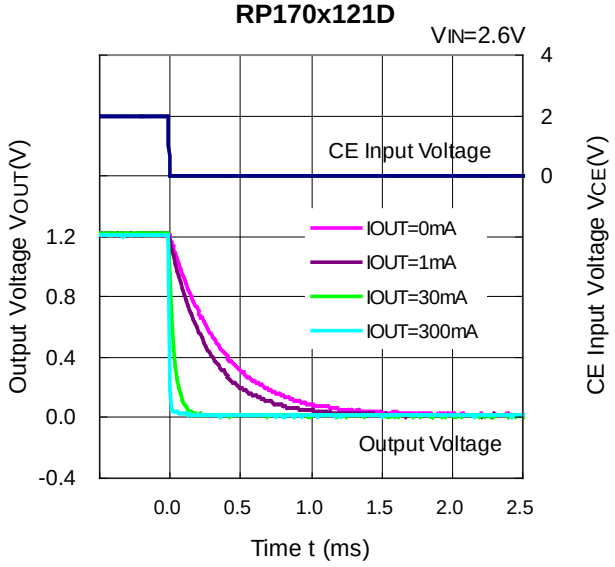
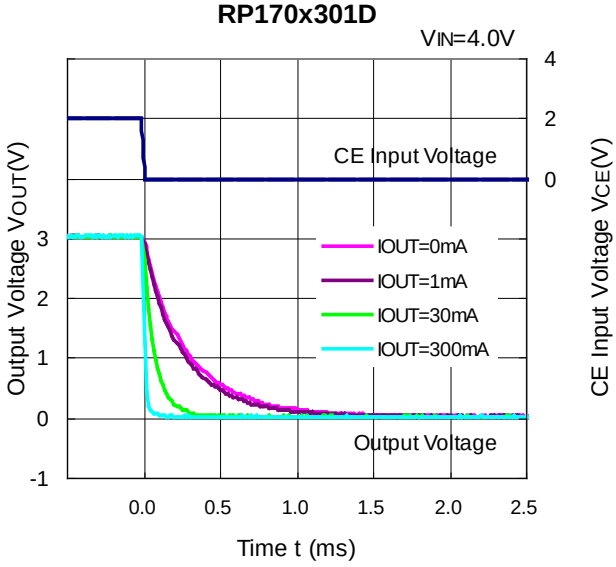


15) Turn Off Speed with CE pin (D Version) (C1=Ceramic 1.0μF, Ta=25°C)

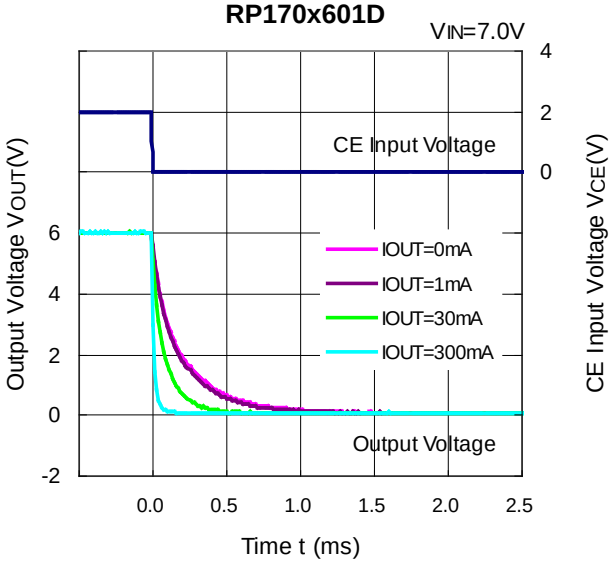
RP170x121D



RP170x301D



RP170x601D



Ver. A

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

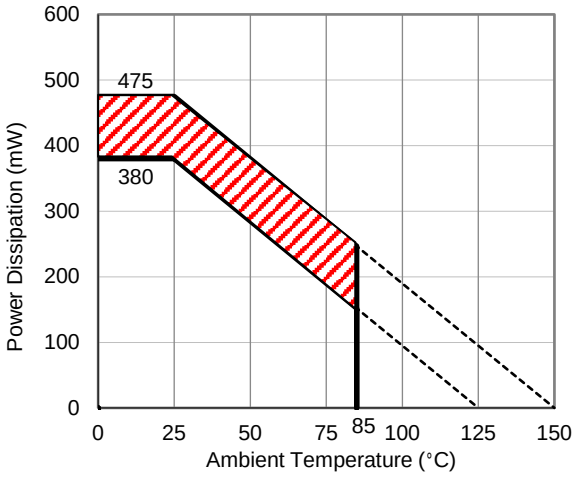
Item	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.5 mm × 44 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

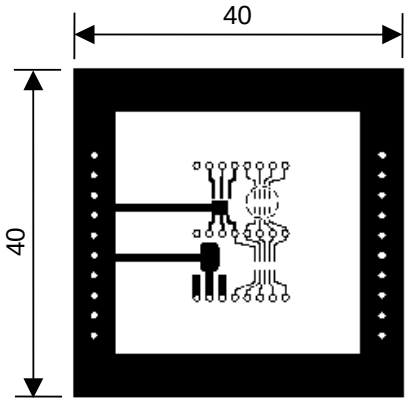
Item	Standard Test Land Pattern
Power Dissipation	380 mW
Thermal Resistance (θja)	θja = 263°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 75°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



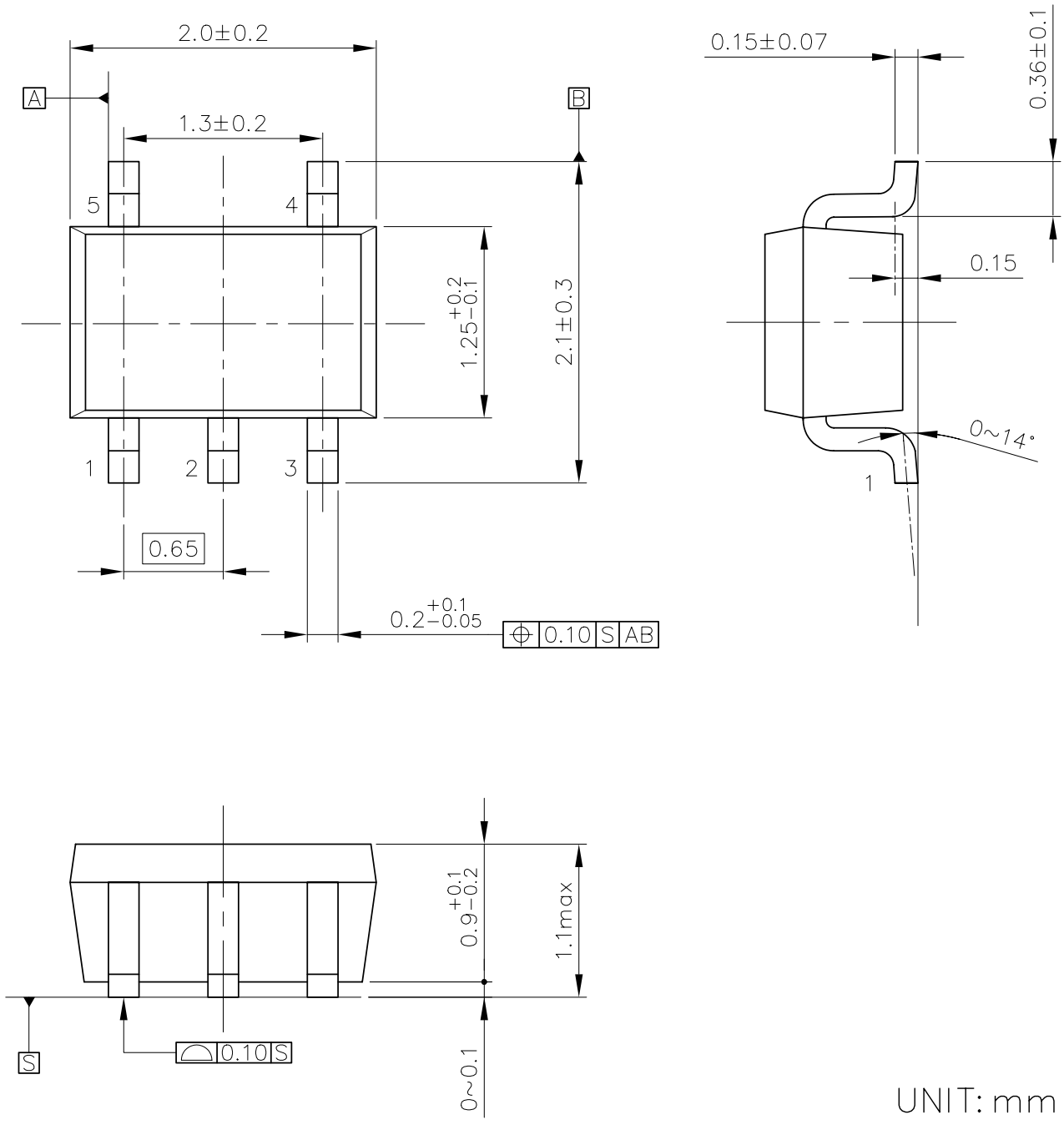
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



UNIT: mm

SC-88A Package Dimensions

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

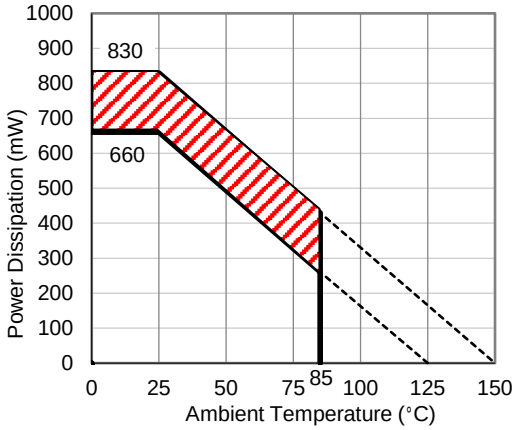
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 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 = 125°C)

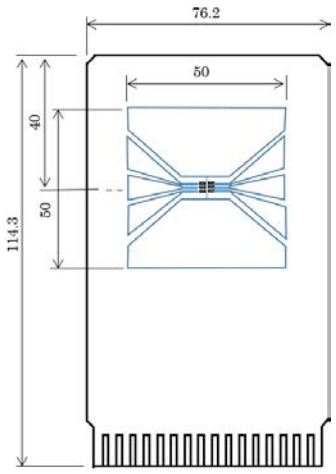
Item	Measurement Result
Power Dissipation	660 mW
Thermal Resistance (θja)	θja = 150°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 51°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



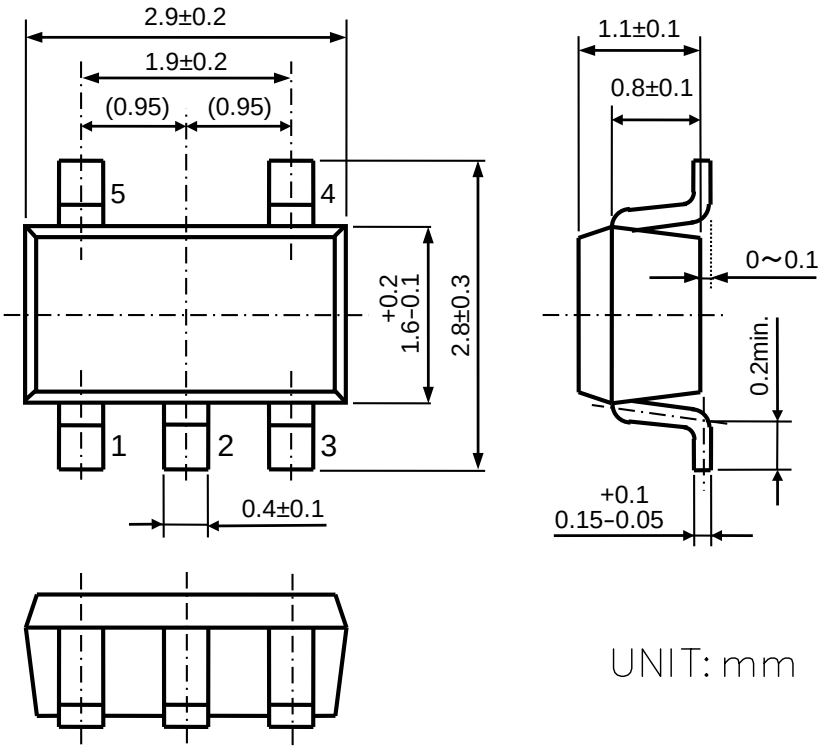
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



SOT-23-5 Package Dimensions

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

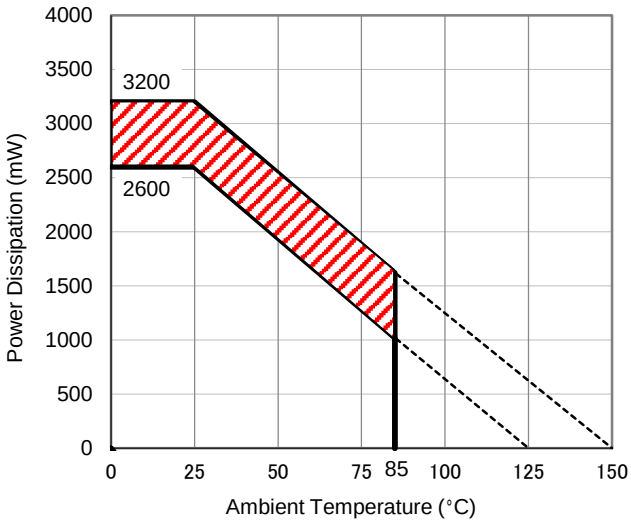
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 13 pcs

Measurement Result (Ta = 25°C, Tjmax = 125°C)

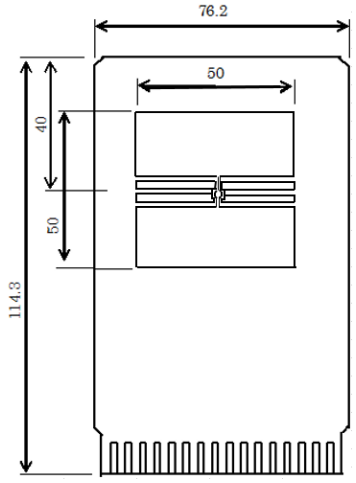
Item	Measurement Result
Power Dissipation	2600 mW
Thermal Resistance (θja)	θja = 38°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 13°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



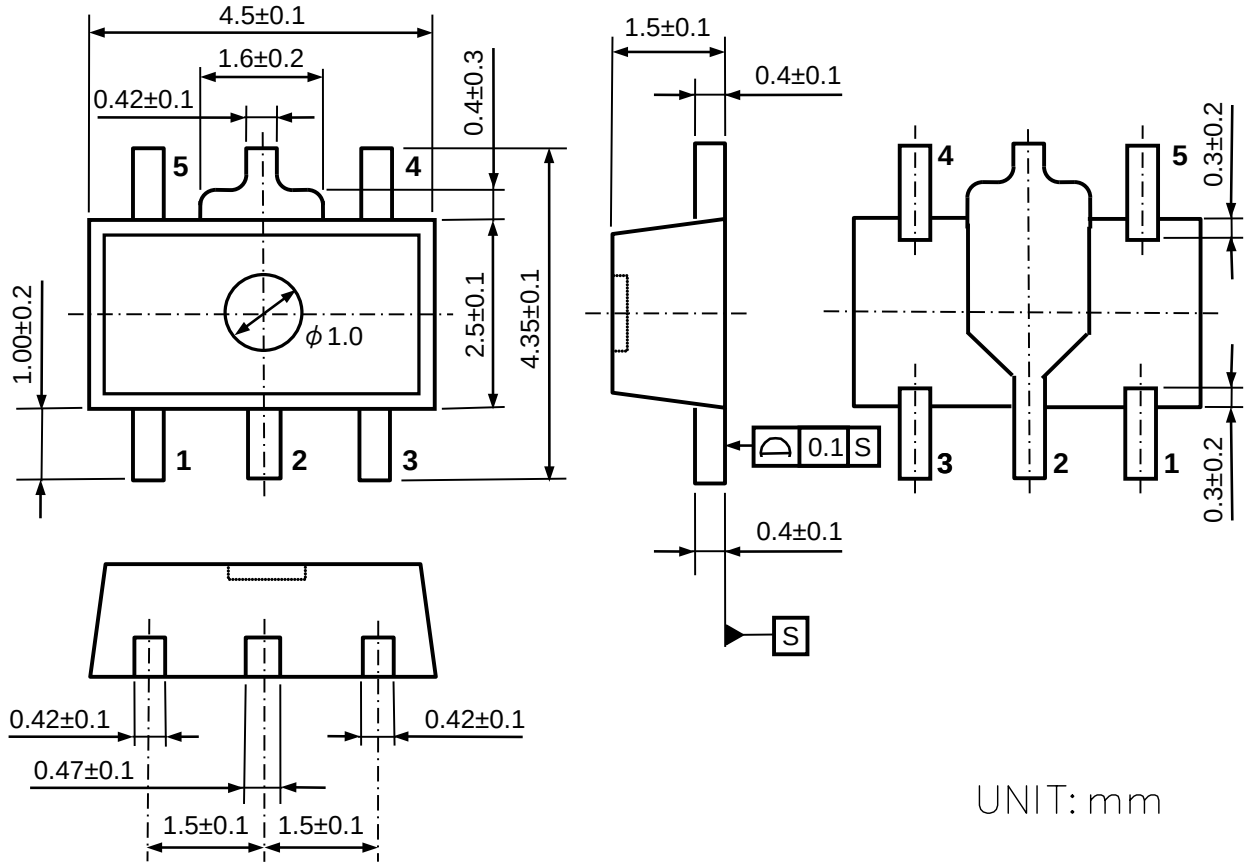
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

Total Hours of Use	Total Years of Use (4 hours/day)
13,000 hours	9 years



SOT-89-5 Package Dimensions

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