



3-MODE 150mA LDO REGULATOR

R1162x SERIES (Preliminary)

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.

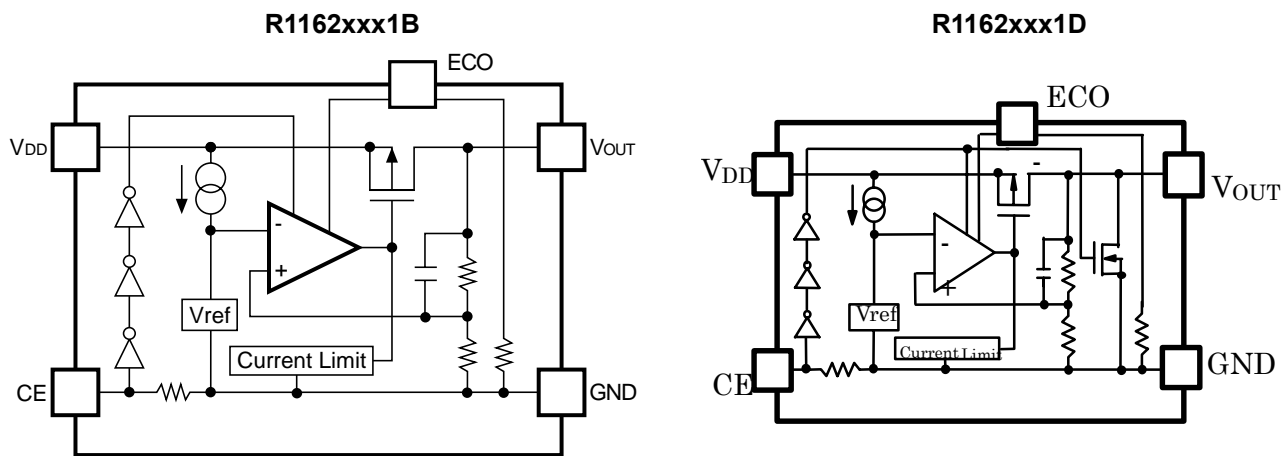
FEATURES

- Ultra-Low Supply CurrentTyp. 5.5 μ A (Low Power Mode)
Typ. 70 μ A (Fast Transient Mode)
- Standby ModeTyp. 0.1 μ A
- Low Dropout VoltageTyp. 0.25V ($I_{OUT}=150\text{mA}$ Output Voltage=3.0V Type)
- High Ripple RejectionTyp. 70dB ($f=1\text{kHz}$, FT Mode)
.....Typ. 60dB ($f=10\text{kHz}$, FT Mode)
- Low Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100\text{ppm}/^\circ\text{C}$
- Excellent Line RegulationTyp. 0.02%/V
- High Output Voltage Accuracy..... $\pm 2.0\%$ ($\pm 3.0\%$ 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 circuitTyp. 40mA (Current at short mode)
- Performs with Ceramic Capacitors $C_{in}=1\mu\text{F}$, $C_{out}=0.47\mu\text{F}$

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



SELECTION GUIDE

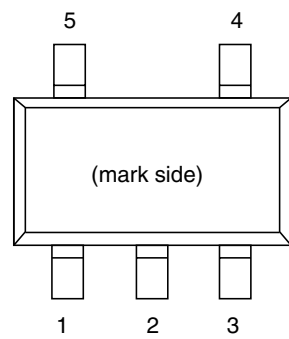
The output voltage, function of auto-discharge, package, and the packing type for the ICs can be selected at the user's request. The selection can be available by designating the part number as shown below;

R1162xx1x-xx ← Part Number
 ↑↑ ↑↑
 a b c d

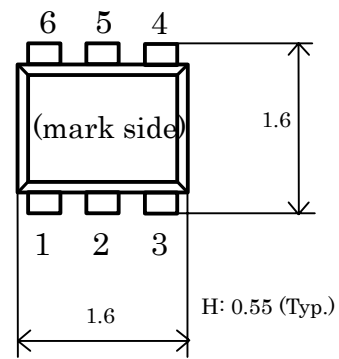
Code	Contents
a	Designation of Package Type : N:SOT-23-5 (Mini-mold) D:SON1612-6
b	Setting Output Voltage (V _{OUT}) : Stepwise setting with a step of 0.1V in the range of 1.5V to 4.0V is possible. Exceptions: 1.85V=R1162X181X5, 2.85V=R1162X281X5
c	Designation of Chip Enable Option : B: "H" active type. D: "H" active type. With auto discharge function
d	Designation of Taping Type : Refer to Taping Specifications; TR type is the standard direction.

PIN CONFIGURATION

SOT-23-5



SON1612-6



PIN DESCRIPTION

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

SON-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 ~ 6.5	V
V_{CE}	Input Voltage (\overline{CE} / CE Pin)	-0.3 ~ 6.5	V
V_{OUT}	Output Voltage	-0.3 ~ $V_{IN}+0.3$	V
I_{OUT}	Output Current	180	mA
P_D	Power Dissipation	250	mW
T_{opt}	Operating Temperature Range	-40 ~ 85	°C
T_{stg}	Storage Temperature Range	-55 ~ 125	°C

ELECTRICAL CHARACTERISTICS

• R1162xxx1B/D

T_{opt}=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} ≤ 2V	-1.2 (-24)	0 0	1.2 (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
ΔV _{OUT} / ΔI _{OUT}	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, I _{OUT} = 0mA V _{ECO} = GND		5.5	9.0	μA
I _{standby}	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} ≤ 6V I _{OUT} = 30mA, V _{ECO} = V _{IN} V _{OUT} ≤ 1.6V: 2.2V ≤ V _{IN} ≤ 6.0V		0.02	0.10	%/V
ΔV _{OUT} / ΔV _{IN}	Line Regulation (LP Mode)	Set V _{OUT} +0.5V ≤ V _{IN} ≤ 6V 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} / ΔT	Output Voltage Temperature Coefficient	I _{OUT} = 30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/°C
I _{LM}	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

$T_{opt} = 25^{\circ}\text{C}$

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

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

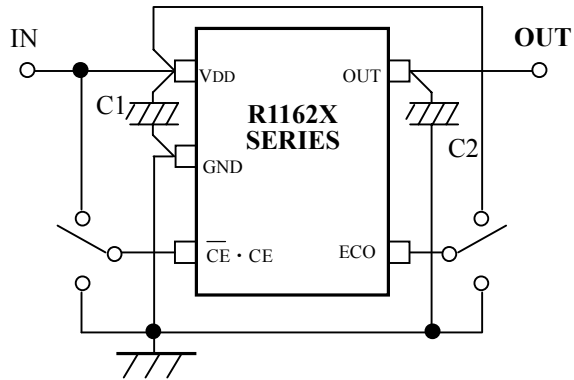
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a $0.47\mu\text{F}$ or more capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance).

PCB Layout

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 $1.0\mu\text{F}$ 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.

TYPICAL APPLICATION



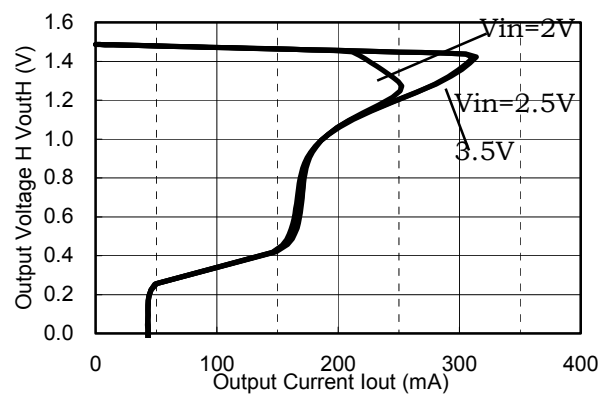
(External Components)
 Output Capacitor; Ceramic Type
 Input Capacitor; Ceramic Type

TYPICAL CHARACTERISTICS

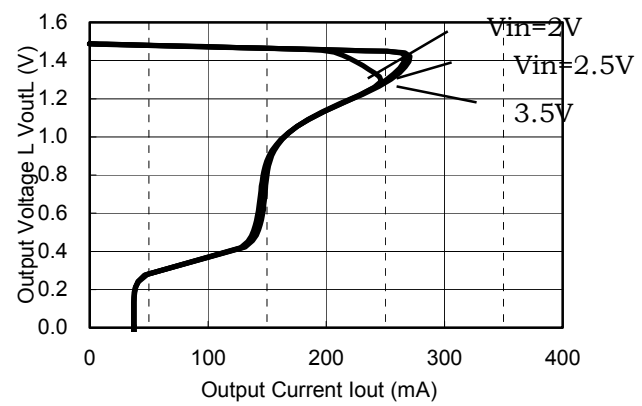
Unless otherwise provided, capacitors are ceramic type.

1) Output Voltage vs. Output Current

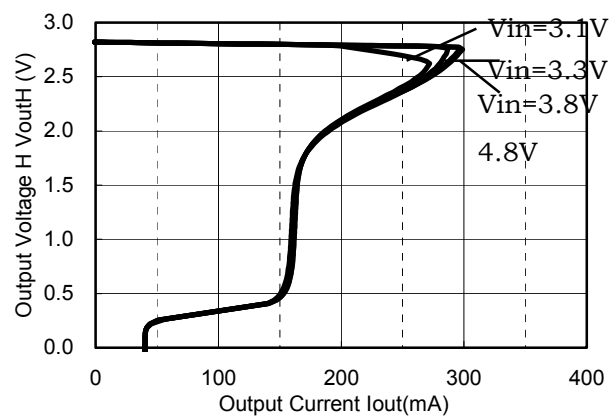
R1162X15X ECO=H



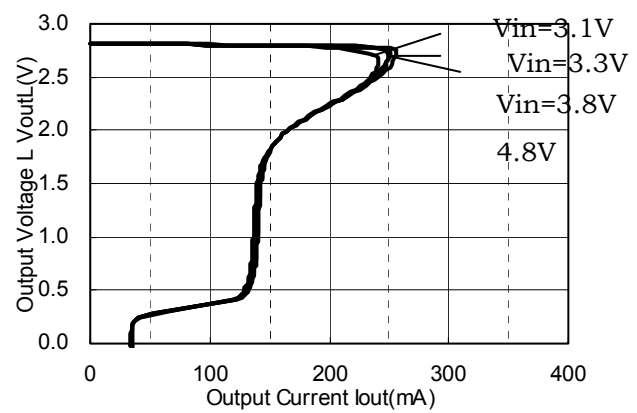
R1162X15X ECO=L



R1162X28X ECO=H

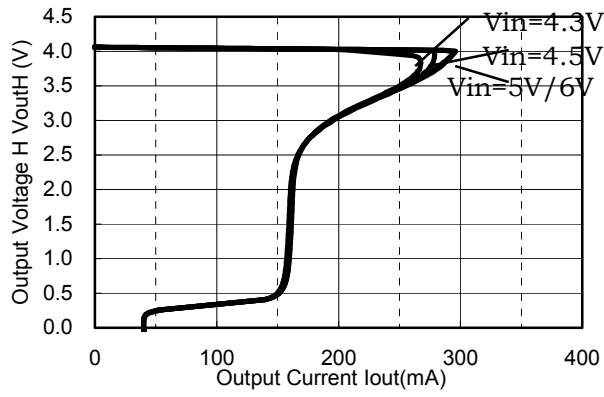


R1162X28X ECO=L

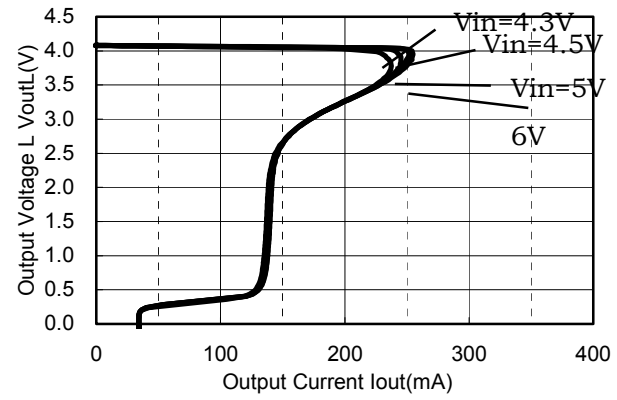


R1162x

R1162X40X ECO=H

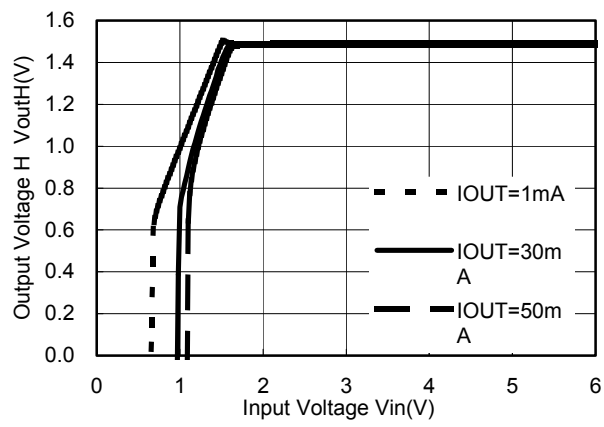


R1162X40X ECO=L

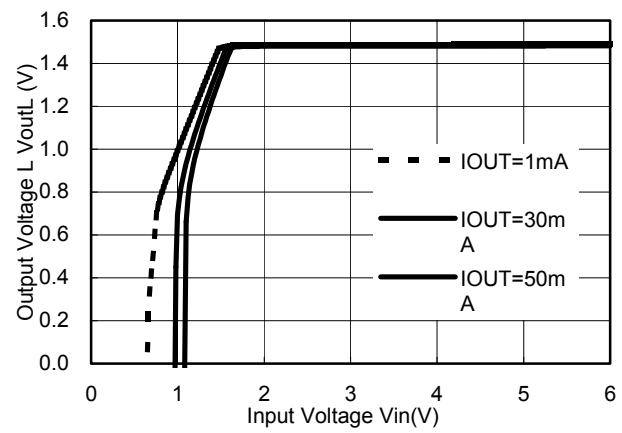


2) Output Voltage vs. Input Voltage

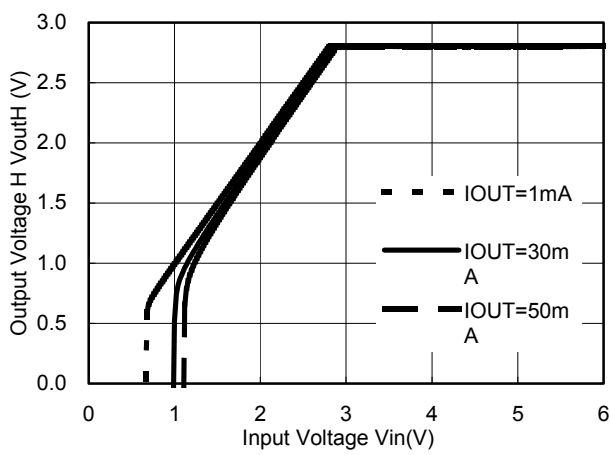
R1162X15X ECO=H



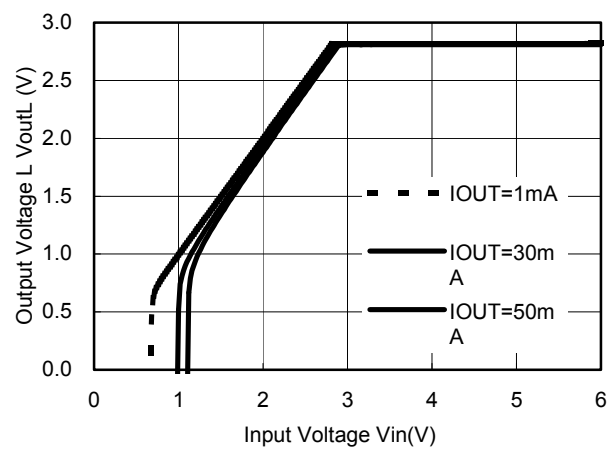
R1162X15X ECO=L



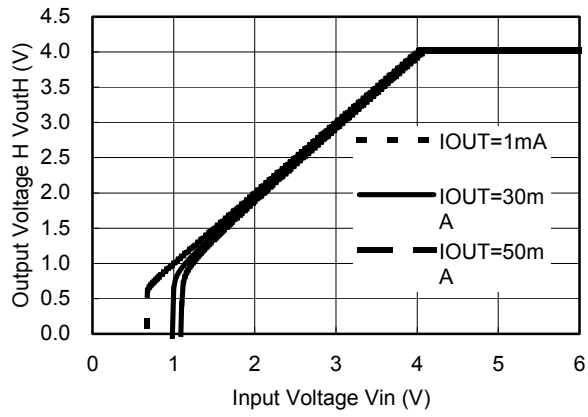
R1162X28X ECO=H



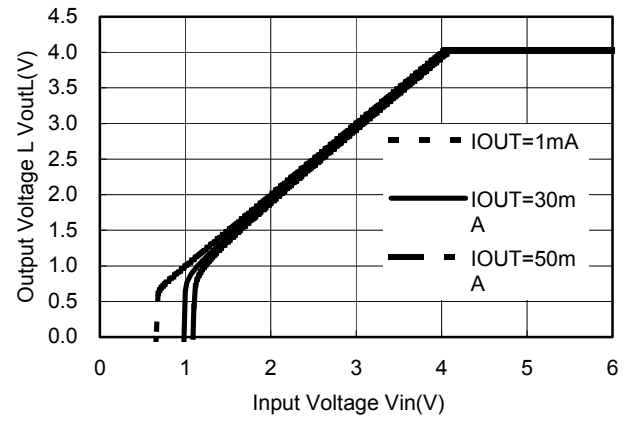
R1162X28X ECO=L



R1162X40X ECO=H

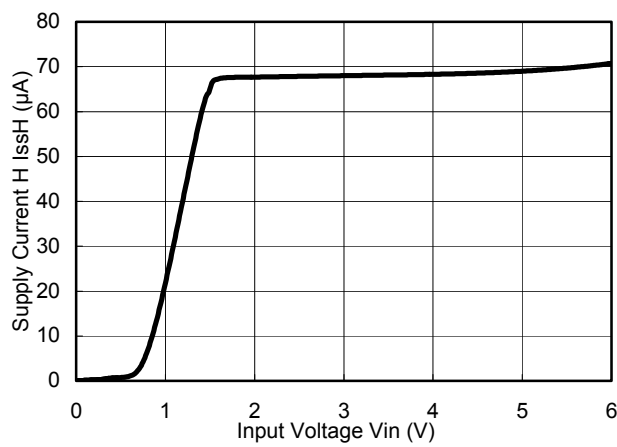


R1162X40X ECO=L

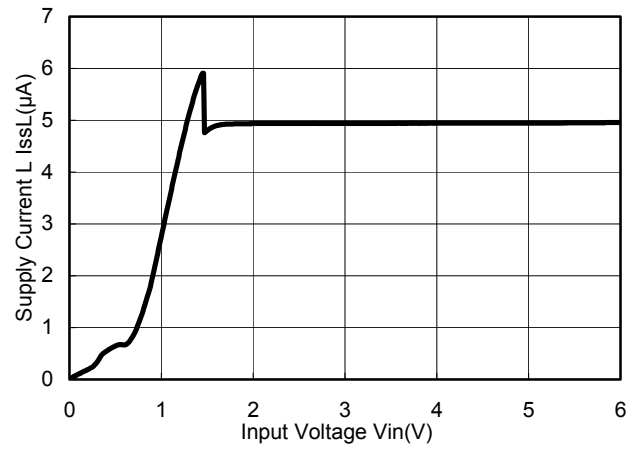


3) Supply Current vs. Input Voltage

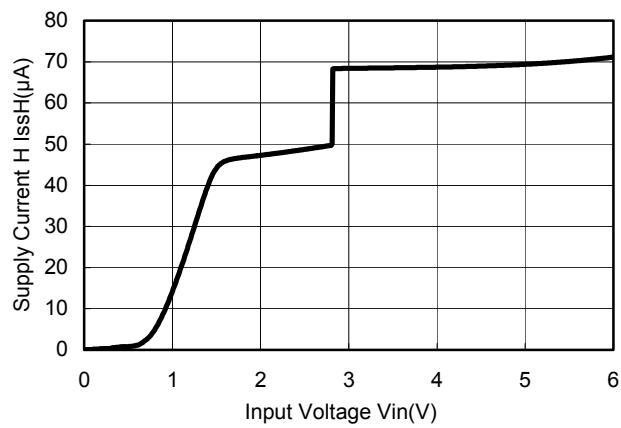
R1162X15X ECO=H



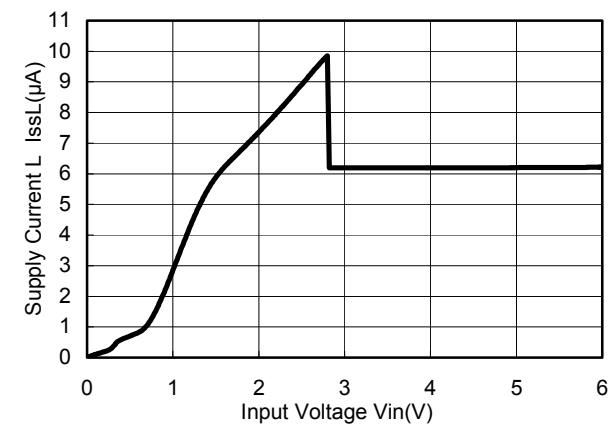
R1162X15X ECO=L



R1162X28X ECO=H

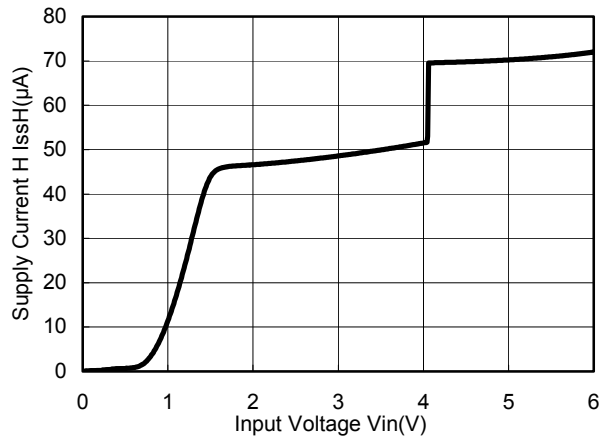


R1162X28X ECO=L

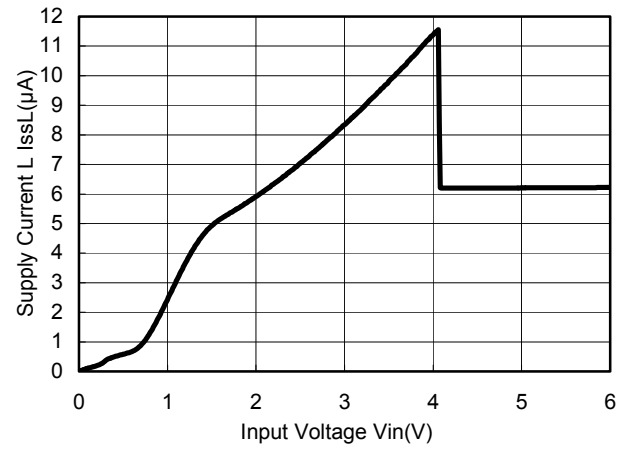


R1162x

R1162X40X ECO=H

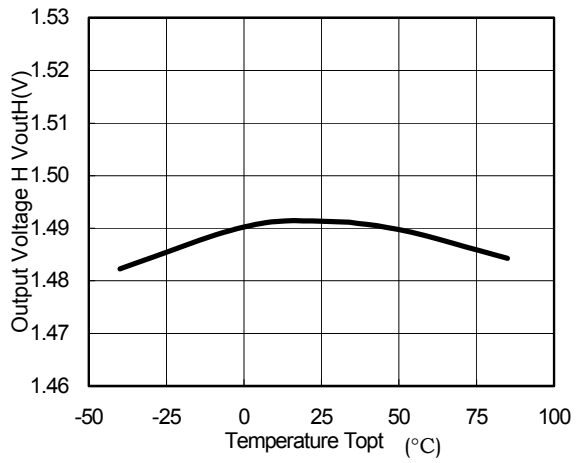


R1162X40X ECO=L

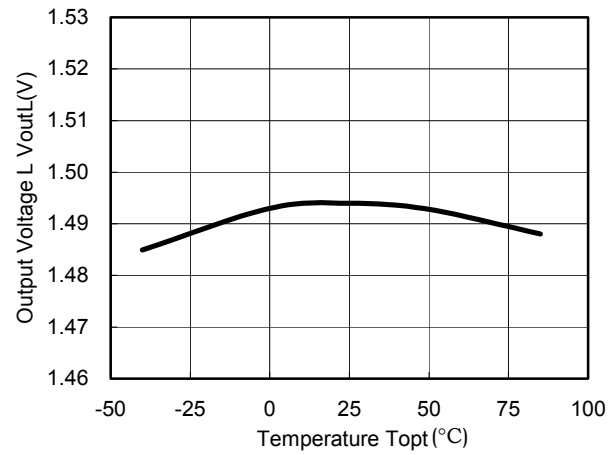


4) Output Voltage vs. Temperature

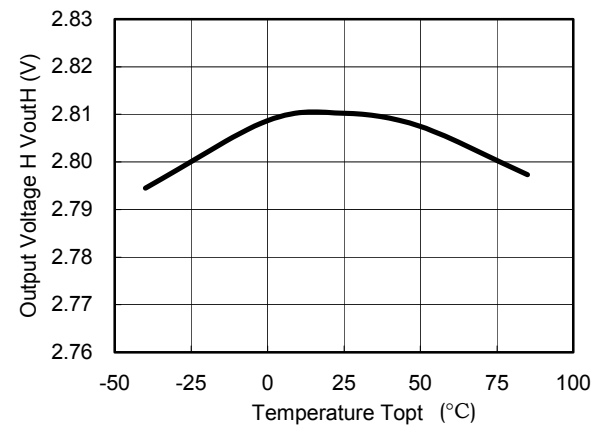
R1162X15X ECO=H



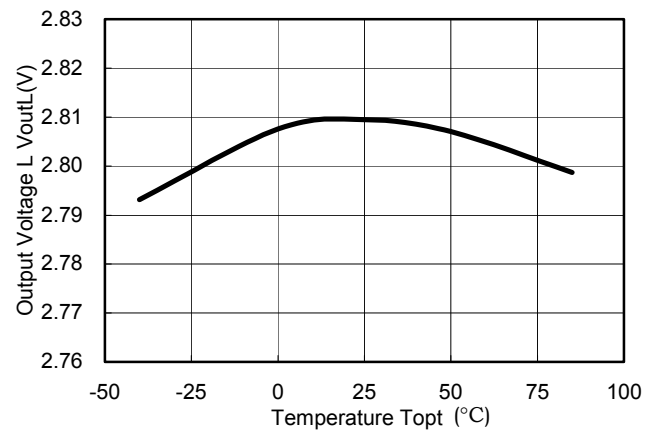
R1162X15X ECO=L



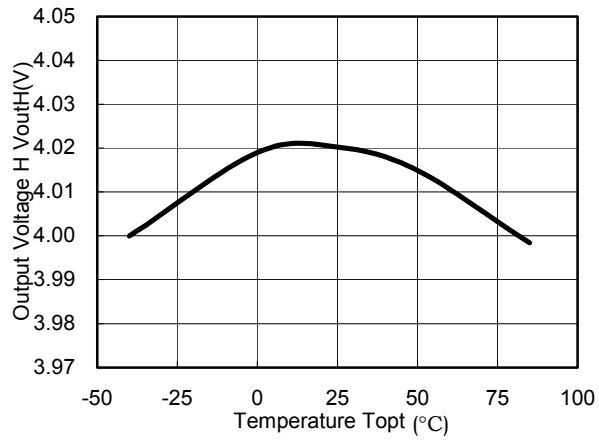
R1162X28X ECO=H



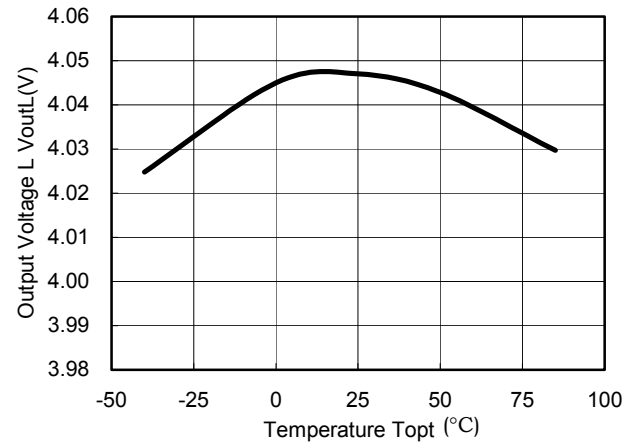
R1162X28X ECO=L



R1162X40X ECO=H

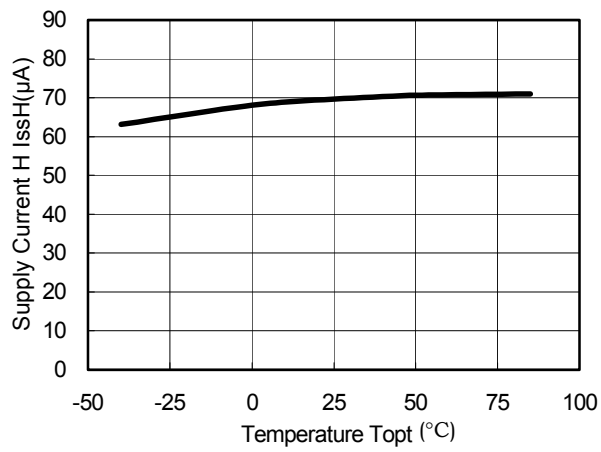


R1162X40X ECO=L

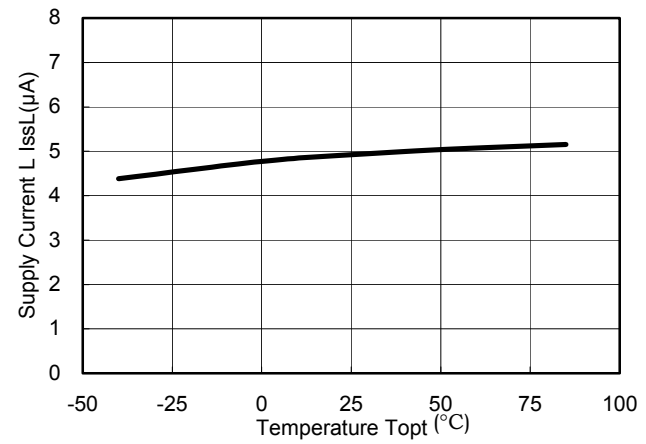


5) Supply Current vs. Temperature

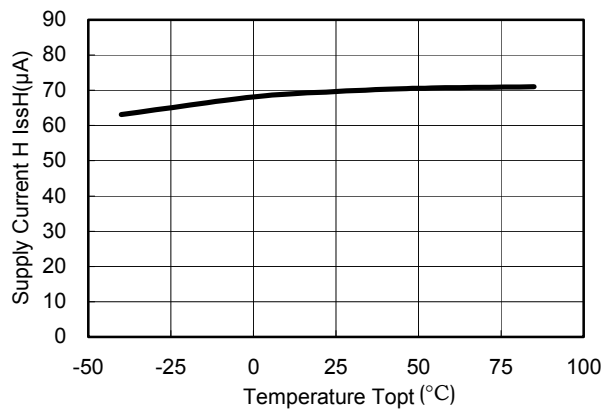
R1162X15X ECO=H



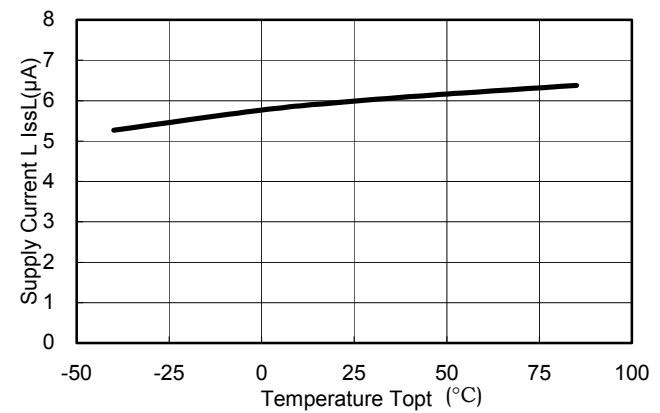
R1162X15X ECO=L



R1162X28X ECO=H

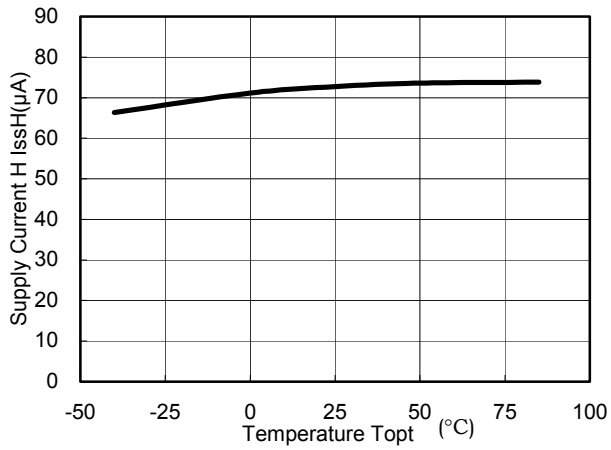


R1162X28X ECO=L

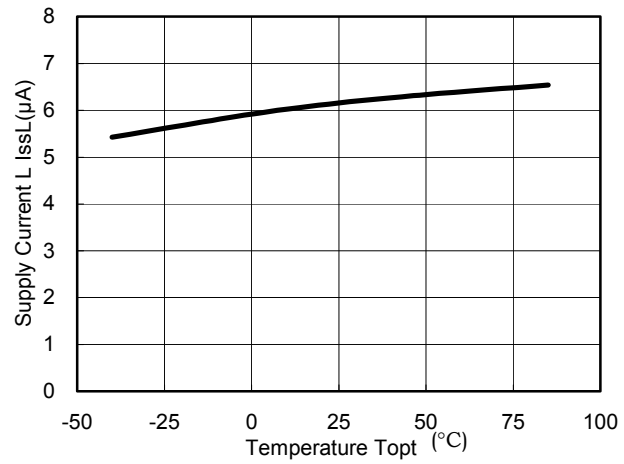


R1162x

R1162X40X ECO=H

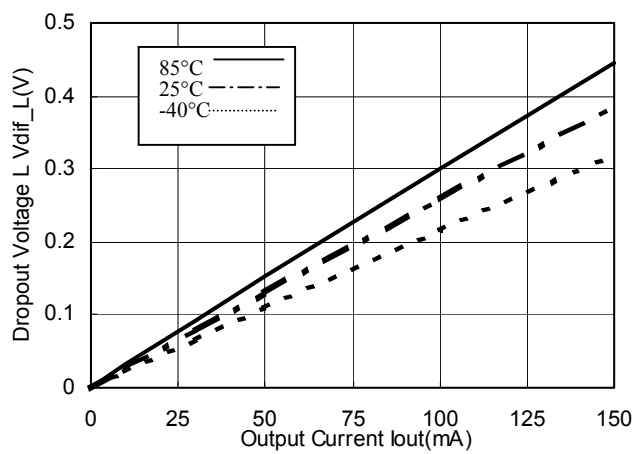


R1162X40X ECO=L

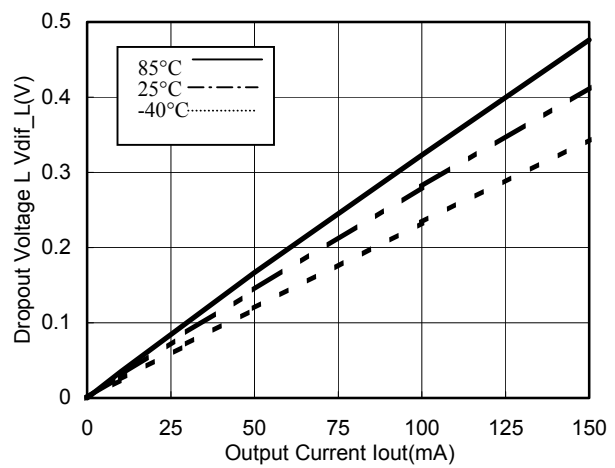


6) Dropout Voltage vs. Output Current

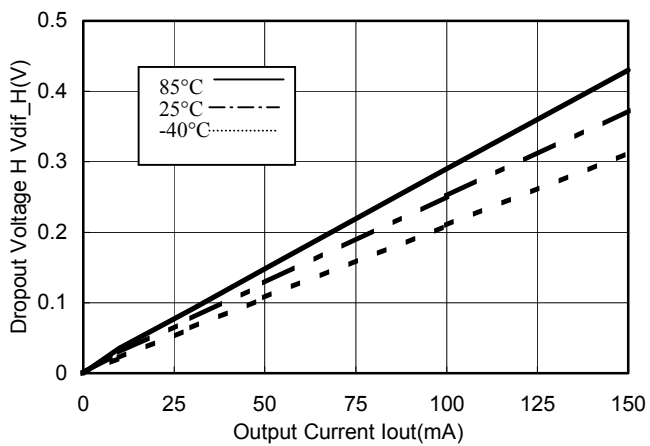
R1162X15X ECO=H



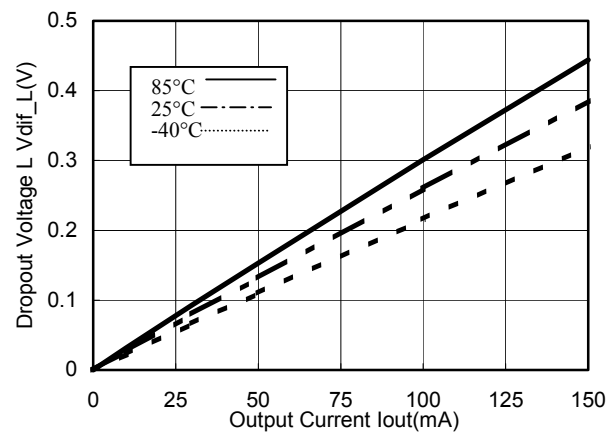
R1162X15X ECO=L



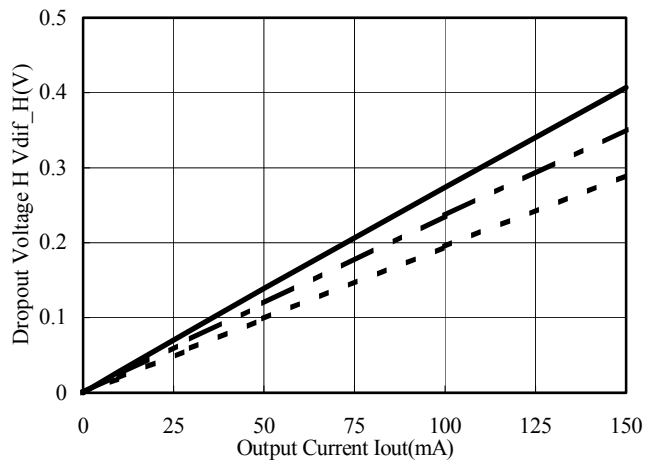
R1162X16X ECO=H



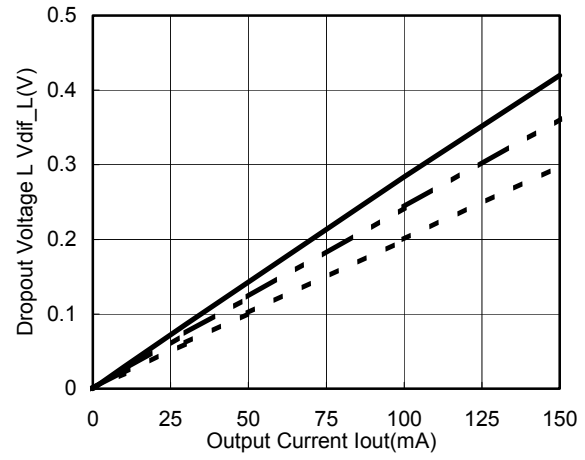
R1162X16X ECO=L



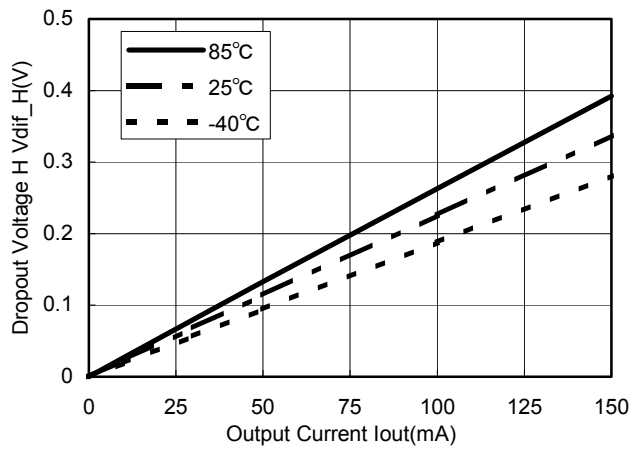
R1162X17X ECO=H



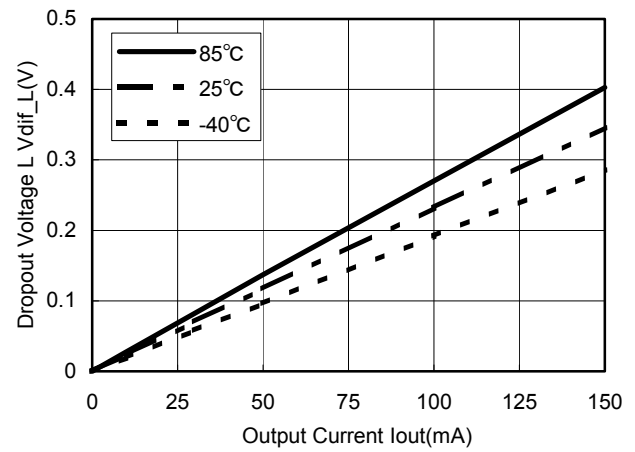
R1162X17X ECO=L



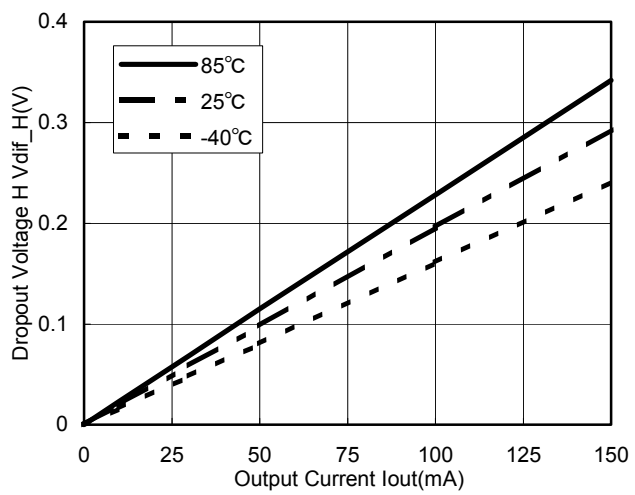
R1162X18X ECO=H



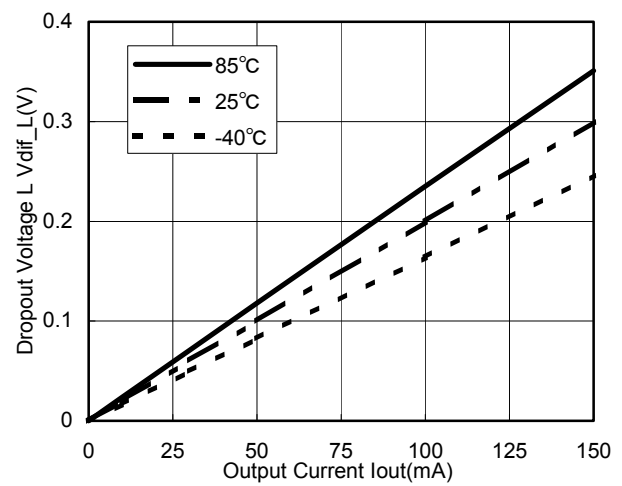
R1162X18X ECO=L



R1162X21X ECO=H

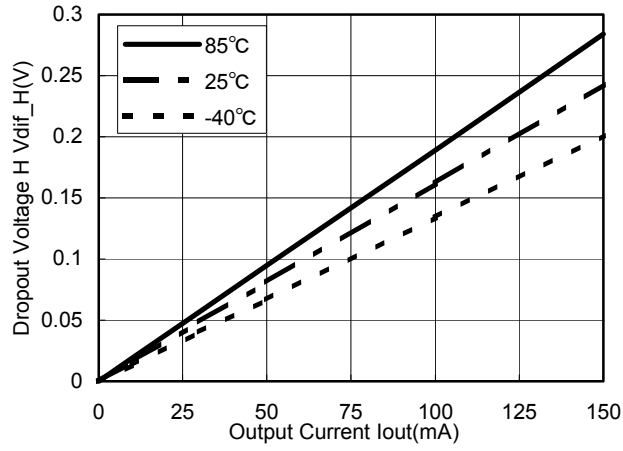


R1162X21X ECO=L

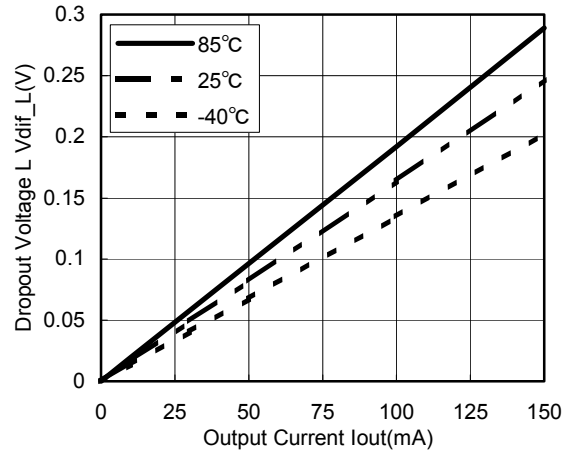


R1162x

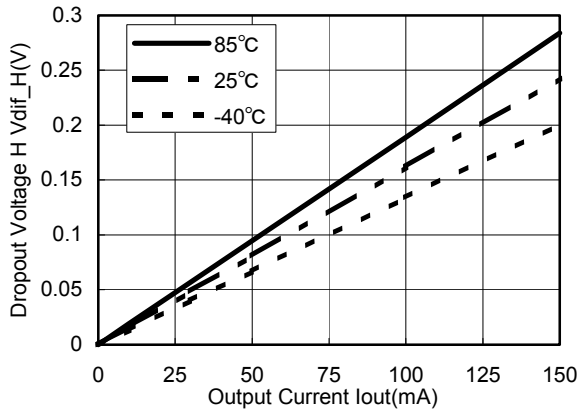
R1162X28X ECO=H



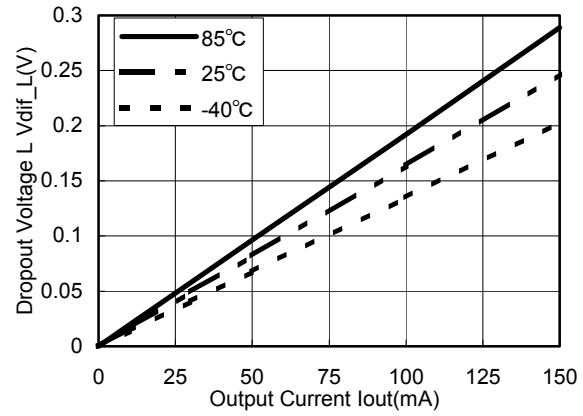
R1162X28X ECO=L



R1162X40X ECO=H

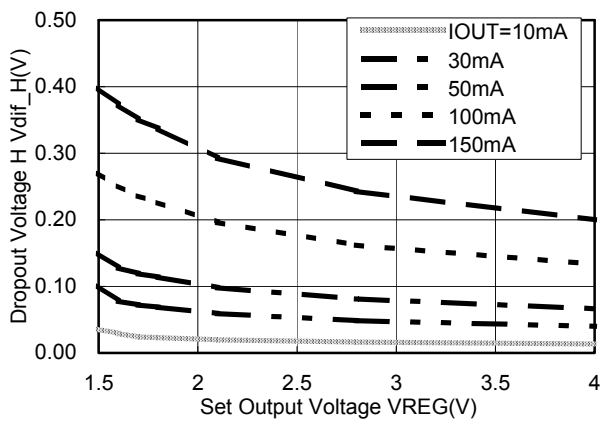


R1162X40X ECO=L

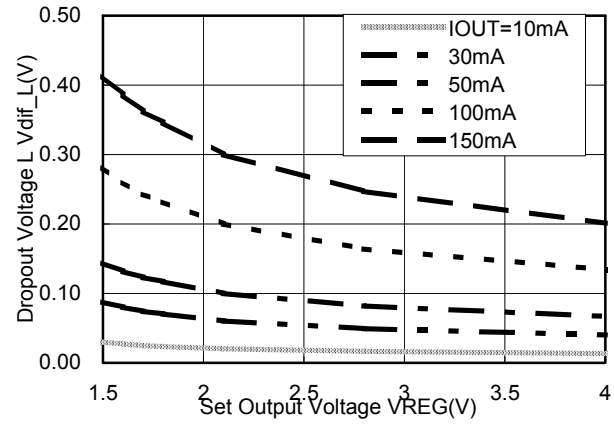


7) Dropout Voltage vs. Set Output Voltage

R1162X ECO=H

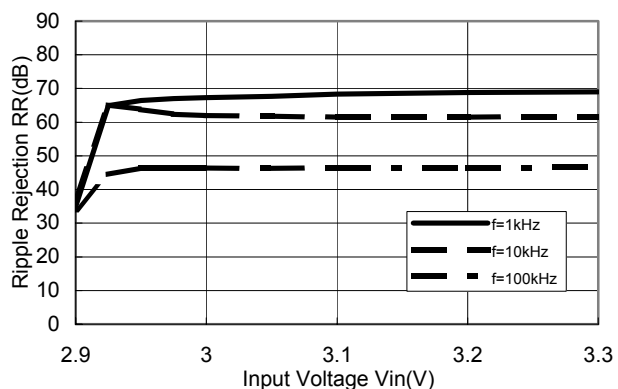


R1162X ECO=L

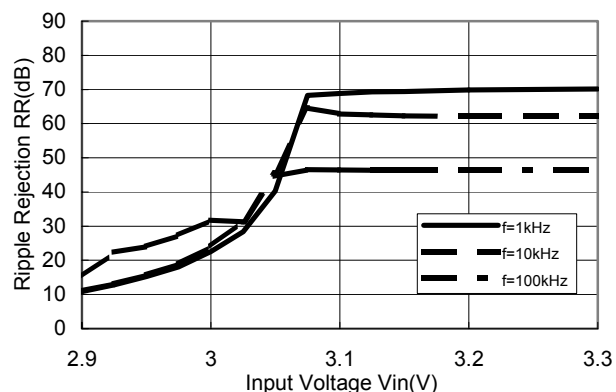


8) Ripple Rejection vs. Input Bias Voltage

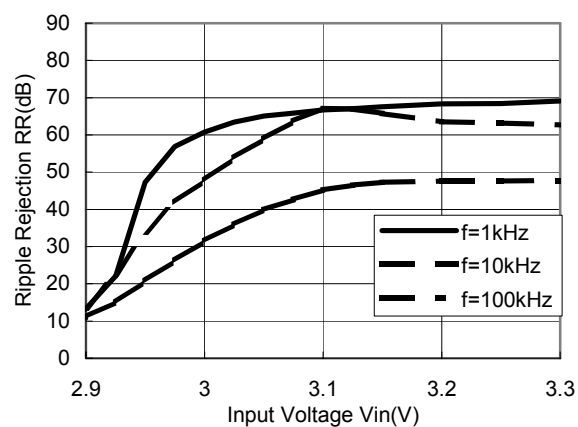
R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=1mA Ripple=0.2Vp-p



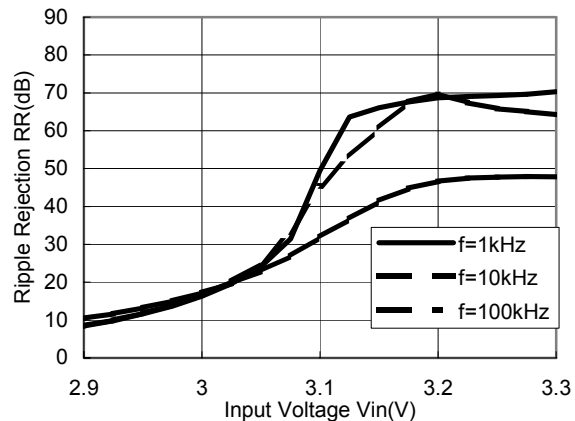
R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=1mA Ripple=0.5Vp-p



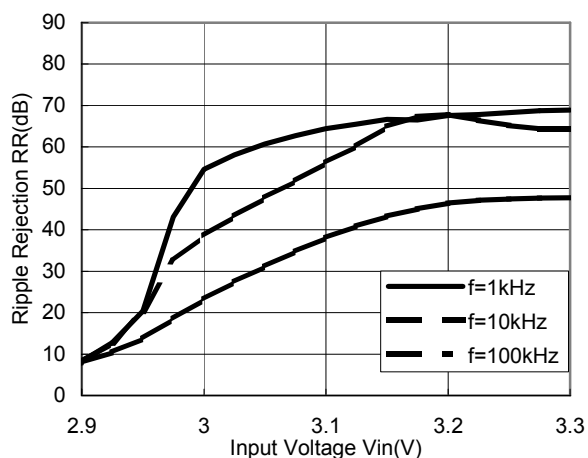
R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=30mA Ripple=0.2Vp-p



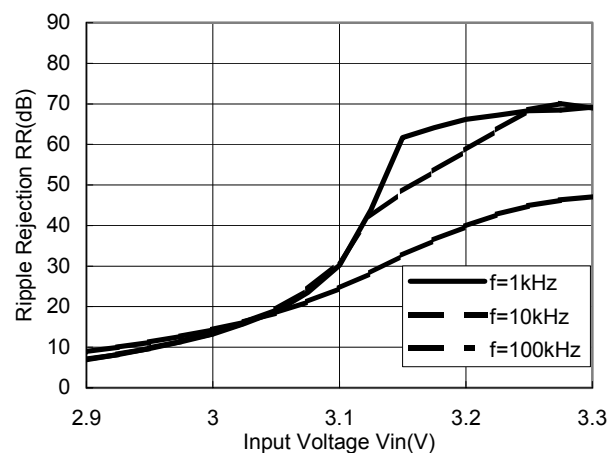
R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=30mA Ripple=0.5Vp-p



R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=50mA Ripple=0.2Vp-p



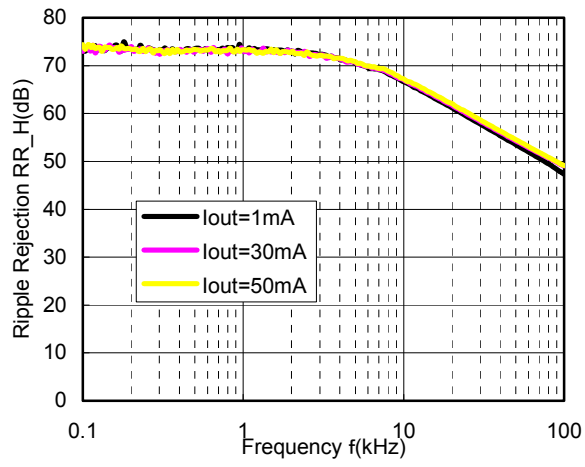
R1162X28X ECO=H, Cin=none, Cout=0.47uF, Iout=50mA Ripple=0.5Vp-p



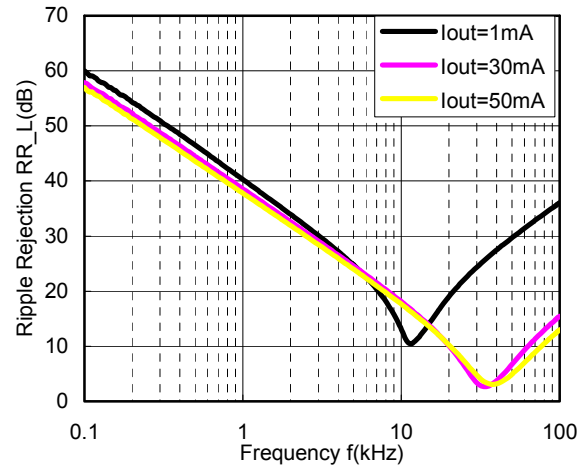
R1162x

9) Ripple Rejection vs. Frequency(Cin=none)

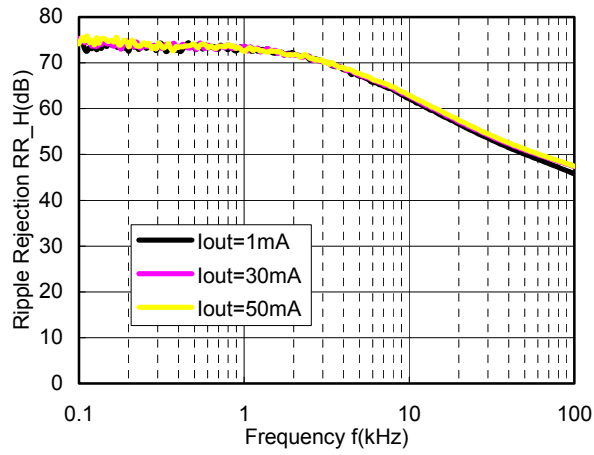
R1162X15X ECO=H Cout=0.47uF VIN=2.5VDC+0.2Vp-p



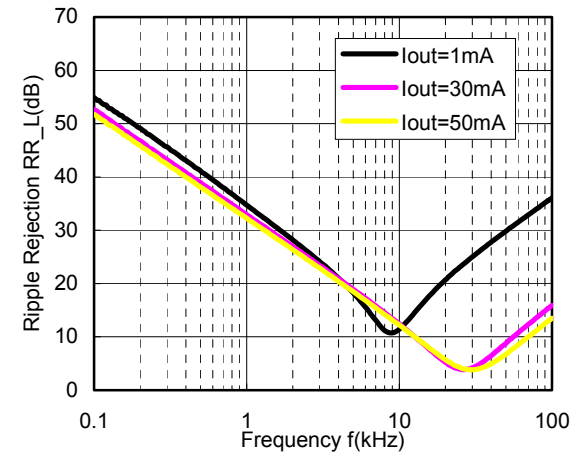
R1162X15X ECO=L Cout=0.47uF VIN=2.5VDC+0.2Vp-p



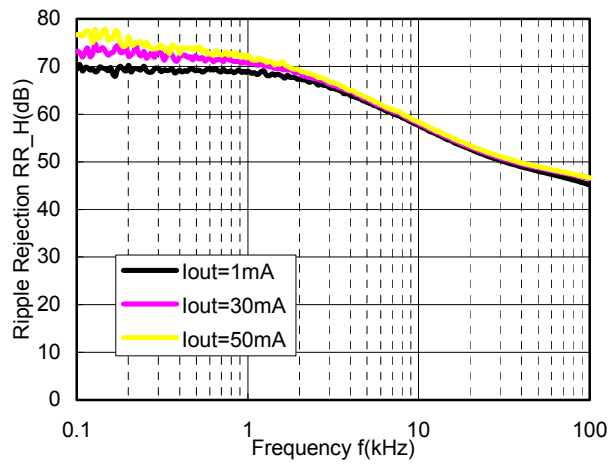
R1162X28X ECO=H Cout=0.47uF VIN=3.8VDC+0.2Vp-p



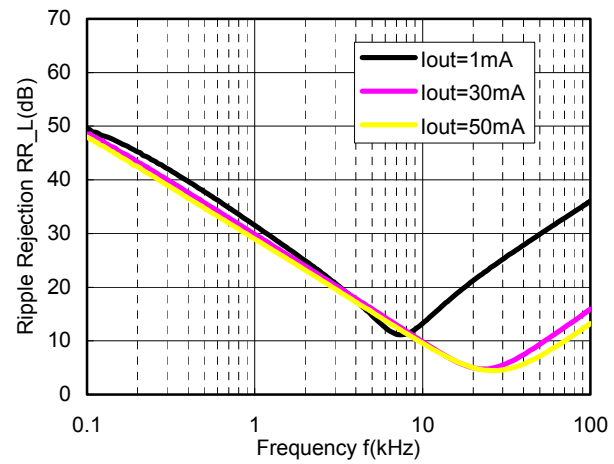
R1162X28X ECO=L Cout=0.47uF VIN=3.8VDC+0.2Vp-p



R1162X40X ECO=H Cout=0.47uF VIN=5.0VDC+0.2Vp-p

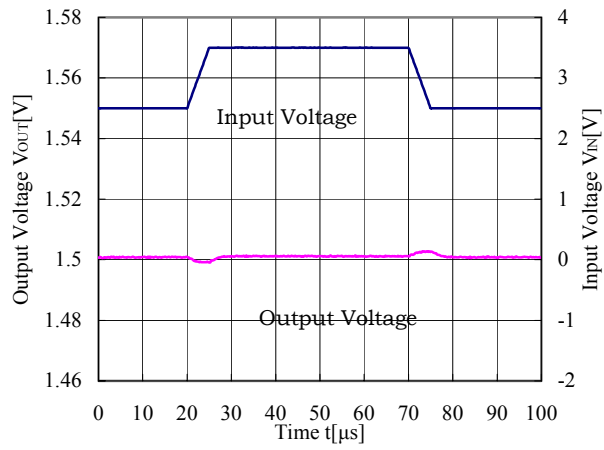


R1162X40X ECO=L Cout=0.47uF VIN=5.0VDC+0.2Vp-p

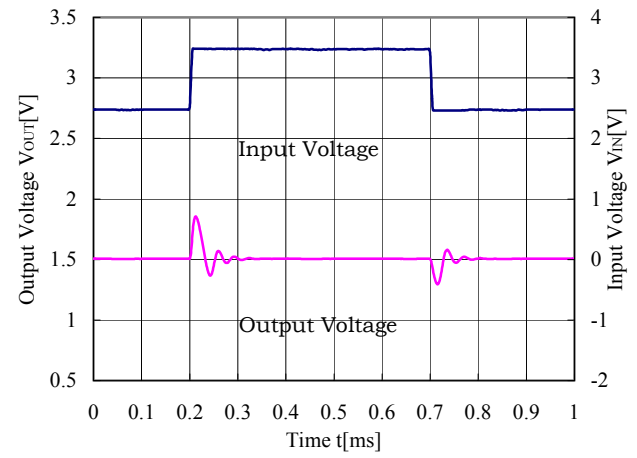


10) Input Transient Response

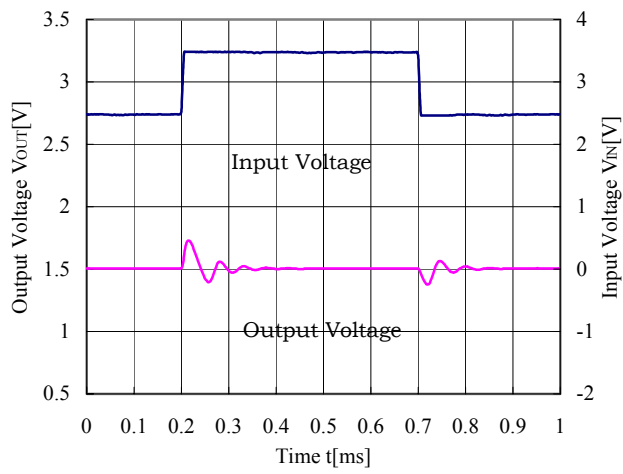
R1162X15X ECO=H, Cin=none, Cout=0.47uF, Iout=30mA



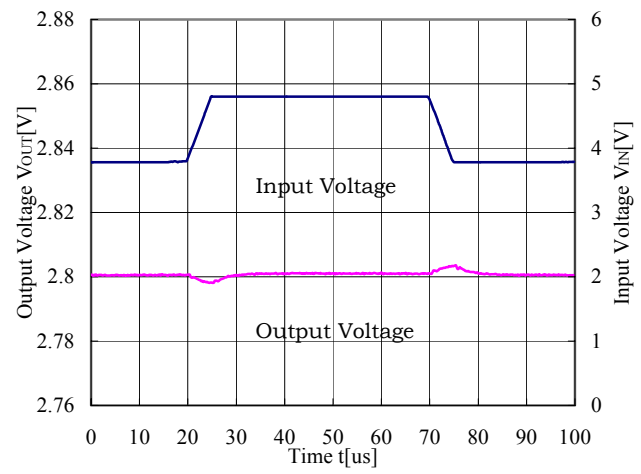
R1162X15X ECO=L, Cin=none, Cout=0.47uF, Iout=10mA



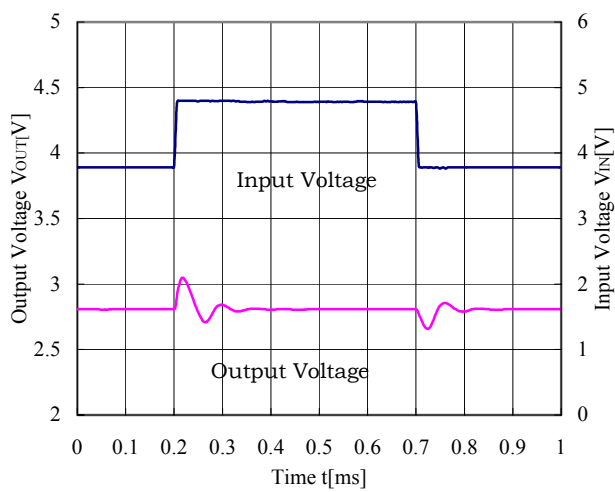
R1162X15X ECO=L, Cin=none, Cout=1uF, Iout=10mA



R1162X28X ECO=H, Cin=none, Cout=1uF, Iout=30mA



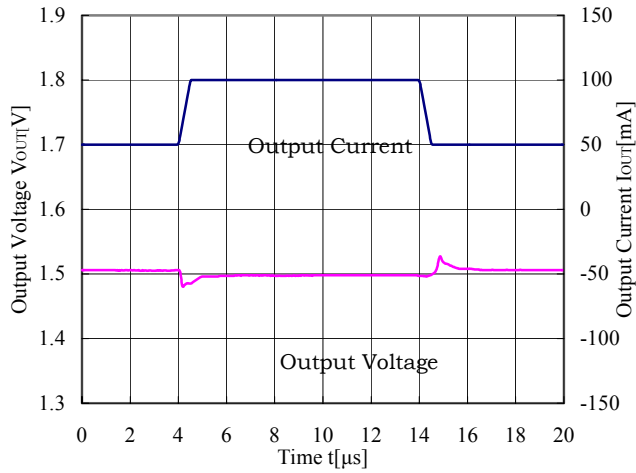
R1162X28X ECO=H, Cin=none, Cout=1uF, Iout=10mA



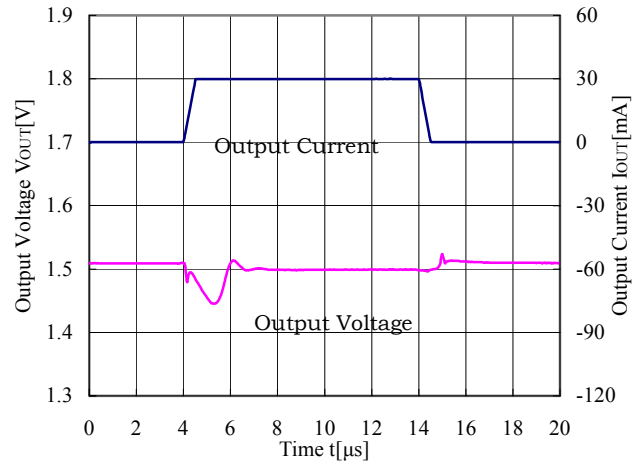
R1162x

11) Load Transient Response

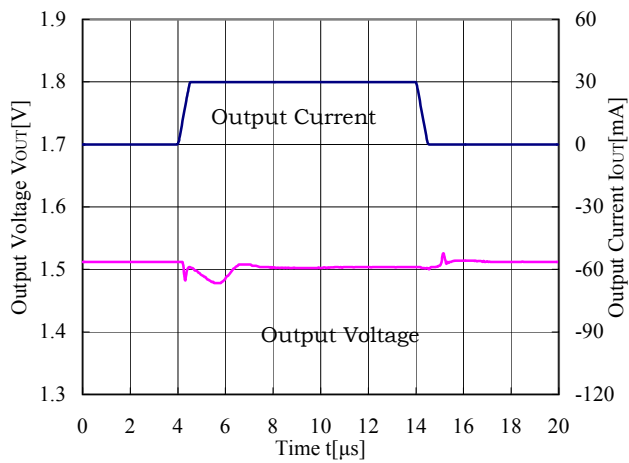
R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$



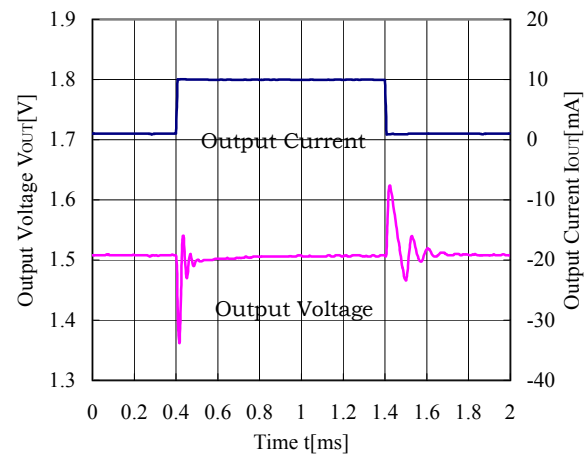
R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$



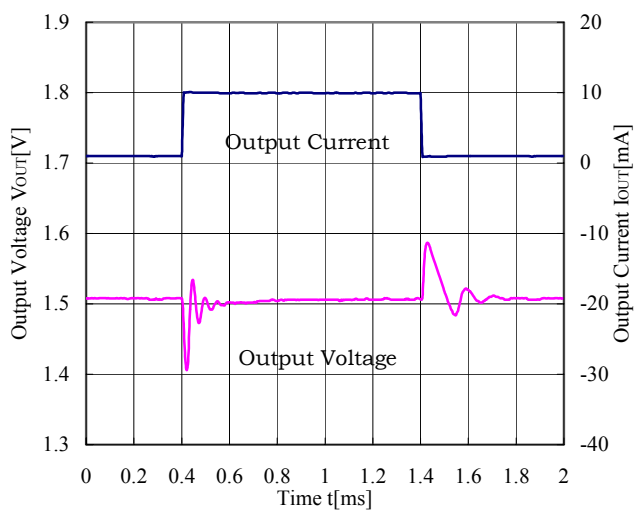
R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=1\mu F$



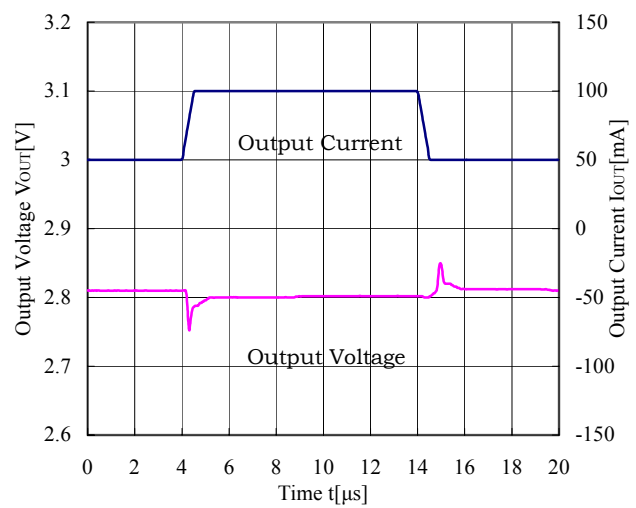
R1162X15X ECO=L, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$



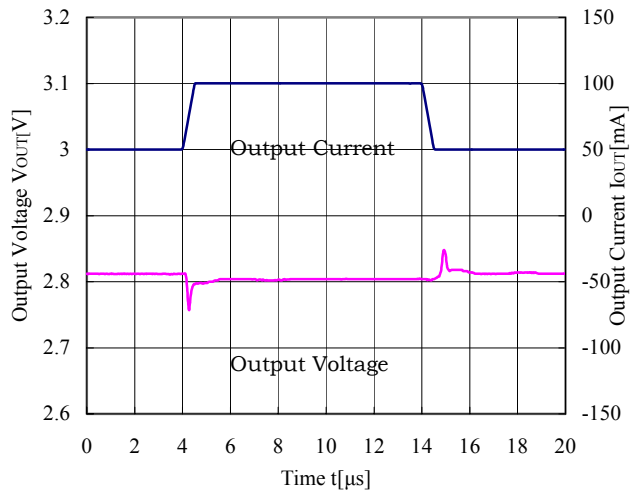
R1162X15X ECO=L, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=1\mu F$



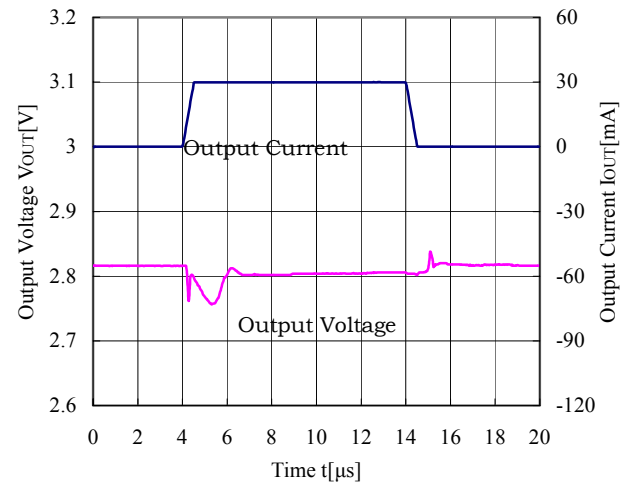
R1162X28X ECO=H, $V_{in}=3.8V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$



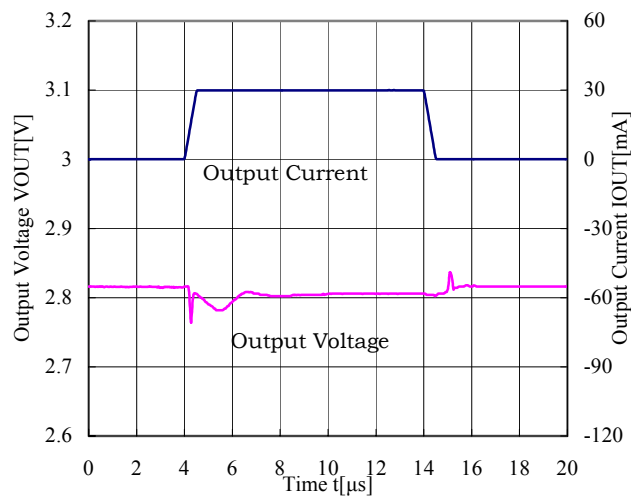
R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=1uF



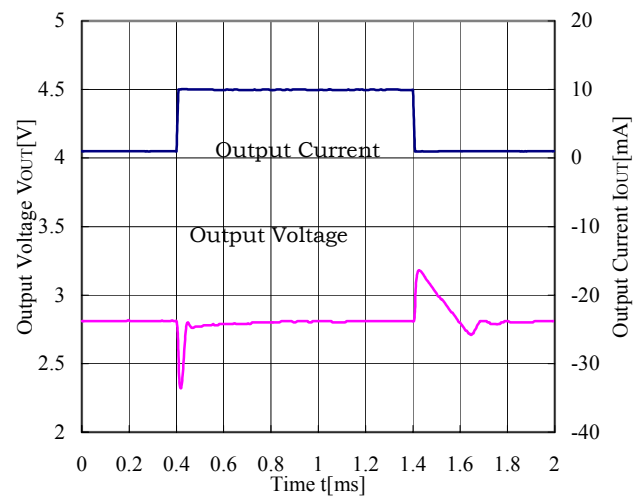
R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=0.47uF



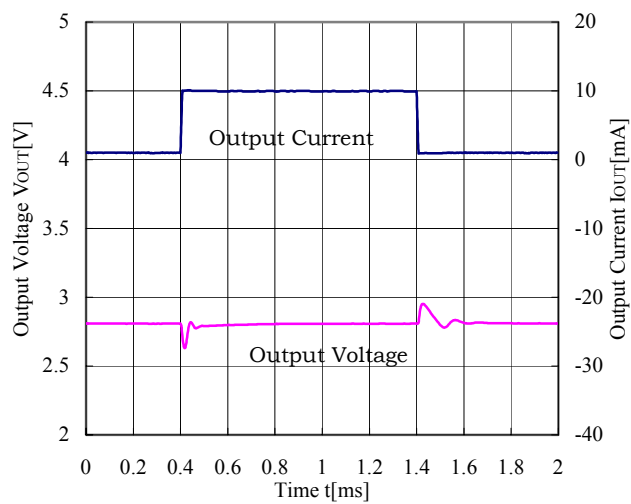
R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=1uF



R1162X28X ECO=L, Vin=3.8V, Cin=1uF, Cout=0.47uF

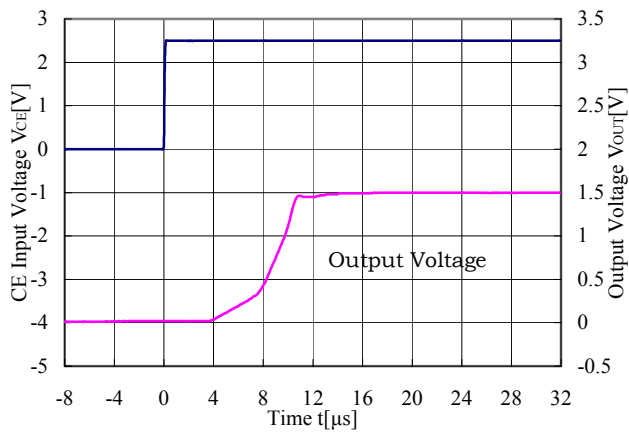
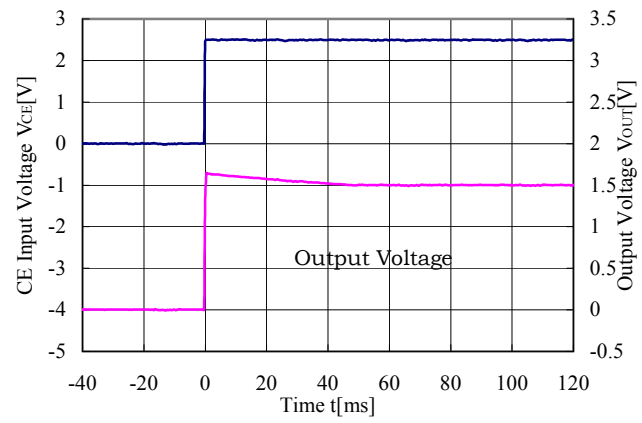
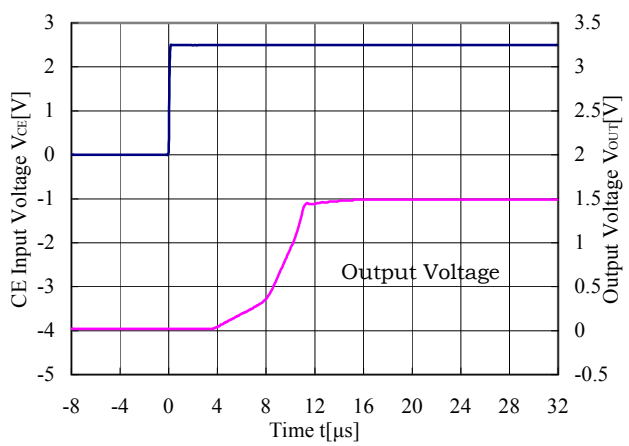
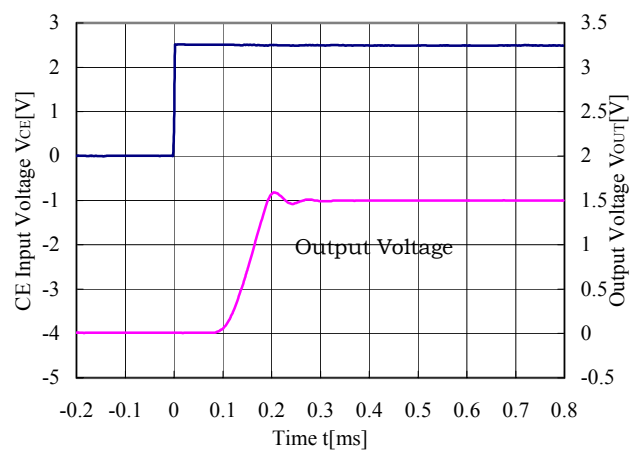
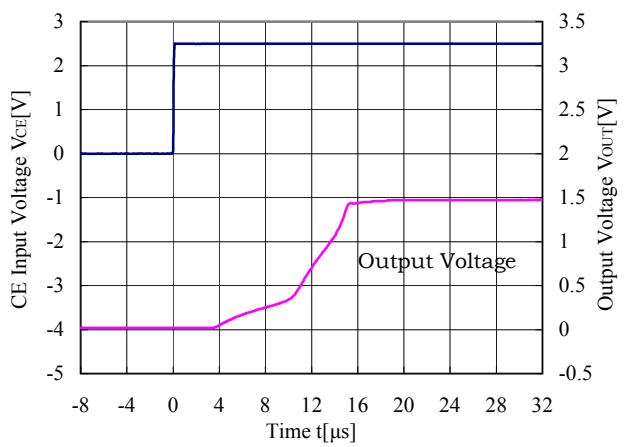
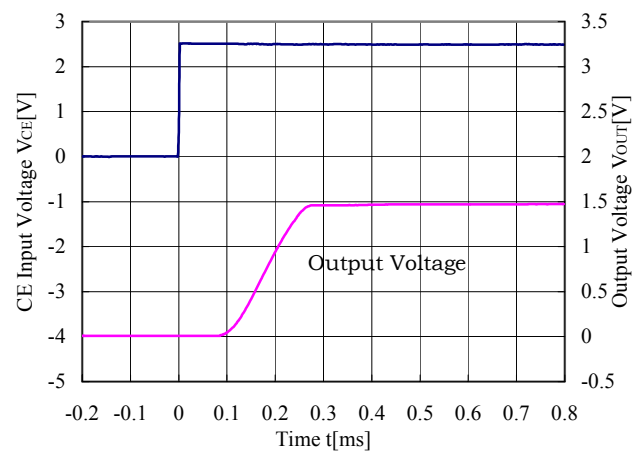


R1162X28X ECO=L, Vin=3.8V, Cin=1uF, Cout=1uF

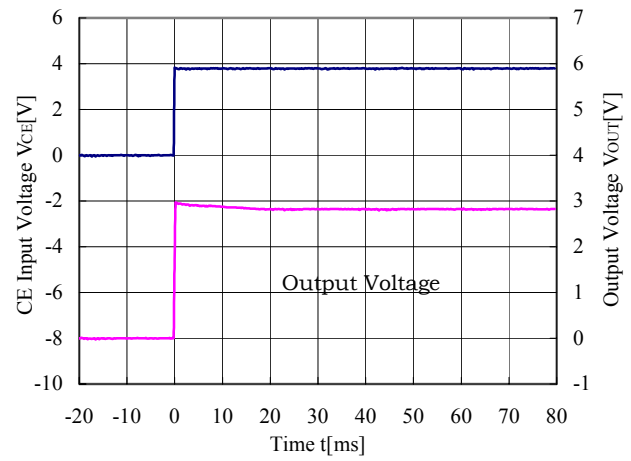
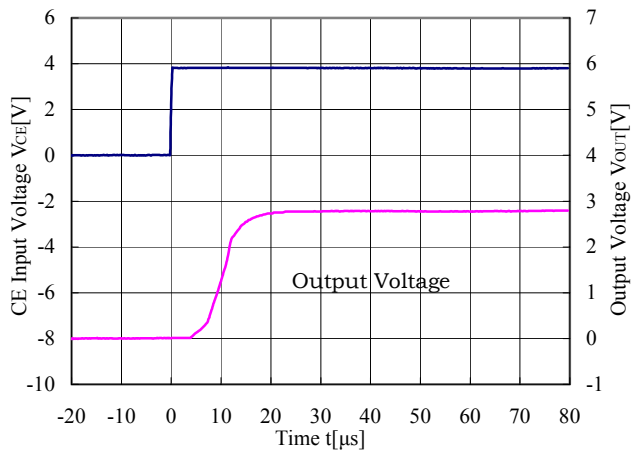


R1162x

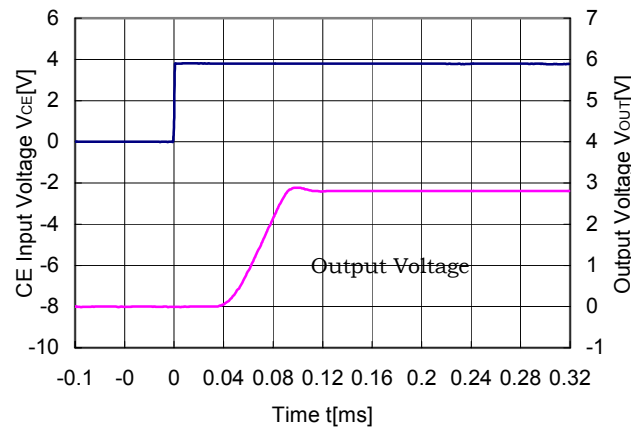
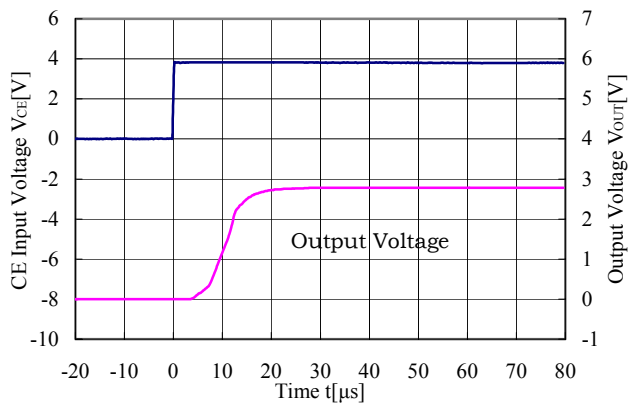
12) Turn on speed with CE pin

R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=0mA$ R1162X15X ECO=L, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=0mA$ R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=30mA$ R1162X15X ECO=L, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=30mA$ R1162X15X ECO=H, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=150mA$ R1162X15X ECO=L, $V_{in}=2.5V$, $C_{in}=1\mu F$, $C_{out}=0.47\mu F$, $I_{out}=150mA$ 

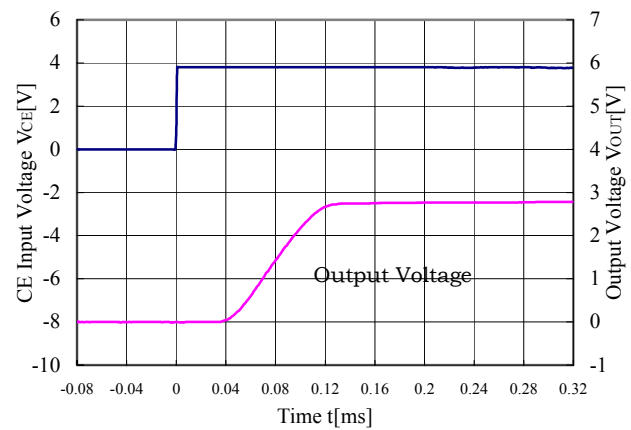
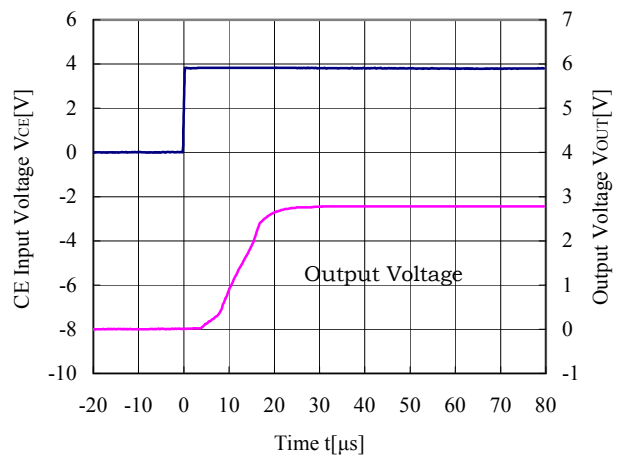
R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=0mA R1162X28X ECO=L, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=0mA



R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=30mA R1162X28X ECO=L, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=30mA

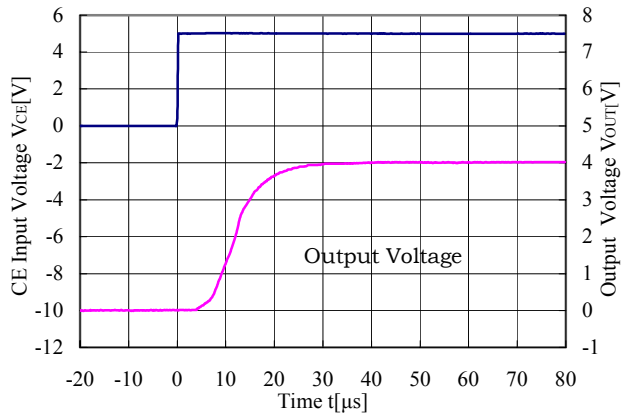


R1162X28X ECO=H, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=150mA R1162X28X ECO=L, Vin=3.8V, Cin=1uF, Cout=0.47uF, Iout=150mA

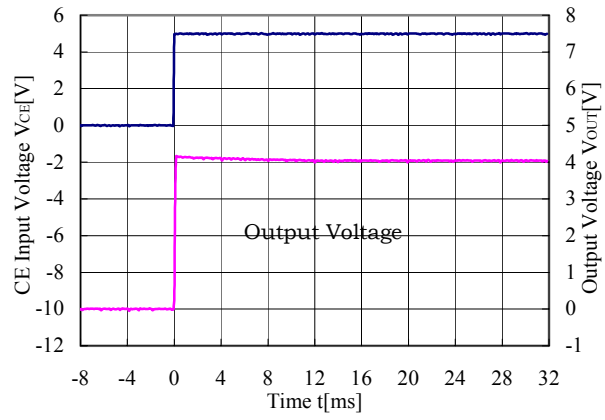


R1162x

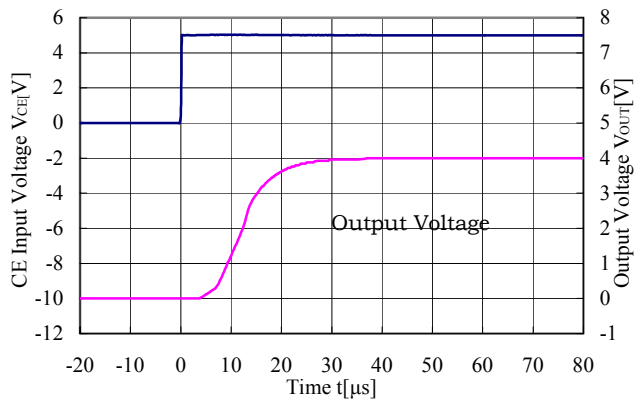
R1162X40X ECO=H, Vin=5.0V, Cin=1uF
Cout=0.47uF, Iout=0mA



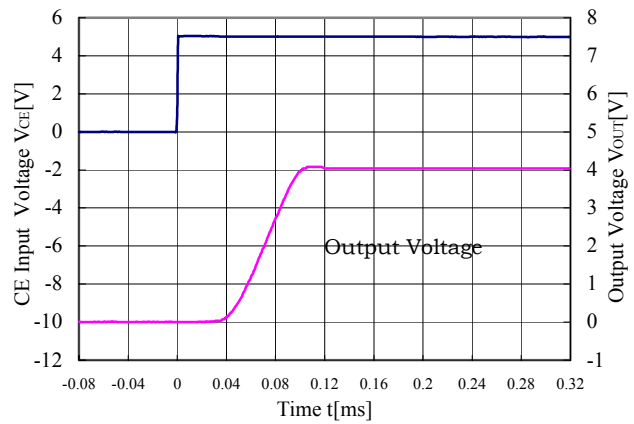
R1162X40X ECO=L, Vin=5.0V, Cin=1uF
Cout=0.47uF, Iout=0mA



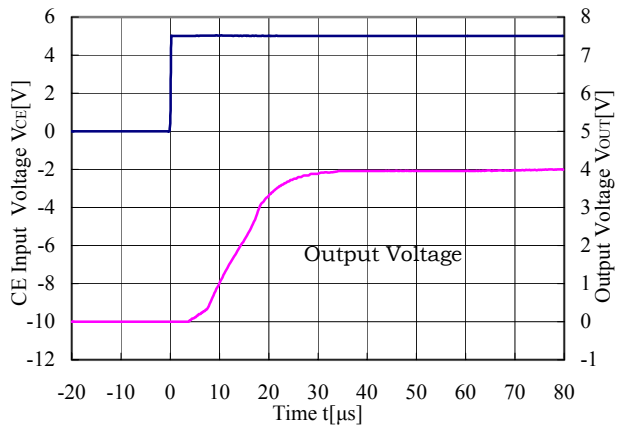
R1162X40X ECO=H, Vin=5.0V, Cin=1uF,
Cout=0.47uF, Iout=30mA



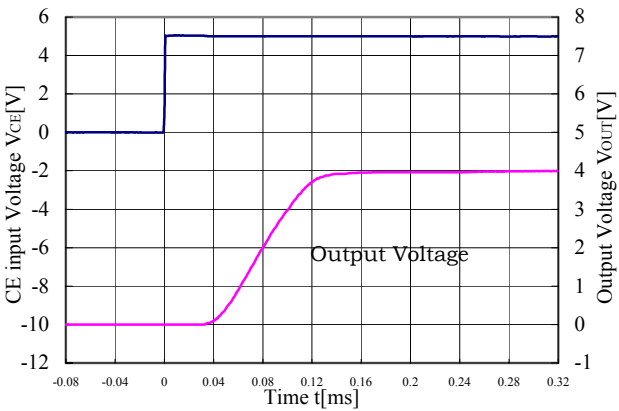
R1162X40X ECO=L, Vin=5.0V, Cin=1uF,
Cout=0.47uF, Iout=30mA



R1162X40X ECO=H, Vin=5.0V, Cin=1uF,
Cout=0.47uF, Iout=150mA

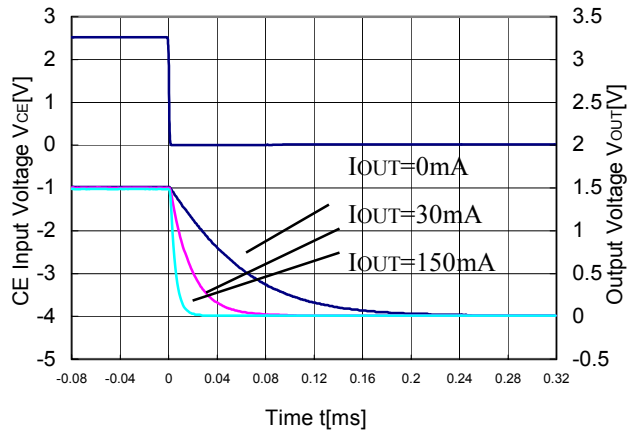


R1162X40X ECO=L, Vin=5.0V, Cin=1uF,
Cout=0.47uF, Iout=150mA

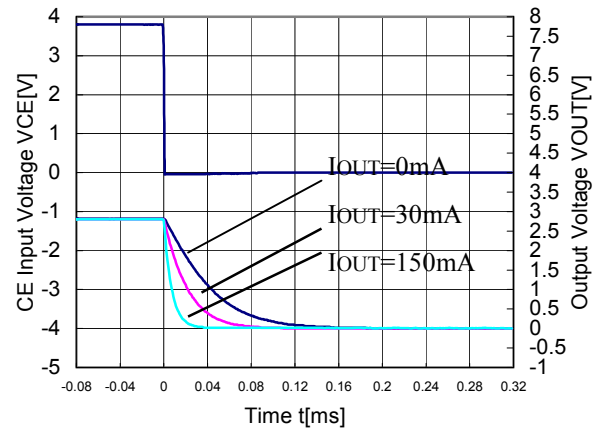


13) Turn off speed with CE pin

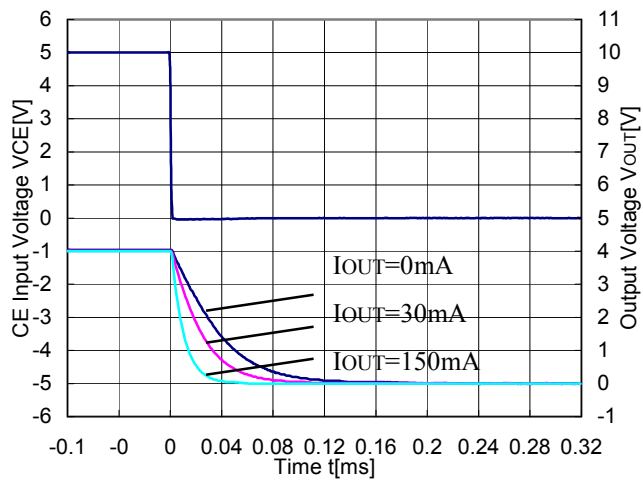
R1162X15XD Vin=2.5V, Cin=1uF, Cout=0.47uF



R1162X28XD Vin=3.8V, Cin=1uF, Cout=0.47uF

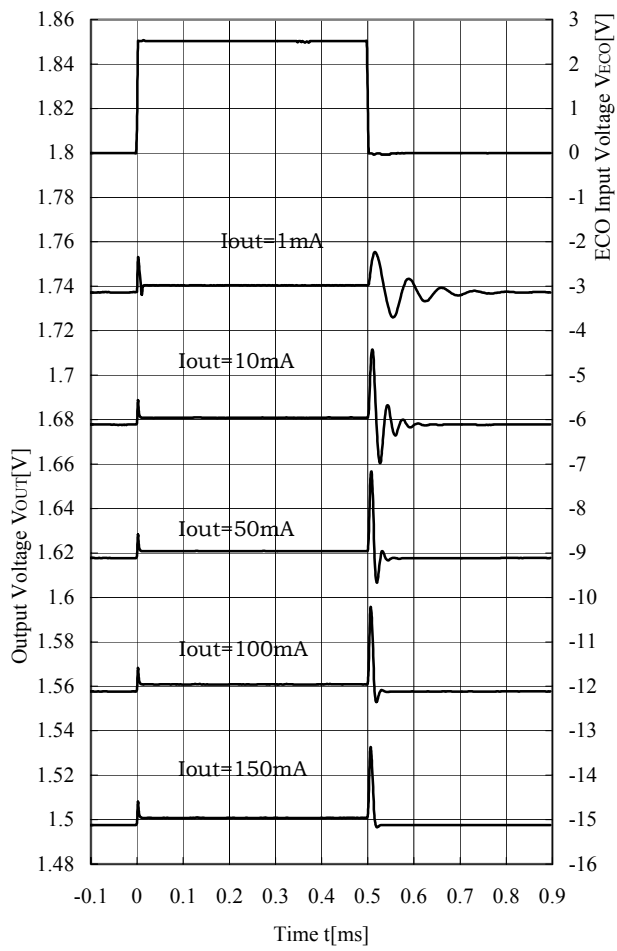


R1162X40XD Vin=5.0V, Cin=1uF, Cout=0.47uF

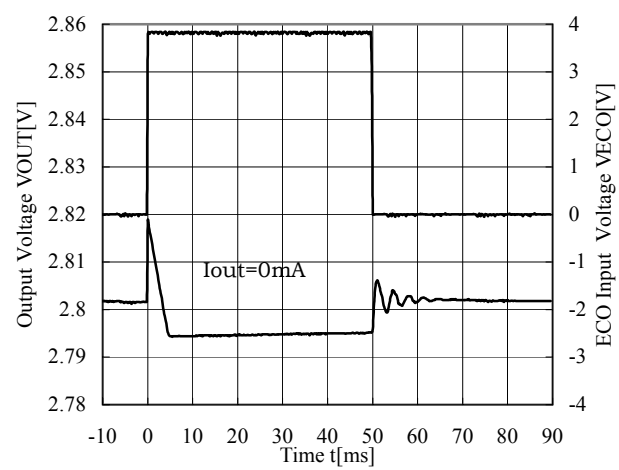
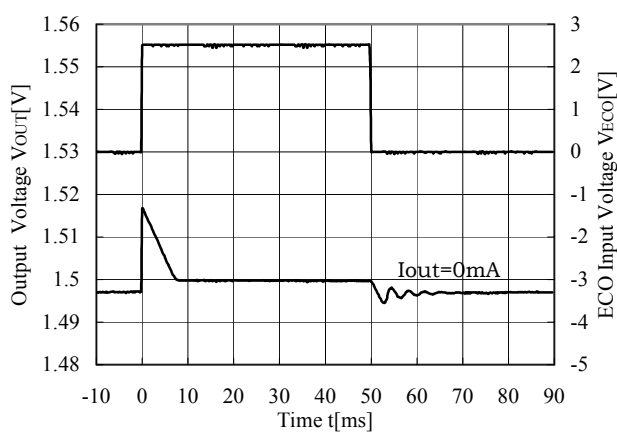
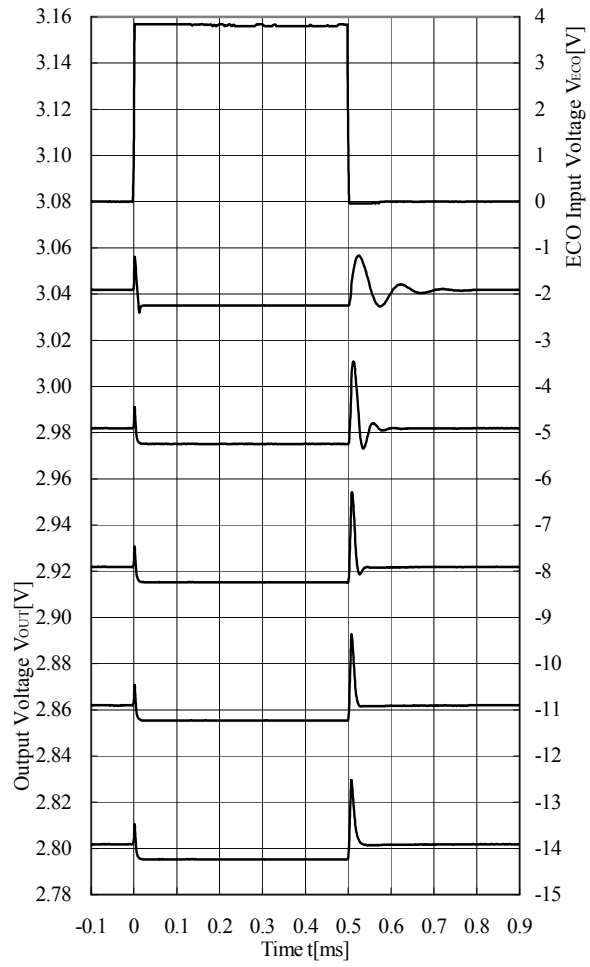


14) Output Voltage at Mode alternative point

R1162X15X Vin=2.5V, Cin= 1.0uF, Cout= 0.47uF



R1162X28X Vin=3.8V, Cin= 1.0uF, Cout= 0.47uF



TECHNICAL NOTES

When using these ICs, consider the following points:

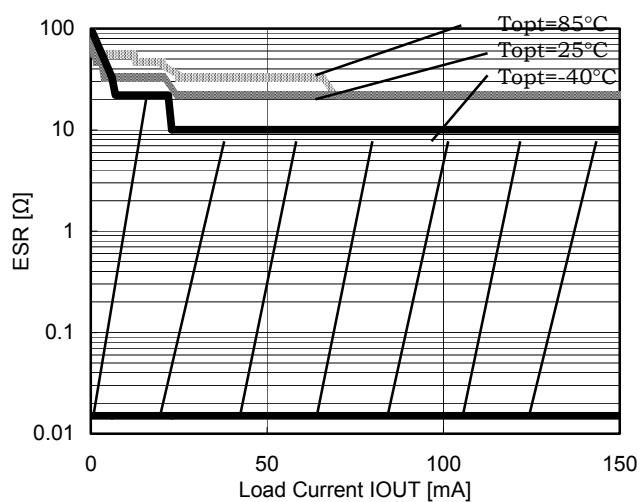
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance) in the range described as follows:

The relations between I_{OUT} (Output Current) and ESR of Output Capacitor are shown below. The conditions when the white noise level is under $40\mu V$ (Avg.) are marked as the hatched area in the graph.

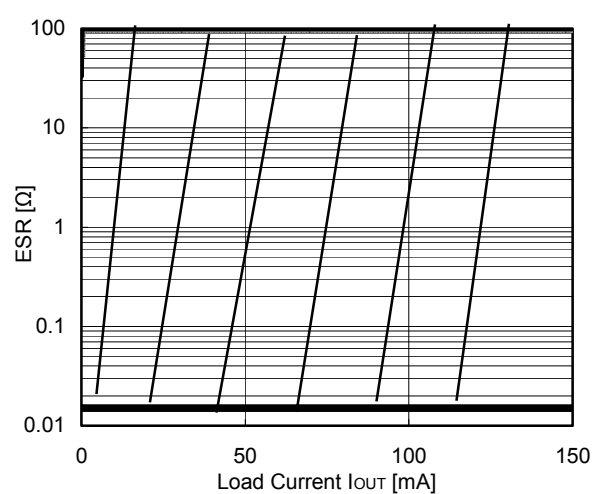
<Test conditions>

(1) Frequency band: 10Hz to 2MHz

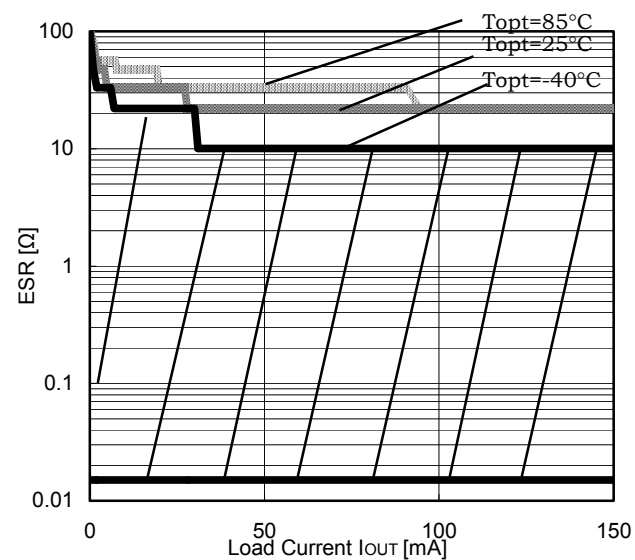
R1162X15X ECO=H $V_{in}=2.0V$ to $6.0V$, $C_{in}=1\mu F$
 $C_{out}=0.47\mu F$



R1162X15X ECO=L $V_{in}=2.0V$ to $6.0V$, $C_{in}=1\mu F$
 $C_{out}=0.47\mu F$



R1162X28X ECO=H $V_{in}=3.1V$ to $6.0V$, $C_{in}=1\mu F$
 $C_{out}=0.47\mu F$



R1162X28X ECO=L $V_{in}=3.1V$ to $6.0V$, $C_{in}=1\mu F$
 $C_{out}=0.47\mu F$

