NISSHINBO

R1160x SERIES

3-MODE 200mA LDO REGULATOR

NO.EA-083-140530

OUTLINE

The R1160x Series consist of CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, and low ON-resistance. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, resistors for setting Output Voltage, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage and a chip enable function. To prevent the destruction by over current, current limit circuit is included. The R1160x Series have 3-mode. One is standby mode with CE or standby control pin. Other two modes are realized with ECO pin™. Fast Transient Mode (FT mode) and Low Power Mode (LP mode) are alternative with ECO pin™. Consumption current is reduced to 1/10 at Low Power Mode compared with Fast Transient Mode. Output voltage is maintained between FT mode and LP mode.

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

FEATURES

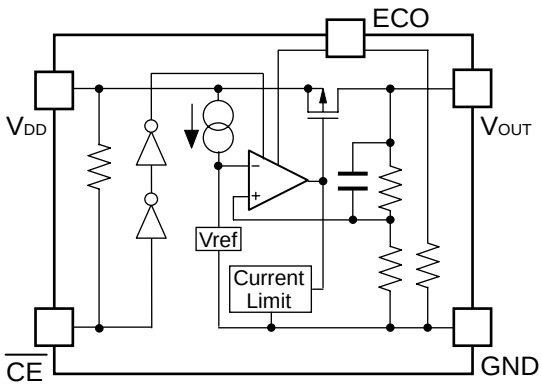
- Supply Current (Low Power Mode)..... Typ. 3.5μA (V_{OUT} ≤ 1.5V)
- Supply Current (Fast Transient Mode)..... Typ. 40μA
- Supply Current (Standby Mode)..... Typ. 0.1μA
- Dropout Voltage ..... Typ. 0.14V (I_{OUT}=200mA, V_{OUT}=2.8V)
- Ripple Rejection..... Typ. 70dB (f=1kHz, FT Mode)
- Temperature-Drift Coefficient of Output Voltage ..... Typ. ±100ppm/°C
- Line Regulation..... Typ. 0.05%/V
- Output Voltage Accuracy..... ±2.0% (±3.0% at LP Mode)
- Output Voltage Range..... 0.8V to 3.3V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Input Voltage Range ..... 1.4V to 6.0V
- Built-in Fold Back Protection Circuit ..... Typ. 50mA (Current at short mode)
- Packages SOT-23-5, SON-6

APPLICATIONS

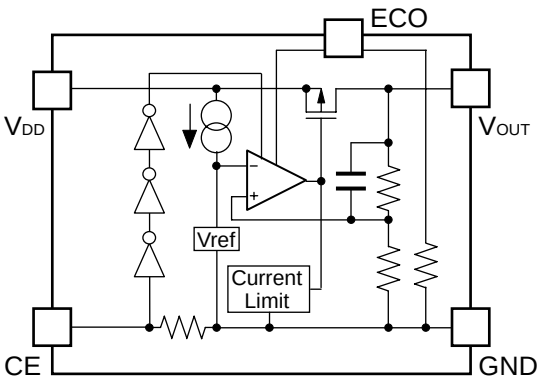
- Precision Voltage References.
- Power source for electrical appliances such as cameras, VCRs and hand-held communication equipment.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R1160xxx1A



R1160xxx1B



SELECTION GUIDE

The output voltage, chip enable polarity, and package, etc. for the ICs can be selected at the user's request.

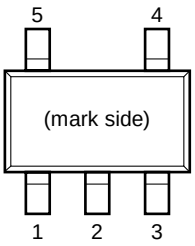
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1160Nxx1∗-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
R1160Dxx1∗-TR-FE	SON-6	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 0.8V(08) to 3.3V(33) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

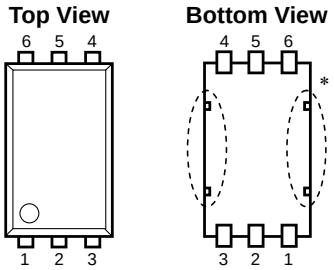
∗ : CE pin polarity are options as follows.
(A) "L" active type.
(B) "H" active type.

PIN CONFIGURATION

- **SOT-23-5**



- **SON-6**



PIN DESCRIPTIONS

- **SOT-23-5**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	$\overline{CE}$ or CE	Chip Enable Pin
4	ECO	MODE alternative pin
5	V_{OUT}	Output Pin

- **SON-6**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	NC	No Connection
3	V_{OUT}	Output Pin
4	ECO	MODE alternative pin
5	GND	Ground Pin
6	$\overline{CE}$ or CE	Chip Enable Pin

∗) Tab suspension leads are GND level. (They are connected to the reverse side of this IC.)
The tab suspension leads should be open and do not connect to other wires or land patterns.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{ECO}	Input Voltage (ECO Pin)	−0.3 to V_{IN}+0.3	V
V_{CE}	Input Voltage ($\overline{CE}$ or CE Pin)	−0.3 to V_{IN}+0.3	V
V_{OUT}	Output Voltage	−0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	250	mA
P_D	Power Dissipation (SOT-23-5)*	420	mW
	Power Dissipation (SON-6) *	500	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.

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

- **R1160xxx1A**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN} 1μA ≤ I_{OUT} ≤ 30mA*1	×0.98 (-30mV)		×1.02 (30mV)	V
	Output Voltage (LP Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=GND 1μA ≤ I_{OUT} ≤ 30mA*2	×0.97 (-45mV)		×1.03 (45mV)	V
I_{OUT}	Output Current	V_{IN} – V_{OUT}=1V	200			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN} 1mA ≤ I_{OUT} ≤ 200mA		20	40	mV
	Load Regulation (LP Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=GND 1mA ≤ I_{OUT} ≤ 100mA		10	40	mV
V_{DIF}	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
I_{SS1}	Supply Current (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN},		40	70	μA
I_{SS2}	Supply Current (LP Mode)	V_{IN}=Set V_{OUT}+1V, V_{OUT} ≤ 1.5V, V_{ECO}=GND		3.5	6.0	μA
		V_{IN}=Set V_{OUT}+1V, V_{OUT} ≥ 1.6V, V_{ECO}=GND		4.5	8.0	μA
Istandby	Supply Current (Standby)	V_{IN}=V_{CE}=Set V_{OUT}+1V V_{ECO}=GND or V_{IN}		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation (FT Mode)	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 6V I_{OUT}=30mA, V_{ECO}=V_{IN} (In case that V_{OUT} ≤ 0.9V, 1.4V ≤ V_{IN} ≤ 6V)		0.05	0.20	%/V
	Line Regulation (LP Mode)	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 6V I_{OUT}=30mA, V_{ECO}=GND (In case that V_{OUT} ≤ 0.9V, 1.4V ≤ V_{IN} ≤ 6V)		0.10	0.30	%/V
RR	Ripple Rejection (FT Mode)	f=1kHz, Ripple 0.2Vp-p V_{IN}=Set V_{OUT}+1V I_{OUT}=30mA, V_{ECO}=V_{IN}		70		dB
V_{IN}	Input Voltage		1.4		6.0	V
ΔV_{OUT}/ ΔTopt	Output Voltage Temperature Coefficient	I_{OUT}=30mA –40°C ≤ Topt ≤ 85°C		±100		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V		50		mA
R_{PUC}	$\overline{CE}$ Pull-up Resistance		2.0	5.0	14.0	MΩ
R_{PDE}	ECO Pull-down Resistance		1.5	5.0	14.0	MΩ
V_{CEH}	$\overline{CE}$,ECO Input Voltage "H"		1.0		V_{IN}	V
V_{CEL}	$\overline{CE}$,ECO Input Voltage "L"		0		0.3	V

∗1 : ±30mV Tolerance for V_{OUT} ≤ 1.5V

∗2 : ±45mV Tolerance for V_{OUT} ≤ 1.5V

R1160x

- **R1160xxx1B**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN} 1μA ≤ I_{OUT} ≤ 30mA*1	×0.980 (-30mV)		×1.020 (30mV)	V
	Output Voltage (LP Mode)	V_{IN}=Set V_{OUT}+1V,V_{ECO}=GND 1μA ≤ I_{OUT} ≤ 30mA*2	×0.970 (-45mV)		×1.030 (45mV)	V
I_{OUT}	Output Current	V_{IN}–V_{OUT}=1V	200			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN} 1mA ≤ I_{OUT} ≤ 200mA		20	40	mV
	Load Regulation (LP Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=GND 1mA ≤ I_{OUT} ≤ 100mA		10	40	mV
V_{DIF}	Dropout Voltage	Refer to the ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE				
I_{SS1}	Supply Current (FT Mode)	V_{IN}=Set V_{OUT}+1V, V_{ECO}=V_{IN}		40	70	μA
I_{SS2}	Supply Current (LP Mode)	V_{IN}=Set V_{OUT}+1V, V_{OUT} ≤ 1.5V, V_{ECO}=GND		3.5	6.0	μA
		V_{IN}=Set V_{OUT}+1V, V_{OUT} ≥ 1.6V, V_{ECO}=GND		4.5	8.0	μA
Istandby	Supply Current (Standby)	V_{IN}=Set V_{OUT}+1V V_{CE}=GND, V_{ECO}=GND or V_{IN}		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation (FT Mode)	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 6.0V I_{OUT}=30mA, V_{ECO}=V_{IN} (In case that V_{OUT} ≤ 0.9V, 1.4V ≤ V_{IN} ≤ 6V)		0.05	0.20	%/V
	Line Regulation (LP Mode)	Set V_{OUT}+0.5V ≤ V_{IN} ≤ 6.0V I_{OUT}=30mA, V_{ECO}=GND (In case that V_{OUT} ≤ 0.9V, 1.4V ≤ V_{IN} ≤ 6V)		0.10	0.30	%/V
RR	Ripple Rejection (FT Mode)	f=1kHz, Ripple 0.2Vp-p V_{IN}=Set V_{OUT}+1V I_{OUT}=30mA, V_{ECO}=V_{IN}		70		dB
V_{IN}	Input Voltage		1.4		6.0	V
ΔV_{OUT}/ ΔTopt	Output Voltage Temperature Coefficient	I_{OUT}=30mA –40°C ≤ Topt ≤ 85°C		±100		ppm /°C
I_{SC}	Short Current Limit	V_{OUT}=0V		50		mA
R_{PDC}	CE Pull-down Resistance		2.0	5.0	14.0	MΩ
R_{PDE}	ECO Pull-down Resistance		1.5	5.0	14.0	MΩ
V_{CEH}	CE, ECO Input Voltage "H"		1.0		V_{IN}	V
V_{CEL}	CE, ECO Input Voltage "L"		0		0.3	V

∗1 : ±30mV Tolerance for V_{OUT} ≤ 1.5V

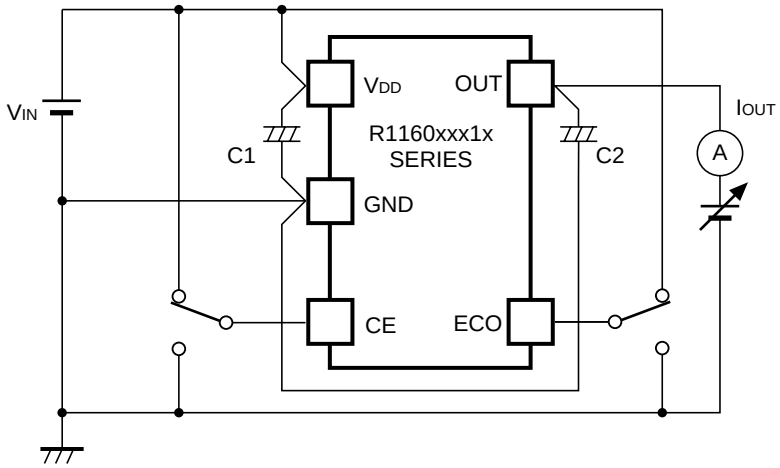
∗2 : ±45mV Tolerance for V_{OUT} ≤ 1.5V

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE**

Topt=25°C

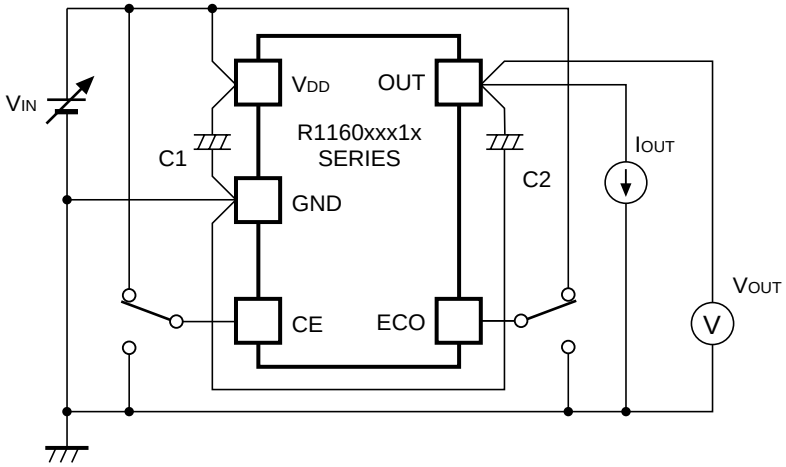
Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Condition	Typ.	Max.
0.8 ≤ V_{OUT} ≤ 0.9	I_{OUT}=200mA	0.40	0.70
1.0 ≤ V_{OUT} ≤ 1.4		0.30	0.50
1.5 ≤ V_{OUT} ≤ 2.5		0.20	0.30
2.6 ≤ V_{OUT}		0.14	0.20 (ECO="H") 0.25 (ECO="L")

TEST CIRCUITS



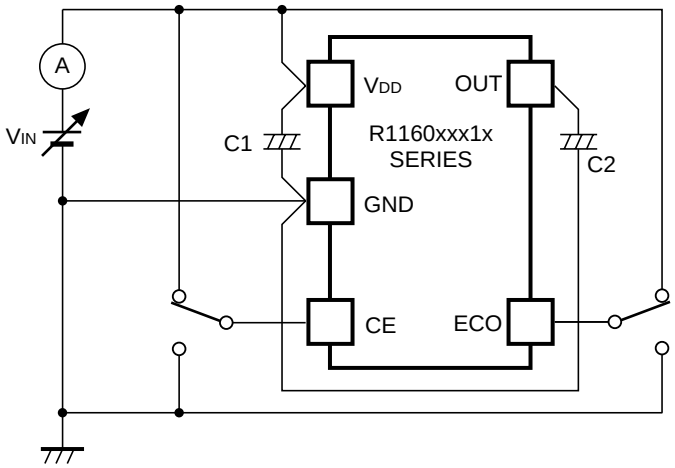
C1=Tantal 1.0µF
C2=Tantal 2.2µF

Fig.1 Output Voltage vs. Output Current Test Circuit



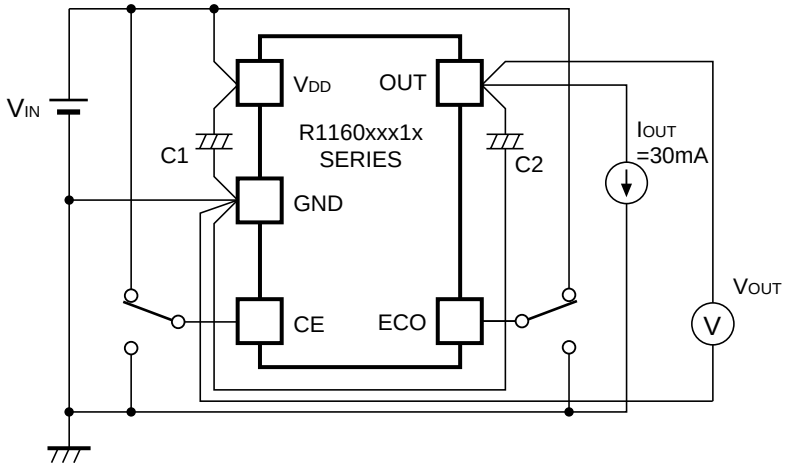
C1=Tantal 1.0µF
C2=Tantal 2.2µF

Fig.2 Output Voltage vs. Input Voltage Test Circuit



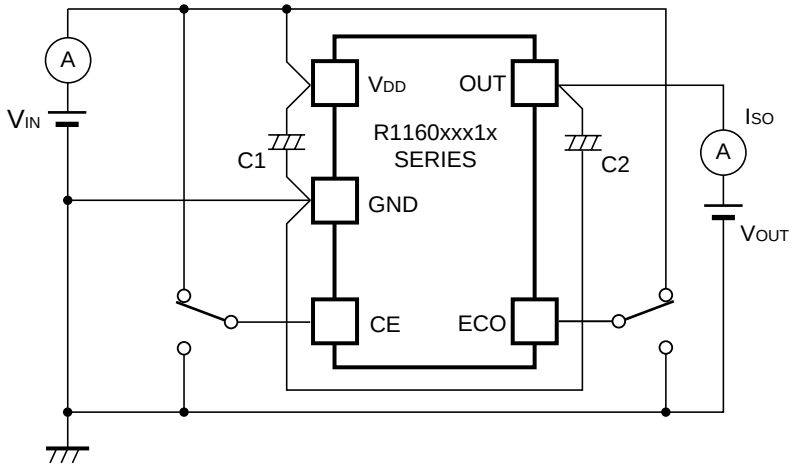
C1=Tantal 1.0µF
C2=Tantal 2.2µF

Fig.3 Supply Current vs. Input Voltage Test Circuit



C1=Tantal 1.0µF
C2=Tantal 2.2µF

Fig.4 Output Voltage vs. Temperature Test Circuit



C1=Tantal 1.0µF
C2=Tantal 2.2µF

Fig.5 Supply Current vs. Temperature Test Circuit

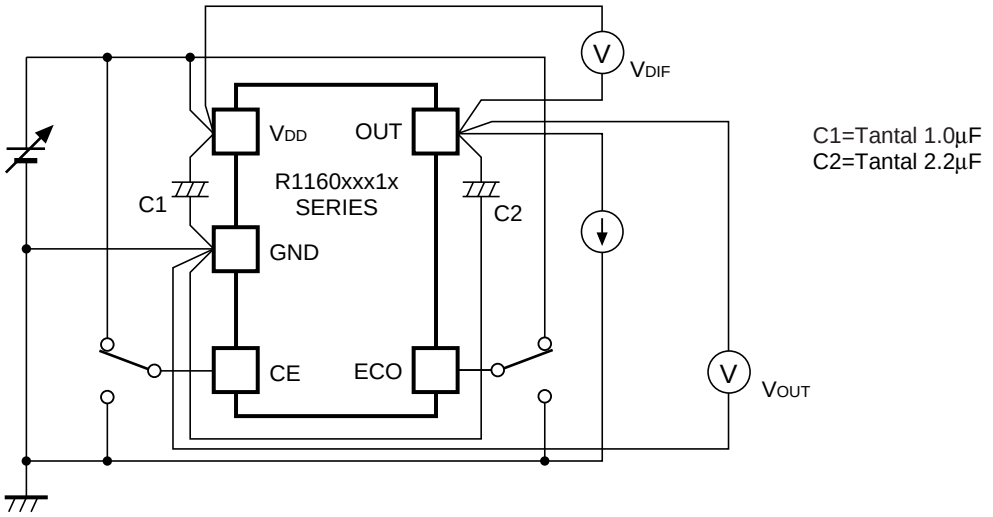


Fig. 6 Dropout Voltage vs. Output Current/ Set Output Voltage Test Circuit

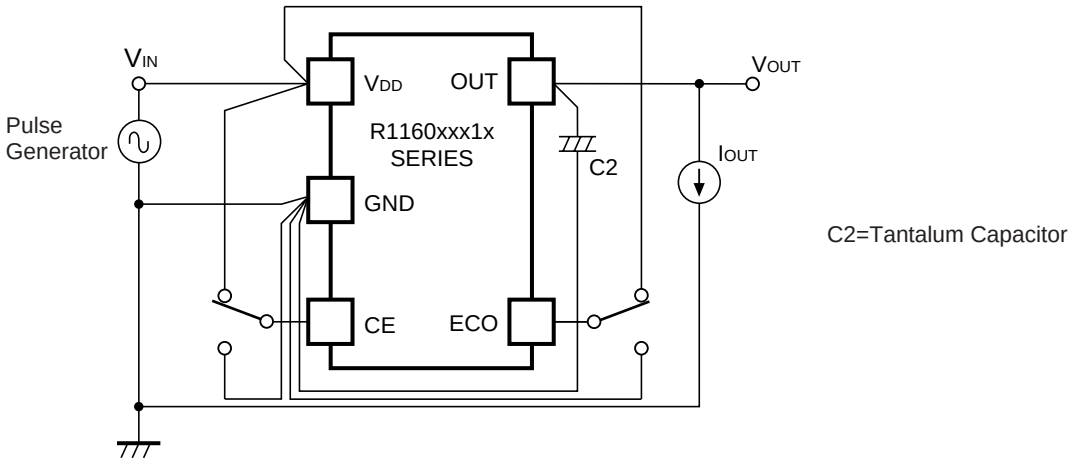


Fig. 7 Ripple Rejection Test Circuit

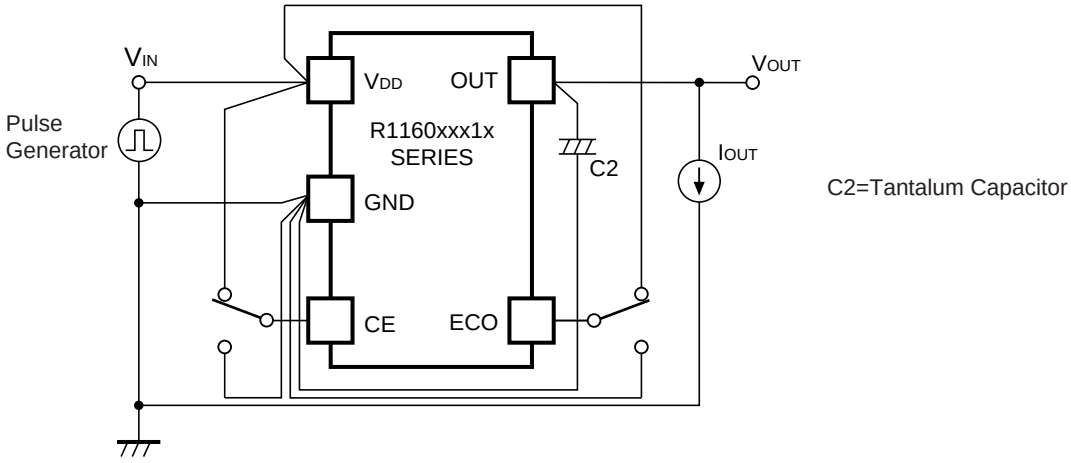


Fig.8 Input Transient Response Test Circuit

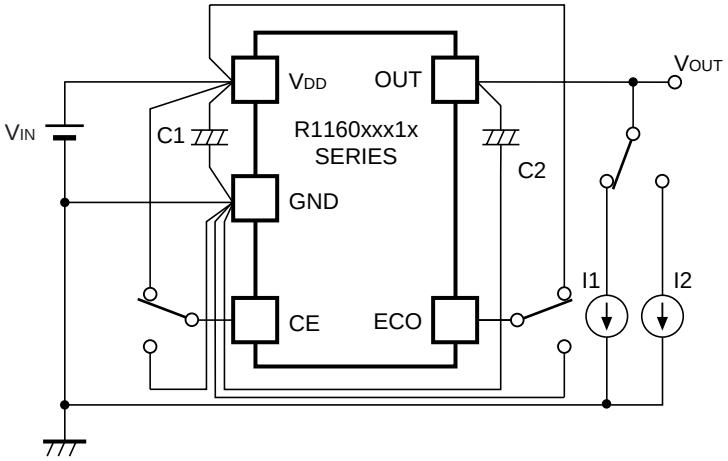


Fig.9 Load Transient Response Test Circuit

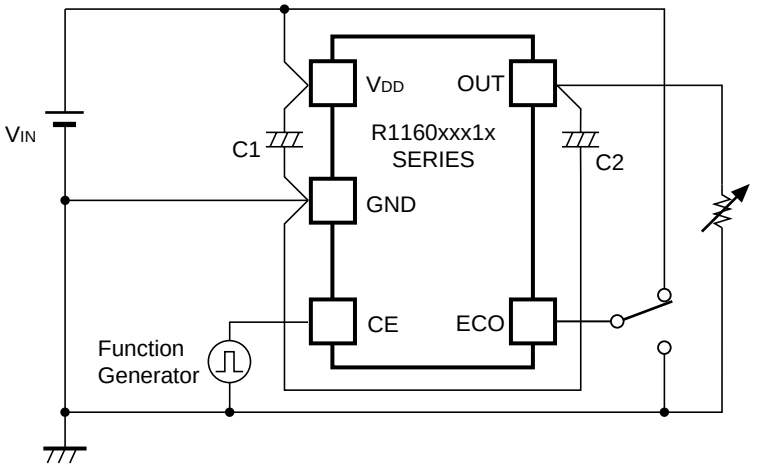


Fig.10 Turn on Speed with CE pin Test Circuit

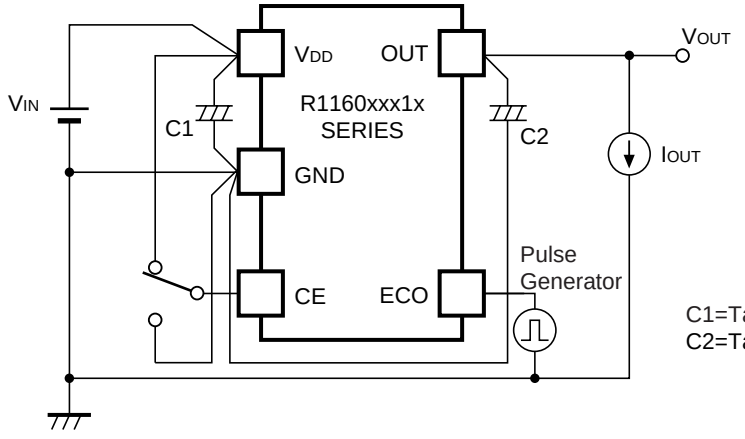


Fig.11 MODE Transient Response Test Circuit

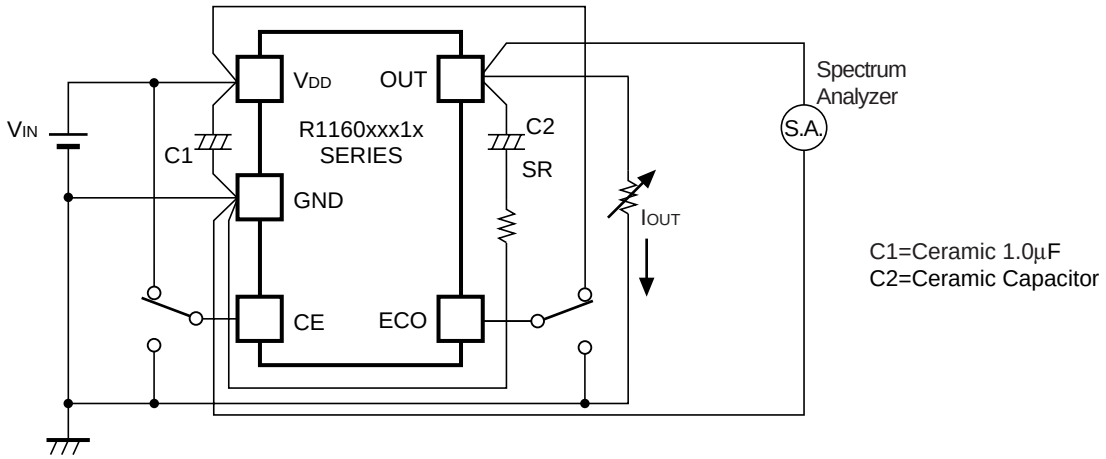
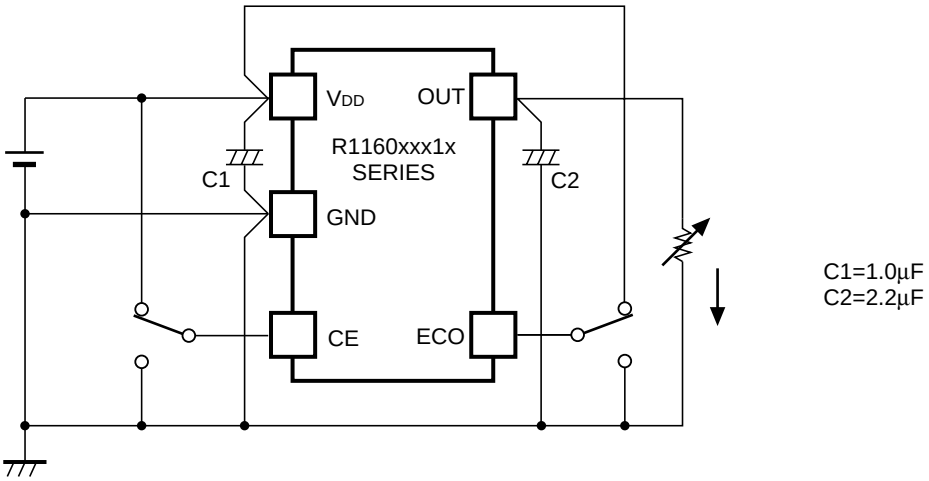


Fig.12 Output Noise Test Circuit (I_{OUT} vs. ESR)

TYPICAL APPLICATION

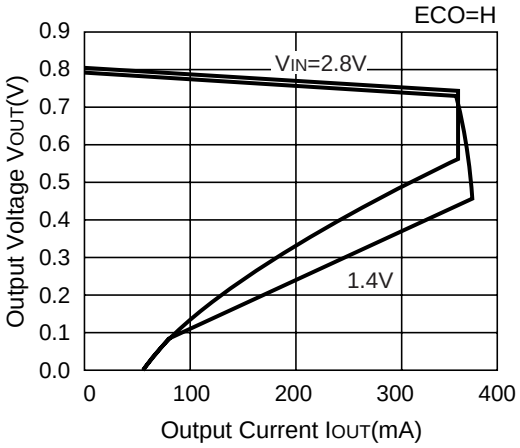


(External Components)
C1: Ceramic Capacitor 1µF
C2: Tantalum Capacitor 2.2µF

TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

R1160x081x



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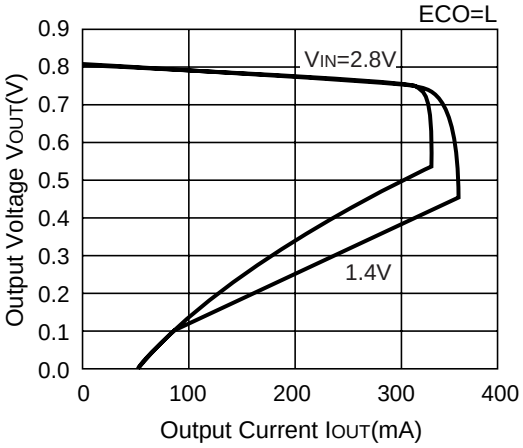

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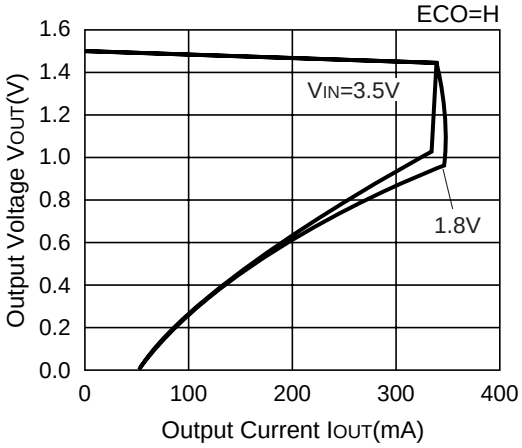

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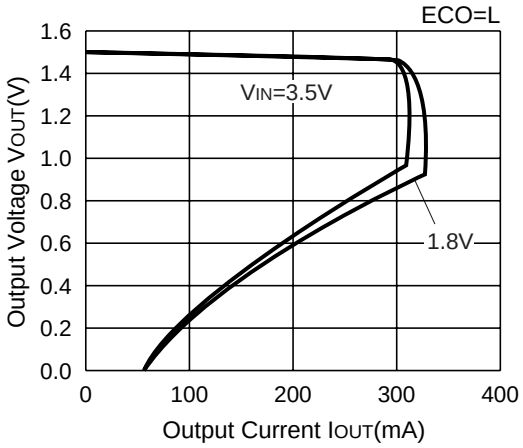

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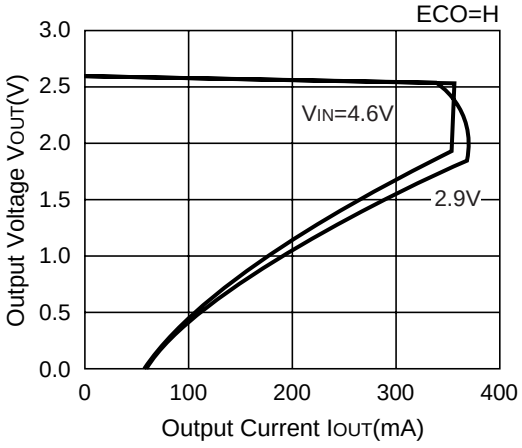

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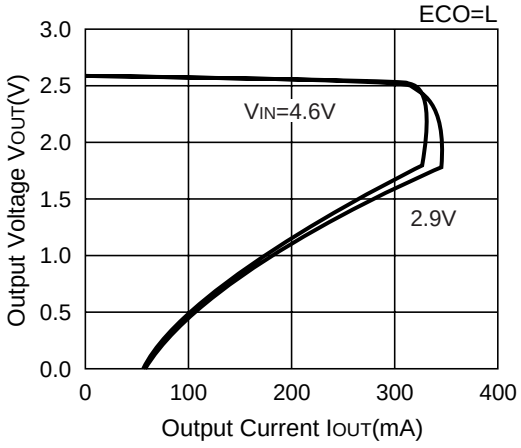

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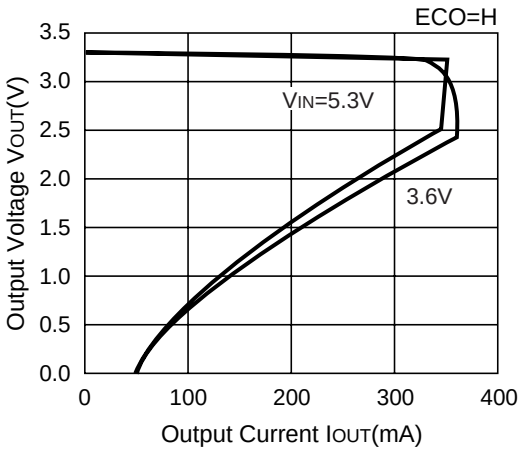

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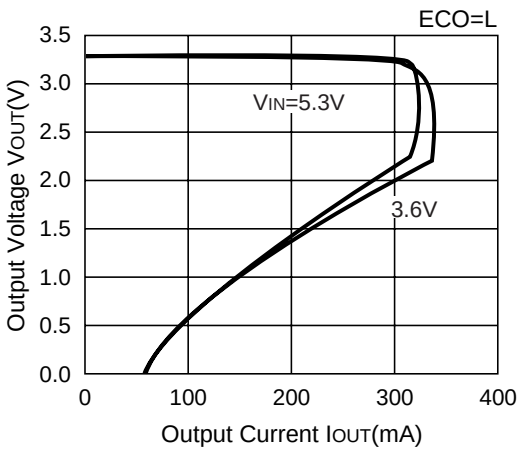
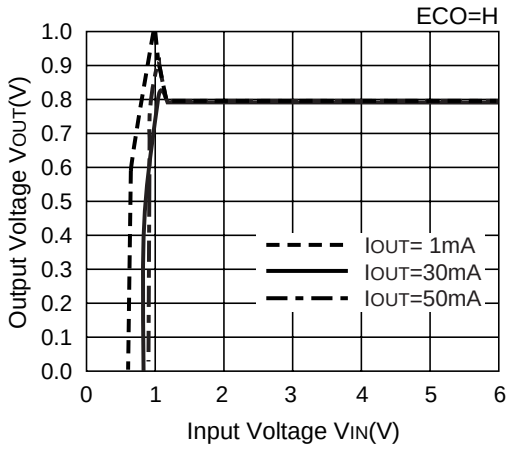


2) Output Voltage vs. Input Voltage

R1160x081x



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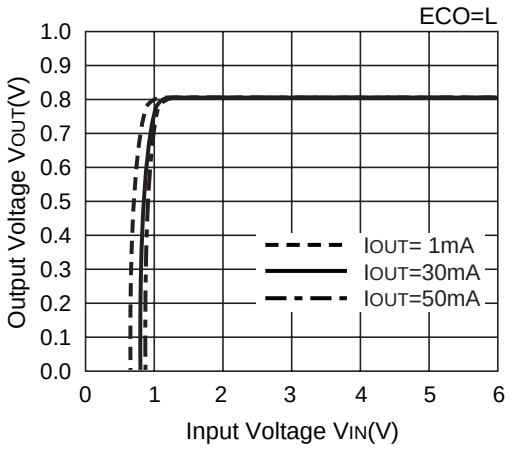

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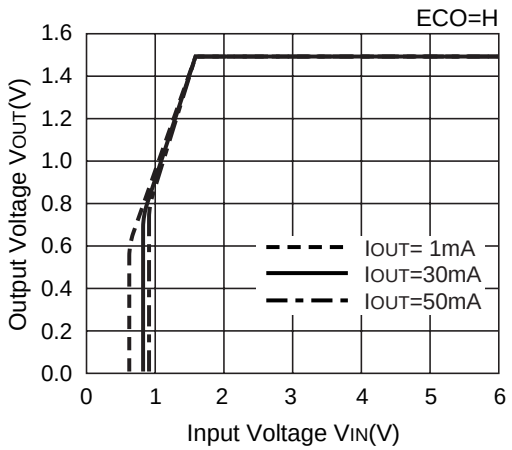

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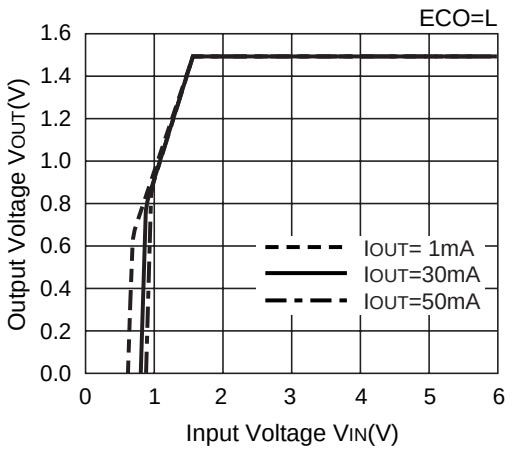

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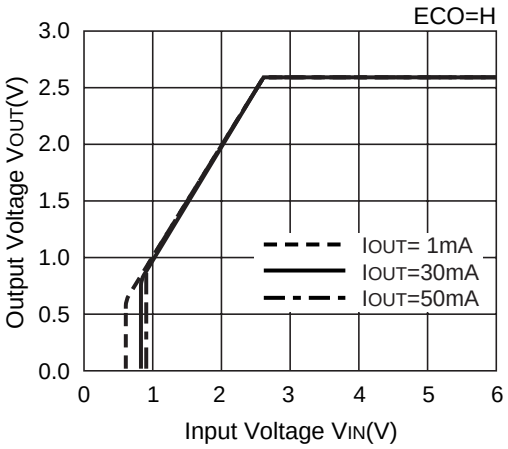

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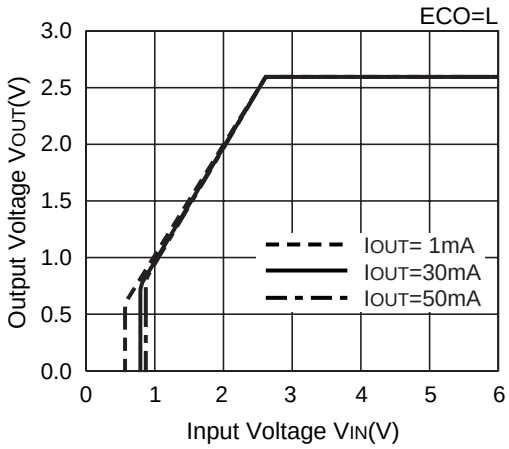

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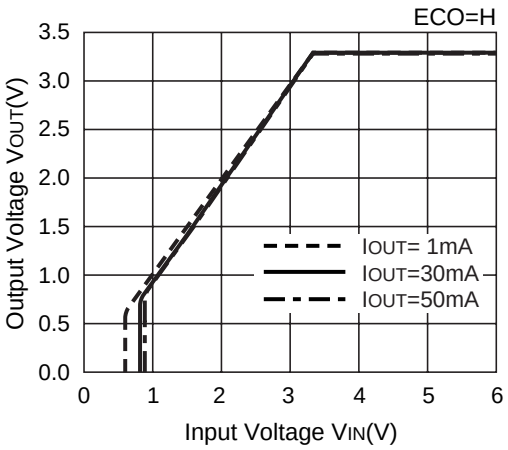

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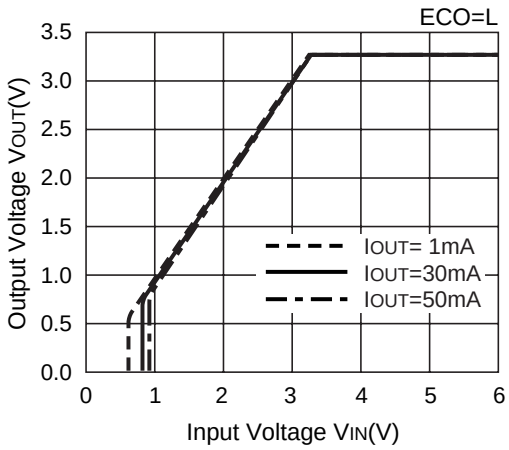
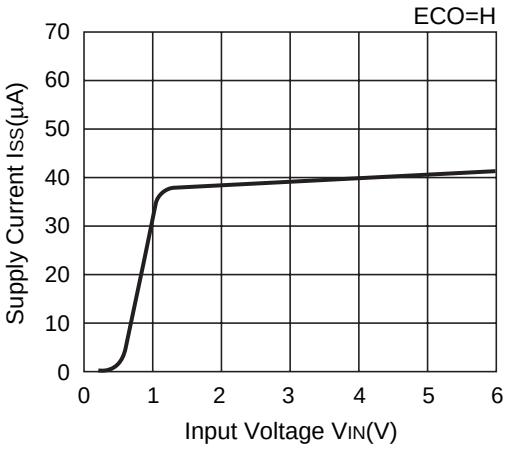


3) Supply Current vs. Input Voltage

R1160x081x



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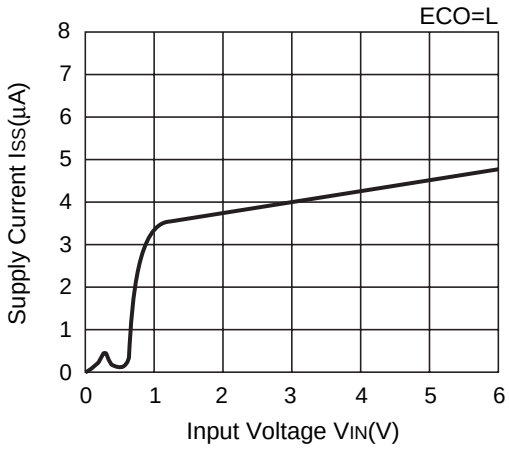

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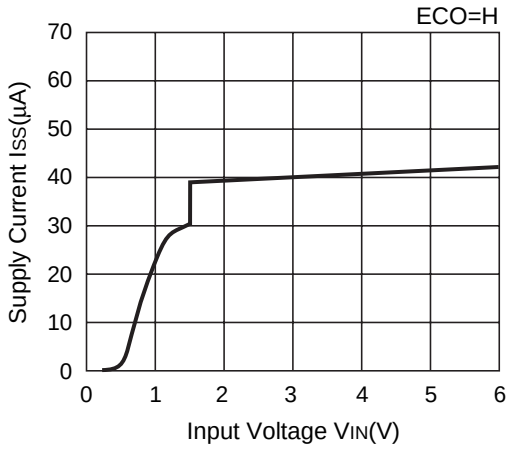

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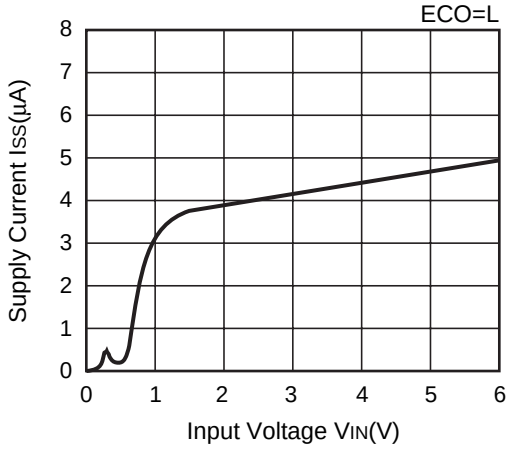

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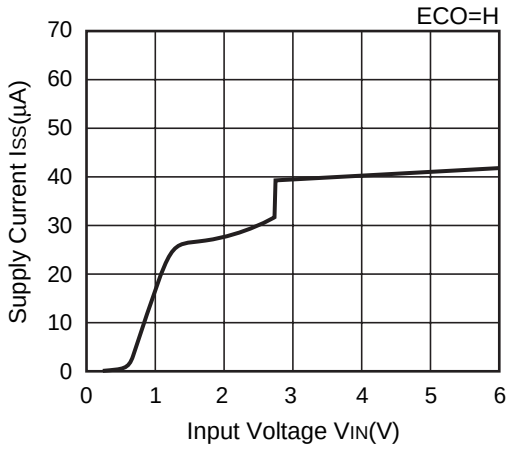

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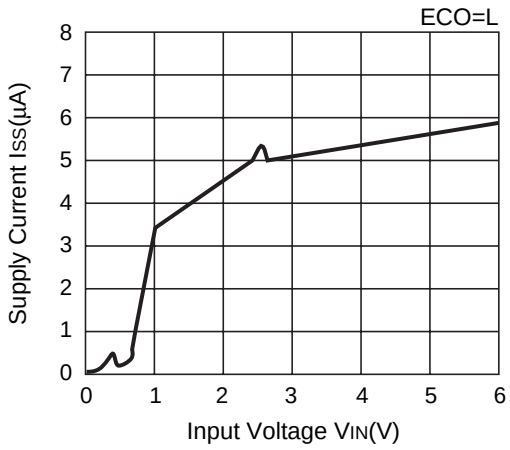

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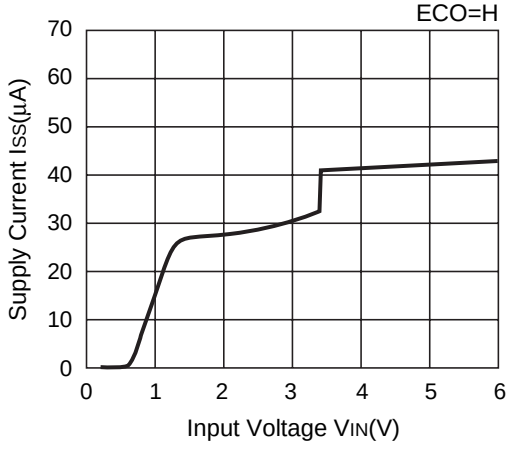

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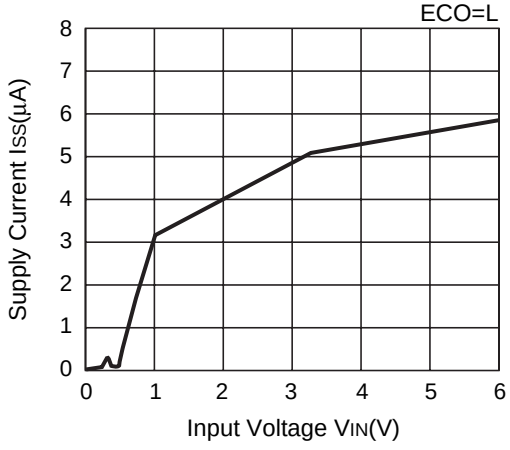
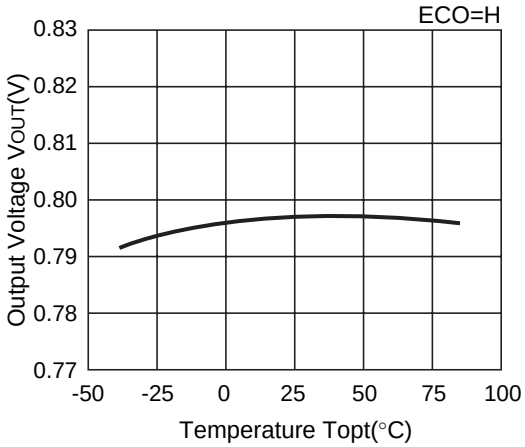


4) Output Voltage vs. Temperature

R1160x081x



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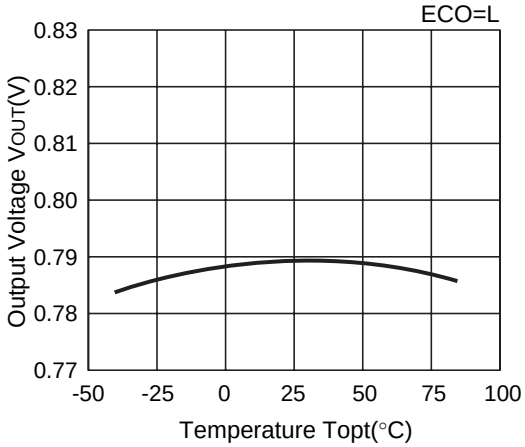

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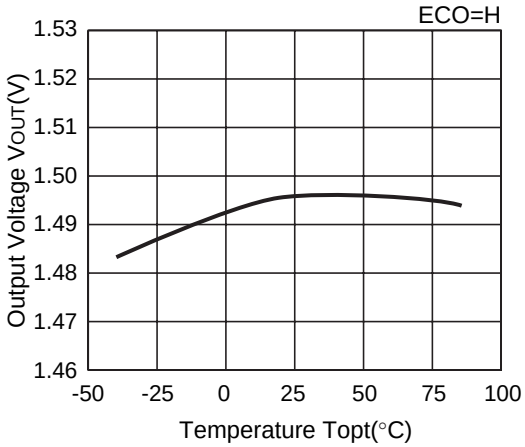

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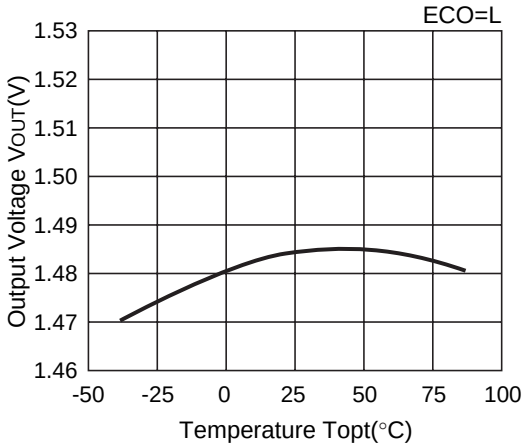

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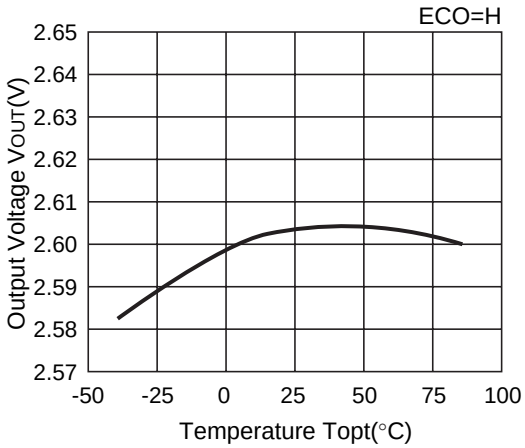

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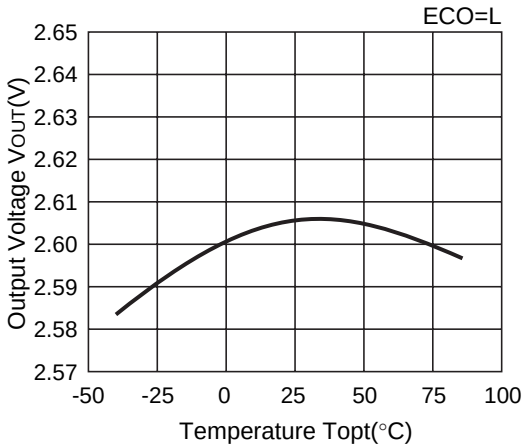

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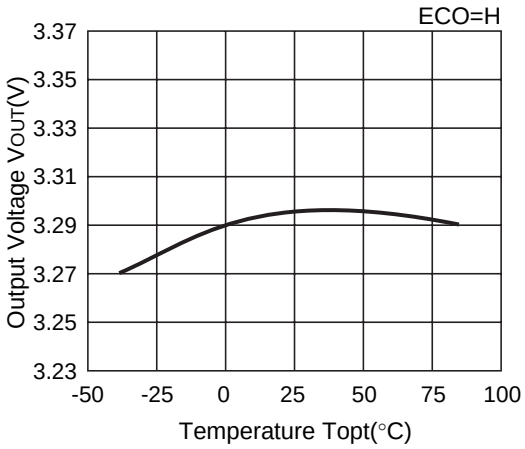

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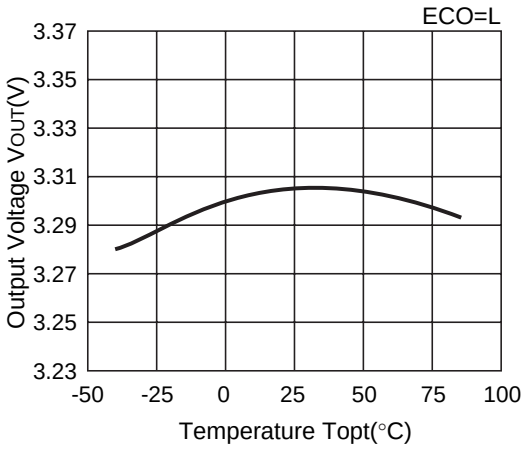
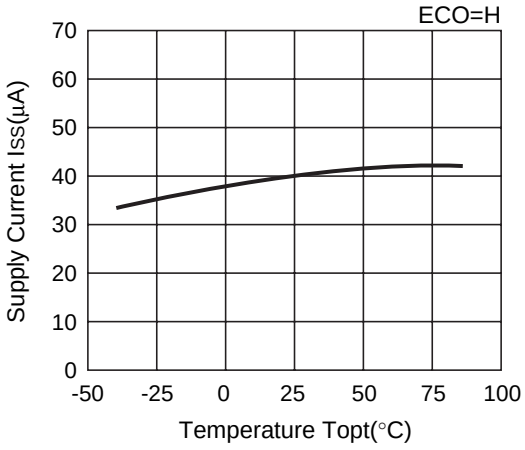


5) Supply Current vs. Input Voltage

R1160x081x



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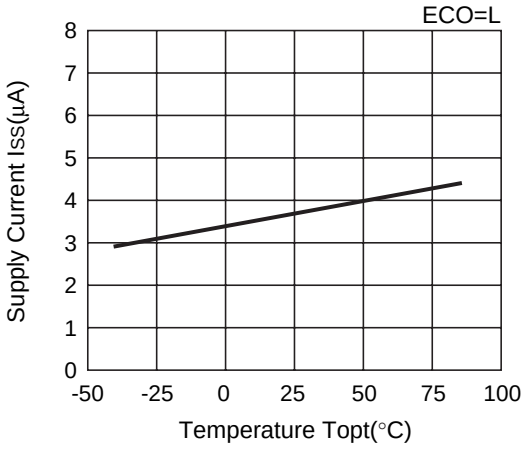

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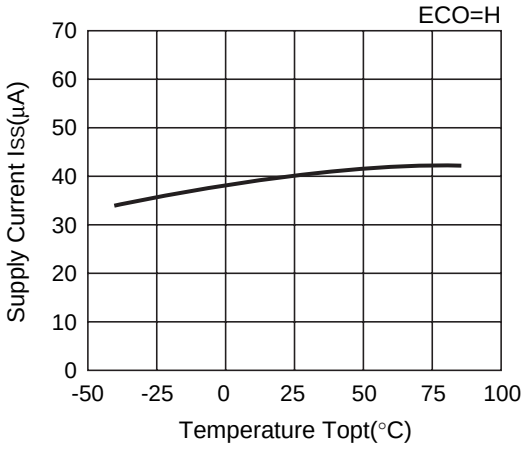

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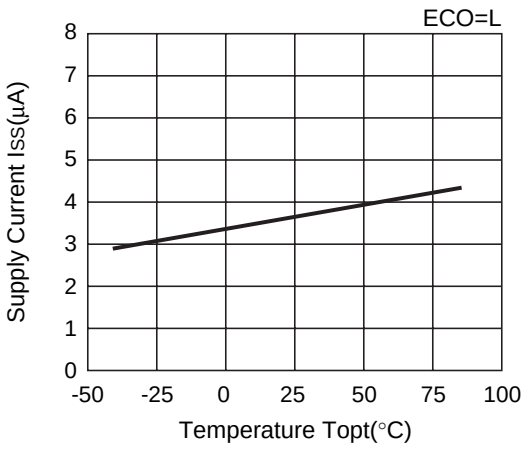
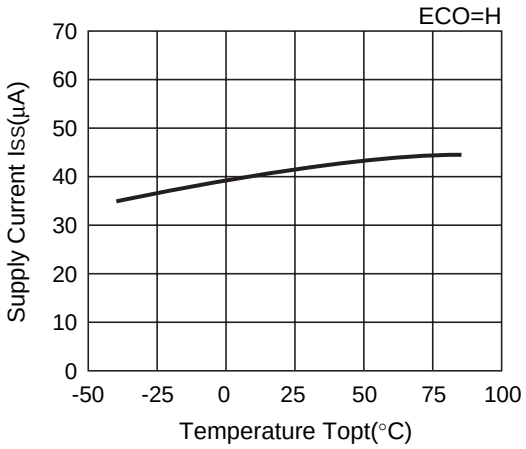


R1160x

R1160x261x



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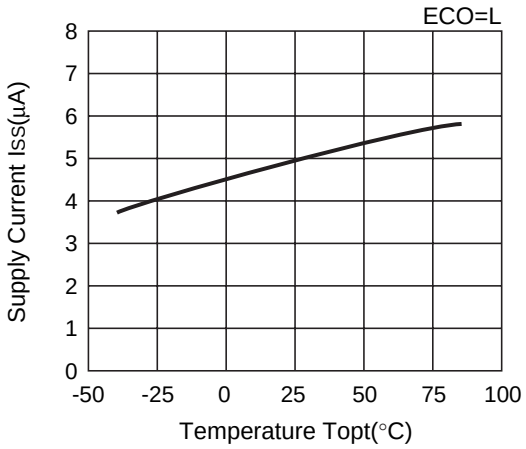

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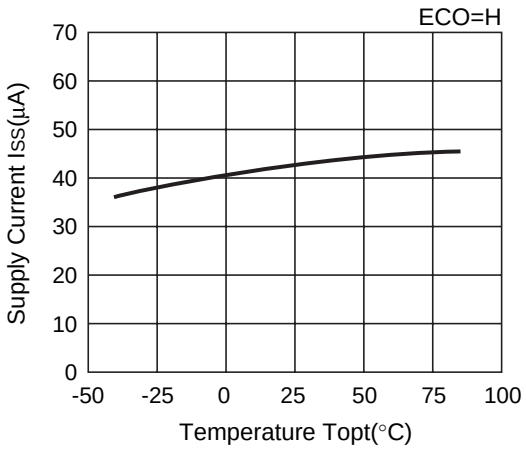

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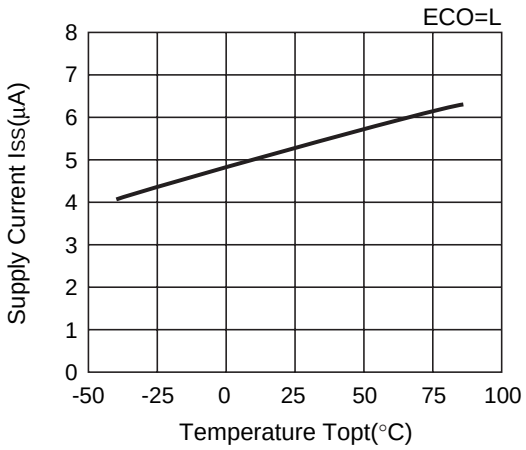
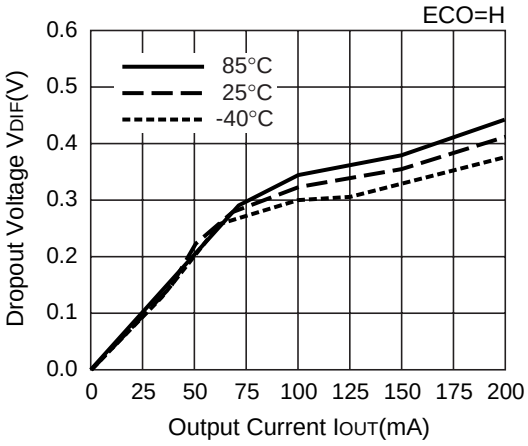
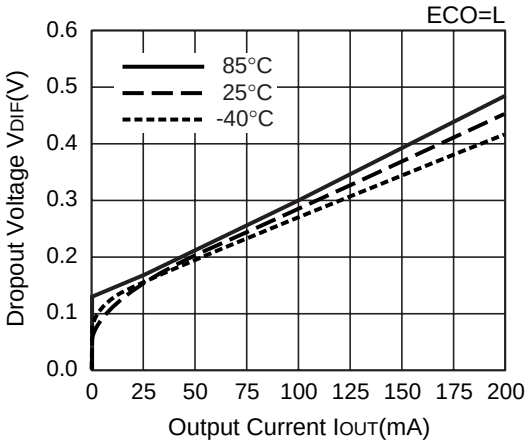


6) Dropout Voltage vs. Output Current

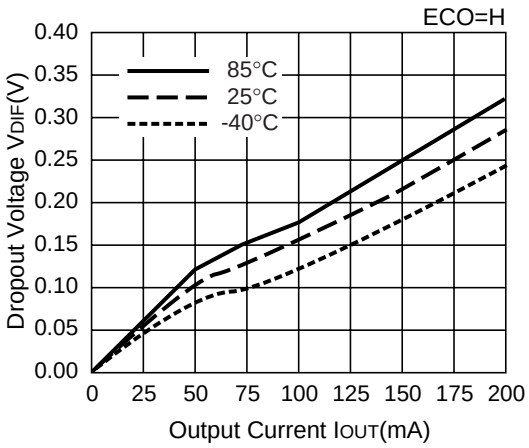
R1160x081x



R1160x081x



R1160x101x



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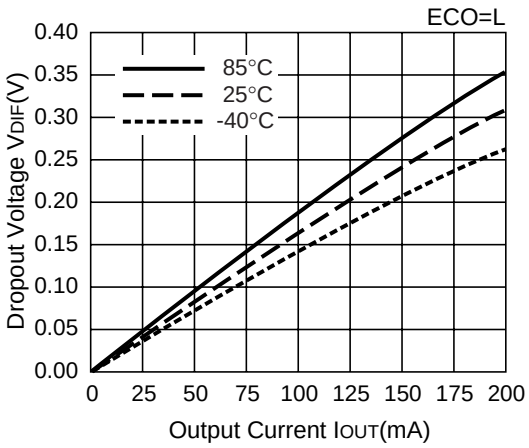

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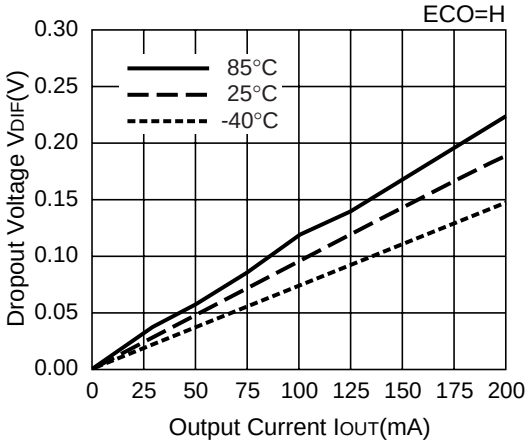

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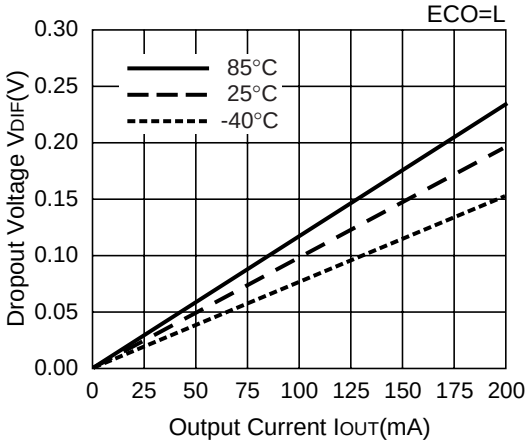

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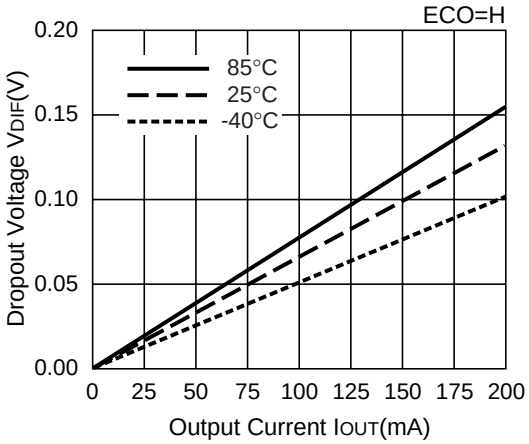

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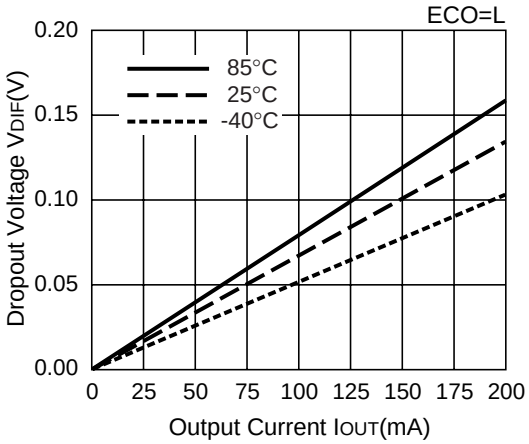
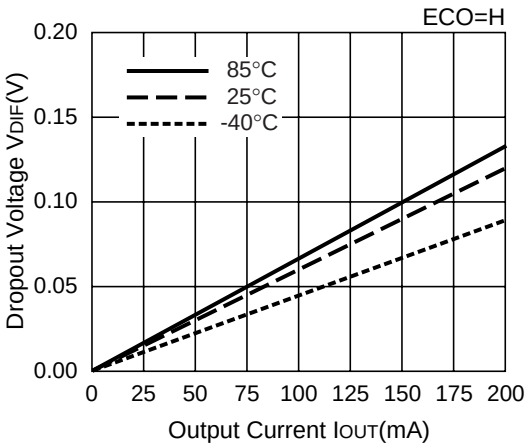
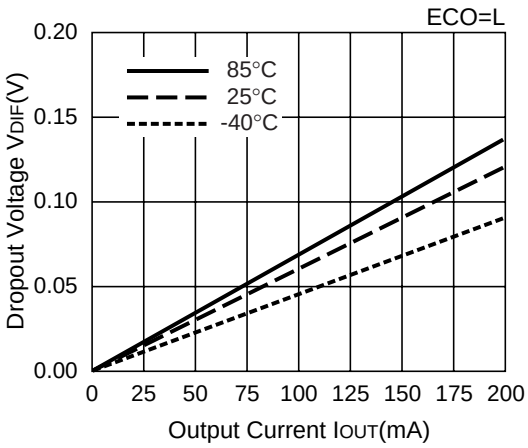


R1160x

R1160x331x

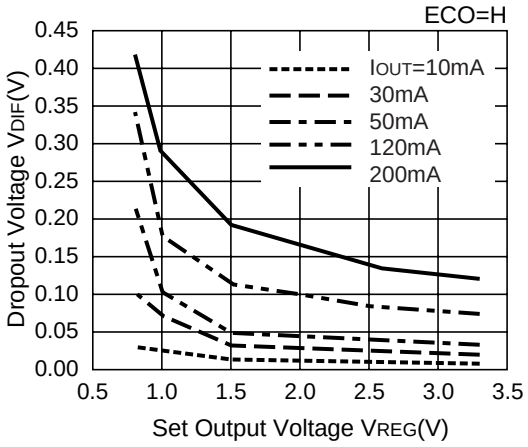


R1160x331x

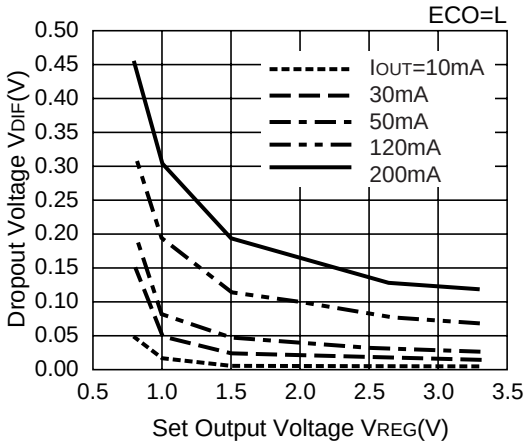


7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

R1160xxx1x

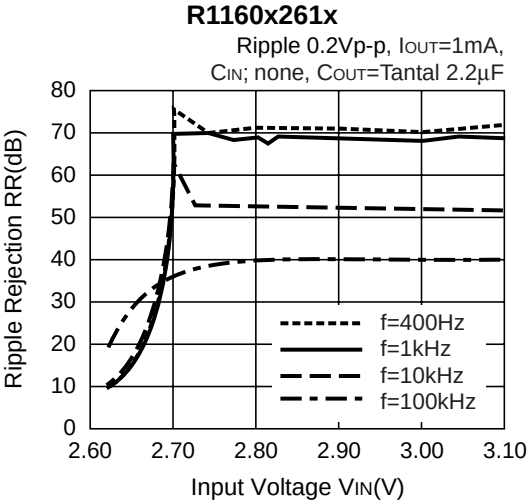


R1160xxx1x

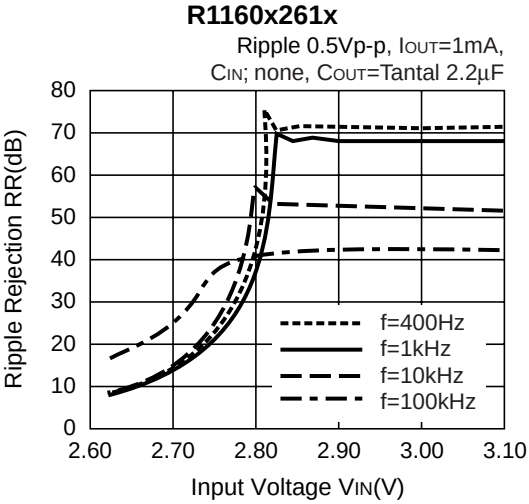


8) Ripple Rejection vs. Input Bias (Topt=25°C)

R1160x261x

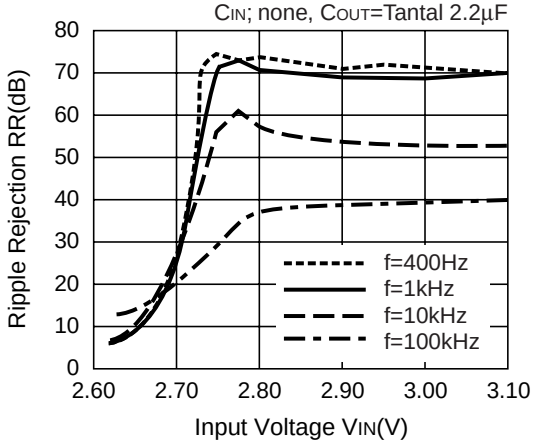


R1160x261x



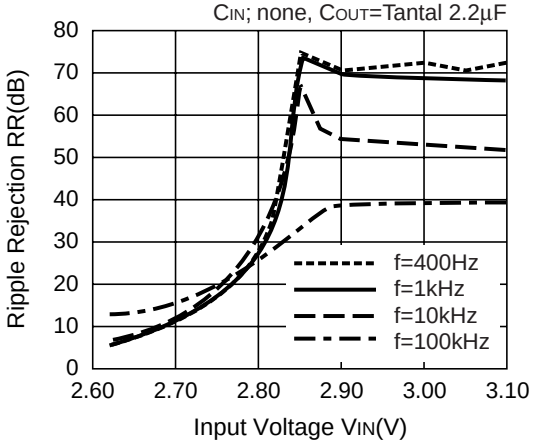
R1160x261x

Ripple 0.2Vp-p, I_{OUT}=30mA,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



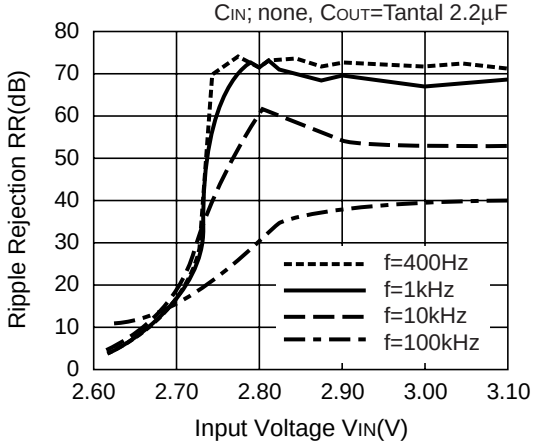
R1160x261x

Ripple 0.5Vp-p, I_{OUT}=30mA,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



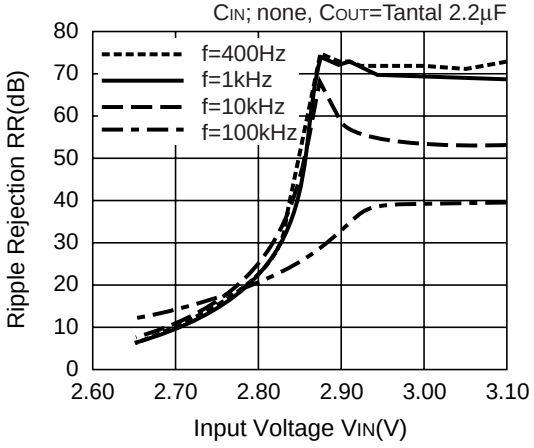
R1160x261x

Ripple 0.2Vp-p, I_{OUT}=50mA,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



R1160x261x

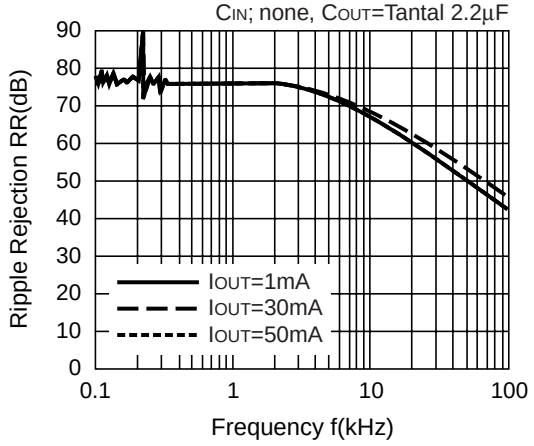
Ripple 0.5Vp-p, I_{OUT}=50mA,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



9) Ripple Rejection vs. Frequency

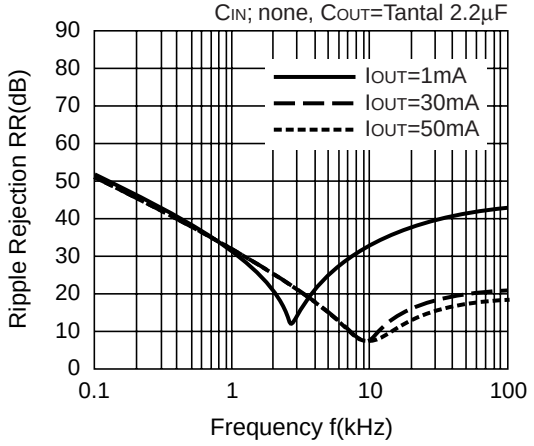
R1160x081x

ECO=H, V_{IN}1.8V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



R1160x081x

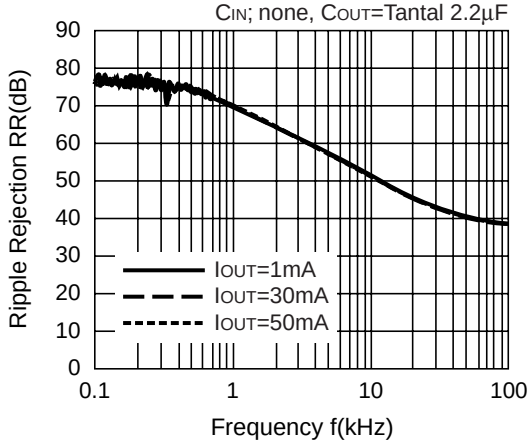
ECO=L, V_{IN}1.8V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



R1160x

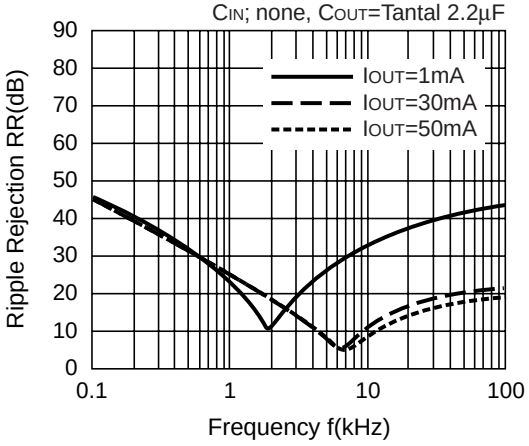
R1160x151x

ECO=H, V_{IN}2.5V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



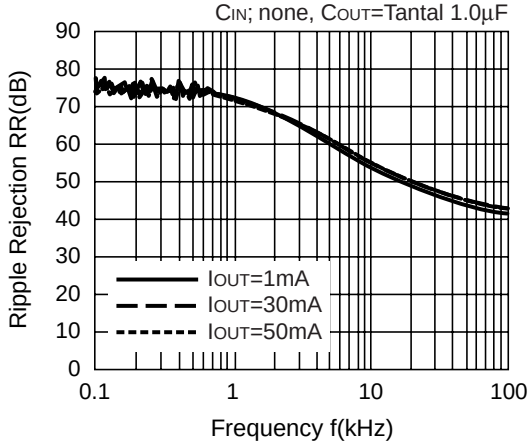
R1160x151x

ECO=L, V_{IN}2.5V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



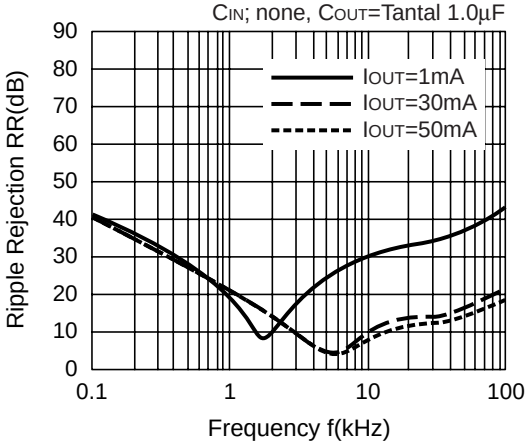
R1160x261x

ECO=H, V_{IN}3.6V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 1.0µF



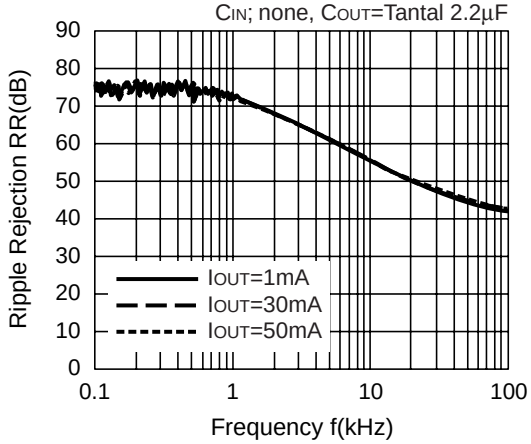
R1160x261x

ECO=L, V_{IN}3.6V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 1.0µF



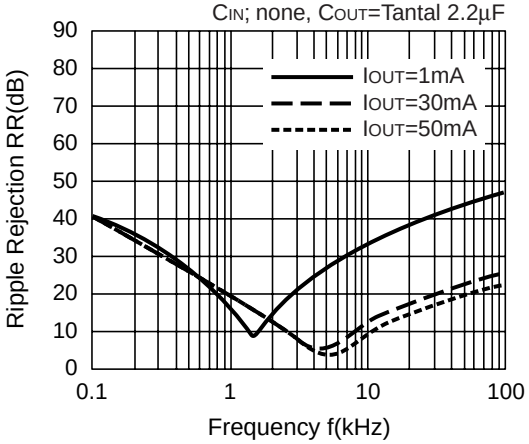
R1160x261x

ECO=H, V_{IN}3.6V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



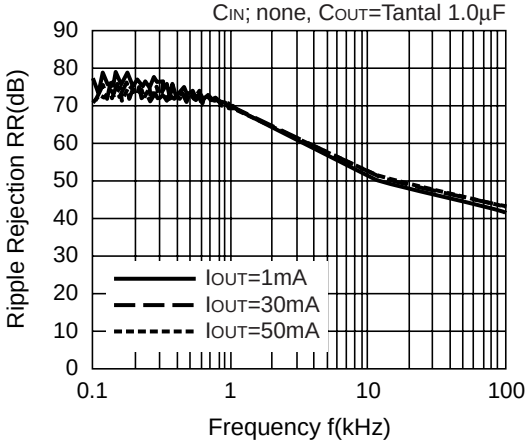
R1160x261x

ECO=L, V_{IN}3.6V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



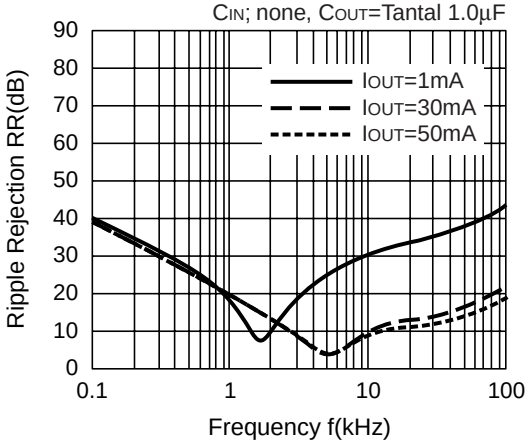
R1160x331x

ECO=H, V_{IN}4.3V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 1.0µF



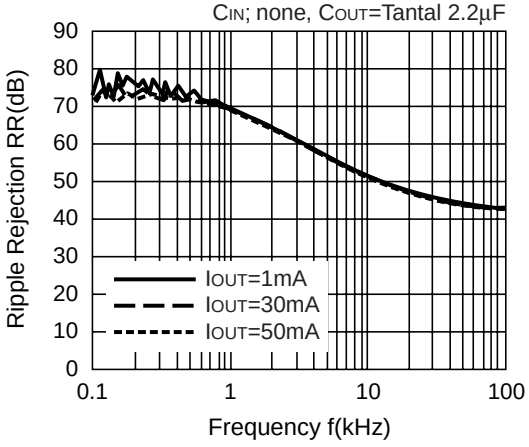
R1160x331x

ECO=L, V_{IN}4.3V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 1.0µF



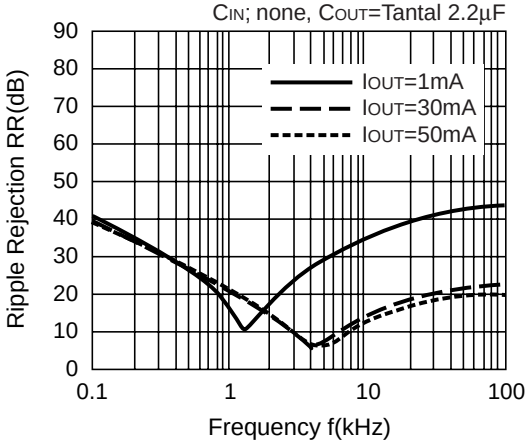
R1160x331x

ECO=H, V_{IN}4.3V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



R1160x331x

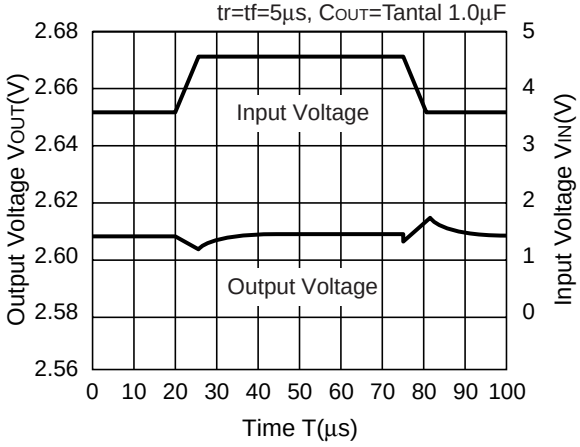
ECO=L, V_{IN}4.3V_{DC}+0.2Vp-p,
C_{IN}; none, C_{OUT}=Tantal 2.2µF



10) Input Transient Response

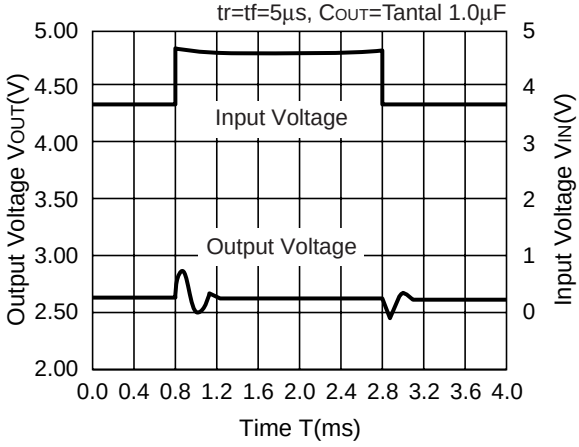
R1160x261x

ECO=H, I_{OUT}=30mA,
tr=tf=5µs, C_{OUT}=Tantal 1.0µF



R1160x261x

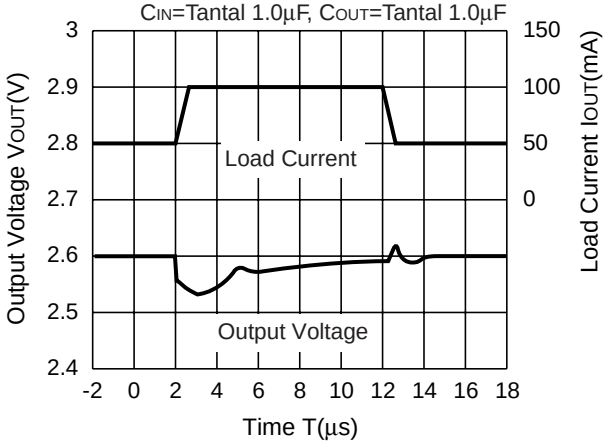
ECO=L, I_{OUT}=10mA,
tr=tf=5µs, C_{OUT}=Tantal 1.0µF



11) Load Transient Response

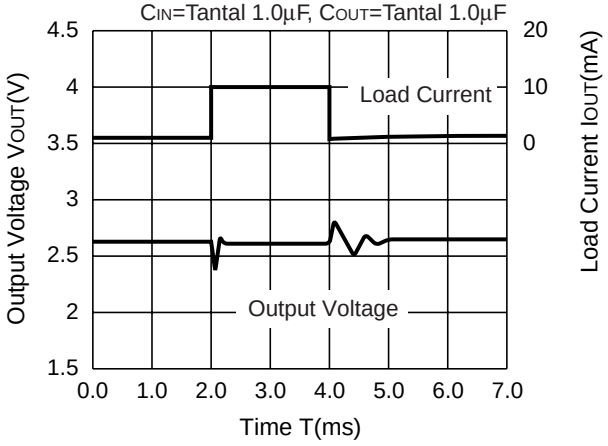
R1160x261x

ECO=H, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 1.0µF



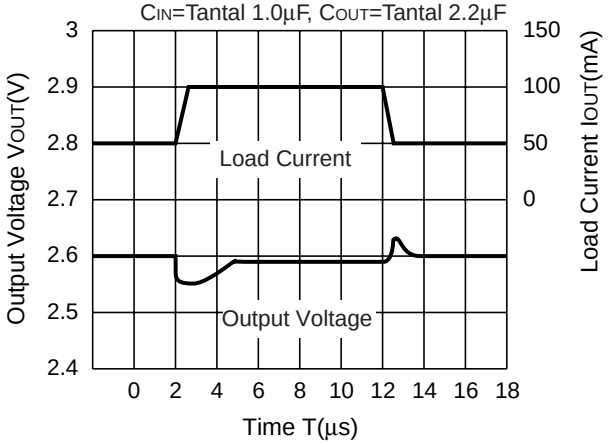
R1160x261x

ECO=L, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 1.0µF



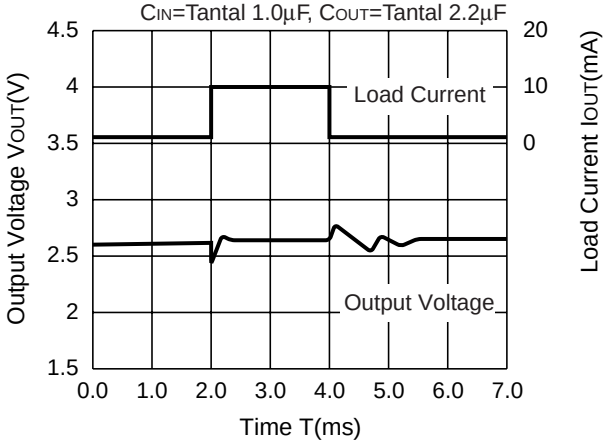
R1160x261x

ECO=H, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 2.2µF



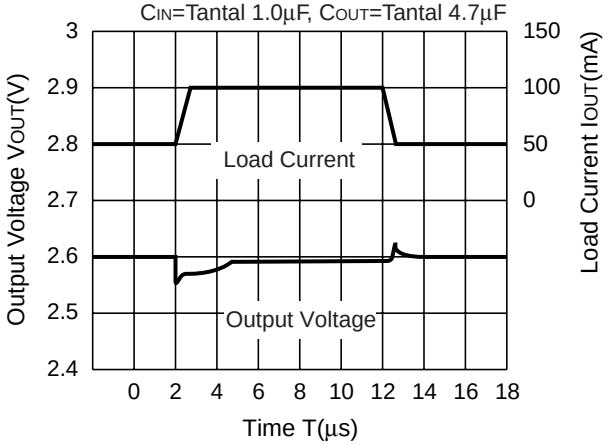
R1160x261x

ECO=L, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 2.2µF



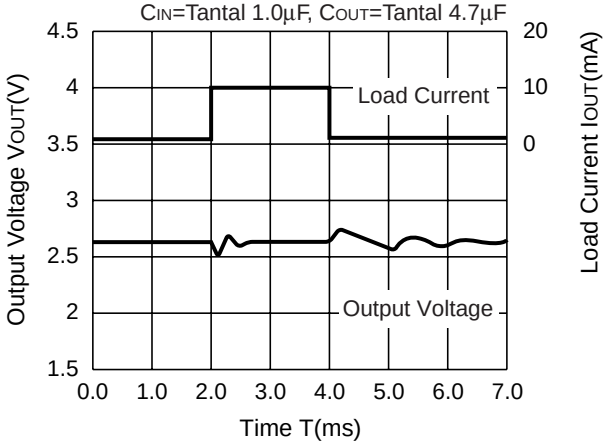
R1160x261x

ECO=H, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 4.7µF



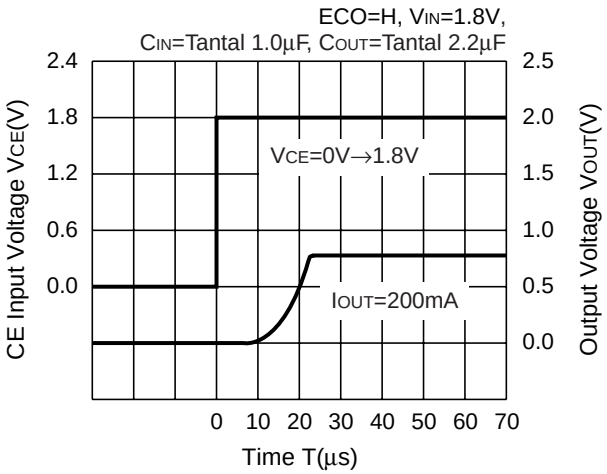
R1160x261x

ECO=L, V_{IN}=3.6V,
C_{IN}=Tantal 1.0µF, C_{OUT}=Tantal 4.7µF

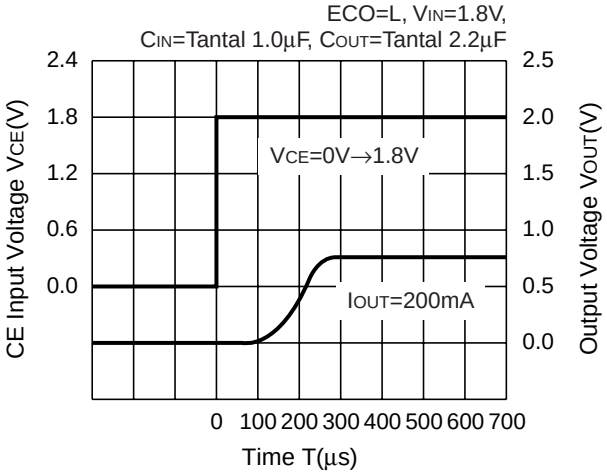


12) Turn on speed with CE pin

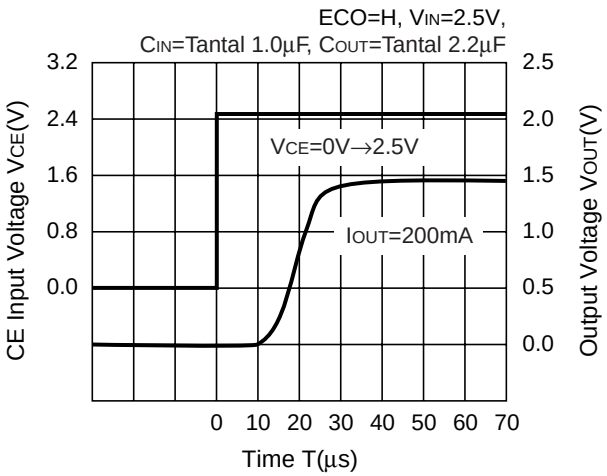
R1160x081B



R1160x081B



R1160x151B



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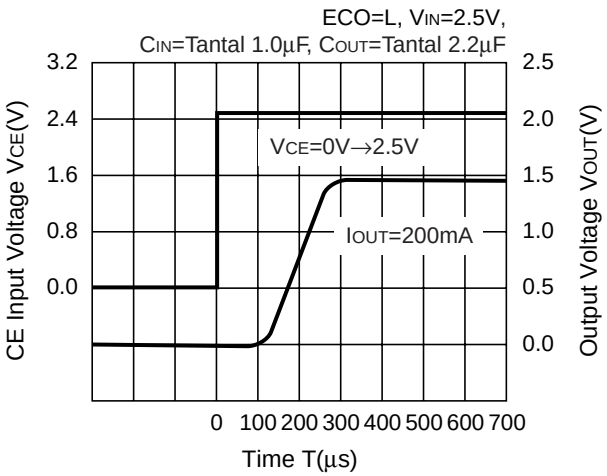

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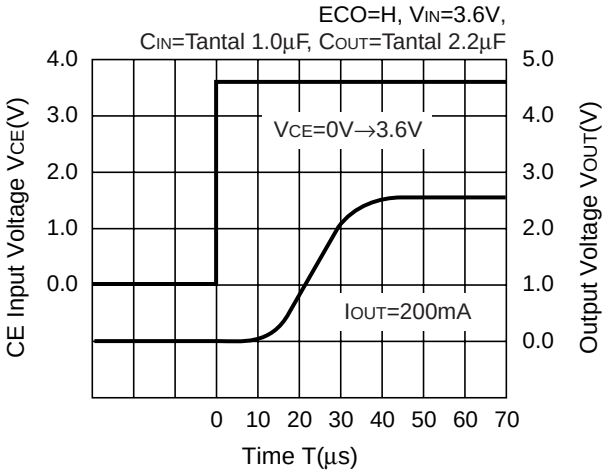

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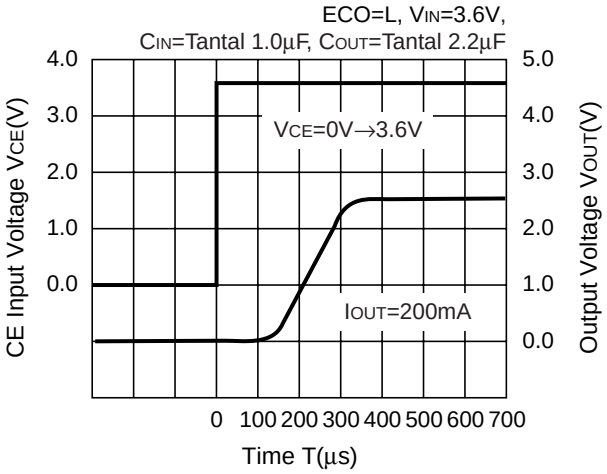

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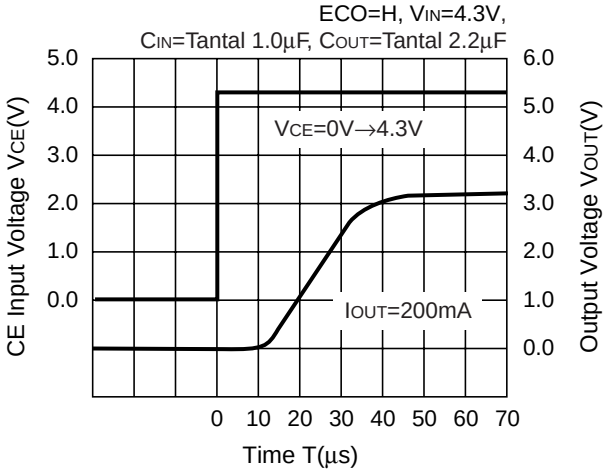

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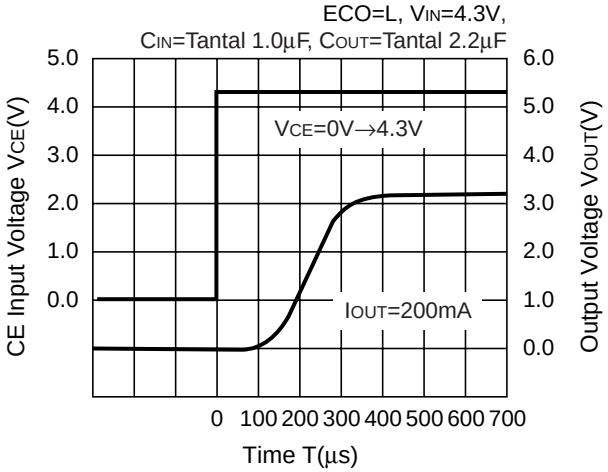
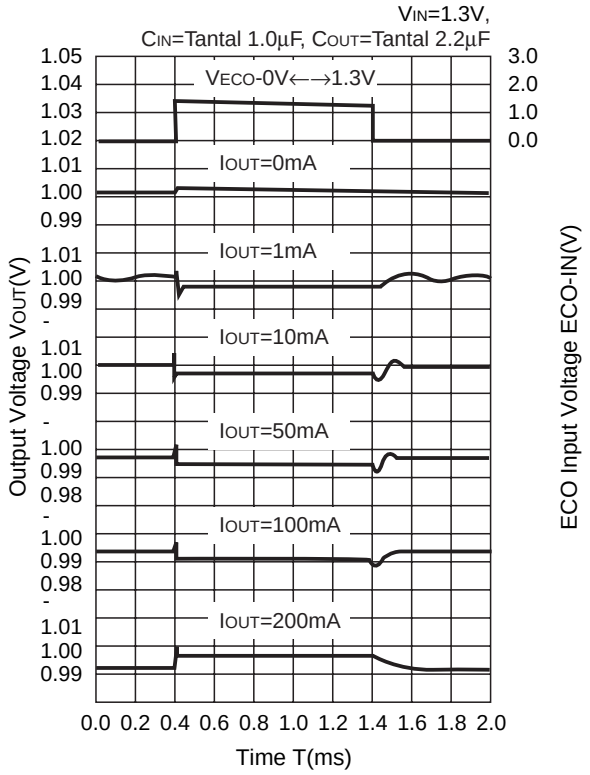
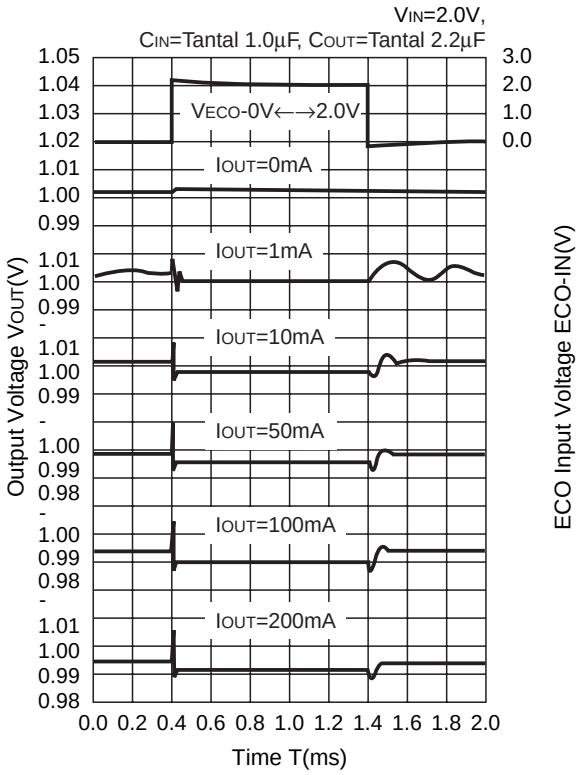


13) Output Voltage at Mode alternative point

R1160x101x



R1160x101x



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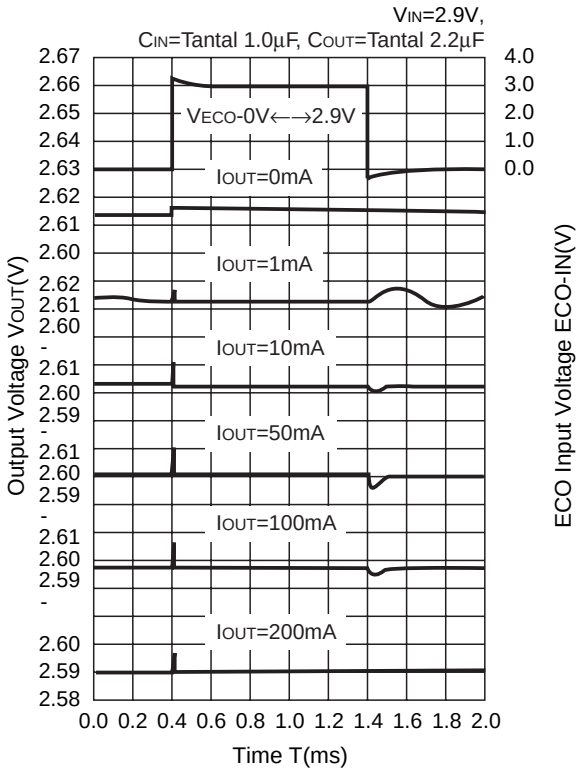
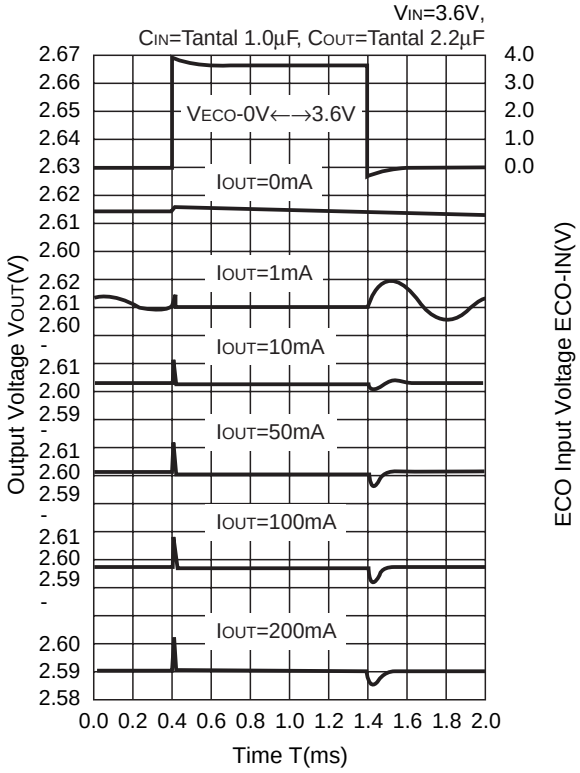
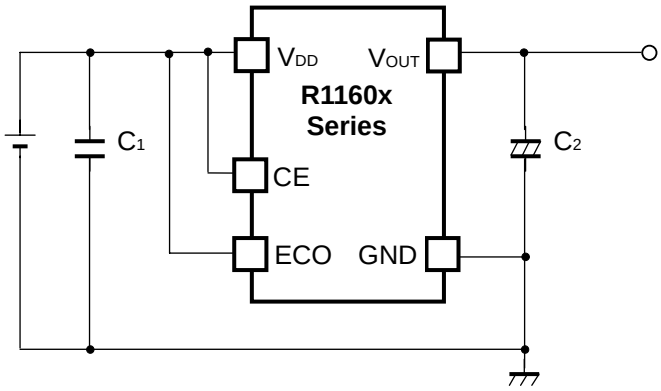


R1160x261x



TECHNICAL NOTES



(External Components)
C1: Ceramic Capacitor 1μF
C2: Tantalum Capacitor 2.2μF

When using these ICs, consider the following points:

1. 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.

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 C2 with 2.2μF or more and good ESR (Equivalent Series Resistance).

(Note: If additional ceramic capacitors are connected with parallel to the output pin with an output capacitor for phase compensation, the operation might be unstable. Because of this, test 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.

If you use a ceramic type output capacitor, please connect about 1Ω resistor in series for the stability of output voltage.

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

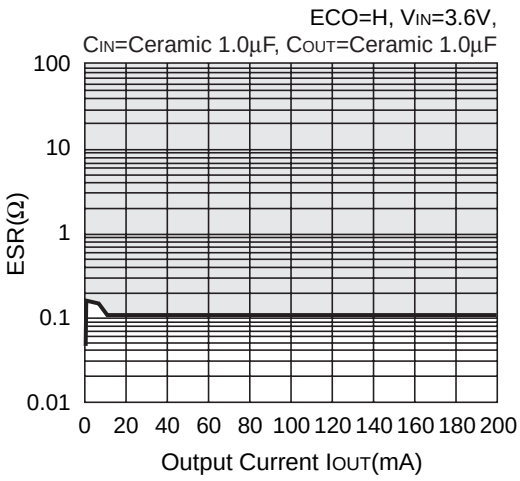
When using these ICs, consider the following points:

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.

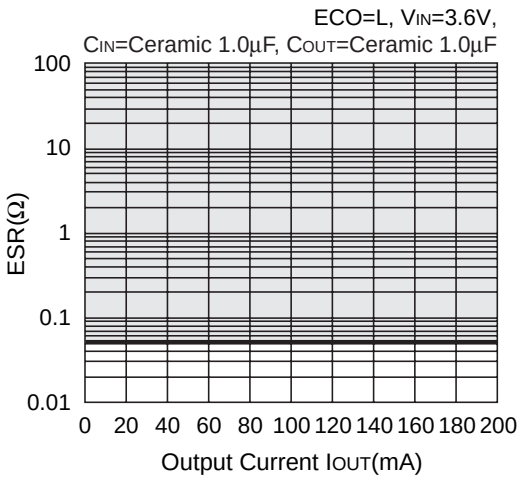
Measurement conditions

Frequency Band : 10Hz to 2MHz
Temperature : 25°C

R1160x261x



R1160x261x



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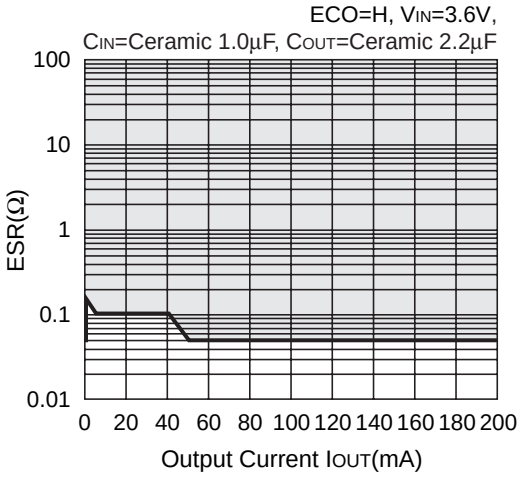
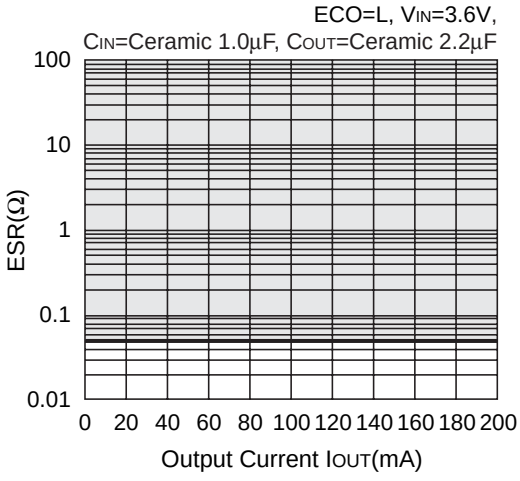


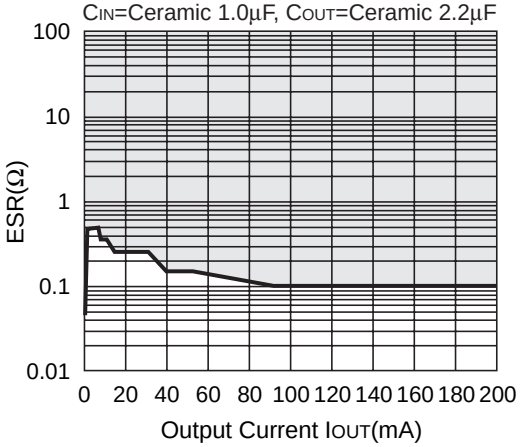
R1160x261x



R1160x

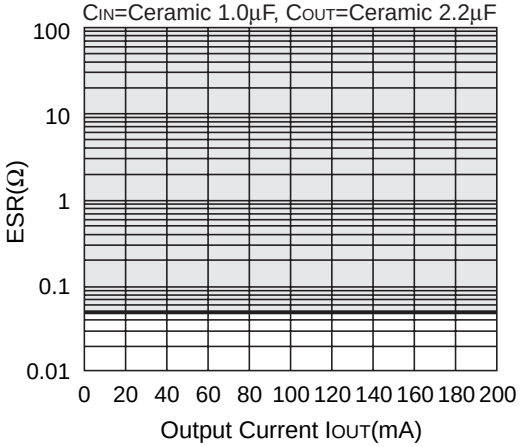
R1160x081x

ECO=H, VIN=1.8V,
CIN=Ceramic 1.0µF, COUT=Ceramic 2.2µF



R1160x081x

ECO=L, VIN=1.8V,
CIN=Ceramic 1.0µF, COUT=Ceramic 2.2µF



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