0.8%ACCURACY 0.7V OUTPUT 400mA LDO REGULATOR

NO.EA-281-131031

OUTLINE

The RP116Z Series are low voltage 400mA voltage regulator. These ICs had been further improved of low-voltage capability compared with previous low-voltage product.

The input voltage is as low as Min. 1.0V and the output voltage can be set from 0.7V. The output voltage accuracy has been improved to ±0.8% and due to a built-in transistor with low on-resistance of 0.55Ω (at V_{OUT}=1.5V).

Each of these ICs consists of a voltage reference unit, an error amplifier, a resistor-net for voltage setting, and a current limit circuits for over-current for the destruction prevention by the over-current.

The CE pin can switch the regulator to standby mode.

The RP116Z is available in the small and thin WLCSP-4-P7 package (0.69mm square, 0.36mm thickness and 0.4mm pitch), consequently providing a high density mounting.

FEATURES

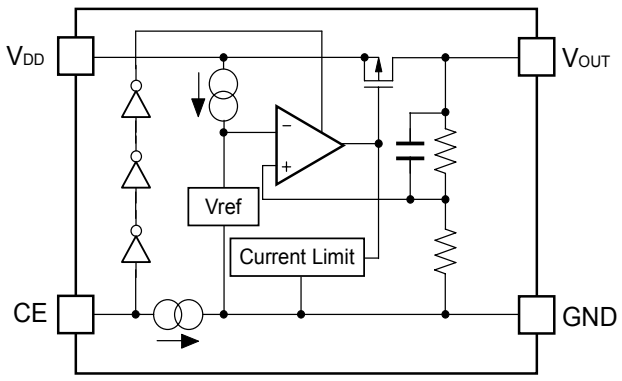
- Supply Current ..... Typ. 48μA
- Standby Current ..... Typ. 0.1μA
- Ripple Rejection ..... Typ. 60dB (f=10kHz)
- Input Voltage Range ..... 1.0V to 3.6V
- Output Voltage Range ..... 0.7V to 1.8V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy ..... ±0.8% (V_{OUT}≥1.0V, T_{opt}=25°C)
- Temperature-Drift Coefficient of Output Voltage ... Typ. ±60ppm/°C
- Dropout Voltage ..... Typ. 0.22V (V_{OUT}=1.5V)
- Line Regulation ..... Typ. 0.10%/V
- Package WLCSP-4-P7
- Built-in Fold Back Protection Circuit ..... Typ. 110mA (Current at short mode)
- Built-in Constant Slope Circuit
- Ceramic capacitors are recommended to be used with this IC .....1.0μF or more

APPLICATIONS

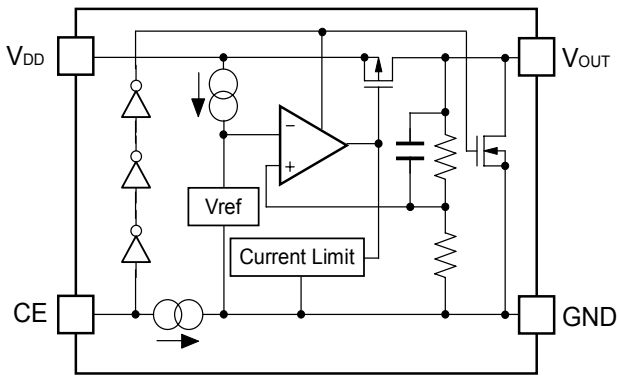
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

RP116Zxx1B



RP116Zxx1D



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RP116Zxx1∗-TR-F	WLCSP-4-P7	5,000 pcs	Yes	Yes

xx: Setting Output Voltage (V_{OUT}) :

Fixed Type: 07 to 18 Stepwise setting with 0.1V increment in the range from 0.7V to 1.8V

Exception:1.25V=RP116Z121x5-TR-F

1.85V=RP116Z181x5-TR-F

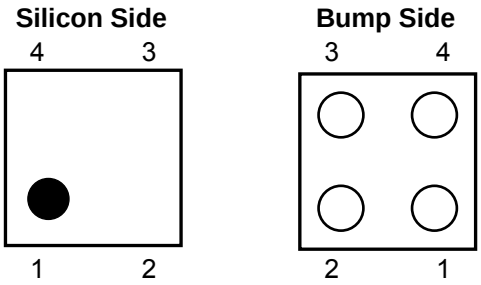
∗ : Designation of Active Type:

B : "H" Active, without auto discharge function at off state.

D : "H" Active, with auto discharge function at off state.

PIN CONFIGURATIONS

● **WLCSP-4-P7**



PIN DESCRIPTIONS

● **WLCSP-4-P7**

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

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	4.0	V
V_{CE}	Input Voltage (CE Pin)	−0.3 to 4.0	V
V_{OUT}	Output Voltage	−0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	500	mA
P_D	Power Dissipation (WLCSP-4-P7)*	278	mW
Topt	Operating Temperature Range	−40 to 85	°C
Tstg	Storage Temperature Range	−55 to 125	°C

∗) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

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

ELECTRICAL CHARACTERISTICS

- **RP116Z**

V_{IN}=Set V_{OUT}+1V, I_{OUT}=1mA, C_{IN}=C_{OUT}=1µF, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by Design Engineering at −40°C ≤ Ta≤ 85°C.

(Ta=25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	Ta=25°C	V_{OUT} ≧1.0V	x 0.992		x 1.008	V
			V_{OUT}<1.0V	-8		+8	mV
		-40°C ≦ Ta ≦ 85°C	V_{OUT} ≧1.0V	x 0.983		x 1.017	V
			V_{OUT}<1.0V	-17		+17	mV
I_{OUT}	Output Current			400			mA
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	1mA ≦ I_{OUT} ≦ 400mA			25	45	mV
V_{DIF}	Dropout Voltage	Please see the table on next page					
I_{SS}	Supply Current	I_{OUT}=0mA			48	75	µA
Istandby	Supply Current (Standby)	V_{CE}=0V			0.1	8.0	µA
ΔV_{OUT} /ΔV_{IN}	Line Regulation	Set V_{OUT}+0.5V ≦ V_{IN} ≦ 3.6V In case Set V_{OUT}<0.8V, 1.3V ≦ V_{IN} ≦ 3.6V			0.10	0.25	%/V
RR	Ripple Rejection	f=10kHz Ripple 0.2Vp-p V_{IN}=Set V_{OUT}+1.0V I_{OUT}=30mA			60		dB
V_{IN}	Input Voltage			1.0		3.6	V
ΔV_{OUT} /ΔTa	Output Voltage Temperature Coefficient	-40°C ≦ Ta ≦ 85°C			±60		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V			110		mA
I_{PD}	CE Pull-down Current				0.38	0.7	µA
V_{CEH}	CE Input Voltage "H"			0.9			V
V_{CEL}	CE Input Voltage "L"					0.4	V
en	Output Noise	BW=10Hz to 100kHz I_{OUT}=30mA V_{OUT}=0.7V			30		µVrms
R_{LOW}	Low Output Nch Tr. ON Resistance (D version Only)	V_{IN}=2.0V V_{CE}=0V			43		Ω

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj≈Ta=25°C) except Output Noise, Ripple Rejection and Output Voltage Temperature Coefficient items.

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

- **Dropout Voltage by Output Voltage**

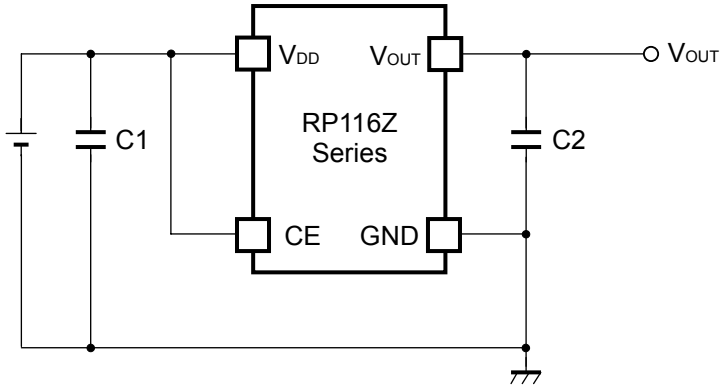
(Ta=25°C)

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
0.7 ≤ V_{OUT} < 0.8	I_{OUT}=400mA	0.48	0.62
0.8 ≤ V_{OUT} < 0.9		0.40	0.54
0.9 ≤ V_{OUT} < 1.0		0.36	0.47
1.0 ≤ V_{OUT} < 1.2		0.32	0.45
1.2 ≤ V_{OUT} < 1.5		0.28	0.38
1.5 ≤ V_{OUT}		0.22	0.31

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

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.

TYPICAL APPLICATION



(External Components)
C1, C2 Ceramic 1.0μF MURATA: GRM155B31A105KE15

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with 1.0μF or more.

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

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.

Impedance of Input pin

CE pull-down constant current circuit is built in the RP116Z.

However, if the CE pin is floating and the wiring is long, the malfunction may occur by noise. Therefore, fully evaluation on the actual PCB is necessary.

CONSTANT SLOPE CIRCUITS

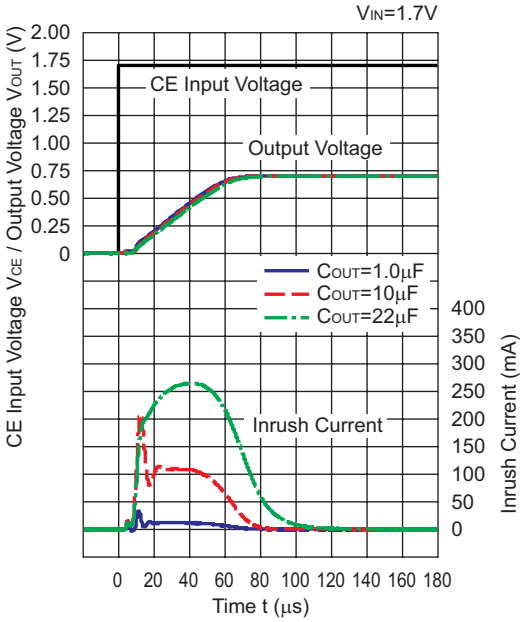
The RP116Z Series is equipped with a constant slope circuit as a soft-start circuit, which allows the output voltage to start up gradually when the CE is turned on.

The constant slope circuit minimizes the inrush current at the start-up and also prevents the overshoot of the output voltage.

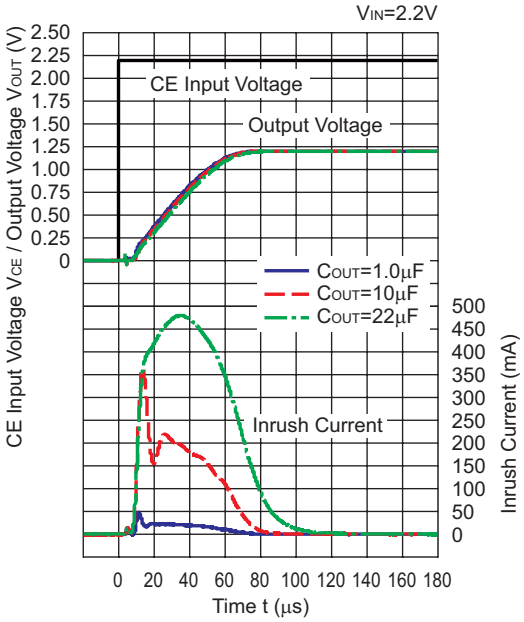
The capacitor to create the start-up slope is built in the IC that does not require any external components. The start-up time and the start-up slope angle are fixed inside the IC. For more details, please refer to the graph 15 of “Inrush Current Characteristics Example”.

Inrush Current Characteristics Example (C1=1.0µF, Topt=25ºC)

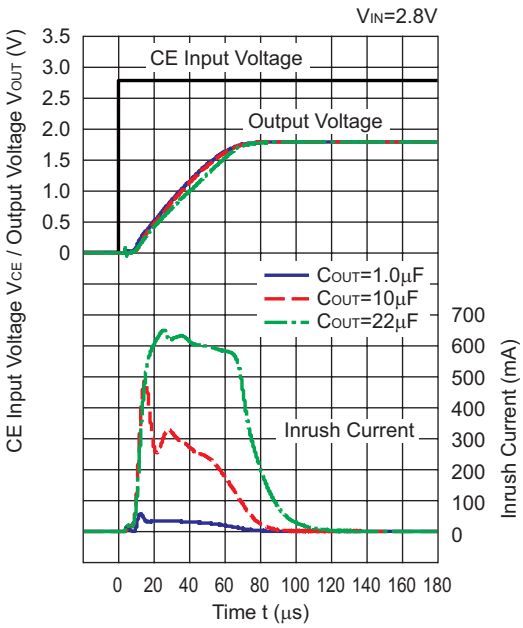
RP116Z071B/D



RP116Z121B/D



RP116Z181B/D



PACKAGE INFORMATION

- **Power Dissipation (WLCSP-4-P7)**

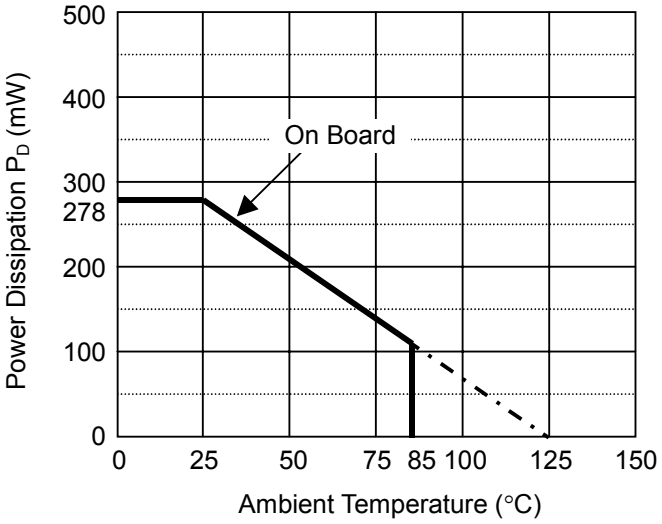
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

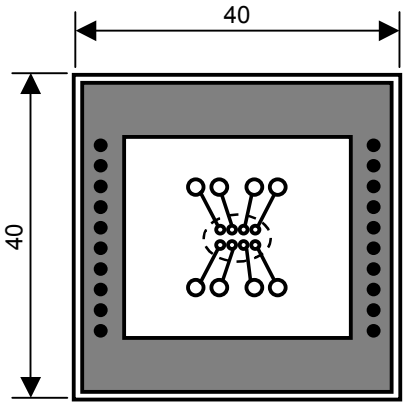
	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm x 40mm x 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-hole	ϕ 0.5mm x 28pcs

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

	Standard Land Pattern
Power Dissipation	278mW
Thermal Resistance	θja=(125-25°C)/0.278W=360°C/W
	θjc=46°C/W



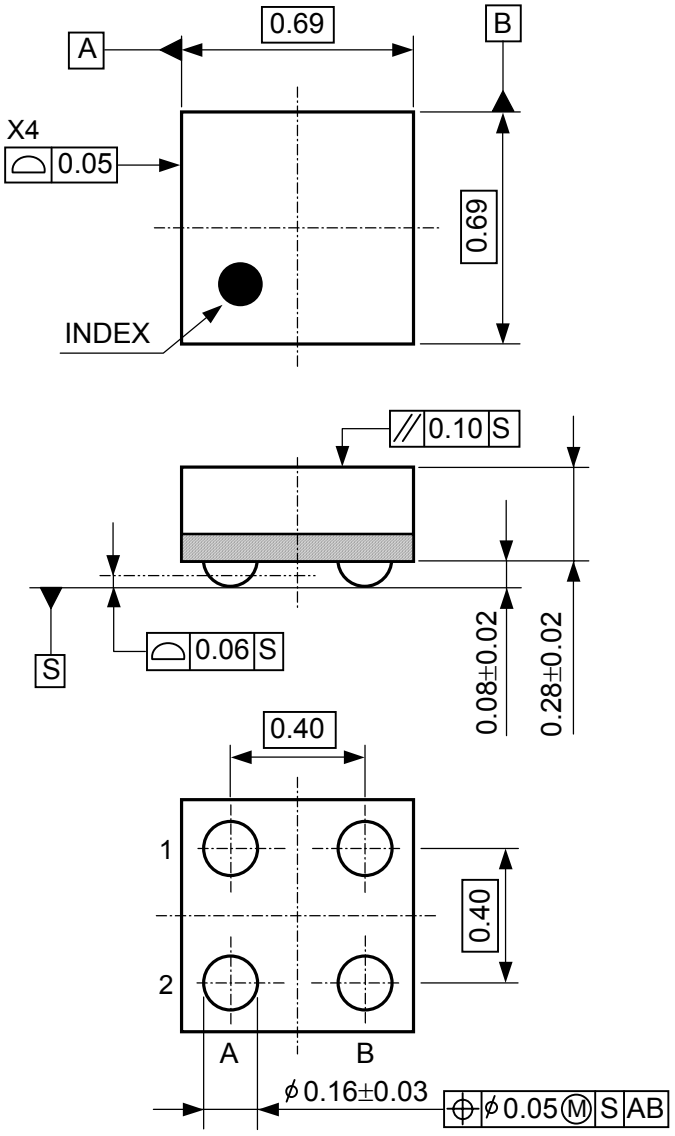
Power Dissipation



Measurement Board Pattern

IC Mount Aria (Unit : mm)

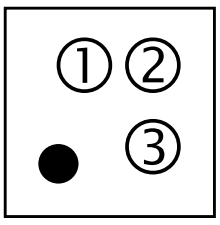
- **Package Dimensions (WLCSP-4-P7)**



Unit: mm

- **Mark Specifications (WLCSP-4-P7)**

① : Product Code … **A**
②③ : Lot No … Alphanumeric serial number.



- **RP116Z Series marking list table (WLCSP-4-P7)**

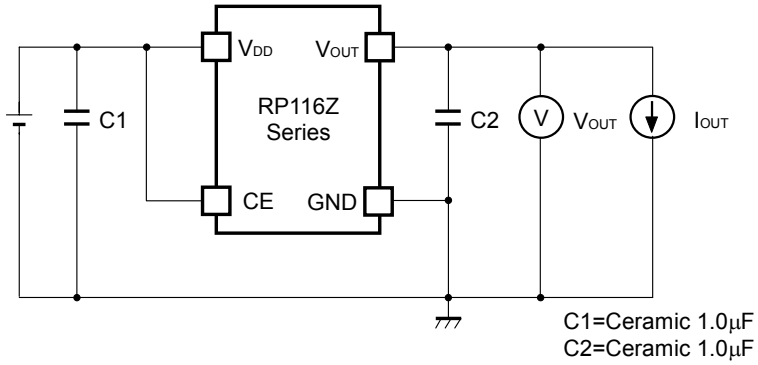
●RP116Zxx1B

Product Name	V_{SET}
RP116Z071B	0.7V
RP116Z081B	0.8V
RP116Z091B	0.9V
RP116Z101B	1.0V
RP116Z111B	1.1V
RP116Z121B	1.2V
RP116Z131B	1.3V
RP116Z141B	1.4V
RP116Z151B	1.5V
RP116Z161B	1.6V
RP116Z171B	1.7V
RP116Z181B	1.8V
RP116Z121B5	1.25V
RP116Z181B5	1.85V

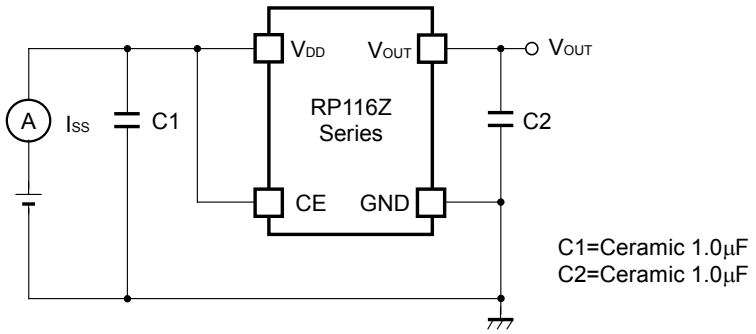
●RP116Zxx1D

Product Name	V_{SET}
RP116Z071D	0.7V
RP116Z081D	0.8V
RP116Z091D	0.9V
RP116Z101D	1.0V
RP116Z111D	1.1V
RP116Z121D	1.2V
RP116Z131D	1.3V
RP116Z141D	1.4V
RP116Z151D	1.5V
RP116Z161D	1.6V
RP116Z171D	1.7V
RP116Z181D	1.8V
RP116Z121D5	1.25V
RP116Z181D5	1.85V

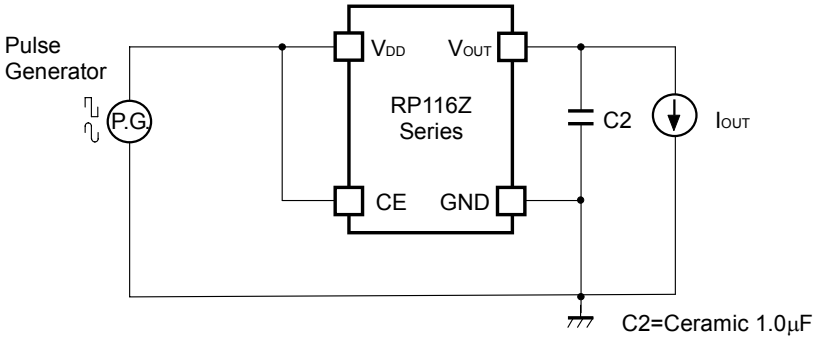
TEST CIRCUITS



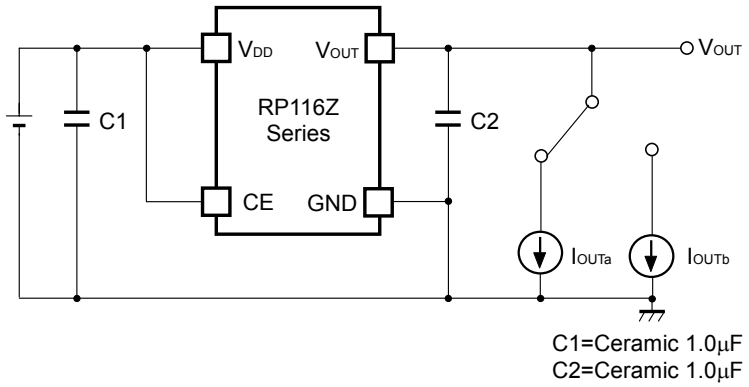
Basic Test Circuit



Supply Current Test Circuit



Ripple Rejection Test Circuit

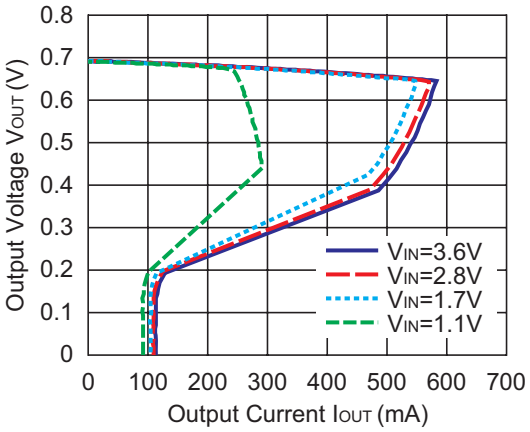


Load Transient Response Test Circuit

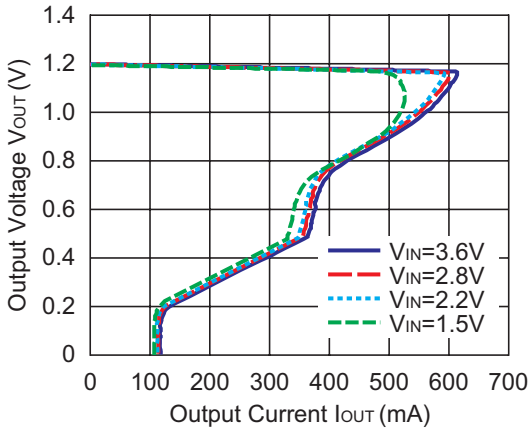
TYPICAL CHARACTERISTICS

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

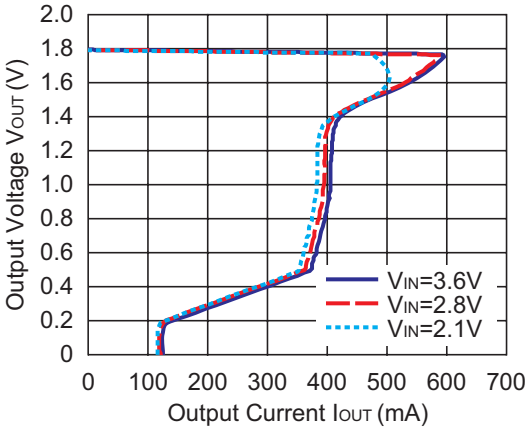
RP116Z071x



RP116Z121x

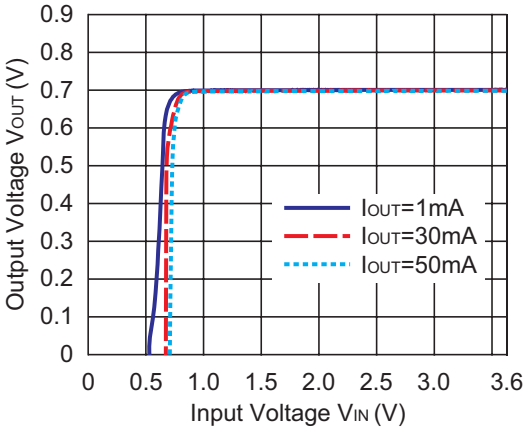


RP116Z181x

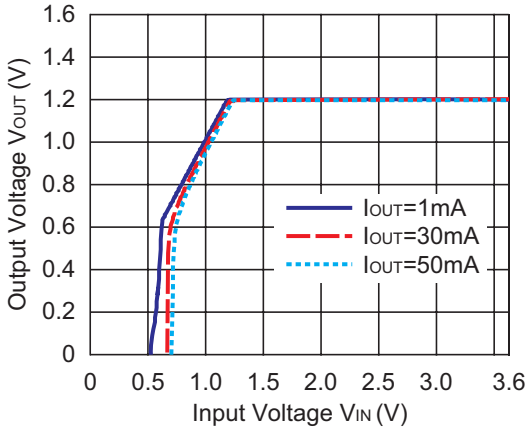


2) Output Voltage vs. Input Voltage (Topt=25°C)

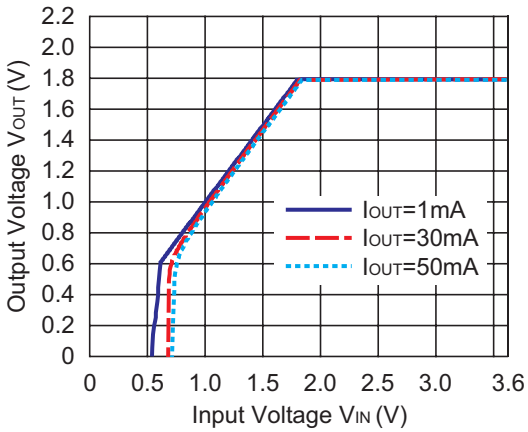
RP116Z071x



RP116Z121x

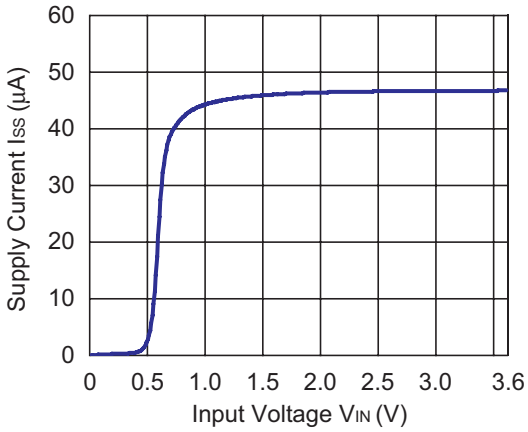


RP116Z181x

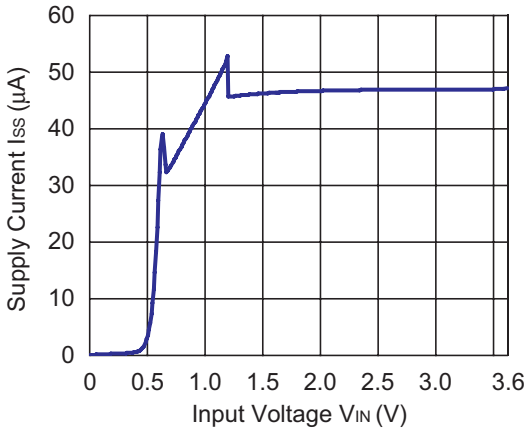


3) Supply Current vs. Input Voltage (Topt=25°C)

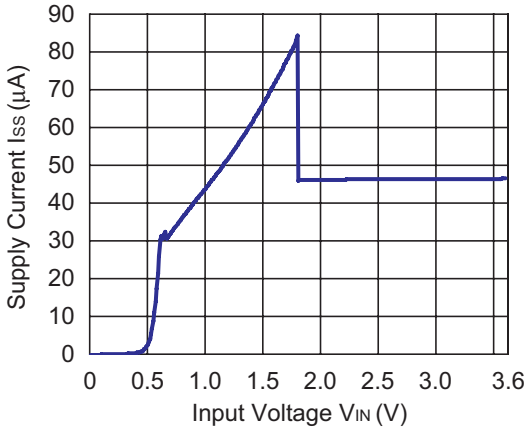
RP116Z071x



RP116Z121x

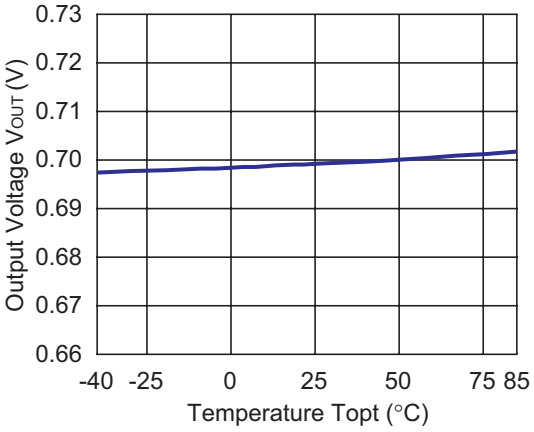


RP116Z181x

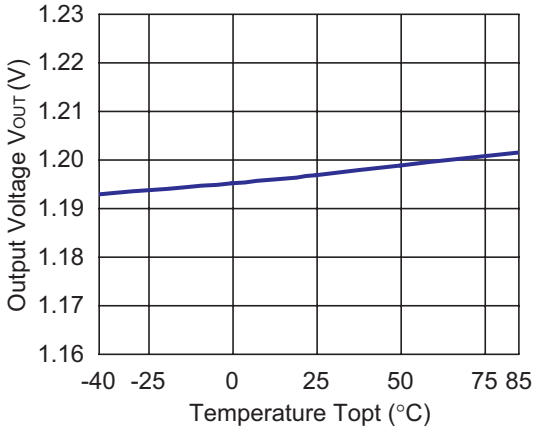


4) Output Voltage vs. Temperature

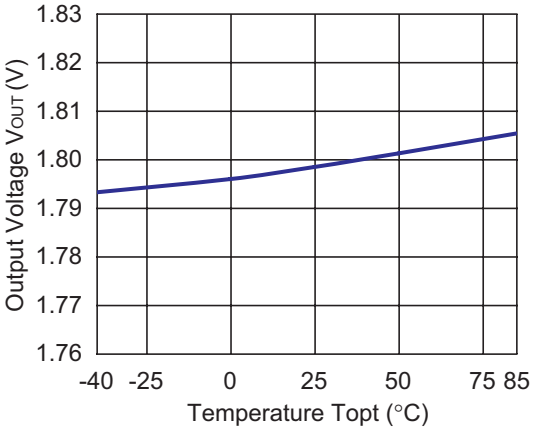
RP116Z071x



RP116Z121x

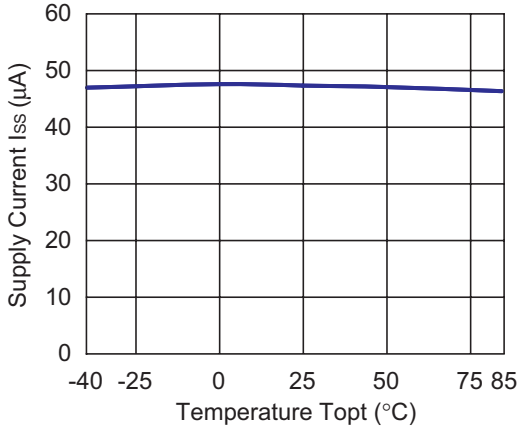


RP116Z181x

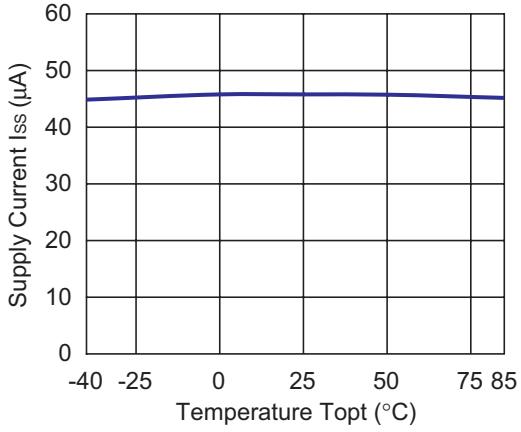


5) Supply Current vs. Temperature

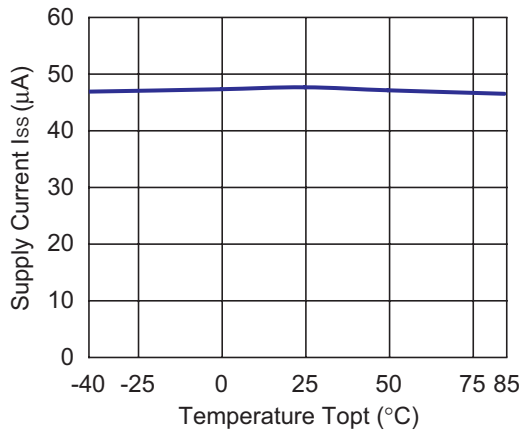
RP116Z071x



RP116Z121x

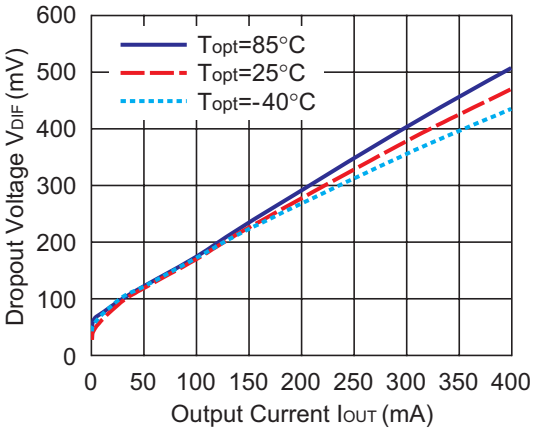


RP116Z181x

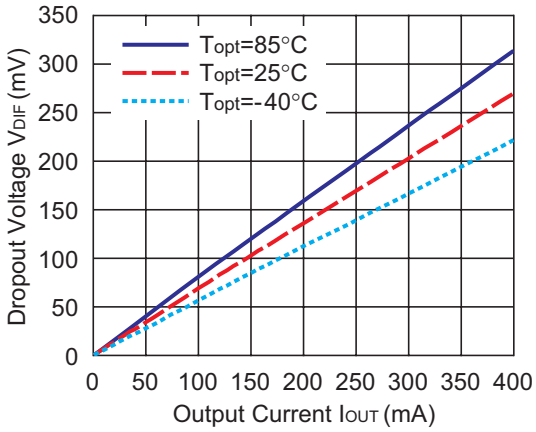


6) Dropout Voltage vs. Output Current

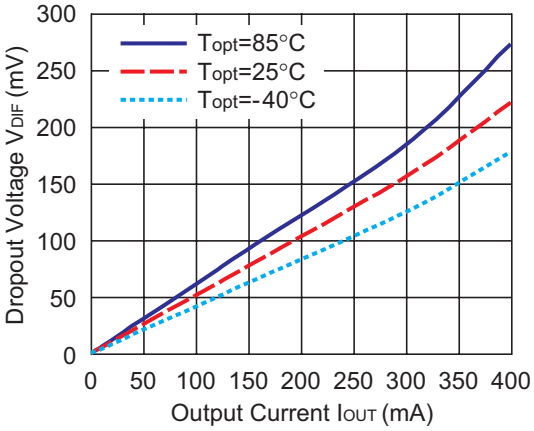
RP116Z071x



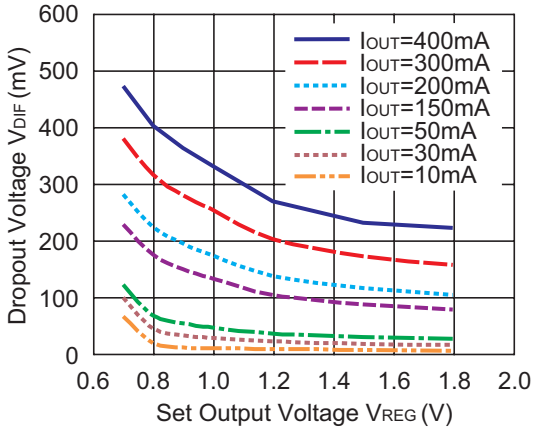
RP116Z121x



RP116Z181x

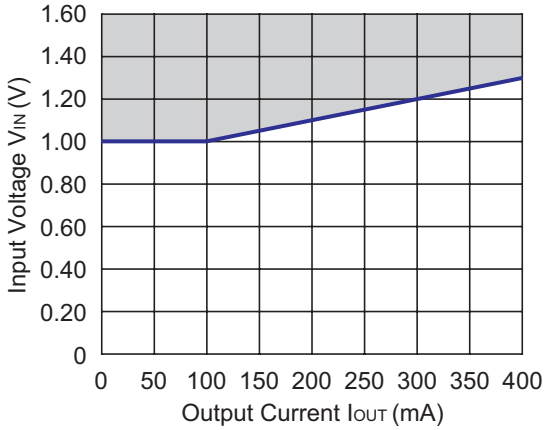


7) Dropout Voltage vs Set Output Voltage (Topt=25°C)



8) Minimum Operating Voltage

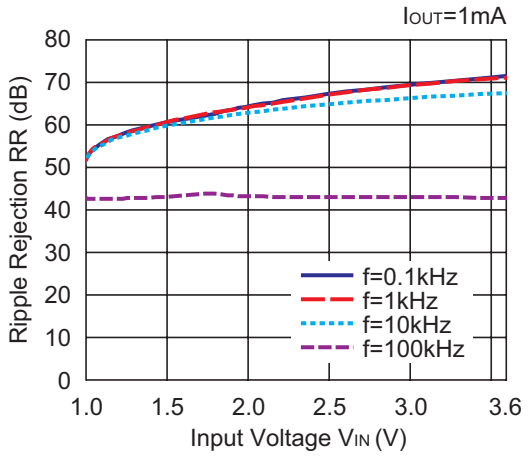
RP116Z071x



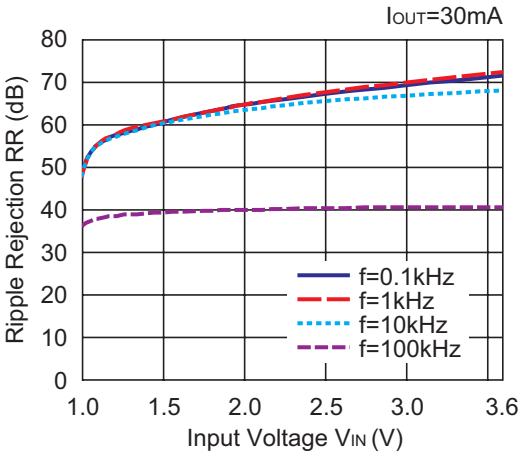
Hatched area is avaiable
for 0.7V output

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

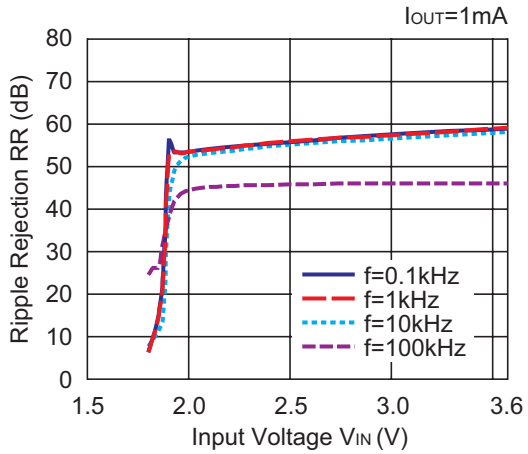
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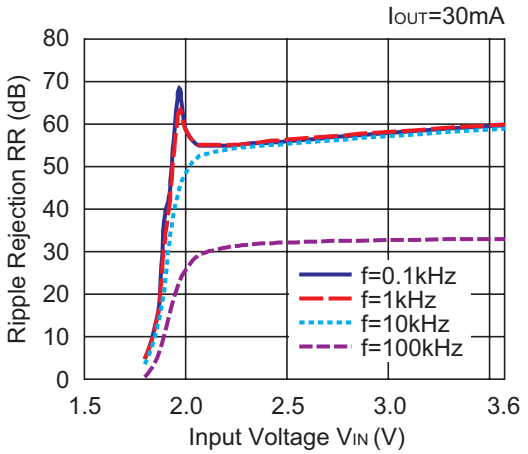
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RP116Z181x

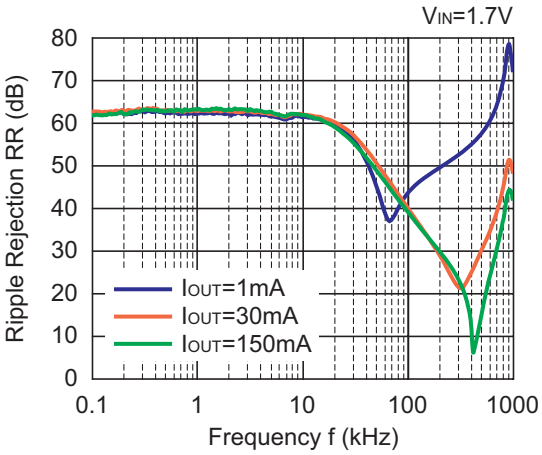


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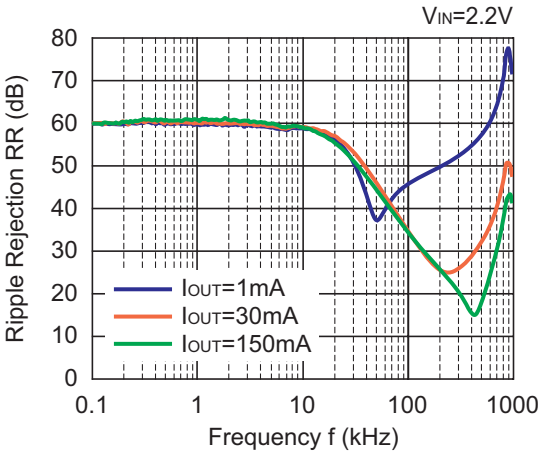


10) Ripple Rejection vs. Frequency (C1=none, C2=1.0µF, Ripple=0.1Vp-p, Topt=25°C)

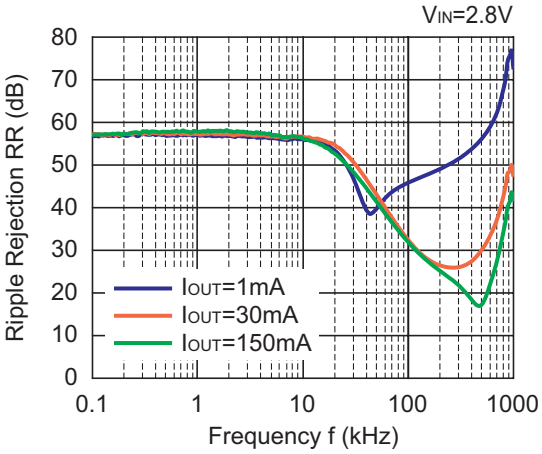
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RP116Z121x

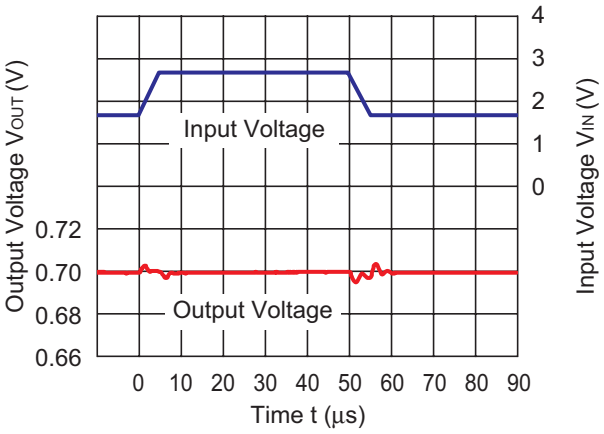


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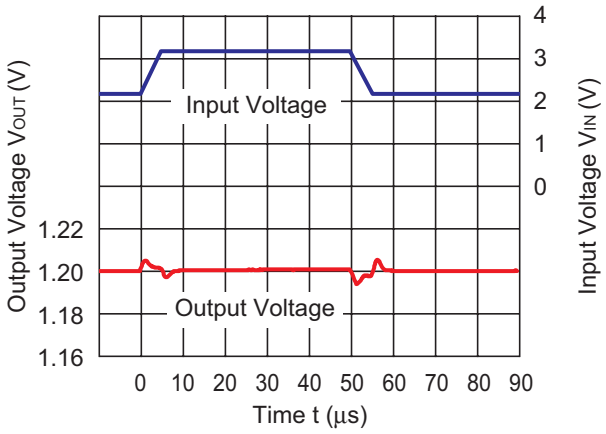


11) Input Transient Response (C1=none, C2=1.0µF, I_{OUT}=30mA, tr=tf=5µs, Topt=25°C)

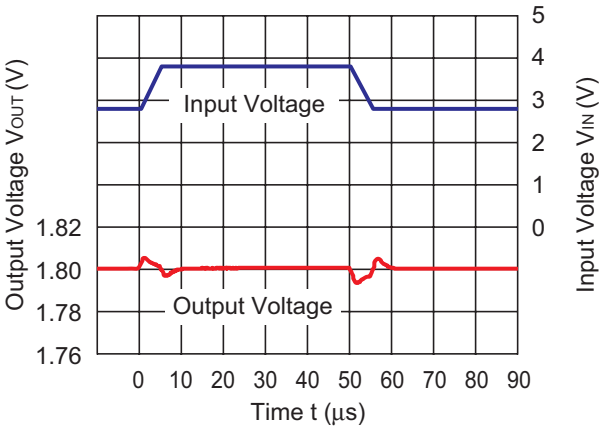
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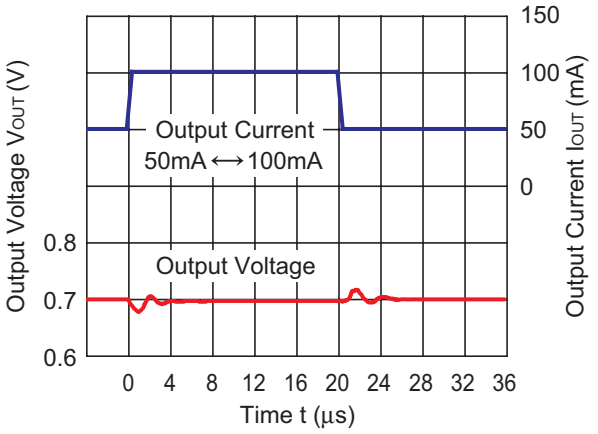


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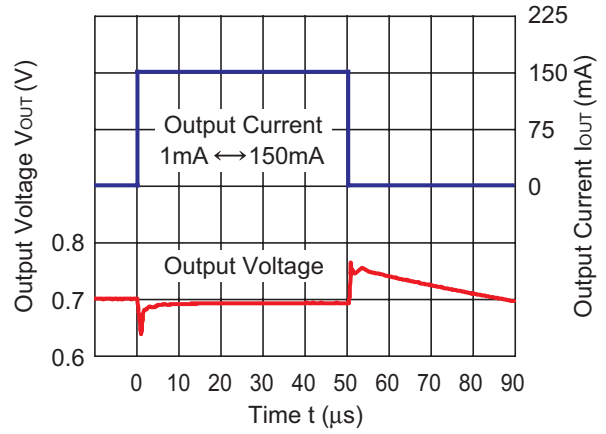


12) Load Transient Response (C1=C2=1.0µF, tr=tf=5µs, Topt=25°C)

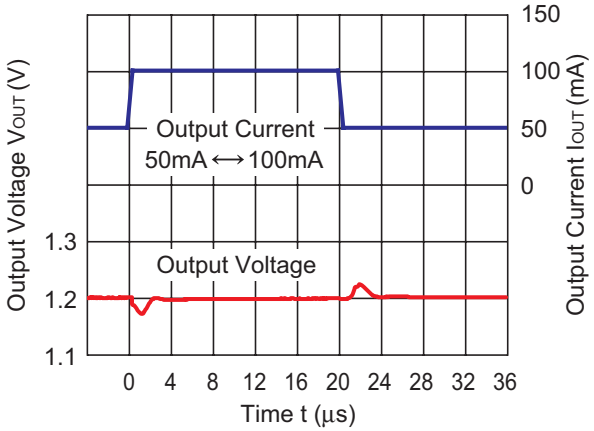
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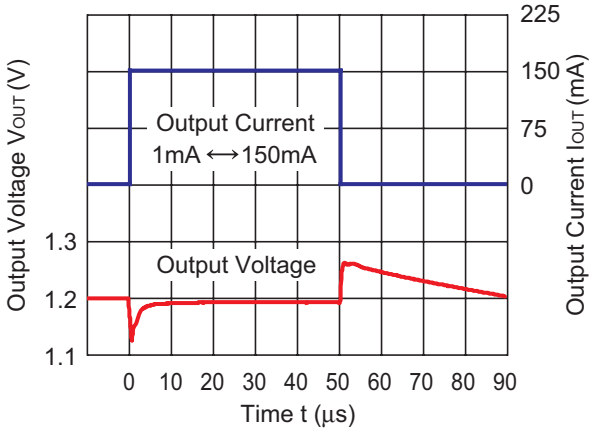
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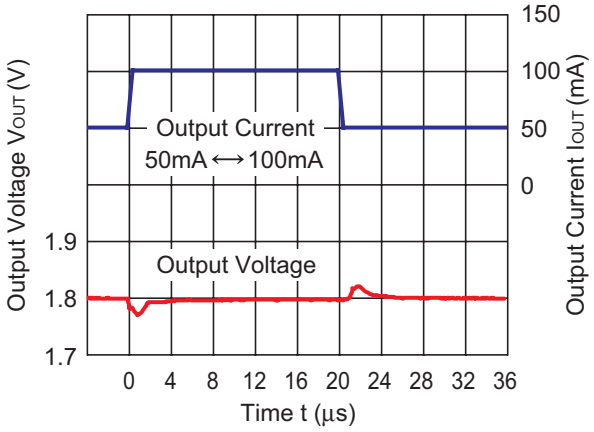
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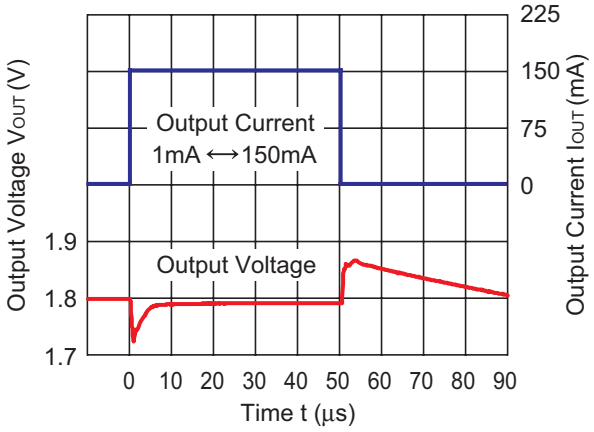
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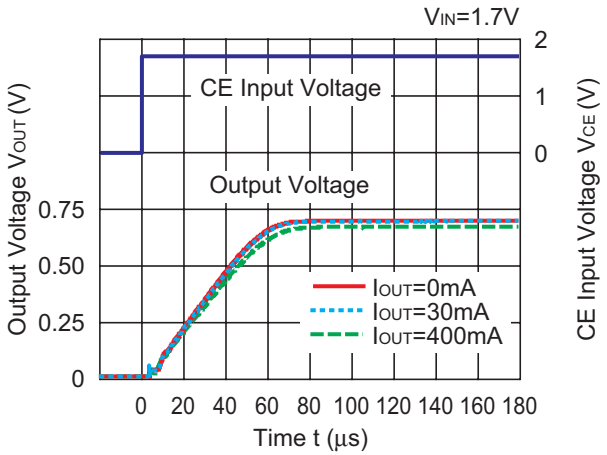


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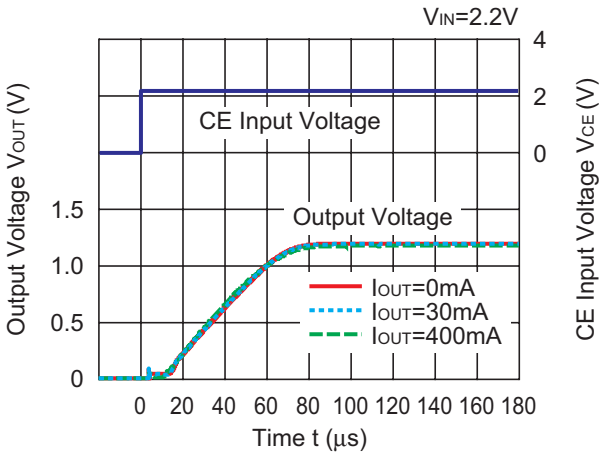


13) Turn On Speed with CE pin (C1=C2=1.0µF, Topt=25°C)

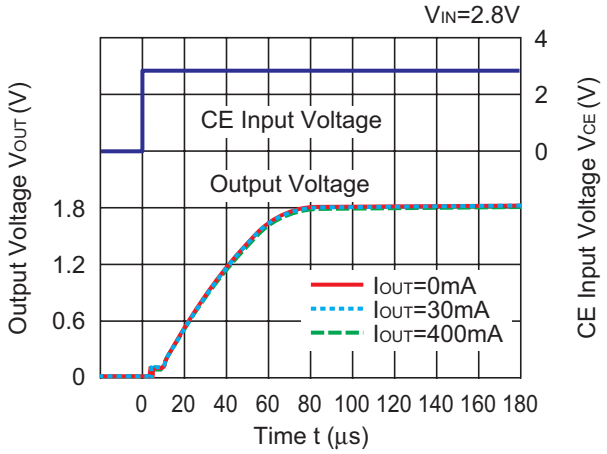
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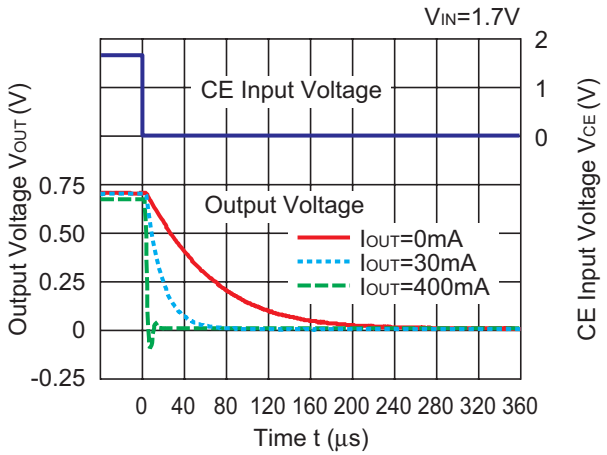


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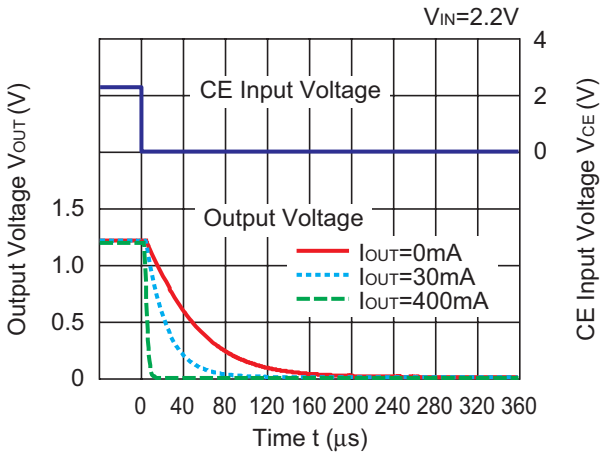


14) Turn Off Speed with CE pin (C1=C2=1.0µF, Topt=25°C)

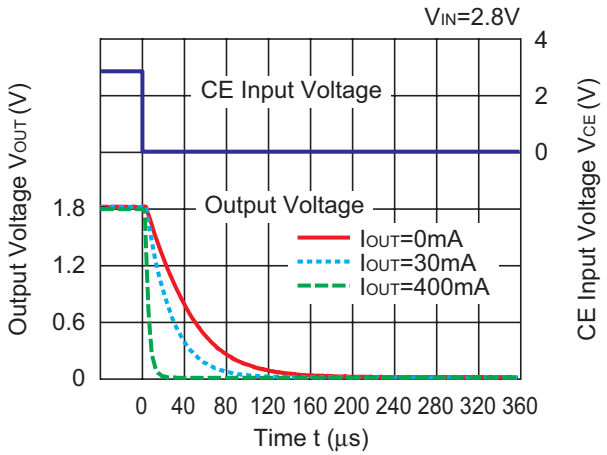
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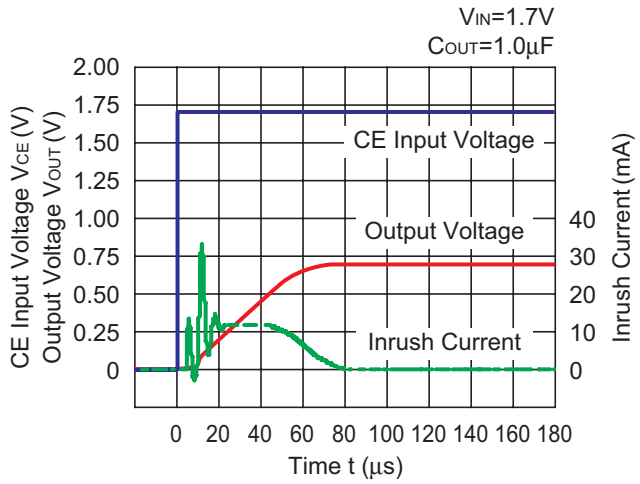


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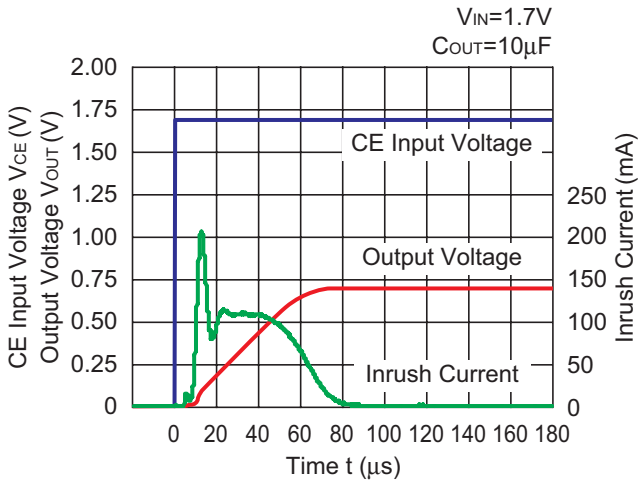


15) Inrush Current at Start up (C1=1.0µF, Topt=25°C)

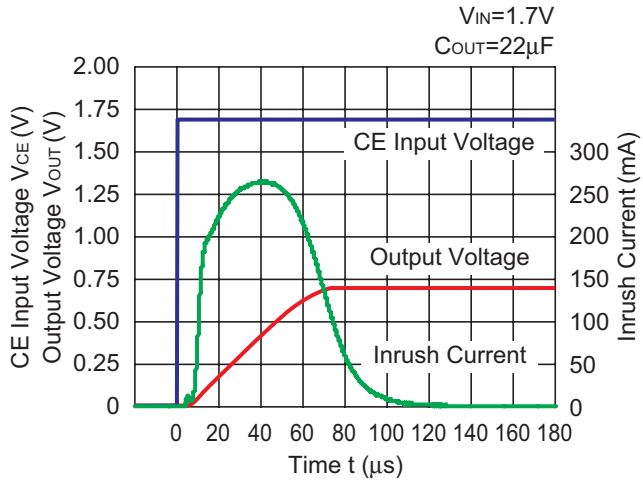
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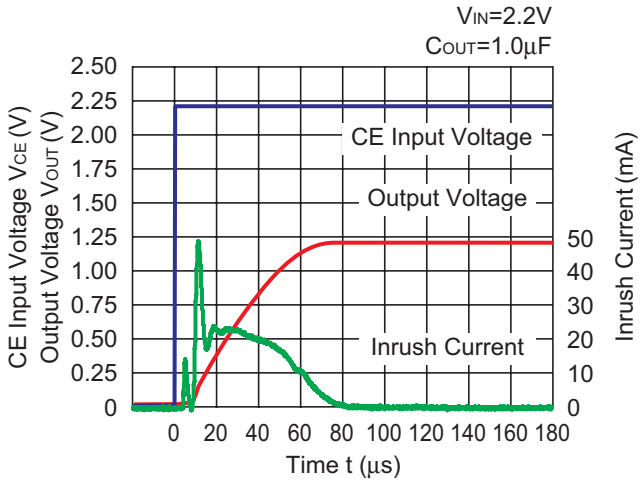
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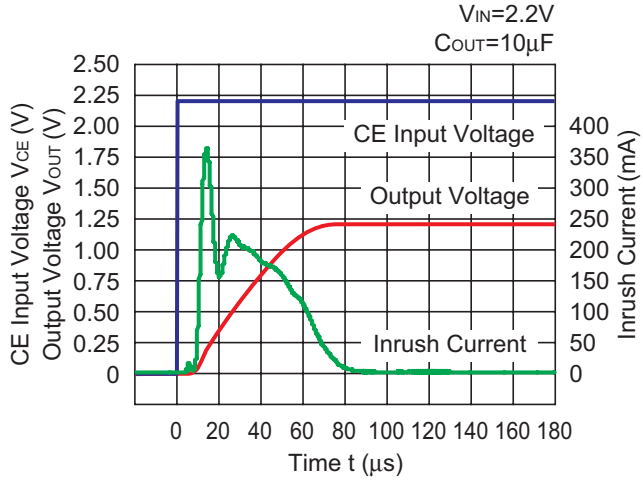
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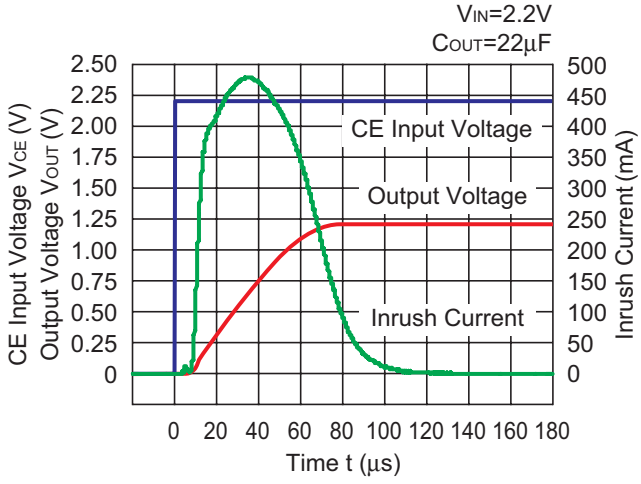
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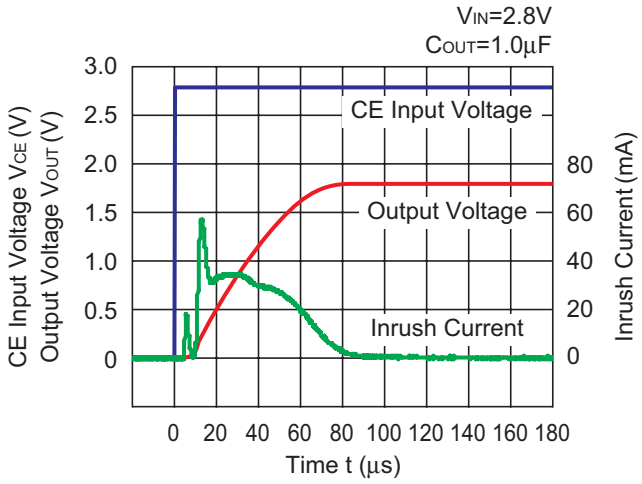
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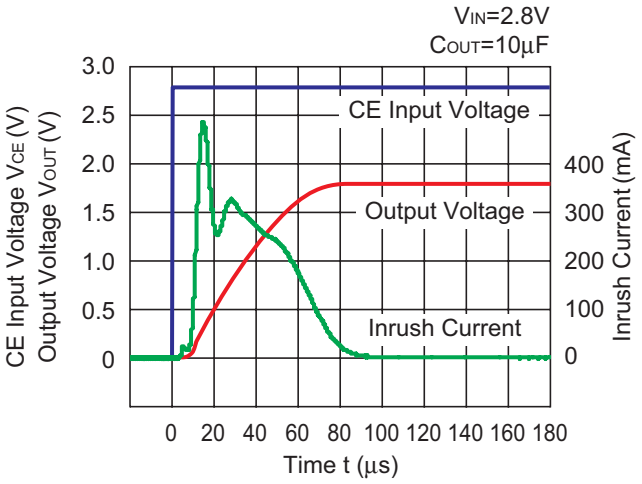
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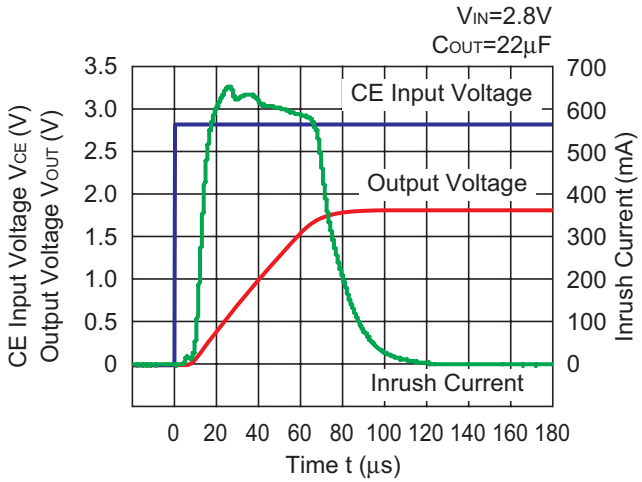
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ESR vs. Output Current

When using these ICs, consider the following points:

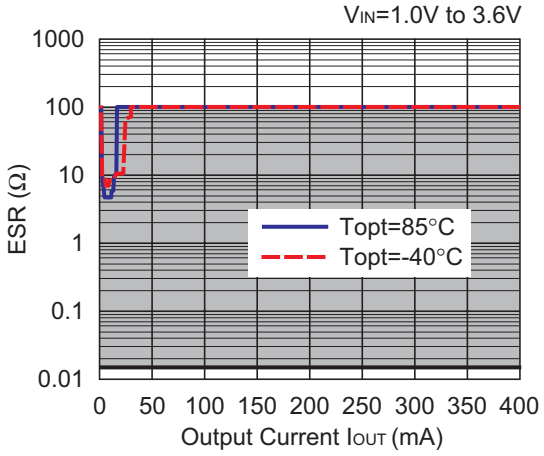
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under 40μV (Avg.) are marked as the hatched area in the graph.

Measurement conditions

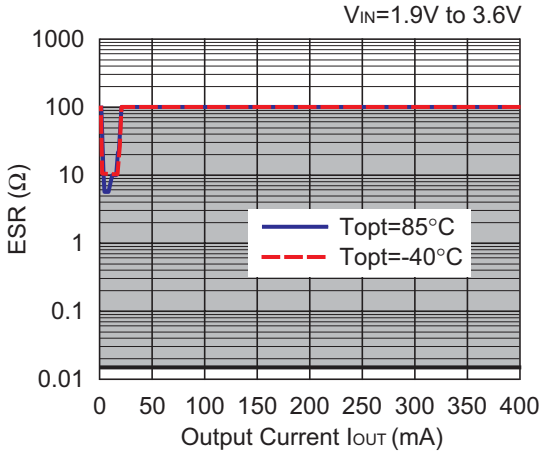
Frequency Band: 10Hz to 3MHz
Temperature : –40°C to 85°C
C1, C2 : 1.0μF MURATA GRM155B31A105KE15

If other than ceramic capacitors such as tantalum, the ESR of the capacitor might be higher than expected. This graph shows the stable area with ESR limit. In the actual evaluation, we used Murata GRM155B31A105KE15, therefore, bias characteristics of the same kind of ceramic capacitors are considered.

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