∗R1116D (SON1612-6) is the non-promotion product. As of March in 2014.

RICOH

R1116x SERIES

LOW NOISE 150mA LDO REGULATOR

NO. EA-126-111026

OUTLINE

The R1116x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low on Resistance, and high ripple rejection. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a short current limit circuit, a chip enable circuit, and so on.

These ICs perform with low dropout voltage and the chip-enable function. The supply current at no load of this IC is only 10μA, and the line transient response and the load transient response of the R1116x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The supply current at no load of R1116x Series is remarkably reduced compared with R1114x Series. The mode change signal to reduce the supply current is not necessary. The output voltage accuracy is also improved. (±1.5%)

The output voltage of these ICs is fixed with high accuracy. Since the packages for these ICs are SOT-23-5 and SON1612-6 therefore high density mounting of the ICs on boards is possible.

R1126N Series that a pin configuration differs from R1116N Series are available.

FEATURES

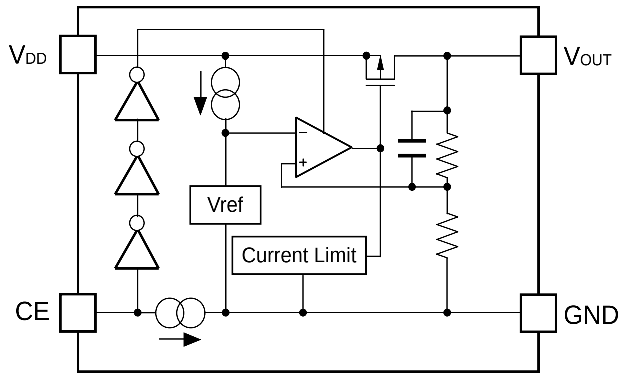
- Supply Current .... Typ. 10μA
- Standby Current .... Typ. 0.1μA
- Input Voltage Range .... 1.8V to 6.0V
- Output Voltage Range .... 1.5V to 4.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage .... Typ. 0.29V (I_{OUT}=150mA,V_{OUT}=2.8V)
- Ripple Rejection .... Typ. 70dB (f=1kHz, V_{OUT}=3.0V)
  Typ. 53dB (f=10kHz)
- Output Voltage Accuracy .... ±1.5% (1.5V ≦ V_{OUT} ≦ 3.0V), ±2.0% (V_{OUT}>3.0V)
- Temperature-Drift Coefficient of Output Voltage .... Typ. ±100ppm/°C
- Line Regulation .... Typ. 0.02%/V
- Packages .... SOT-23-5 , SON1612-6
- Built-in Fold Back Protection Circuit .... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ... C_{IN}=C_{OUT}=1.0μF (Ceramic)

APPLICATIONS

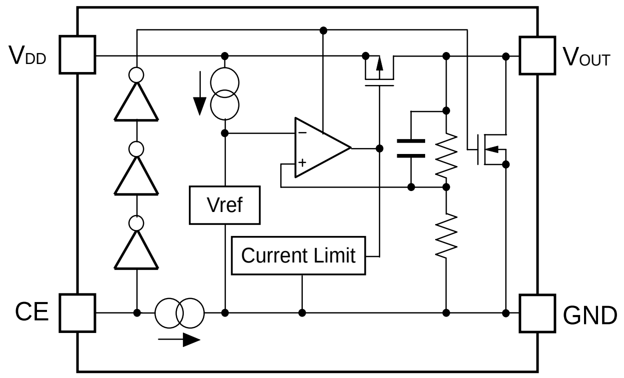
- Power source for portable communication equipment.
- Power source for portable music player.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R1116xxx1B



R1116xxx1D



SELECTION GUIDE

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

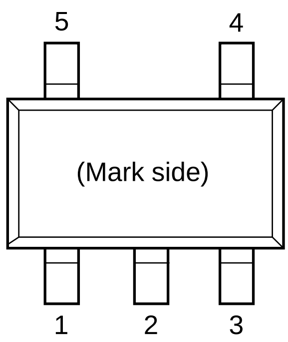
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1116Dxx1∗-TR-FE	SON1612-6	4,000 pcs	Yes	Yes
R1116Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.5V(15) to 4.0V(40) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

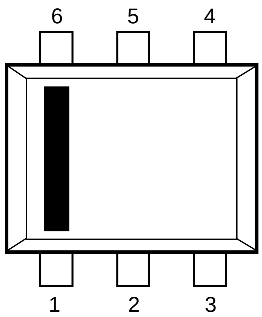
∗ : CE pin polarity and auto discharge function at off state are options as follows.
(B) "H" active, without auto discharge function at off state
(D) "H" active, with auto discharge function at off state

PIN CONFIGURATIONS

● SOT-23-5



● SON1612-6



PIN DESCRIPTIONS

● SOT-23-5

Pin No.	Symbol	Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin
4	NC	No Connection
5	V_{OUT}	Output pin

● SON1612-6

Pin No.	Symbol	Description
1	CE	Chip Enable Pin
2	GND	Ground Pin
3	V_{DD}	Input Pin
4	V_{OUT}	Output Pin
5	GND	Ground Pin
6	NC	No Connection

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{CE}	Input Voltage (CE Pin)	6.5	V
V_{OUT}	Output Voltage	-0.3~$V_{IN}+0.3$	V
I_{OUT}	Output Current	160	mA
P_D	Power Dissipation (SOT-23-5)*	420	mW
	Power Dissipation (SON1612-6)*	500	
Topt	Operating Temperature Range	−40~85	°C
Tstg	Storage Temperature Range	−55~125	°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

- **R1116xxx1B/D**

Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN} = Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 30mA	V_{OUT} ≦ 3.4V	×0.985		×1.015	V
			V_{OUT} > 3.4V	×0.980		×1.020	
I_{OUT}	Output Current	V_{IN}−V_{OUT}=1.0V		150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}=Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 150mA 1.5V ≦ V_{OUT} < 2.0V 2.0V ≦ V_{OUT} < 3.0V 3.0V ≦ V_{OUT}			28 33 35	55 66 80	mV
V_{DIF}	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE					
I_{SS}	Supply Current	V_{IN}=Set V_{OUT}+1V, I_{OUT}=0mA			10	18	μA
Istandby	Supply Current (Standby)	V_{IN}=Set V_{OUT}+1V, V_{CE}=V_{DD}			0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	I_{OUT}=30mA Set V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V			0.02	0.10	%/V
RR	Ripple Rejection	f=1kHz f=10kHz Ripple 0.2Vp-p V_{IN}−V_{OUT}=1.0V,I_{OUT}=30mA			70 53		dB
V_{IN}	Input Voltage			1.8		6.0	V
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	I_{OUT}=30mA −40°C ≦ Topt ≦ 85°C			±100		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V			40		mA
I_{PD}	CE Pull-down Current				0.5		μA
V_{CEH}	CE Input Voltage "H"			1.0		6.0	V
V_{CEL}	CE Input Voltage "L"			0.0		0.3	V
en	Output Noise	BW=10Hz to 100kHz			30		μVrms
R_{LOW}	On Resistance of Nch Tr. for auto-discharge (Only for D version)	V_{CE}=0V			70		Ω

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

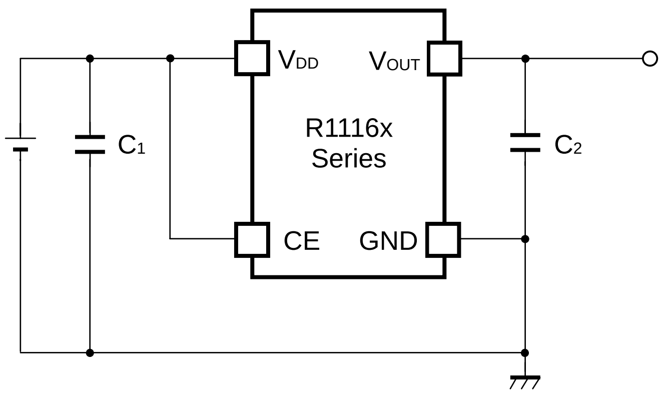
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE**

Topt = 25°C

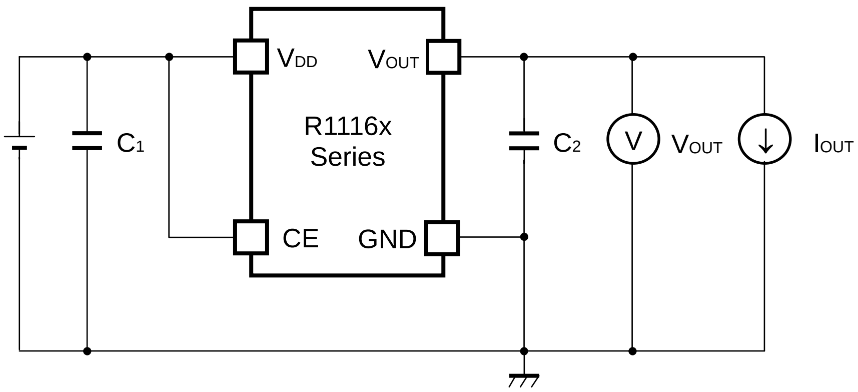
Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
V_{OUT} = 1.5V	I_{OUT}=150mA	0.54	0.86
1.5V < V_{OUT} ≦ 1.6V		0.50	0.75
1.6V < V_{OUT} ≦ 1.7V		0.46	0.70
1.7V < V_{OUT} ≦ 2.0V		0.44	0.65
2.0V < V_{OUT} ≦ 2.7V		0.37	0.56
2.7V < V_{OUT} ≦ 4.0V		0.29	0.46

TYPICAL APPLICATIONS



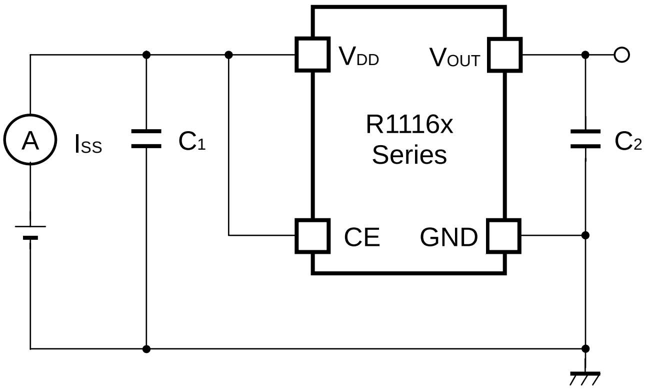
(External Components)
C_2 Ceramic 1.0μF Ex. Murata GRM155B30J105KE18B
Kyocera CM05X5R105K06AB
C_1 Ceramic 1.0μF

TEST CIRCUITS



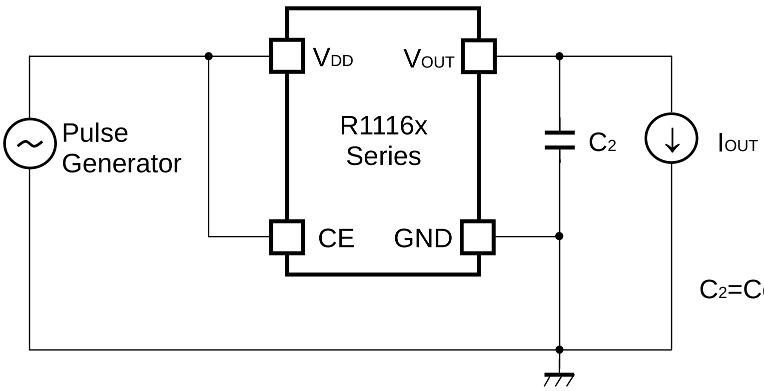
C_1=Ceramic 1.0μF
C_2=Ceramic 1.0μF

Fig.1 Standard test Circuit



C_1=Ceramic 1.0μF
C_2=Ceramic 1.0μF

Fig.2 Supply Current Test Circuit



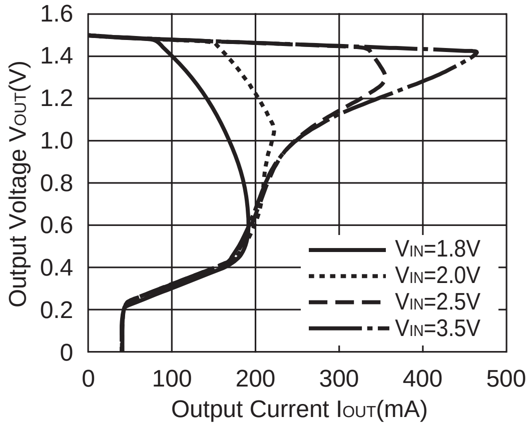
C_2=Ceramic 1.0μF

Fig.3 Ripple Rejection, Line Transient Response Test Circuit

TYPICAL CHARACTERISTICS

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

R1116x151x



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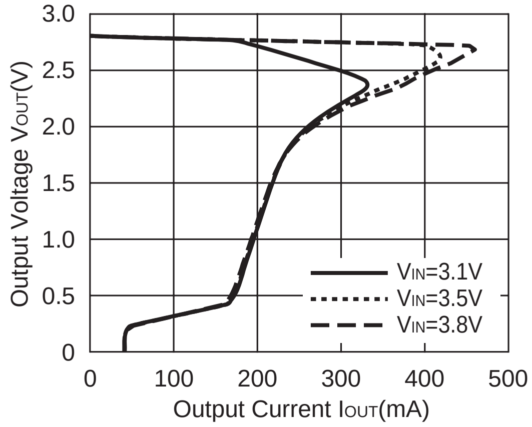

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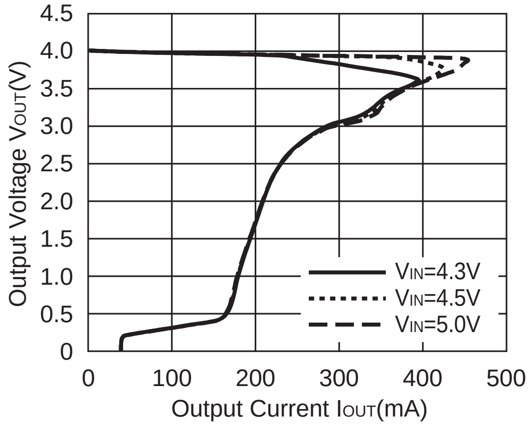
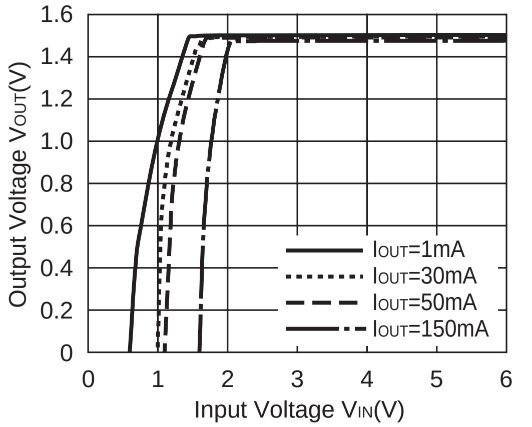


2) Output Voltage vs. Input Voltage (Topt=25°C)

R1116x151x



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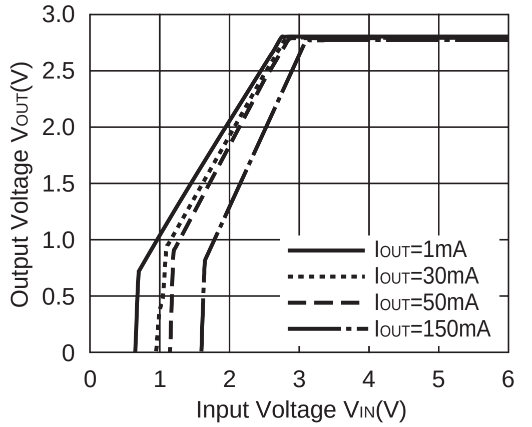
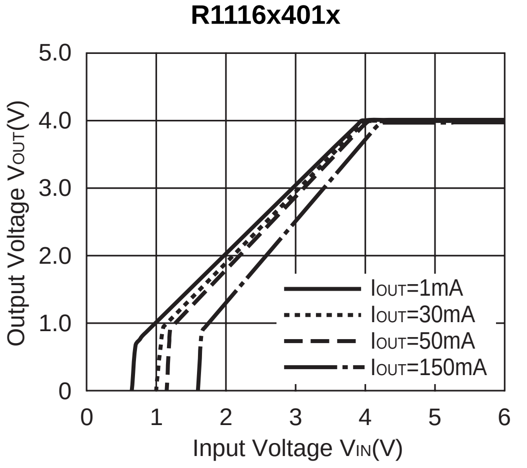
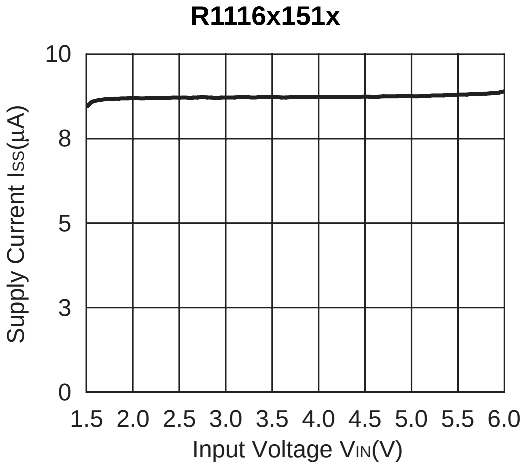
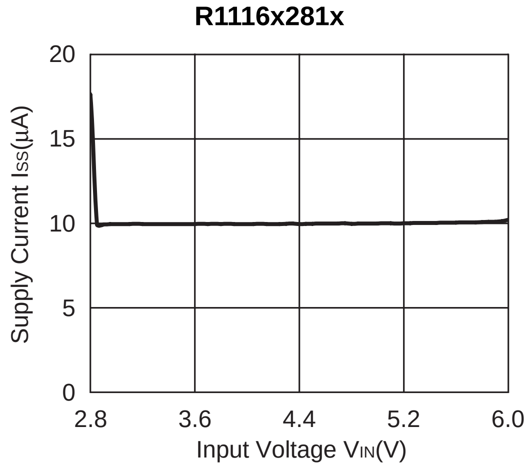
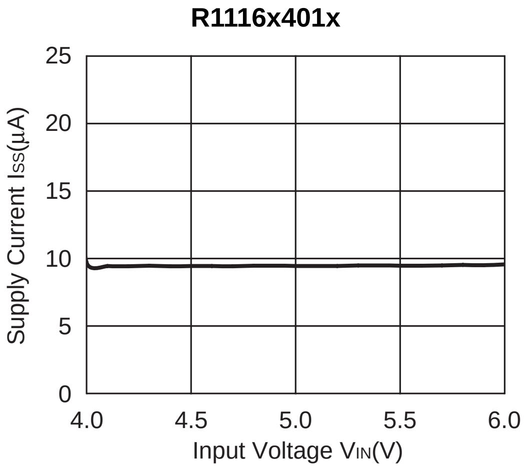




3) Supply Current vs. Input Voltage (Topt=25°C)

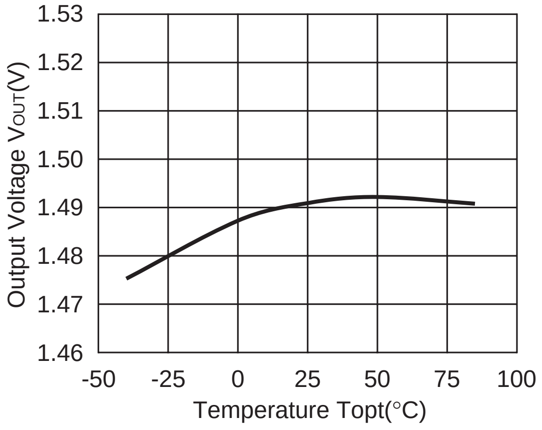






4) Output Voltage vs. Temperature

R1116x151x



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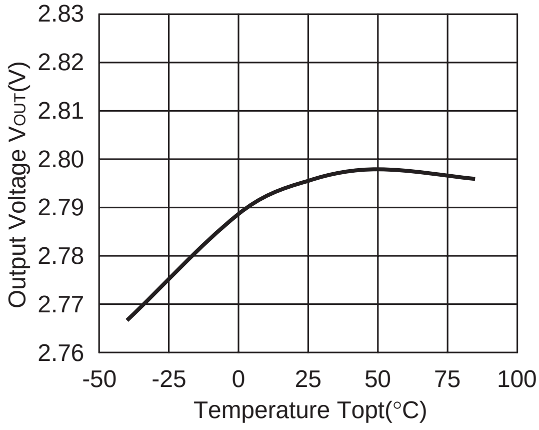

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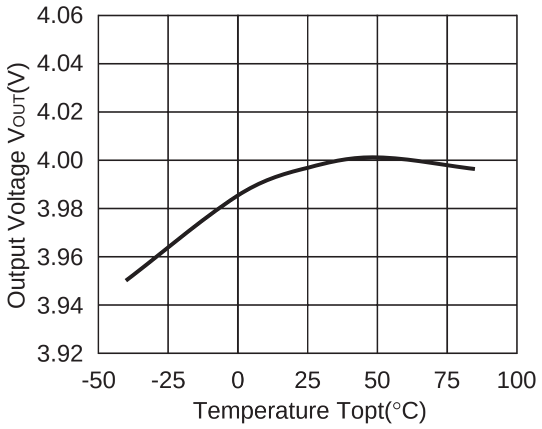
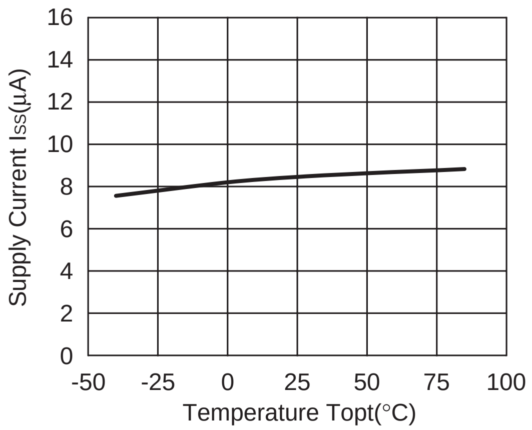


5) Supply Current vs. Temperature

R1116x151x



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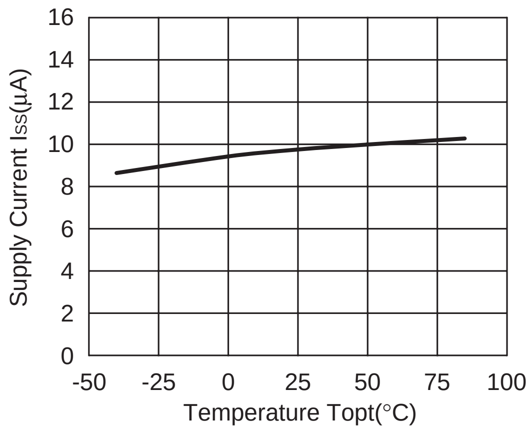

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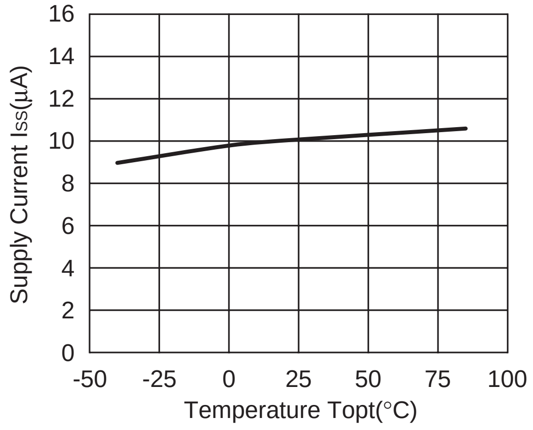
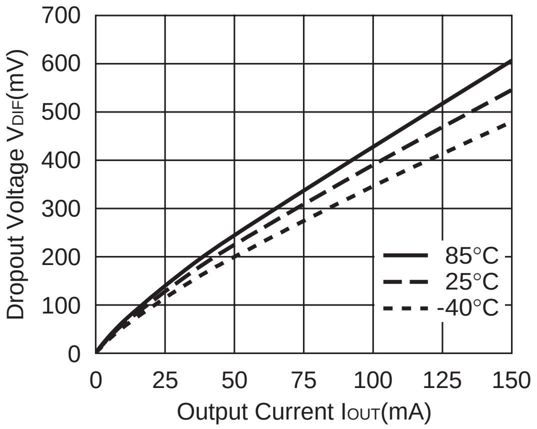
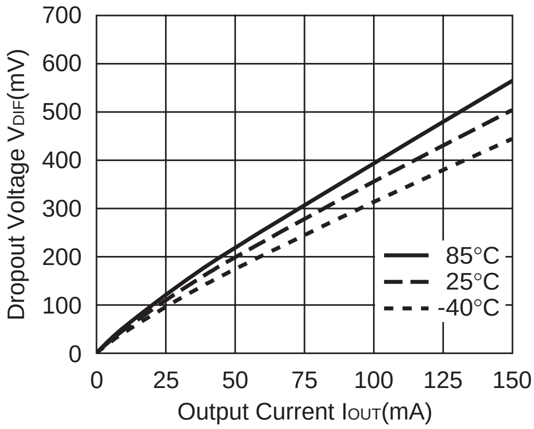


6) Dropout Voltage vs. Temperature

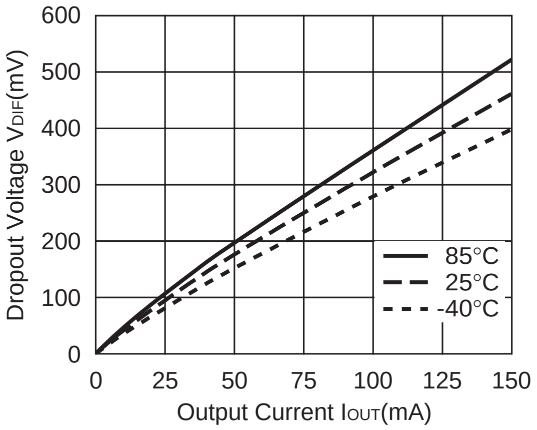
R1116x151x



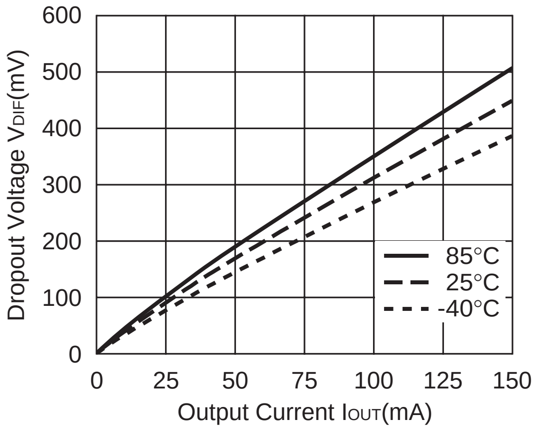
R1116x161x



R1116x171x



R1116x181x



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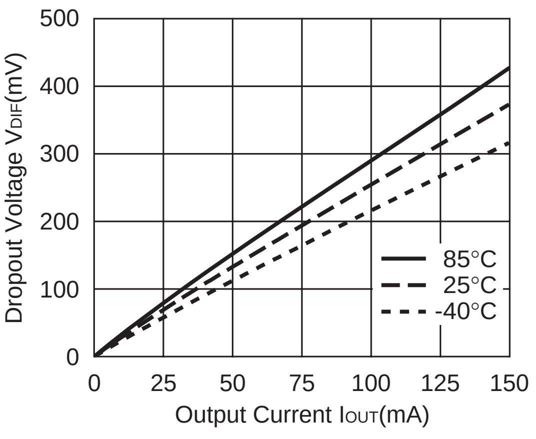

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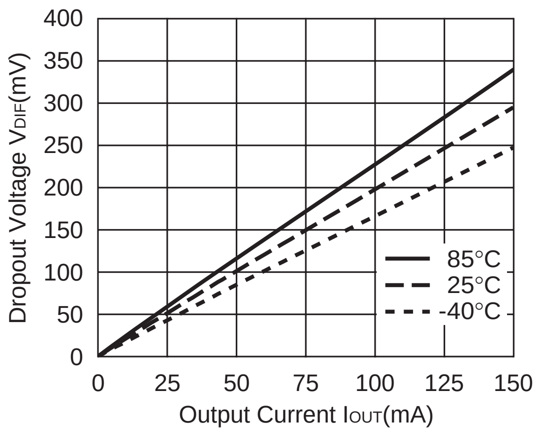

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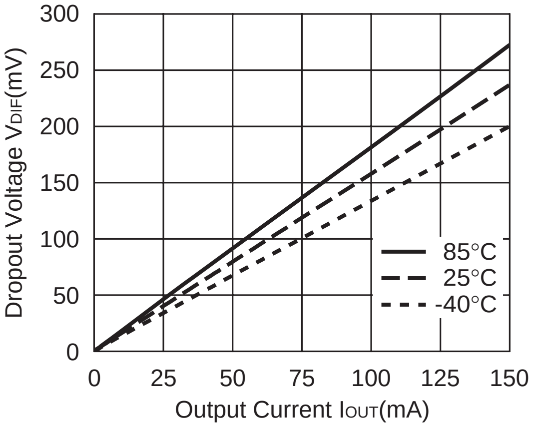
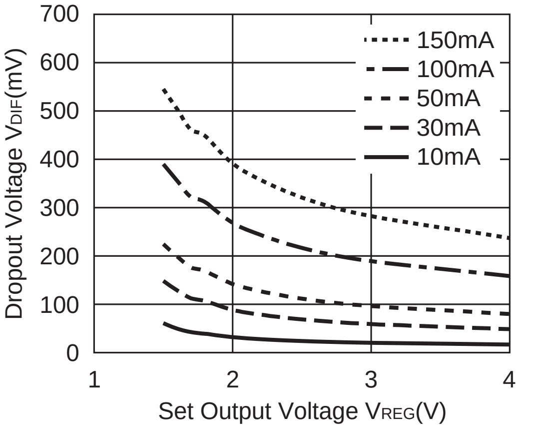


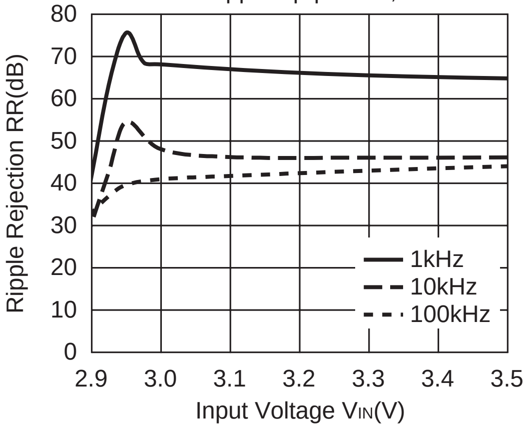
7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)



8) Ripple Rejection vs. Input Bias Voltage (Topt=25°C, C_{IN} = none, C_{OUT} = 1µF)

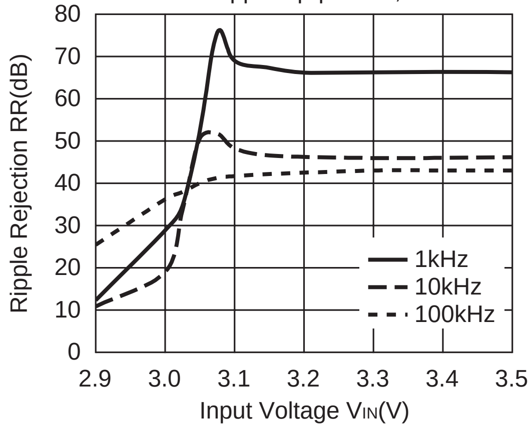
R1116x281x

Ripple Vp-p=0.2V, I_{OUT}=1mA



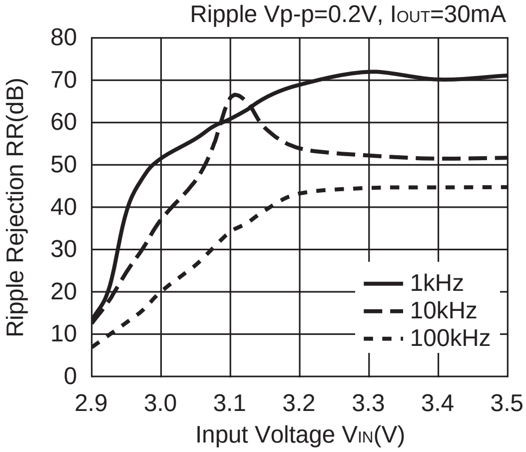
R1116x281x

Ripple Vp-p=0.5V, I_{OUT}=1mA



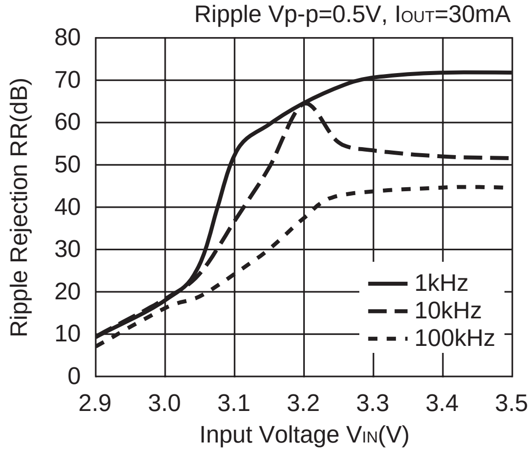
R1116x281x

Ripple Vp-p=0.2V, I_{OUT}=30mA



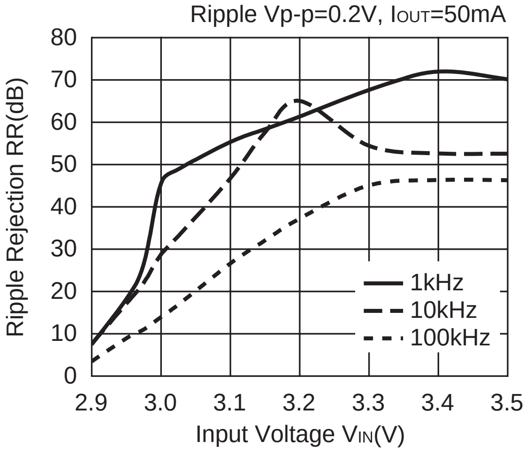
R1116x281x

Ripple Vp-p=0.5V, I_{OUT}=30mA



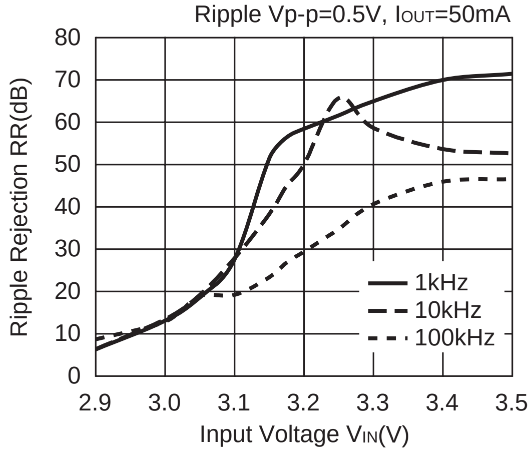
R1116x281x

Ripple Vp-p=0.2V, I_{OUT}=50mA



R1116x281x

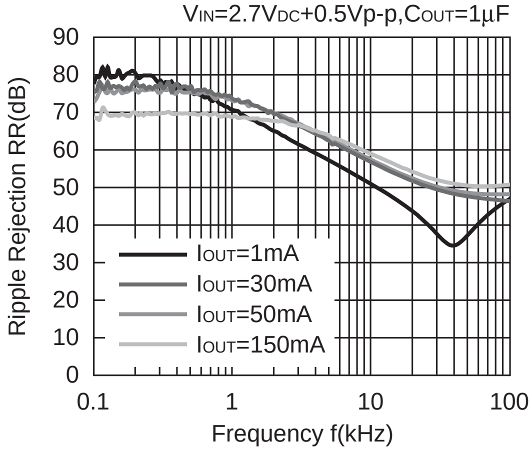
Ripple Vp-p=0.5V, I_{OUT}=50mA



9) Ripple Rejection vs. Frequency (C_{IN}=none)

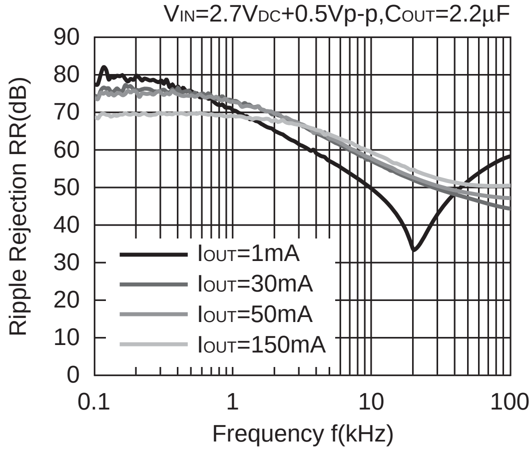
R1116x151x

V_{IN}=2.7V_{DC}+0.5Vp-p,C_{OUT}=1μF



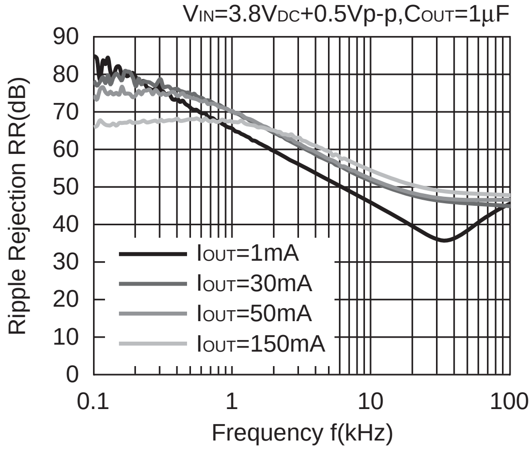
R1116x151x

V_{IN}=2.7V_{DC}+0.5Vp-p,C_{OUT}=2.2μF



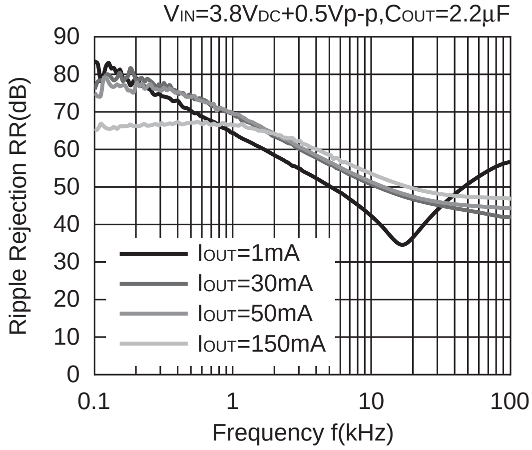
R1116x281x

V_{IN}=3.8V_{DC}+0.5Vp-p,C_{OUT}=1μF



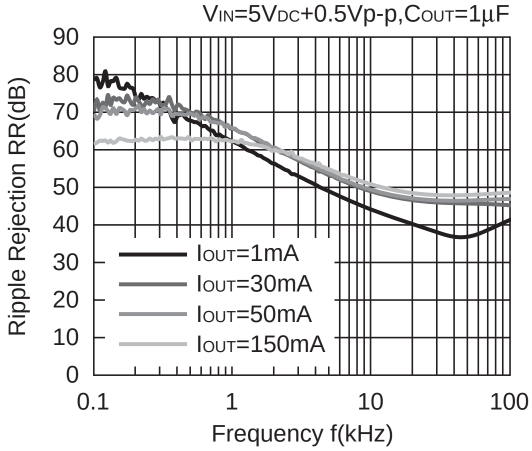
R1116x281x

V_{IN}=3.8V_{DC}+0.5Vp-p,C_{OUT}=2.2μF



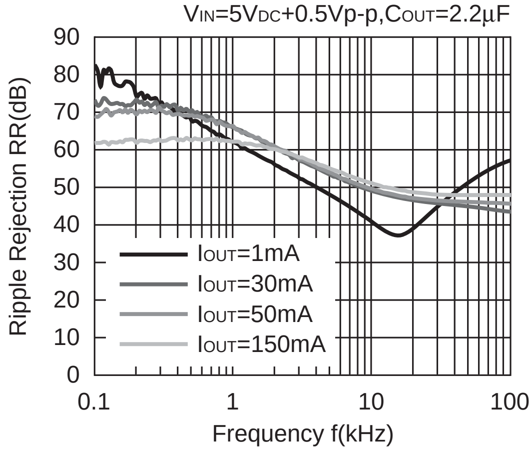
R1116x401x

V_{IN}=5V_{DC}+0.5Vp-p,C_{OUT}=1μF



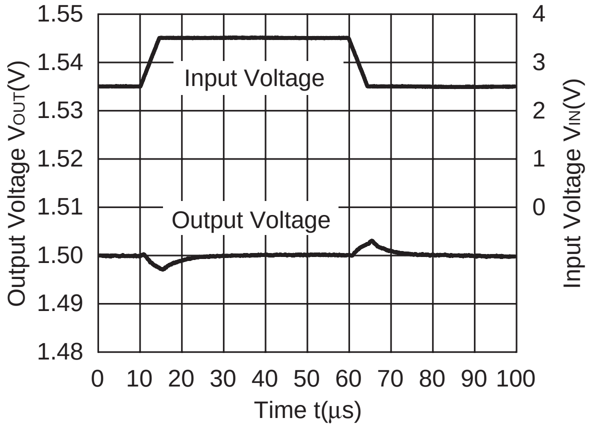
R1116x401x

V_{IN}=5V_{DC}+0.5Vp-p,C_{OUT}=2.2μF

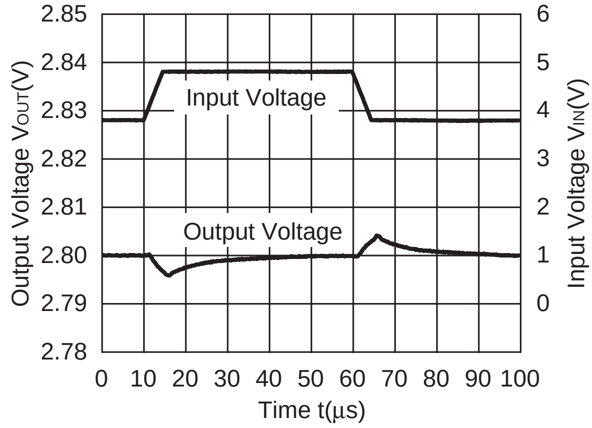


10) Input Transient Response (I_{OUT}=30mA, C_{IN}= none, tr=tf=5μs, C_{OUT} = Ceramic 1μF)

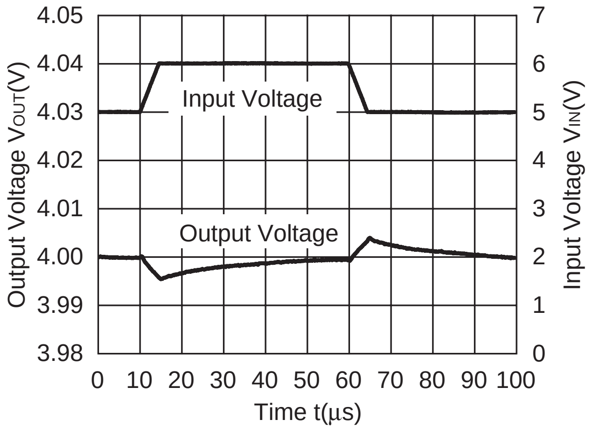
R1116x151x



R1116x281x

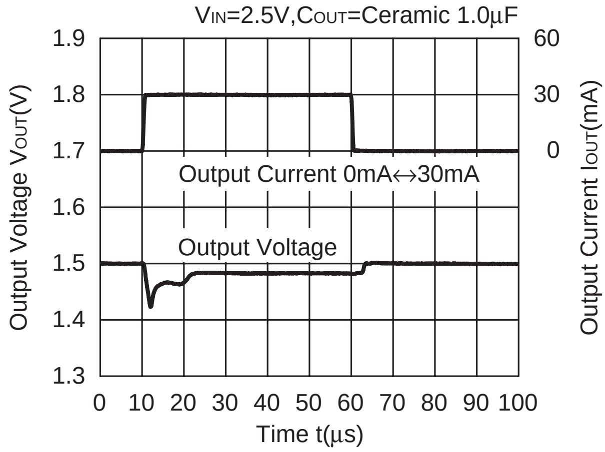


R1116x401x

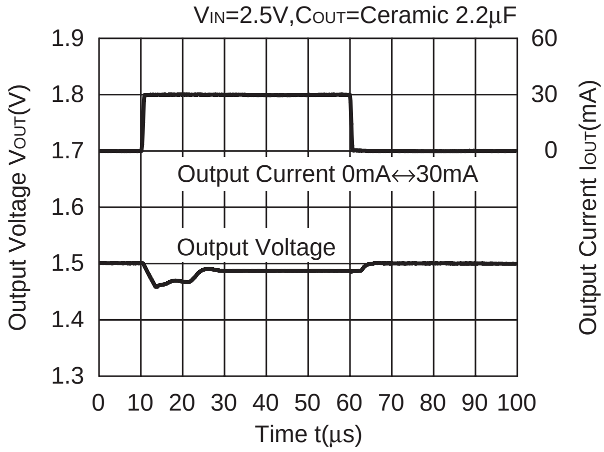


11) Load Transient Response (tr=tf=0.5μs, C_{IN}=Ceramic 1μF)

R1116x151x

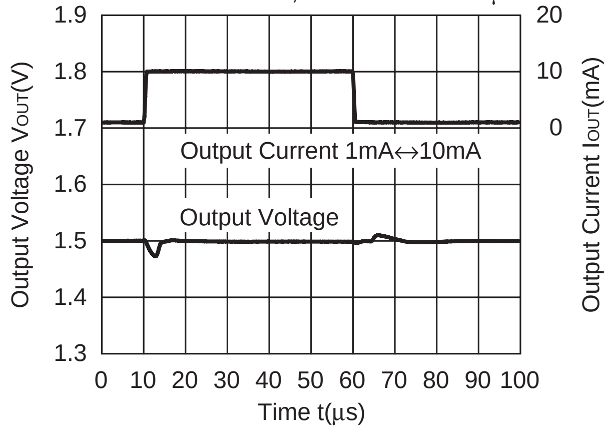


R1116x151x



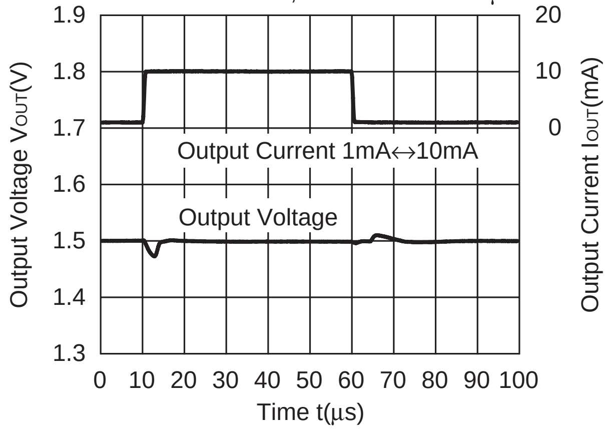
R1116x151x

V_{IN}=2.5V,C_{OUT}=Ceramic 1.0µF



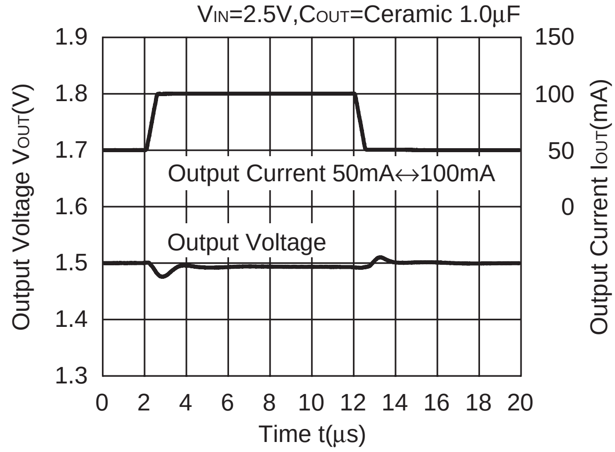
R1116x151x

V_{IN}=2.5V,C_{OUT}=Ceramic 2.2µF



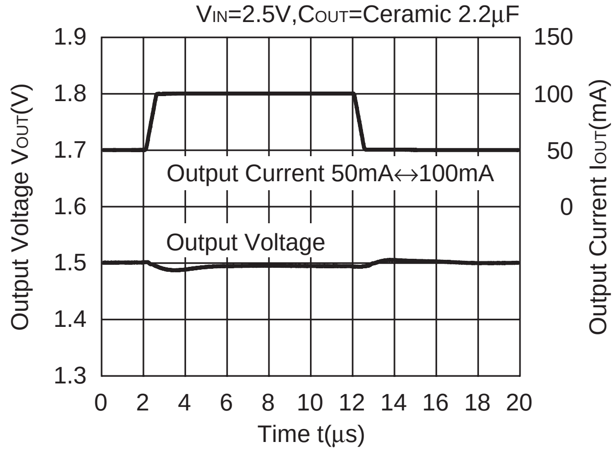
R1116x151x

V_{IN}=2.5V,C_{OUT}=Ceramic 1.0µF



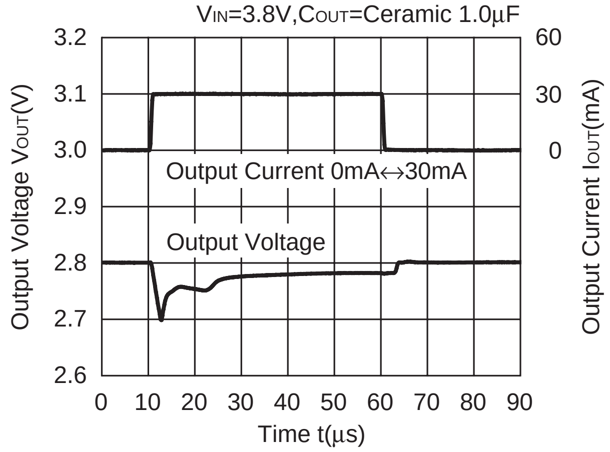
R1116x151x

V_{IN}=2.5V,C_{OUT}=Ceramic 2.2µF



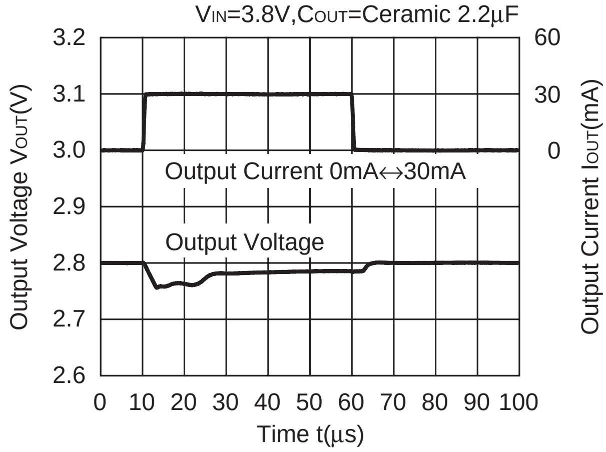
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 1.0µF



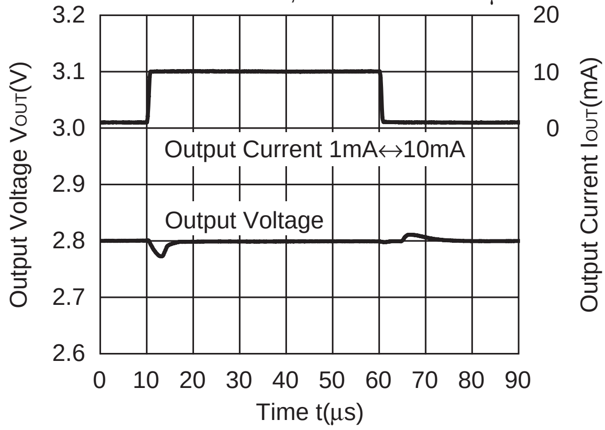
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 2.2µF



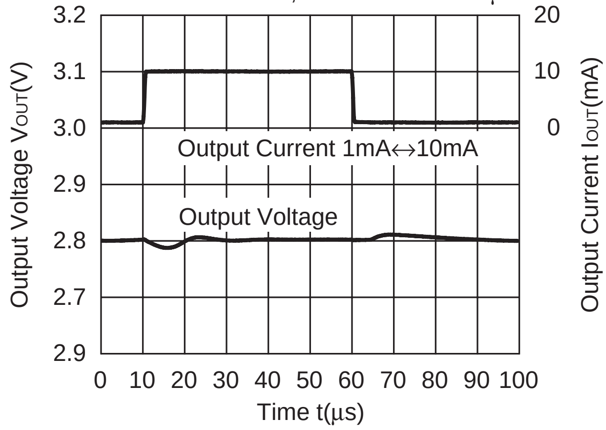
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 1.0µF



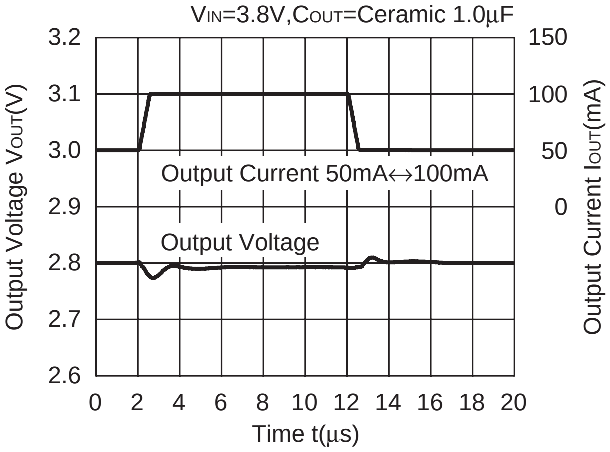
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 2.2µF



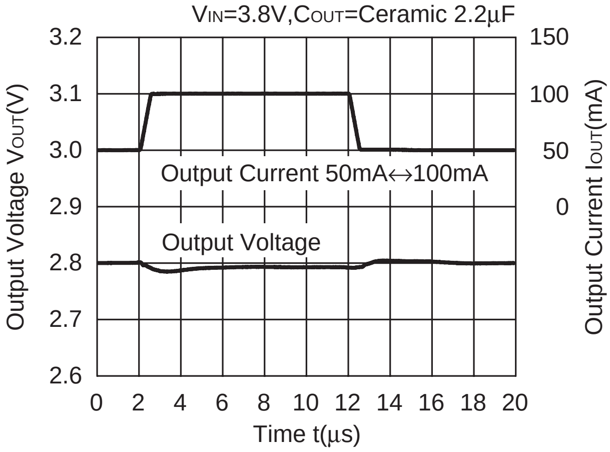
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 1.0µF



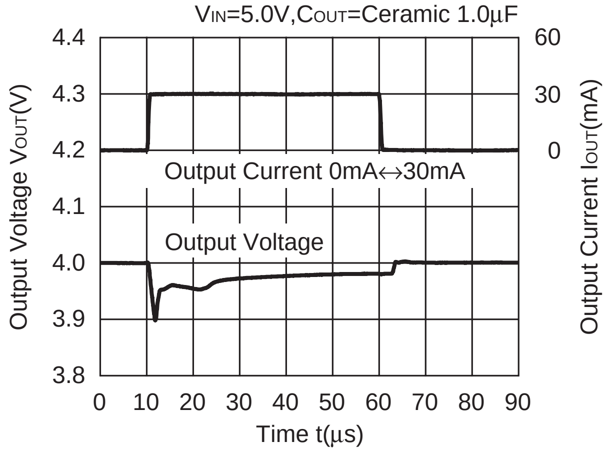
R1116x281x

V_{IN}=3.8V,C_{OUT}=Ceramic 2.2µF



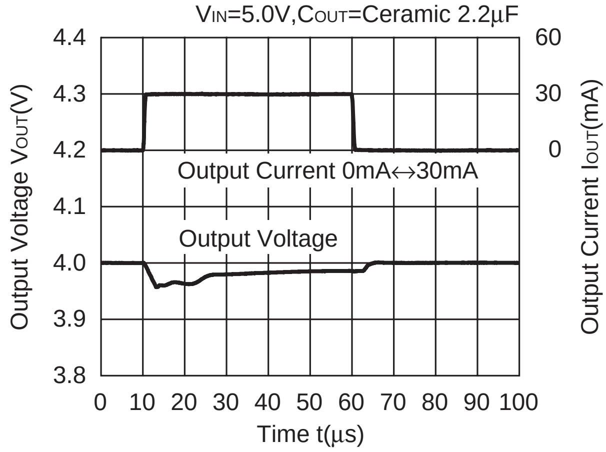
R1116x401x

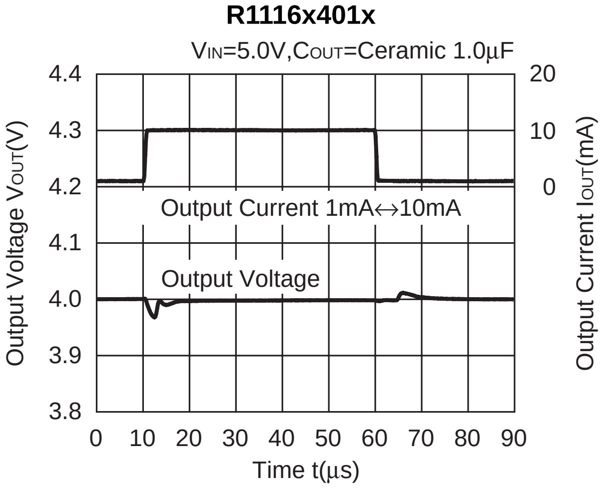
V_{IN}=5.0V,C_{OUT}=Ceramic 1.0µF

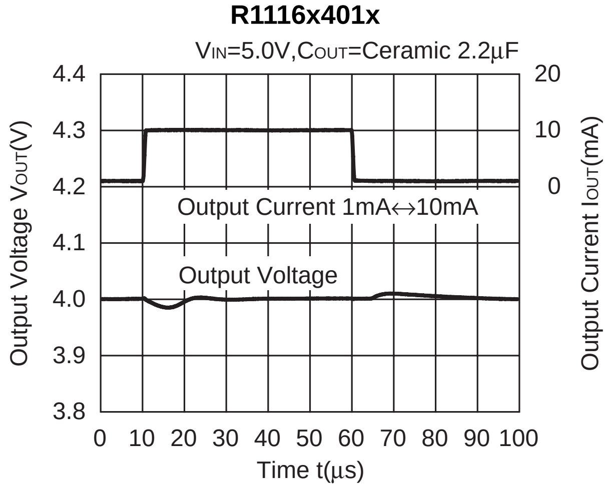


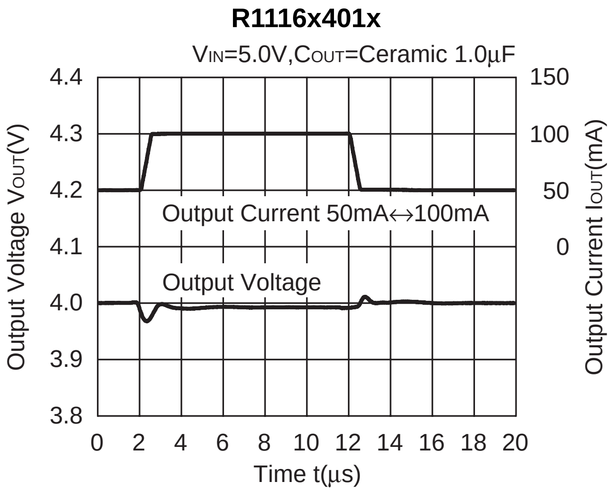
R1116x401x

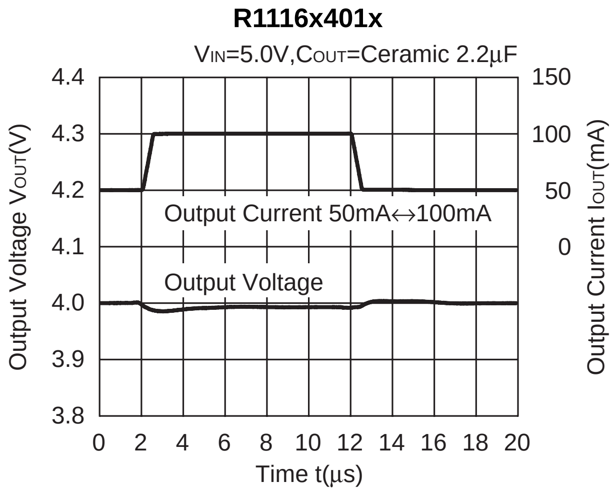
V_{IN}=5.0V,C_{OUT}=Ceramic 2.2µF



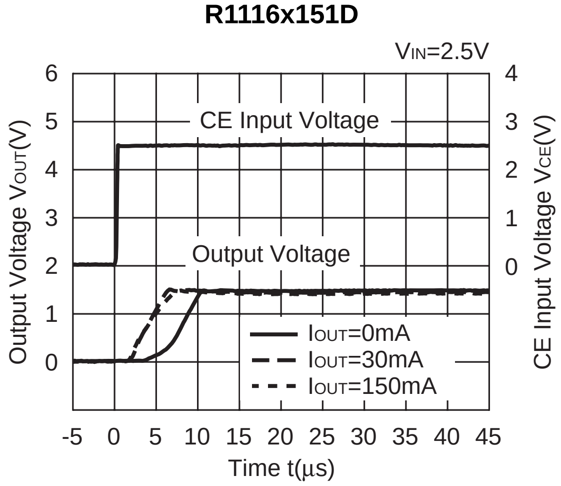


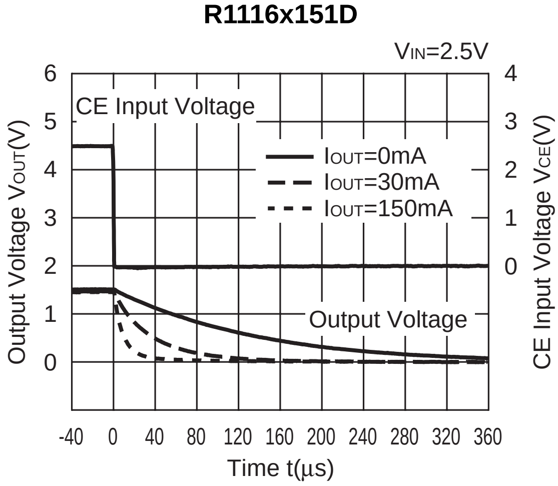


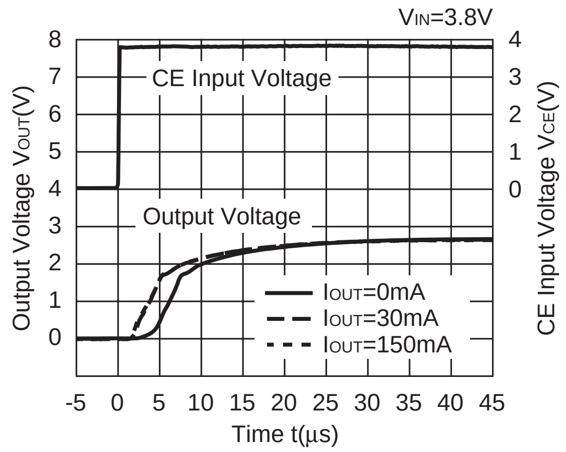


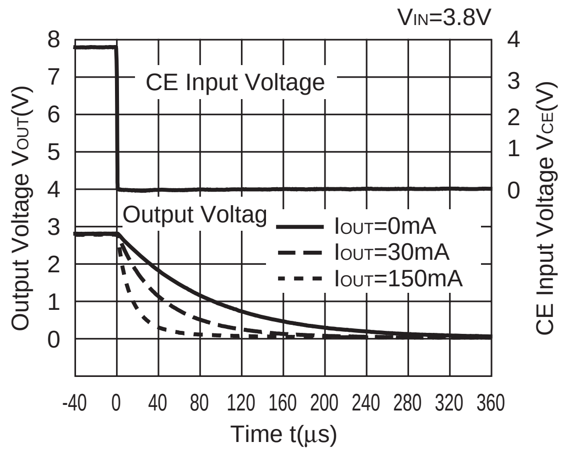


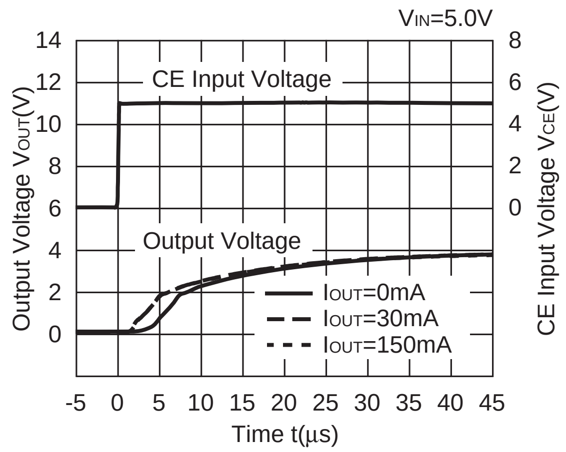
12) Turn-on/off speed with CE pin (D version) (C_{IN}=Ceramic 1.0µF, C_{OUT}=Ceramic 1.0µF)

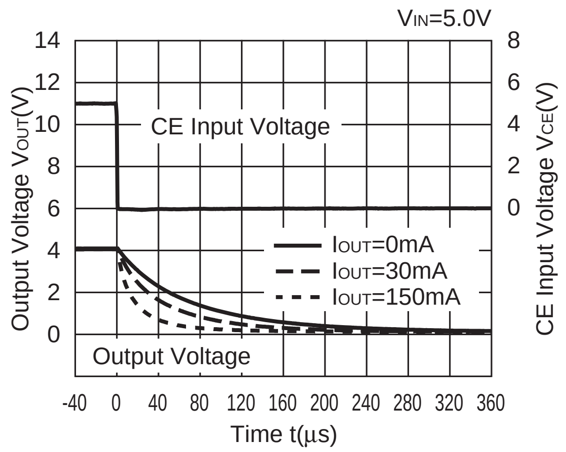




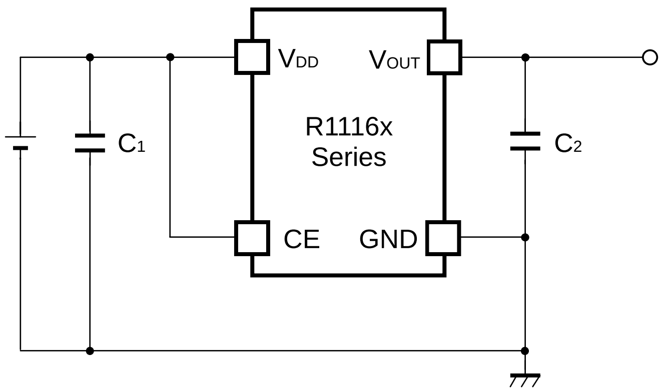

R1116x281D
VIN=3.8V
CE Input Voltage
Output Voltage
IOUT=0mA
IOUT=30mA
IOUT=150mA
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
Time t(μs)


R1116x281D
VIN=3.8V
CE Input Voltage
Output Voltag
IOUT=0mA
IOUT=30mA
IOUT=150mA
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
Time t(μs)


R1116x401D
VIN=5.0V
CE Input Voltage
Output Voltage
IOUT=0mA
IOUT=30mA
IOUT=150mA
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
Time t(μs)


R1116x401D
VIN=5.0V
CE Input Voltage
IOUT=0mA
IOUT=30mA
IOUT=150mA
Output Voltage
Output Voltage VOUT(V)
CE Input Voltage VCE(V)
Time t(μs)

TECHNICAL NOTES



(External Components)
C_2 Ceramic 1.0μF Ex. Murata GRM155B30J105KE18B
Kyocera CM05X5R105K06AB
C_1 Ceramic 1.0μF

When using these ICs, consider the following points:

1.Mounting on PCB

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

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

2.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 C_2 with good frequency characteristics and ESR (Equivalent Series Resistance). (Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable. Evaluate your circuit with considering frequency characteristics.
Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit with actual using capacitors.

ESR vs. Output Current

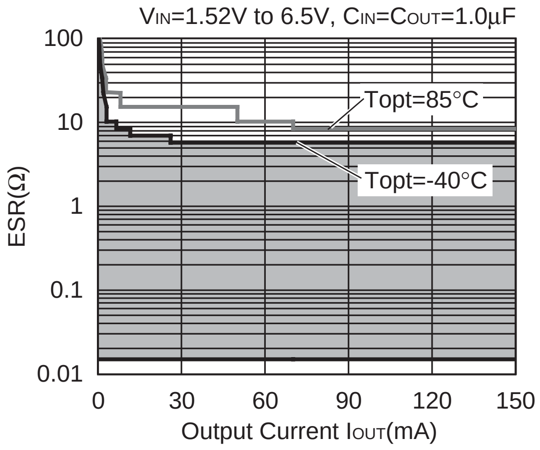
When using these ICs, consider the following points:

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.

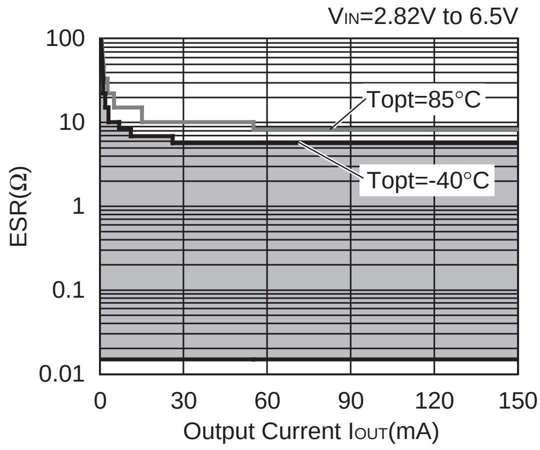
Measurement conditions

$V_{IN}=V_{OUT}+1V$
C_{OUT}: GRM155B30J105KE18B
Frequency Band: 10Hz to 2MHz
Temperature: –40°C to 25°C

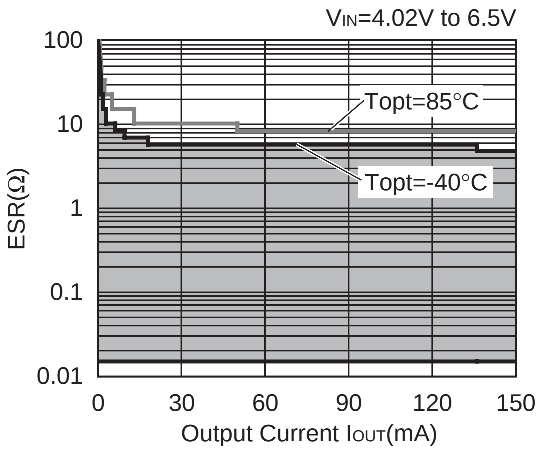
R1116x151x



R1116x281x



R1116x401x



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