RICOH

RP132x Series

AEC-Q100 Compliant

Low on Resistance / Low Voltage 1 A LDO for Automotive Applications

NO.EC-265-190408

OUTLINE

The RP132x Series are voltage-regulators with a built-in low ON-resistance transistor and output current is 1A capability. These ICs have two versions: fixed output voltage type and externally adjustable output voltage type. The minimum output voltage can be set from 1.4V. Otherwise, the load regulation of RP132x has much improved when compared with conventional regulators. It's Typ.5mV at I_{OUT}=0.1mA to 1A.

Each of these ICs consists of a voltage reference unit, an error amplifier, a resistor net for setting output voltage, current limit circuits to prevent over-current and a thermal-shutdown circuit. A standby mode with ultra low supply current can be realized with the chip enable function.

The packages for these ICs are SOT-89-5, HSOP-6J and TO-252-5-P2. They range from high-density mounting to ultra high wattage.

FEATURES

- Input Voltage Range (Maximum Rating)..... 1.4V to 6.5V (7V)
- Operating Temperature Range ..... −40°C to 105°C
- Output Current ..... Min. 1A
- Supply Current ..... Typ. 65μA
- Standby Current ..... Typ. 0.15μA
- Output Voltage Range..... 0.8V, 1.05V, 1.2V, 1.5V, 1.8V, 2.5V, 3.0V, 3.3V, 5.0V
  *Contact Ricoh sales representatives for other voltages.
  Adjustable Output Voltage Type: 0.8V to 5.5V
- Dropout Voltage ..... Typ. 0.52V (V_{OUT}=3.0V, I_{OUT}=1A)
- Ripple Rejection..... Typ. 70dB (f=1kHz, V_{OUT}=3.0V)
- Output Voltage Accuracy..... ±1.0%
- Output Voltage Temperature-Drift Coefficient ..... Typ. ±60ppm/°C
- Line Regulation ..... Typ. 0.052%/V
- Load Regulation ..... Typ. 3mV at I_{OUT}=300mA, Typ. 5mV at I_{OUT}=1A
- Packages SOT-89-5, HSOP-6J, TO-252-5-P2
- Inrush Current Limit Circuit ..... Typ. 500mA
  B/D version: Inrush current limit time is 500μs.
- Fold-Back Protection Circuit ..... Typ. 250mA (Current at short mode)
- Thermal Shutdown Circuit ..... Thermal Shutdown Temperature: Typ. 165°C
  Released Temperature: Typ. 95°C
- Auto Discharge Function ..... D version
- Ceramic capacitors are recommended to be used with this IC .....2.2μF or more ($V_{OUT} \leq 3.6V$)
  4.7μF or more ($V_{OUT} > 3.6V$)

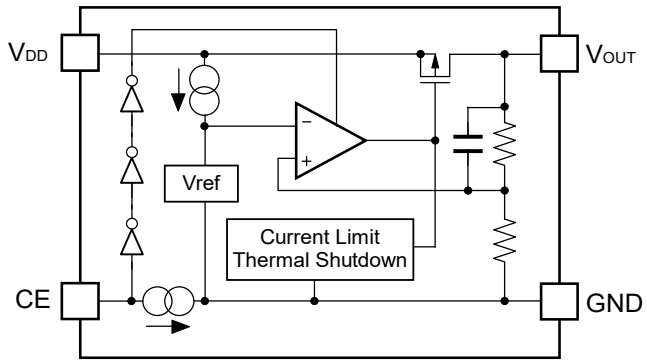
APPLICATIONS

- Power source for accessories such as car audios, car navigation systems, and ETC systems
- Power source for control units including EV inverter and charge control.

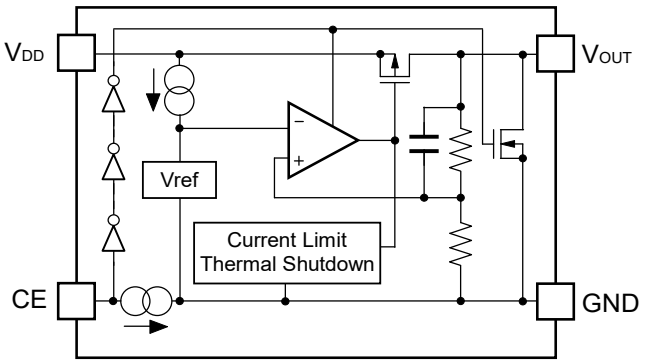
BLOCK DIAGRAMS

- **Fixed Output Voltage Type（HSOP-6J / SOT-89-5）**

RP132Sxx2B / RP132Hxx2B

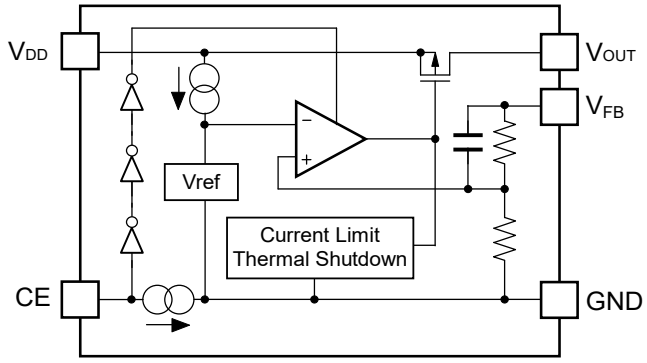


RP132Sxx2D / RP132Hxx2D

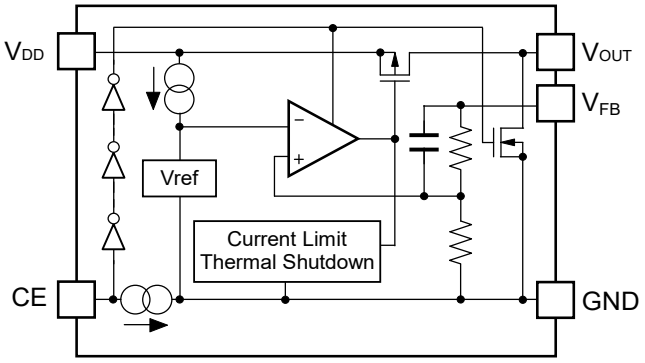


- **Fixed Output Voltage Type（TO-252-5-P2）**

RP132Jxx1B

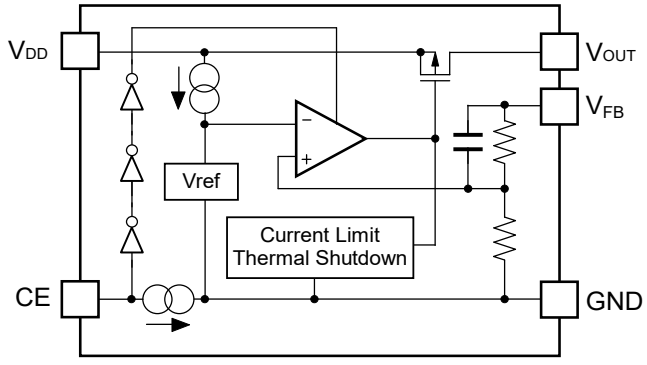


RP132Jxx1D

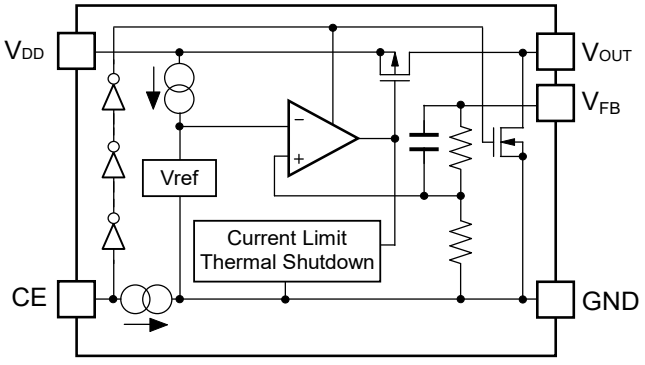


- **Adjustable Output Voltage Type（HSOP-6J / SOT-89-5 / TO-252-5-P2）**

RP132S001B / RP132H001B / RP132J001B



RP132S001D / RP132H001D / RP132J001D



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP132H001∗-T1-#E	SOT-89-5	1,000 pcs	Yes	Yes
RP132Hxx2∗-T1-#E				
RP132S001∗-E2-#E	HSOP-6J	1,000 pcs	Yes	Yes
RP132Sxx2∗-E2-#E				
RP132J001∗-T1-#E	TO-252-5-P2	3,000 pcs	Yes	Yes
RP132Jxx1∗-T1-#E				

RP132x001x is the adjustable output voltage type.
xx: Specify the set output voltage (V_{SET}) of the fixed output voltage type.
0.8V(08), 1.2V(12), 1.5V(15), 1.8V(18), 2.5V(25), 3.0V(30), 3.3V(33), 5.0V(50)
1.05V(RP132x10xx5)
*Contact Ricoh sales representatives for other voltages.

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

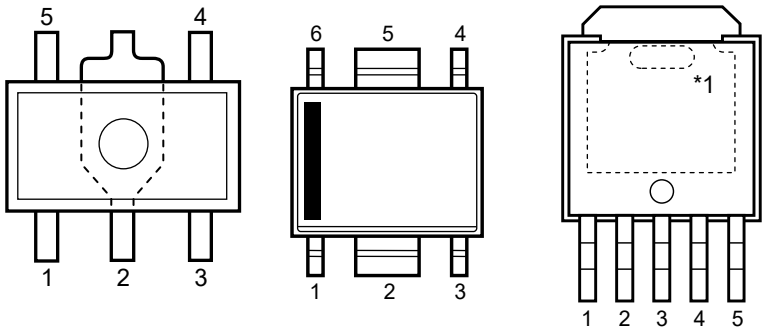
: Specify Automotive Class Code

	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 105°C	25°C	High Temperature
J	-40°C to 105°C	-40°C to 105°C	High and Low Temperature

* 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

● **SOT-89-5** ● **HSOP-6J** ● **TO-252-5-P2**



● **SOT-89-5**

Pin No.	Symbol	Pin Description
1	CE	Chip Enable Pin ("H" Active) (RP132Hxx2B/D)
	V_{FB}	Feed Back Pin (RP132H001B/D)
2	GND	Ground Pin
3	GND	Ground Pin (RP132Hxx2B/D)
	CE	Chip Enable Pin ("H" Active) (RP132H001B/D)
4	V_{DD}	Input Pin
5	V_{OUT}	Output Pin

When using Fixed Output Voltage Type (RP132Hxx2x), No.2 pin and No. 3 pin must be wired each other when mounted on boards. When using Adjstable Output Voltage Type (RP132H001x), please follow "Notes on Adjustable Output Voltage Type Settings".

● **HSOP-6J**

Pin No.	Symbol	Pin Description
1	V_{OUT}	Output Pin
2	GND	Ground Pin
3	GND	Ground Pin (RP132Sxx2B/D)
	V_{FB}	Feed Back Pin (RP132S001B/D)
4	CE	Chip Enable Pin ("H" Active)
5	GND	Ground Pin
6	V_{DD}	Input Pin

When using Fixed Output Voltage Type (RP132Hxx2x),No.2 pin, No. 3 pin, and No.5 pin must be wired each other when mounted on boards. When using Adjstable Output Voltage Type (RP132S001x), please follow "Notes on Adjustable Output Voltage Type Settings".

- **TO-252-5-P2**

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

*1 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.
When using Fixed Output Voltage Type(RP132Jxx1x),V_{OUT} pin and V_{FB} pin should be connected. When using Adjstable Output Voltage Type (RP132J001x), please follow "Notes on the Adjustable Output Voltage Type Settings".

ABSOLUTE MAXIMUM RATINGS

Symbol	Item			Rating	Unit
V_{IN}	Input Voltage			7.0	V
V_{CE}	Input Voltage (CE Pin)			−0.3 to 7.0	V
V_{FB}	Input Voltage (V_{FB} Pin)			−0.3 to 7.0	V
V_{OUT}	Output Voltage			−0.3 to V_{IN}+0.3	V
P_D	Power Dissipation*	SOT-89-5	JEDEC STD. 51	3200	mV
		HSOP-6J	JEDEC STD. 51	3400	
		TO-252-5-P2	JEDEC STD. 51	4800	
Tj	Junction Temperature			−40 to 150	°C
Tstg	Storage Temperature Range			−55 to 150	°C

∗) Refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

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

RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	1.4 to 6.5	V
Ta	Operating Temperature Range	−40 to 105	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such 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}+1.0V, I_{OUT}=1mA, C_{IN}=2.2μF, C_{OUT}=2.2μF(V_{SET} ≤ 3.6V), 4.7μF(V_{SET} > 3.6V), unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

- **RP132xxxxB/D (-AE) (Fixed Output Voltage Type)** (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 ≤ 105°C	V_{OUT} > 1.5V	☐×0.981		☐×1.019	V
			V_{OUT} ≤ 1.5V	☐−29		☐29	mV
I_{LIM}	Output Current Limit			☐1			A
ΔV_{OUT}/ ΔI_{OUT}	Load Regulation	0.1mA ≤ I_{OUT} ≤ 300mA			3	☐20	mV
		0.1mA ≤ I_{OUT} ≤ 1A			5	☐60	
V_{DIF}	Dropout Voltage	Refer to the *Product-specific Electrical Characteristics*					
I_{SS}	Supply Current	I_{OUT}=0mA (V_{IN}=6.5V)			65	☐85	μA
Istandby	Standby Current	V_{CE}=0V, V_{IN}=6.5V			0.15	0.60	μA
ΔV_{OUT}/ ΔV_{IN}	Line Regulation	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 6.5V ∗ However, V_{IN} ≥1.6V			0.05	☐0.10	%/V
I_{SC}	Short Current Limit	V_{OUT}=0V			250		mA
I_{PD}	CE Pull-down Current				0.3	☐0.7	μA
V_{CEH}	CE Input Voltage "H"			☐1.0			V
V_{CEL}	CE Input Voltage "L"					☐0.4	V
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			95		°C
R_{LOW}	Low Output Nch Tr. ON Resistance (D version)	V_{IN}=4.0V, V_{CE}=0V			50		Ω

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj≈Ta=25ºC) except for Dropout Voltage and Load Regulation at 1A Output Current.

The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

RP132xxxxB/D (-AE) (Fixed Output Voltage Type) Product-specific Electrical Characteristics (Ta = 25°C)

Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = -40 to 105°C)			V_{DIF} [V] (Iout = 300 mA)		V_{DIF} [V] (Iout = 1 A)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.
RP132x08xx	0.785	0.800	0.815	0.771	0.800	0.829	0.67	0.89	1.20	1.54
RP132x12xx	1.185	1.200	1.215	1.171	1.200	1.229	0.36	0.54	0.90	1.23
RP132x15xx	1.485	1.500	1.515	1.471	1.500	1.529				
RP132x18xx	1.782	1.800	1.818	1.766	1.800	1.834	0.24	0.33	0.78	1.05
RP132x25xx	2.475	2.500	2.525	2.453	2.500	2.548				
RP132x30xx	2.970	3.000	3.030	2.943	3.000	3.057	0.15	0.21	0.52	0.72
RP132x33xx	3.267	3.300	3.333	3.237	3.300	3.363	0.13	0.18	0.46	0.68
RP132x50xx	4.950	5.000	5.050	4.905	5.000	5.095				
RP132x10xx5	1.035	1.050	1.065	1.021	1.050	1.079	0.51	0.73	1.05	1.39

V_{IN}= V_{SET} +1.0V, I_{OUT}=1mA, C_{IN}=2.2μF, C_{OUT}=2.2μF(V_{OUT} ≤ 3.6V), 4.7μF(V_{OUT} > 3.6V), unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

- **RP132x001B/D (-AE) (Adjustable Output Voltage Type)** (Ta=25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{FB}	Feedback Voltage	Ta=25°C	$V_{OUT}=V_{FB}$	0.785	0.800	0.815	V
		−40°C ≤ Ta ≤ 105°C		[0.771]		[0.829]	
V_{OUT}	Output Voltage Adjusting Range			0.8		5.5	V
I_{LIM}	Output Current Limit	$V_{OUT}=V_{FB}$		[1]			A
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	0.1mA ≤ I_{OUT} ≤ 300mA			3	[20]	mV
		0.1mA ≤ I_{OUT} ≤ 1A			5	[60]	
V_{DIF}	Dropout Voltage	$V_{OUT}=V_{FB}$	I_{OUT}=300mA		0.67	[0.89]	V
			I_{OUT}=1A		1.20	[1.54]	
I_{SS}	Supply Current	$V_{OUT}=V_{FB}$, I_{OUT}=0mA (V_{IN}=6.5V)			65	[85]	μA
Istandby	Standby Current	V_{CE}=0V, V_{IN}=6.5V			0.15	0.60	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{OUT}=V_{FB}$, 1.6V ≤ V_{IN} ≤ 6.5V			0.05	[0.10]	%/V
I_{SC}	Short Current Limit	$V_{OUT}=V_{FB}$=0V			250		mA
I_{PD}	CE Pull-down Current				0.3	[0.7]	μA
V_{CEH}	CE Input Voltage "H"			[1.0]			V
V_{CEL}	CE Input Voltage "L"					[0.4]	V
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			95		°C
R_{LOW}	Low Output Nch Tr. ON Resistance (D version)	V_{IN}=4.0V, V_{CE}=0V			50		Ω

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj≈Ta=25°C) except for Dropout Voltage and Load Regulation at 1A Output Current.

V_{IN}= V_{SET} +1.0V, I_{OUT}=1mA, C_{IN}=2.2μF, C_{OUT}=2.2μF(V_{OUT} ≤ 3.6V), 4.7μF(V_{OUT} > 3.6V), unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

- **RP132xxxxB/D (-JE) (Fixed Output Voltage Type)** (-40°C ≤ Ta ≤ 105°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Ta=25°C	V_{SET} > 1.5V	×0.99		×1.01	V
			V_{SET} ≤ 1.5V	−15		15	mV
		−40°C ≤ Ta ≤ 105°C	V_{SET} > 1.5V	×0.981		×1.019	V
			V_{SET} ≤ 1.5V	−29		29	mV
I_{LIM}	Output Current Limit			1			A
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1mA ≤ I_{OUT} ≤ 300mA			3	20	mV
		0.1mA ≤ I_{OUT} ≤ 1A			5	[60]	
V_{DIF}	Dropout Voltage	Refer to the *Product-specific Electrical Characteristics*					
I_{SS}	Supply Current	I_{OUT}=0mA (V_{IN}=6.5V)			65	85	μA
$I_{standby}$	Standby Current	V_{CE}=0V, V_{IN}=6.5V	Ta=25°C		0.15	0.6	μA
			−40°C ≤ Ta ≤ 105°C			4.0	μA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET}+0.5V ≤ V_{IN} ≤ 6.5V, ∗ However, V_{IN} ≥ 1.6V			0.05	0.10	%/V
I_{SC}	Short Current Limit	V_{OUT}=0V			250		mA
I_{PD}	CE Pull-down Current				0.3	0.7	μA
V_{CEH}	CE Input Voltage "H"			1.0			V
V_{CEL}	CE Input Voltage "L"					0.4	V
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			95		°C
R_{LOW}	Low Output Nch Tr. ON Resistance (D version)	V_{IN}=4.0V, V_{CE}=0V			50		Ω

All test items listed under Electrical Characteristics are done except for Dropout Voltage and Load Regulation at 1A Output Current.

The specifications surrounded by ☐ are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

RP132xxxxB/D (-JE) (Fixed Output Voltage Type) Product-specific Electrical Characteristics (-40°C ≤ Ta ≤ 105°C)

Product Name	V_{OUT} [V] (Ta = 25°C)			V_{OUT} [V] (Ta = -40 to 105°C)			V_{DIF} [V] (Iout = 300 mA)		V_{DIF} [V] (Iout = 1 A)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.	TYP.	MAX.
RP132x08xx	0.785	0.800	0.815	0.771	0.800	0.829	0.67	0.89	1.20	1.54
RP132x12xx	1.185	1.200	1.215	1.171	1.200	1.229	0.36	0.54	0.90	1.23
RP132x15xx	1.485	1.500	1.515	1.471	1.500	1.529				
RP132x18xx	1.782	1.800	1.818	1.766	1.800	1.834	0.24	0.33	0.78	1.05
RP132x25xx	2.475	2.500	2.525	2.453	2.500	2.548				
RP132x30xx	2.970	3.000	3.030	2.943	3.000	3.057	0.15	0.21	0.52	0.72
RP132x33xx	3.267	3.300	3.333	3.237	3.300	3.363	0.13	0.18	0.46	0.68
RP132x50xx	4.950	5.000	5.050	4.905	5.000	5.095				
RP132x10xx5	1.035	1.050	1.065	1.021	1.050	1.079	0.51	0.73	1.05	1.39

V_{IN}= V_{SET} +1.0V, I_{OUT}=1mA, C_{IN}=2.2μF, C_{OUT}=2.2μF(V_{OUT} ≤ 3.6V), 4.7μF(V_{OUT} > 3.6V), unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

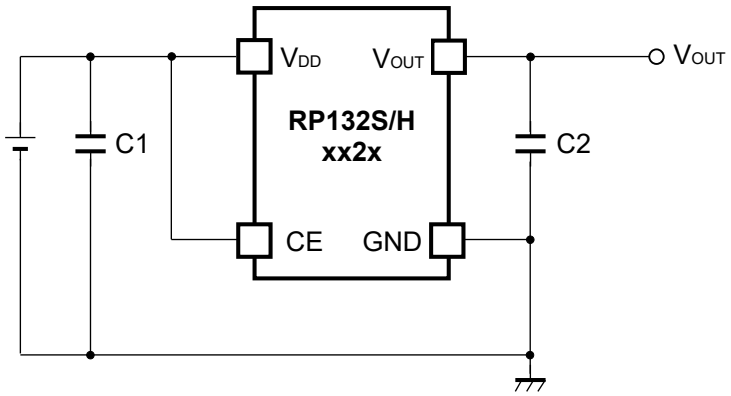
- **RP132x001B/D (-JE) (Adjustable Output Voltage Type)** (-40°C ≤ Ta ≤ 105°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{FB}	Feedback Voltage	Ta=25°C	V_{OUT}=V_{FB}	0.785	0.800	0.815	V
		−40°C ≤ Ta ≤ 105°C		0.771		0.829	
V_{OUT}	Output Voltage Adjusting Range			0.8		5.5	V
I_{LIM}	Output Current Limit	V_{OUT}=V_{FB}		1			A
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1mA ≤ I_{OUT} ≤ 300mA			3	20	mV
		0.1mA ≤ I_{OUT} ≤ 1A			5	[60]	
V_{DIF}	Dropout Voltage	V_{OUT}=V_{FB}	I_{OUT}=300mA		0.67	0.89	V
			I_{OUT}=1A		1.20	[1.54]	
I_{SS}	Supply Current	V_{OUT}=V_{FB}, I_{OUT}=0mA (V_{IN}=6.5V)			65	85	μA
$I_{standby}$	Standby Current	V_{CE}=0V, V_{IN}=6.5V	Ta=25°C		0.15	0.6	μA
			−40°C ≤ Ta ≤ 105°C			4.0	μA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{OUT}=V_{FB}, 1.6V ≤ V_{IN} ≤ 6.5V			0.05	0.10	%/V
I_{SC}	Short Current Limit	V_{OUT}=V_{FB}=0V			250		mA
I_{PD}	CE Pull-down Current				0.3	0.7	μA
V_{CEH}	CE Input Voltage "H"			1.0			V
V_{CEL}	CE Input Voltage "L"					0.4	V
T_{TSD}	Thermal Shutdown Detection Temperature	Junction Temperature			165		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			95		°C
R_{LOW}	Low Output Nch Tr. ON Resistance (D version)	V_{IN}=4.0V, V_{CE}=0V			50		Ω

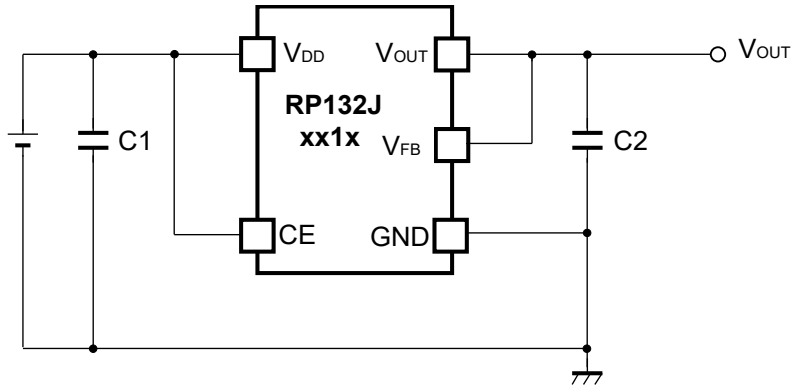
All test items listed under Electrical Characteristics are done except for Dropout Voltage and Load Regulation at 1A Output Current.

TYPICAL APPLICATION

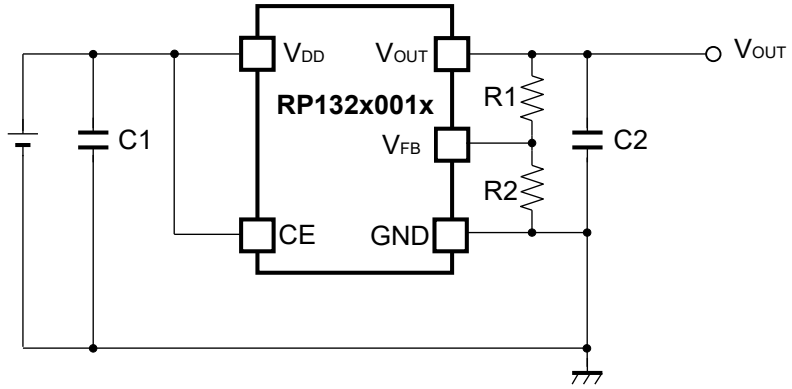
Fixed Output Voltage Type (HSOP-6J/ SOT-89-5)



Fixed Output Voltage Type (TO-252-5-P2)



Adjustable Output Voltage Type (HSOP-6J / SOT-89-5/ TO-252-5-P2）



TECHNICAL NOTES

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 good frequency characteristics and ESR (Equivalent Series Resistance).

If a tantalum capacitor is used, and its ESR of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

Recommended value of the external capacitors

V_{OUT}	Capacitors	
$V_{SET} \leq 3.6V$	C1	2.2μF
	C2	2.2μF
$V_{SET} > 3.6V$	C1	2.2μF
	C2	4.7μF

Please refer to "Technical Notes on Adjustable Output Voltage Type" when using R1 and R2 as output capacitors.

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 between V_{DD} and GND pin with a capacitance value as "Recommendation value of the external capacitors" above or more, and as close as possible to the pins.

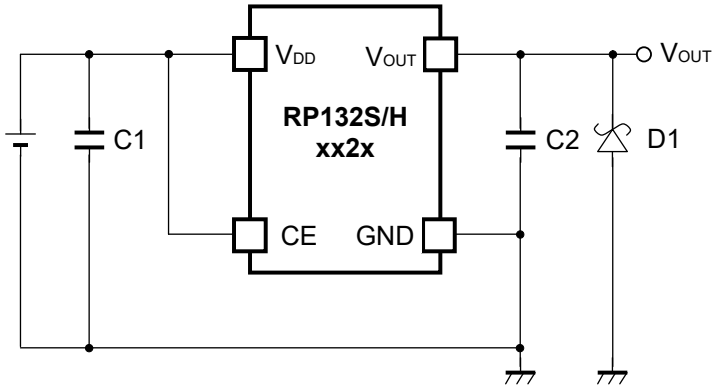
Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

Transient Response

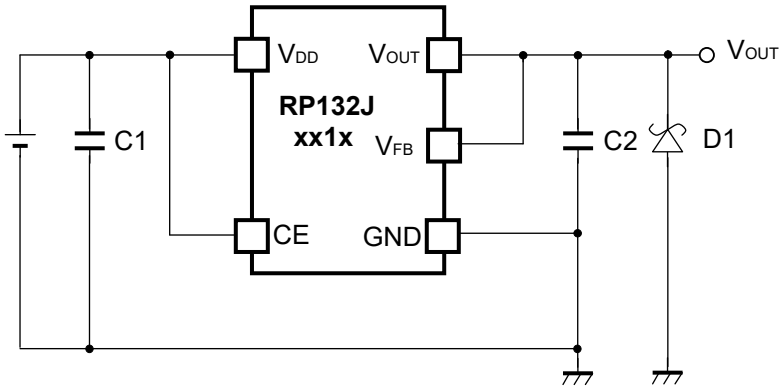
When using the Adjustable Output Voltage Type, the transient response could be affected by the external resistors. Evaluate the circuit taking the actual conditions of use into account.

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION

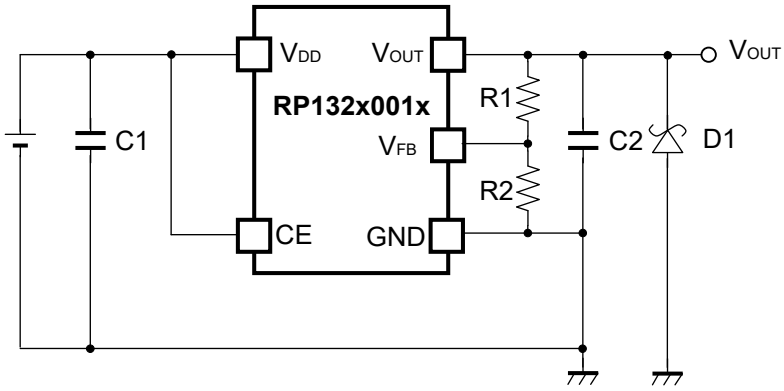
Fixed Output Voltage Type (HSOP-6J / SOT-89-5)



Fixed Output Voltage Type (TO-252-5-P2)



Adjustable Output Voltage Type (HSOP-6J / SOT-89-5/ TO-252-5-P2)



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.

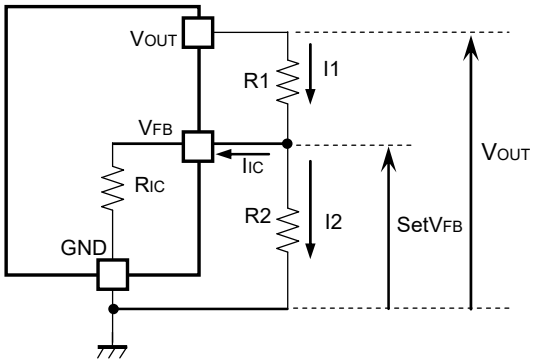
ADJUSTABLE OUTPUT VOLTAGE TYPE SETTINGS

Output Voltage Setting Method

Adjustable Output Voltage Type can be adjusted the output voltage up to 5.5V by using the external divider resistors. Also, please use 16kΩ or less for R2 resistor.

If the V_{FB} voltage is described as $setV_{FB}$, the output voltage can be set by using the following equations

$SetV_{FB}$ is equal to 0.8V. The V_{OUT} pin of Adjustable Output Voltage Type should be connected to the V_{FB} pin.



$$I1 = I_{IC} + I2 \quad \cdots (1)$$

$$I2 = setV_{FB} / R2 \quad \cdots (2)$$

Thus,

$$I1 = I_{IC} + setV_{FB} / R2 \quad \cdots (3)$$

Therefore,

$$V_{OUT} = setV_{FB} \times R1 \times I1 \quad \cdots (4)$$

Put Equation (3) into Equation (4), then

$$V_{OUT} = setV_{FB} + R1 (I_{IC} + setV_{FB} / R2)$$

$$= setV_{FB} \times (1+R1/ R2) + R1 \times I_{IC} \quad \cdots (5)$$

In Equation (5), R1x I_{IC} is the error-causing factor in V_{OUT}.

As for I_{IC},

$$I_{IC} = setV_{FB} / R_{IC} \quad \cdots (6)$$

Therefore, the error-causing factor R1x I_{IC} can be described as follows.

$$R1 \times I_{IC} = R1 \times setV_{FB} / R_{IC}$$

$$= setV_{FB} \times R1 / R_{IC} \quad \cdots (7)$$

For better accuracy, choosing R1 ($<<R_{IC}$) reduces this error.

Without the error-causing factor R1x I_{IC}, the output voltage can be calculated by the following equation

$$V_{OUT} = setV_{FB} \times ((R1 + R2) / R2) \quad \cdots (8)$$

R_{IC} of RP132x is approximately Typ.1.3MΩ (Ta=25°C, this value is guaranteed by design).

The value could be affected by the temperature, therefore evaluate the circuit taking the actual conditions of use into account.

INRUSH CURRENT LIMIT TIME SETTINGS

The RP132x Series include the circuit which can limit the inrush current at start-up to 500mA or less. The current limit time of B/D version is fixed internally as approximately Typ.500μs.

Please note that during the inrush current limit time, the load current cannot be more than the limited current.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-89-5)

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

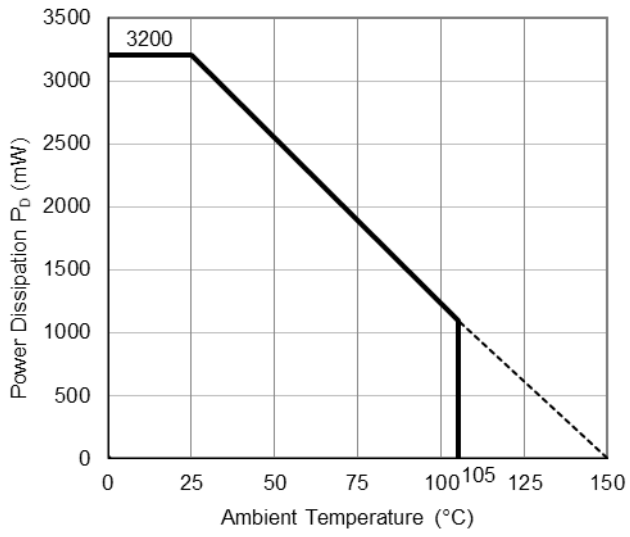
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 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 = 150°C)

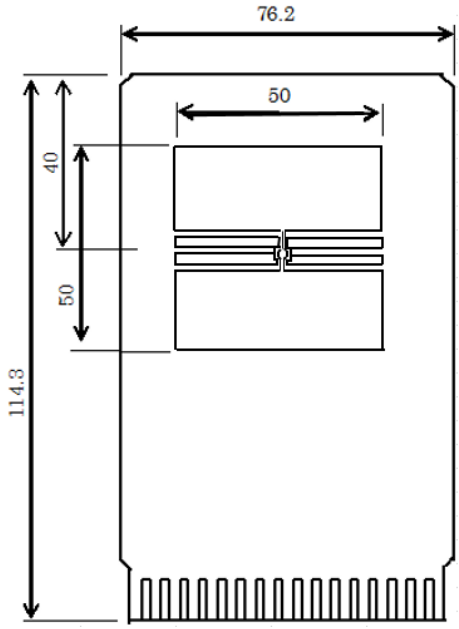
Item	Measurement Result
Power Dissipation	3200 mW
Thermal Resistance (θja)	θja = 38°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 13°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

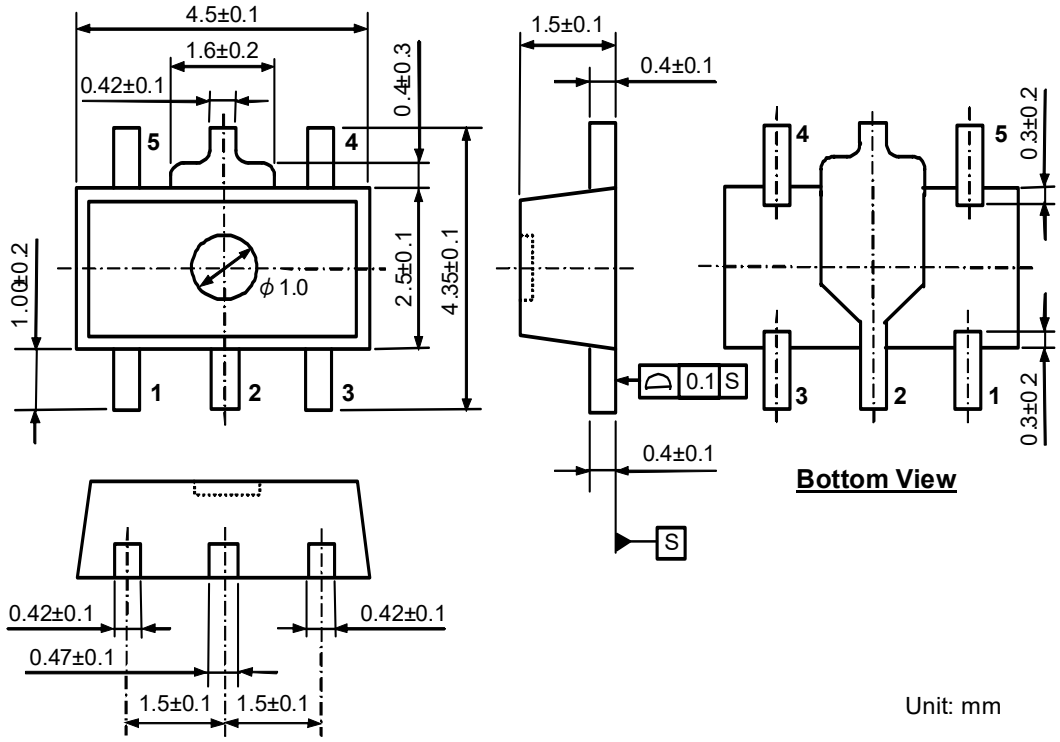


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (SOT-89-5)



SOT-89-5 Package Dimensions

POWER DISSIPATION (HSOP-6J)

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

Measurement Conditions

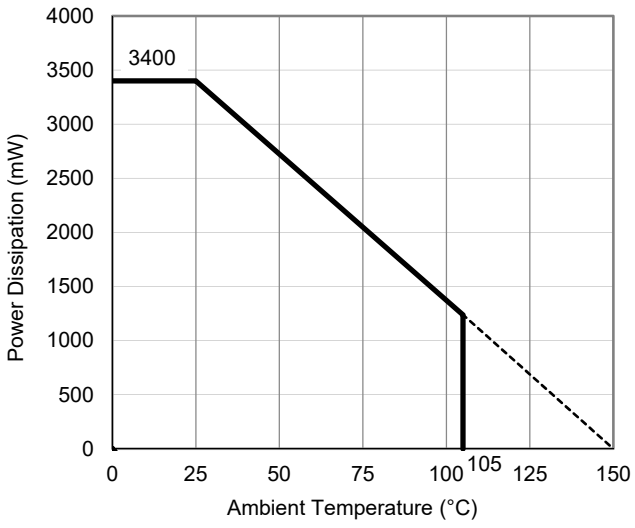
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 28 pcs

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

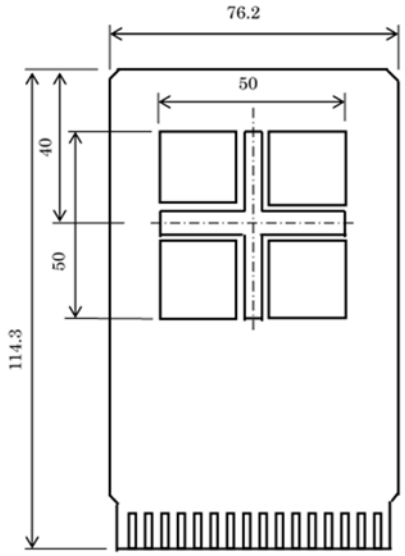
Item	Measurement Result
Power Dissipation	3400 mW
Thermal Resistance (θja)	θja = 37°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 7°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

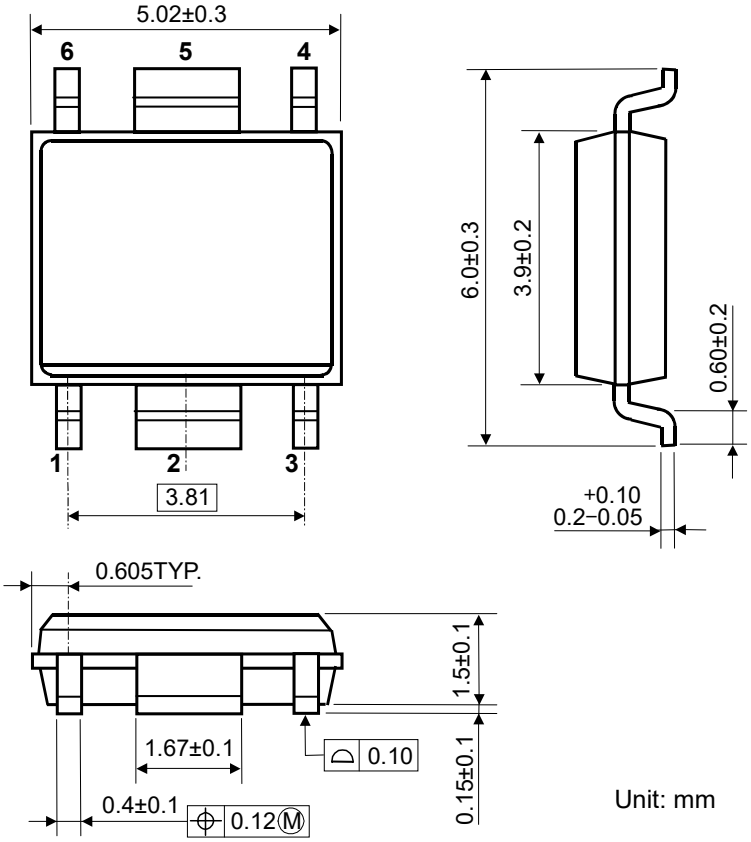


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (HSOP-6J)



HSOP-6J Package Dimensions

POWER DISSIPATION (TO-252-5-P2)

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

Measurement Conditions

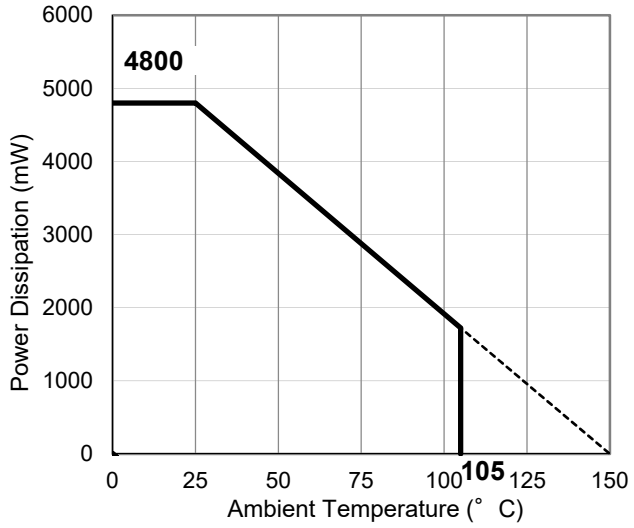
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square
Through-holes	ϕ 0.3 mm × 21 pcs

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

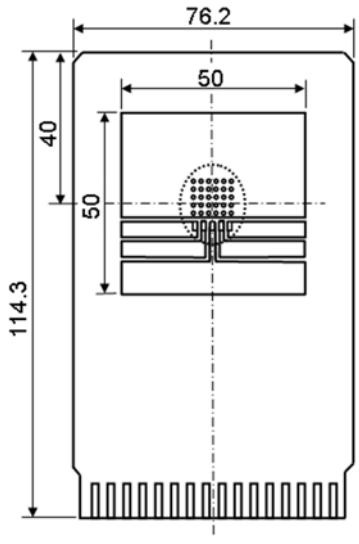
Item	Measurement Result
Power Dissipation	4800 mW
Thermal Resistance (θja)	θja = 26°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 7°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

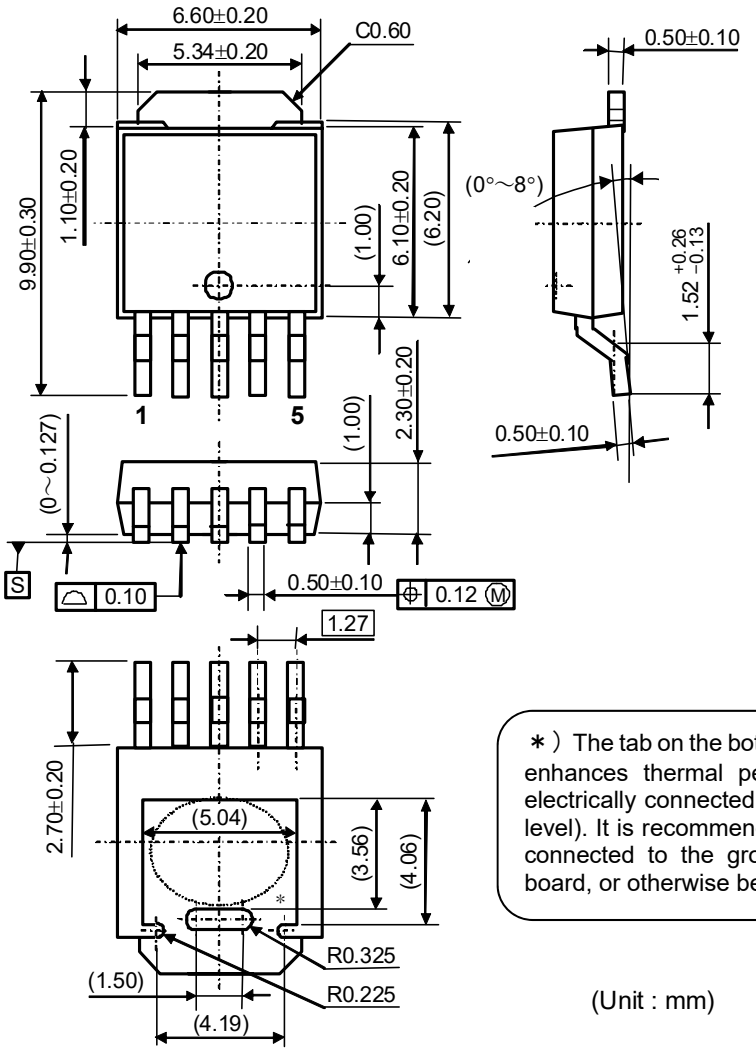


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (TO-252-5-P2)



＊）The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

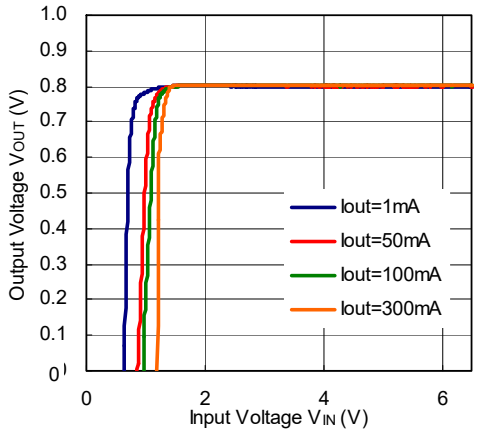
(Unit : mm)

TYPICAL CHARACTERISTICS

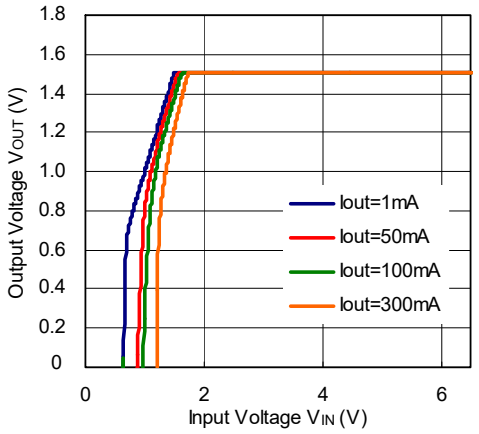
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

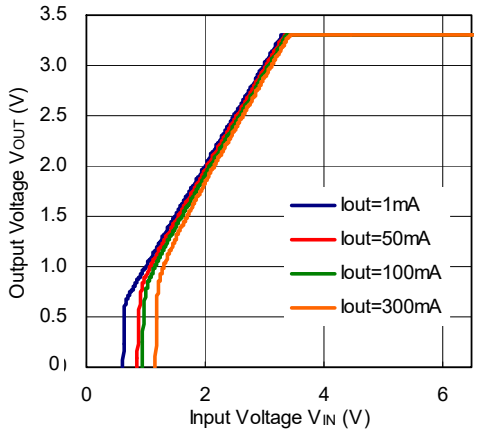
RP132x08xx



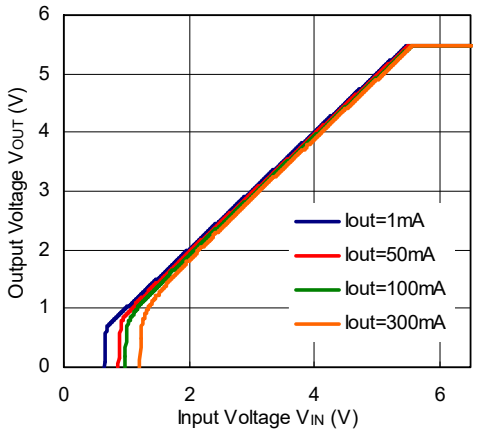
RP132x15xx



RP132x33xx

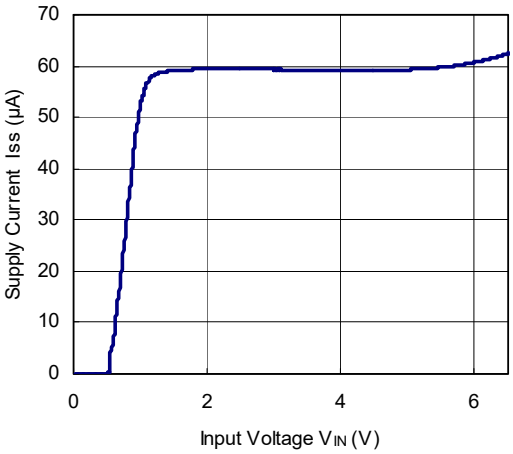


RP132x55xx

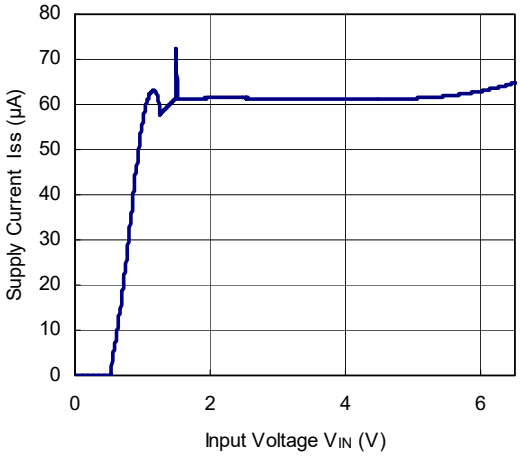


2) Supply Current vs. Input Voltage (Ta=25°C)

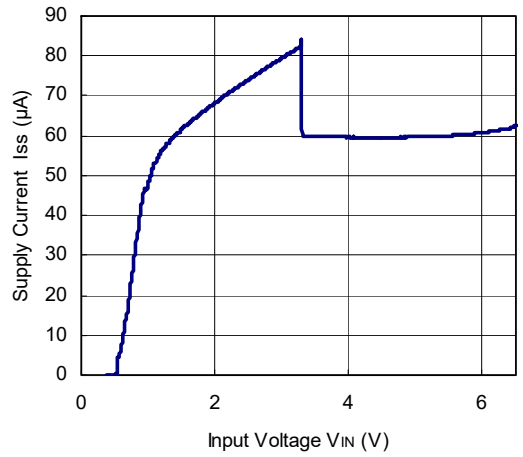
RP13x08xx



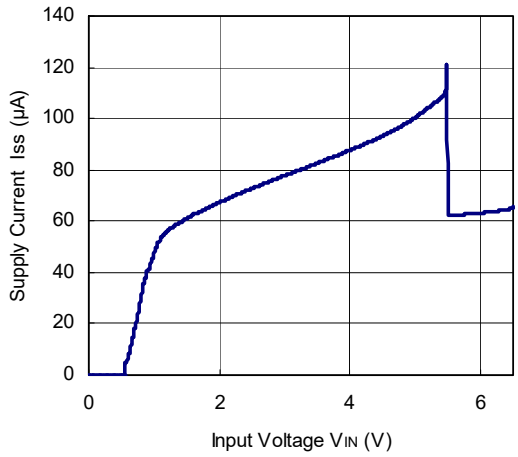
RP132x15xx



RP132x33xx

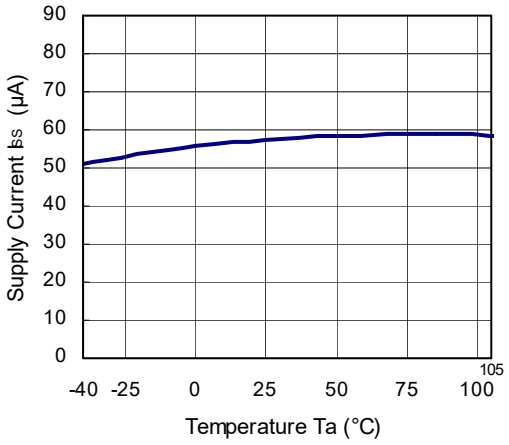


RP132x55xx

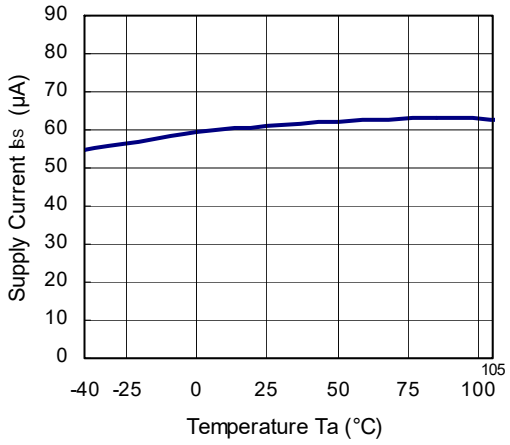


3) Supply Current vs. Temperature

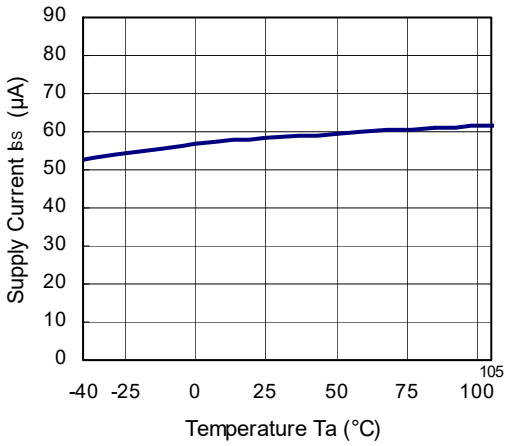
RP132x08xx



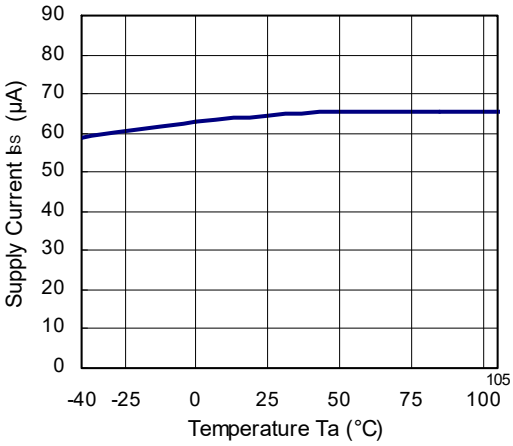
RP132x15xx



RP132x33xx

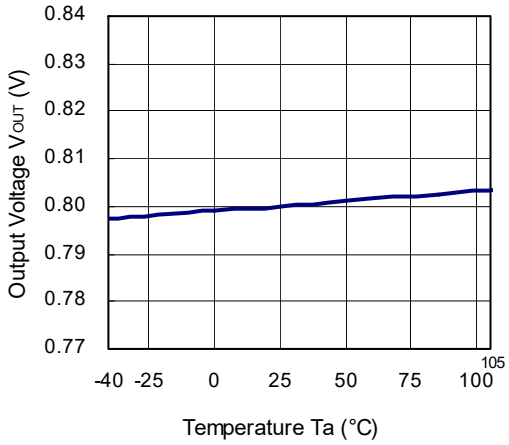


RP132x55xx

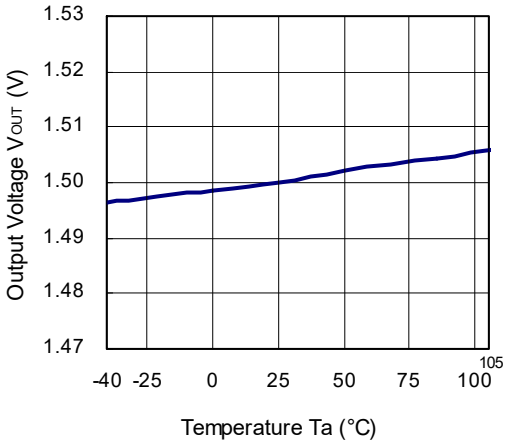


4) Output Voltage vs. Temperature

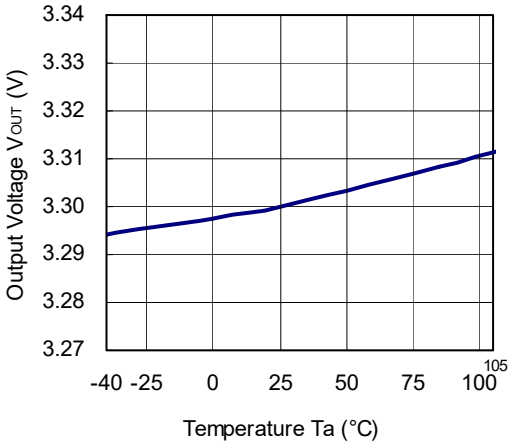
RP132x08xx



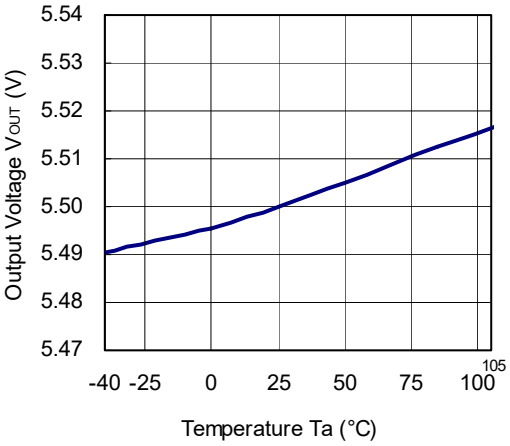
RP132x15xx



RP132x33xx

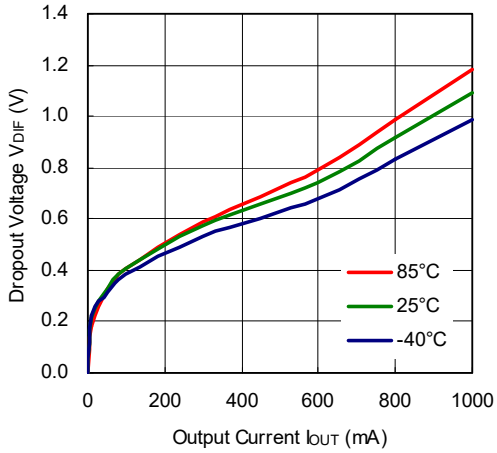


RP132x55xx

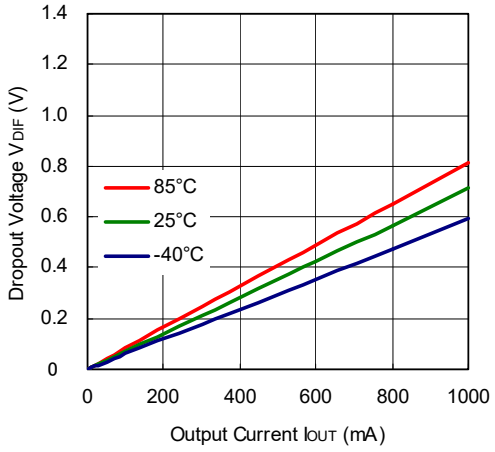


5) Dropout Voltage vs. Output Current

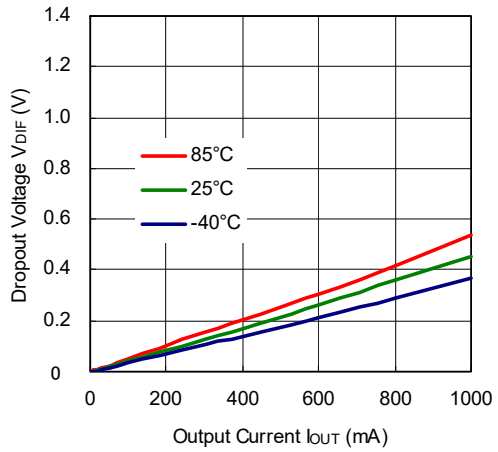
RP132x08xx



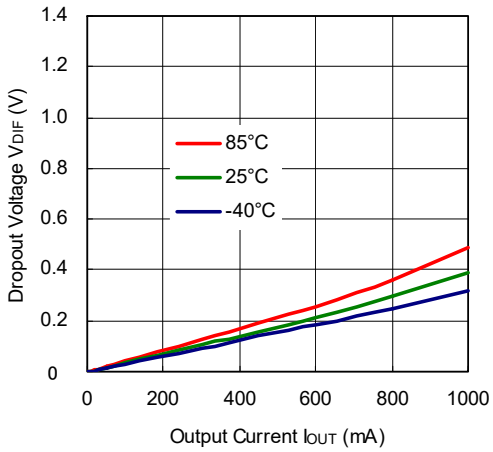
RP132x15xx



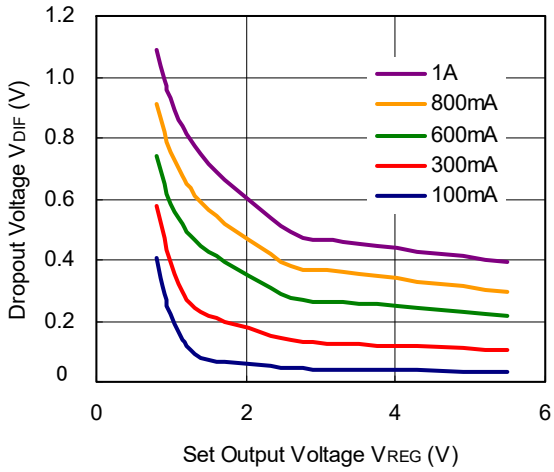
RP132x33xx



RP132x55xx

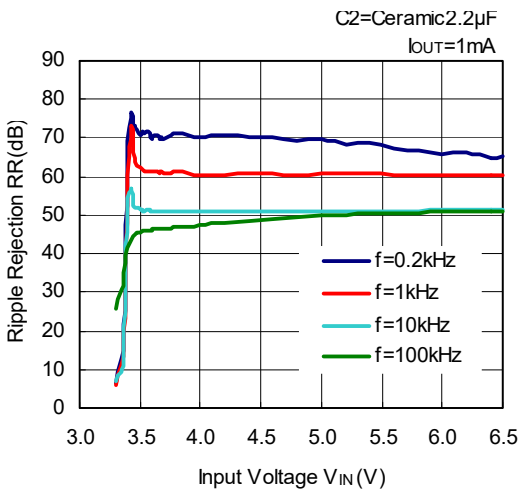


6) Dropout Voltage vs. Set Output Voltage

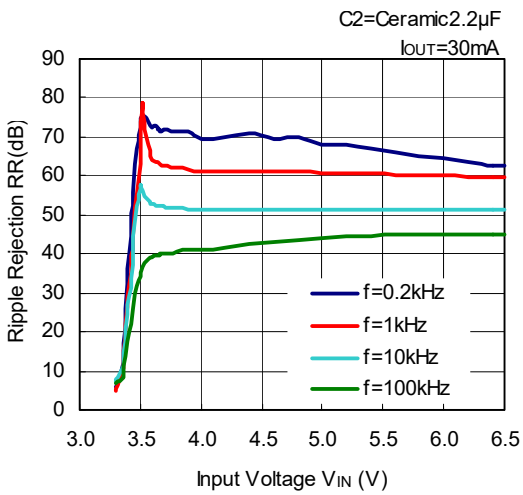


7) Ripple Rejection vs. Input Voltage (C1=none, Ripple=0.2Vp-p, Ta=25°C)

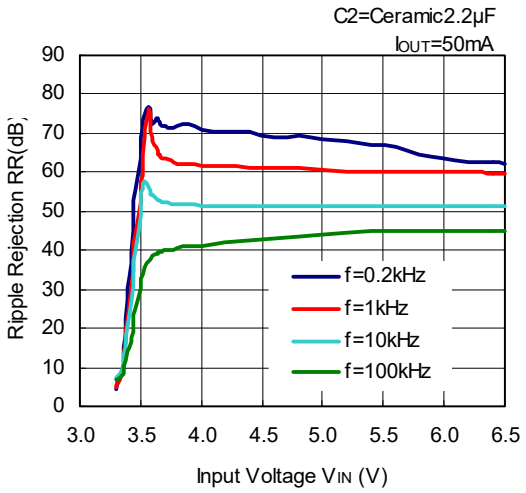
RP132x33xx



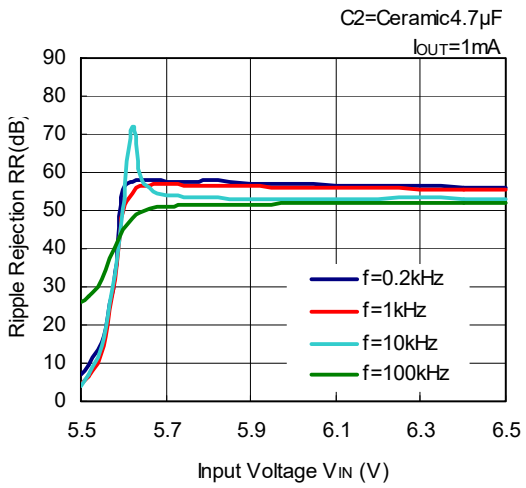
RP132x33xx



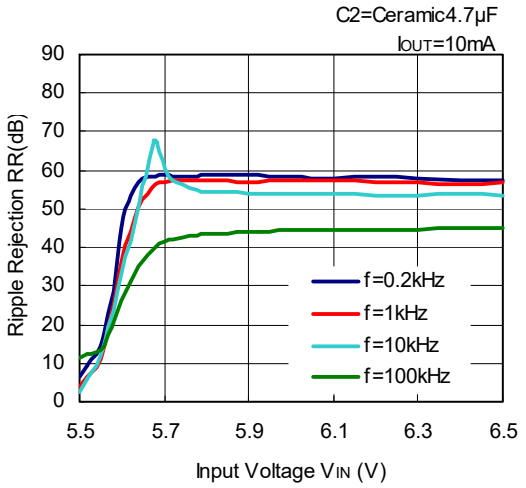
RP132x33xx



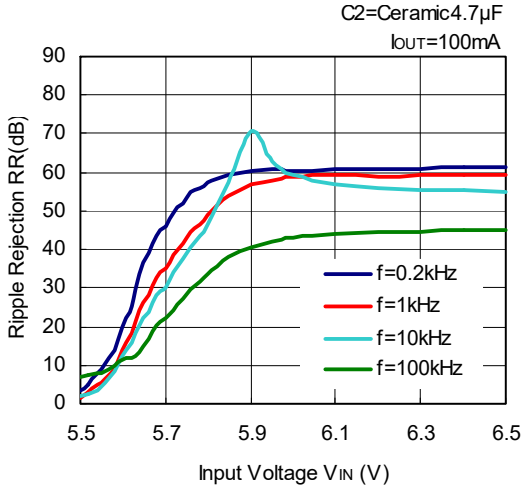
RP131x55xx



RP132x55xx

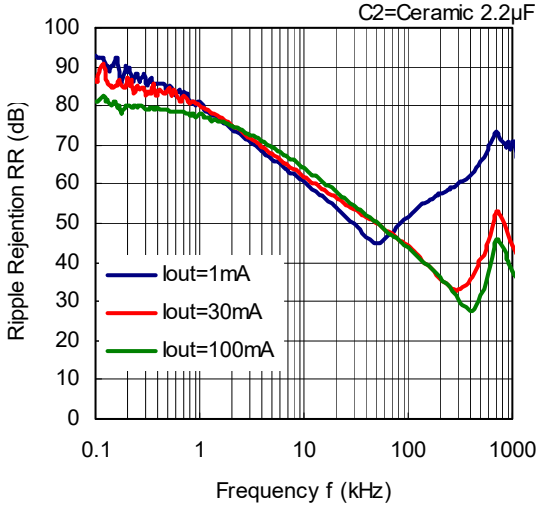


RP132x55xx

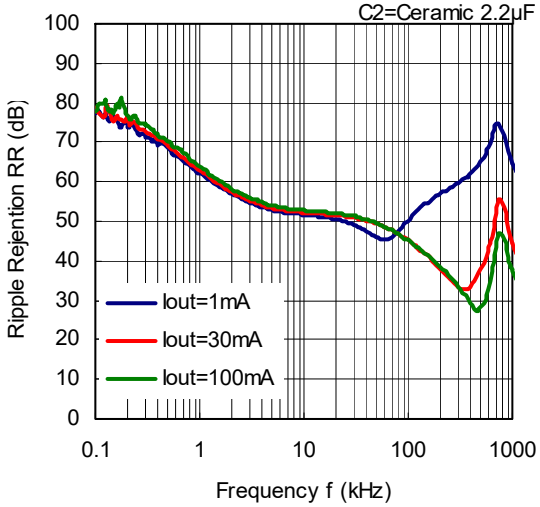


8) Ripple Rejection vs. Frequency (C1=none, Ta=25°C)

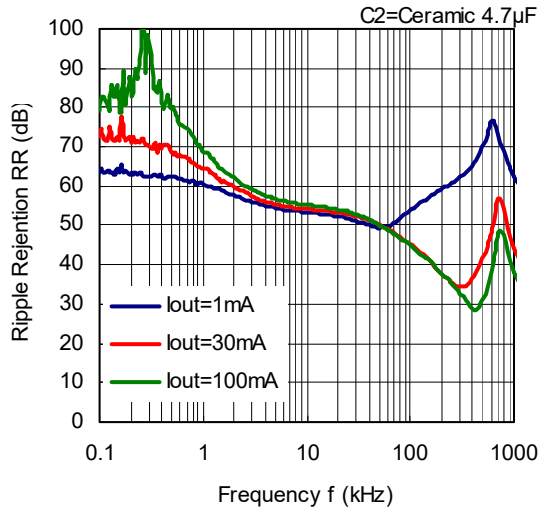
RP132x08xx



RP132x33xx

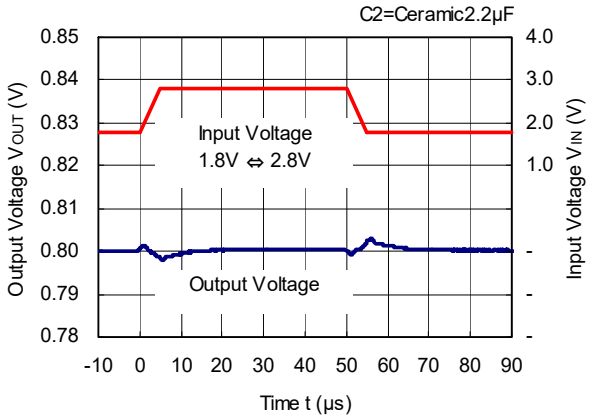


RP132x551x



9) Input Transient Response (C1=none, I_{OUT}=100mA, tr=tf=5µs, Ta=25°C)

RP132x08xx



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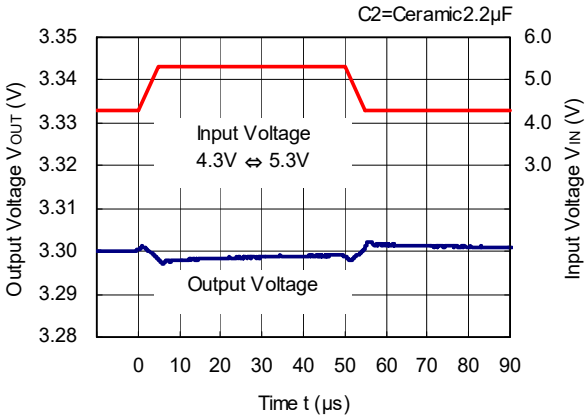

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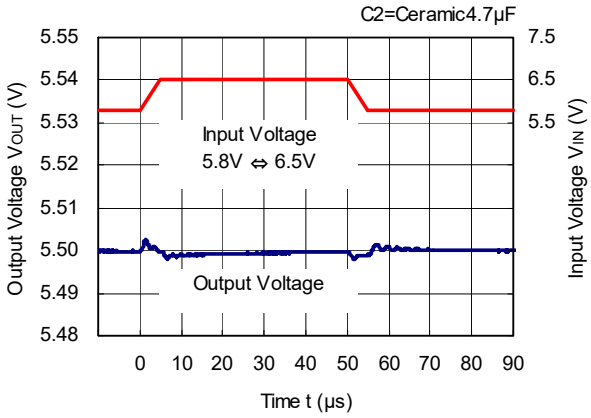
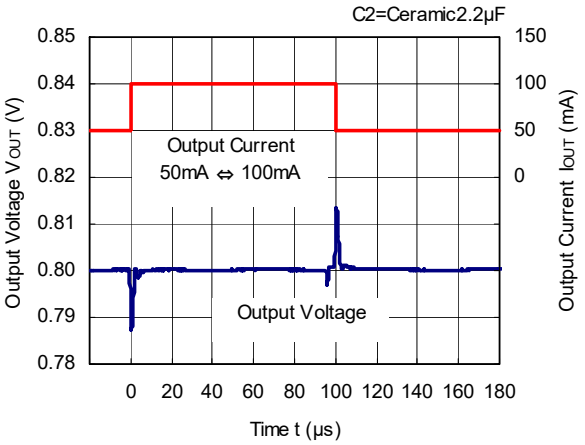


10) Load Transient Response (V_{IN}=V_{OUT}+1.0V, C1=Ceramic 2.2µF, tr=tf=0.5µs, Ta=25°C)

RP132x08xx



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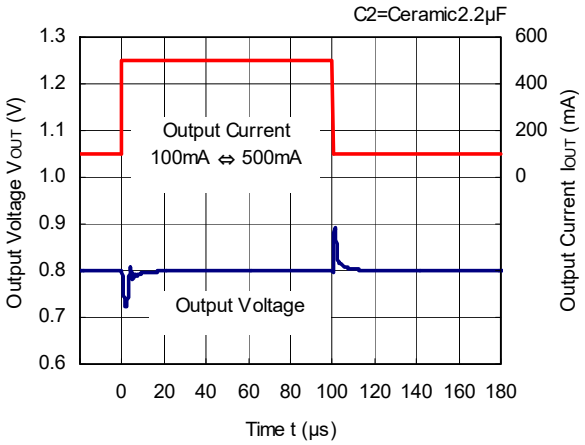

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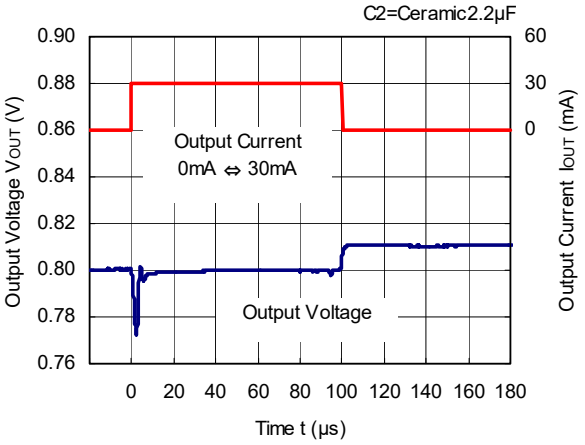

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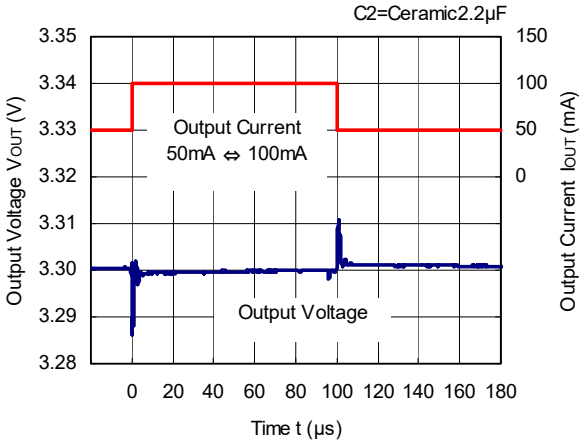

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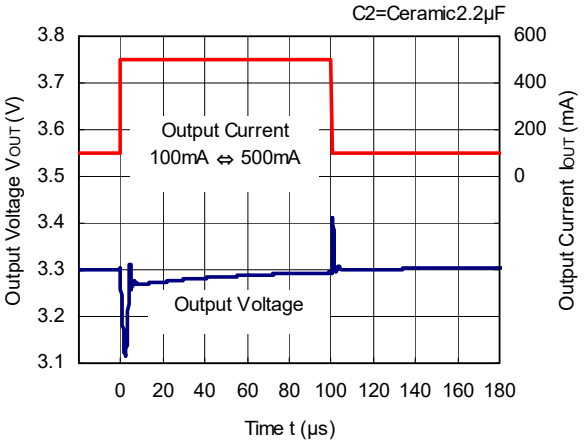

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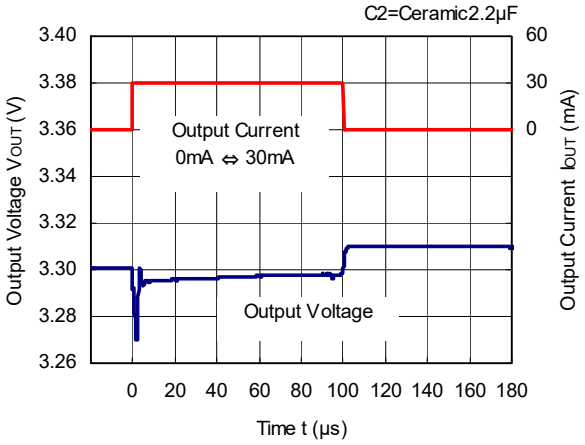

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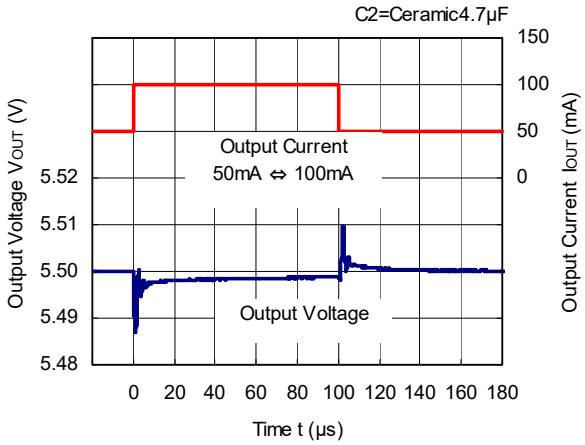

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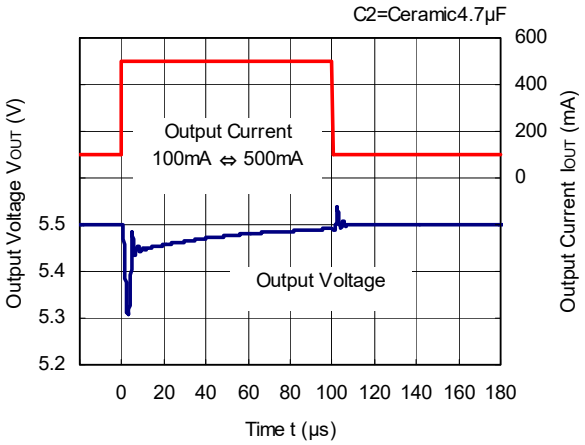

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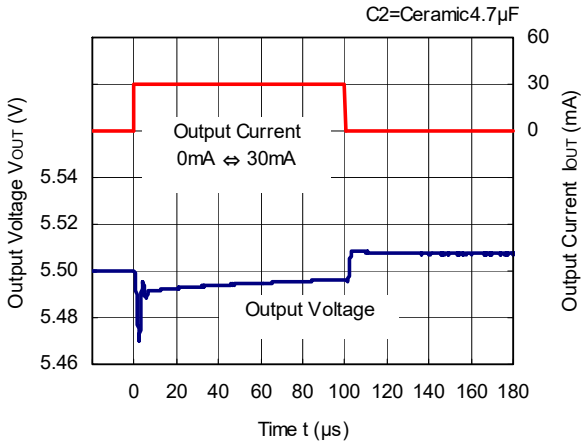
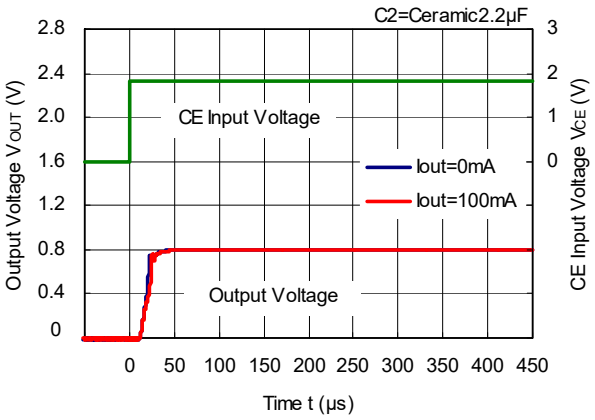


11) Turn on Speed with CE pin (C1=Ceramic 2.2µF, Ta=25°C)

RP132x08xx



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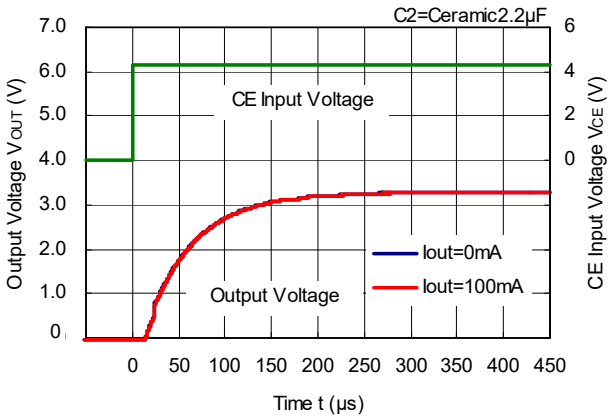

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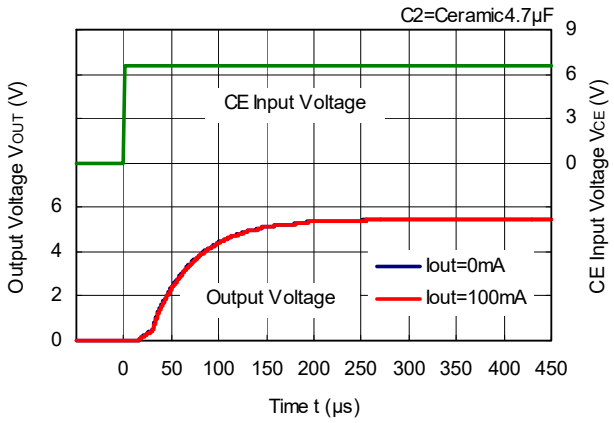
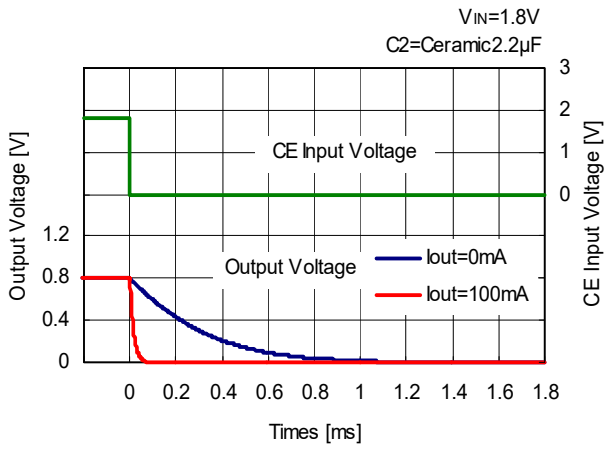


12) Turn off Speed with CE pin (D version) (C1=Ceramic 2.2µF, Ta=25°C)

RP132x08xD



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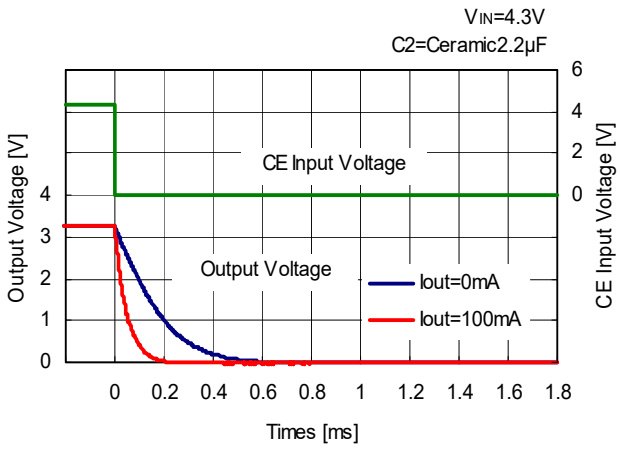
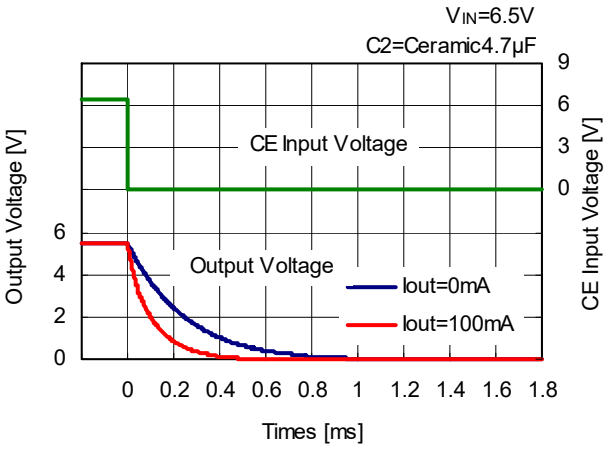
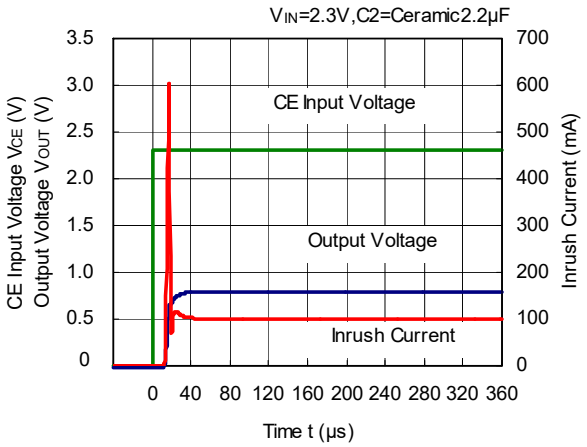


RP132x55xD



13) Inrush Current (C1=Ceramic 2.2µF, I_{OUT}=100mA, Ta=25°C)

RP132x08xx



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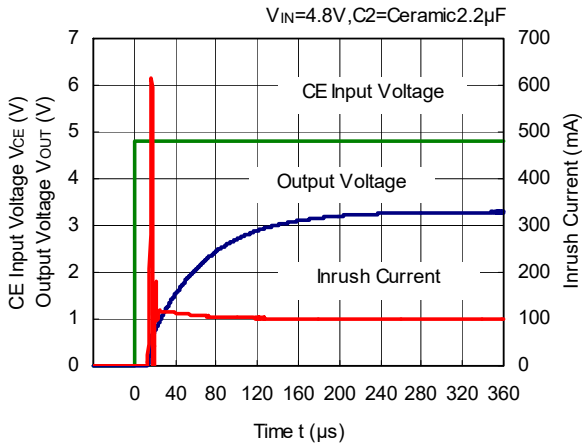

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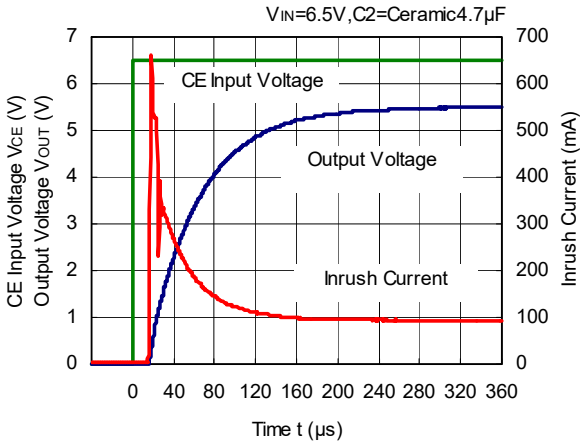
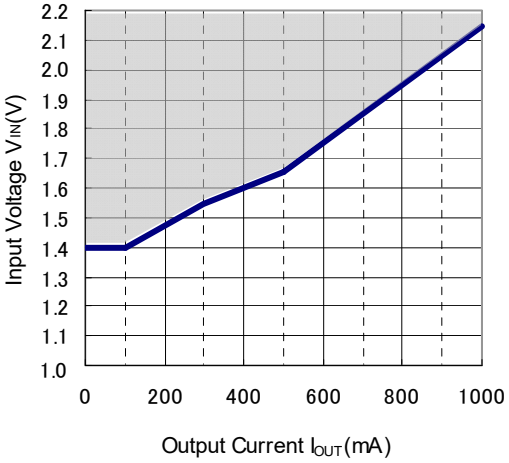


14) Minimum Operating Voltage

RP132x08xx



The operation rage that can output 0.8V is shown by the hatched area in the graph.

ESR vs. Output Current

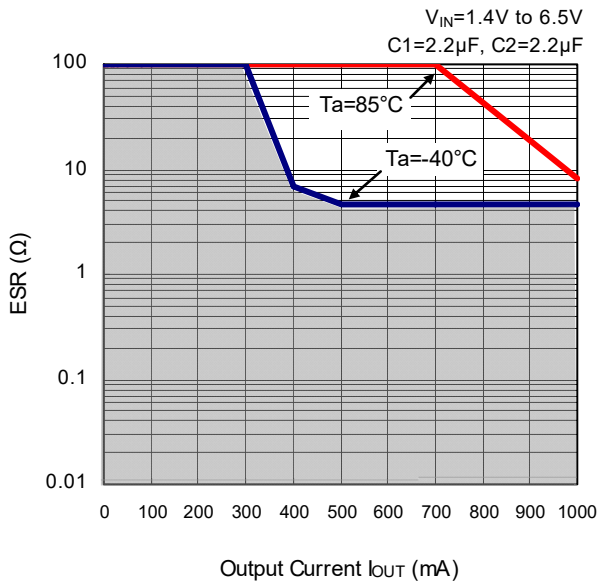
When using these ICs, consider the following points:

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.

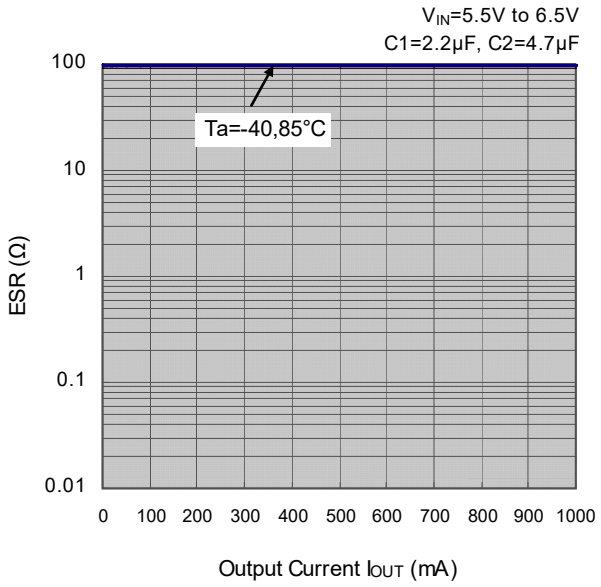
Measurement Conditions

Frequency Band : 10Hz to 2MHz
Temperature : −40°C to 85°C
Hatched Area : Noise level is under 40μVms (Avg.)
C1 : 2.2μF (Kyocera CM05X5R225M06A)
C2 : 2.2μF (V_{OUT} = 0.8V, Kyocera CM105X5R225K06AB)
4.7μF (V_{OUT} = 5.5V, Kyocera CM105X5R475M06AB)

RP132x08xx



RP132x55xx



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