150mA LDO REGULATOR FOR AUTOMOTIVE APPLICATIONS

NO.EC-105-140212

OUTLINE

The R1180x is a CMOS-based voltage regulator IC with high output voltage accuracy, extremely low supply current, and low ON-resistance. This IC consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a current limit circuit which prevents the destruction by excess current, and so on.
The output voltage is fixed with high accuracy. B version has a chip enable pin, therefore ultra-low consumption current standby mode can be realized with the pin.

The R1180x is available in SOT-23-5 package which is possible to mount at high density.

FEATURES

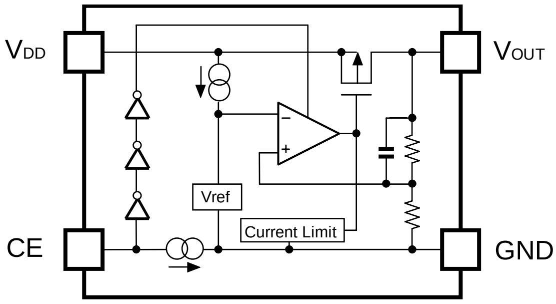
- Input Voltage (Maximum Rating)............................. 1.7V to 6.0V (6.5V)
- Supply Current .... Typ. 1.0μA
  (Except the current through CE pull-down circuit)
- Standby Mode .... Typ. 0.1μA
- Dropout Voltage .... Typ. 0.25V (I_{OUT}=150mA 3.0V Output type)
- Temperature-Drift Coefficient of Output Voltage ...... Typ. ±100ppm/°C
- Line Regulation .... Typ. 0.05%/V
- Output Voltage Accuracy.. ±2.0%
- Packages SOT-23-5
- Output Voltage Range.. 1.2V to 3.6V (0.1V steps)
- Built-in Fold Back Protection Circuit .... Typ. 40mA (Current at short mode)
- Recommended Ceramic Capacitor to IC .... 0.1μF or more

APPLICATIONS

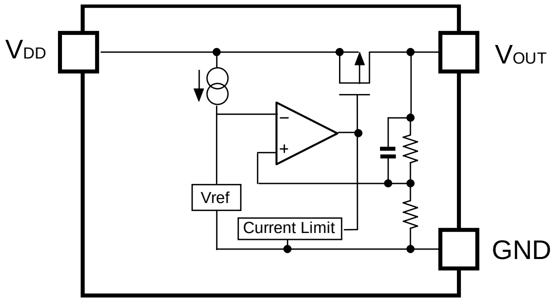
- Power source for car accessories including car audio equipment, car navigation system, and ETC system.
- Power source for control units including EV inverter and charge control.

BLOCK DIAGRAMS

R1180xxx1B



R1180xxx1C



SELECTION GUIDE

The output voltage, CE pin polarity, package, etc. for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1180Nxx1∗-TR-#E	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.2V(12) to 3.6V(36) in 0.1V steps.

∗ : CE pin polarity is options as follows.
(B) "H" Active
(C) without CE pin

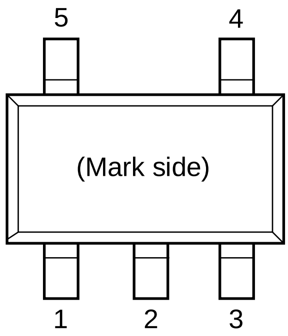
: Specify the automotive class code.

	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	−40°C to 85°C	25°C	High Temperature
H	−40°C to 85°C	25°C	High and Low Temperature

Note: The product with "H" class code supports the device with CE pin ("H" Active) only.
(R1180Nxx1B-TR-HE)

PIN DESCRIPTIONS

● **SOT-23-5**



● **SOT-23-5**

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

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 to V_{IN}+0.3	V
I_{OUT}	Output Current		180	mA
P_D	Power Dissipation (SOT-23-5)*[1]	Standard Land Pattern	525	mW
Tj	Junction Temperature		–40 to 150	°C
Tstg	Storage Temperature Range		–55 to 150	°C

*[1] 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 rating is not assured.

RECOMMENDED OPERATING RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	1.7 to 6.0	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING RATINGS

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

ELECTRICAL CHARACTERISTICS

- **R1180xxx1B/C**

Ta=25°C

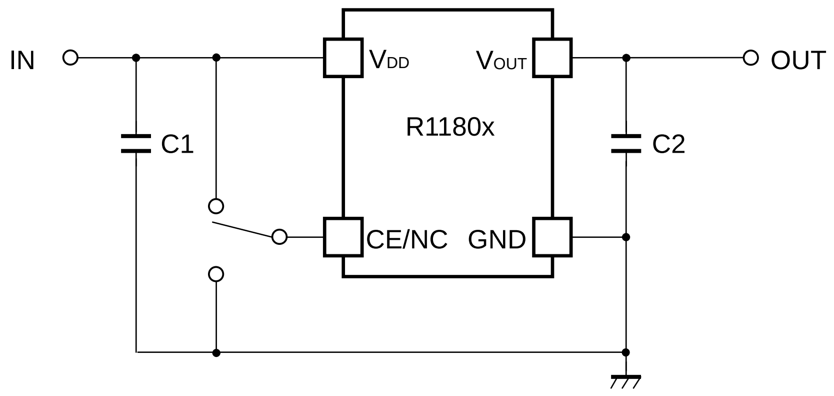
Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=Set V_{OUT}+1V 1mA ≤ I_{OUT} ≤ 30mA		×0.980		×1.020	V
I_{OUT}	Output Current	V_{IN}–V_{OUT}=1.0V(V_{OUT} ≥ 1.5V) V_{IN}=2.4V(V_{OUT}<1.5V)		150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}–V_{OUT}=1.0V(V_{OUT} ≥ 1.5V) V_{IN}=2.4V(V_{OUT}<1.5V) 1µA ≤ I_{OUT} ≤ 150mA			20	40	mV
V_{DIF}	Dropout Voltage	I_{OUT}=150mA		Refer to the *Product-specific Electrical Characteristics.*			
I_{SS}	Supply Current	V_{IN}–V_{OUT}=1.0V,I_{OUT}=0mA			1.0	1.5	µA
Istandby	Supply Current (Standby)	V_{IN}–V_{OUT}=1.0V,V_{CE}=GND			0.1	1.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	I_{OUT} =30mA	V_{OUT}+0.5V ≤ V_{IN} ≤ 6.0V (V_{OUT} ≥ 1.5V) 2.0V ≤ V_{IN} ≤ 6.0V (1.2V ≤ V_{OUT} ≤ 1.4V)		0.05	0.20	%/V
V_{IN}	Input Voltage			1.7		6.0	V
$\Delta V_{OUT}/\Delta Ta$	Output Voltage Temperature Coefficient	I_{OUT}=30mA –40°C ≤ Ta ≤ 85°C			±100		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V			40		mA
I_{PD}	CE Pull-down Constant Current	(R1180xxx1B)			0.35		µA
V_{CEH}	CE Input Voltage "H"	(R1180xxx1B)		1.2		6.0	V
V_{CEL}	CE Input Voltage "L"	(R1180xxx1B)		0.0		0.3	V

- **Product-specific Electrical Characteristics**

Topt=25°C

Product Name	V_{OUT} [V]			V_{DIF} [V]	
	MIN.	TYP.	MAX.	TYP.	MAX.
R1180N121x	1.176	1.200	1.224	0.85	1.20
R1180N131x	1.274	1.300	1.326	0.75	1.10
R1180N141x	1.372	1.400	1.428	0.65	1.00
R1180N151x	1.470	1.500	1.530	0.60	0.90
R1180N161x	1.568	1.600	1.632		
R1180N171x	1.666	1.700	1.734	0.50	0.75
R1180N181x	1.764	1.800	1.836		
R1180N191x	1.862	1.900	1.938	0.40	0.65
R1180N201x	1.960	2.000	2.040		
R1180N211x	2.058	2.100	2.142	0.35	0.55
R1180N221x	2.156	2.200	2.244		
R1180N231x	2.254	2.300	2.346		
R1180N241x	2.352	2.400	2.448		
R1180N251x	2.450	2.500	2.550		
R1180N261x	2.548	2.600	2.652		
R1180N271x	2.646	2.700	2.754		
R1180N281x	2.744	2.800	2.856	0.25	0.40
R1180N291x	2.842	2.900	2.958		
R1180N301x	2.940	3.000	3.060		
R1180N311x	3.038	3.100	3.162		
R1180N321x	3.136	3.200	3.264		
R1180N331x	3.234	3.300	3.366		
R1180N341x	3.332	3.400	3.468		
R1180N351x	3.430	3.500	3.570		
R1180N361x	3.528	3.600	3.672		

TYPICAL APPLICATION



External Parts Example:

C1	1.0µF (Ceramic)
C2	0.1µF (Ceramic)

TECHNICAL NOTES

When using these ICs, consider the following points:

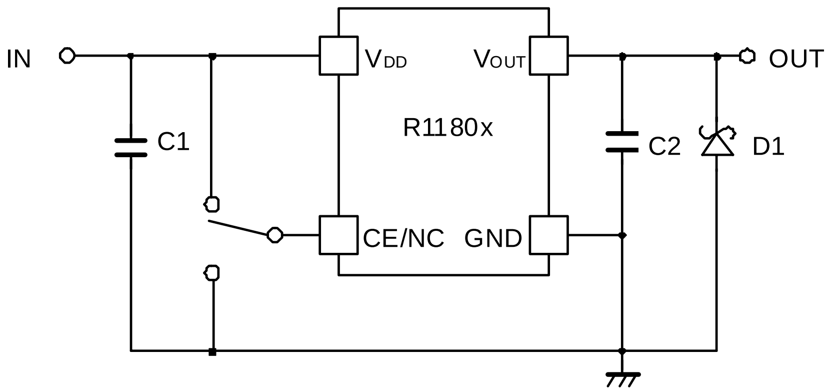
Phase Compensation

In this device, 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). (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 this device with as same external components as ones to be used on the PCB.)

PCB Layout

Ensure the V_{DD} and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. Connect a 1.0µF input capacitor (C1) between the V_{DD} and GND pins, and as close as possible to the pins. Connect C2 as close as possible to the IC to make the wiring as short as possible. Please refer to the Basic Circuit Diagram as above.

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



Ex. R1180x Circuit Diagram

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 (C_{OUT}) 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.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-23-5)

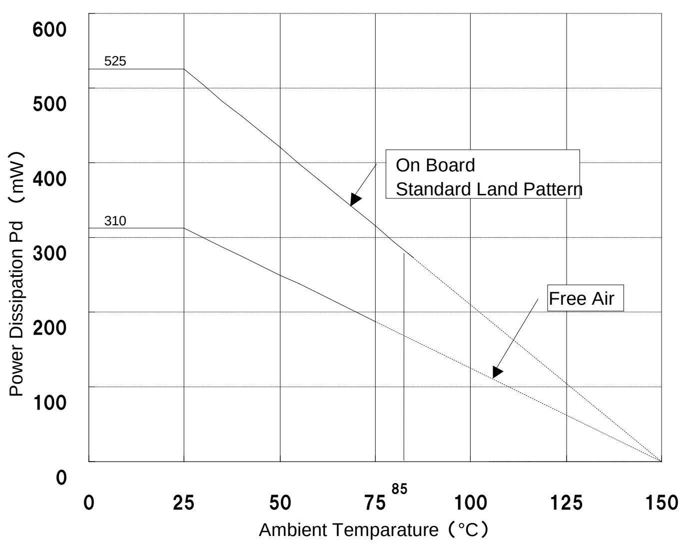
Power Dissipation (P_D), which indicates the P_D of SOT-23-6 package as a substitute, depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

Measurement Conditions

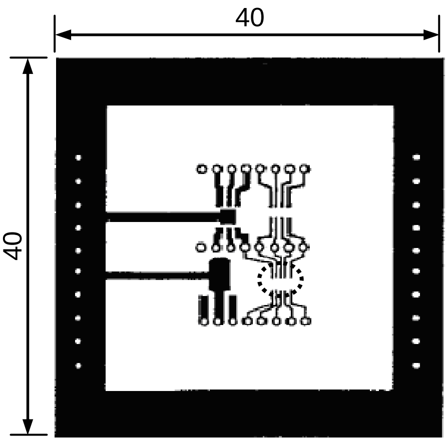
	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm x 40mm x 1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.5mm * 44pcs

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

	Standard Test Land Pattern	Free Air
Power Dissipation	525mW	310mW
Thermal Resistance	θja = (150-25°C)/0.525W = 238°C/W	400°C/W



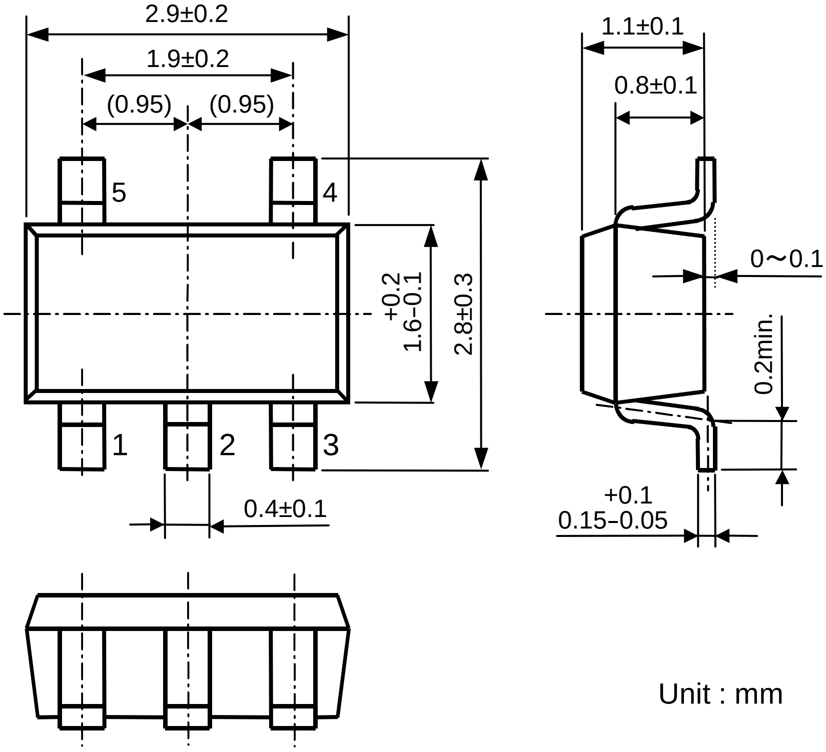
Power Dissipation



Measurement Board Pattern

IC Mount Area (Unit: mm)

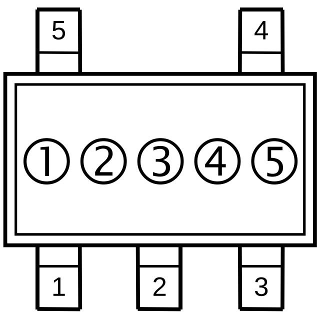
PACKAGE DIMENSIONS (SOT-23-5)



SOT-23-5 Package Dimensions

MARK SPECIFICATION (HSOP-6J)

①②③: Product Code ⋯ Refer to *R1180N MARK SPECFICATION TABLE*
④⑤: Lot Number ⋯ Alphanumeric Serial Number

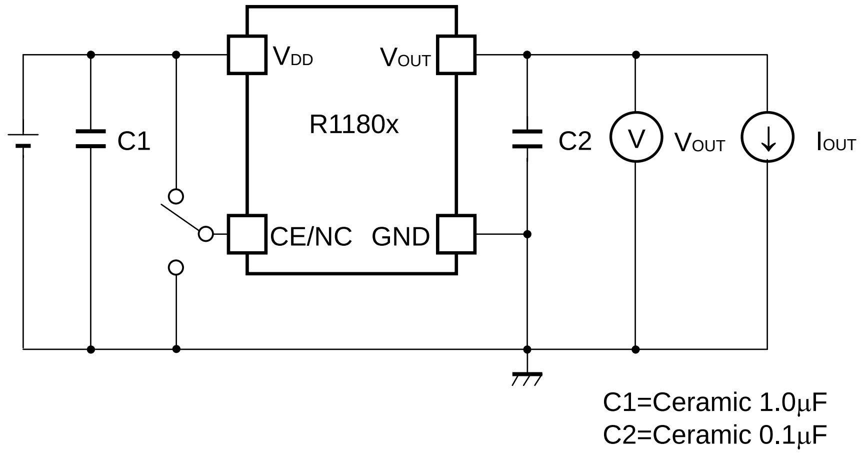


R1180N MARK SPECIFICATION TABLE (SOT-23-5)

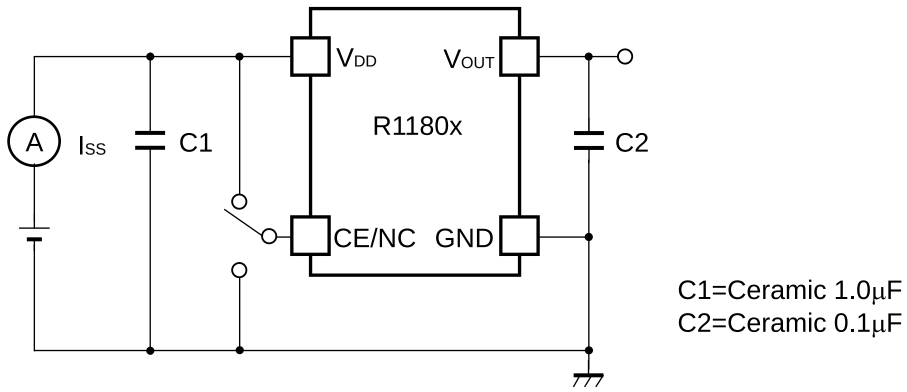
Product Name	① ② ③	V_{SET}
R1180N121B	C 1 2	1.2V
R1180N131B	C 1 3	1.3V
R1180N141B	C 1 4	1.4V
R1180N151B	C 1 5	1.5V
R1180N161B	C 1 6	1.6 V
R1180N171B	C 1 7	1.7 V
R1180N181B	C 1 8	1.8 V
R1180N191B	C 1 9	1.9 V
R1180N201B	C 2 0	2.0 V
R1180N211B	C 2 1	2.1 V
R1180N221B	C 2 2	2.2 V
R1180N231B	C 2 3	2.3 V
R1180N241B	C 2 4	2.4 V
R1180N251B	C 2 5	2.5 V
R1180N261B	C 2 6	2.6 V
R1180N271B	C 2 7	2.7 V
R1180N281B	C 2 8	2.8 V
R1180N291B	C 2 9	2.9 V
R1180N301B	C 3 0	3.0 V
R1180N311B	C 3 1	3.1 V
R1180N321B	C 3 2	3.2 V
R1180N331B	C 3 3	3.3 V
R1180N341B	C 3 4	3.4 V
R1180N351B	C 3 5	3.5 V
R1180N361B	C 3 6	3.6 V

Product Name	① ② ③	V_{SET}
R1180N121C	D 1 2	1.2V
R1180N131C	D 1 3	1.3V
R1180N141C	D 1 4	1.4V
R1180N151C	D 1 5	1.5V
R1180N161C	D 1 6	1.6 V
R1180N171C	D 1 7	1.7 V
R1180N181C	D 1 8	1.8 V
R1180N191C	D 1 9	1.9 V
R1180N201C	D 2 0	2.0 V
R1180N211C	D 2 1	2.1 V
R1180N221C	D 2 2	2.2 V
R1180N231C	D 2 3	2.3 V
R1180N241C	D 2 4	2.4 V
R1180N251C	D 2 5	2.5 V
R1180N261C	D 2 6	2.6 V
R1180N271C	D 2 7	2.7 V
R1180N281C	D 2 8	2.8 V
R1180N291C	D 2 9	2.9 V
R1180N301C	D 3 0	3.0 V
R1180N311C	D 3 1	3.1 V
R1180N321C	D 3 2	3.2 V
R1180N331C	D 3 3	3.3 V
R1180N341C	D 3 4	3.4 V
R1180N351C	D 3 5	3.5 V
R1180N361C	D 3 6	3.6 V

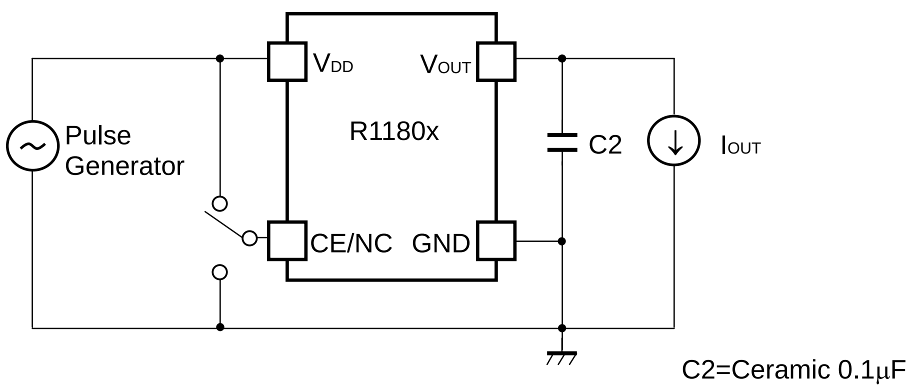
TEST CIRCUITS



Standard Test Circuit



Supply Current Test Circuit



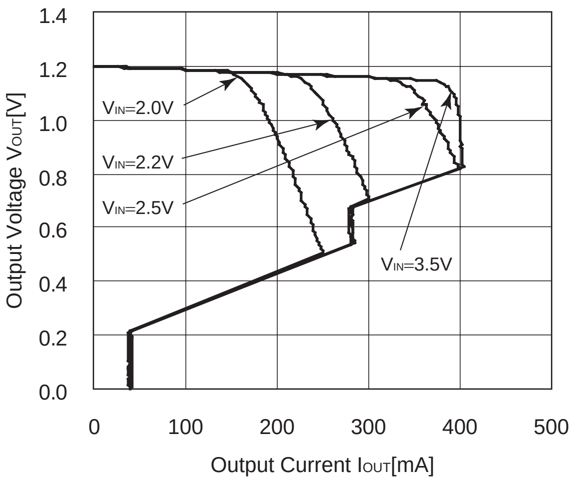
Ripple Rejection, Line Transient Response Test Circuit

TYPICAL CHARACTERISTICS

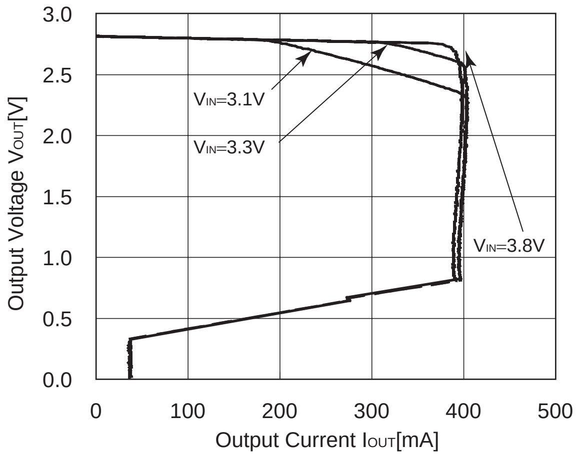
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

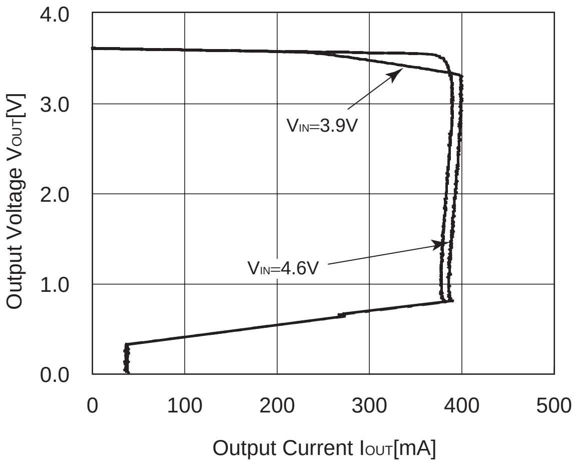
R1180x121x



R1180x281x

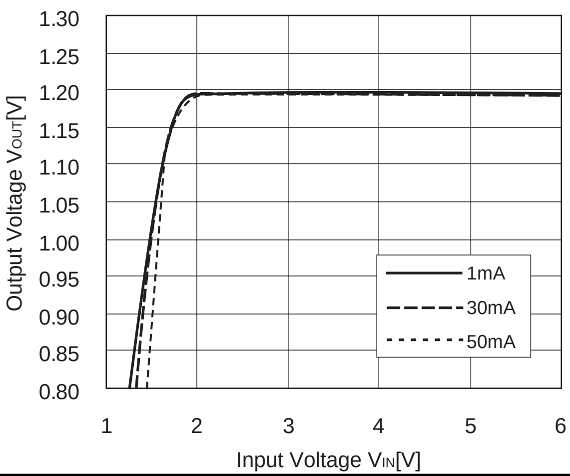


R1180x361x

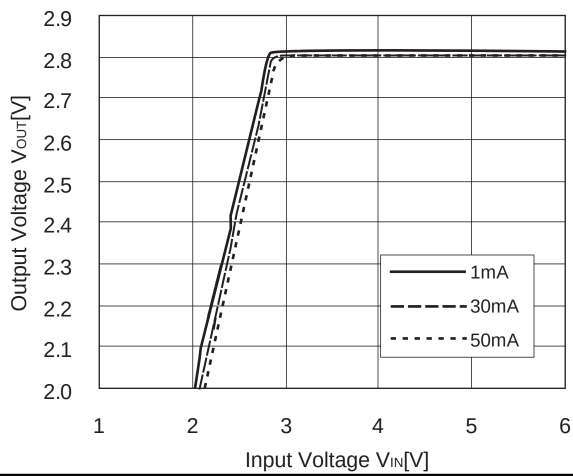


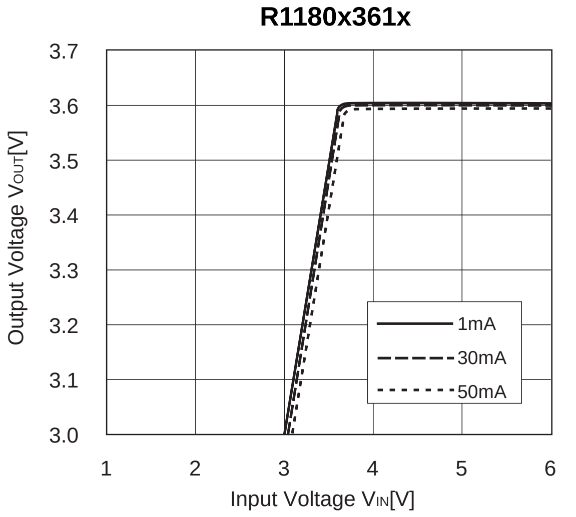
2) Output Voltage vs. Input Voltage (Ta=25°C)

R1180x121x

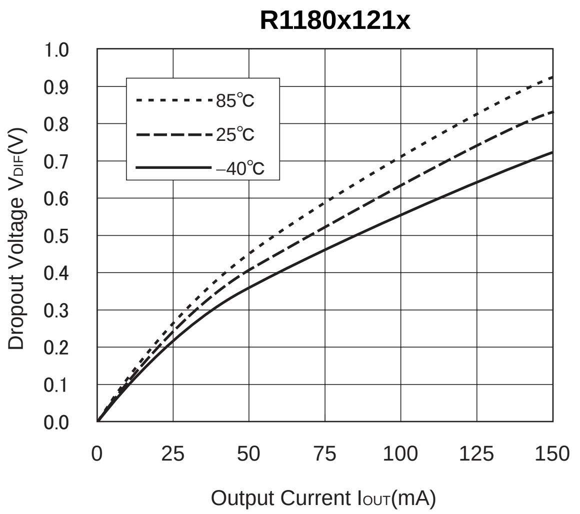


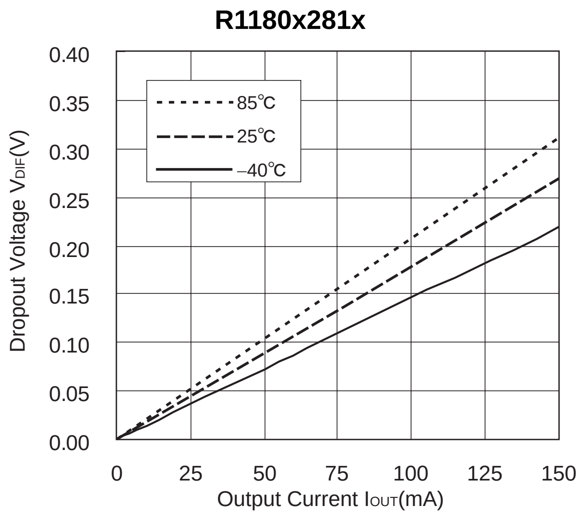
R1180x281x

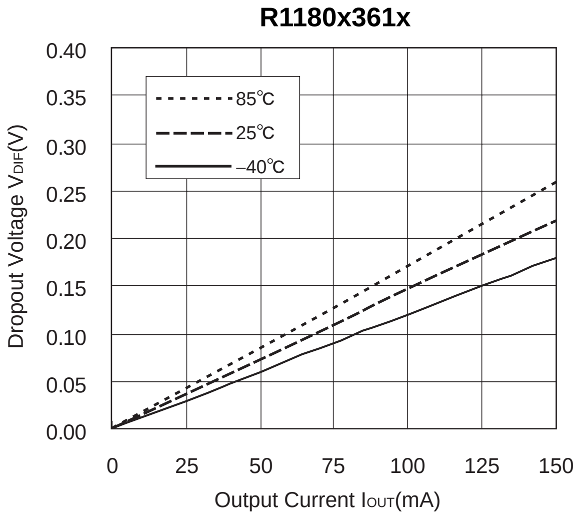




3) Dropout Voltage vs. Output Current

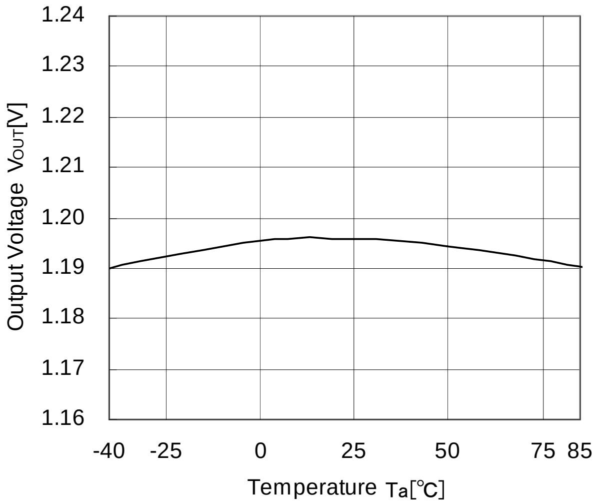




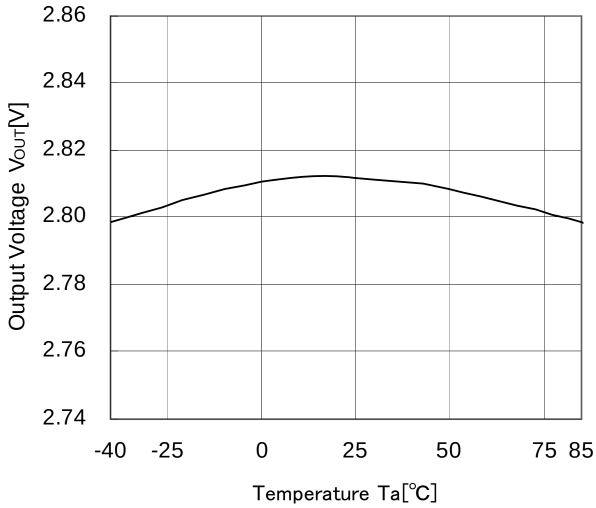


4) **Output Voltage vs. Temperature (I_{OUT}=30mA)**

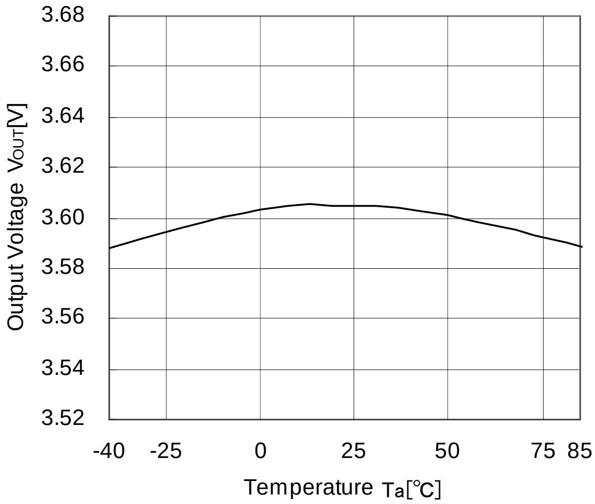
R1180x121x (V_{IN}=2.2V)



R1180x281x (V_{IN}=3.8V)

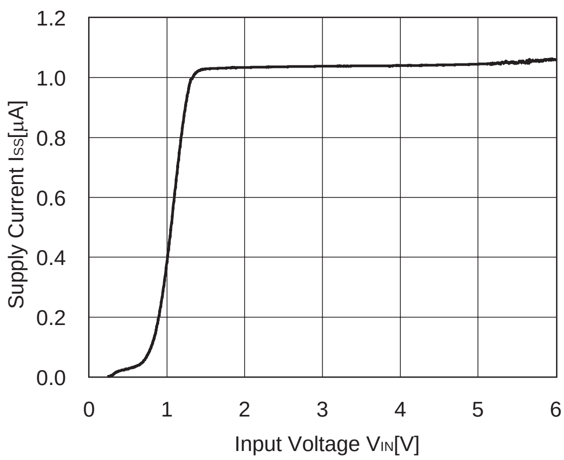


R1180x361x (V_{IN}=4.6V)

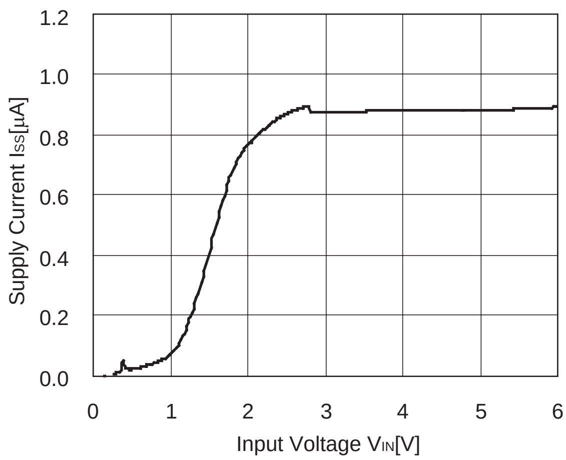


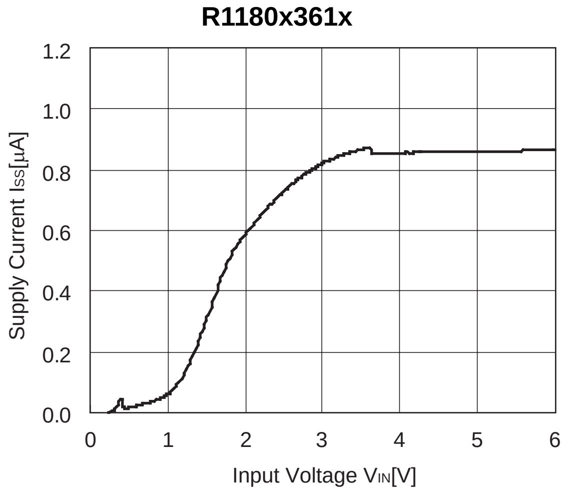
5) **Supply Current vs. Input Voltage (Ta=25°C)**

R1180x121x

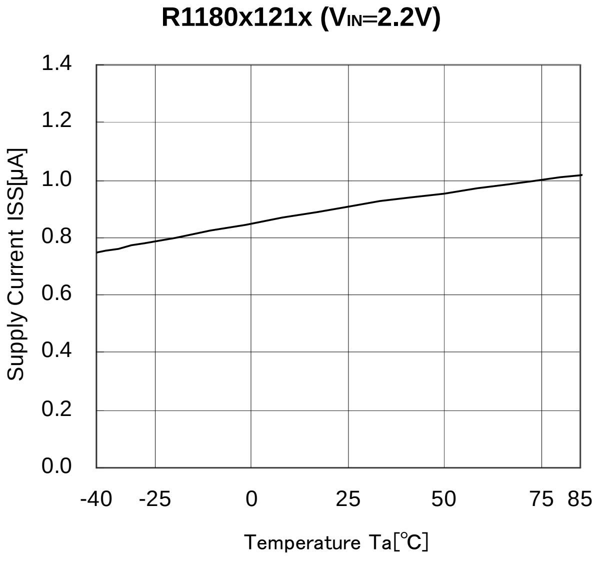


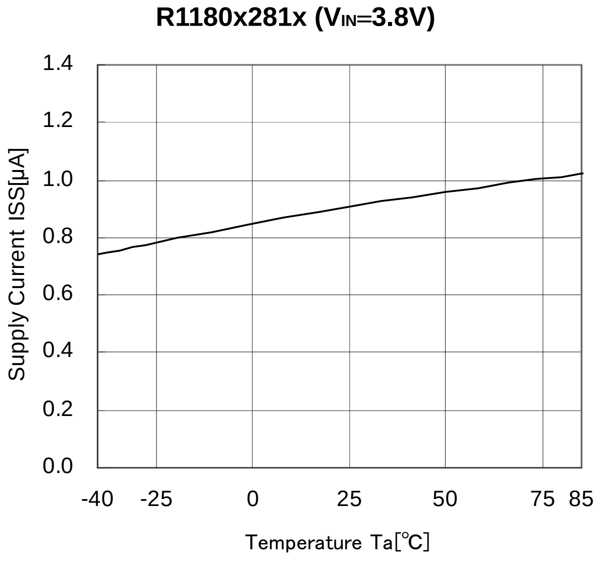
R1180x281x

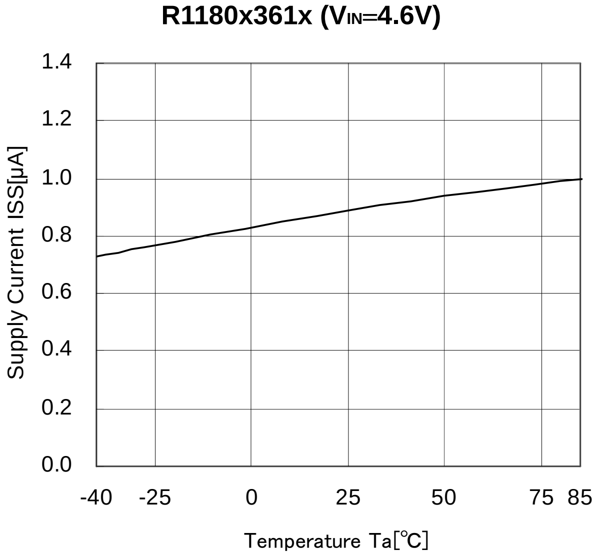




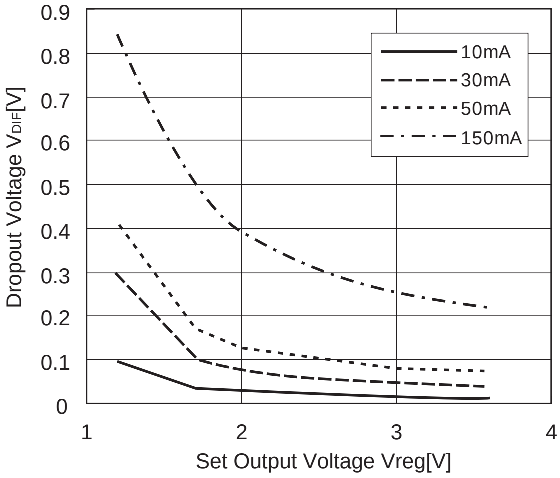
6) **Supply Current vs. Temperature**





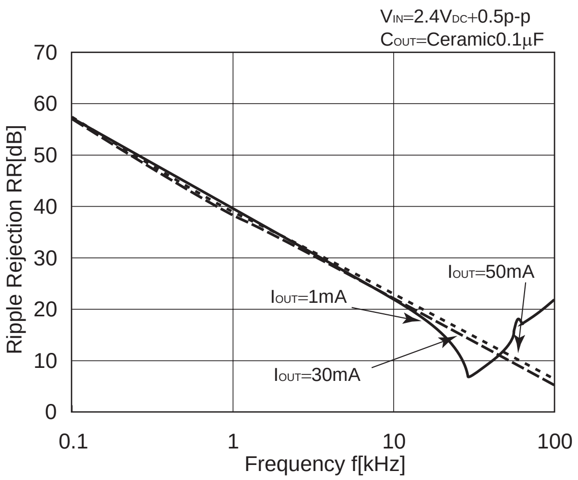


7) Dropout Voltage vs. Set Output Voltage (Ta=25°C)

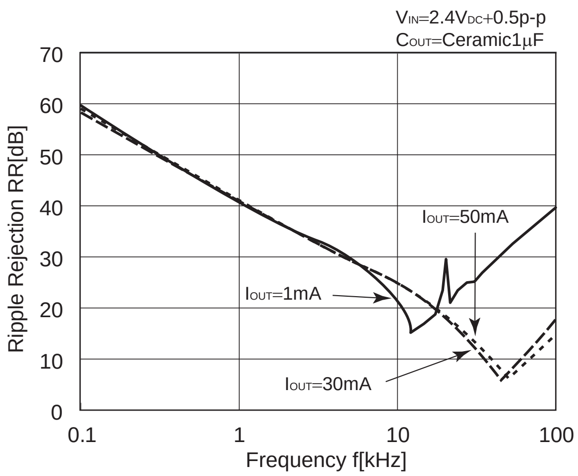


8) **Ripple Rejection vs. Frequency (**C1 =**none)**

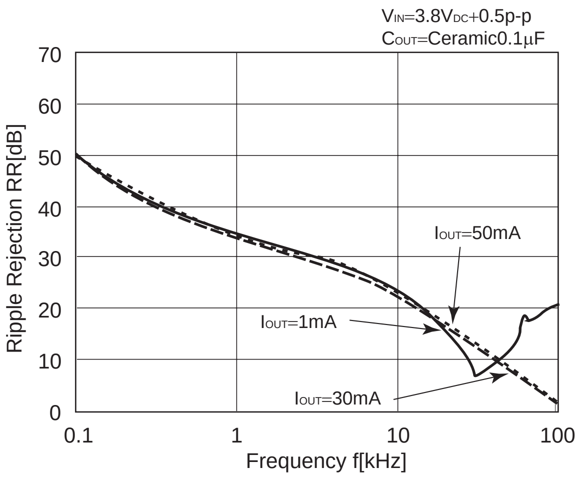
R1180x121x



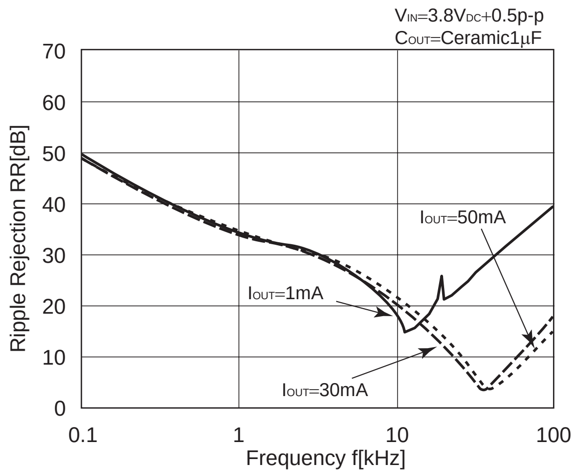
R1180x121x



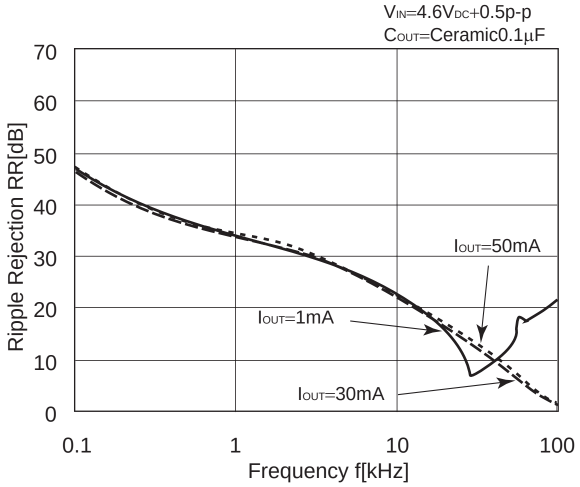
R1180x281x



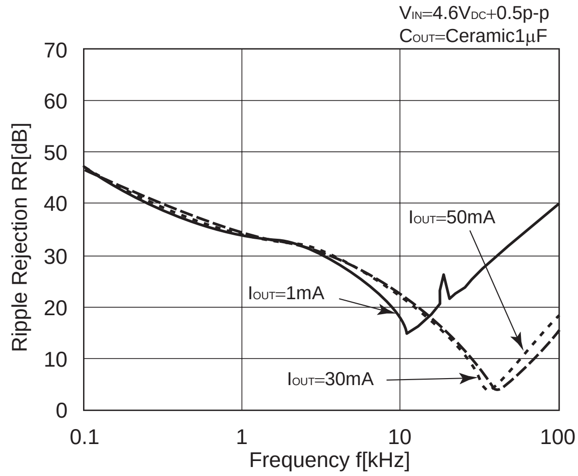
R1180x281x



R1180x361x

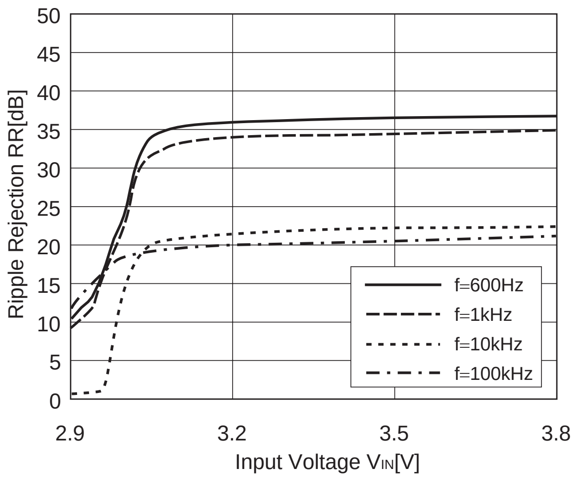


R1180x361x

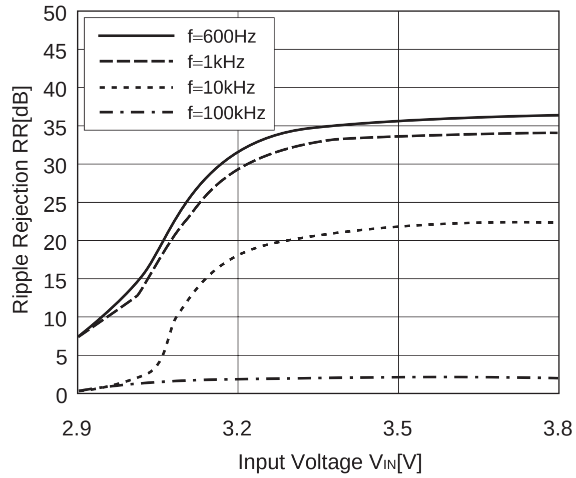


9) **Ripple Rejection vs. Input Bias Voltage (Ta=25°C, C1=none, C2=Ceramic0.1μF)**

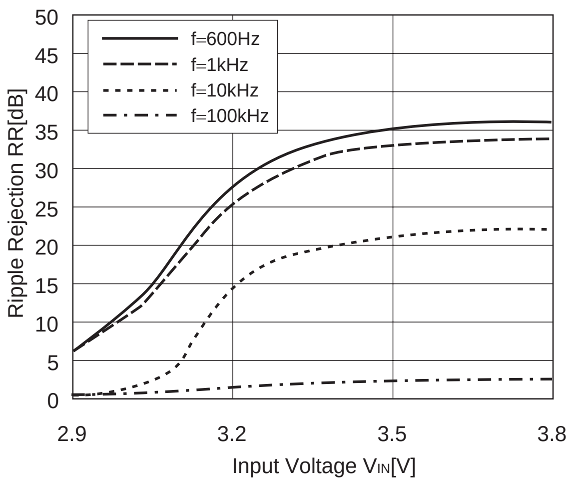
R1180x281x (I_{OUT}=1mA)



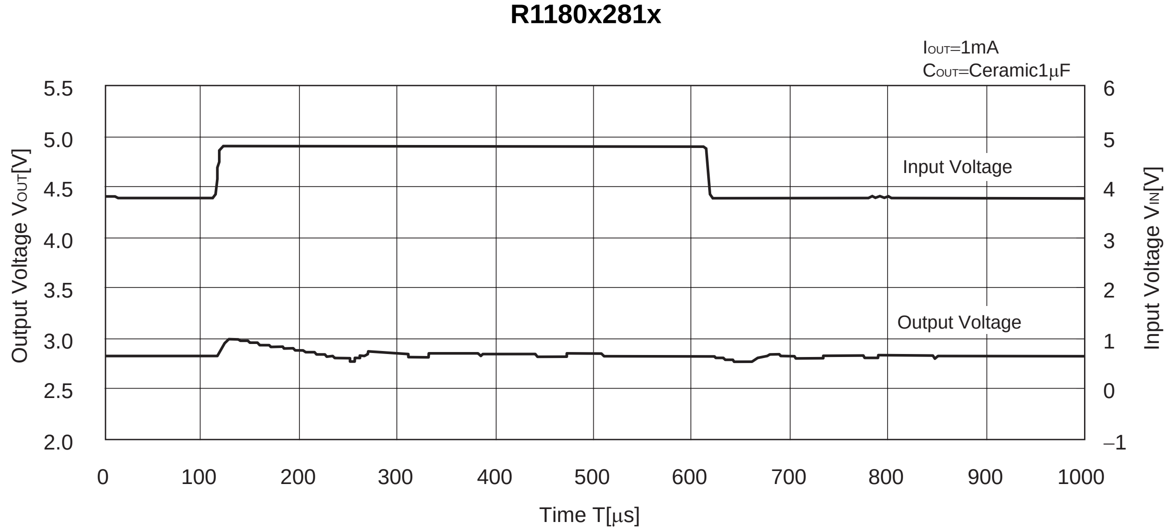
R1180x281x (I_{OUT}=30mA)

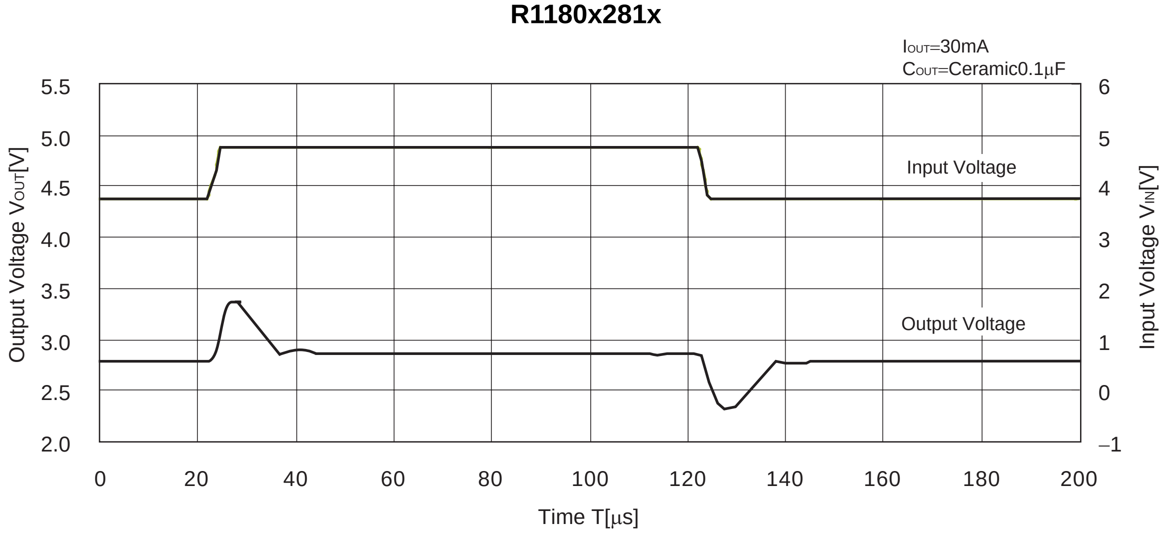


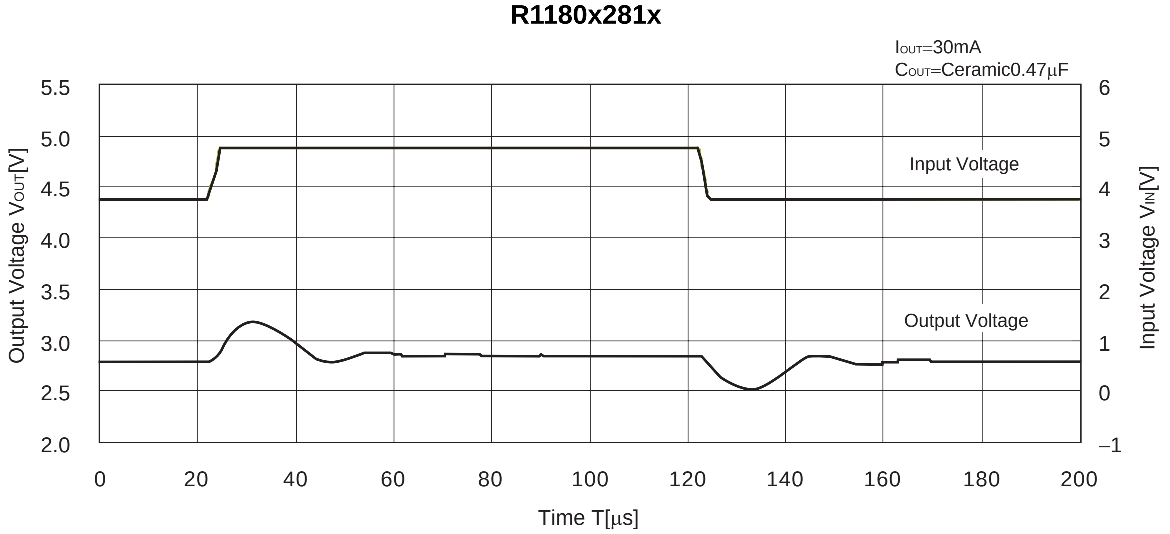
R1180x281x (I_{OUT}=50mA)

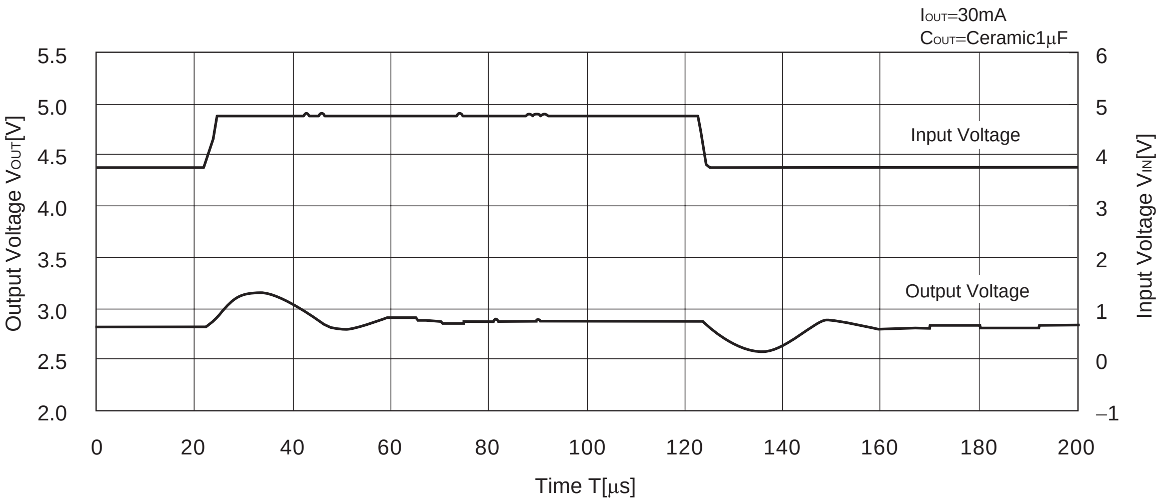


10) Input Transient Response (C1=none, tr=tf=5μs)

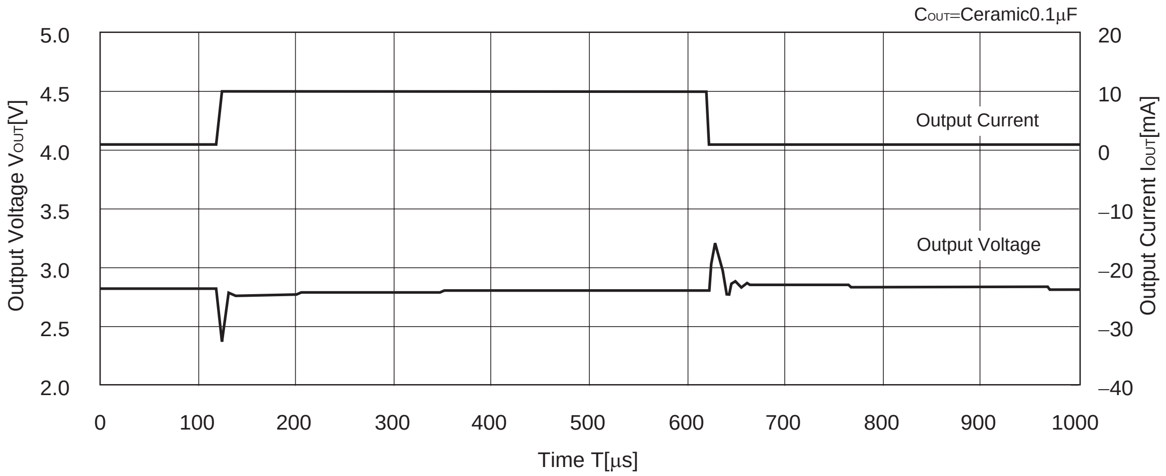


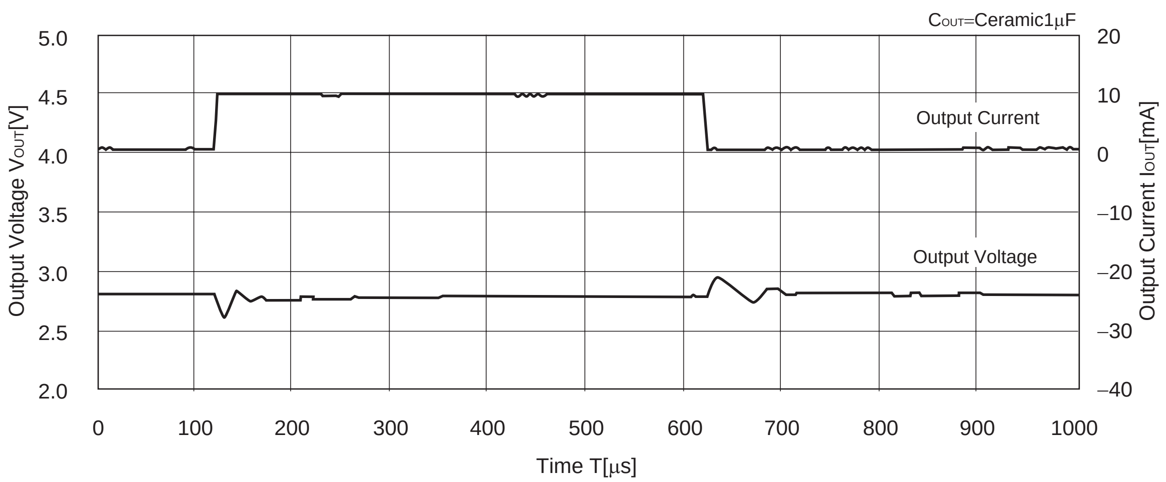


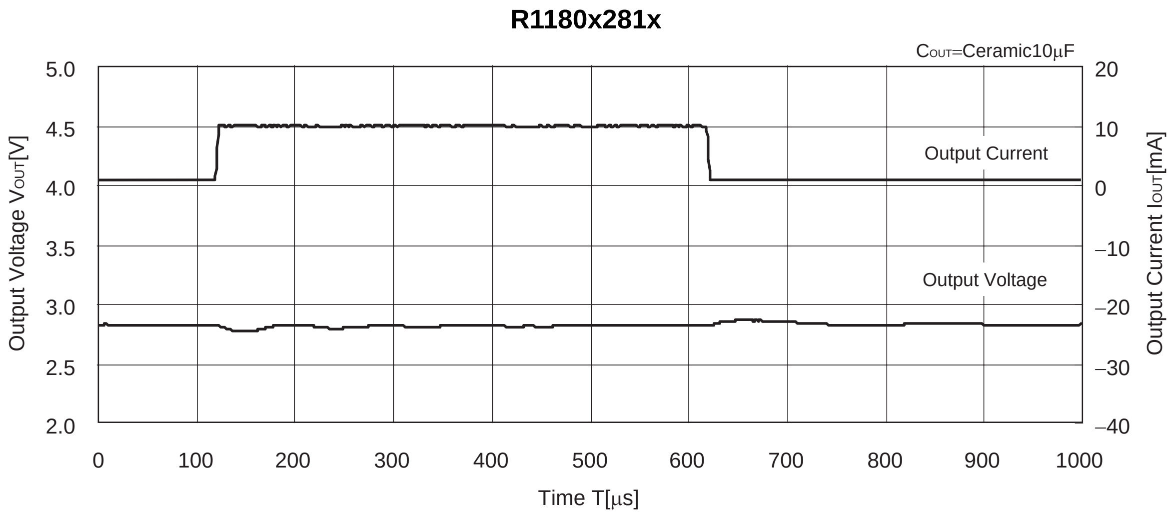


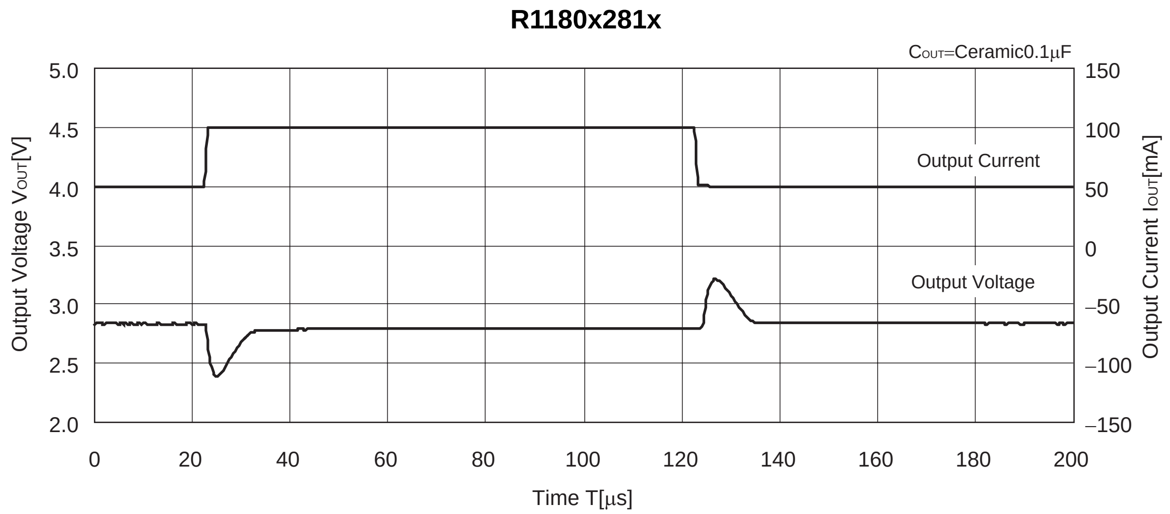


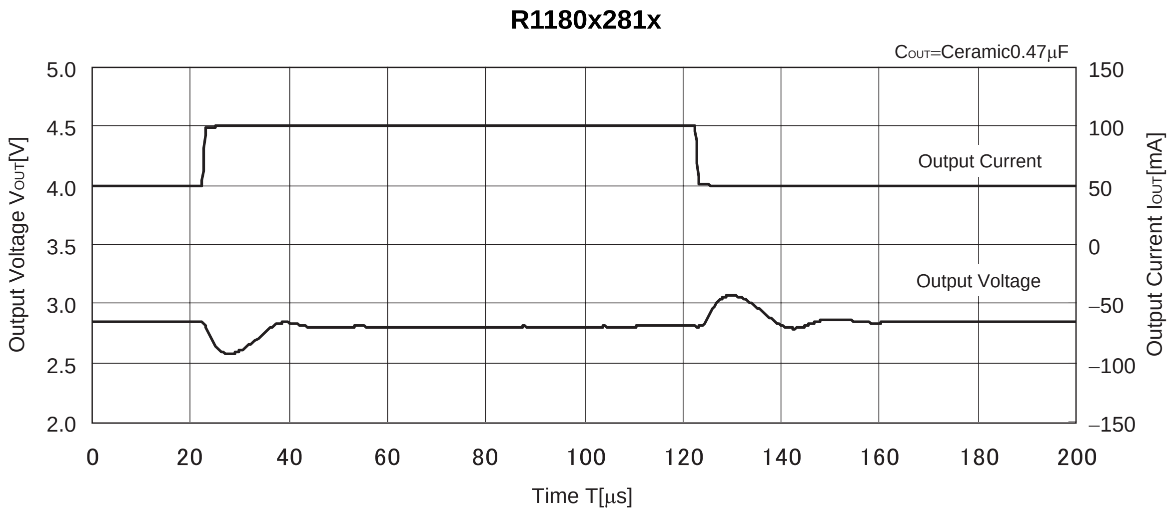
11) Load Transient Response (tr=tf=0.5μs VIN=3.8V)



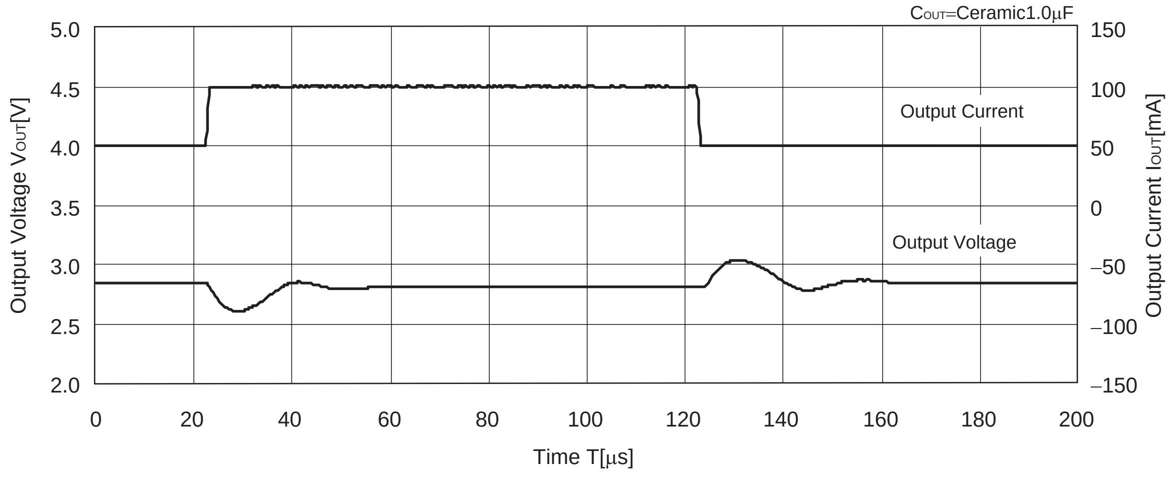



R1180x281x
COUT=Ceramic10μF
Output Voltage VOUT[V]
Output Current IOUT[mA]
Output Current
Output Voltage
Time T[μs]


R1180x281x
COUT=Ceramic0.1μF
Output Voltage VOUT[V]
Output Current IOUT[mA]
Output Current
Output Voltage
Time T[μs]


R1180x281x
COUT=Ceramic0.47μF
Output Voltage VOUT[V]
Output Current IOUT[mA]
Output Current
Output Voltage
Time T[μs]

R1180x281x


COUT=Ceramic1.0μF
Output Current
Output Voltage
Output Voltage VOUT[V]
Output Current IOUT[mA]
Time T[μs]
5.0
4.5
4.0
3.5
3.0
2.5
2.0
150
100
50
0
−50
−100
−150
0
20
40
60
80
100
120
140
160
180
200

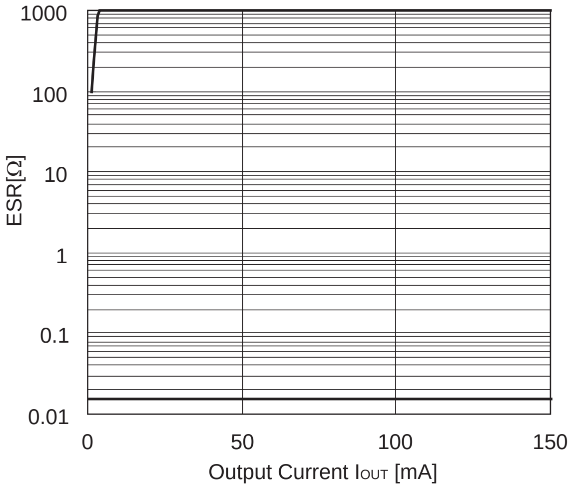
ESR vs. Output Current

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>
(1) $V_{IN}=V_{OUT}+1V$
(2) Frequency Band: 10Hz to 2MHz (BW=30Hz)
(3) Temperature: –40°C to 85°C

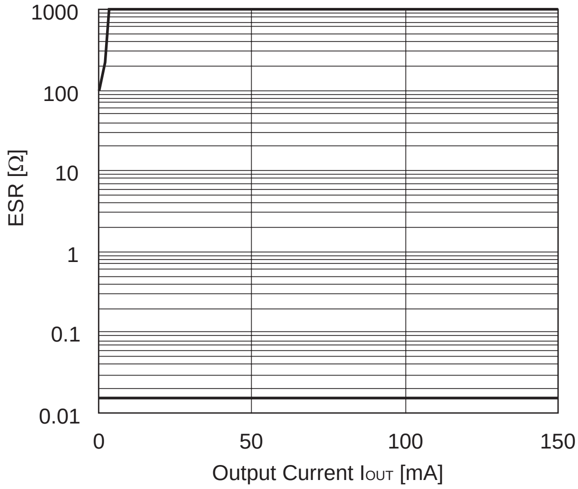
R1180x121x

C1 = Ceramic 1.0μA, C2 = Ceramic 0.1μF



R1180x281x

C1 = Ceramic 1.0μA, C2 = Ceramic 0.1μF



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