RICOH

R1162x SERIES

3-MODE 150mA LDO REGULATOR

NO.EA-110-0512

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 and SON1612-6 packages, high density mounting of the ICs on boards is possible.

FEATURES

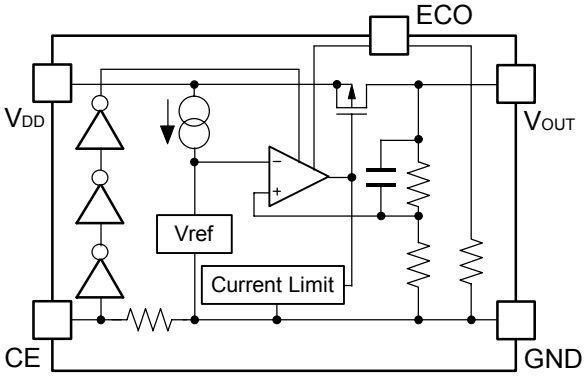
- Ultra-Low Supply Current.....Typ. 5.5μA (Low Power Mode),
  Typ. 70μA (Fast Transient Mode)
- Standby Mode .....Typ. 0.1μA
- Low Dropout Voltage.....Typ. 0.25V (I_{OUT}=150mA Output Voltage=3.0V Type)
- High Ripple Rejection .....Typ. 70dB (f=1kHz, FT Mode)
  Typ. 60dB (f=10kHz, FT Mode)
- Low Temperature-Drift Coefficient of Output Voltage Typ. ±100ppm/°C
- Excellent Line Regulation .....Typ. 0.02%/V
- High Output Voltage Accuracy .....±2.0%(±3.0% at LP Mode)
- Small Package .....SOT-23-5 (Super Mini-mold), SON1612-6
- Output Voltage .....Stepwise setting with a step of 0.1V
  in the range of 1.5V to 4.0V is possible
- 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

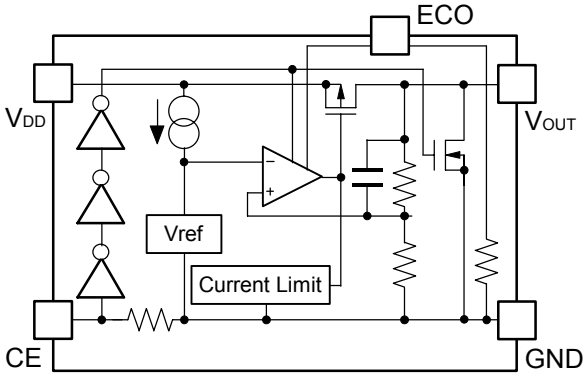
- Precision Voltage References.
- Power source for electrical appliances such as cameras, VCRs and hand-held communication equipment.
- Power source for battery-powered equipment.

BLOCK DIAGRAM

R1162xxx1B



R1162xxx1D



SELECTION GUIDE

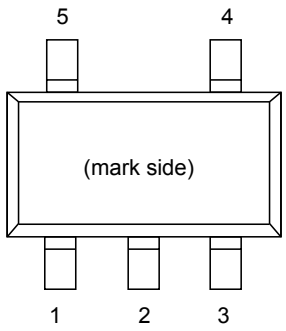
The output voltage, function of auto-discharge, package, and the packing type for the ICs can be selected at the user's request. The selection can be available by designating the part number as shown below;

R1162xxx1x-xx ←Part Number
↑↑ ↑ ↑
a b c d

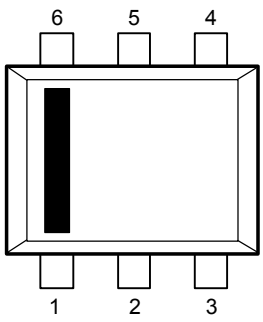
Code	Contents
a	Designation of Package Type : N:SOT-23-5 (Mini-mold) D:SON1612-6
b	Setting Output Voltage (V_{OUT}) : Stepwise setting with a step of 0.1V in the range of 1.5V to 4.0V is possible. Exceptions: 1.85V=R1162x181x5, 2.85V=R1162x281x5
c	Designation of Chip Enable Option : B: "H" active type. D: "H" active type. With auto discharge function
d	Designation of Taping Type : Refer to Taping Specifications;TR type is the standard direction.

PIN CONFIGURATIONS

- **SOT-23-5**



- **SON1612-6**



PIN DESCRIPTIONS

- **R1116N (SOT-23-5)**

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

- **R1116D (SON1612-6)**

Pin No.	Symbol	Description
1	CE	Chip Enable Pin
2	GND	Ground Pin
3	V_{DD}	Input Pin
4	V_{OUT}	Output Pin
5	GND	Ground Pin
6	ECO	MODE alternative 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) *1	420	mW
	Power Dissipation (SON1612-6) *1	500	MW
Topt	Operating Temperature Range	−40 ~ 85	°C
Tstg	Storage Temperature Range	−55 ~ 125	°C

∗1 For Power Dissipation, please refer to PACKAGE INFORMATION to be described.

ELECTRICAL CHARACTERISTICS

- **R1162xxx1B/D**

Topt=25°C

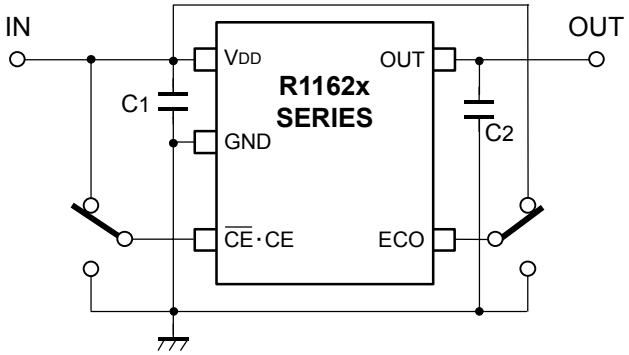
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN} = Set V_{OUT}+1V V_{ECO} = V_{IN} 1mA ≦ I_{OUT} ≦ 30mA Note 1	V_{OUT} ×0.98		V_{OUT} ×1.02	V
		V_{IN} = Set V_{OUT} + 1V V_{ECO} =GND 1mA ≦ I_{OUT} ≦ 30mA Note 2	V_{OUT} ×0.97		V_{OUT} ×1.03	V
ΔV_{OUT}	Output Voltage Deviation between 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
Ilim	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)

C_2 Ceramic 0.47μF Ex. Murata GRM40B474K

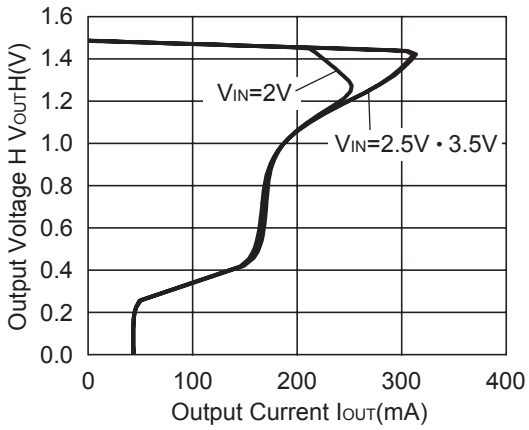
Kyocera CM105B474K

C_1 Ceramic 1.0μF

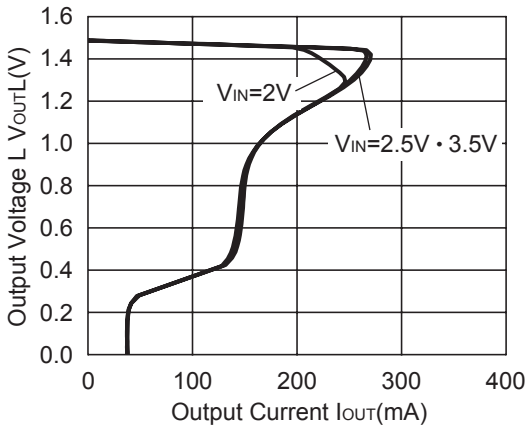
TYPICAL CHARACTERISTICS Unless otherwise provided, capacitors are ceramic type.

1) Output Voltage vs. Output Current

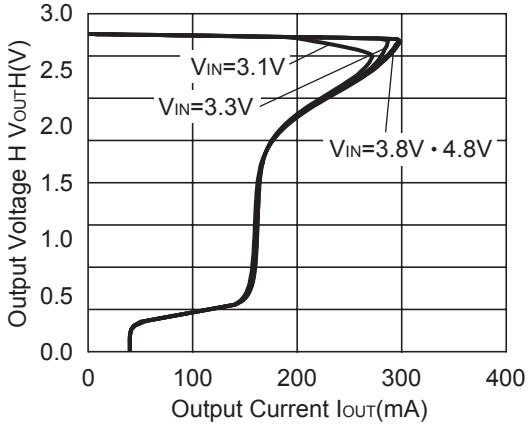
R1162x15x (ECO=H)



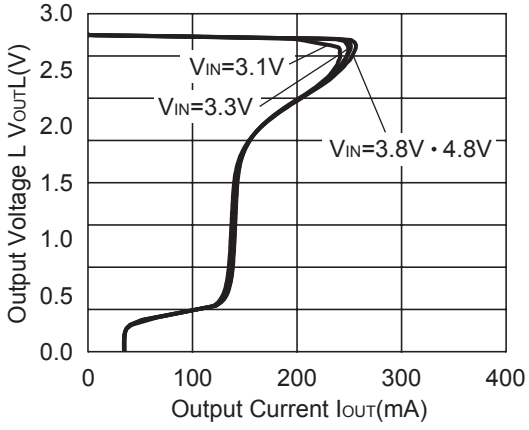
R1162x15x (ECO=L)



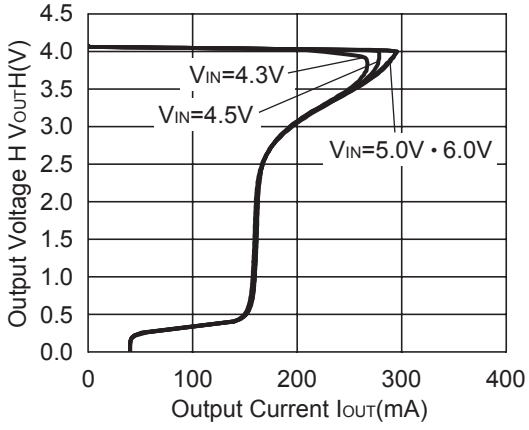
R1162x28x (ECO=H)



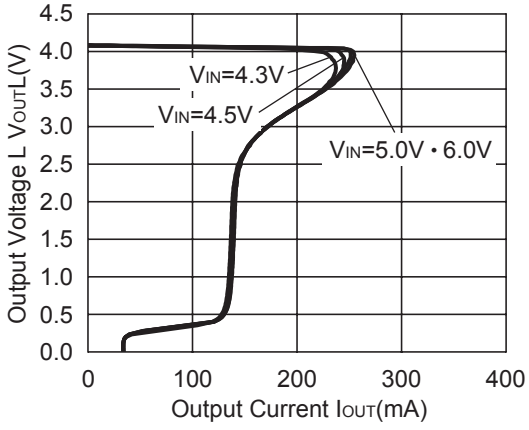
R1162x28x (ECO=L)



R1162x40x (ECO=H)

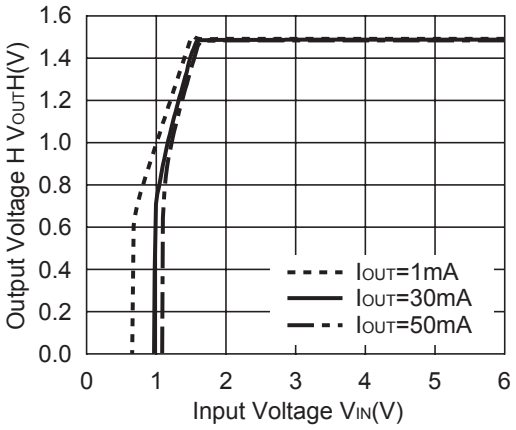


R1162x40x (ECO=L)

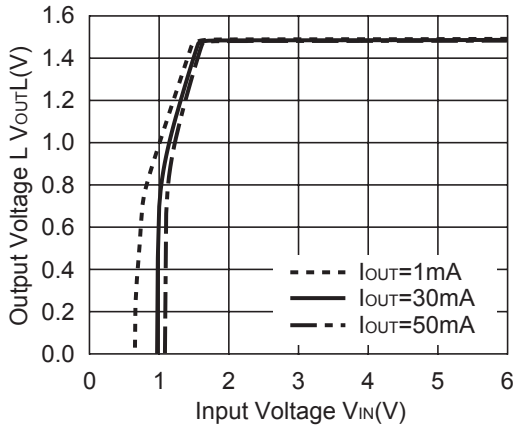


2) Output Voltage vs. Input Voltage

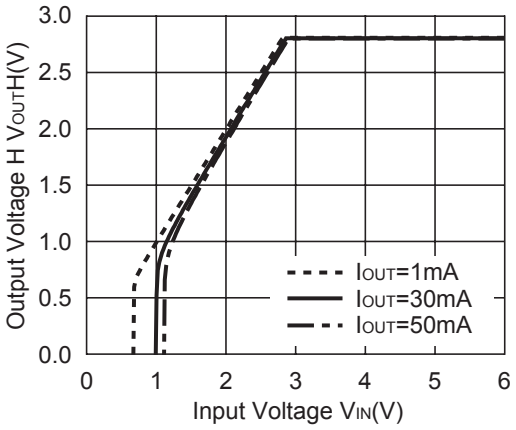
R1162x15x (ECO=H)



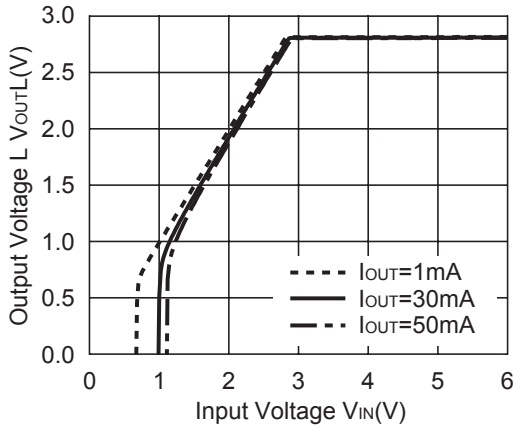
R1162x15x (ECO=L)



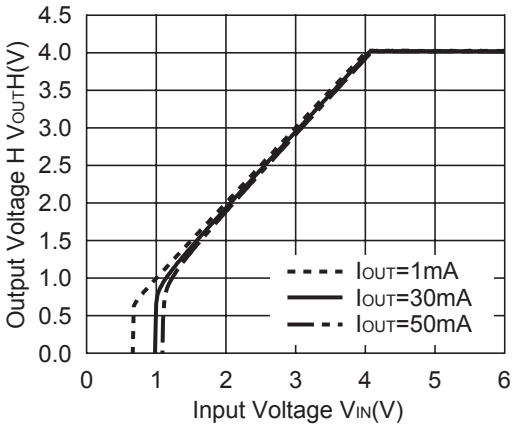
R1162x28x (ECO=H)



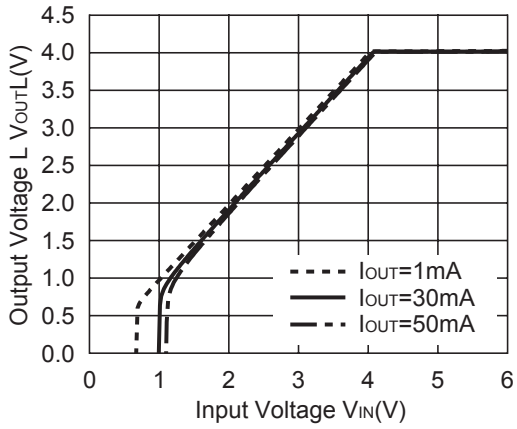
R1162x28x (ECO=L)



R1162x40x (ECO=H)

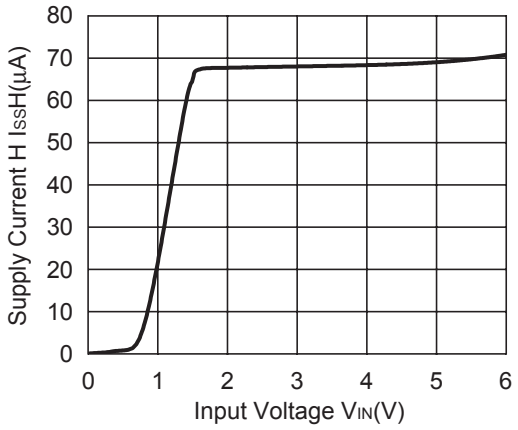


R1162x40x (ECO=L)

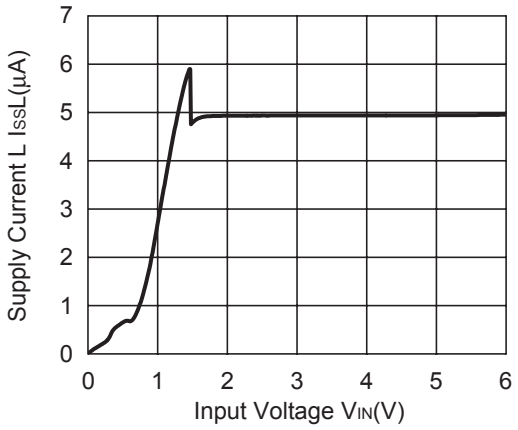


3) Supply Current vs. Input Voltage

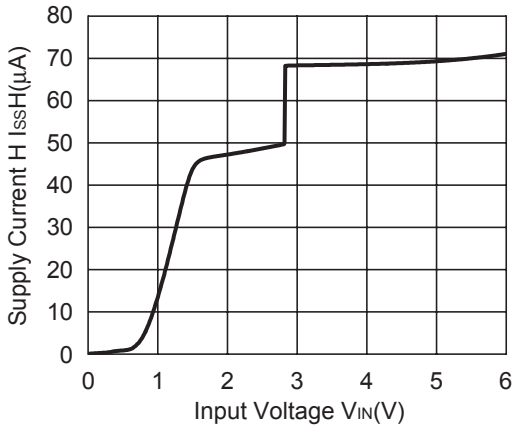
R1162x15x (ECO=H)



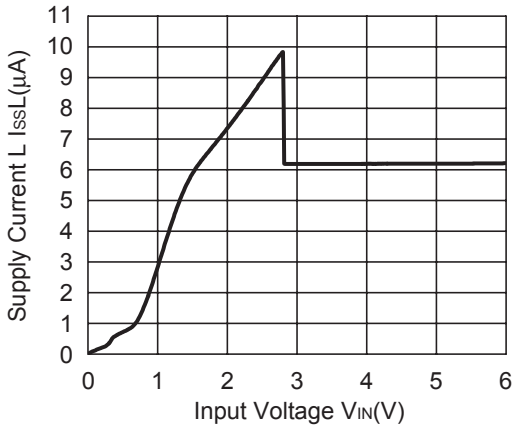
R1162x15x (ECO=L)



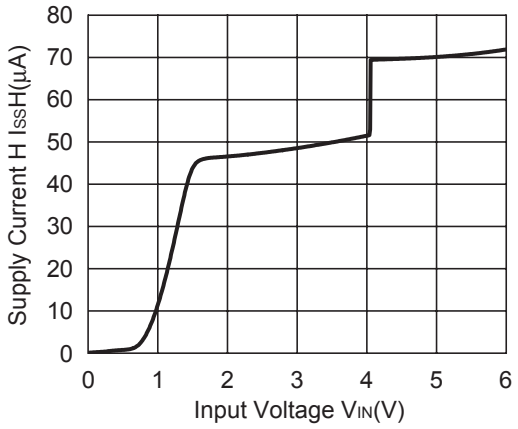
R1162x28x (ECO=H)



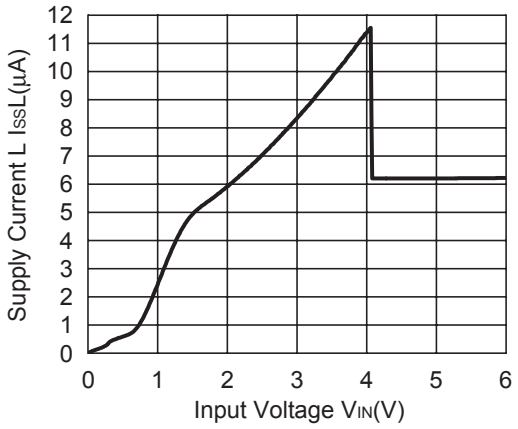
R1162x28x (ECO=L)



R1162x40x (ECO=H)

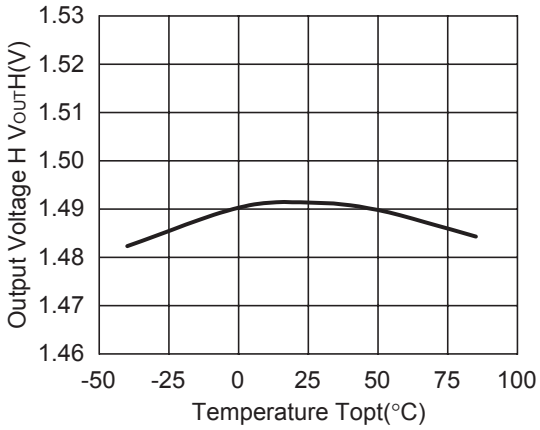


R1162x40x (ECO=L)

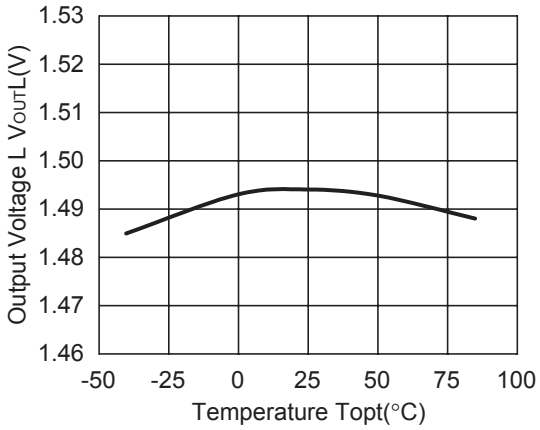


4) Output Voltage vs. Temperature

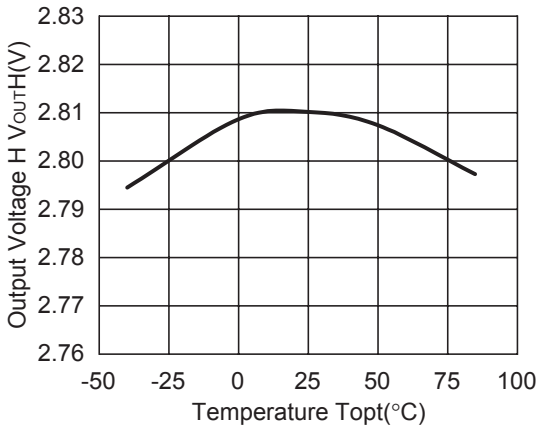
R1162x15x (ECO=H)



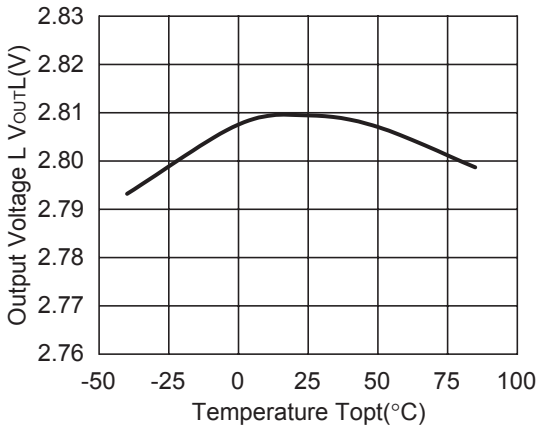
R1162x15x (ECO=L)



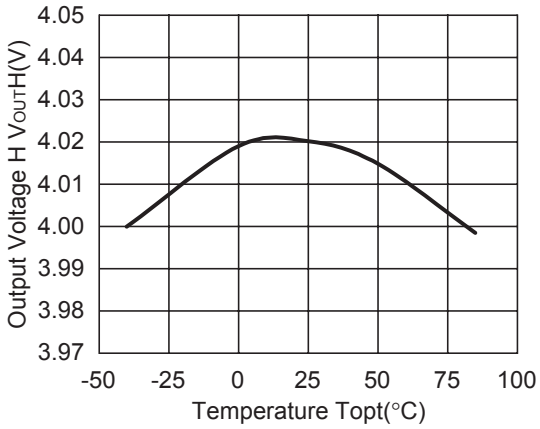
R1162x28x (ECO=H)



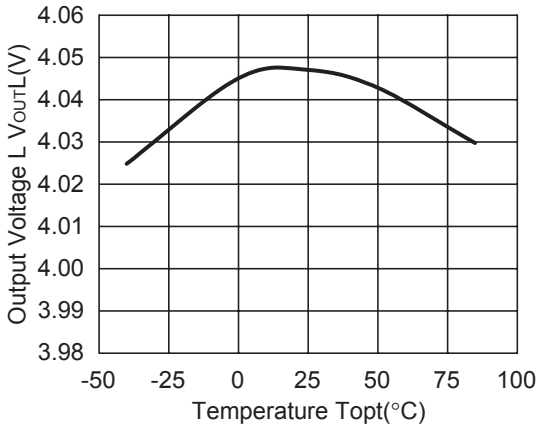
R1162x28x (ECO=L)



R1162x40x (ECO=H)

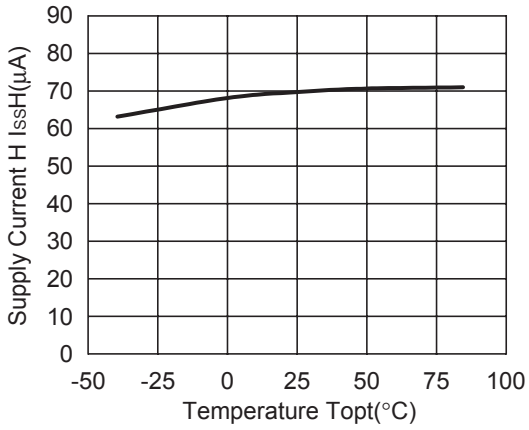


R1162x40x (ECO=L)

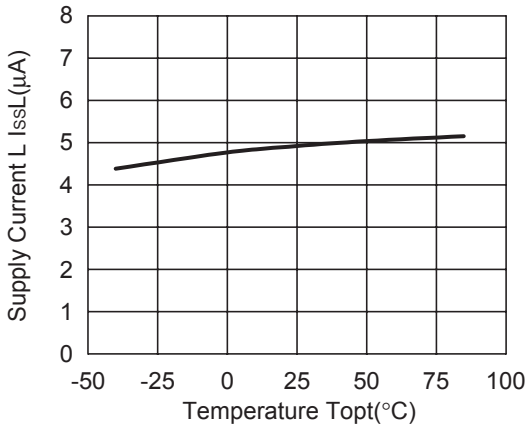


5) Supply Current vs. Temperature

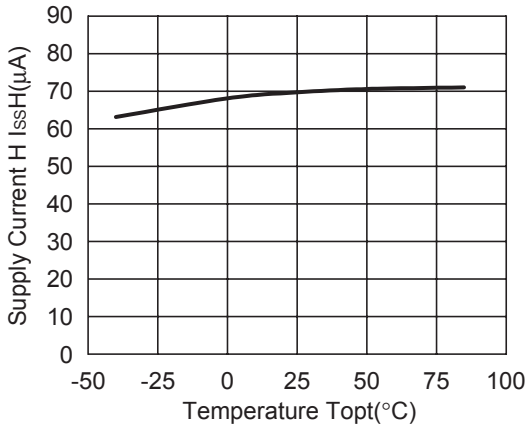
R1162x15x (ECO=H)



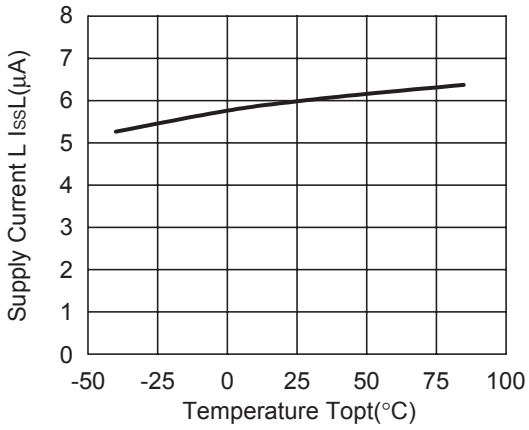
R1162x15x (ECO=L)



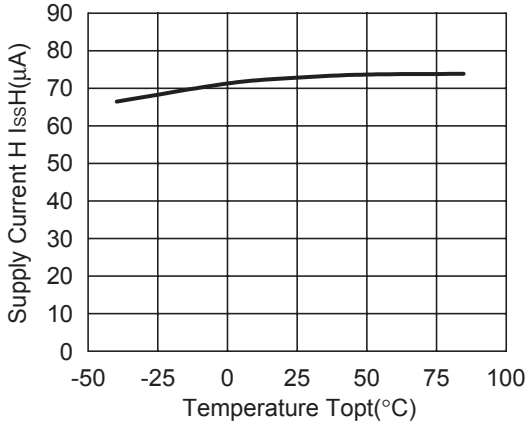
R1162x28x (ECO=H)



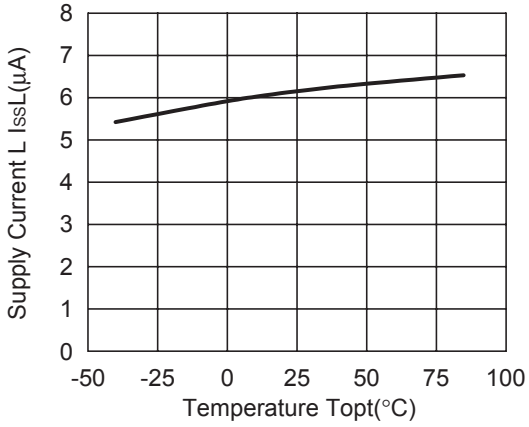
R1162x28x (ECO=L)



R1162x40x (ECO=H)

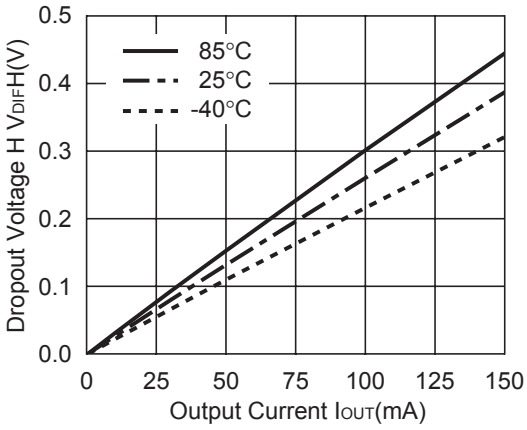


R1162x40x (ECO=L)

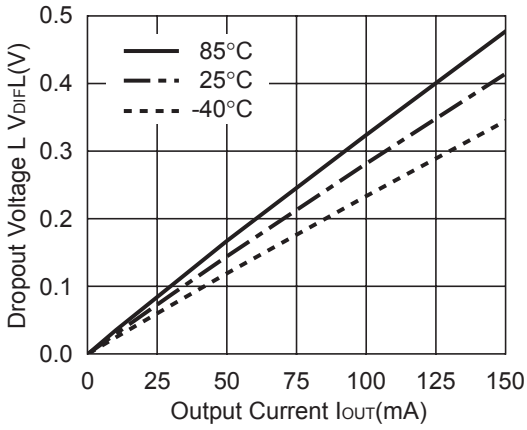


6) Dropout Voltage vs. Output Current

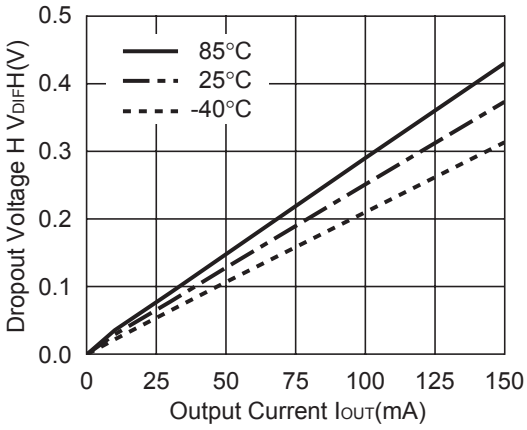
R1162x15x (ECO=H)



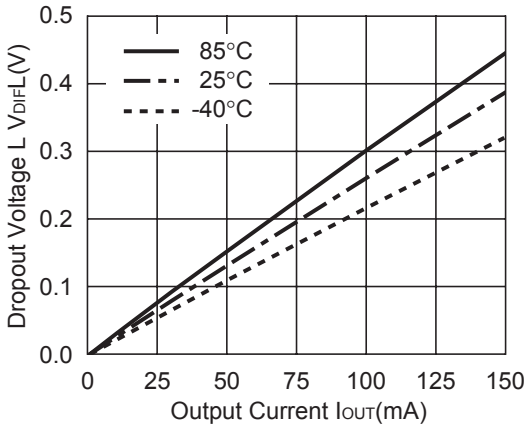
R1162x15x (ECO=L)



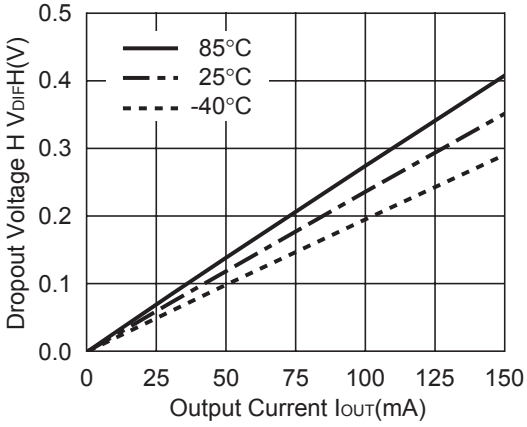
R1162x16x (ECO=H)



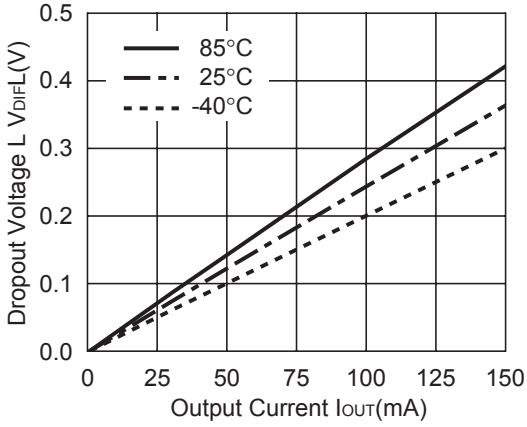
R1162x16x (ECO=L)



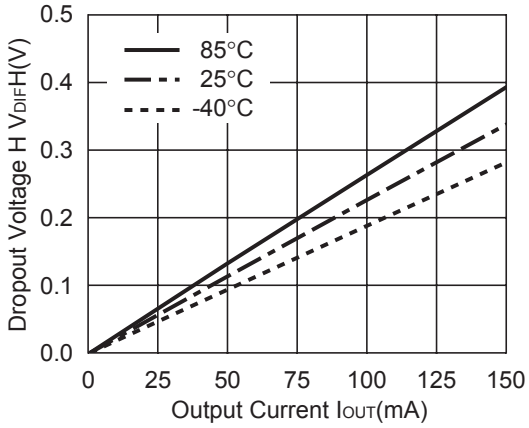
R1162x17x (ECO=H)



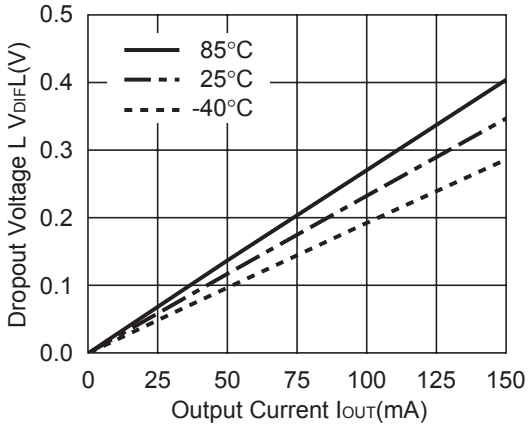
R1162x17x (ECO=L)



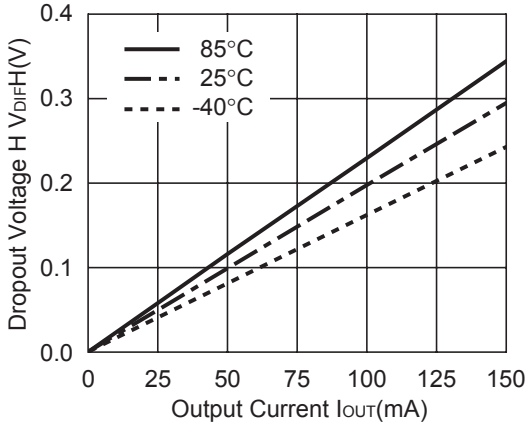
R1162x18x (ECO=H)



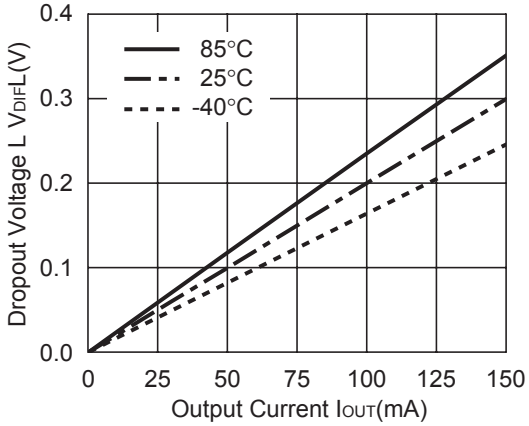
R1162x18x (ECO=L)



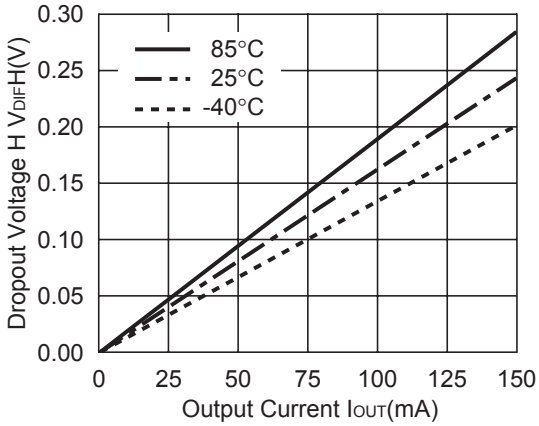
R1162x21x (ECO=H)



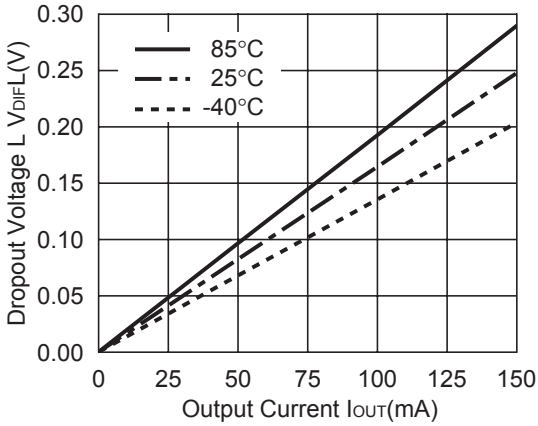
R1162x21x (ECO=L)



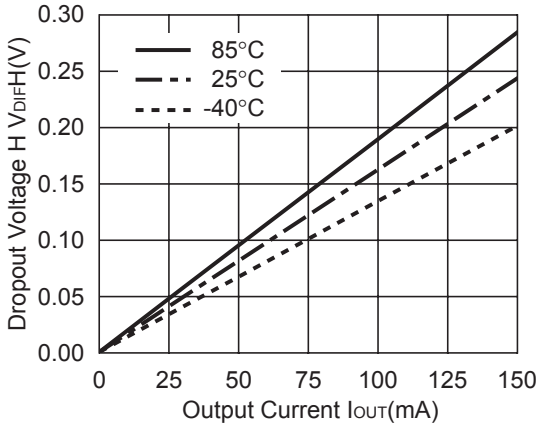
R1162x28x (ECO=H)



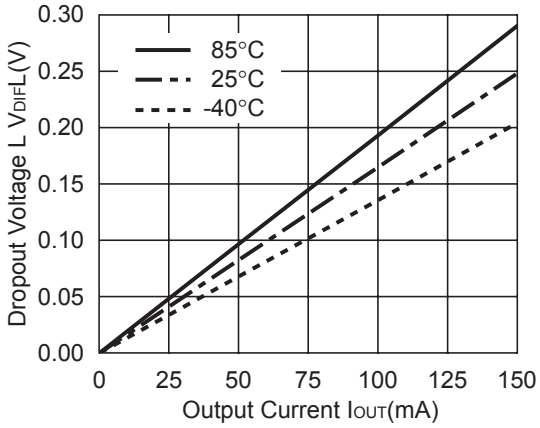
R1162x28x (ECO=L)



R1162x40x (ECO=H)

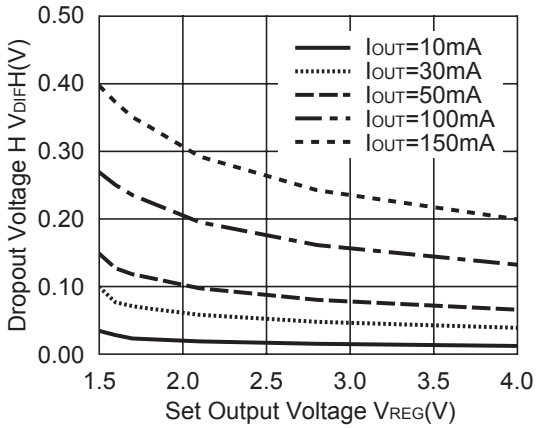


R1162x40x (ECO=L)

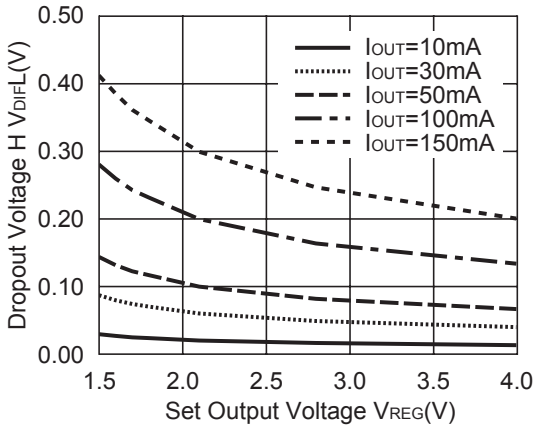


7) Dropout Voltage vs. Set Output Voltage

R1162x (ECO=H)

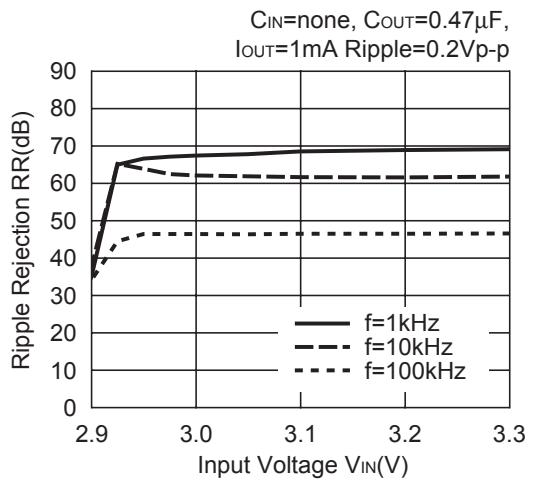


R1162x (ECO=L)

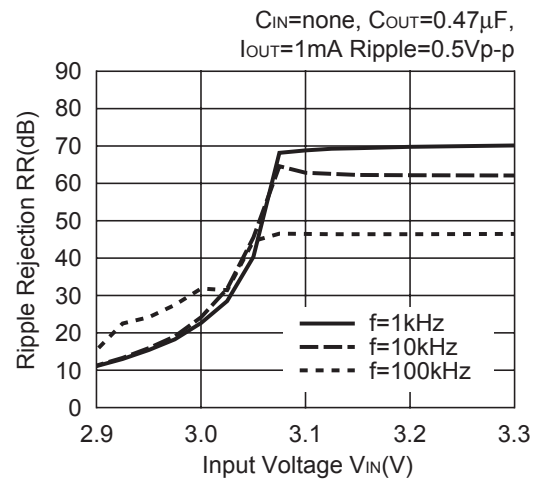


8) Ripple Rejection vs. Input Bias Voltage

R1162x28x (ECO=H)

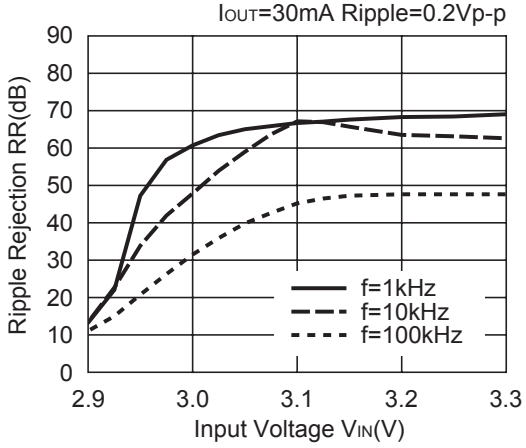


R1162x28x (ECO=H)



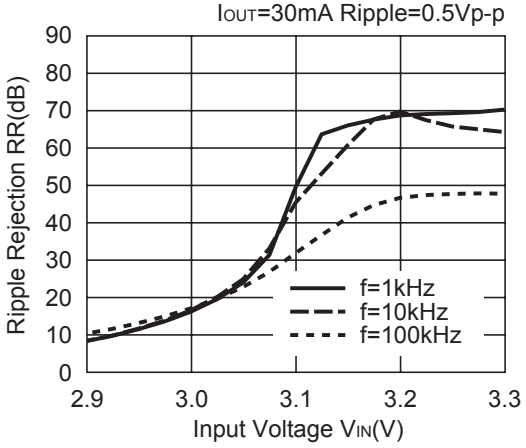
R1162x28x (ECO=H)

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



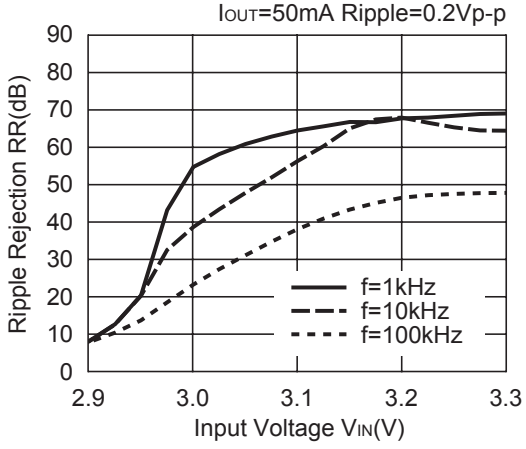
R1162x28x (ECO=H)

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



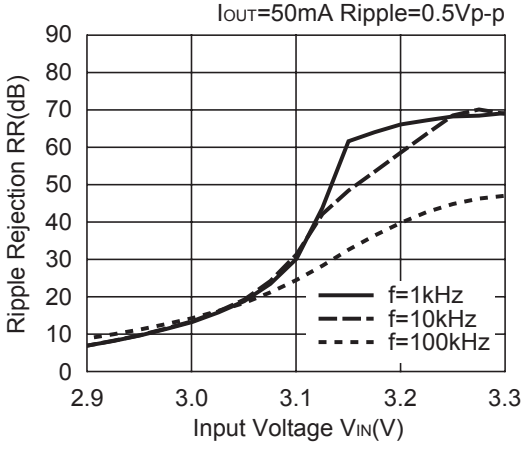
R1162x28x (ECO=H)

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



R1162x28x (ECO=H)

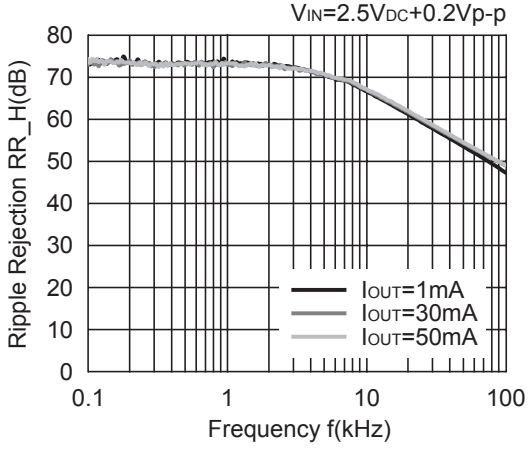
C_{IN}=none, C_{OUT}=0.47µF,
I_{OUT}=50mA Ripple=0.5Vp-p



9) Ripple Rejection vs. Frequency

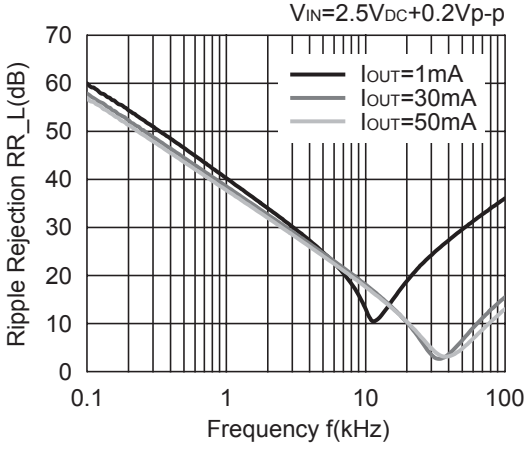
R1162x15x (ECO=H)

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

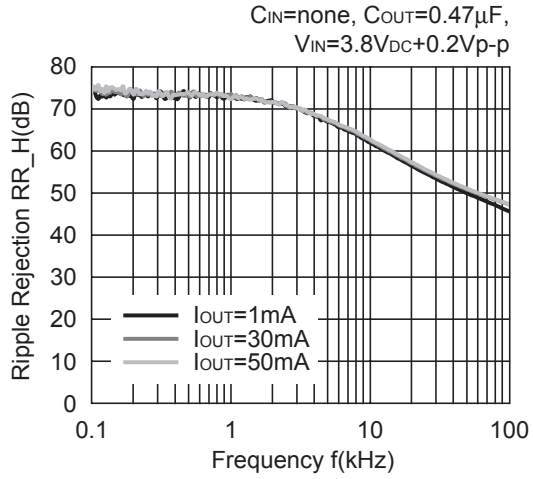


R1162x15x (ECO=L)

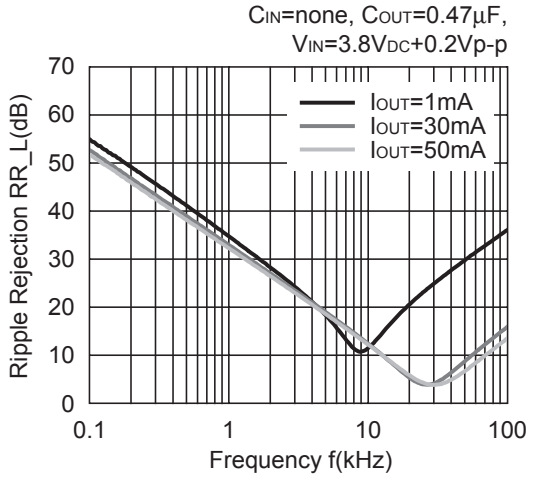
C_{IN}=none, C_{OUT}=0.47µF,
V_{IN}=2.5V_{DC}+0.2Vp-p



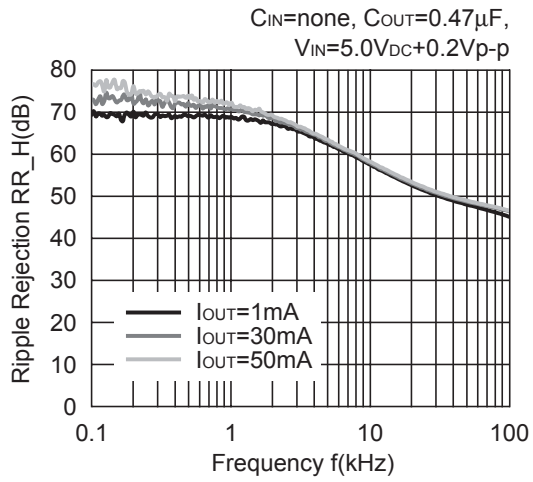
R1162x28x (ECO=H)



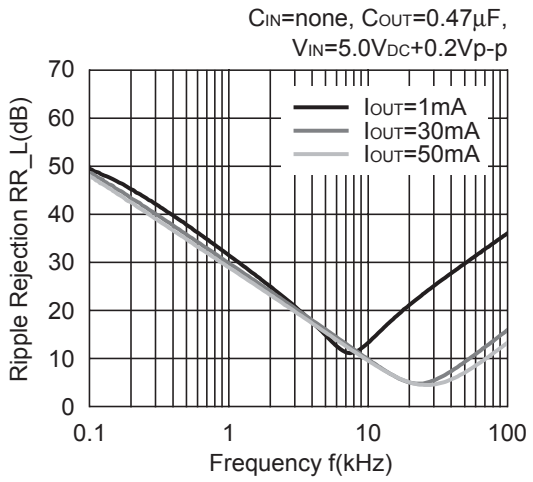
R1162x28x (ECO=L)



R1162x40x (ECO=H)

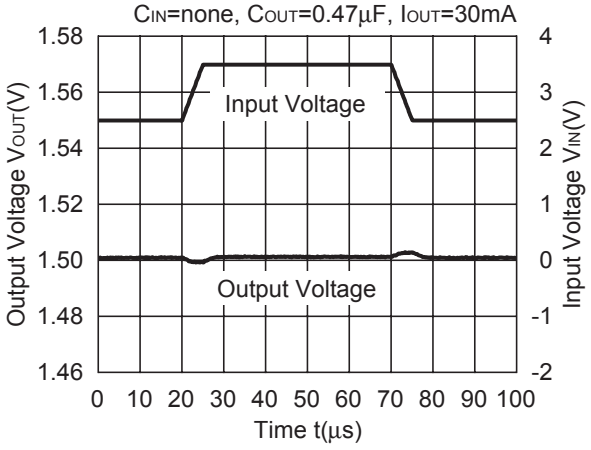


R1162x40x (ECO=L)

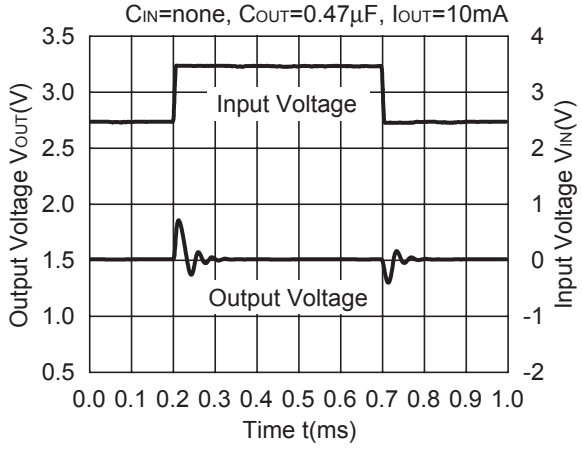


10) Input Transient Response

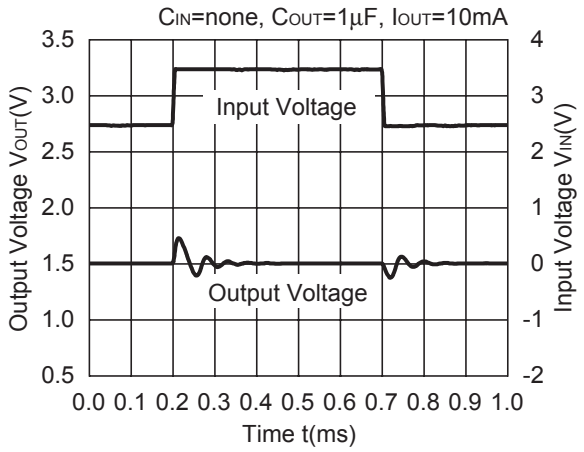
R1162x15x (ECO=H)



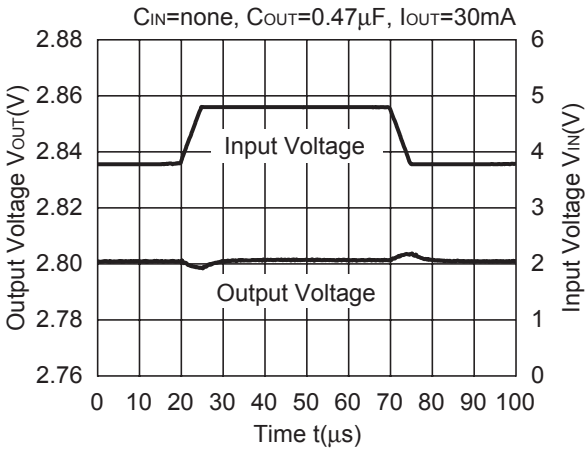
R1162x15x (ECO=L)



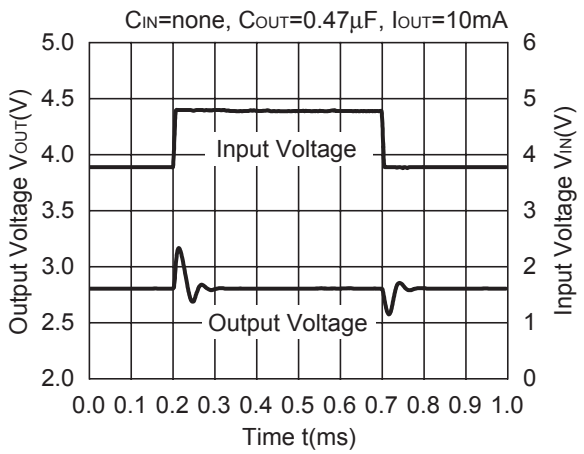
R1162x15x (ECO=L)



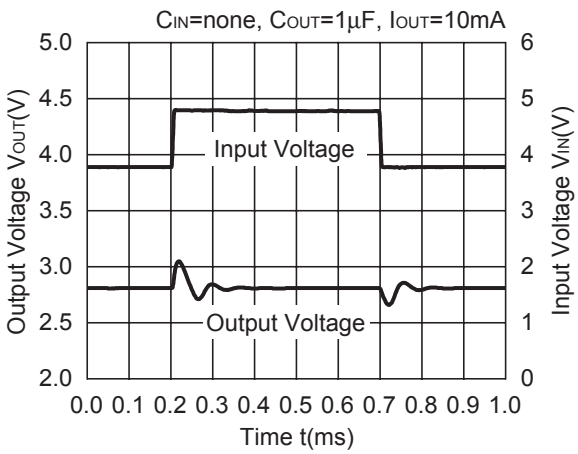
R1162x28x (ECO=H)



R1162x28x (ECO=L)

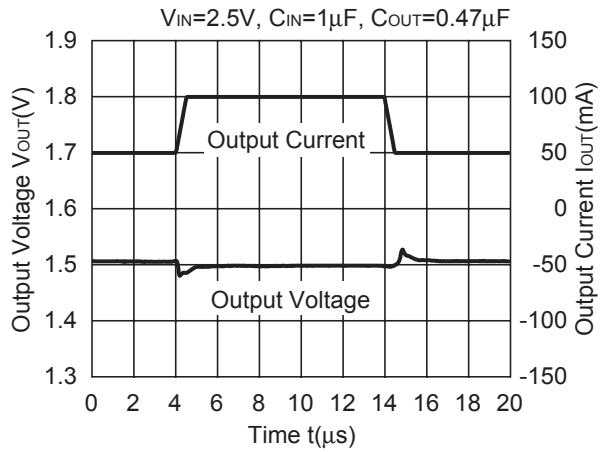


R1162x28x (ECO=L)

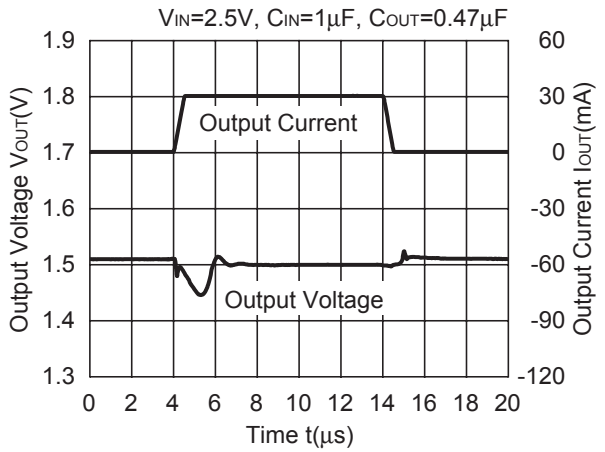


11) Load Transient Response

R1162x15x (ECO=H)

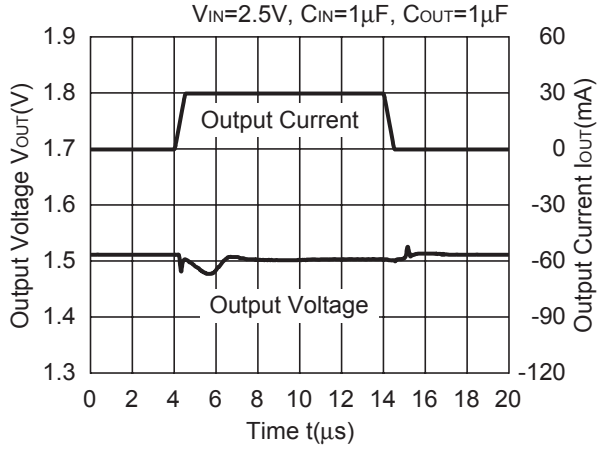


R1162x15x (ECO=H)



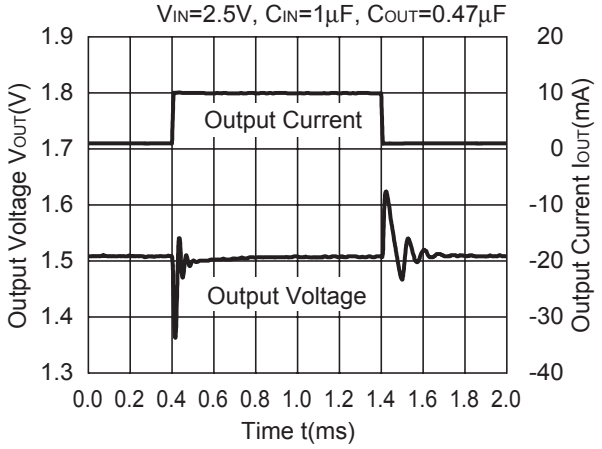
R1162x15x (ECO=H)

V_{IN}=2.5V, C_{IN}=1µF, C_{OUT}=1µF



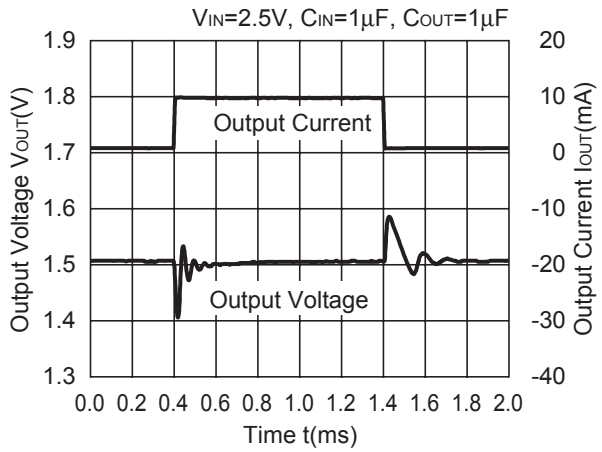
R1162x15x (ECO=L)

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



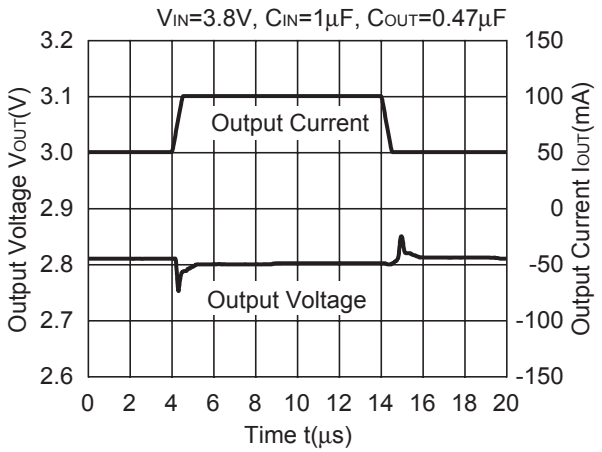
R1162x15x (ECO=L)

V_{IN}=2.5V, C_{IN}=1µF, C_{OUT}=1µF



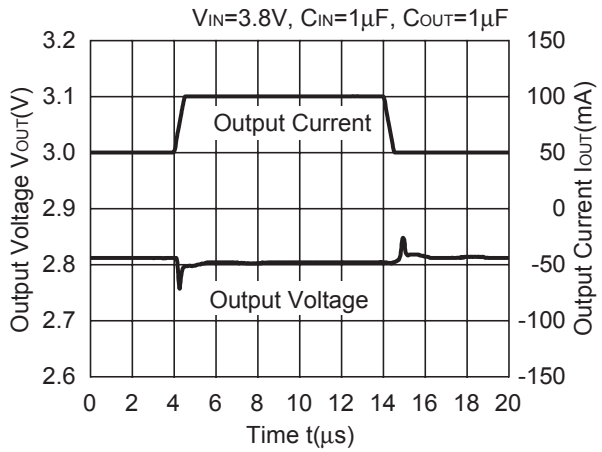
R1162x28x (ECO=H)

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



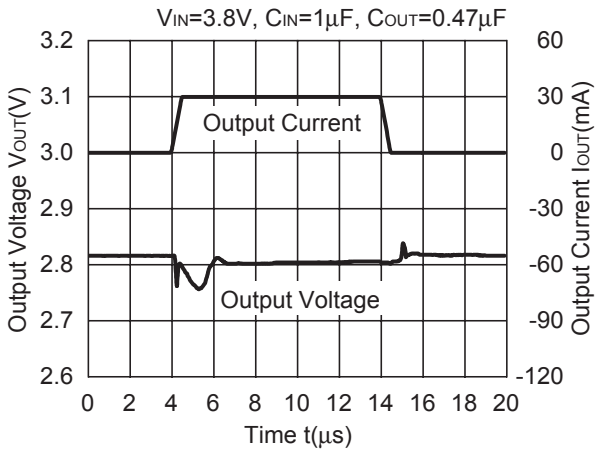
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF, C_{OUT}=1µF

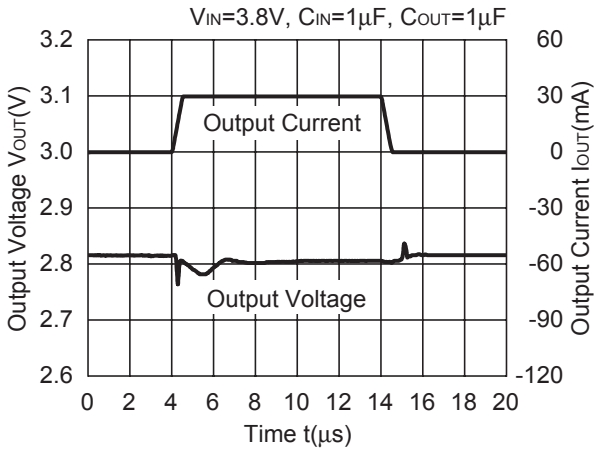


R1162x28x (ECO=H)

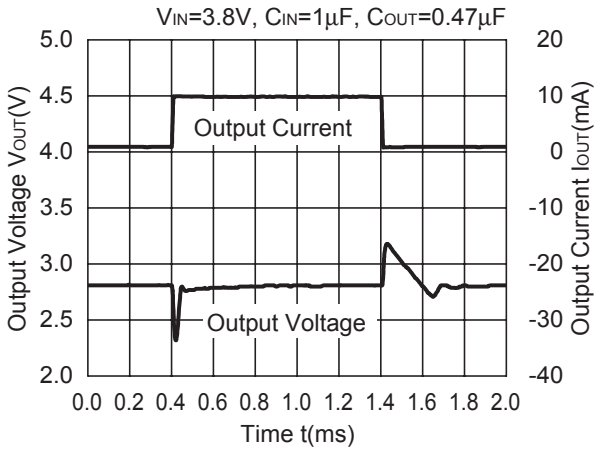
V_{IN}=3.8V, C_{IN}=1µF, C_{OUT}=0.47µF



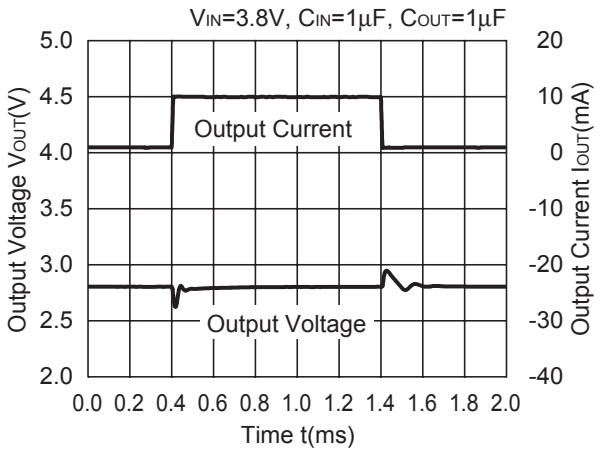
R1162x28x (ECO=H)



R1162x28x (ECO=L)

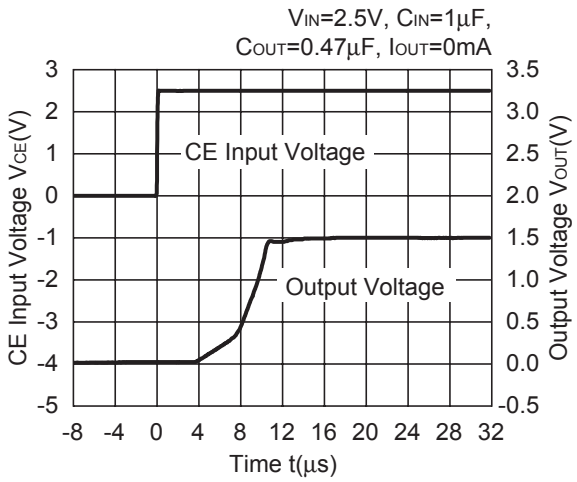


R1162x28x (ECO=L)

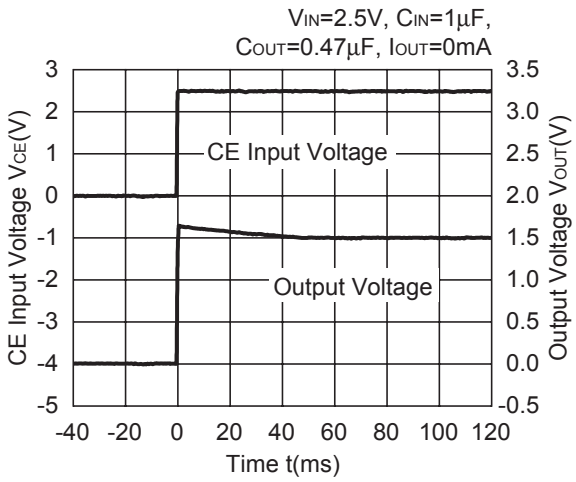


12) Turn on speed with CE pin

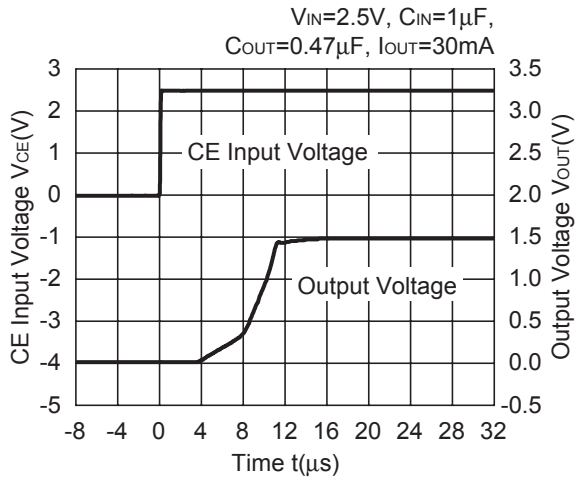
R1162x15x (ECO=H)



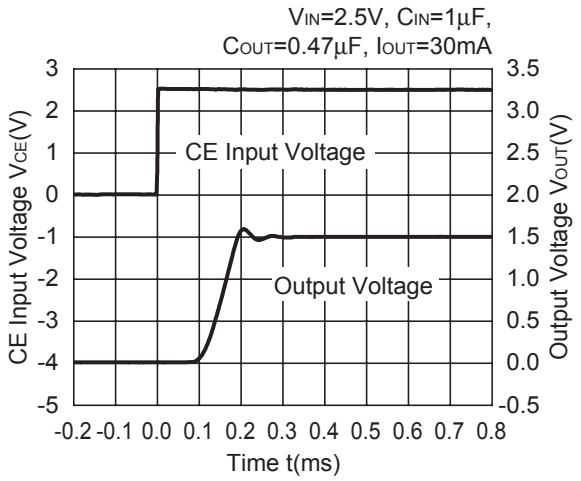
R1162x15x (ECO=L)



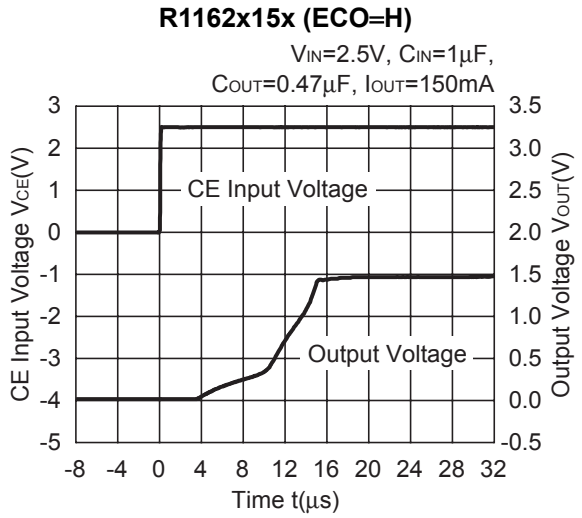
R1162x15x (ECO=H)



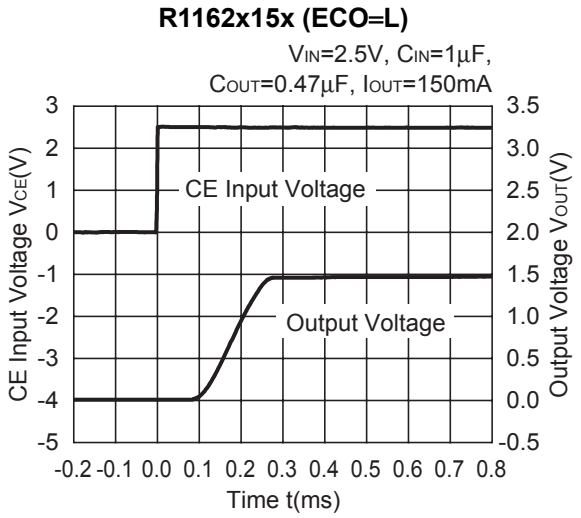
R1162x15x (ECO=L)



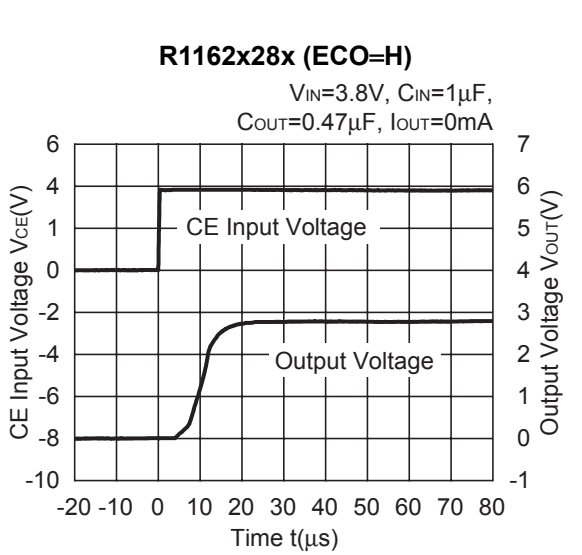
R1162x15x (ECO=H)



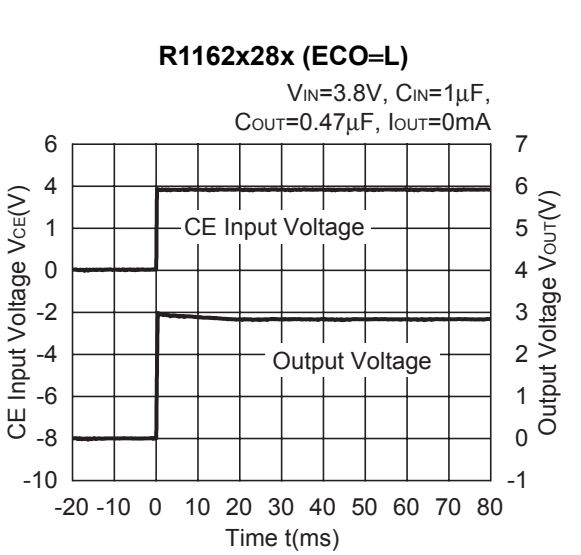
R1162x15x (ECO=L)



R1162x28x (ECO=H)

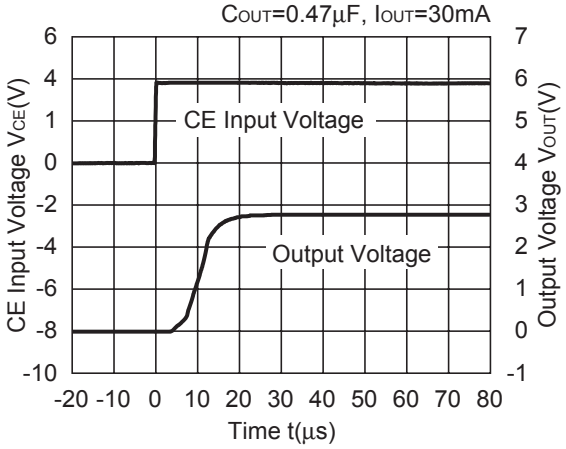


R1162x28x (ECO=L)



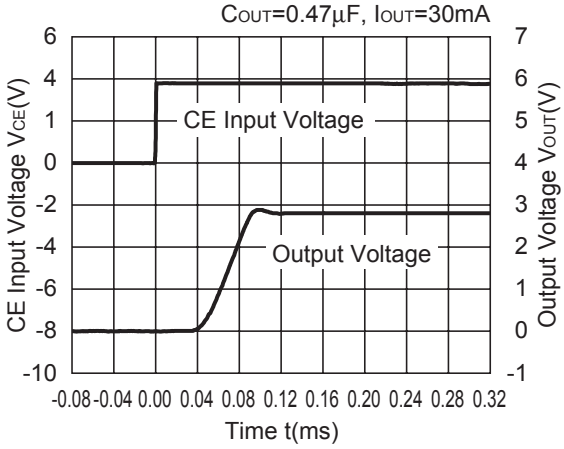
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=30mA



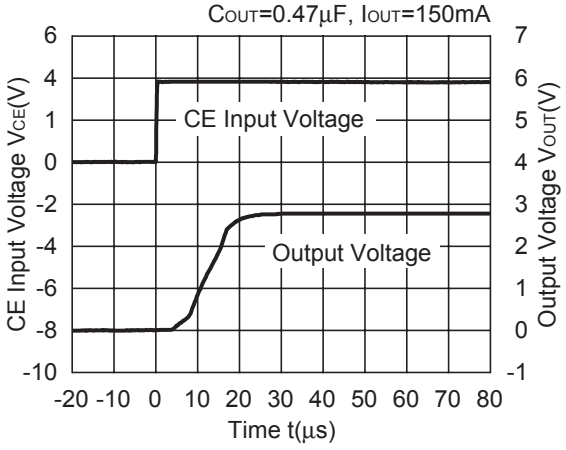
R1162x28x (ECO=L)

V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=30mA



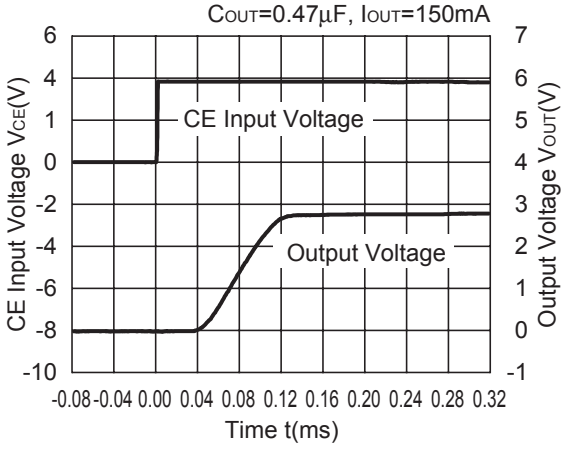
R1162x28x (ECO=H)

V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=150mA



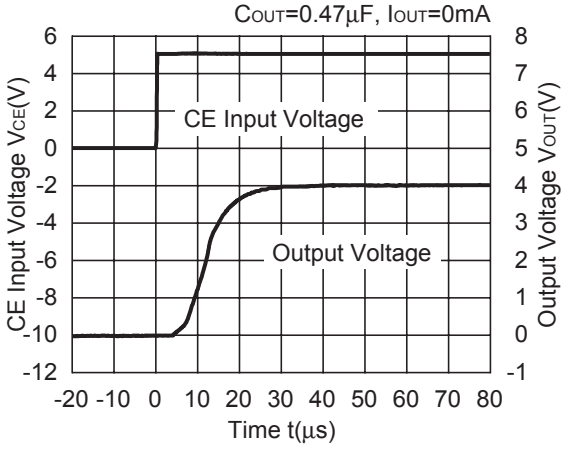
R1162x28x (ECO=L)

V_{IN}=3.8V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=150mA



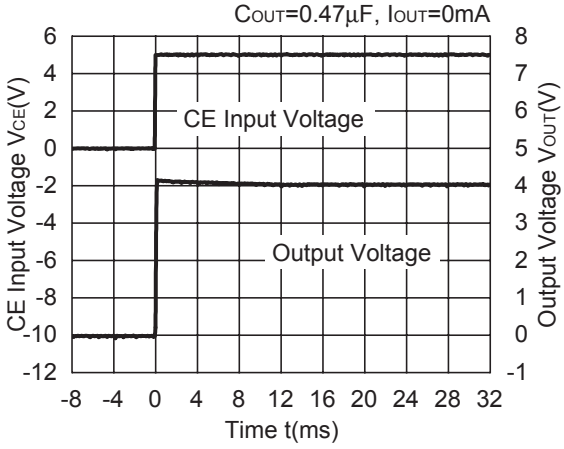
R1162x40x (ECO=H)

V_{IN}=5.0V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=0mA

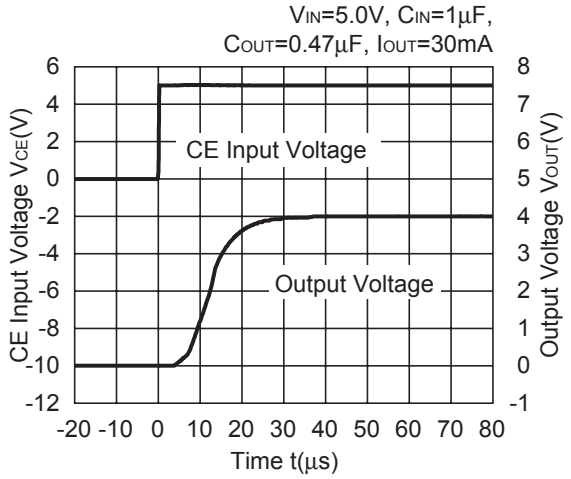


R1162x40x (ECO=L)

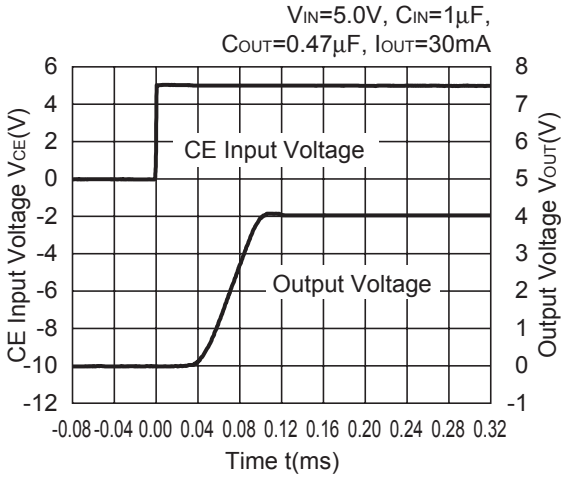
V_{IN}=5.0V, C_{IN}=1µF,
C_{OUT}=0.47µF, I_{OUT}=0mA



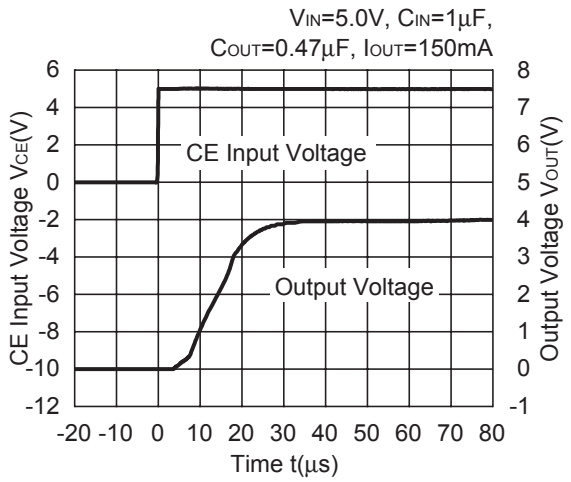
R1162x40x (ECO=H)



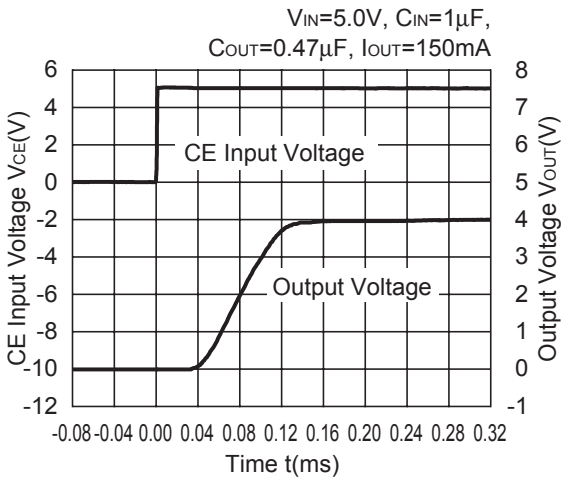
R1162x40x (ECO=L)



R1162x40x (ECO=H)

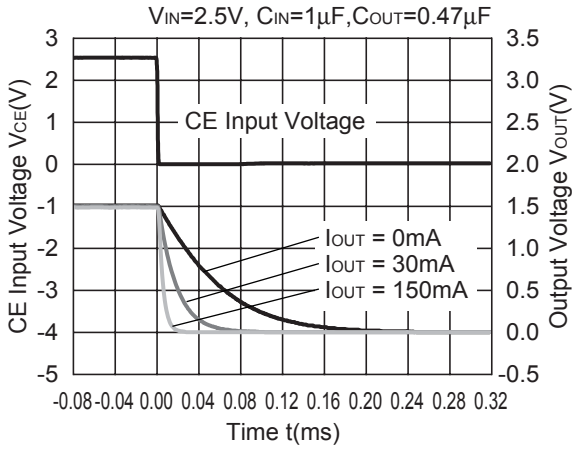


R1162x40x (ECO=L)

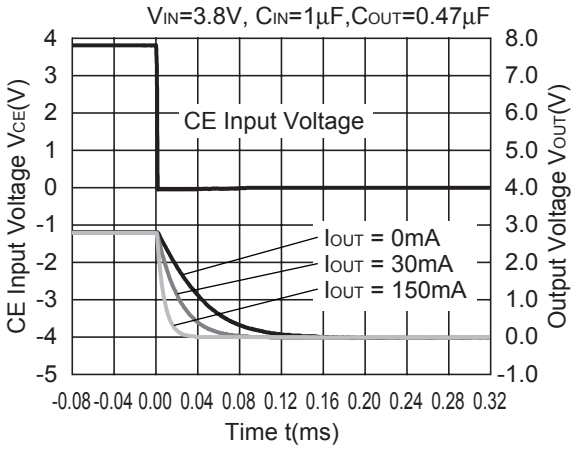


13) Turn off speed with CE pin

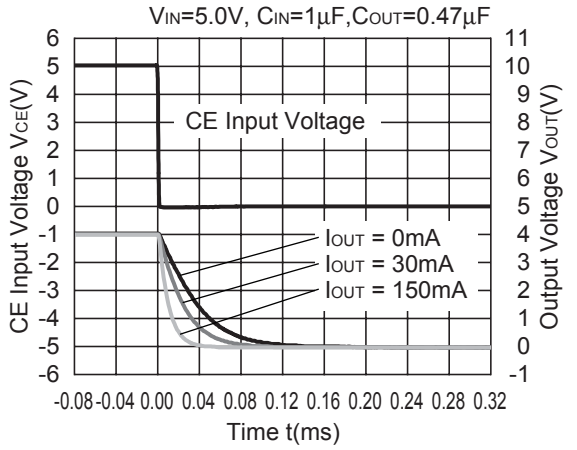
R1162x15xD



R1162x28xD



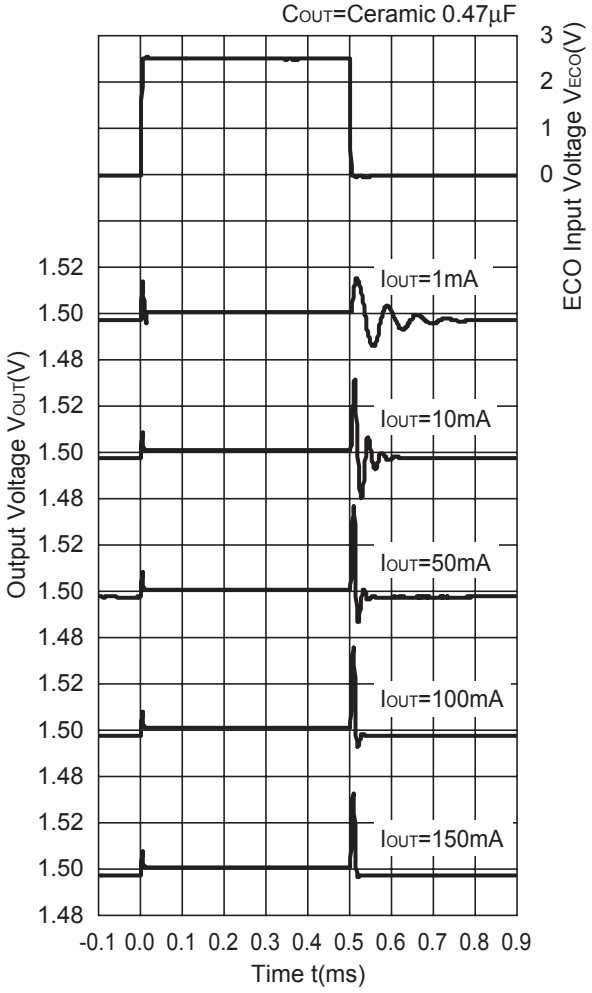
R1162x40xD

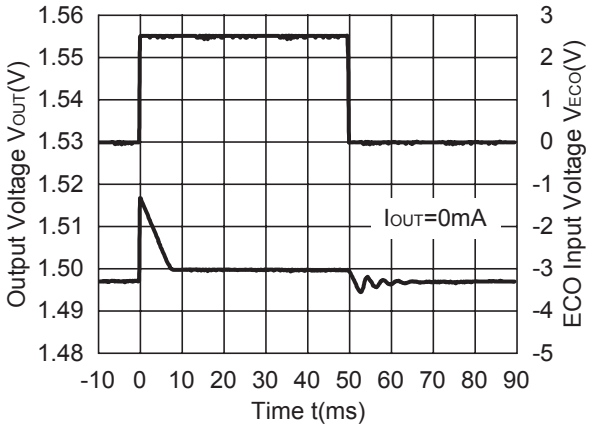


14) Output Voltage at Mode alternative point

R1162x15x

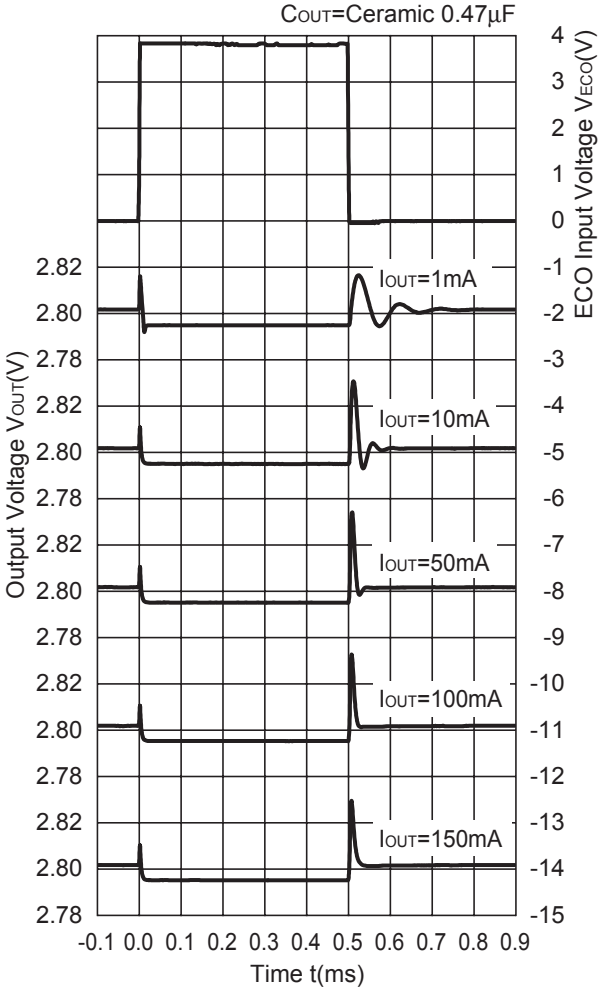
V_{IN}=2.5V, C_{IN}=Ceramic 1.0µF,
C_{OUT}=Ceramic 0.47µF

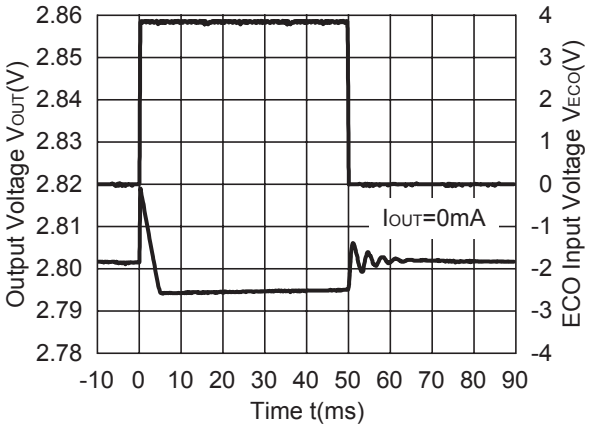




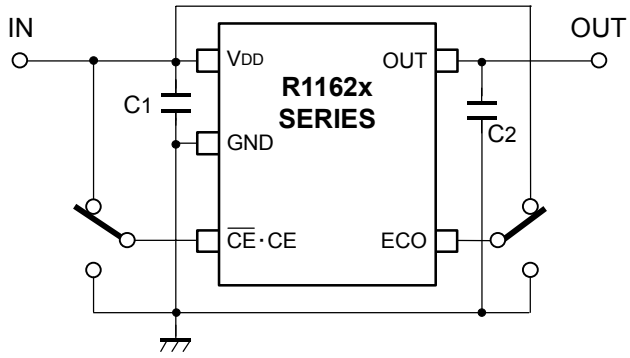
R1162x28x

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.

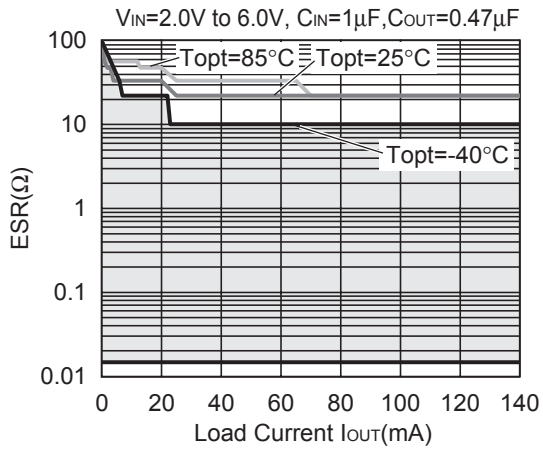
For this purpose, be sure to use a capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance) in the range described as follows:

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.

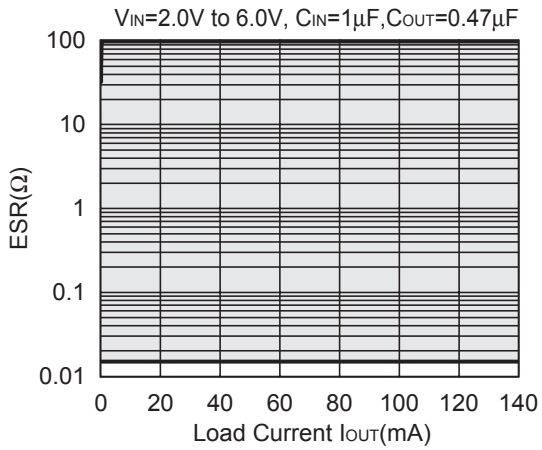
<Test conditions>

(1) Frequency band: 10Hz to 2MHz

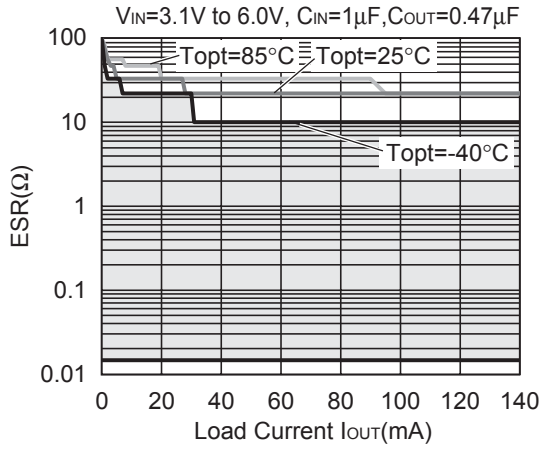
R1162x15x (ECO=H)



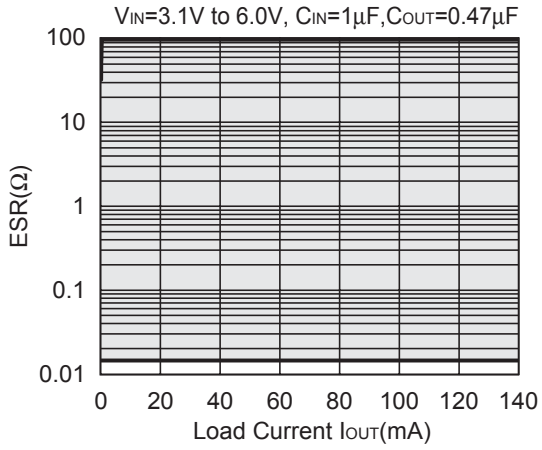
R1162x15x (ECO=L)



R1162x28x (ECO=H)



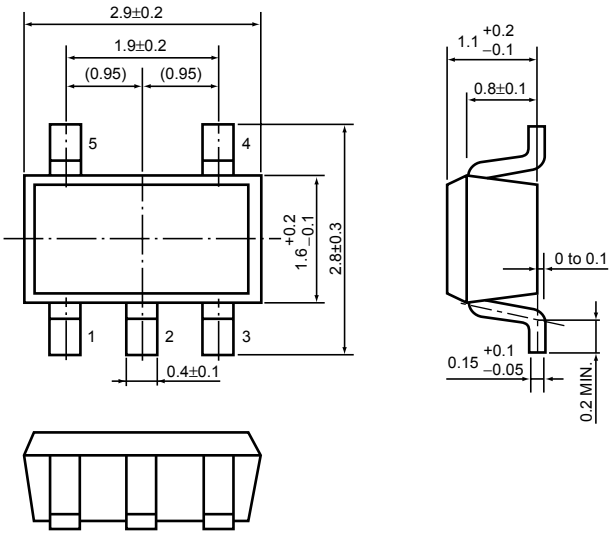
R1162x28x (ECO=L)



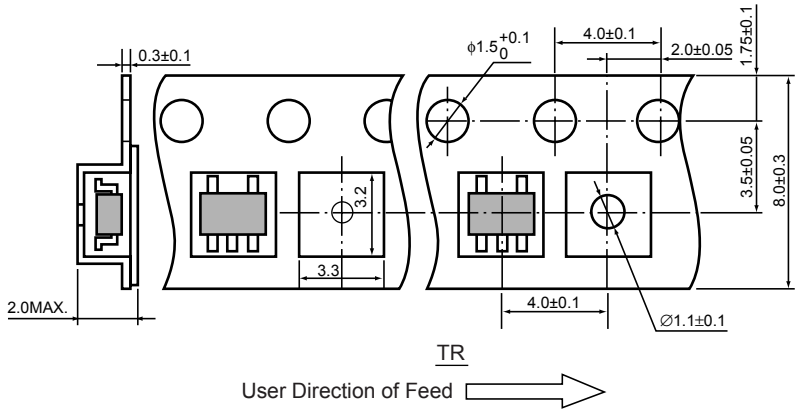
- **SOT-23-5 (SC-74A)**

Unit: mm

PACKAGE DIMENSIONS

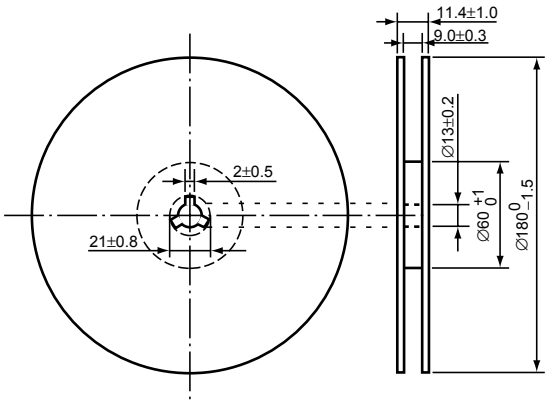


TAPING SPECIFICATION



TAPING REEL DIMENSIONS

(1reel=3000pcs)



POWER DISSIPATION (SOT-23-5)

This specification is at mounted on board. Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

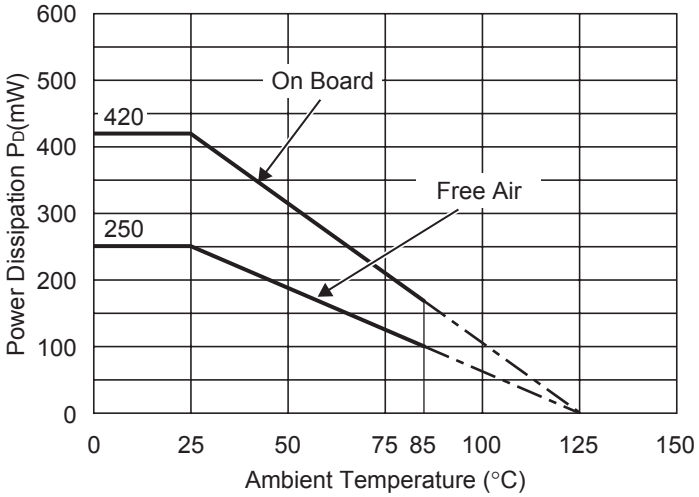
Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plactic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-hole	ϕ0.5mm × 44pcs

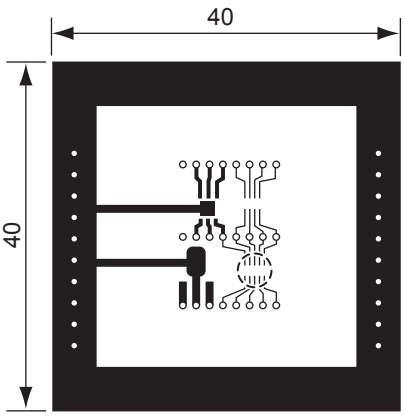
Measurement Result

(Topt=25°C,Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	θja=(125−25°C)/0.42W=263°C/W	400°C/W



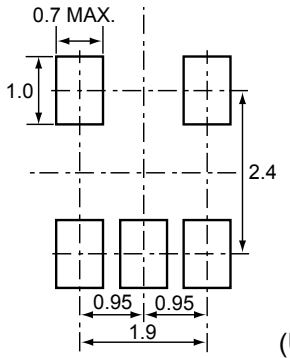
Power Dissipation



Measurement Board Pattern

IC Mount Area Unit : mm

RECOMMENDED LAND PATTERN

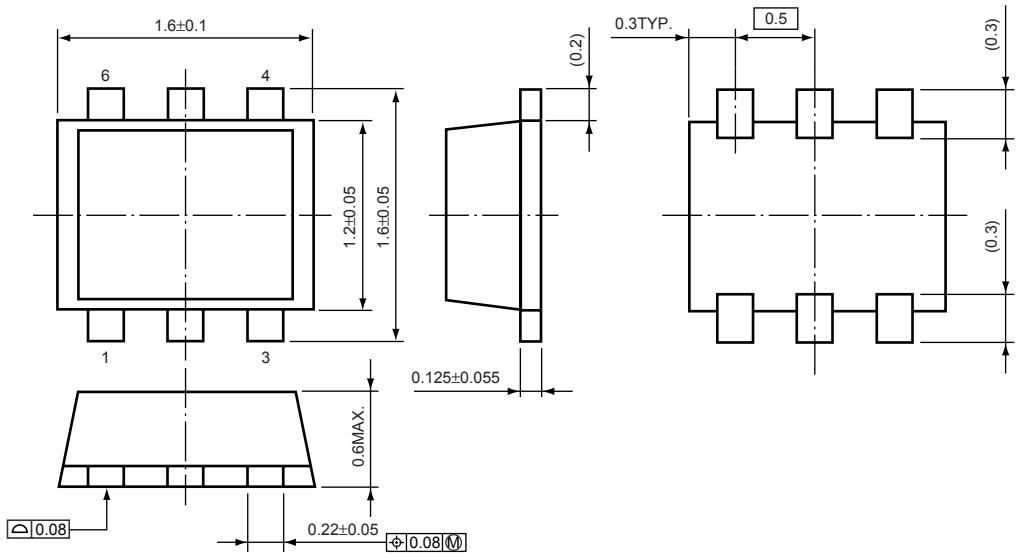


(Unit: mm)

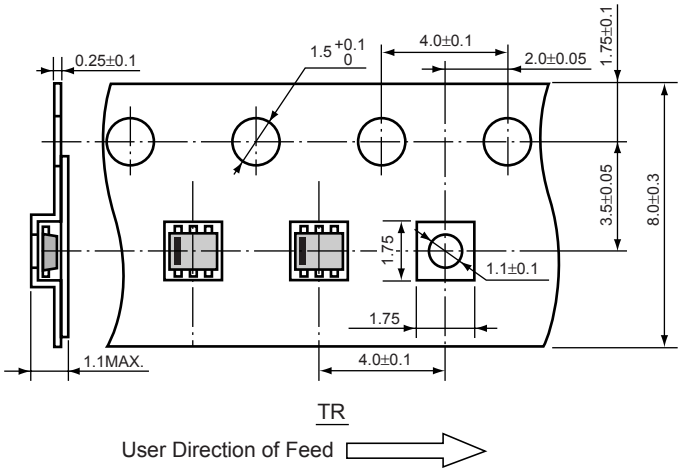
- **SON1612-6**

Unit: mm

PACKAGE DIMENSIONS

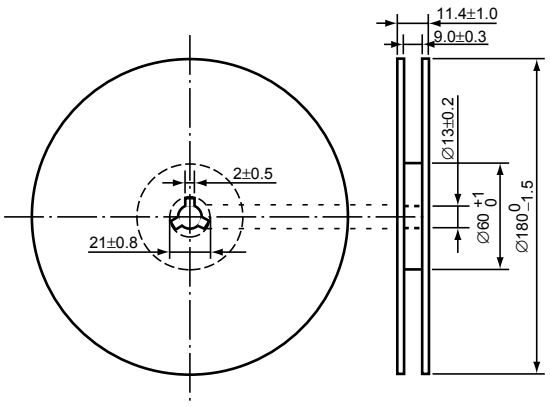


TAPING SPECIFICATION



TAPING REEL DIMENSIONS

(1reel=4000pcs)



Power Dissipation (SON1612-6)

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

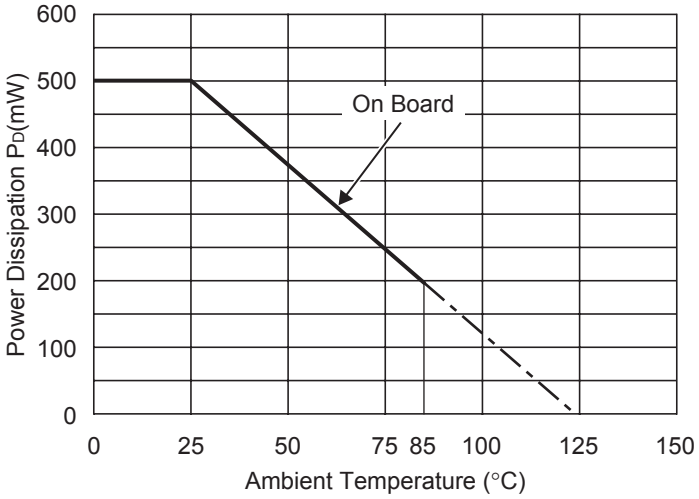
Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plactic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50%, Back side : Approx.50%
Through-hole	ϕ0.5mm × 24pcs

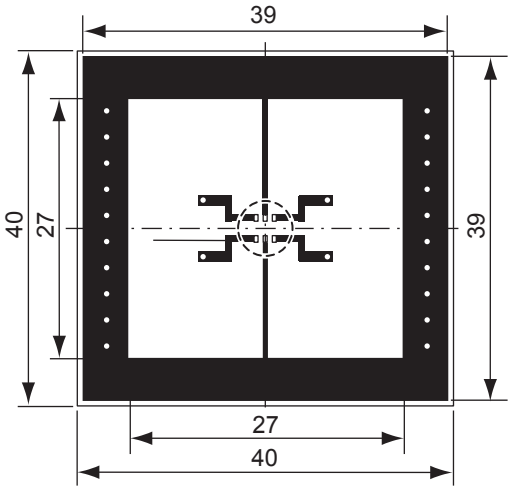
Measurement Result

(Topt=25°C,Tjmax=125°C)

	Standard Land Pattern
Power Dissipation	500mW
Thermal Resistance	θja=(125−25°C)/0.5W=200°C/W



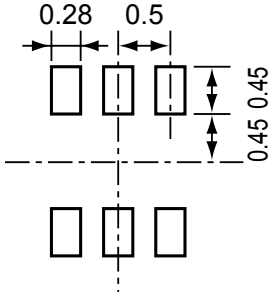
Power Dissipation



Measurement Board Pattern

IC Mount Area Unit : mm

RECOMMENDED LAND PATTERN



(Unit: mm)