Low Power / Fast Mode Alternative 200mA LDO Regulator

NO.EA-279-170710

OUTLINE

The RP202x is voltage regulator IC with high output voltage accuracy, low dropout voltage and low supply current. This IC performs with the chip enable function and realize a standby mode with low supply current. To prevent the destruction by over current, the current limit circuit is included. The RP202x has 3-mode. One is standby mode with CE pin. The other two are the fast response mode (Fast Mode) and the low power mode, and switch over automatically according to the load current of the LDO. Supply current of IC itself at light load is automatically reduced. The output voltage is maintained between Fast Mode and ECO Mode.

The RP202x consists of a voltage reference unit, an error amplifier, a resister net for voltage setting, and a current limit circuit.

Since the packages are SOT-23-5, SC-88A, and DFN(PL)1010-4, high density mounting of the IC on boards is possible.

FEATURES

- Input Voltage Range ····· 1.4V to 5.25V
- Output Voltage Range ····· 0.8V to 4.0V (0.1V steps)
- Supply Current (I_{OUT}=0mA) ····· Typ. 2.5μA
- Supply Current (I_{OUT}=10mA)····· Typ. 50μA
- Supply Current (Standby Mode)····· Typ. 0.1μA
- Dropout Voltage ····· Typ. 0.20V (I_{OUT}=200mA, V_{OUT}=2.8V)
- Ripple Rejection····· Typ. 70dB (f=1kHz, V_{OUT}=2.8V, I_{OUT}=30mA)
- Line Regulation····· Typ. 0.02%/V (I_{OUT}=10mA)
- Packages ····· DFN(PL)1010-4, SC-88A, SOT-23-5
- Built-in Foldback Protection Circuit····· Typ. 60mA (Current at short mode)
- Built-in Constant Slope Circuit (Soft-start Function)
- Ceramic capacitors are recommended to be used with this IC 0.47μF 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.

SELECTION GUIDE

The output voltage, auto discharge function(1), and package, for the IC can be selected at the user's request.

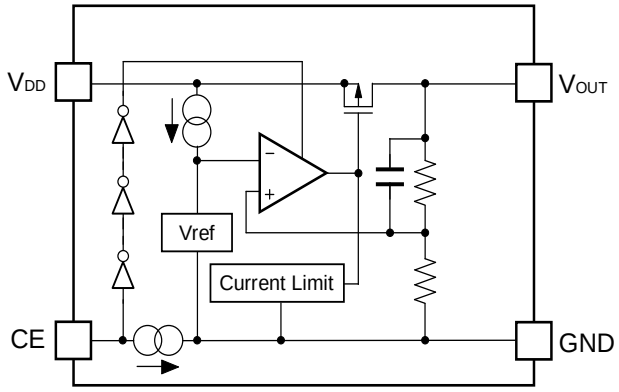
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP202Kxx1∗-TR	DFN(PL)1010-4	10,000pcs	Yes	Yes
RP202Qxx2∗-TR-FE	SC-88A	3,000pcs	Yes	Yes
RP202Nxx1∗-TR-FE	SOT-23-5	3,000pcs	Yes	Yes

xx: The output voltage can be designated in the range from 0.8V(08) to 4.0V(40) in 0.1V steps.

∗ : 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

RP202xxxxB



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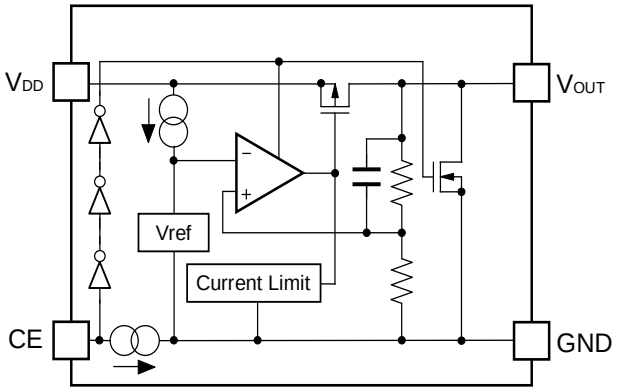
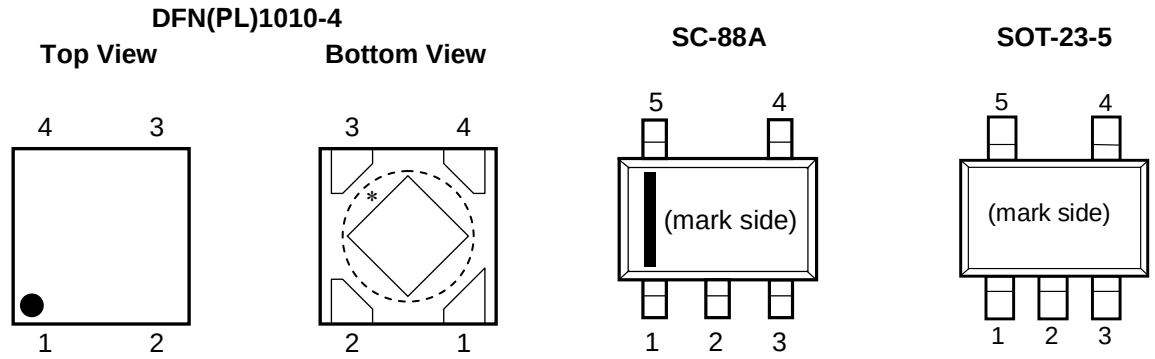


(1) Auto-discharge function quickly lowers the output voltage to 0V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

PIN DESCRIPTIONS



DFN(PL)1010-4

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

∗ Tab is GND level. (They are connected to the reverse side of this IC.) The tab is better to be connected to the GND, but leaving it open is also acceptable.

SC-88A

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

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

(1) Pin No. 2 is connected to the bottom of the IC. It is recommended that the pin be connected to the ground plane on the board, or otherwise be left floating so that there is no contact with other potentials.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.0	V
V_{CE}	Input Voltage (CE Pin)	−0.3 to 6.0	V
V_{OUT}	Output Voltage	−0.3 to V_{IN} + 0.3	V
I_{OUT}	Output Current	220	mA
P_D	Power Dissipation (DFN(PL)1010-4, Standard Test Land Pattern) [1]	400	mW
	Power Dissipation (SC-88A, Standard Test Land Pattern) [1]	380	
	Power Dissipation (SOT-23-5, Standard Test Land Pattern) [1]	420	
Tj	Junction Temperature Range	−40 to 125	°C
Tstg	Storage Temperature Range	−55 to 125	°C

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	1.4 to 5.25	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 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.

(1) Refer to *POWER DISSIPATION* for detailed information.

ELECTRICAL CHARACTERISTICS

V_{IN}=Set V_{OUT}+1V, I_{OUT}=1mA, C_{IN}=C_{OUT}=0.47μF, unless otherwise noted.
The specification in □ is checked and guaranteed by design engineering at -40°C≤Ta≤85°C. (Ta=25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	I_{OUT}=5mA (Fast Mode) Ta=25°C	V_{OUT} > 2.0V	× 0.99		×1.01	V
			V_{OUT} ≤ 2.0V	-20mV		20mV	
		I_{OUT}=5mA (Fast Mode) -40°C ≤ Ta ≤ 85°C	V_{OUT} > 2.0V	□×0.965□		□×1.025□	
			V_{OUT} ≤ 2.0V	□−70mV□		□50mV□	
I_{OUT}	Output Current			□200□			mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	1mA ≤ I_{OUT} ≤ 10mA	V_{OUT} > 2.0V	−1.0		1.0	%
			V_{OUT} ≤ 2.0V	−20		20	mV
		10mA ≤ I_{OUT} ≤ 200mA		□−20□	10	□30□	mV
V_{DIF}	Dropout Voltage	Refer to the "Dropout Voltage"					
I_{SS1}	Supply Current (I_{OUT}=0mA)(1)	I_{OUT}=0mA			2.5	□5.0□	μA
I_{SS2}	Supply Current (I_{OUT}=10mA)	I_{OUT}=10mA			50		μA
Istandby	Standby Current	V_{CE}=GND			0.1	1.0	μA
I_{OUTH}	Fast Mode switch-over current	I_{OUT}= Light load to Heavy load				□8.0□	mA
I_{OUTL}	Low Power Mode switch-over current	I_{OUT}= Heavy load to Light load		□1.0□	2.0		mA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{OUT}+0.5V ≤ V_{IN} ≤ 5V 1.4V ≤ V_{IN}	I_{OUT}=1mA (Low Power Mode)			□±0.50□	%/V
			I_{OUT}=10mA (Fast Mode)		±0.02	□±0.10□	
RR	Ripple Rejection	f=1kHz Ripple 0.2Vp-p V_{IN}=V_{OUT}+1.0V, I_{OUT}=30mA	V_{OUT} ≤ 1.8V		75		dB
			1.8< V_{OUT} ≤2.8V		70		
			2.8< V_{OUT} ≤3.3V		65		
			3.3 < V_{OUT}		60		
I_{SC}	Short Current Limit	V_{OUT}=0V			60		mA
I_{CEPD}	CE Pull-down Constant Current				0.3	□0.6□	μA
V_{CEH}	CE Input Voltage “H”			□1.0□			V
V_{CEL}	CE Input Voltage “L”					□0.4□	V
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	V_{IN} = 4.0V V_{CE} = 0V			60		Ω

All of units are tested and specified under load conditions such that Tj≈Ta□25°C except for Ripple Rejection, Output Voltage Temperature Coefficient.

(1) The value of supply current is excluding the Pull-down constant current of CE Pin.

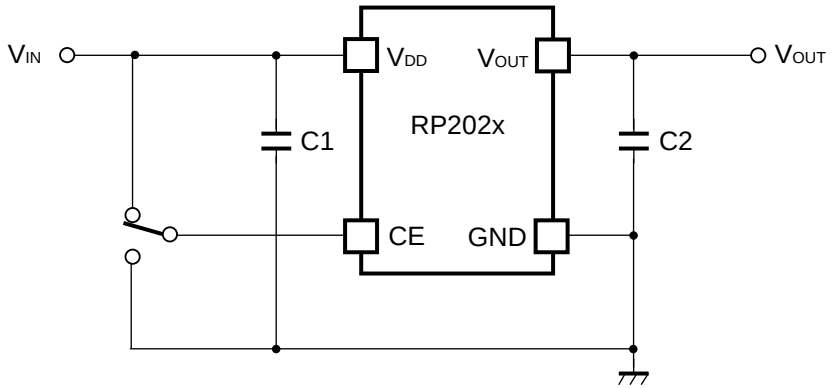
Dropout Voltage

(Ta＝25°C)

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
0.8 ≤ V_{OUT}<0.9	I_{OUT}=200mA	0.60	0.79
0.9 ≤ V_{OUT}<1.0		0.55	0.73
1.0 ≤ V_{OUT}<1.1		0.50	0.64
1.1 ≤ V_{OUT}<1.2		0.45	0.61
1.2 ≤ V_{OUT}<1.3		0.40	0.56
1.3 ≤ V_{OUT}<1.4		0.37	0.53
1.4 ≤ V_{OUT}<1.5		0.34	0.48
1.5 ≤ V_{OUT}<1.8		0.31	0.43
1.8 ≤ V_{OUT}<2.1		0.27	0.39
2.1 ≤ V_{OUT}<2.5		0.245	0.36
2.5 ≤ V_{OUT}<2.8		0.215	0.31
2.8 ≤ V_{OUT}<3.0		0.20	0.29
3.0 ≤ V_{OUT}<3.3		0.19	0.28
3.3 ≤ V_{OUT}<3.6		0.18	0.27
3.6 ≤ V_{OUT}		0.175	0.27

APPLICATION INFORMATION

TYPICAL APPLICATION



(External Components)

C1, C2 : Ceramic Capacitor 0.47μF MURATA: GRM155B31A474KE14

Phase Compensation

Phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 0.47μF 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 the IC with as same external components as ones to be used on the PCB.)

PCB Layout

The impedances of V_{DD} line and GND line has to be low as possible. The high impedances may result in the unstable operation or a noise pickup. The output capacitor with 0.47μF or more should be placed between V_{DD} and GND. The line from V_{DD} to the output capacitor, and the line from the output capacitor to GND must be wired as short as possible.

The output capacitor is placed between V_{OUT} and GND as phase compensation. The line from V_{OUT} to the output capacitor, and the line from the capacitor to GND must be wired as short as possible. Please refer to the “Basic Test Circuit” below.

ESR vs. Output Current

When using the IC, consider the following points:

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 : 0.47μF

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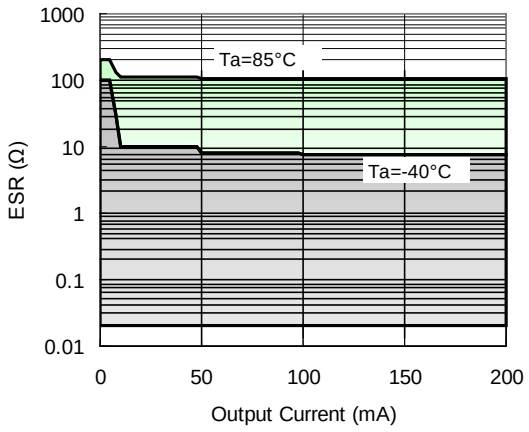

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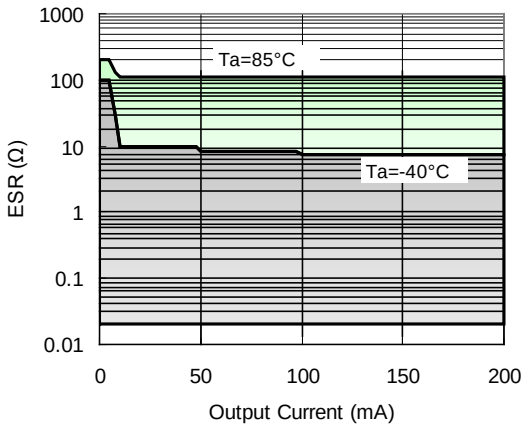

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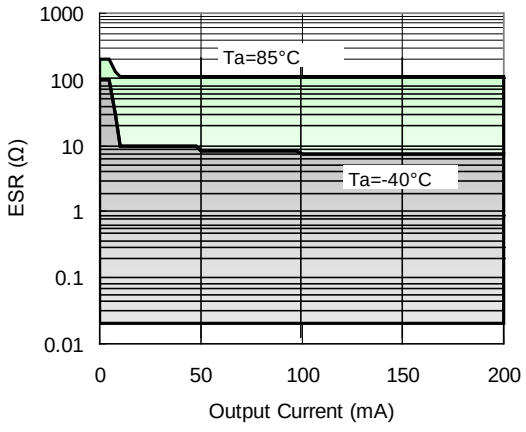

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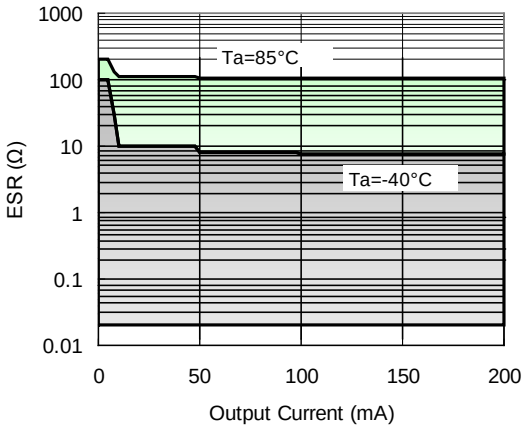

TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (C1=0.47µF, C2=0.47µF, Ta=25℃)

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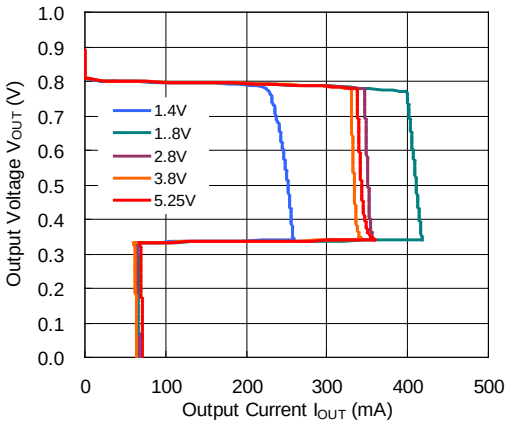

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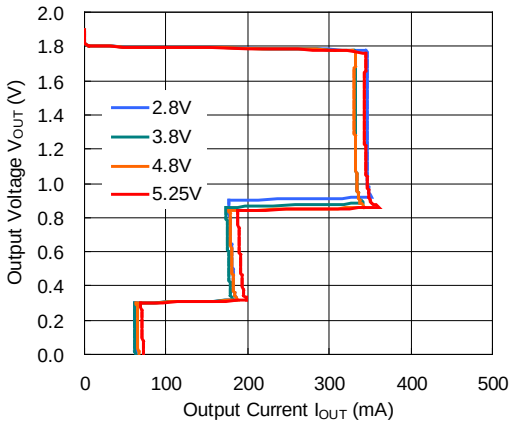

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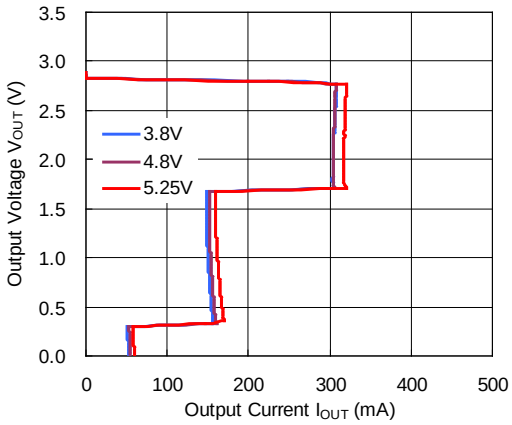

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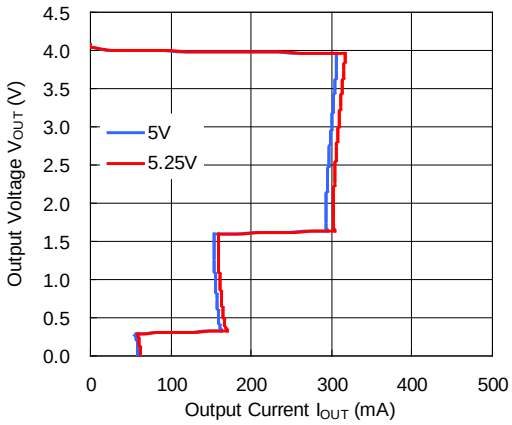

2) Output Voltage vs. Input Voltage (C1=0.47µF, C2=0.47µF, Ta=25℃)

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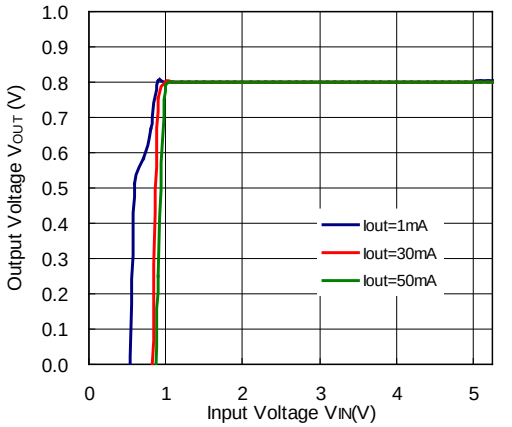

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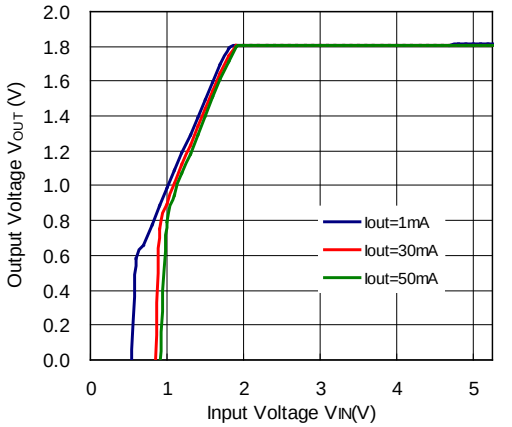

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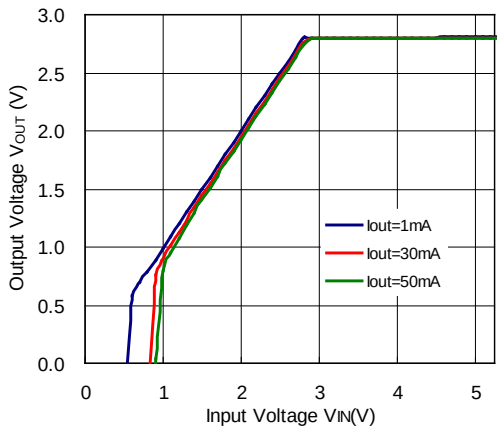

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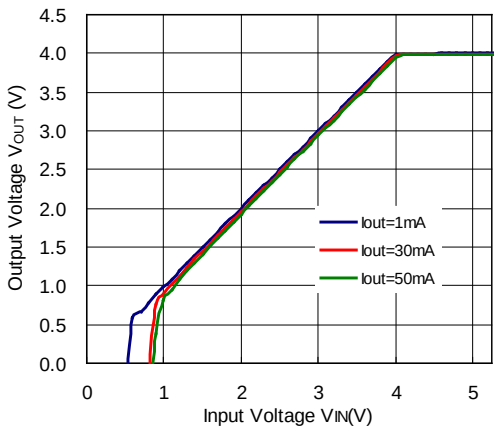

3) Supply Current vs. Input Voltage (C1=0.47µF, C2=0.47µF, Ta=25°C)

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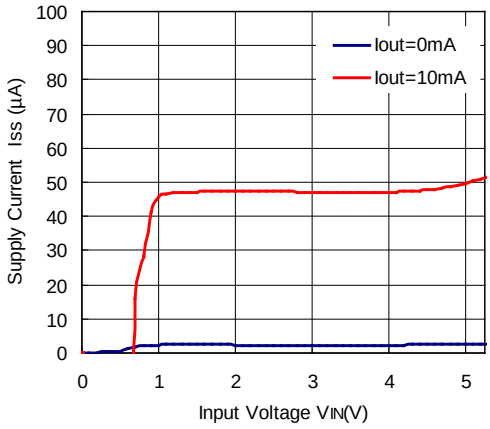

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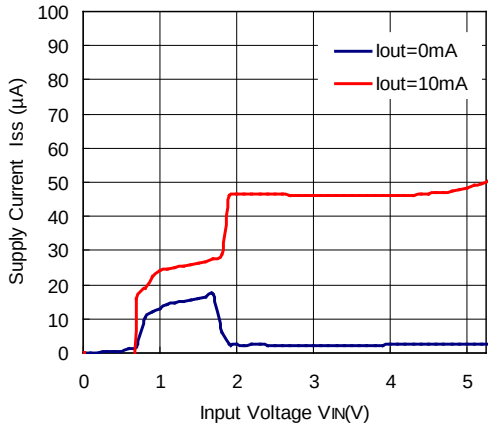

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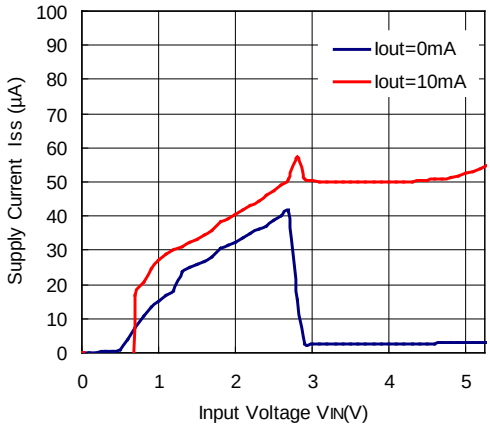

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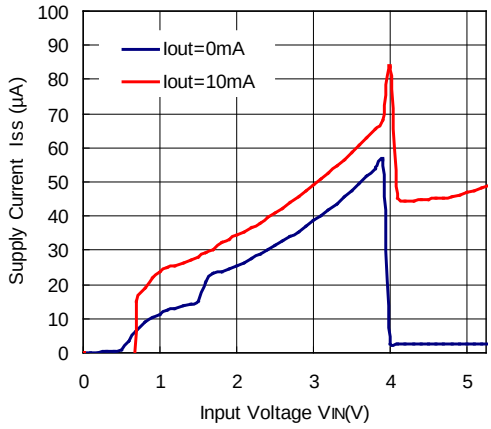

4) Supply Current vs. Output Current (C1=0.47µF, C2=0.47µF, Ta=25℃)

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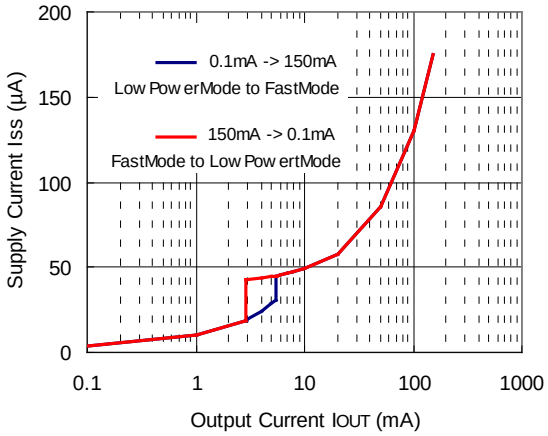

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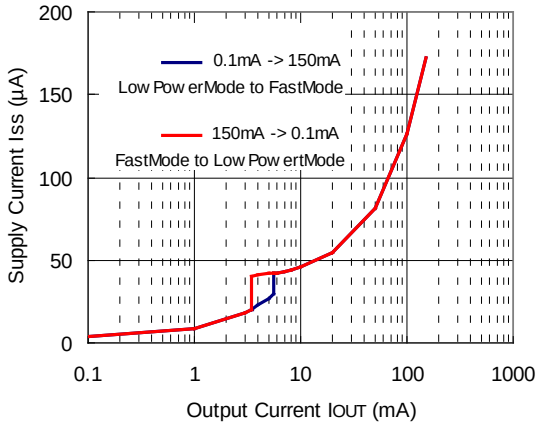

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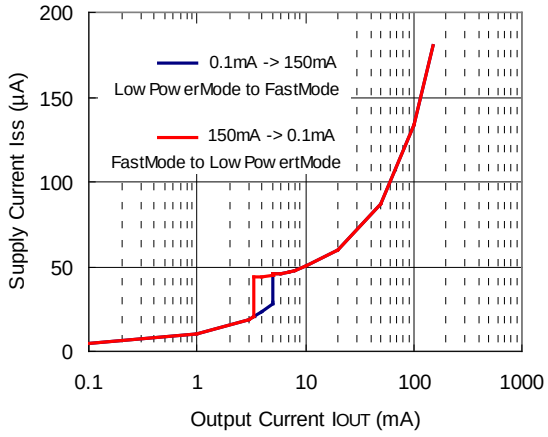

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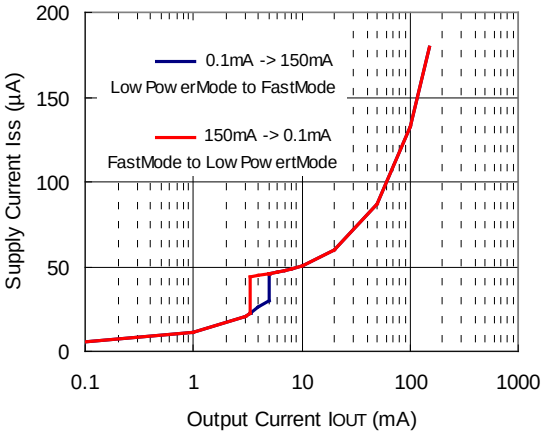
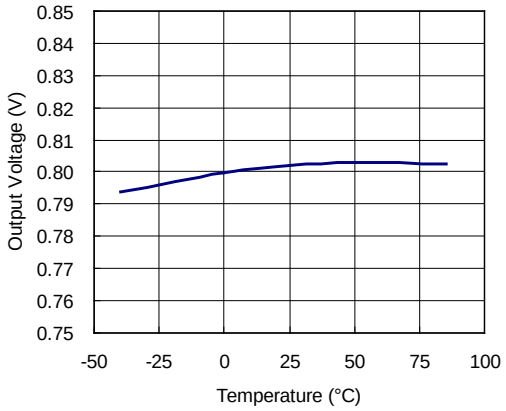


5) Output Voltage vs. Temperature (C1=0.47µF, C2=0.47µF, IOUT=1mA)

RP202x08xx

VIN=1.8V



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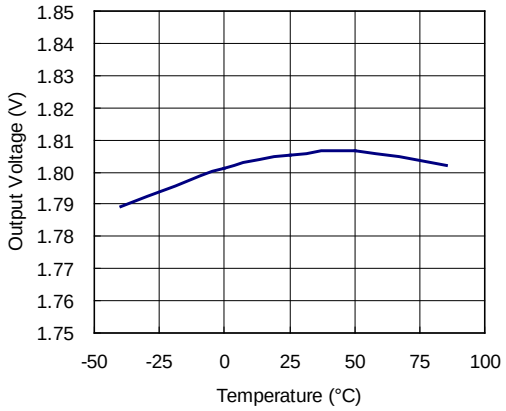
VIN=2.8V



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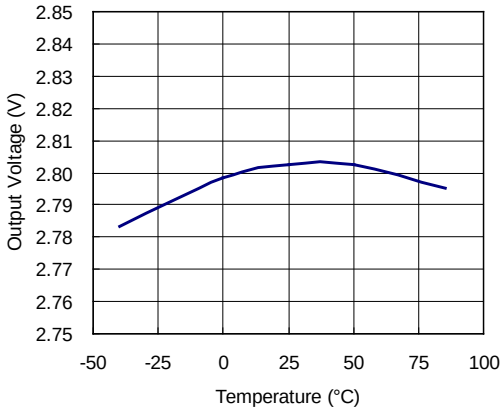

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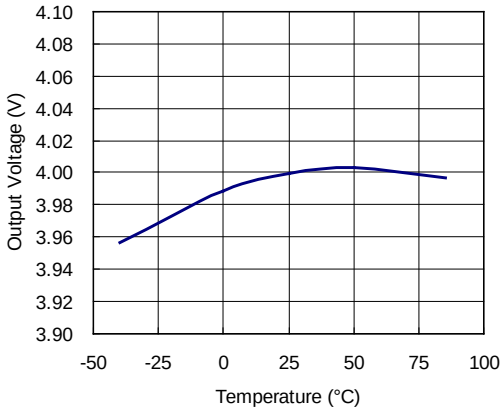
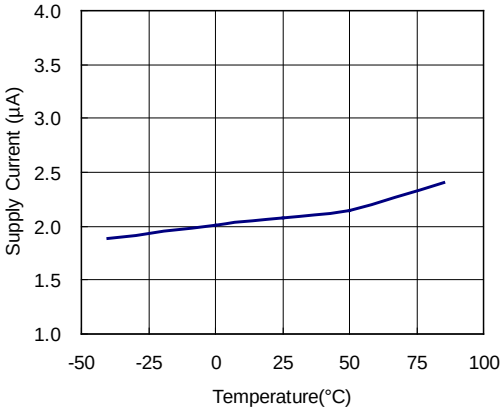


6) Supply Current vs. Temperature (C1=0.47µF, C2=0.47µF)

RP202x08xx

(Auto ECO Low Power Mode)

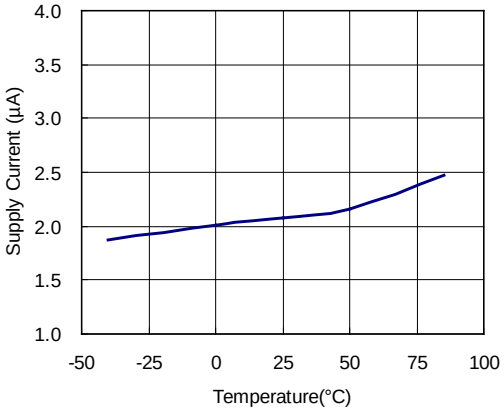
V_{IN}=1.8V , I_{OUT}=0mA



RP202x18xx

(Auto ECO Low Power Mode)

V_{IN}=2.8V , I_{OUT}=0mA



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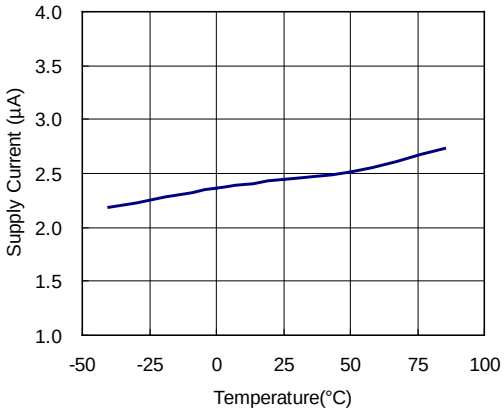
(Auto ECO Low Power Mode)

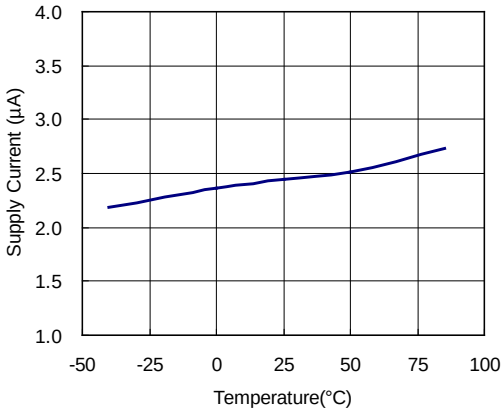
V_{IN}=3.8V , I_{OUT}=0mA



RP202x40xx

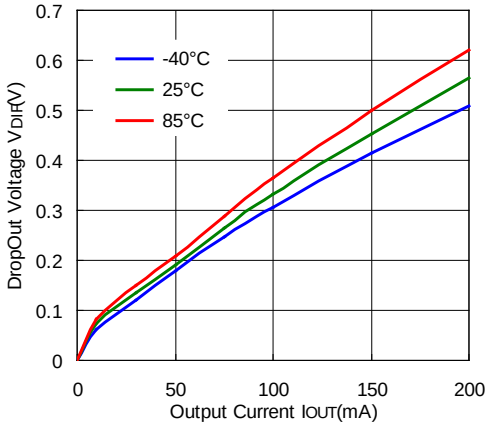
(Auto ECO Low Power Mode)

V_{IN}=5.0V , I_{OUT}=0mA

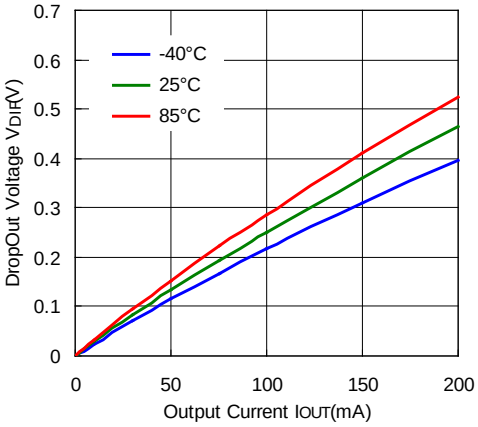


7) Dropout Voltage vs. Output Current (C1=0.47µF, C2=0.47µF)

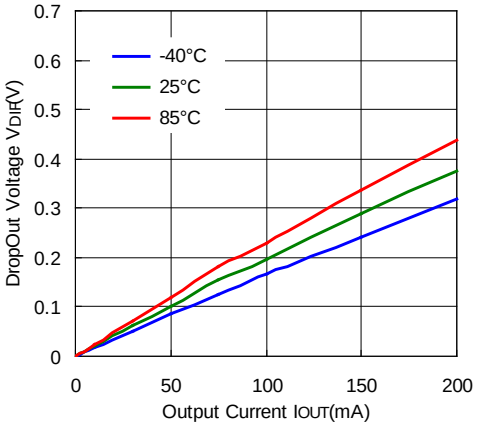
RP202x08xx



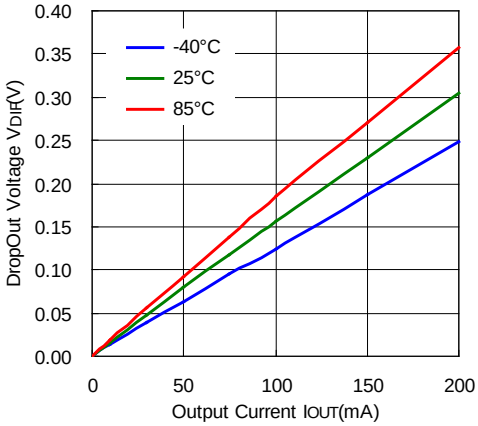
RP202x10xx



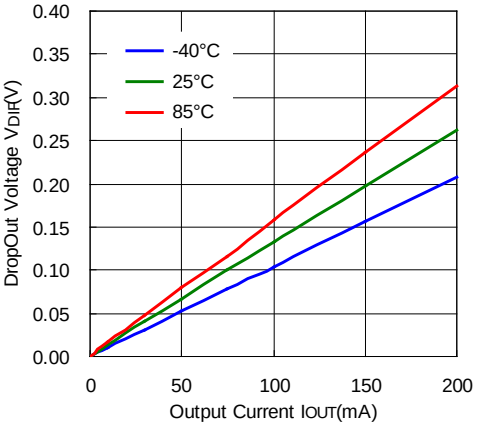
RP202x12xx



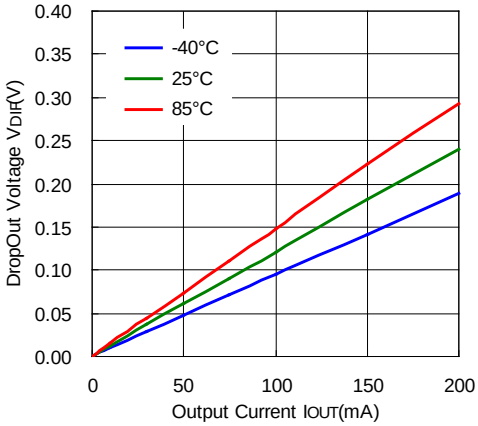
RP202x15xx



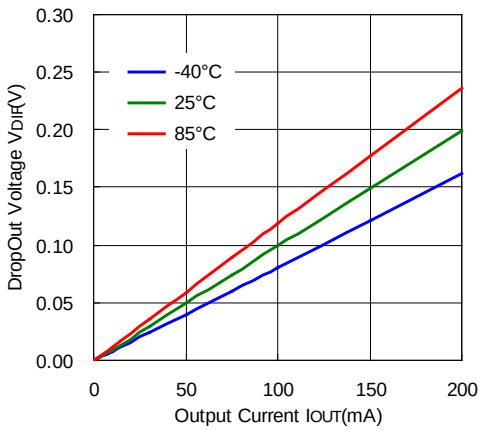
RP202x18xx



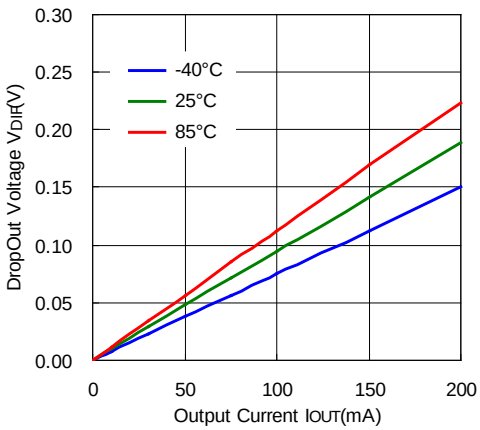
RP202x21xx



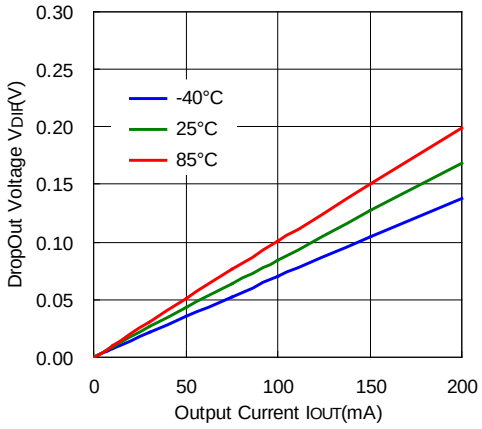
RP202x28xx



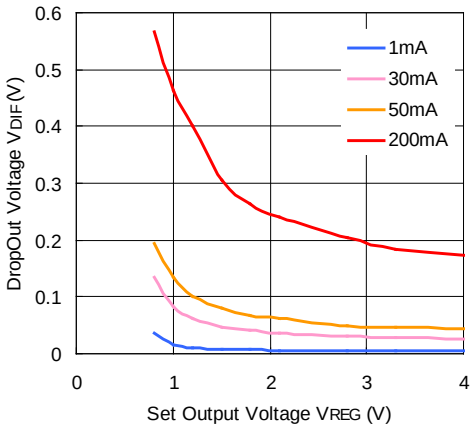
RP202x33xx



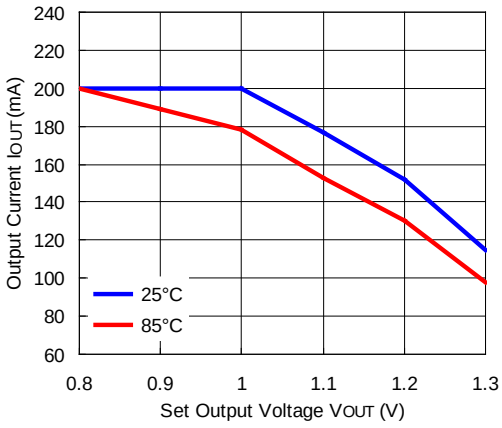
RP202x40xx



8) Dropout Voltage vs Set Output Voltage

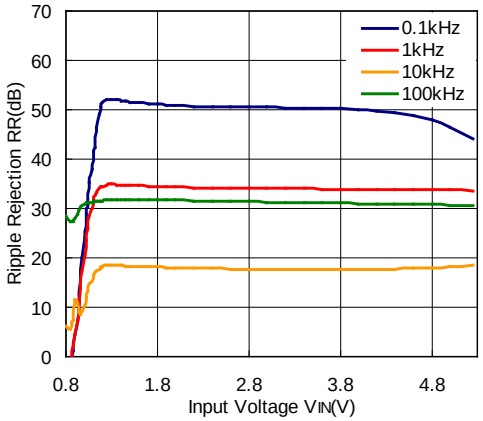


9) Maximum Output Current vs. Set Output Voltage (C1=0.47µF, C2=0.47µF, V_{IN}=1.4V)

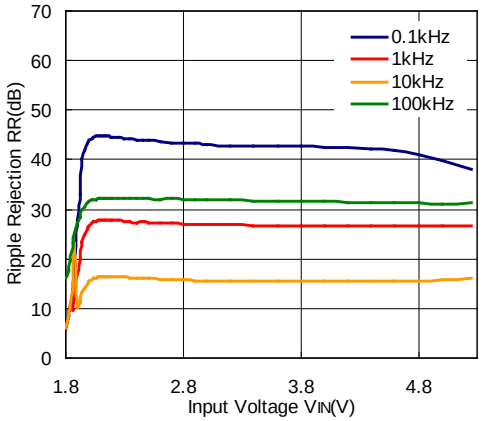


10) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=0.47µF, Ripple=0.2Vp-p, Ta=25°C)

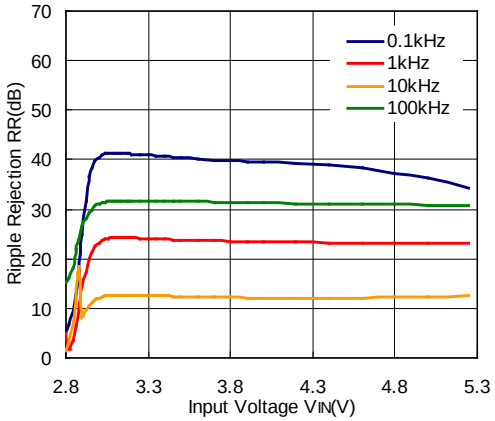
RP202x08xx
(Auto ECO Low Power Mode)
IOUT=1mA



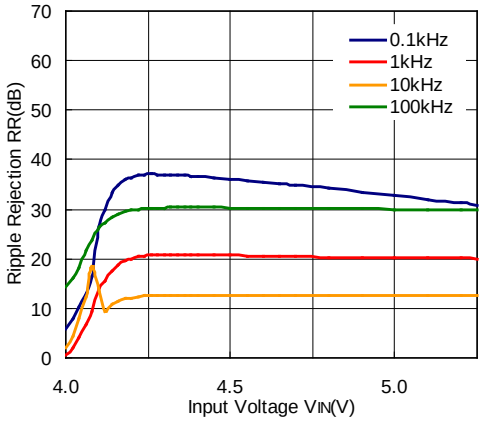
RP202x18xx
(Auto ECO Low Power Mode)
IOUT=1mA



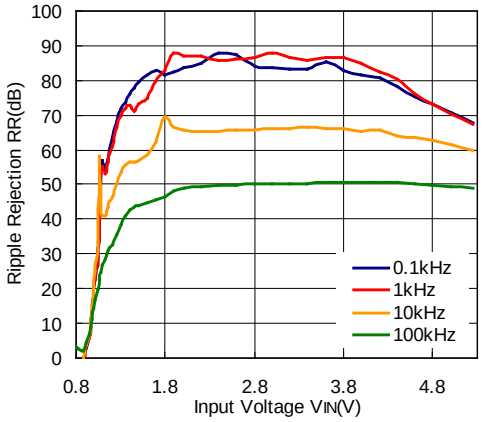
RP202x28xx
(Auto ECO Low Power Mode)
IOUT=1mA



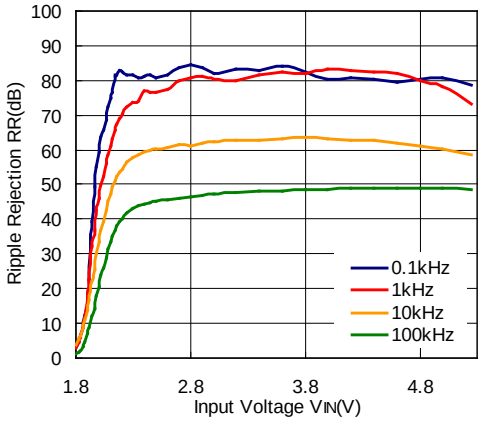
RP202x40xx
(Auto ECO Low Power Mode)
IOUT=1mA



RP202x08xx
(Auto ECO FAST Mode)
IOUT=30mA

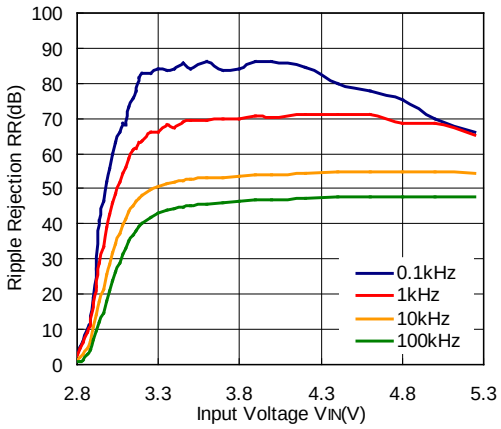


RP202x18xx
(Auto ECO FAST Mode)
IOUT=30mA



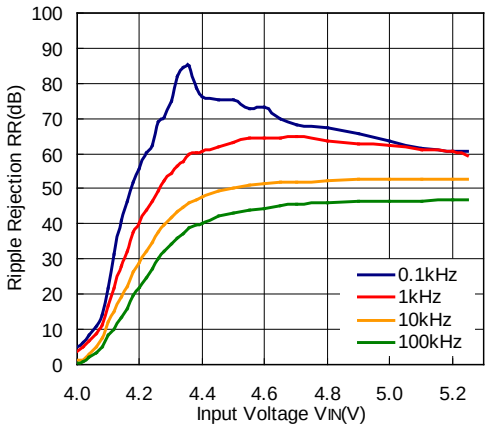
RP202x28xx
(Auto ECO FAST Mode)

IOUT=30mA



RP202x40xx
(Auto ECO FAST Mode)

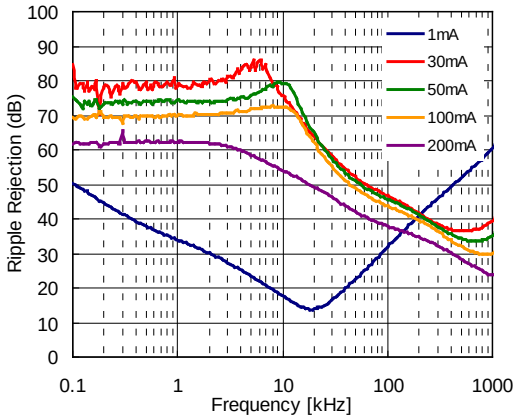
IOUT=30mA



11) Ripple Rejection vs. Frequency (C1=none, C2=0.47µF, Ripple=0.2Vp-p, Ta=25°C)

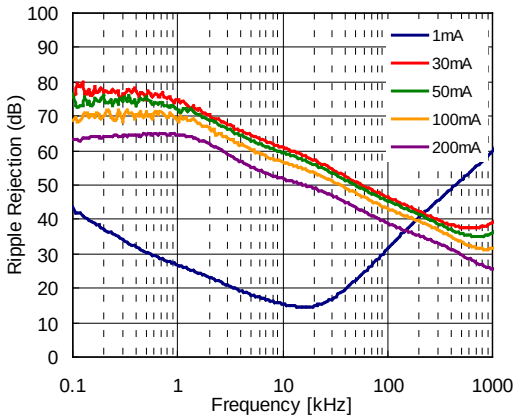
RP202x08xx

VIN=1.8V+0.2Vp-p



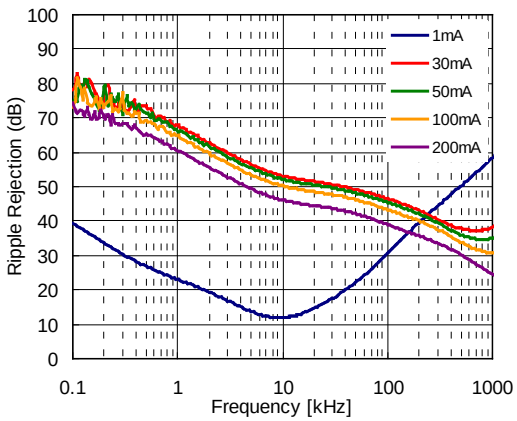
RP202x18xx

VIN=2.8V+0.2Vp-p



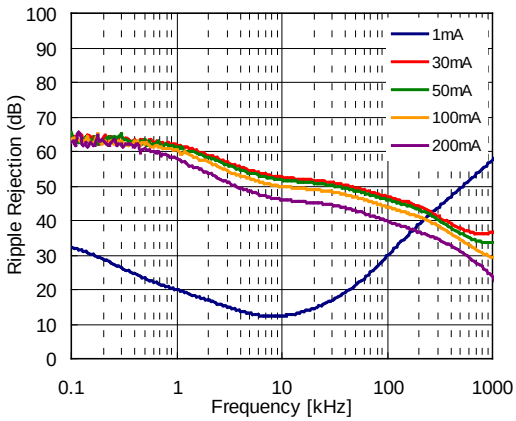
RP202x28xx

VIN=3.8V+0.2Vp-p



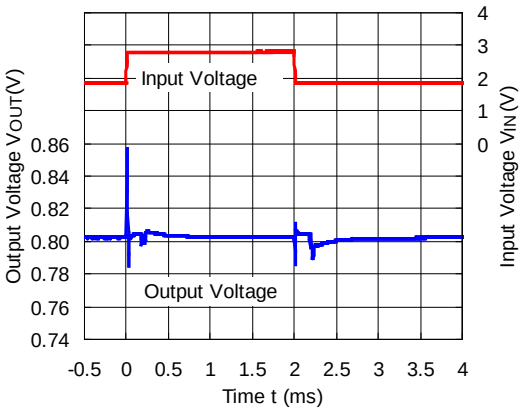
RP202x40xx

VIN=5.0V+0.2Vp-p

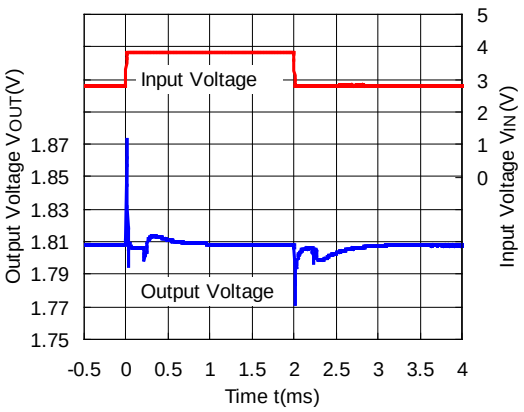


12) Input Transient Response (C1=none, C2=0.47µF, tr=tf=5µs, Ta=25°C)

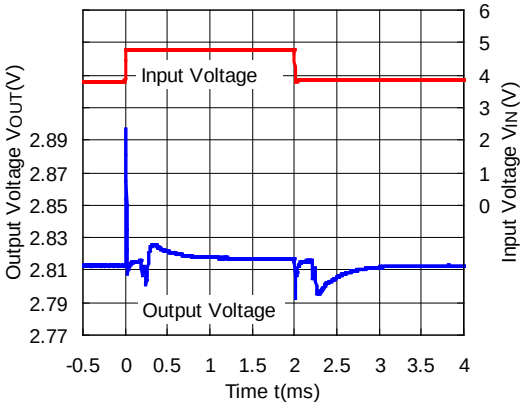
RP202x08xx
(Auto ECO Low Power Mode)
V_{IN}=1.8V⇔2.8V, I_{OUT}=1mA



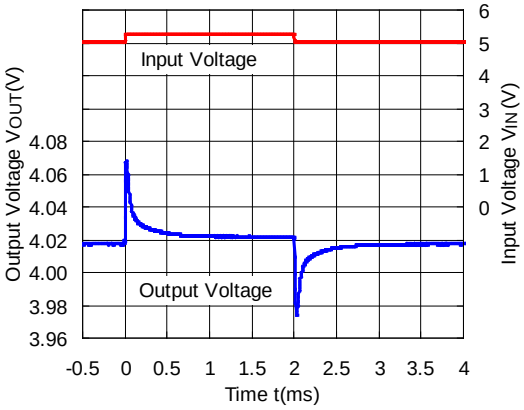
RP202x18xx
(Auto ECO Low Power Mode)
V_{IN}=2.8V⇔3.8V, I_{OUT}=1mA



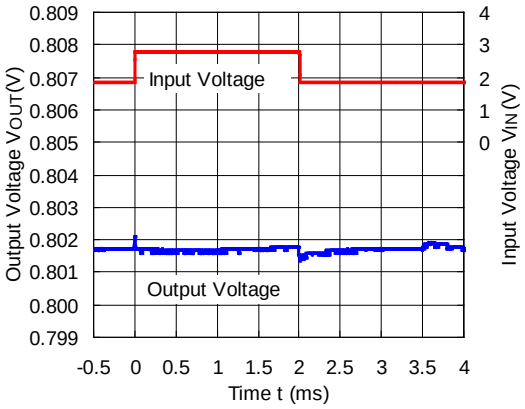
RP202x28xx
(Auto ECO Low Power Mode)
V_{IN}=3.8V⇔4.8V, I_{OUT}=1mA



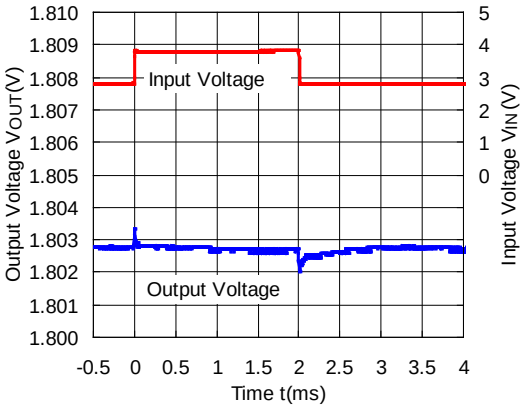
RP202x40xx
(Auto ECO Low Power Mode)
V_{IN}=5.0V⇔5.25V, I_{OUT}=1mA



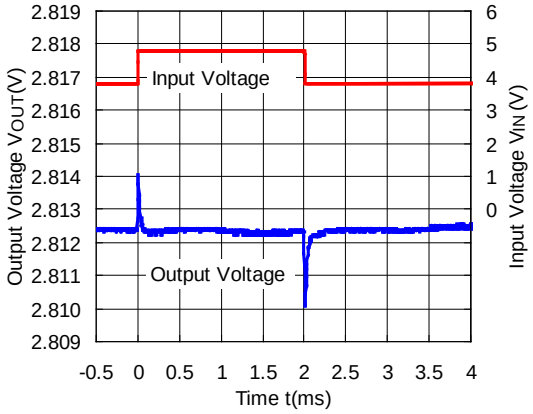
RP202x08xx
(Auto ECO FAST Mode)
V_{IN}=1.8V⇔2.8V, I_{OUT}=30mA



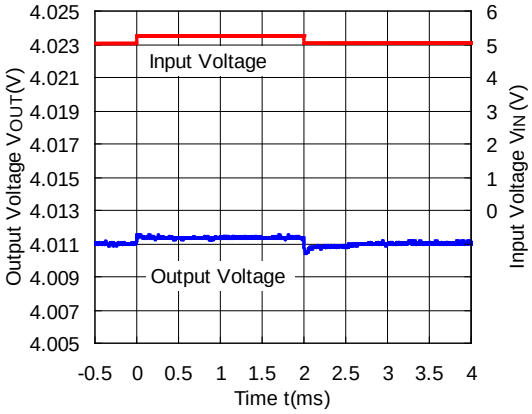
RP202x18xx
(Auto ECO FAST Mode)
V_{IN}=2.8V⇔3.8V, I_{OUT}=30mA



RP202x28xx
(Auto ECO FAST Mode)
V_{IN}=3.8V⇔4.8V, I_{OUT}=30mA

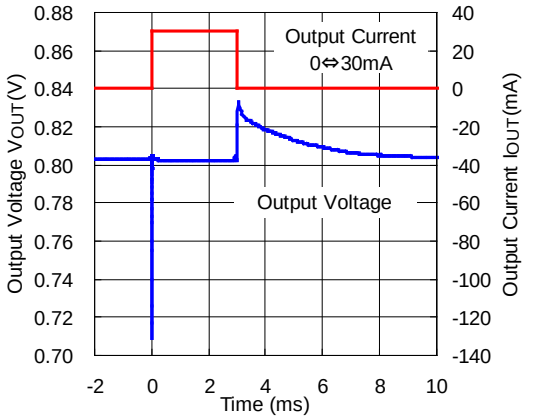


RP202x40xx
(Auto ECO FAST Mode)
V_{IN}=5.0V⇔5.25V, I_{OUT}=30mA

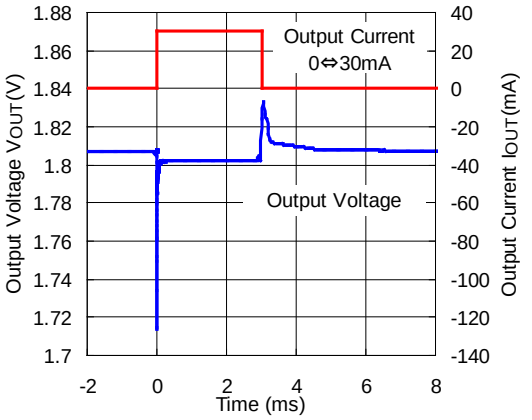


13) Load Transient Response (C1=0.47µF, C2=0.47µF, tr=tf=0.5µs, Ta=25°C)

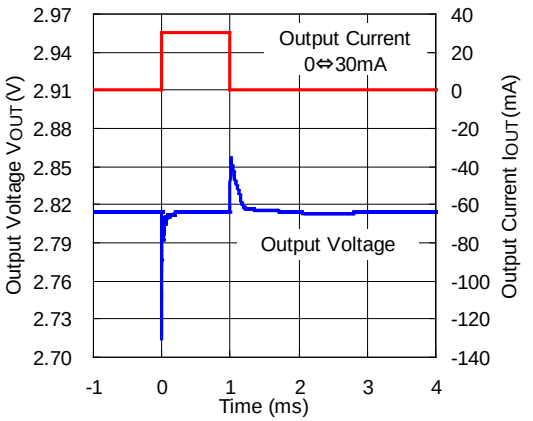
RP202x08xx
(Auto ECO Low Power Mode⇔FAST Mode)
V_{IN}=1.8V



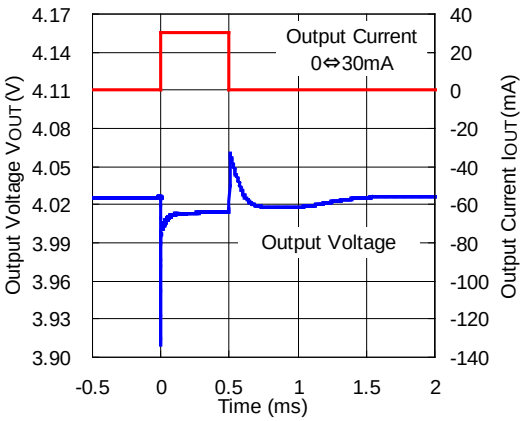
RP202x18xx
(Auto ECO Low Power Mode⇔FAST Mode)
V_{IN}=2.8V



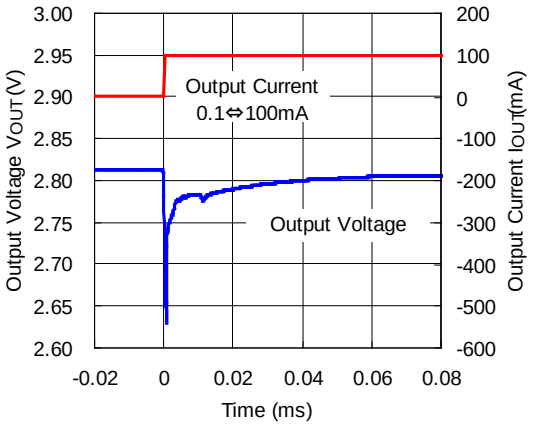
RP202x28xx
(Auto ECO Low Power Mode⇔FAST Mode)
V_{IN}=3.8V



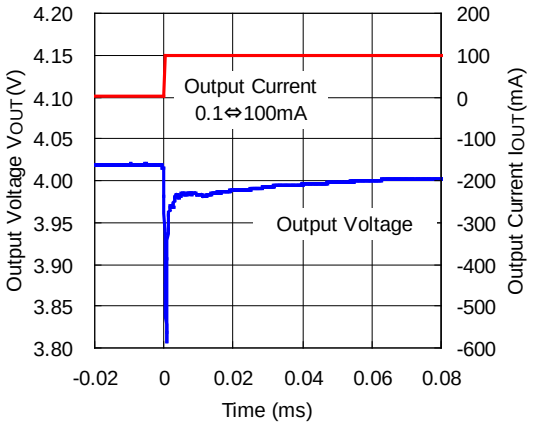
RP202x40xx
(Auto ECO Low Power Mode⇔FAST Mode)
V_{IN}=5.0V



RP202x28xx
(Auto ECO Low Power Mode⇔FAST Mode)
VIN=3.8V

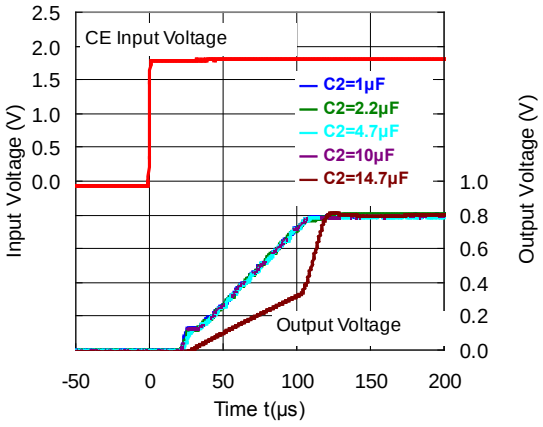


RP202x40xx
(Auto ECO Low Power Mode⇔FAST Mode)
VIN=5.0V

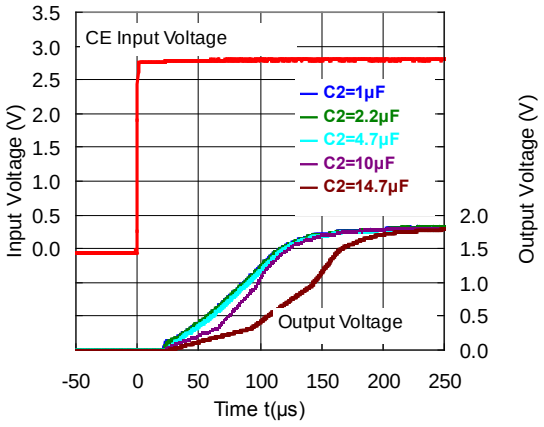


14) Turn On Waveform (Output Voltage) with CE pin (C1=0.47µF, Ta=25°C)

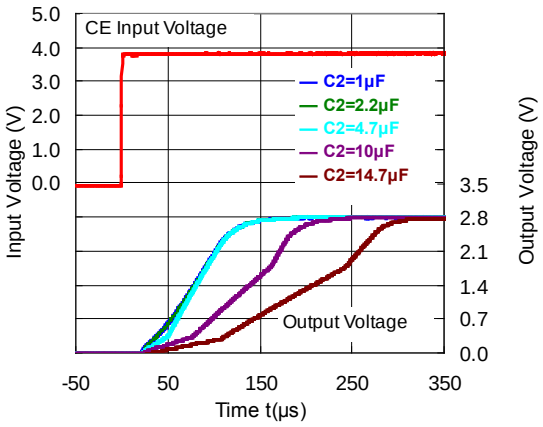
RP202x08xx
VIN=1.8V, IOUT=0mA



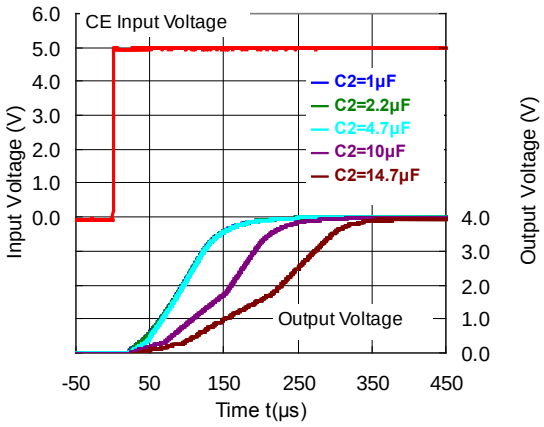
RP202x18xx
VIN=2.8V, IOUT=0mA



RP202x28xx
VIN=3.8V, IOUT=0mA

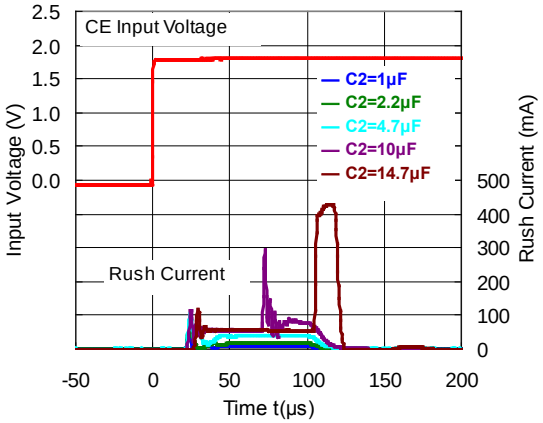


RP202x40xx
VIN=5.0V, IOUT=0mA

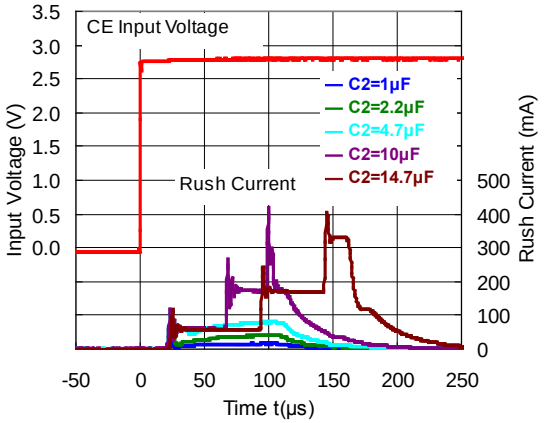


15) Turn On Input Waveform (Input Current) with CE pin (C1=0.47µF, Ta=25°C)

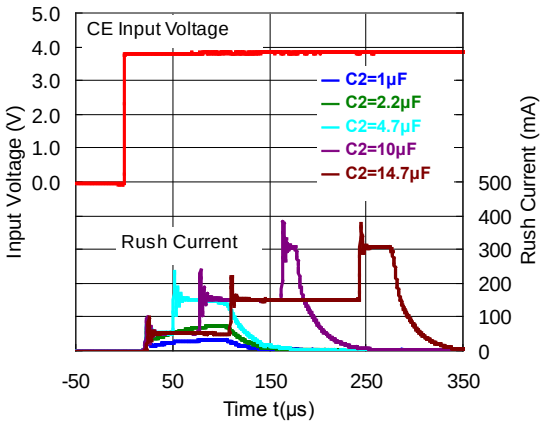
RP202x08xx — V_{IN}=1.8V, I_{OUT}=0mA



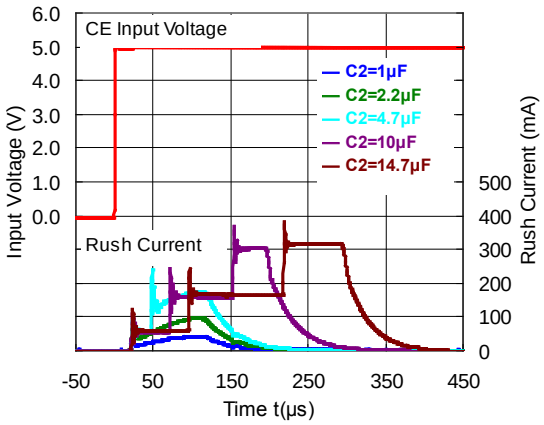
RP202x18xx — V_{IN}=2.8V, I_{OUT}=0mA



RP202x28xx — V_{IN}=3.8V, I_{OUT}=0mA

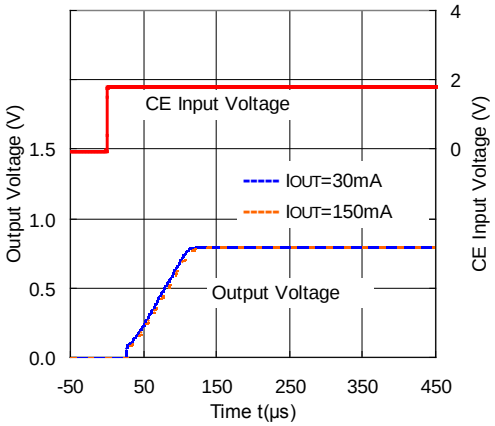


RP202x40xx — V_{IN}=5.0V, I_{OUT}=0mA

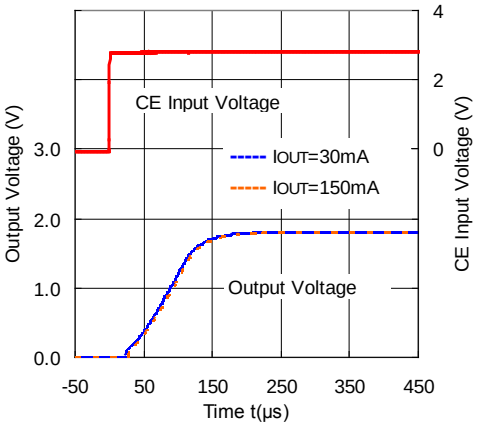


16) Turn On Speed with CE pin (D Version) (C1=0.47µF, C2=0.47µF, Ta=25°C)

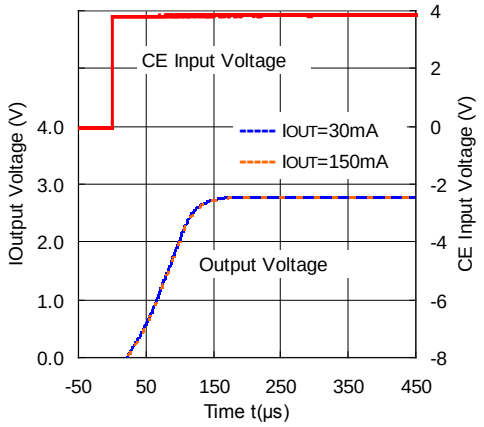
RP202x08xx — V_{IN}=1.8V



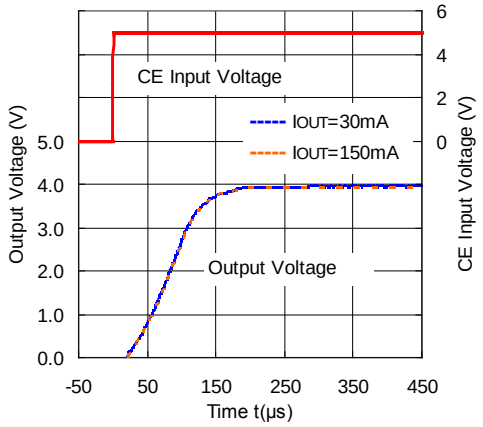
RP202x18xx — V_{IN}=2.8V



RP202x28xx **VIN=3.8V**

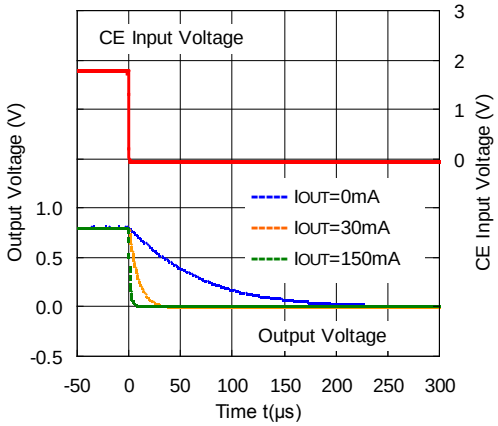


RP202x40xx **VIN=5.0V**

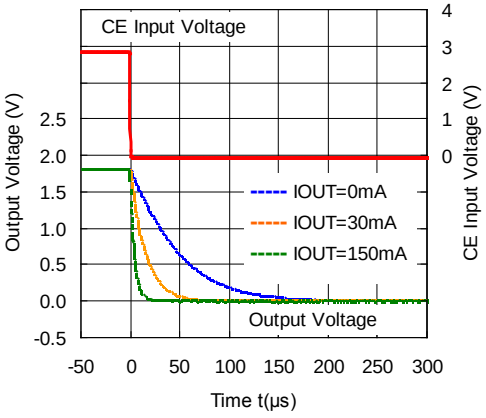


17) Turn Off Speed with CE pin (D Version)（C1=0.47µF, C2=0.47µF, Ta=25°C）

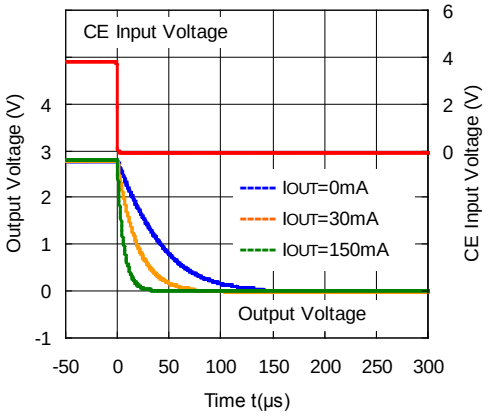
RP202x08xx **VIN=1.8V**



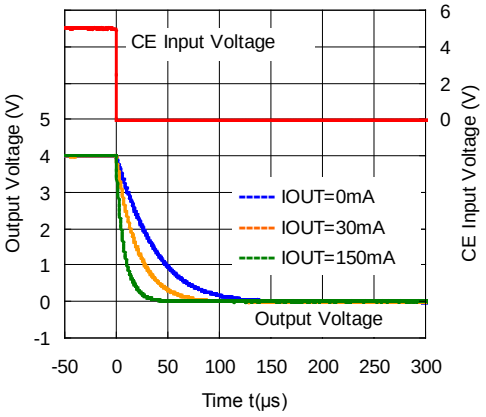
RP202x18xx **VIN=2.8V**



RP202x28xx **VIN=3.8V**



RP202x40xx **VIN=5.0V**



Ver. A

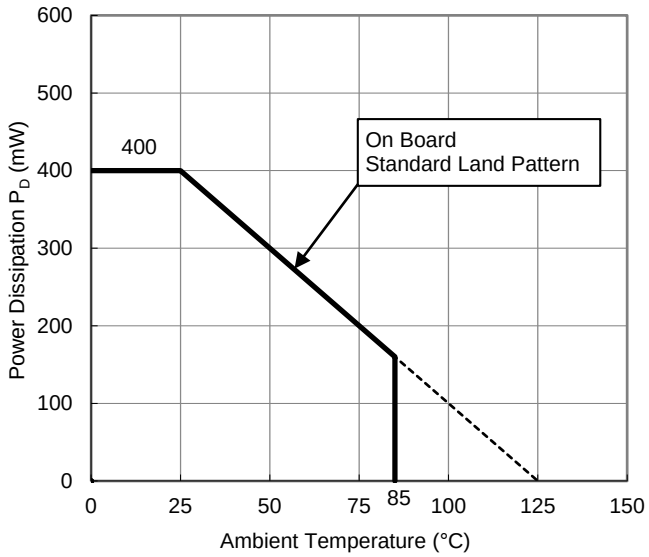
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

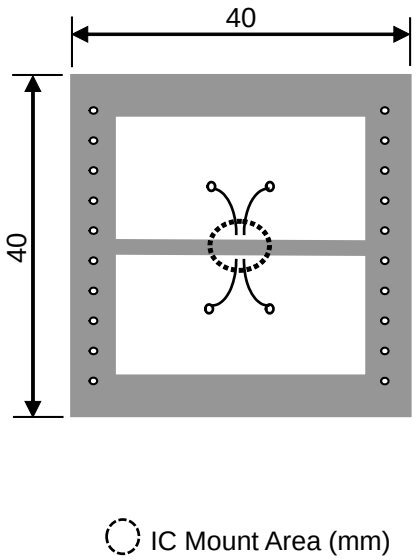
	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.54 mm × 24 pcs

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

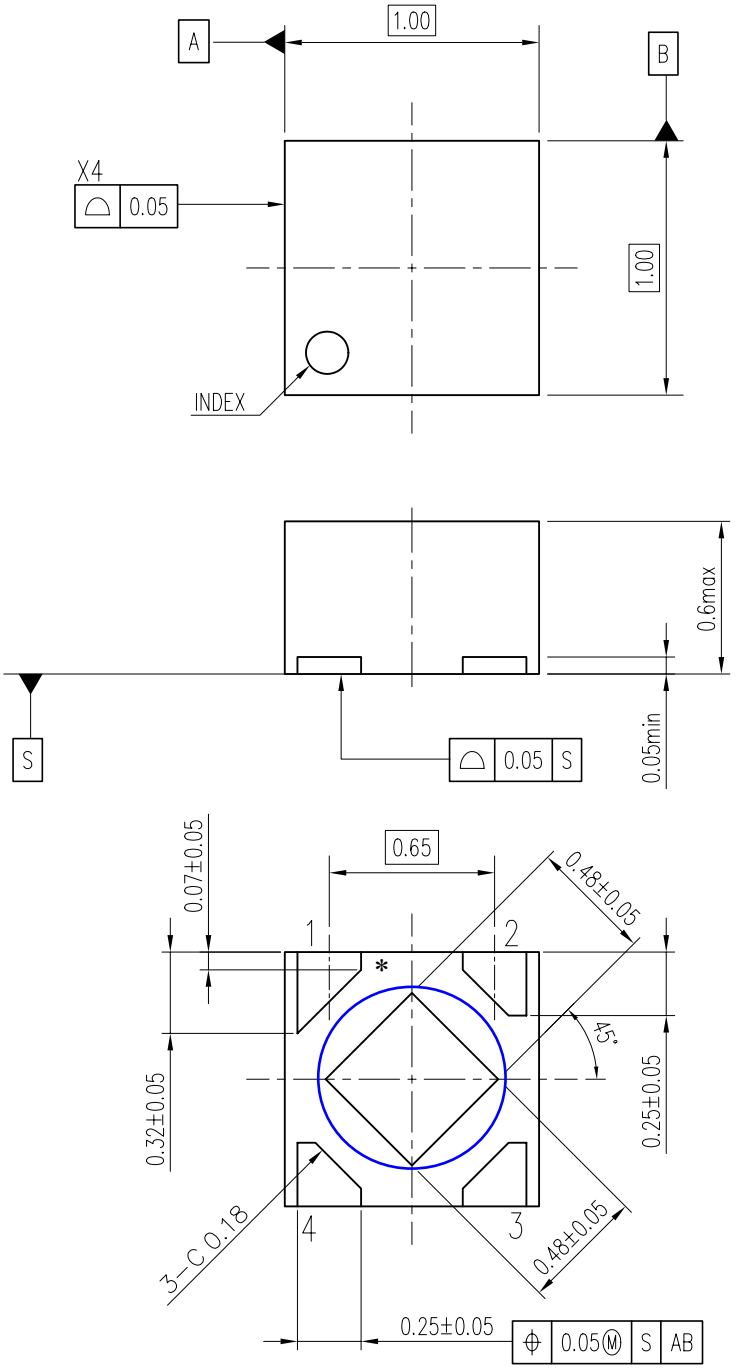
	Standard Test Land Pattern
Power Dissipation	400 mW
Thermal Resistance	θja = (125 − 25°C) / 0.4 W = 250°C/W
	θjc = 67°C/W



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



DFN(PL)1010-4 Package Dimensions (Unit: mm)

* The tab on the bottom of the package shown by blue circle is a substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

Ver. A

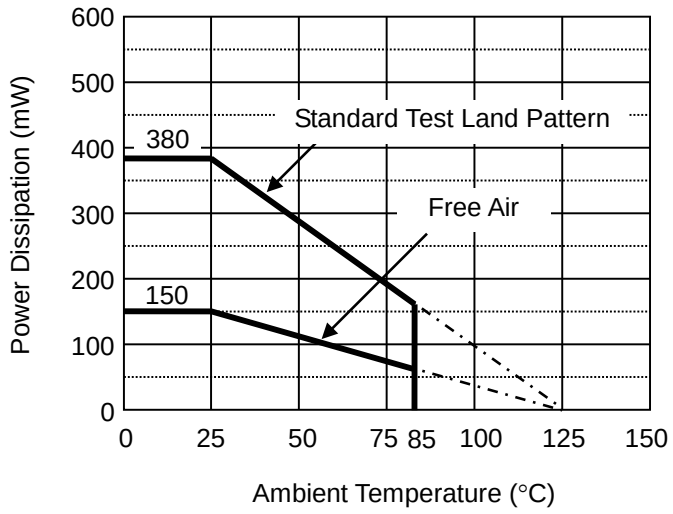
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

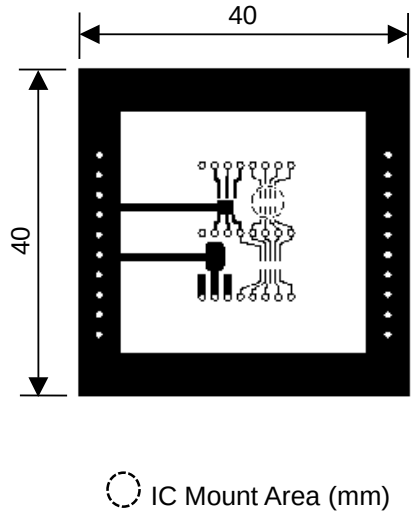
	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm × 40 mm × 1.6 mm
Copper Ratio	Top Side: Approx. 50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.5 mm × 44 pcs

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

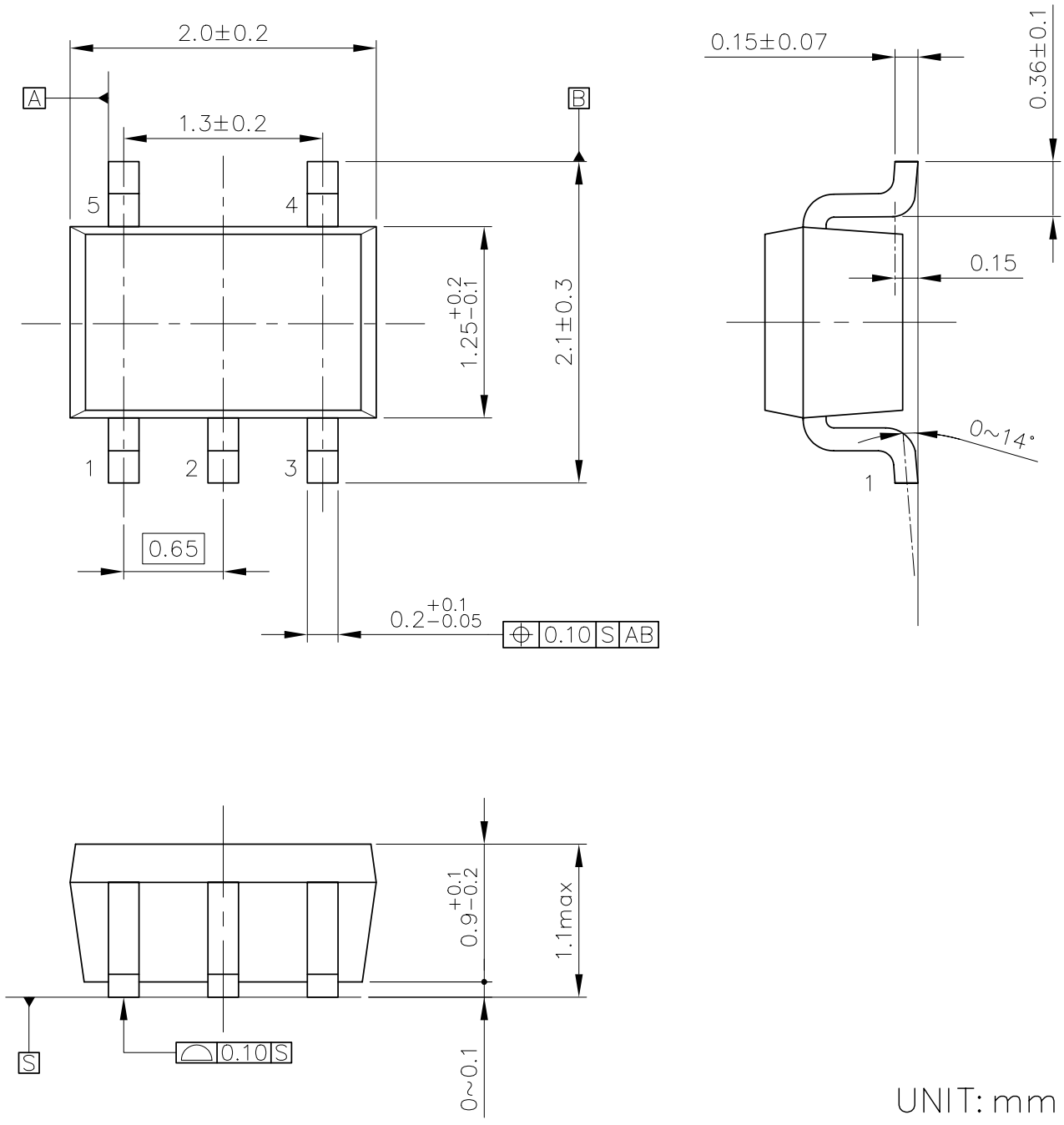
	Standard Test Land Pattern	Free Air
Power Dissipation	380 mW	150 mW
Thermal Resistance	θja = (125 − 25°C) / 0.38W = 263°C/W	θja = (125 − 25°C) / 0.15W = 667°C/W
	θja = 75°C/W	-



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



UNIT: mm

SC-88A Package Dimensions

Ver. A

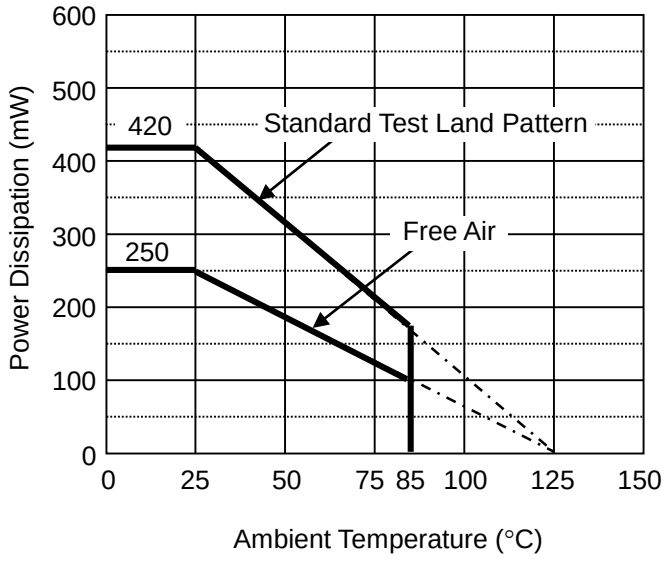
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

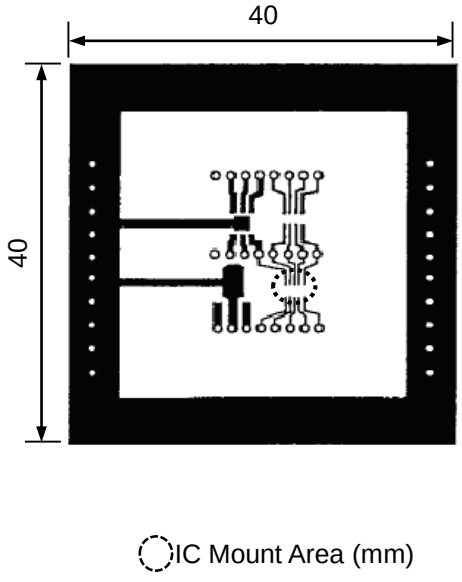
	Standard Test Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-Sided Board)
Board Dimensions	40 mm x 40 mm x 1.6 mm
Copper Ratio	Top Side: Approx.50% Bottom Side: Approx. 50%
Through-holes	ϕ 0.5 mm x 44 pcs

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

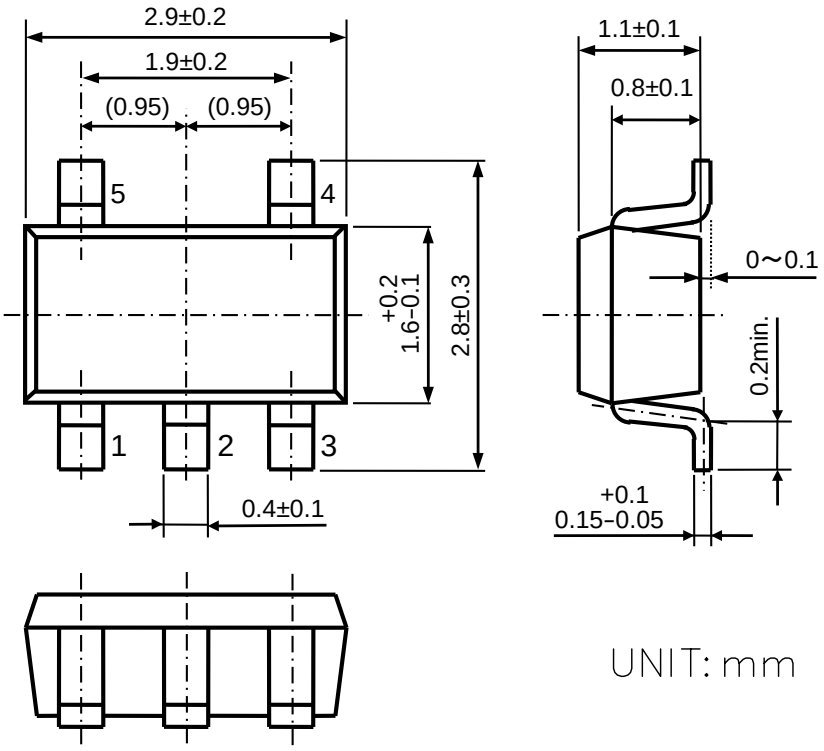
	Standard Test Land Pattern	Free Air
Power Dissipation	420 mW	250 mW
Thermal Resistance	θja = (125 − 25°C) / 0.42 W = 238°C/W	400°C/W



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



SOT-23-5 Package Dimensions

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