3-MODE 150mA LDO REGULATOR

NO.EA-110-120404

OUTLINE

The R1162x Series consist of CMOS-based voltage regulator ICs with high output voltage accuracy and low supply current. 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 so on. The output voltage is internally fixed with high accuracy.

These ICs perform with the chip enable function and realize a standby mode with ultra low supply current. To prevent the destruction by over current, the current limit circuit is included. The R1162x 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 at Low Power Mode compared with Fast Transient Mode. The output voltage is maintained between FT mode and LP mode.

Since the packages for these ICs are SOT-23-5 (Limited) and SON1612-6 packages, high density mounting of the ICs on boards is possible.

FEATURES

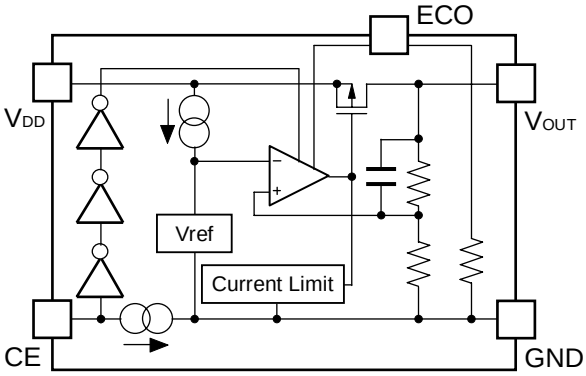
- Supply Current ..... Typ. 5.5μA (Low Power Mode),
  Typ. 70μA (Fast Transient Mode)
- Standby Current ..... Typ. 0.1μA
- High Ripple Rejection ..... Typ. 70dB (f=1kHz, Fast Transient Mode)
  Typ. 60dB (f=10kHz, Fast Transient Mode)
- Input Voltage Range ..... 2.0V to 6.0V
- Output Voltage Range ..... 1.5V to 4.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy ..... ±2.0% (±3.0% at Low Power Mode)
- Temperature-Drift Coefficient of Output Voltage .... Typ. ±100ppm/°C
- Dropout Voltage ..... Typ. 0.25V (I_{OUT}=150mA , V_{OUT}=2.8V)
- Line Regulation ..... Typ. 0.02%/V
- Package ..... SON1612-6, SOT-23-5 (Limited)
- Built-in fold-back protection circuit ..... Typ. 40mA (Current at short mode)
- Performs with Ceramic Capacitors ..... C_{IN}=1.0μF,C_{OUT}=0.47μF

APPLICATIONS

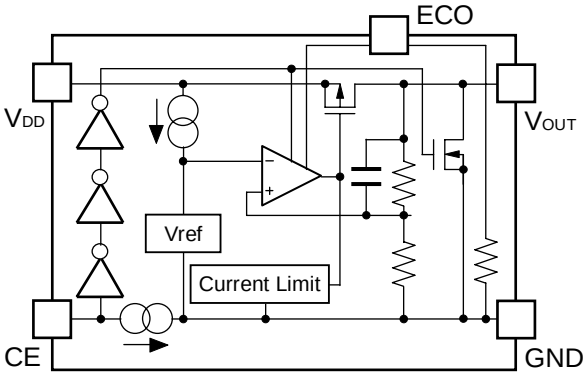
- Precision Voltage References.
- Power source for electrical appliances such as cameras, VCRs and hand-held communication equipment.
- Power source for battery-powered equipment.

BLOCK DIAGRAM

R1162xxx1B



R1162xxx1D



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1162Dxx1∗-TR-FE	SON1612-6	4,000 pcs	Yes	Yes
R1162Nxx1∗-TR-FE	SOT-23-5 (Limited)	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.)

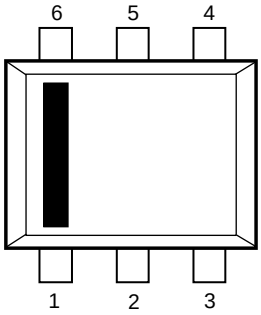
∗ : The auto discharge function at off state are options as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state

The products scheduled to be discontinued (be sold to limited customer) : "Limited"

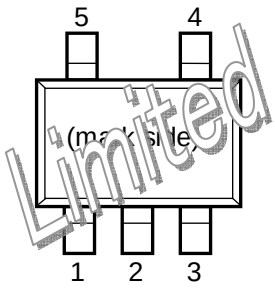
These products will be discontinued in the future. You can not select these products newly.
We will provide these products to the customer who has been using or has ordered them before.
But we recommend changing to other products as soon as possible.

PIN CONFIGURATIONS

- **SON1612-6**



- **SOT-23-5**



PIN DESCRIPTIONS

- **SON1612-6**

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

- **SOT-23-5 (Limited)**

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

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{ECO}	Input Voltage (ECO Pin)	–0.3 to 6.5	V
V_{CE}	Input Voltage ($\overline{CE}$ / CE Pin)	–0.3 to 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) (Limited)*	420	mW
	Power Dissipation (SON1612-6)*	500	MW
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.

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

- **R1162xxx1B/D**

Topt=25°C

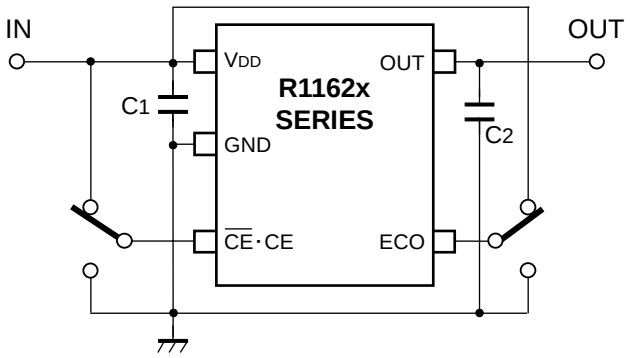
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN} = Set V_{OUT}+1V V_{ECO} = V_{IN} 1mA ≦ I_{OUT} ≦ 30mA Note 1	V_{OUT} ×0.98		V_{OUT} ×1.02	V
		V_{IN} = Set V_{OUT} + 1V V_{ECO} =GND 1mA ≦ I_{OUT} ≦ 30mA Note 2	V_{OUT} ×0.97		V_{OUT} ×1.03	V
ΔV_{OUT}	Output Voltage Deviation between FT Mode and LP Mode	V_{IN} = Set V_{OUT}+1V, I_{OUT} =30mA V_{OUT} ≦ 2.0V	−1.2	0.0	1.2	%
		V_{OUT} ≧ 2.0V	(−24)	0.0	(24)	mV
I_{OUT}	Output Current	V_{IN} − V_{OUT} = 1.0V	150			mA
ΔV_{OUT}/ ΔI_{OUT}	Load Regulation(FT Mode)	V_{IN} =Set V_{OUT}+1V, V_{ECO}=V_{IN} 1mA ≦ I_{OUT} ≦ 150mA		20	40	mV
	Load Regulation(LP Mode)	V_{IN} = Set V_{OUT}+1V,V_{ECO}=GND 1mA ≦ I_{OUT} ≦ 150mA		20	45	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}, I_{OUT}=0mA		70	100	μA
I_{SS2}	Supply Current(LP Mode)	V_{IN} = Set V_{OUT}+1V V_{ECO} = GND, I_{OUT}=0mA		5.5	9.0	μA
Istandby	Supply Current (Standby)	V_{IN} = V_{CE} = Set V_{OUT}+1V		0.1	1.0	μA
ΔV_{OUT}/ ΔV_{IN}	Line Regulation(FT Mode)	Set V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V I_{OUT} = 30mA, V_{ECO} = V_{IN} V_{OUT} ≦ 1.6V: 2.2V ≦ V_{IN} ≦ 6.0V		0.02	0.10	%/V
	Line Regulation(LP Mode)	Set V_{OUT} + 0.5V ≦ V_{IN} ≦ 6.0V I_{OUT} = 30mA, V_{ECO} = GND V_{OUT} ≦ 1.6V: 2.2V ≦ V_{IN} ≦ 6.0V		0.05	0.20	%/V
RR	Ripple Rejection(FT Mode)	f = 1kHz f = 10kHz,Ripple 0.2Vp-p V_{IN} = Set V_{OUT} + 1V I_{OUT} = 30mA, V_{ECO} = V_{IN}		70 60		dB
V_{IN}	Input Voltage		2.0		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		40		mA
I_{PD}	CE Pull-down Constant Current			0.3	0.6	μA
R_{PD}	ECO Pull-down Resistance		2	5	30	MΩ
V_{CEH}	CE, ECO Input Voltage “H”		1.0		6.0	V
V_{CEL}	CE, ECO Input Voltage “L”		0.00		0.35	V
en	Output Noise (Fast Mode)	BW = 10Hz to 100kHz		30		μVrms
en	Output Noise (Low Power Mode)	BW = 10Hz to 100kHz		40		μVrms
R_{LOW}	Nch On resistance for auto-discharge (Applied to D version)	V_{CE}=0V		60		Ω

ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE

Topt = 25°C

Output Voltage V_{OUT} (V)	Dropout Voltage (mV)				
	Condition	V_{DIF}(ECO=H)		V_{DIF}(ECO=L)	
		Typ.	Max.	Typ.	Max.
1.5 ≦ V_{OUT}<1.6	I_{OUT} = 150mA	400	680	420	680
1.6 ≦ V_{OUT}<1.7		380	550	390	550
1.7 ≦ V_{OUT}<1.8		350	520	370	520
1.8 ≦ V_{OUT}<2.0		340	490	350	490
2.0 ≦ V_{OUT}<2.8		290	425	300	430
2.8 ≦ V_{OUT} ≦ 4.0		250	350	250	350

TYPICAL APPLICATION

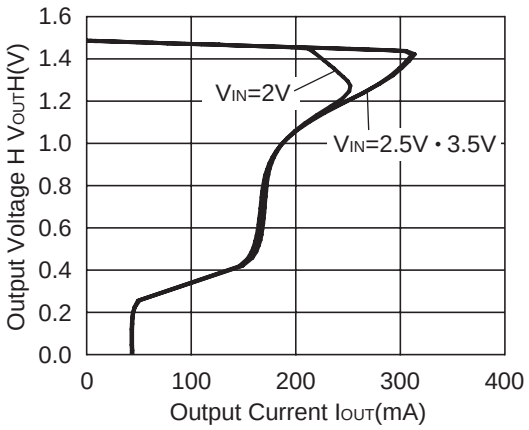


(External Components)
C2 Ceramic 0.47μF Ex. Murata GRM40B474K
Kyocera CM105B474K
C1 Ceramic 1.0μF

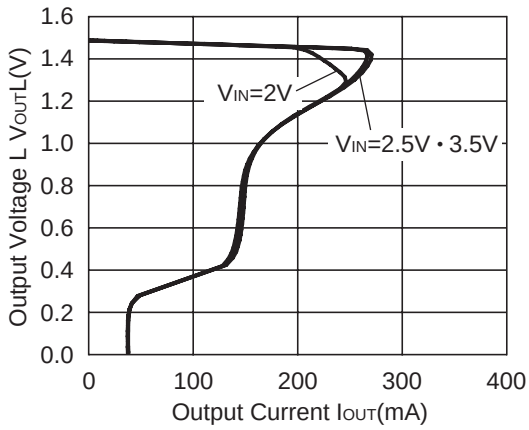
TYPICAL CHARACTERISTICS Unless otherwise provided, capacitors are ceramic type.

1) Output Voltage vs. Output Current

R1162x15x (ECO=H)



R1162x15x (ECO=L)



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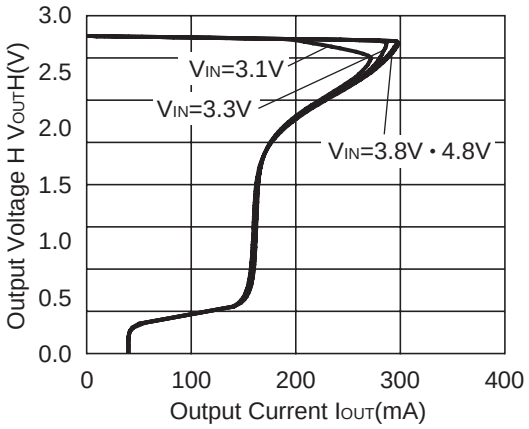

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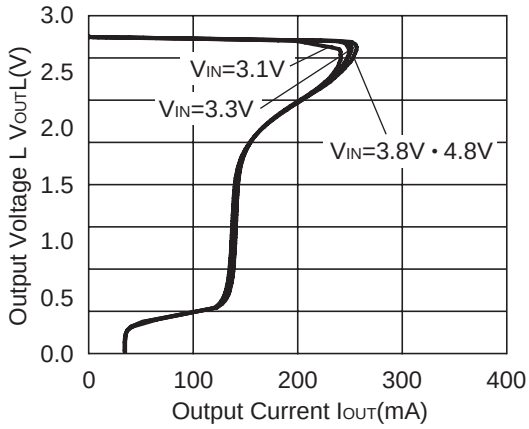

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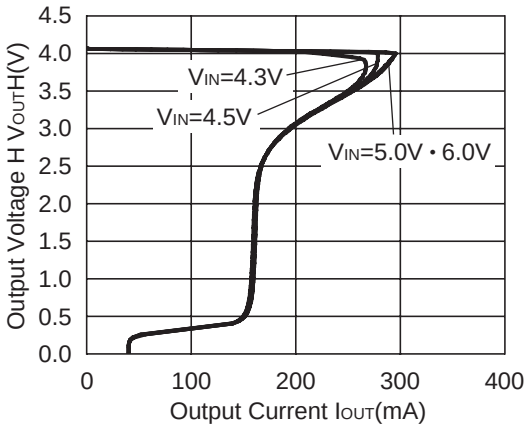

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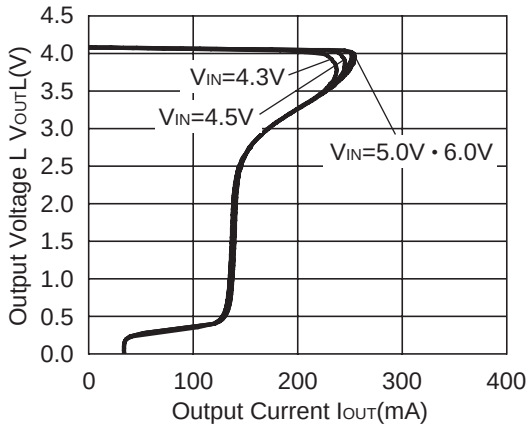
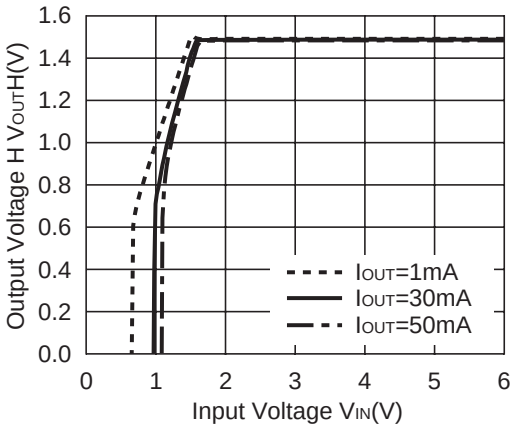


2) Output Voltage vs. Input Voltage

R1162x15x (ECO=H)



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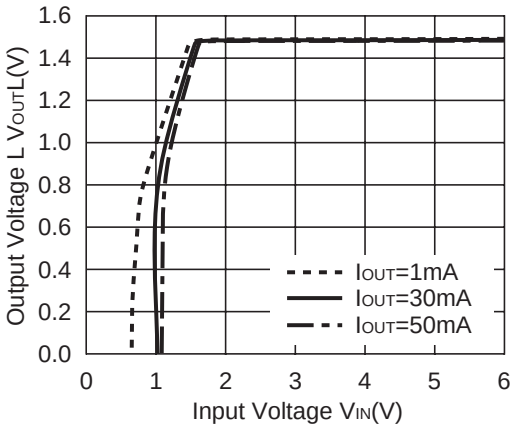

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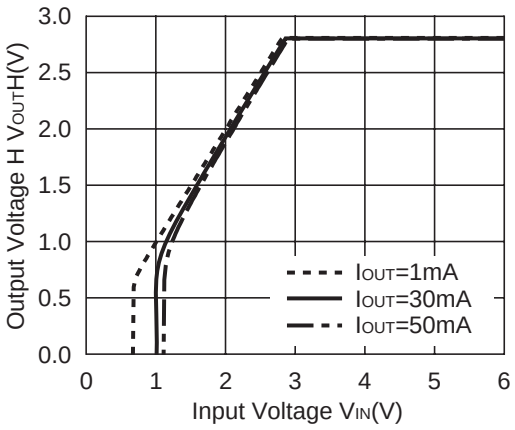

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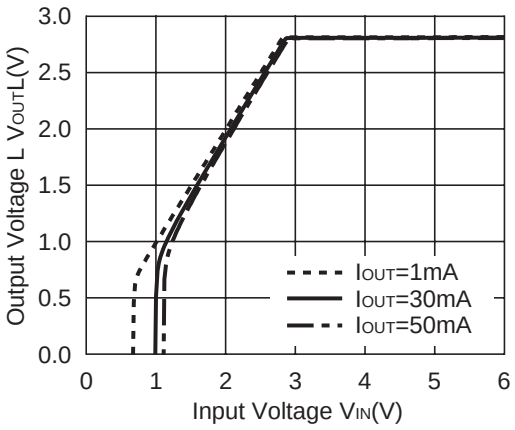

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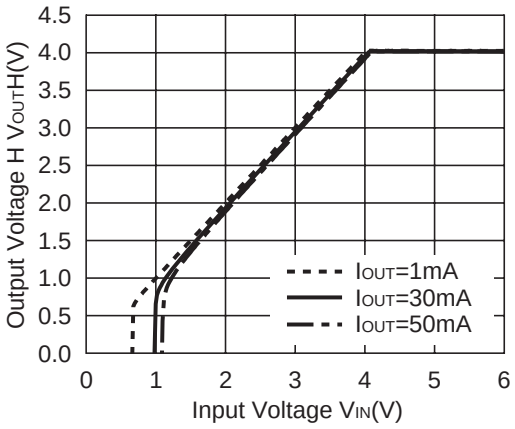

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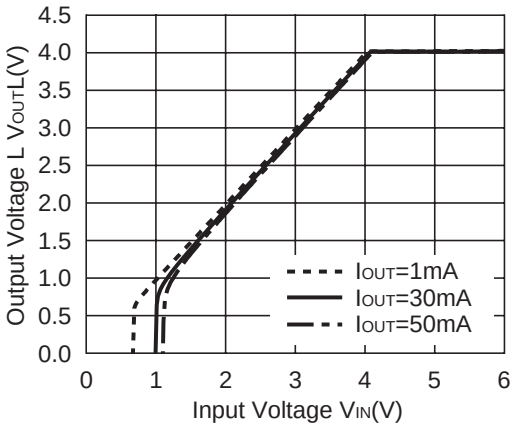
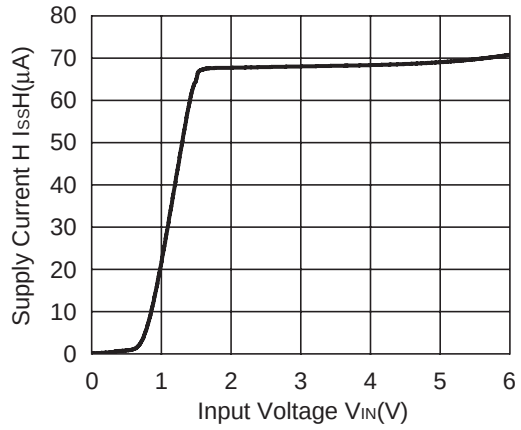


3) Supply Current vs. Input Voltage

R1162x15x (ECO=H)



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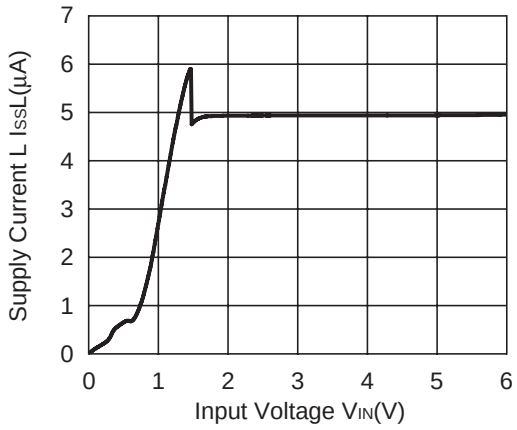

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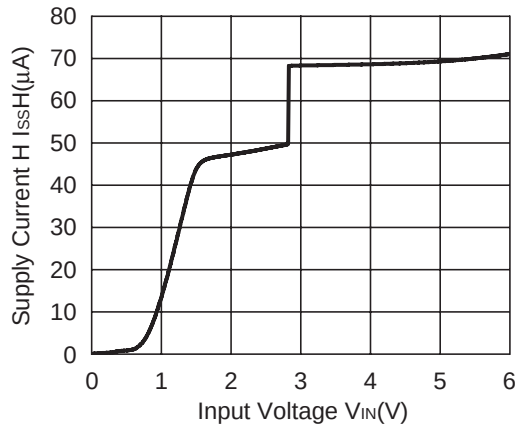

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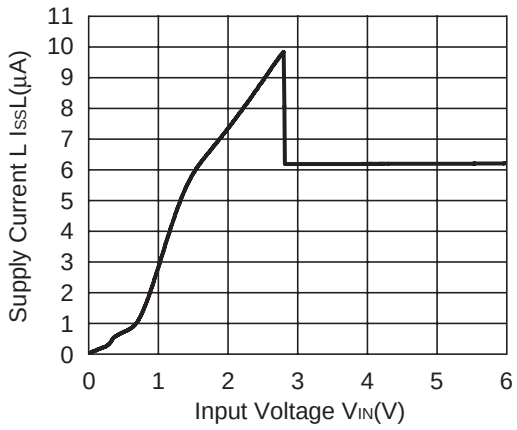

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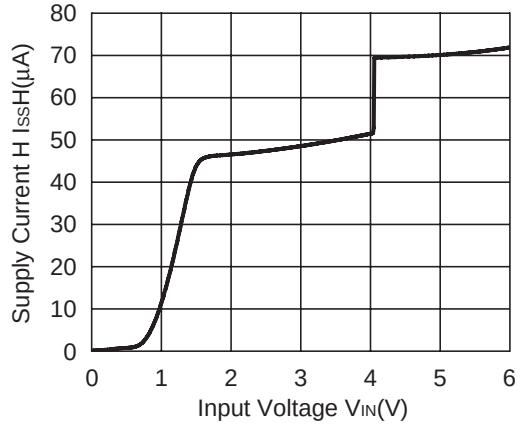

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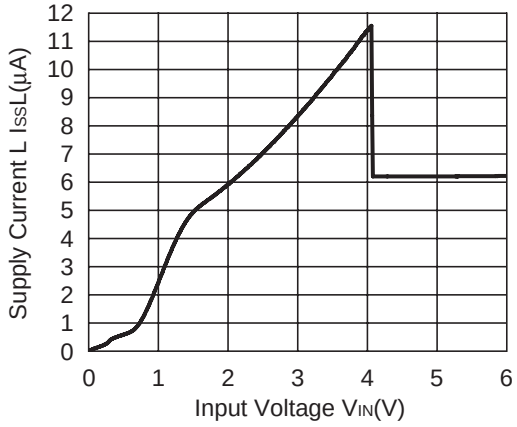
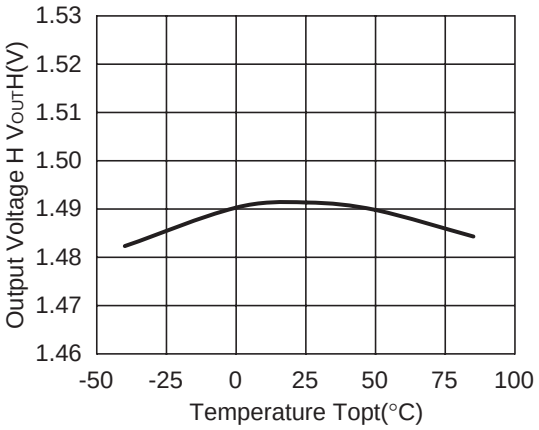


4) Output Voltage vs. Temperature

R1162x15x (ECO=H)



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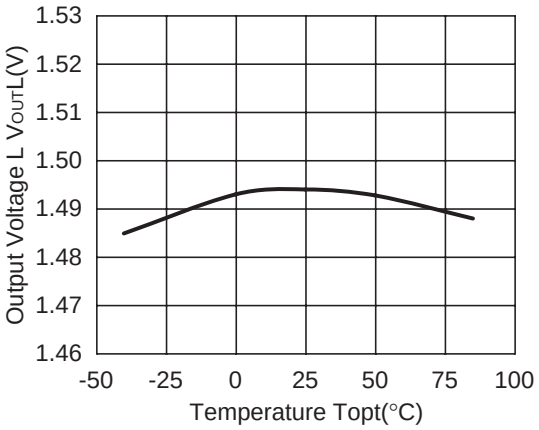

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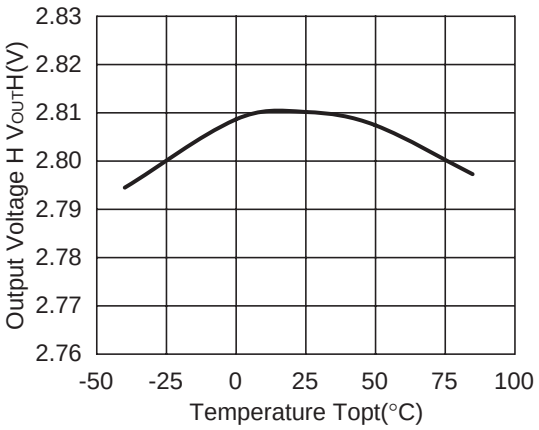

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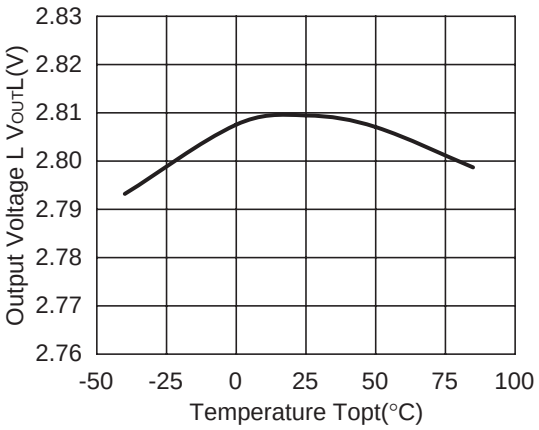

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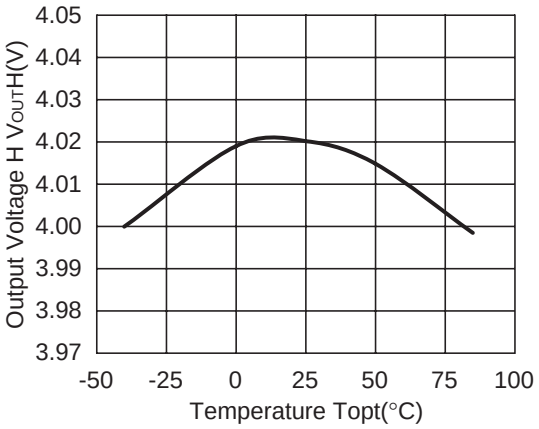

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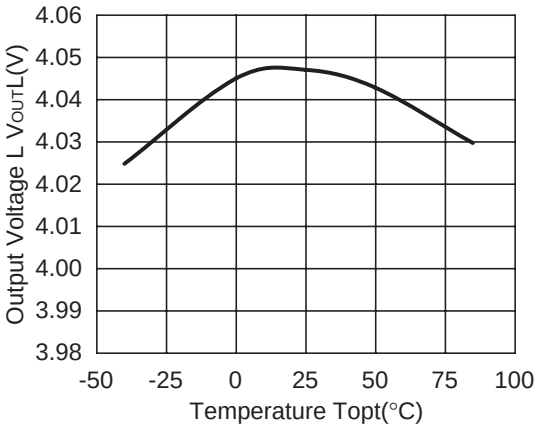
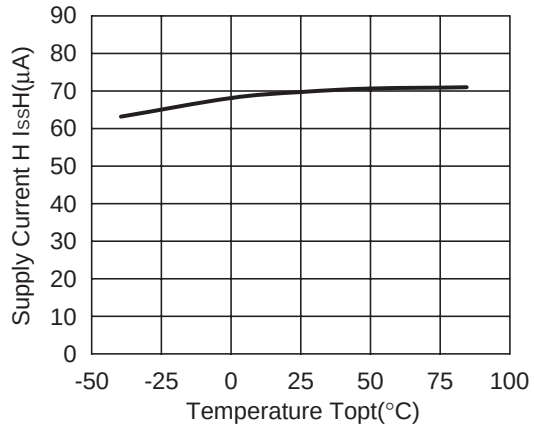
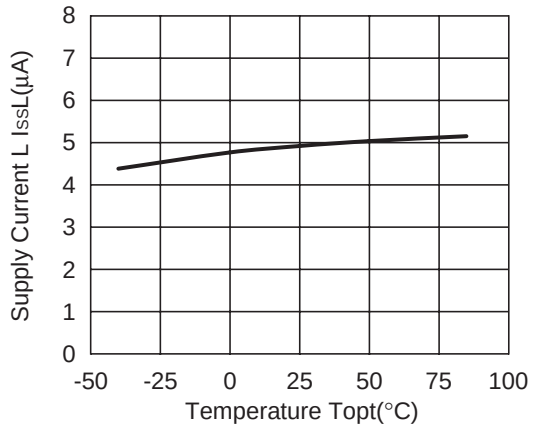


5) Supply Current vs. Temperature

R1162x15x (ECO=H)



R1162x15x (ECO=L)



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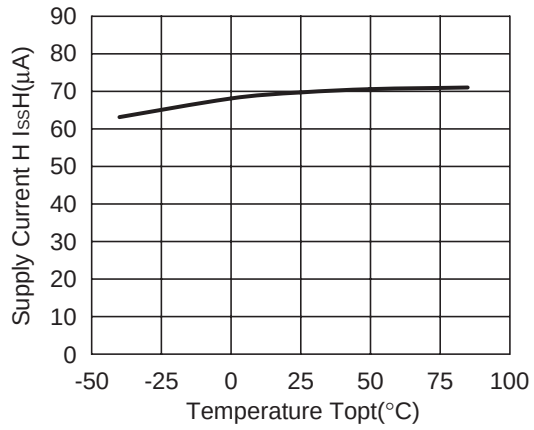

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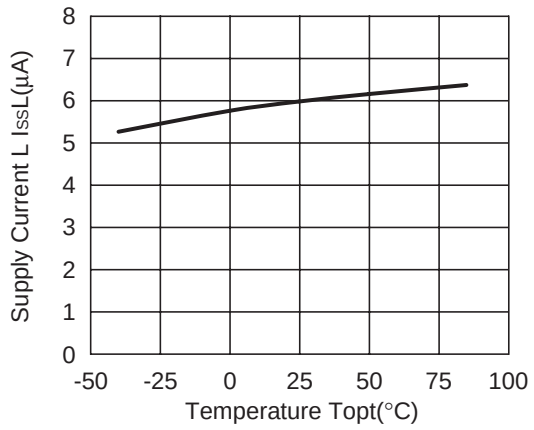

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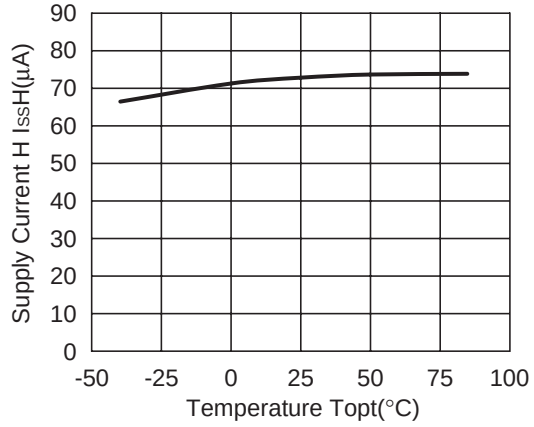

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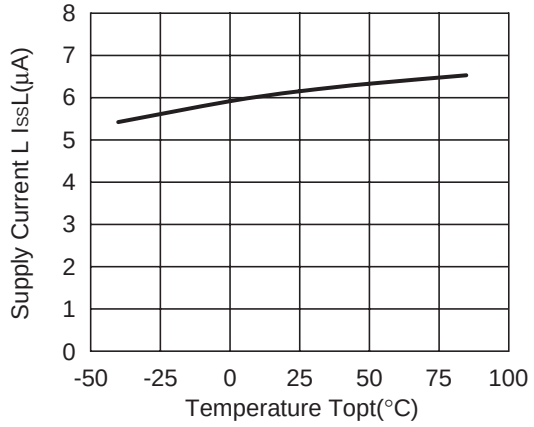
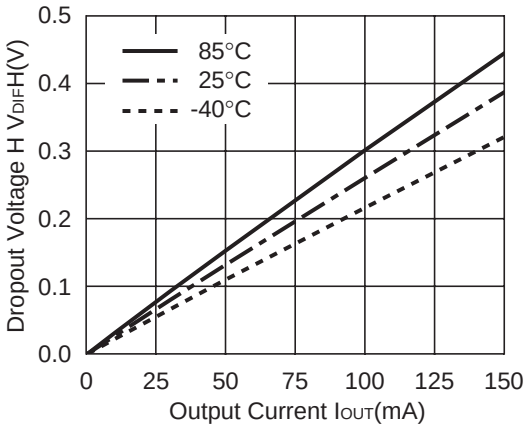
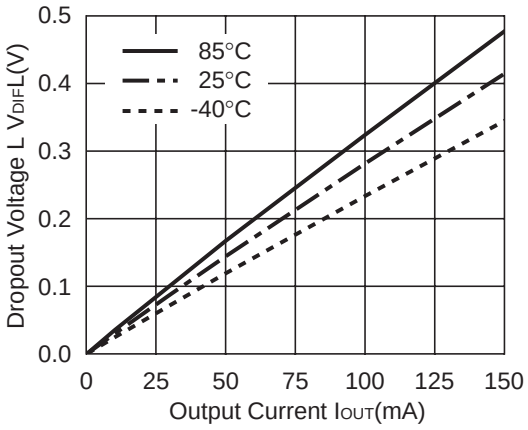


6) Dropout Voltage vs. Output Current

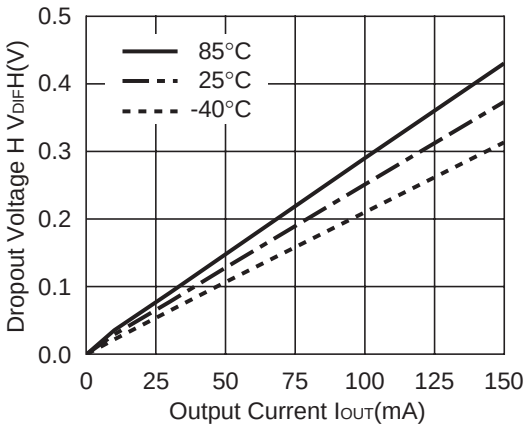
R1162x15x (ECO=H)



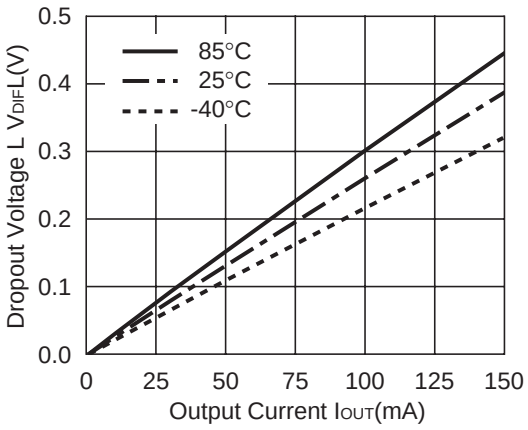
R1162x15x (ECO=L)



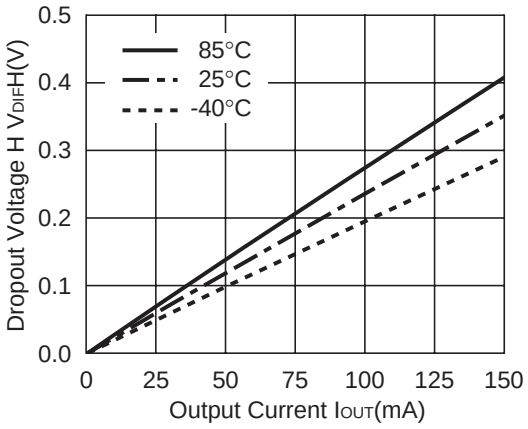
R1162x16x (ECO=H)



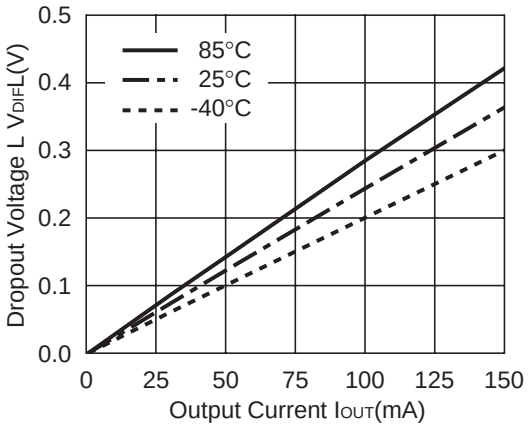
R1162x16x (ECO=L)



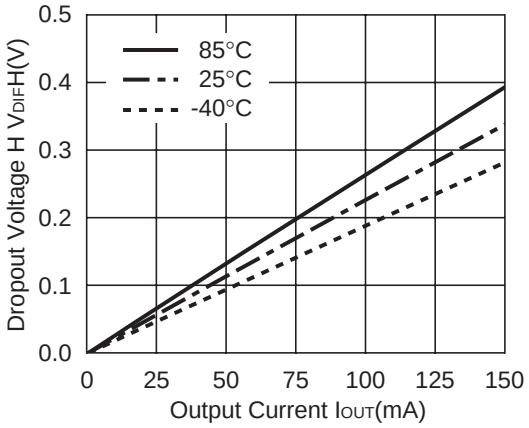
R1162x17x (ECO=H)



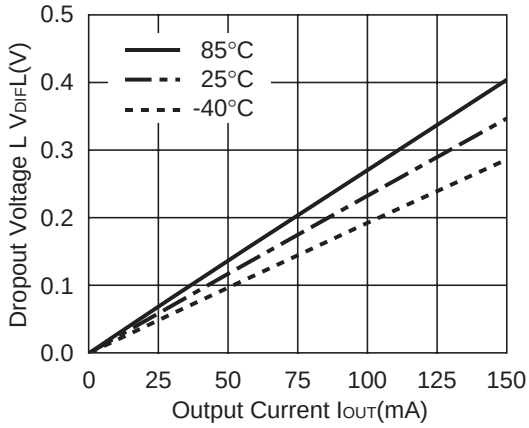
R1162x17x (ECO=L)



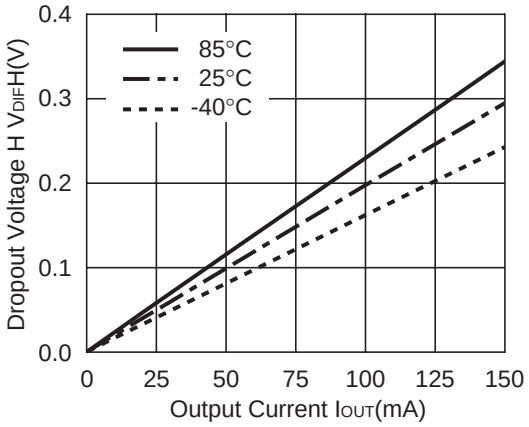
R1162x18x (ECO=H)



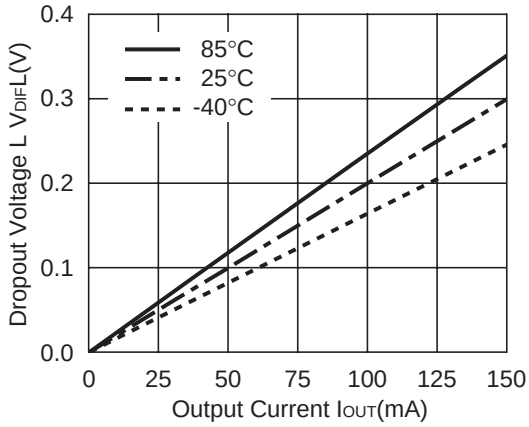
R1162x18x (ECO=L)



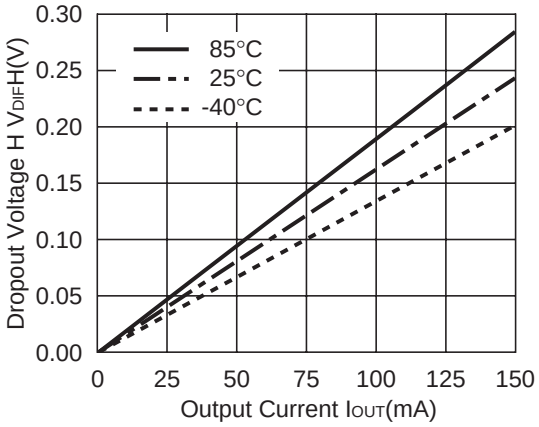
R1162x21x (ECO=H)



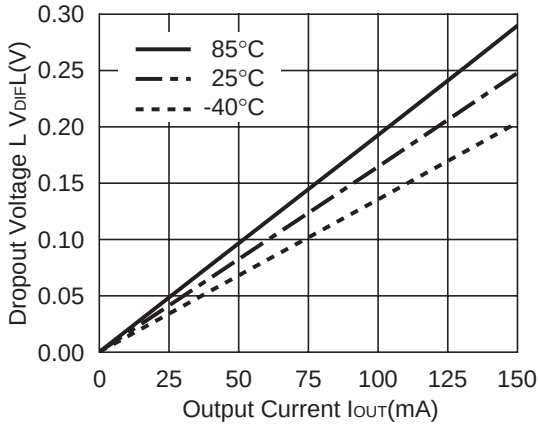
R1162x21x (ECO=L)



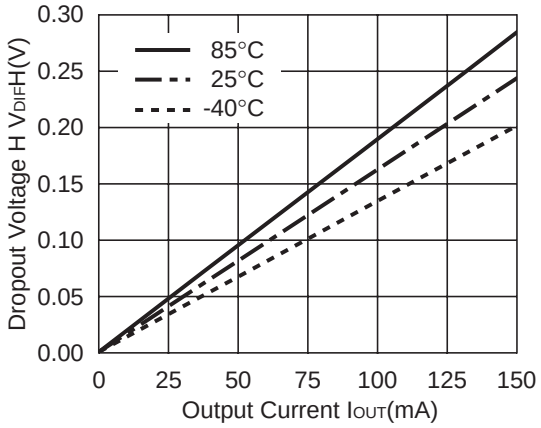
R1162x28x (ECO=H)



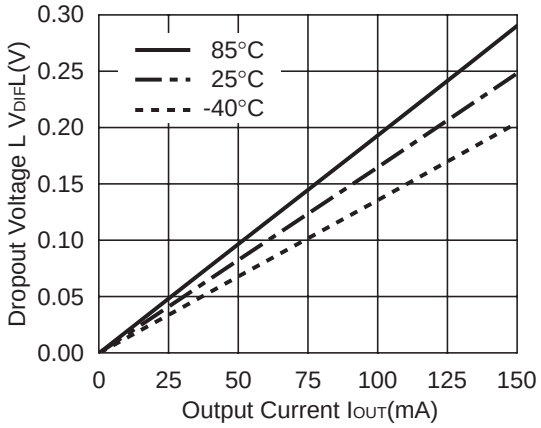
R1162x28x (ECO=L)



R1162x40x (ECO=H)

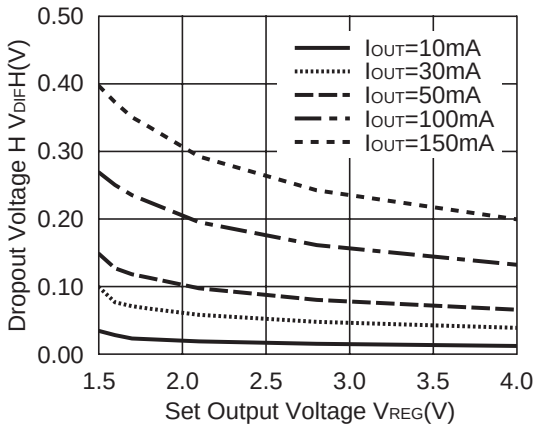


R1162x40x (ECO=L)

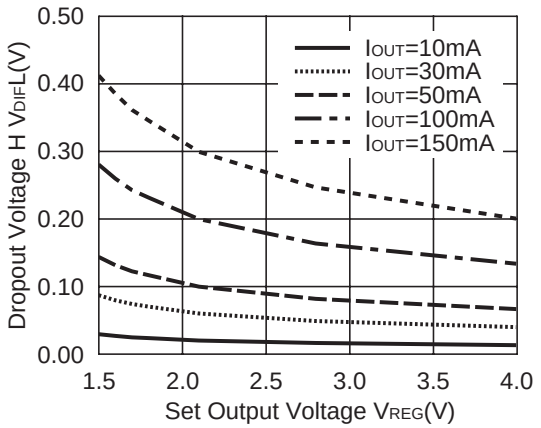


7) Dropout Voltage vs. Set Output Voltage

R1162x (ECO=H)

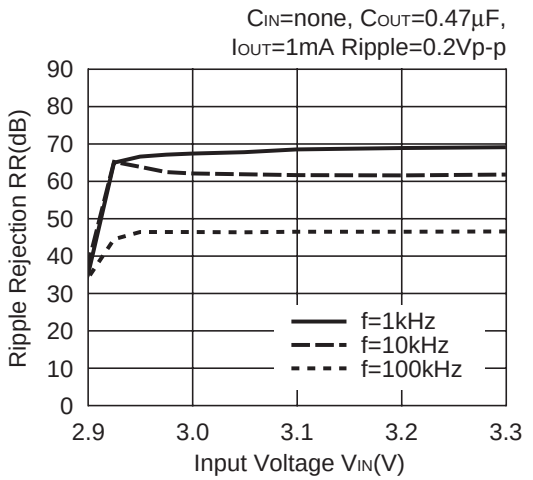


R1162x (ECO=L)

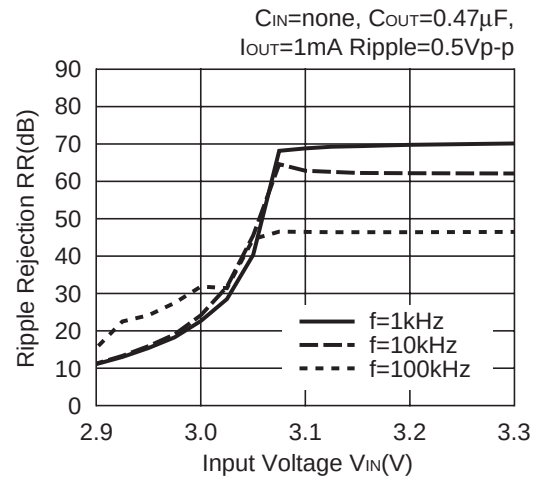


8) Ripple Rejection vs. Input Bias Voltage

R1162x28x (ECO=H)

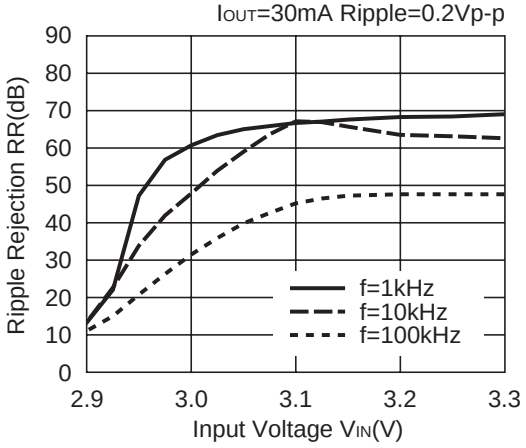


R1162x28x (ECO=H)



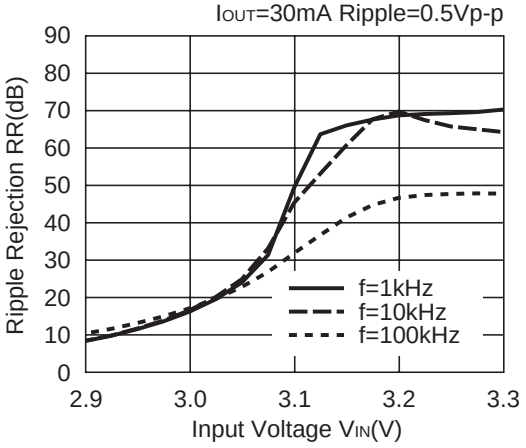
R1162x28x (ECO=H)

C_{IN}=none, C_{OUT}=0.47µF,
I_{OUT}=30mA Ripple=0.2Vp-p



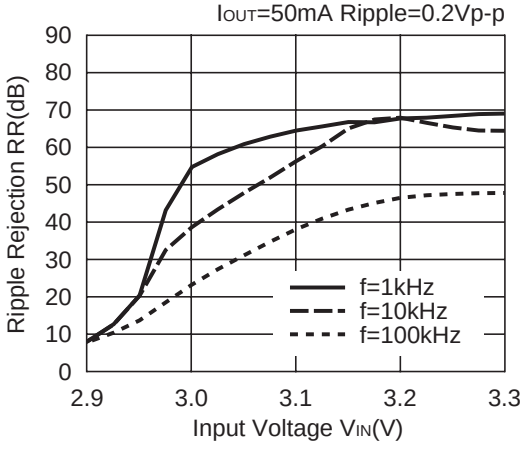
R1162x28x (ECO=H)

C_{IN}=none, C_{OUT}=0.47µF,
I_{OUT}=30mA Ripple=0.5Vp-p



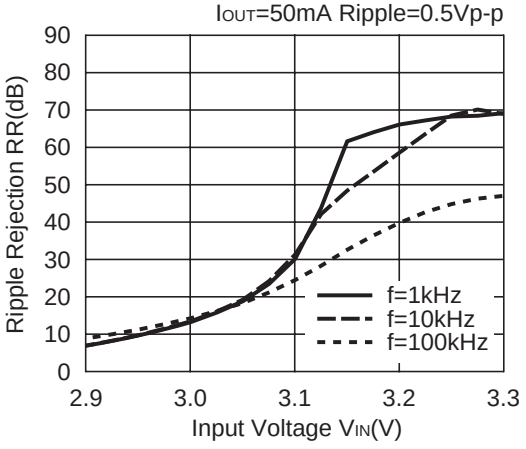
R1162x28x (ECO=H)

C_{IN}=none, C_{OUT}=0.47µF,
I_{OUT}=50mA Ripple=0.2Vp-p



R1162x28x (ECO=H)

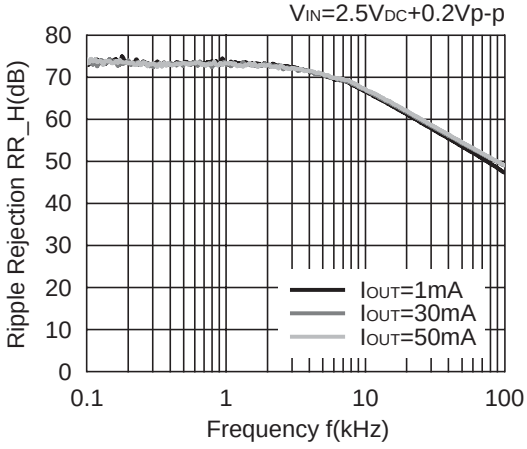
C_{IN}=none, C_{OUT}=0.47µF,
I_{OUT}=50mA Ripple=0.5Vp-p



9) Ripple Rejection vs. Frequency

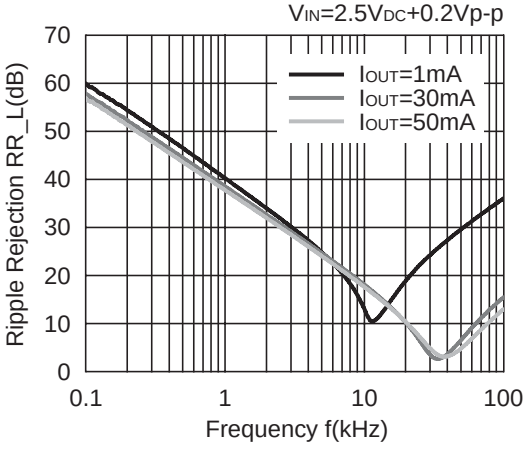
R1162x15x (ECO=H)

C_{IN}=none, C_{OUT}=0.47µF,
V_{IN}=2.5V_{DC}+0.2Vp-p

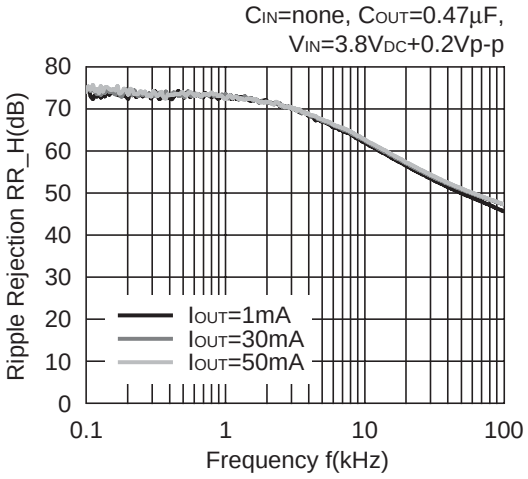


R1162x15x (ECO=L)

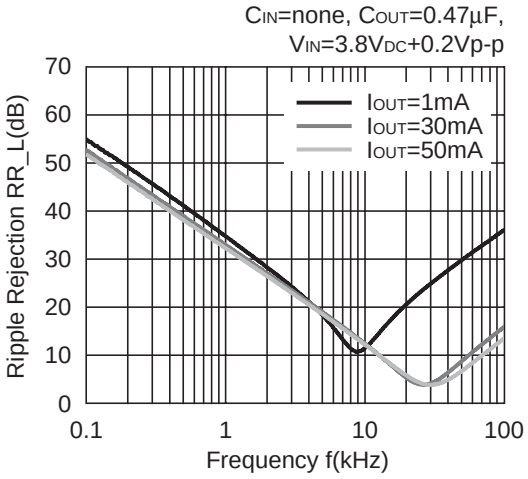
C_{IN}=none, C_{OUT}=0.47µF,
V_{IN}=2.5V_{DC}+0.2Vp-p



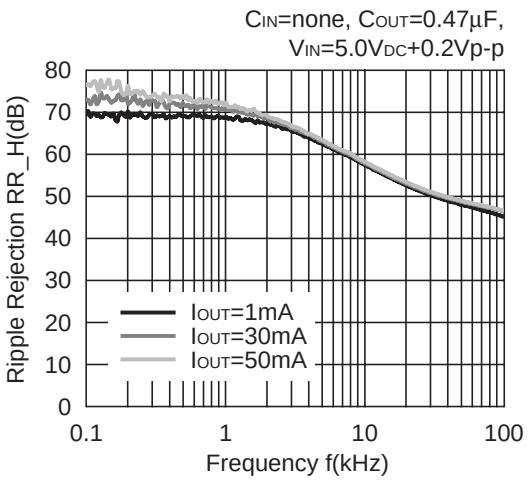
R1162x28x (ECO=H)



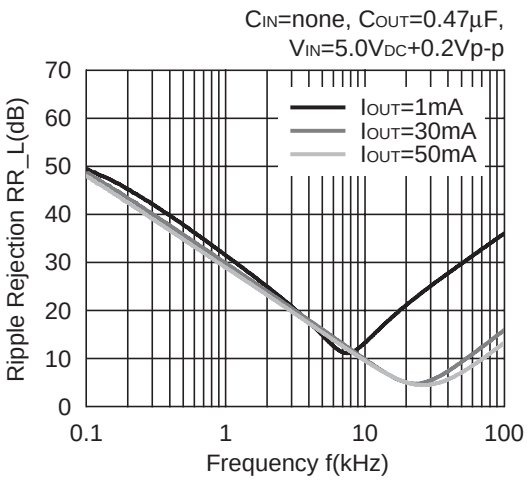
R1162x28x (ECO=L)



R1162x40x (ECO=H)

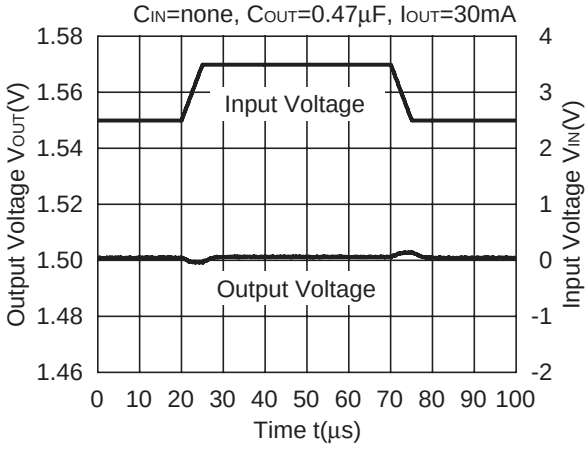


R1162x40x (ECO=L)

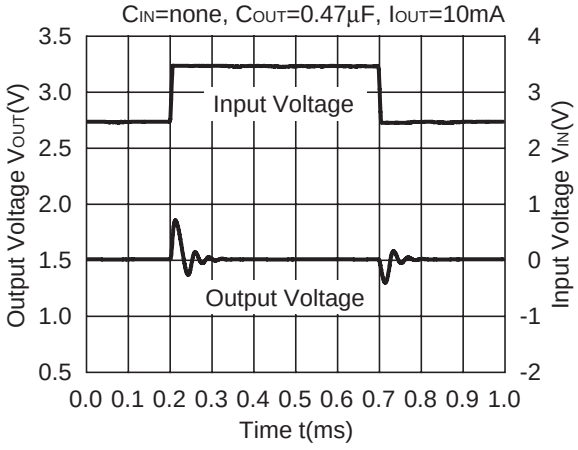


10) Input Transient Response

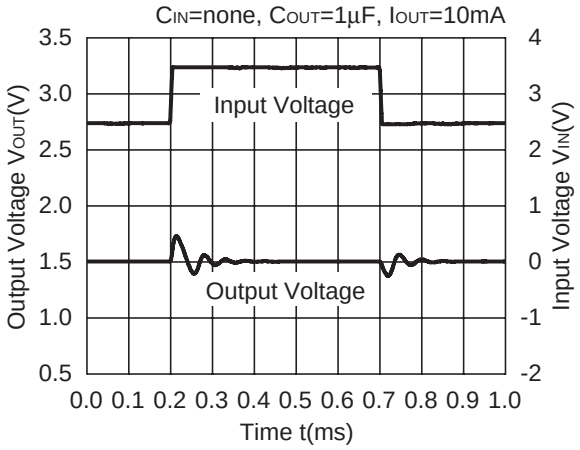
R1162x15x (ECO=H)



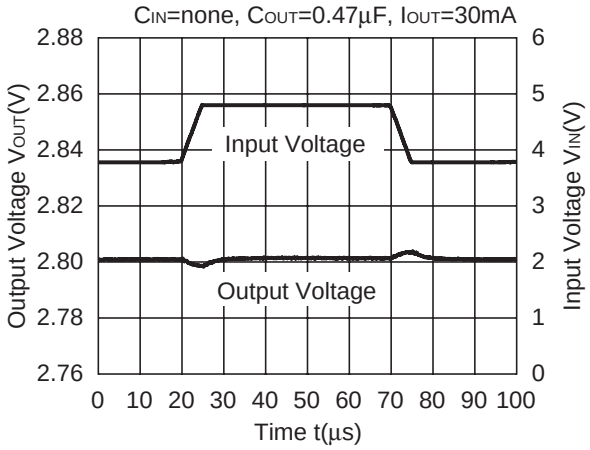
R1162x15x (ECO=L)



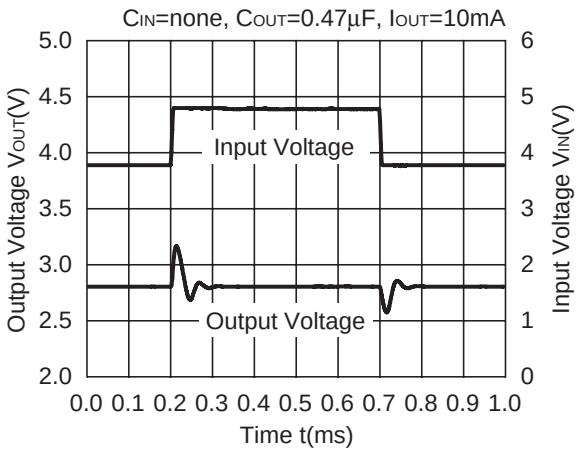
R1162x15x (ECO=L)



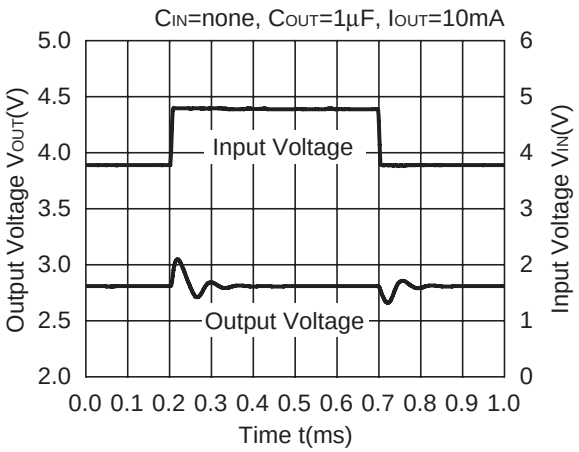
R1162x28x (ECO=H)



R1162x28x (ECO=L)

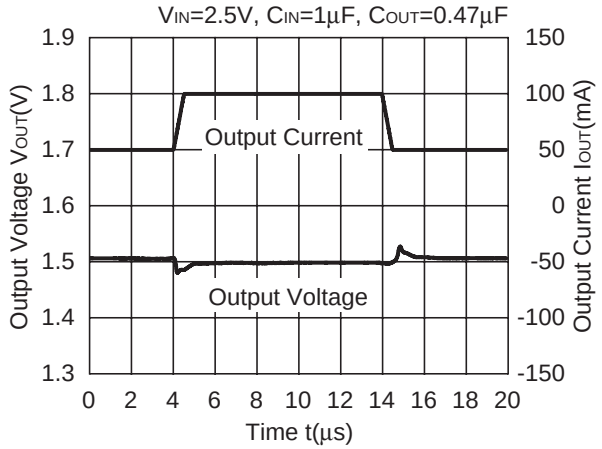


R1162x28x (ECO=L)

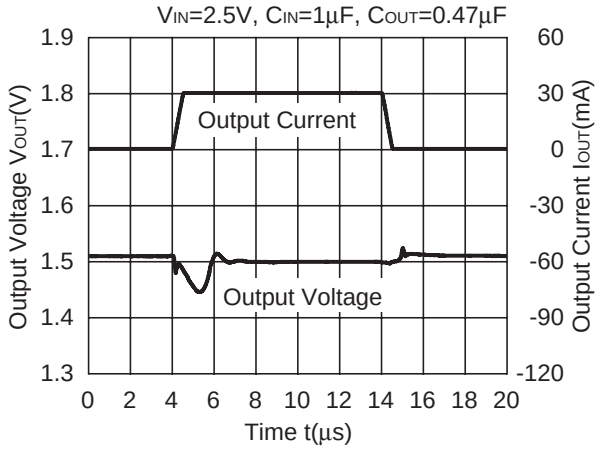


11) Load Transient Response

R1162x15x (ECO=H)

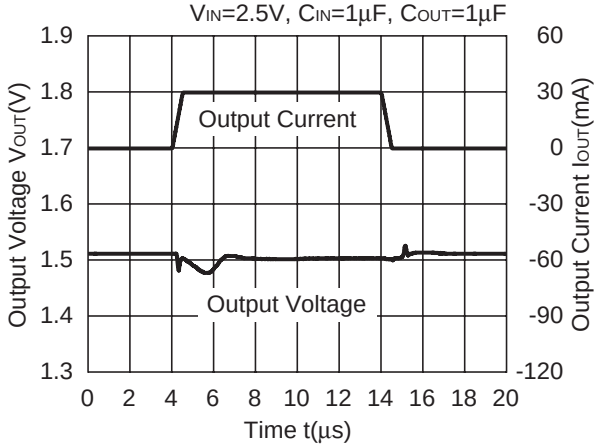


R1162x15x (ECO=H)



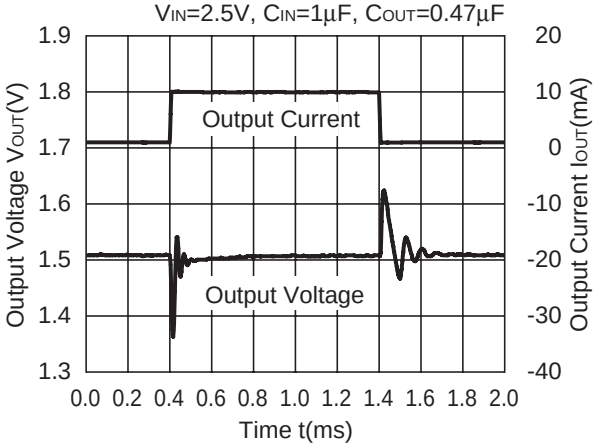
R1162x15x (ECO=H)

V_{IN}=2.5V, C_{IN}=1µF, C_{OUT}=1µF



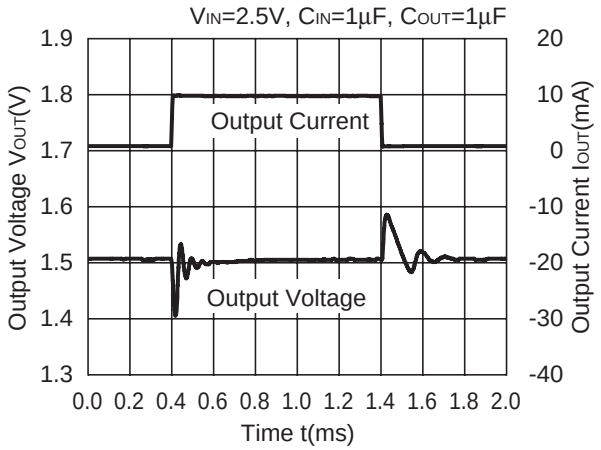
R1162x15x (ECO=L)

V_{IN}=2.5V, C_{IN}=1µF, C_{OUT}=0.47µF



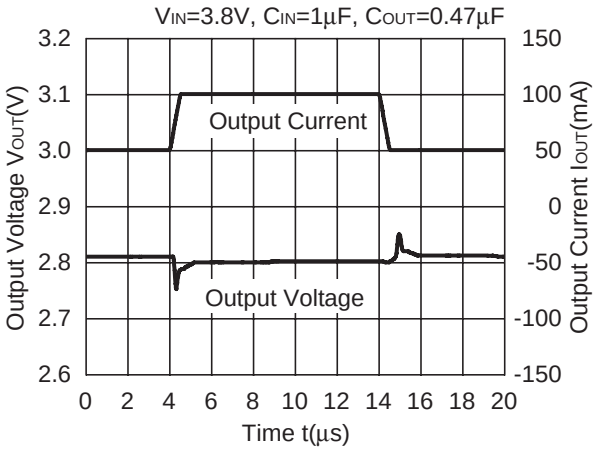
R1162x15x (ECO=L)

V_{IN}=2.5V, C_{IN}=1µF, C_{OUT}=1µF



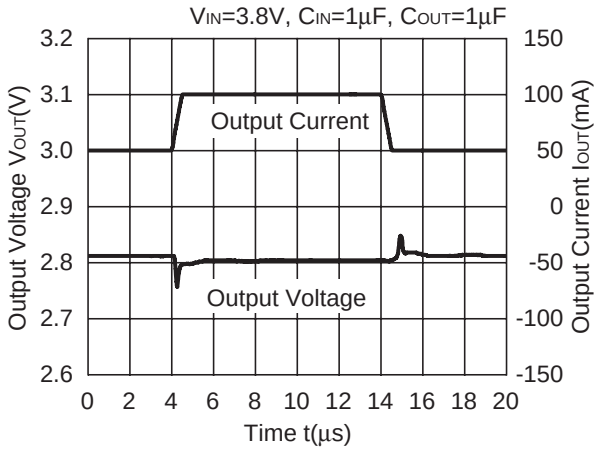
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF, C_{OUT}=0.47µF



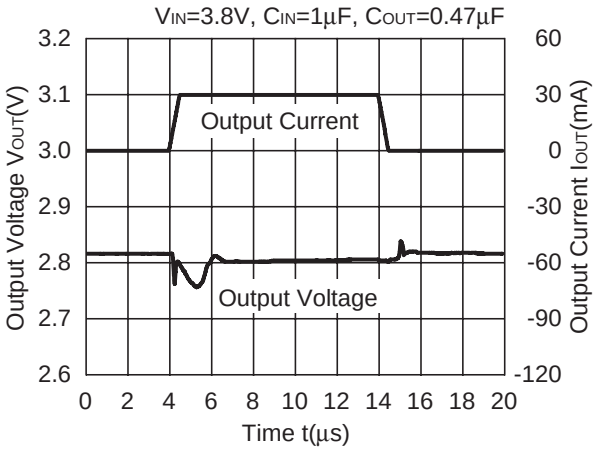
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF, C_{OUT}=1µF

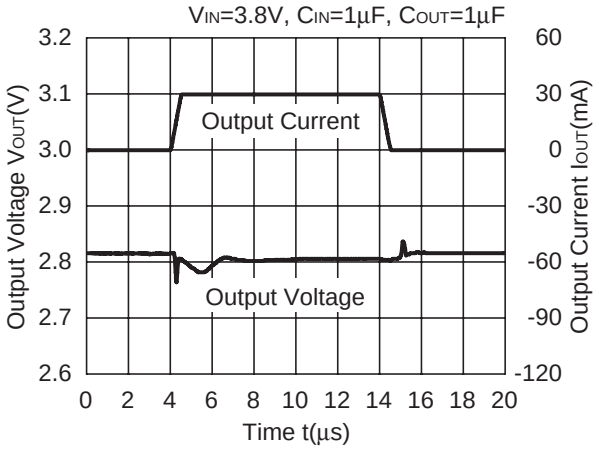


R1162x28x (ECO=H)

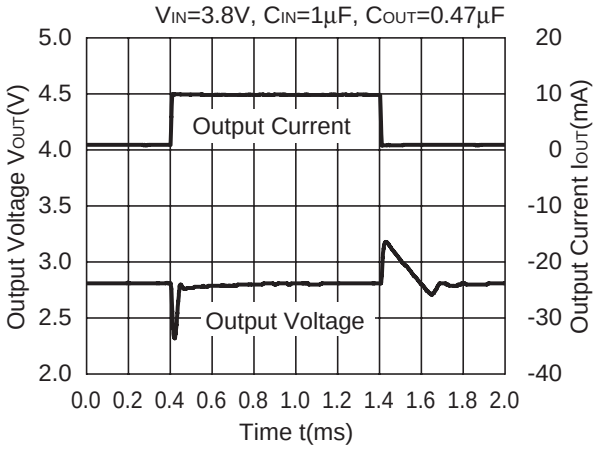
V_{IN}=3.8V, C_{IN}=1µF, C_{OUT}=0.47µF



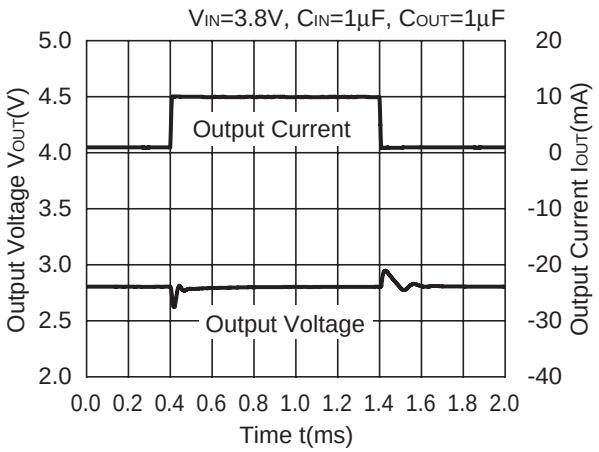
R1162x28x (ECO=H)



R1162x28x (ECO=L)

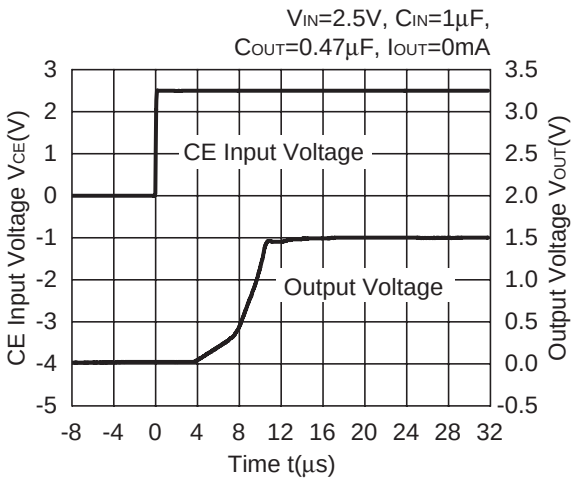


R1162x28x (ECO=L)

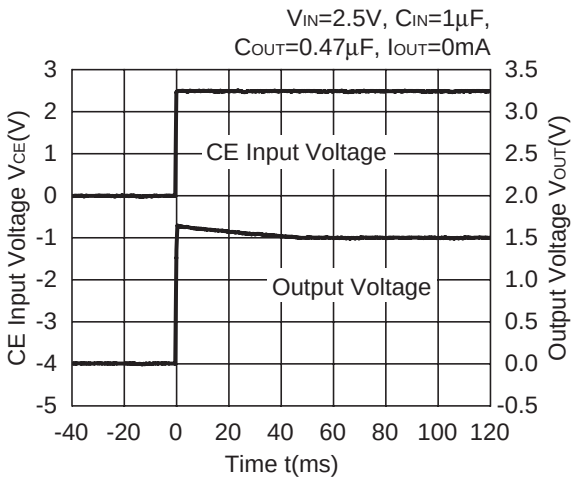


12) Turn on speed with CE pin

R1162x15x (ECO=H)

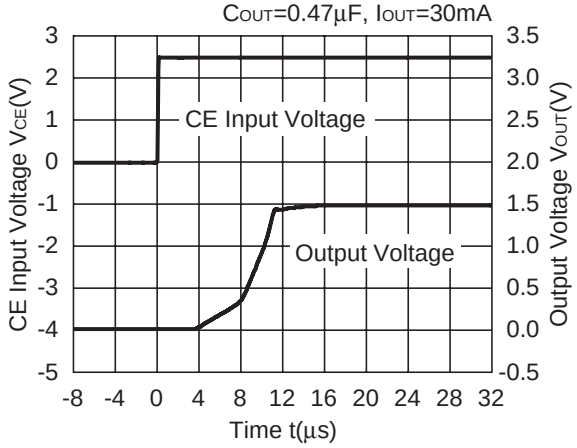


R1162x15x (ECO=L)



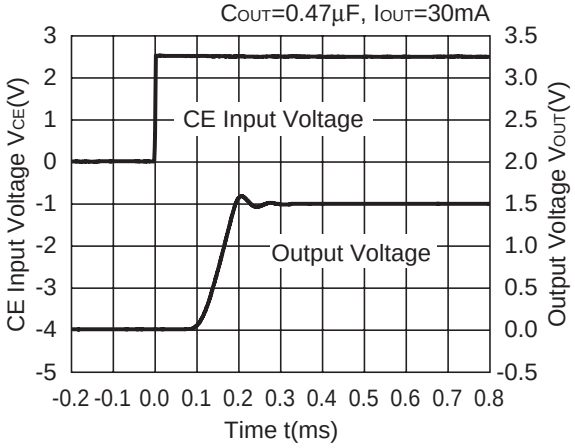
R1162x15x (ECO=H)

V_{IN}=2.5V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=30mA



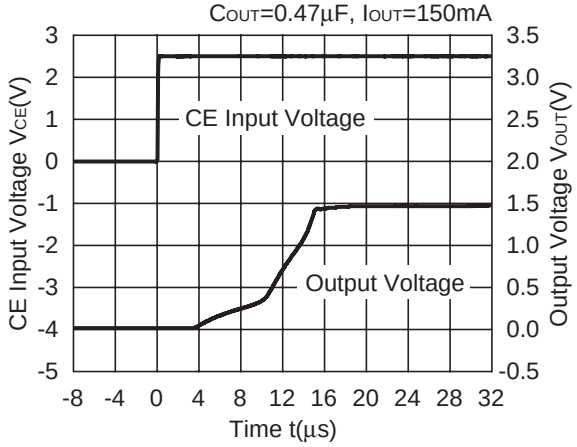
R1162x15x (ECO=L)

V_{IN}=2.5V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=30mA



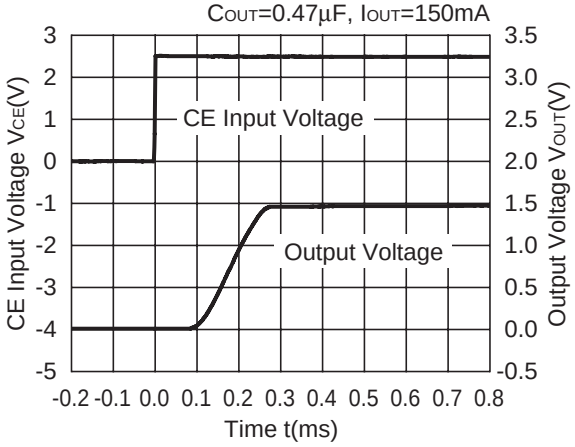
R1162x15x (ECO=H)

V_{IN}=2.5V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=150mA



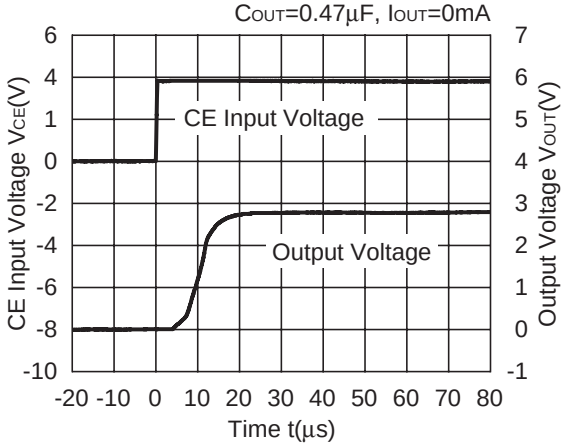
R1162x15x (ECO=L)

V_{IN}=2.5V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=150mA



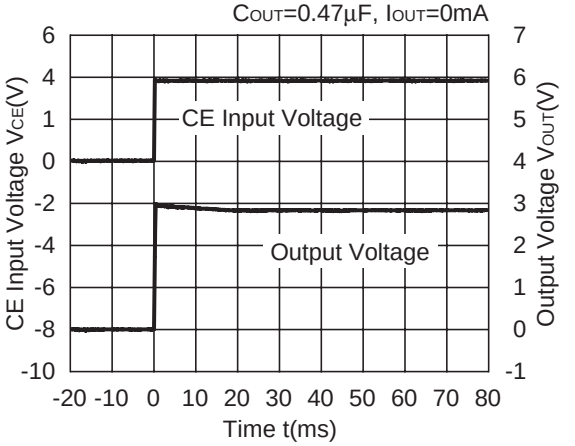
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=0mA

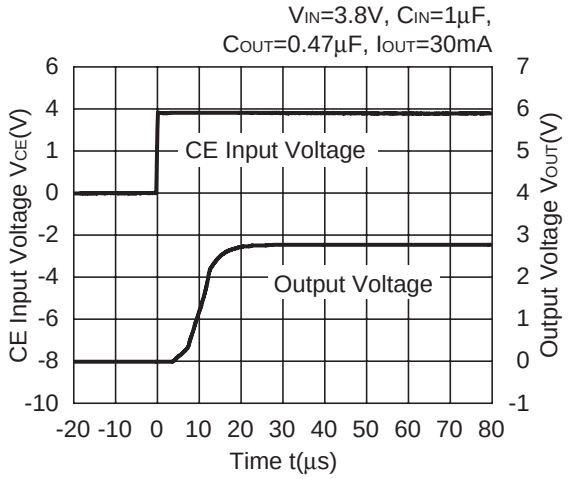


R1162x28x (ECO=L)

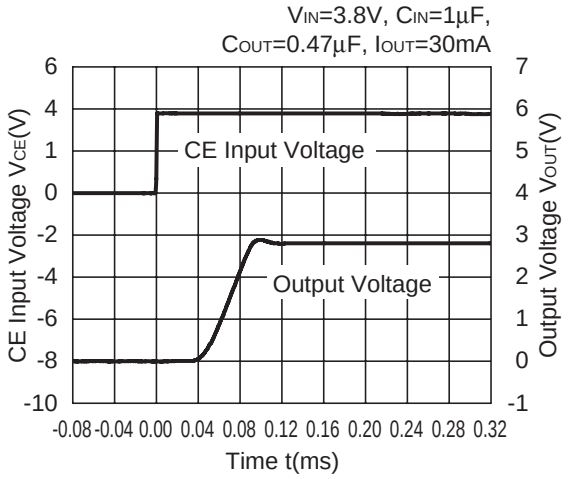
V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=0mA



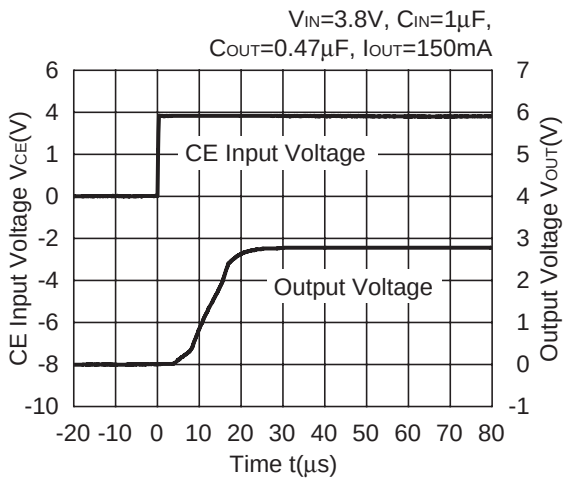
R1162x28x (ECO=H)



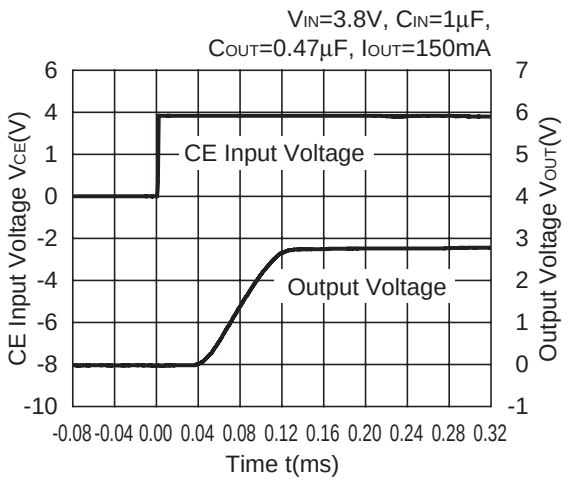
R1162x28x (ECO=L)



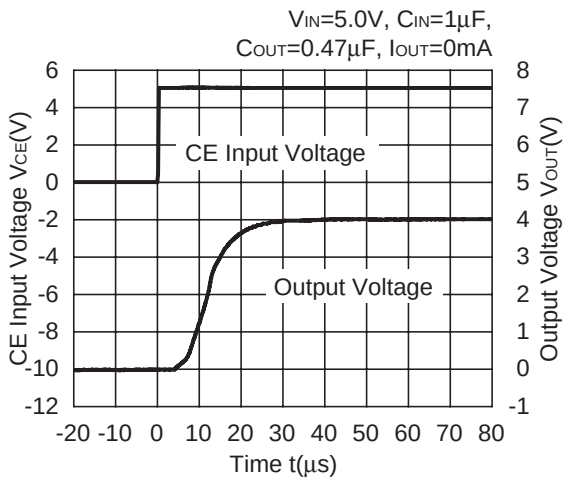
R1162x28x (ECO=H)



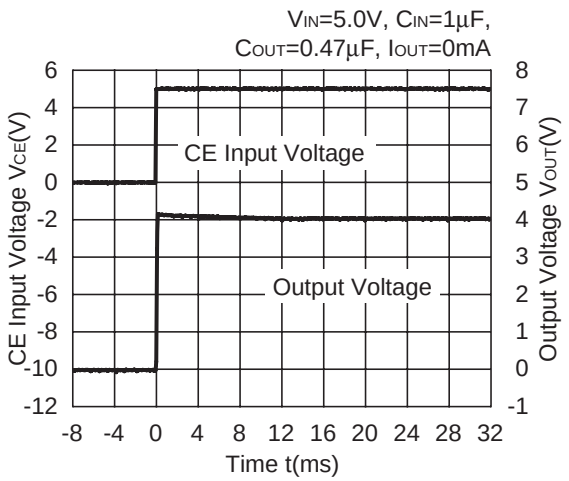
R1162x28x (ECO=L)



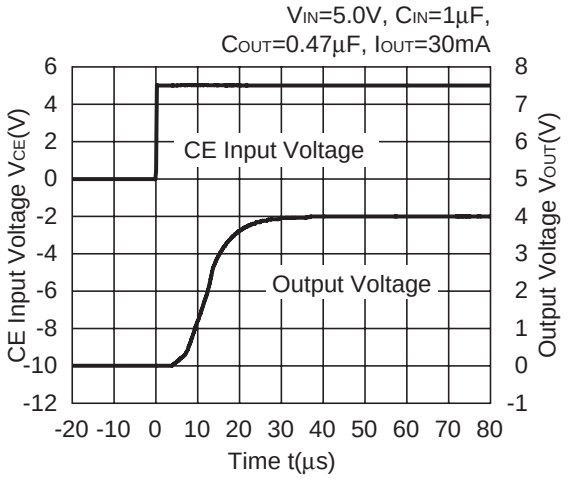
R1162x40x (ECO=H)



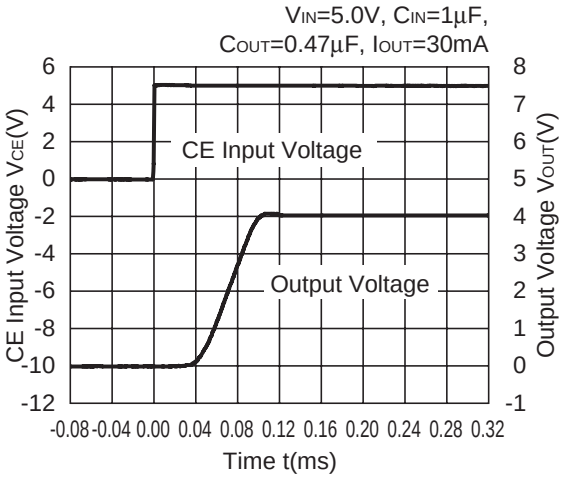
R1162x40x (ECO=L)



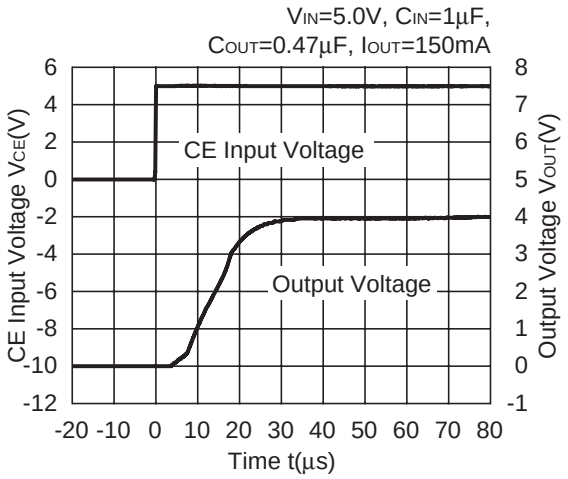
R1162x40x (ECO=H)



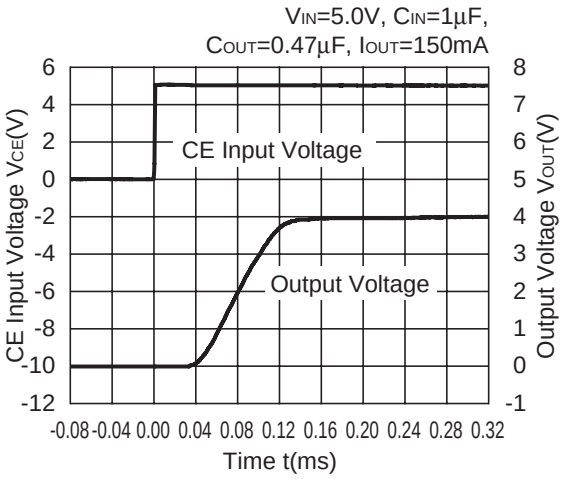
R1162x40x (ECO=L)



R1162x40x (ECO=H)

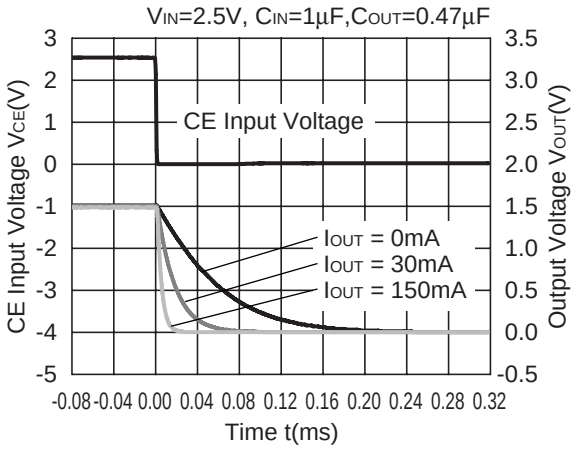


R1162x40x (ECO=L)

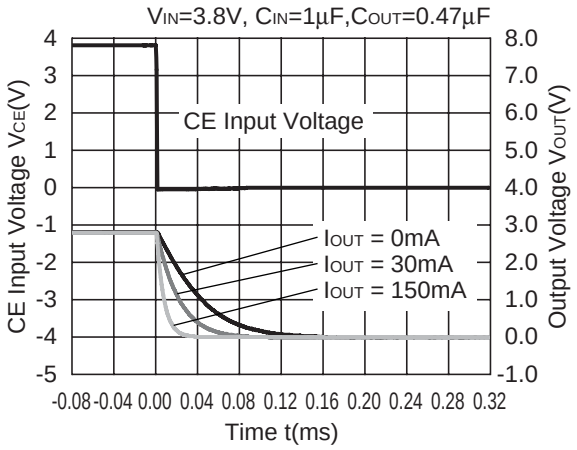


13) Turn off speed with CE pin

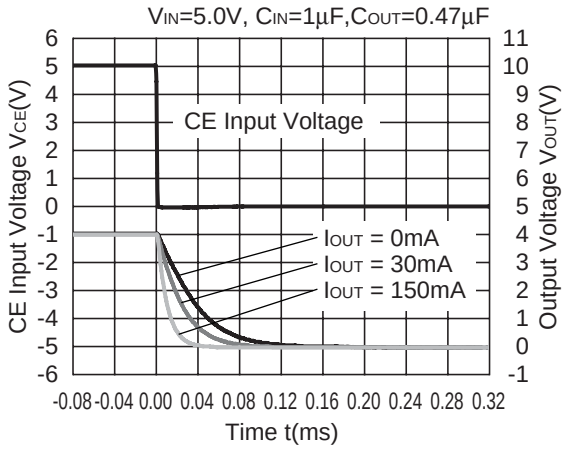
R1162x15xD



R1162x28xD



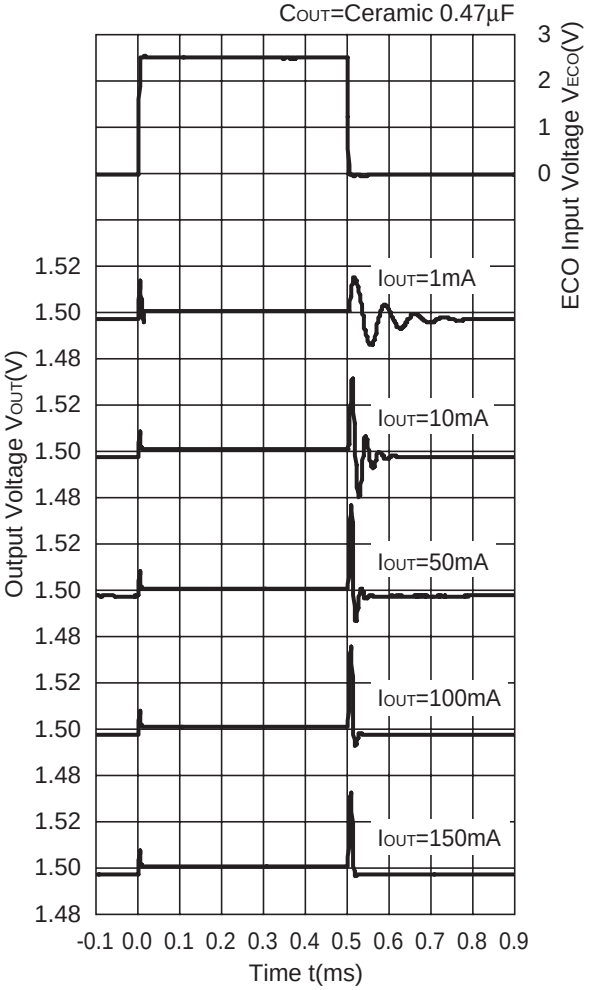
R1162x40xD

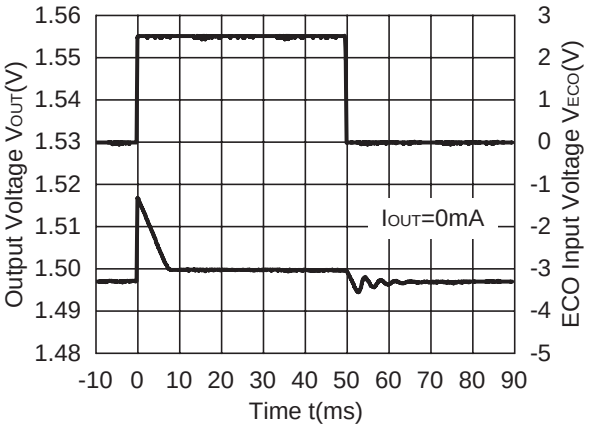


14) Output Voltage at Mode alternative point

R1162x15x

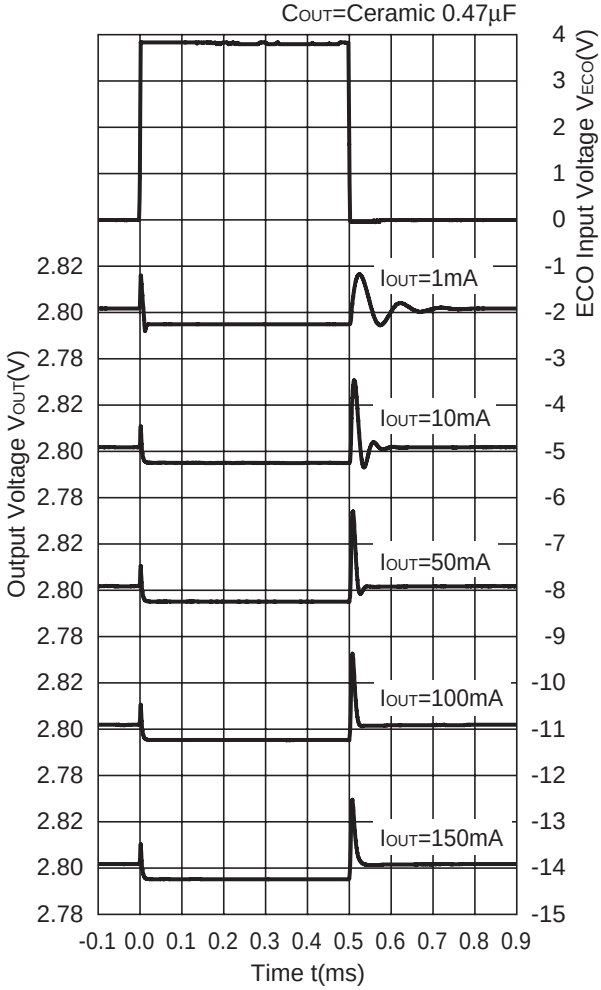
V_{IN}=2.5V, C_{IN}=Ceramic 1.0µF,
C_{OUT}=Ceramic 0.47µF

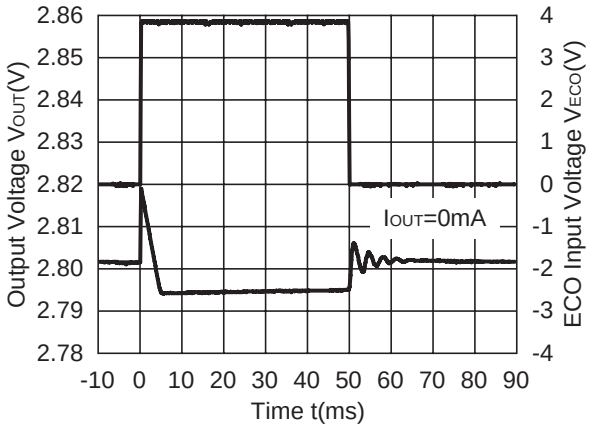




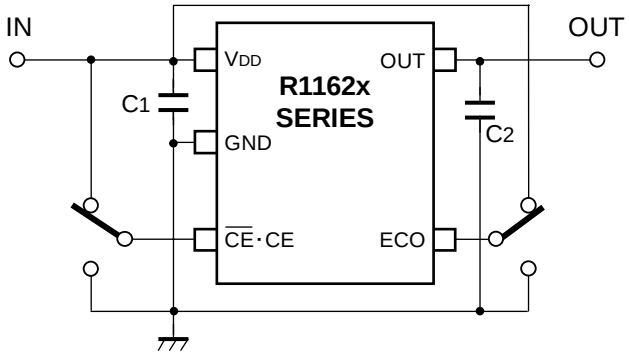
R1162x28x

V_{IN}=3.8V, C_{IN}=Ceramic 1.0µF,
C_{OUT}=Ceramic 0.47µF





TECHNICAL NOTES



(External Components)
C_2 Ceramic 0.47μF Ex. Murata GRM40B474K
Kyocera CM105B474K
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 as much as 1.0μF capacitor between V_{DD} and GND pin as close as possible.

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, be sure to use a 0.47μF or more capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance).

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:

In these ICs, phase compensation is made for securing stable operation even if the load current is varied.

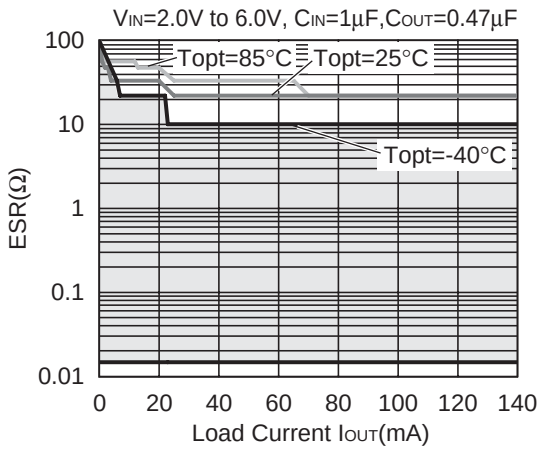
For this purpose, be sure to use a capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance) in the range described as follows:

The relations between I_{OUT} (Output Current) and ESR of 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.

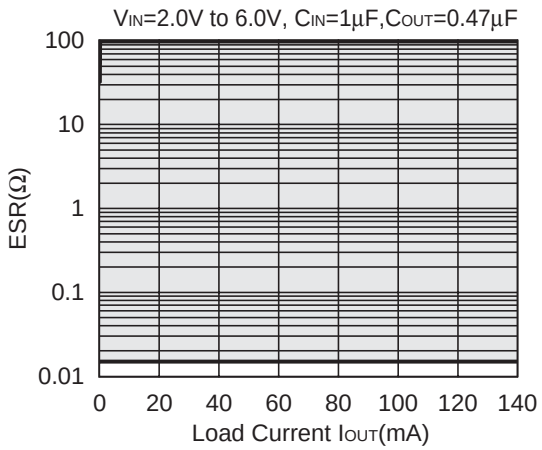
<Test conditions>

(1) Frequency band: 10Hz to 2MHz

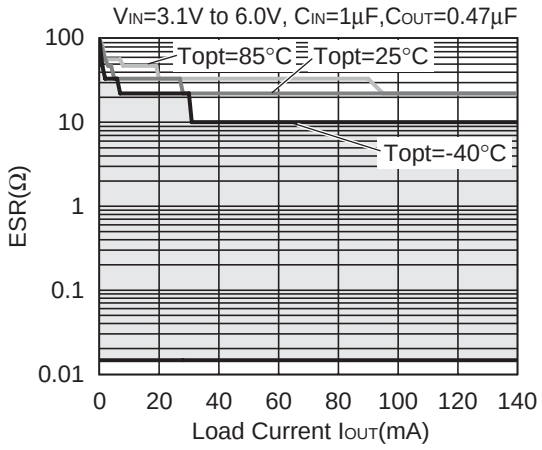
R1162x15x (ECO=H)



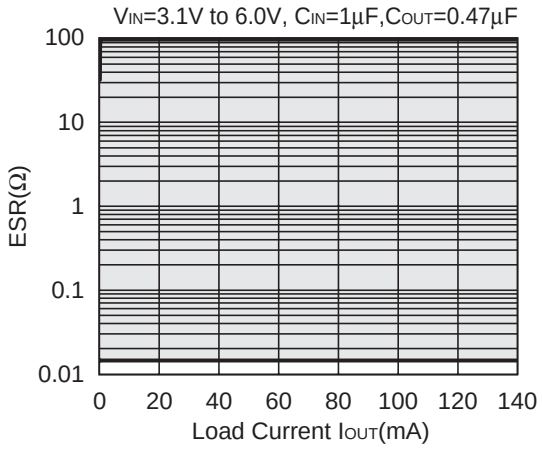
R1162x15x (ECO=L)



R1162x28x (ECO=H)



R1162x28x (ECO=L)



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