

TRIPLE LDO

NO. EA-099-081006

OUTLINE

The R5324x Series are CMOS-based multi positive voltage regulator ICs with high output voltage accuracy, low supply current, low noise, low dropout and high ripple rejection. The R5324x Series contain three voltage regulators. Each of these voltage regulators in the R5324x Series consists of a voltage reference unit, an error amplifier, resistors for setting output voltage, a short current limit circuit, a chip enable circuit, and so on.

The chip enable function contributes to prolong battery life. Further, regulators in the R5324x Series are with low dropout voltage, excellent load transient response and line transient response, thus the R5324x series are very suitable for the power supply for hand-held communication equipment.

Since the packages for these ICs are SON-8 and DFN(PLP)2527-10, high density mounting of the ICs on boards is possible.

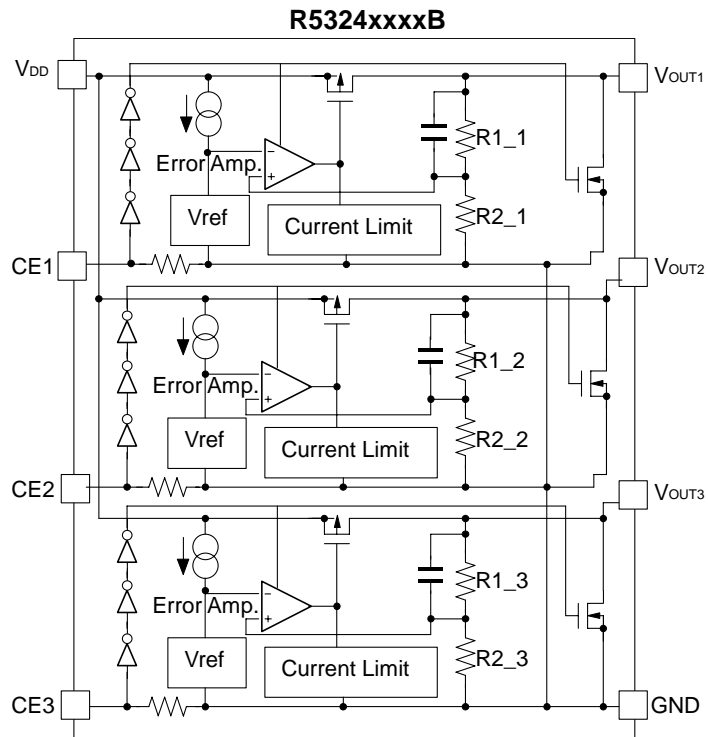
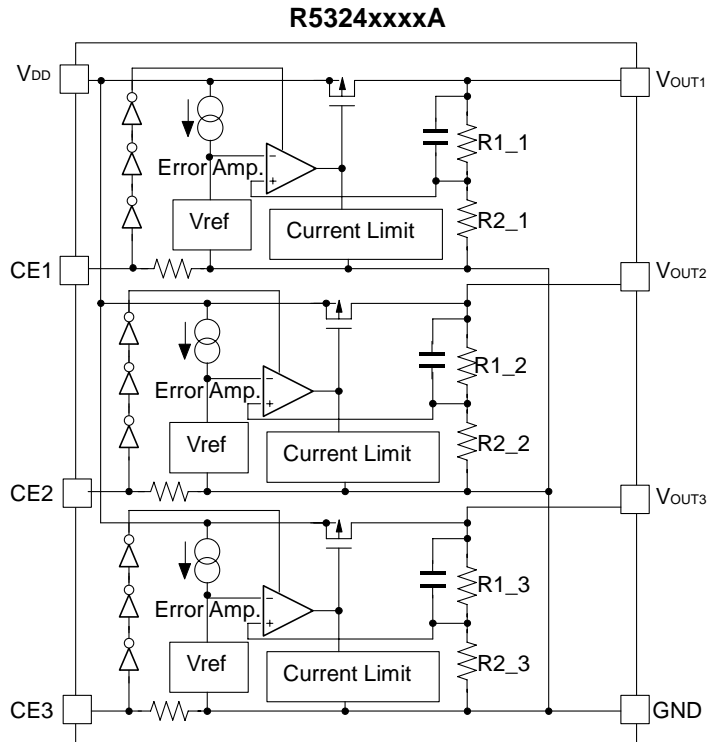
FEATURES

- Supply Current Typ. 90 μ A (VR1, VR2, VR3)
- Standby Current Typ. 0.1 μ A
- Output Current Min. 200mA (VR1), 150mA (VR2), 100mA (VR3)
- Dropout Voltage Typ. 0.23V (VR1) ($I_{OUT}=200mA$, $V_{OUT}=2.8V$)
Typ. 0.22V (VR2) ($I_{OUT}=150mA$, $V_{OUT}=2.8V$)
Typ. 0.15V (VR3) ($I_{OUT}=100mA$, $V_{OUT}=2.8V$)
- Ripple Rejection Typ. 70dB (f=1kHz), Typ. 65dB (f=10kHz)
- Input Voltage Range 2.0V to 6.0V
- Output Voltage Range 1.5V to 4.0V
- Output Voltage Accuracy $\pm 2.0\%$
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100ppm/^{\circ}C$
- Line Regulation Typ. 0.02%/V
- Packages SON-8, DFN(PLP)2527-10
- Built-in fold-back protection circuit Typ. 50mA (VR1), Typ. 40mA (VR2, VR3)
(Current at short mode)
- Ceramic capacitors are recommended to be used with this IC 1.0 μ F or more

APPLICATIONS

- Power source for cellular phones and portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS



SELECTION GUIDE

The selection can be made with designating the part number as shown below:

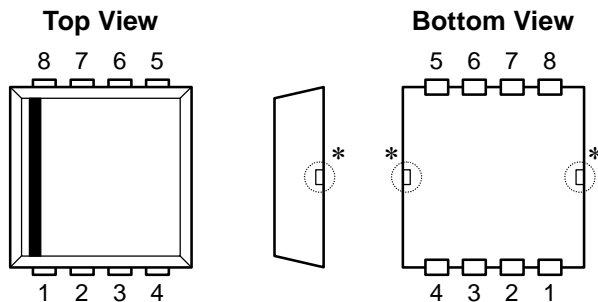
R5324xxxxx-xx-x ←Part Number
 ↑ ↑ ↑ ↑ ↑
 a b c d e

Code	Contents
a	Designation of Package Type: D: SON-8 K: DFN(PLP)2527-10
b	Setting Output Voltage (V_{OUT}): Serial Number for Voltage setting from 001 Stepwise setting with a step of 0.1V in the range of 1.5V to 4.0V is possible.
c	Designation of Mask Option A: active high, without auto discharge function* at OFF state. B: active high, with auto discharge function* at OFF state.
d	Designation of Taping Type: Ex. TR (Refer to Taping Specifications; TR type is the standard direction.)
e	Designation of composition of pin plating: -F : Lead free solder plating (SON-8) None : Au plating (DFN(PLP)2527-10)

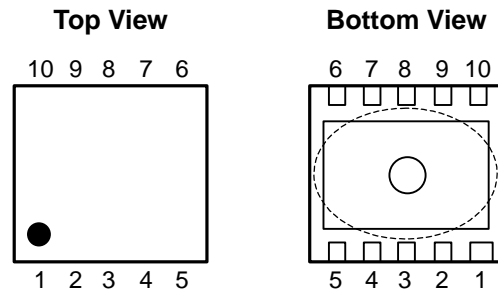
*) When the mode is into standby with CE signal, auto discharge transistor turns on, and it makes the turn-off speed faster than normal type.

PIN CONFIGURATIONS

• SON-8




• DFN (PLP) 2527-10



PIN DESCRIPTIONS


• SON-8

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	CE1	Chip Enable Pin 1
3	CE2	Chip Enable Pin 2
4	CE3	Chip Enable Pin 3
5	GND	Ground Pin
6	V_{OUT3}	Output Pin 3
7	V_{OUT2}	Output Pin 2
8	V_{OUT1}	Output Pin 1

*) Tab in the  parts have GND level. (They are connected to the back side of this IC.)
Do not connect to other wires or land patterns.

• DFN(PLP)2527-10

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	V_{DD}	Input Pin
3	CE1	Chip Enable Pin 1
4	CE2	Chip Enable Pin 2
5	CE3	Chip Enable Pin 3
6	GND	Ground Pin
7	NC	No Connection
8	V_{OUT3}	Output Pin 3
9	V_{OUT2}	Output Pin 2
10	V_{OUT1}	Output Pin 1

*) Tab in the  parts have GND level. (They are connected to the back side of this IC.)
Do not connect to other wires or land patterns.
Both V_{DD} pins must be connected each other at same level as short as possible.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
CE	Input Voltage (CE Pin)	-0.3 to 6.5	V
V_{OUT}	Output Voltage	-0.3 to $V_{IN}+0.3$	V
I_{OUT1}	Output Current (V_{OUT1})	230	mA
I_{OUT2}	Output Current (V_{OUT2})	180	mA
I_{OUT3}	Output Current (V_{OUT3})	180	mA
P_D	Power Dissipation (SON-8)*	480	mW
	Power Dissipation (DFN(PLP)2527-10)*	910	
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 125	°C

*) For Power Dissipation, please refer to PACKAGE INFORMATION to be described.

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.

ELECTRICAL CHARACTERISTICS

• R5324xxxxA/B

VR1

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{OUT}	Output Voltage	V _{IN} -V _{OUT} =1.0V 1mA ≤ I _{OUT} ≤ 30mA	×0.98		×1.02	V	
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	200			mA	
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} -V _{OUT} =1.0V, 1mA ≤ I _{OUT} ≤ 200mA		25	50	mV	
V _{DIF}	Dropout Voltage	I _{OUT} =200mA	V _{OUT} =1.5V		0.36	0.65	V
			V _{OUT} =1.6V		0.34	0.58	
			V _{OUT} =1.7V		0.33	0.56	
			1.8V ≤ V _{OUT} ≤ 2.0V		0.31	0.53	
			2.1V ≤ V _{OUT} ≤ 2.7V		0.28	0.46	
			2.8V ≤ V _{OUT} ≤ 4.0V		0.23	0.35	
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V		90	140	μA	
I _{standby}	Standby Current	V _{IN} -V _{OUT} =1.0V, V _{CE} =GND		0.1	1.0	μA	
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =30mA, V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V (V _{OUT} ≤ 1.6V: 2.2V ≤ V _{IN} ≤ 6.0V)		0.02	0.10	%/V	
RR	Ripple Rejection	sinusoidal Ripple 0.5Vp-p V _{IN} -V _{OUT} =1.0V, I _{OUT} =30mA *V _{OUT} ≤ 1.7V, V _{IN} -V _{OUT} =1.2V, I _{OUT} =30mA	f=1kHz		70	dB	
			f=10kHz		65		
			f=10kHz (V _{OUT} ≥ 2.5V)		60		
V _{IN}	Input Voltage		2		6	V	
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm /°C	
I _{lim}	Short Current Limit	V _{OUT} =0V		50		mA	
R _{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ	
V _{CEH}	CE Input Voltage "H"		1.5		6.0	V	
V _{CEL}	CE Input Voltage "L"		0		0.3	V	
en	Output Noise	BW=10Hz to 100kHz		30		μVrms	
R _{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V _{CE} =0V		50		Ω	

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.

VR2

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{OUT}	Output Voltage	V _{IN} -V _{OUT} =1.0V 1mA ≤ I _{OUT} ≤ 30mA	×0.98		×1.02	V	
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	150			mA	
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} -V _{OUT} =1.0V 1mA ≤ I _{OUT} ≤ 150mA		15	40	mV	
V _{DIF}	Dropout Voltage	I _{OUT} =150mA	V _{OUT} =1.5V		0.34	0.60	V
			V _{OUT} =1.6V		0.32	0.56	
			V _{OUT} =1.7V		0.31	0.53	
			1.8V ≤ V _{OUT} ≤ 2.0V		0.29	0.50	
			2.1V ≤ V _{OUT} ≤ 2.7V		0.26	0.44	
			2.8V ≤ V _{OUT} ≤ 4.0V		0.22	0.33	
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V		90	120	μA	
I _{standby}	Standby Current	V _{IN} -V _{OUT} =1.0V, V _{CE} =GND		0.1	1.0	μA	
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =30mA, V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V (V _{OUT} ≤ 1.6V: 2.2V ≤ V _{IN} ≤ 6.0V)		0.02	0.10	%/V	
RR	Ripple Rejection	sinusoidal Ripple 0.5Vp-p V _{IN} -V _{OUT} =1.0V, I _{OUT} =30mA *V _{OUT} ≤ 1.7V, V _{IN} -V _{OUT} =1.2V, I _{OUT} =30mA	f=1kHz		70	dB	
			f=10kHz		65		
			f=10kHz (V _{OUT} ≥ 2.5V)		60		
V _{IN}	Input Voltage		2		6	V	
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/°C	
I _{lim}	Short Current Limit	V _{OUT} =0V		40		mA	
R _{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ	
V _{CEH}	CE Input Voltage "H"		1.5		6.0	V	
V _{CEL}	CE Input Voltage "L"		0		0.3	V	
e _n	Output Noise	BW=10Hz to 100kHz		30		μVrms	
R _{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V _{CE} =0V		50		Ω	

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.

R5324x

VR3

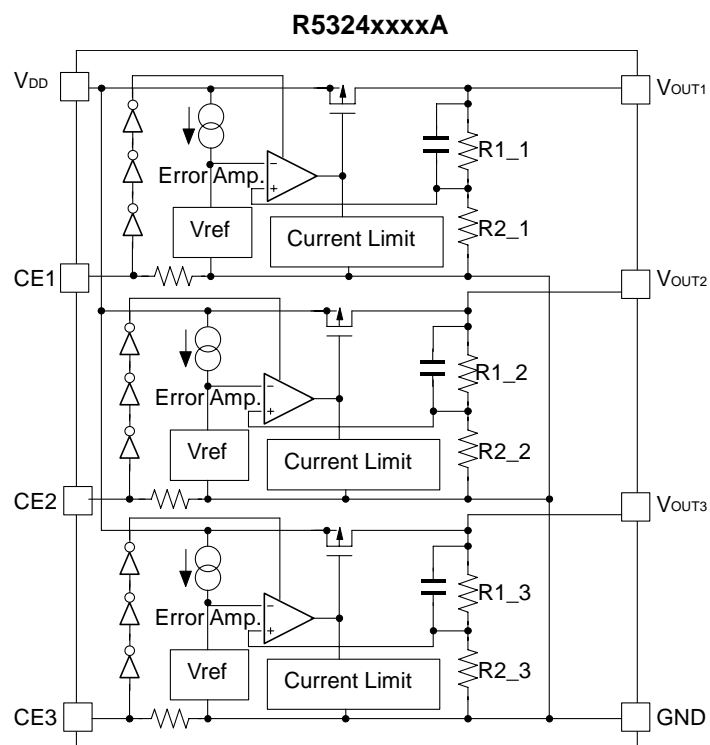
 T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{OUT}	Output Voltage	V _{IN} -V _{OUT} =1.0V 1mA ≤ I _{OUT} ≤ 30mA	×0.98		×1.02	V	
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V	100			mA	
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} -V _{OUT} =1.0V 1mA ≤ I _{OUT} ≤ 100mA		8	20	mV	
V _{DIF}	Dropout Voltage	I _{OUT} =100mA	V _{OUT} =1.5V		0.24	0.44	V
			V _{OUT} =1.6V		0.22	0.40	
			V _{OUT} =1.7V		0.21	0.38	
			1.8V ≤ V _{OUT} ≤ 2.0V		0.20	0.37	
			2.1V ≤ V _{OUT} ≤ 2.7V		0.18	0.33	
			2.8V ≤ V _{OUT} ≤ 4.0V		0.15	0.25	
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V		90	120	μA	
I _{standby}	Standby Current	V _{IN} -V _{OUT} =1.0V, V _{CE} =GND		0.1	1.0	μA	
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =30mA, V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V (V _{OUT} ≤ 1.6V: 2.2V ≤ V _{IN} ≤ 6.0V)		0.02	0.10	%/V	
RR	Ripple Rejection	sinusoidal Ripple 0.5Vp-p V _{IN} -V _{OUT} =1.0V, I _{OUT} =30mA *V _{OUT} ≤ 1.7V, V _{IN} -V _{OUT} =1.2V, I _{OUT} =30mA	f=1kHz		70		dB
			f=10kHz		65		
			f=10kHz (V _{OUT} ≥ 2.5V)		60		
V _{IN}	Input Voltage		2		6	V	
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =30mA -40°C ≤ T _{opt} ≤ 85°C		±100		ppm /°C	
I _{lim}	Short Current Limit	V _{OUT} =0V		40		mA	
R _{PD}	CE Pull-down Resistance		0.7	2.0	5.0	MΩ	
V _{CEH}	CE Input Voltage "H"		1.5		6.0	V	
V _{CEL}	CE Input Voltage "L"		0		0.3	V	
e _n	Output Noise	BW=10Hz to 100kHz		30		μVrms	
R _{LOW}	On Resistance of Nch Tr. for Auto-discharge (Applied to B version)	V _{CE} =0V		50		Ω	

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.

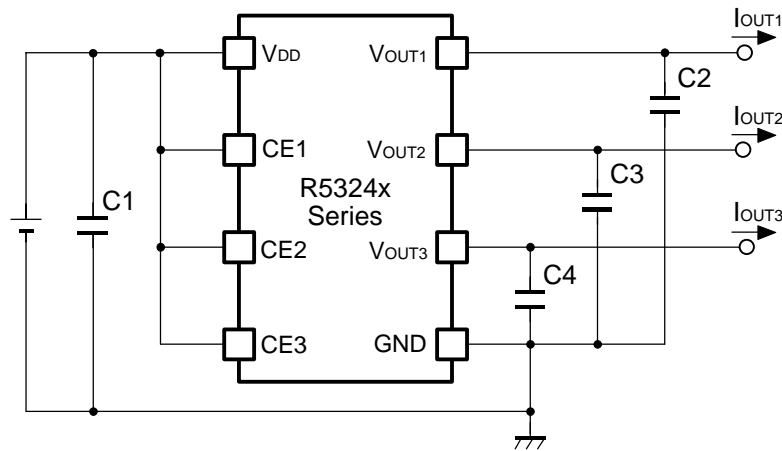
OPERATION



Fluctuation of each regulator's output voltage, or V_{OUT1} , V_{OUT2} , V_{OUT3} is detected individually. Then it is put back to an error amplifier through feedback resistors, or R1_1, R2_1, R1_2, R2_2, R1_3, R2_3 and compared with a reference voltage and compensated for the result and make a constant voltage.

In each regulator, short protection is made with a current limit circuit and stand-by mode is available by a chip enable circuit.

TYPICAL APPLICATION



(External Components)

Output Capacitor : Ceramic 1.0 μ F or more

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, use a capacitor C2, C3 and C4 with 1.0 μ F or more.

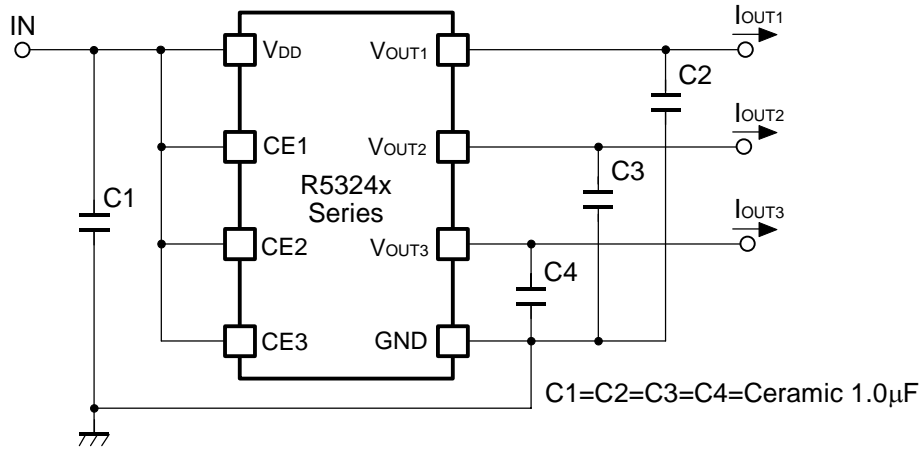
If a tantalum capacitor is used, and its ESR (Equivalent Series Resistance) of C2, C3 and C4 is large, the loop oscillation may result. Because of this, select C2, C3 and C4 carefully considering its frequency characteristics.

PCB Layout

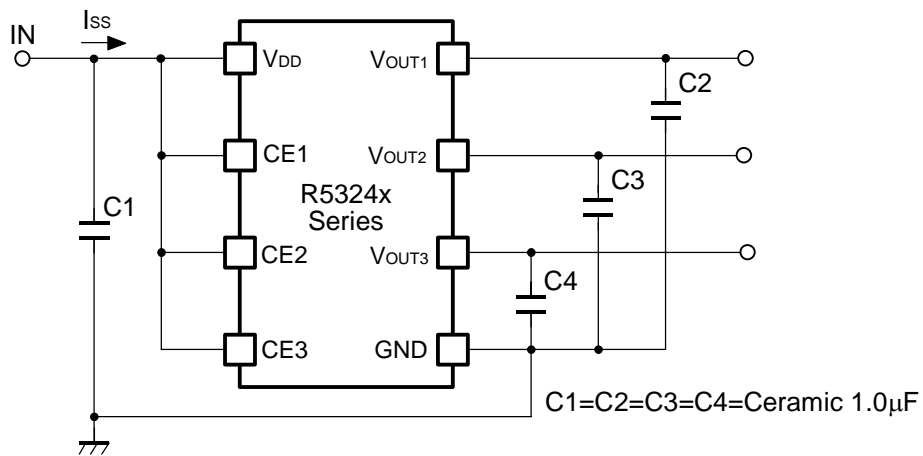
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 1.0 μ F or more between V_{DD} and GND pin, and as close as possible to the pins.

Set external components, especially the output capacitor C2, C3 and C4 as close as possible to the ICs, and make wiring as short as possible.

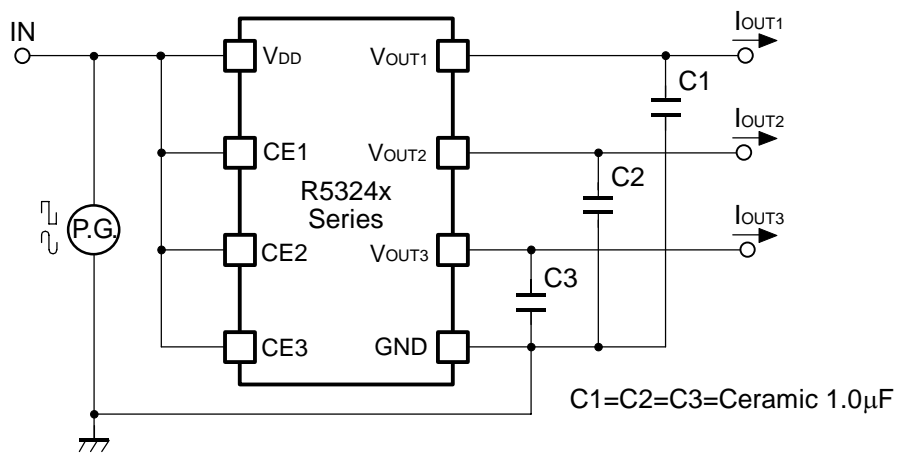
TEST CIRCUIT



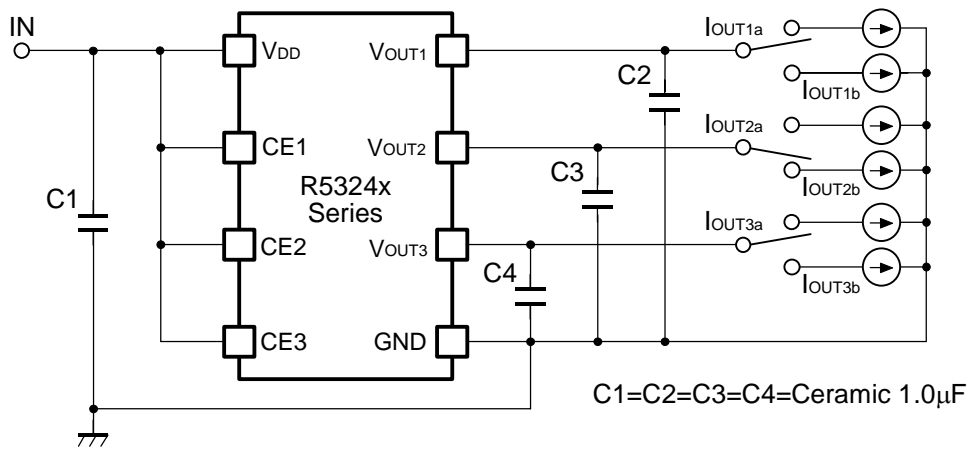
Basic Test Circuit



Test Circuit for Supply Current



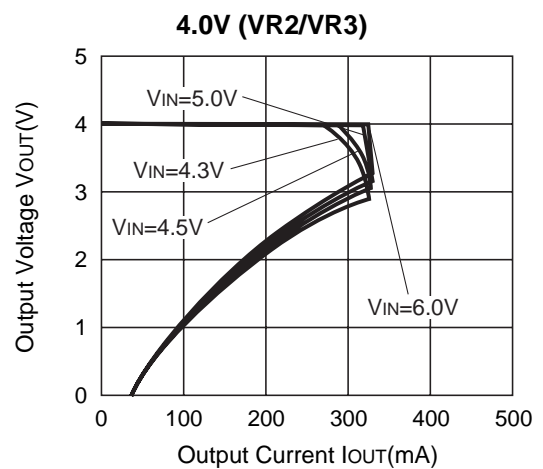
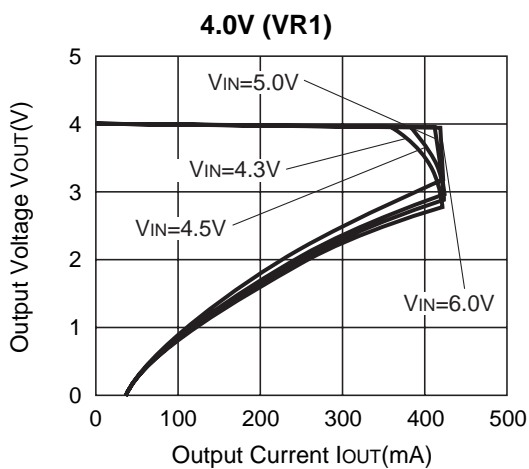
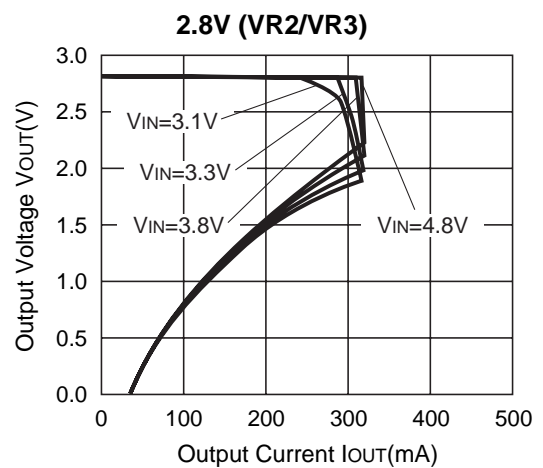
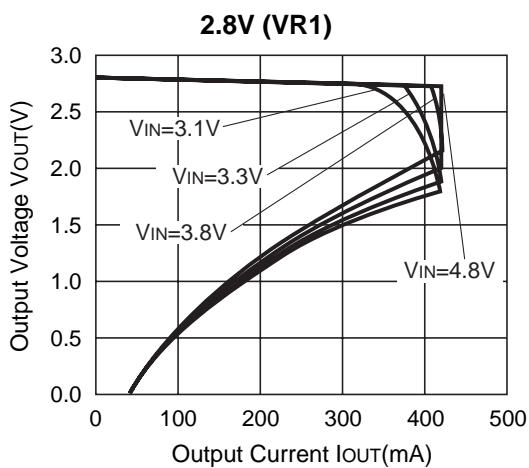
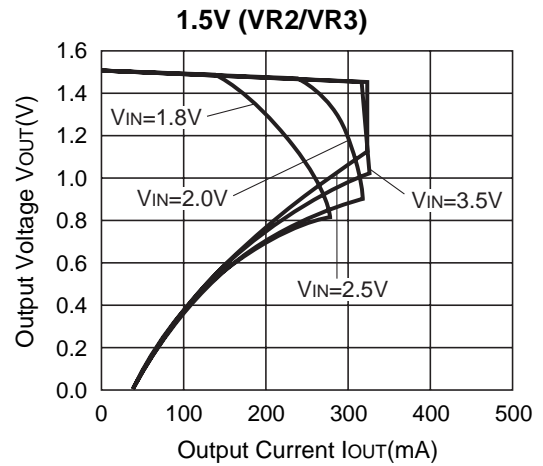
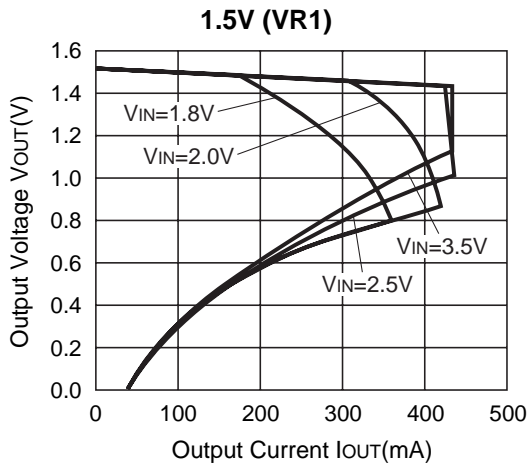
Test Circuit for Ripple Rejection, Input Transient Response



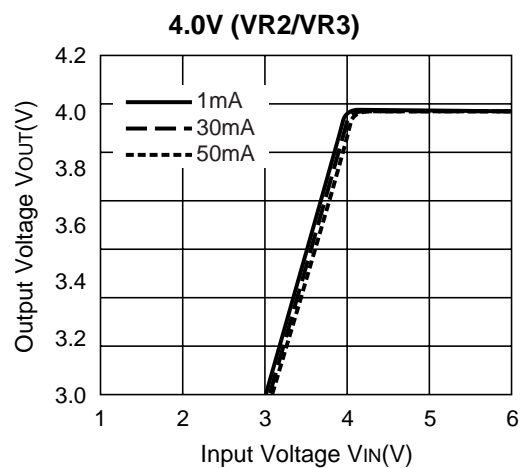
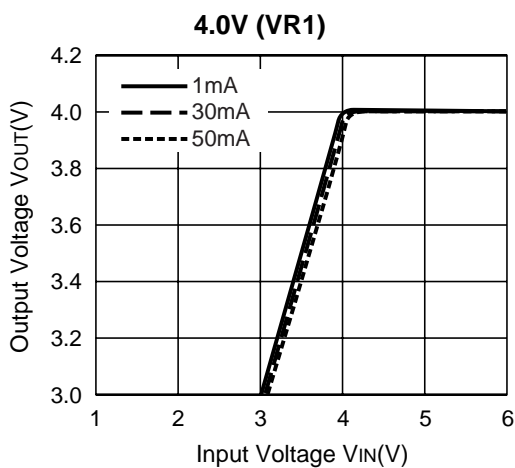
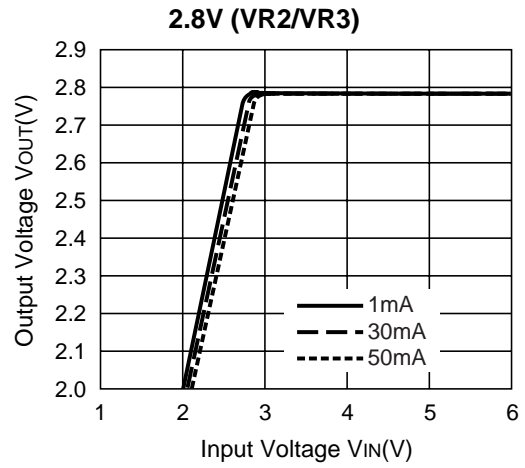
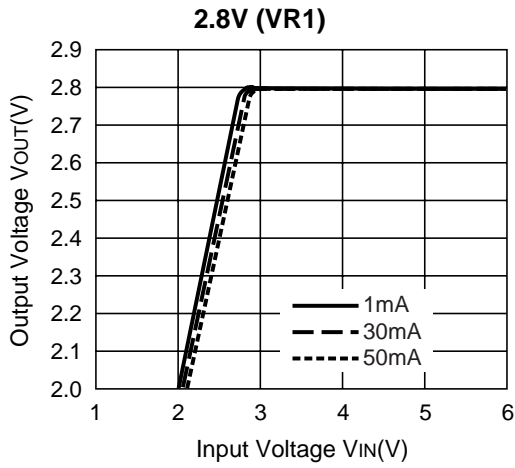
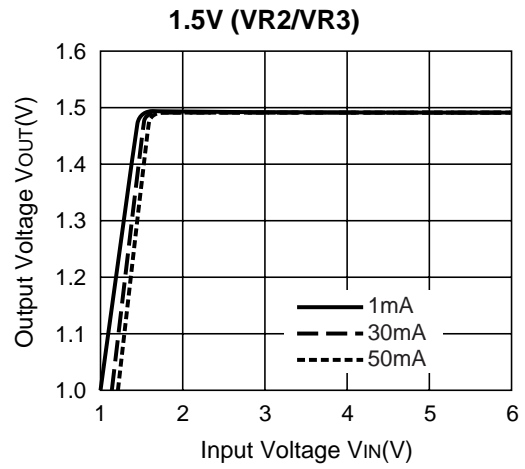
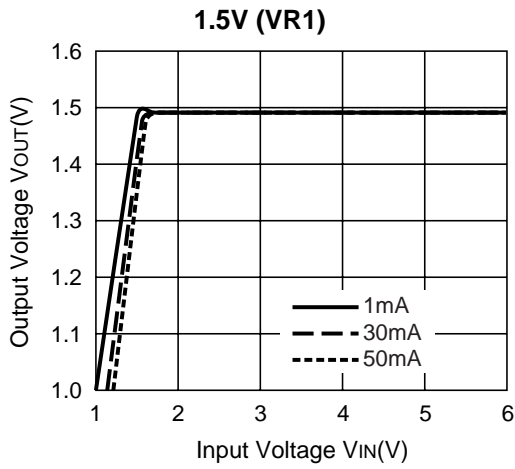
Test Circuit for Load Transient Response

TYPICAL CHARACTERISTICS

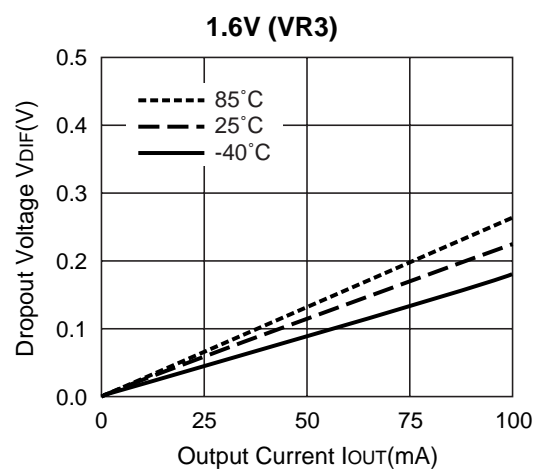
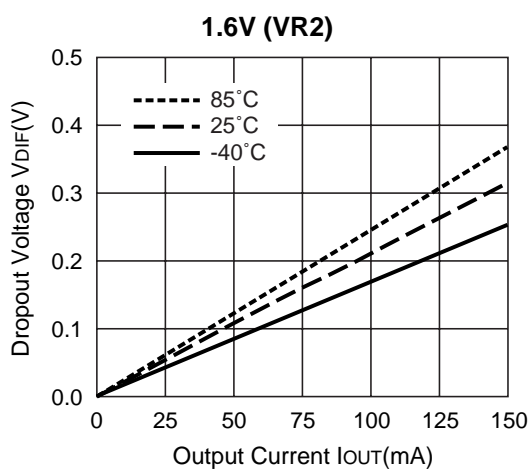
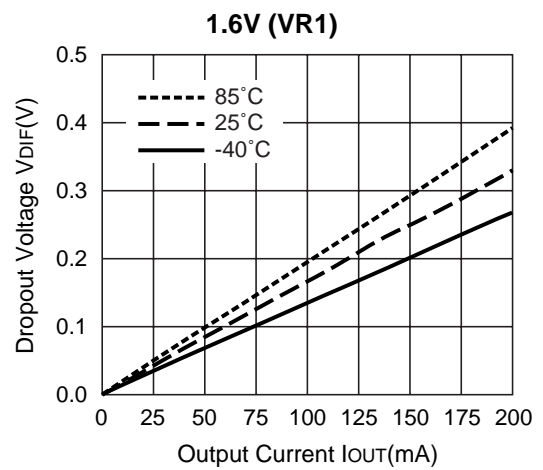
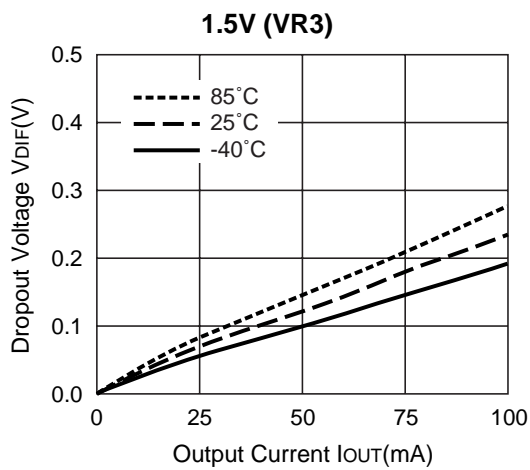
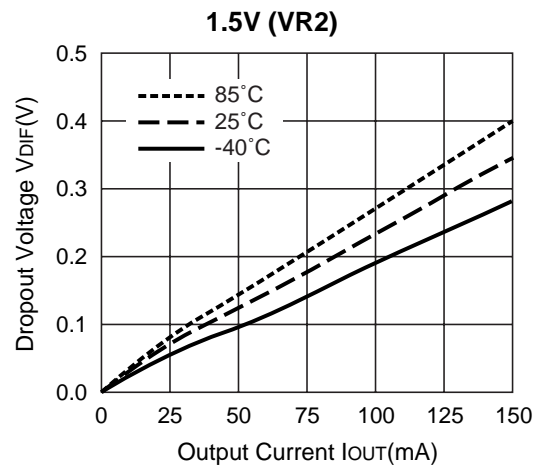
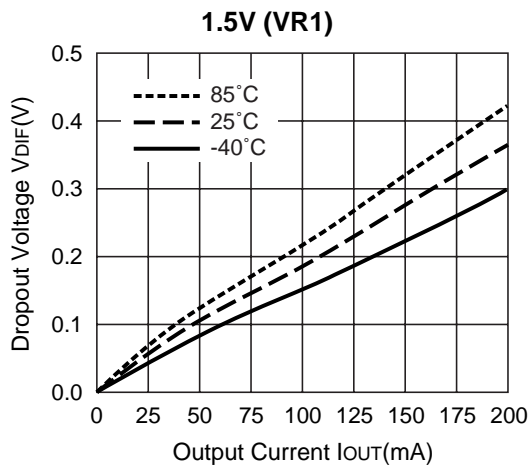
1) Output Voltage vs. Output Current (Topt=25°C)

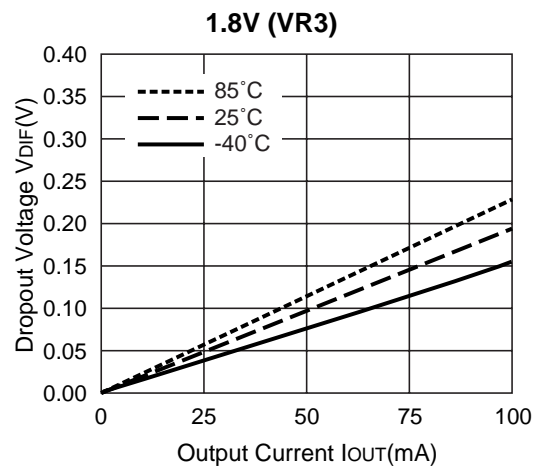
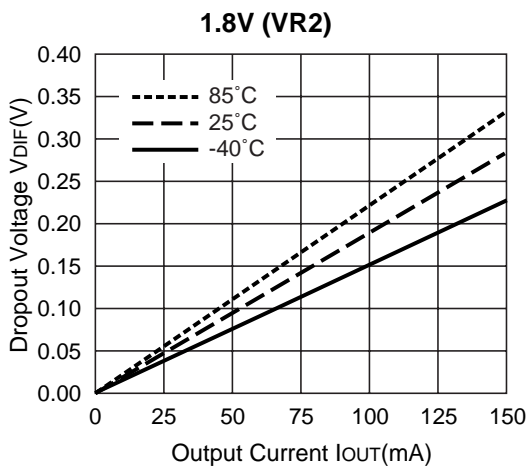
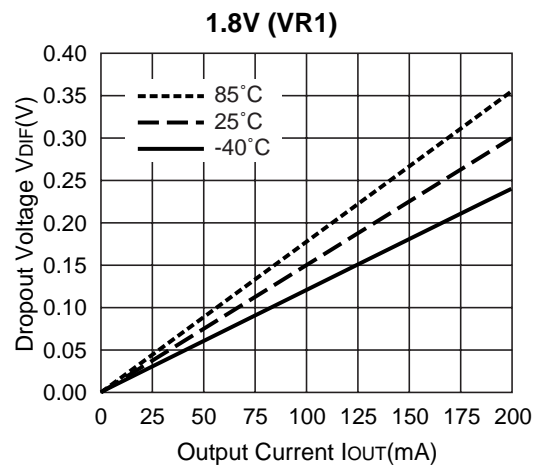
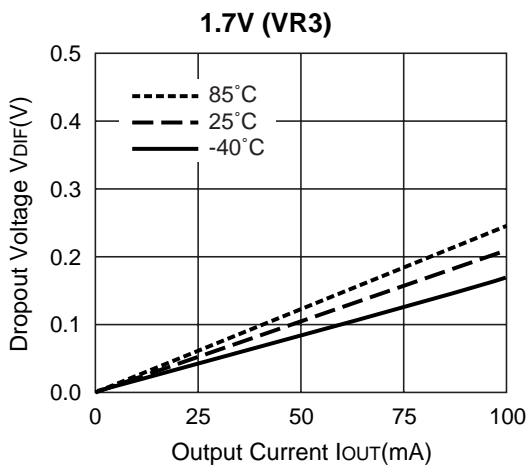
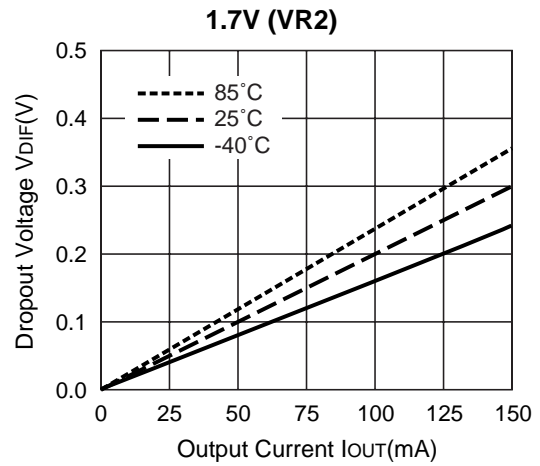
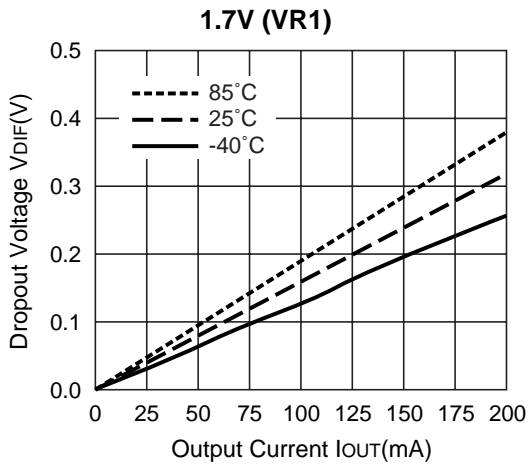


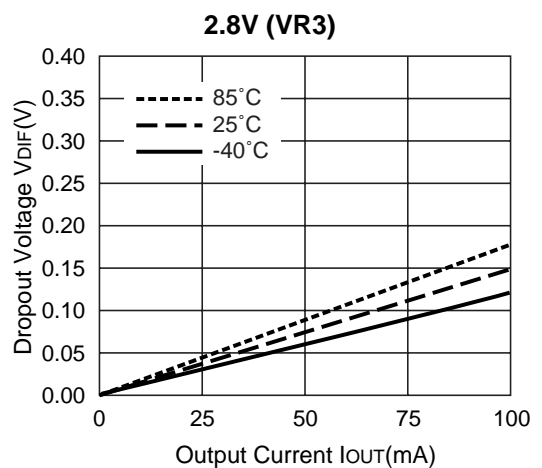
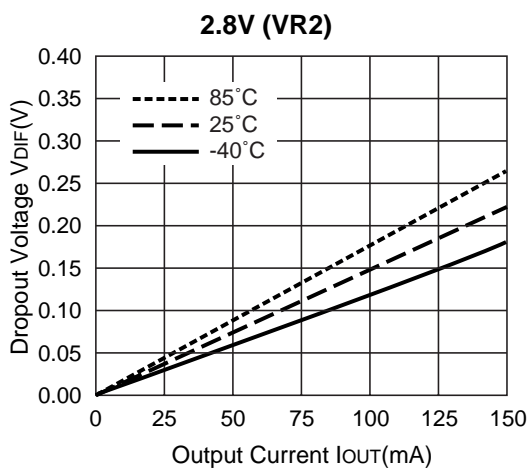
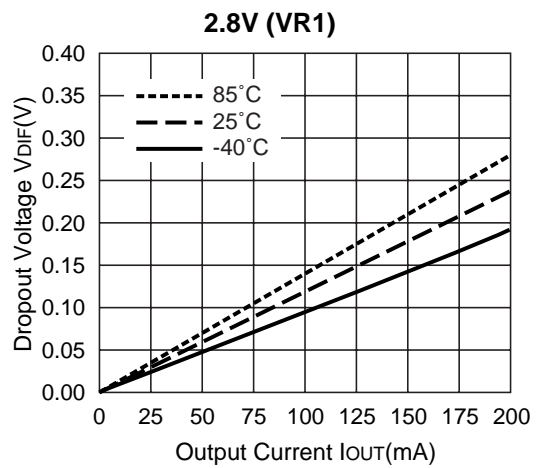
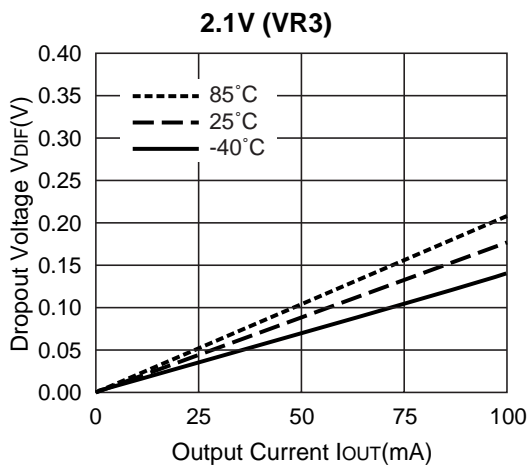
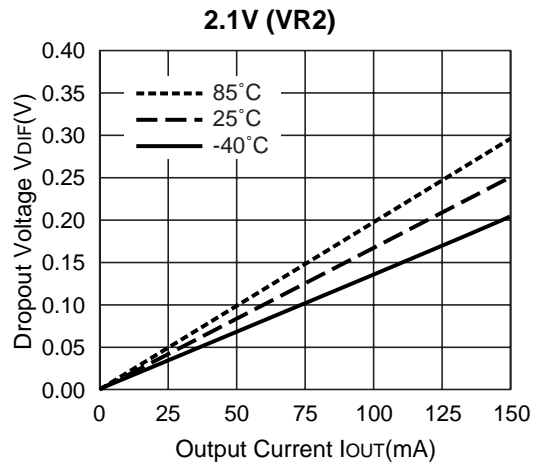
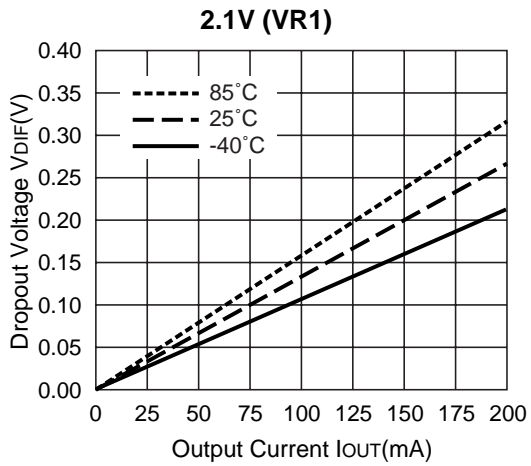
2) Output Voltage vs. Input Voltage (T_{opt}=25°C)

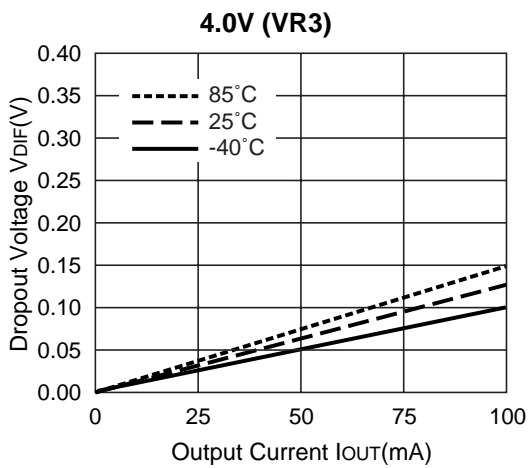
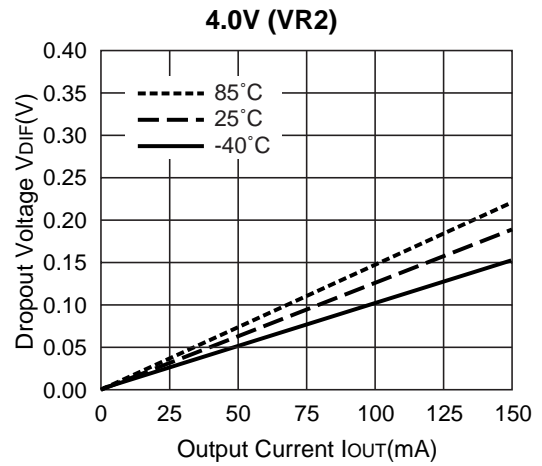
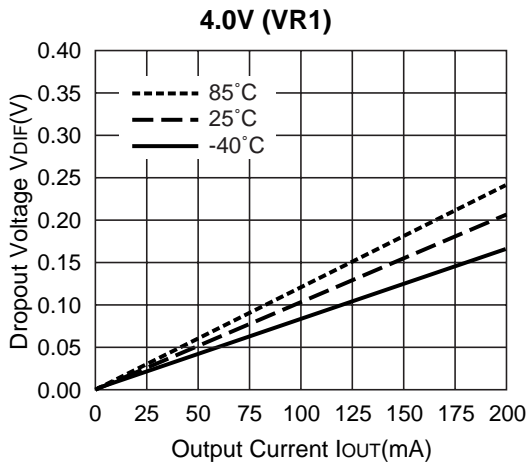


3) Dropout Voltage vs. Output Current

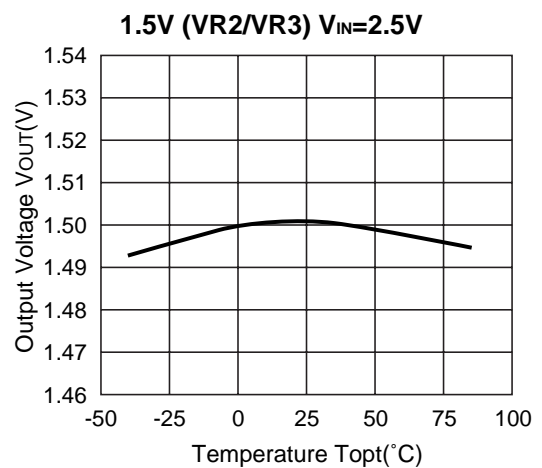
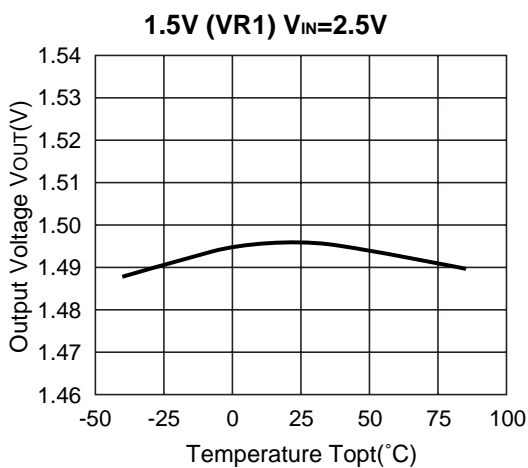


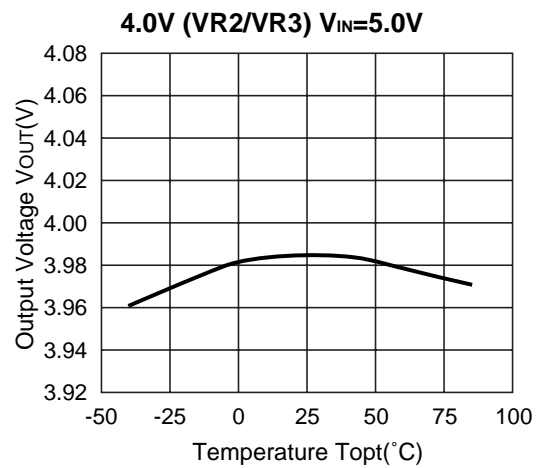
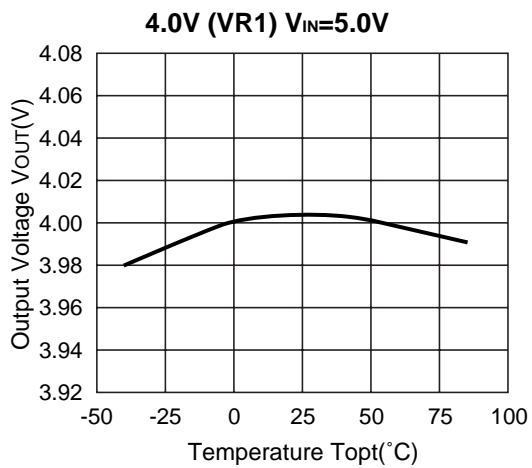
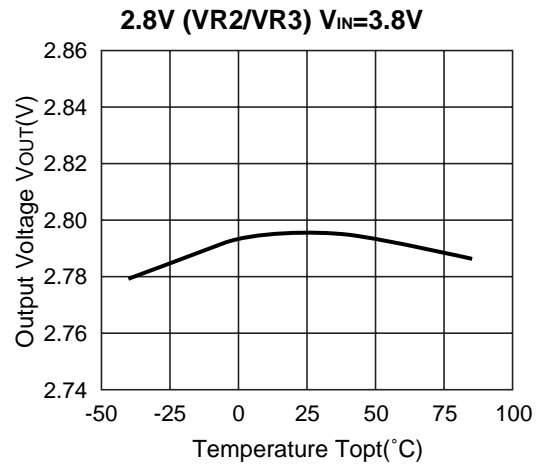
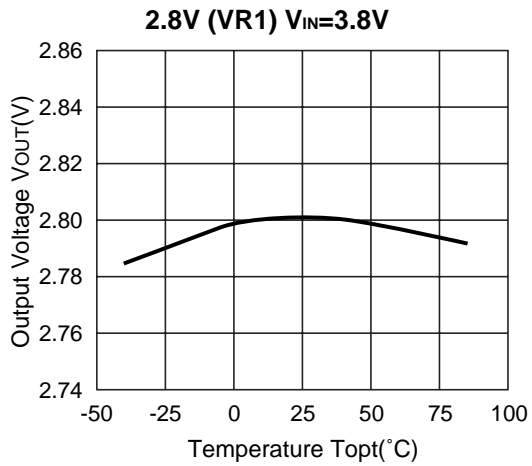




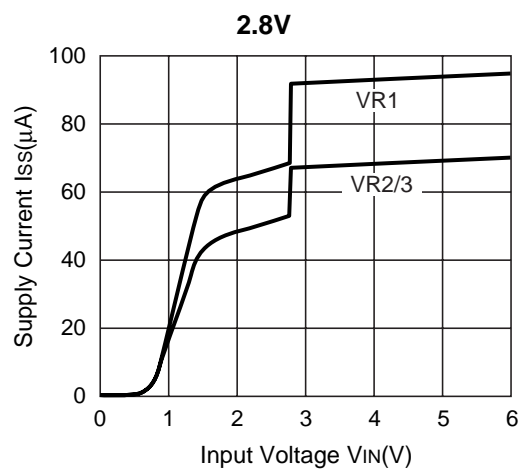
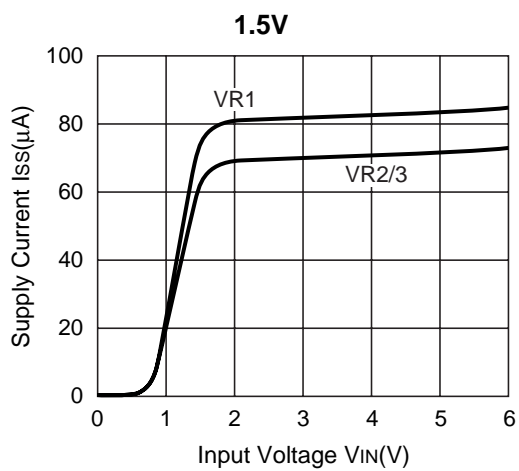


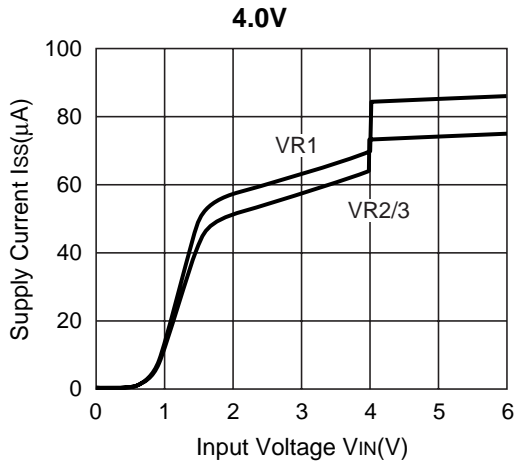
4) Output Voltage vs. Temperature ($I_{OUT}=30mA$)



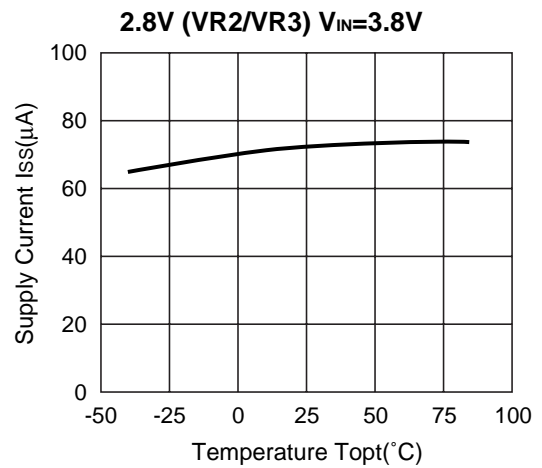
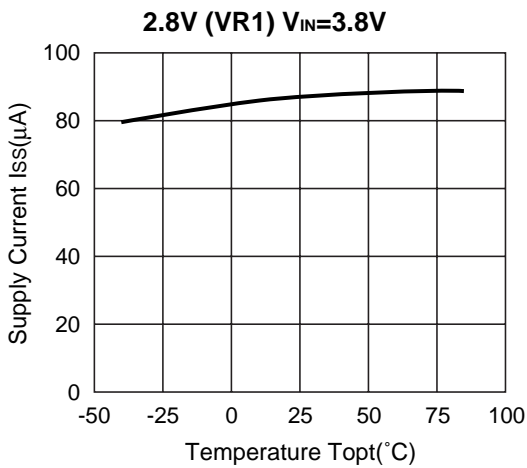
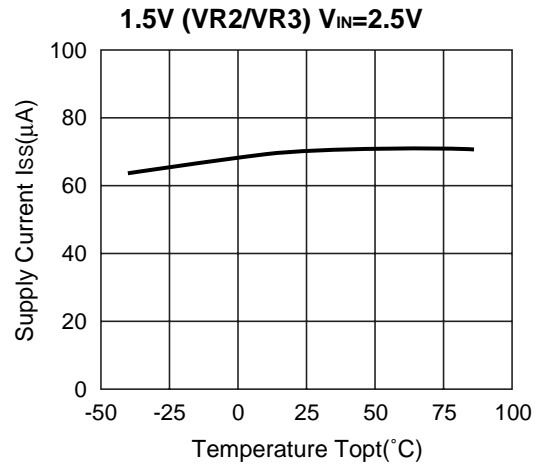
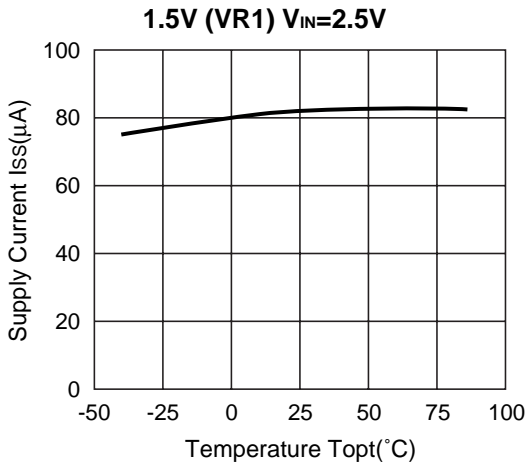


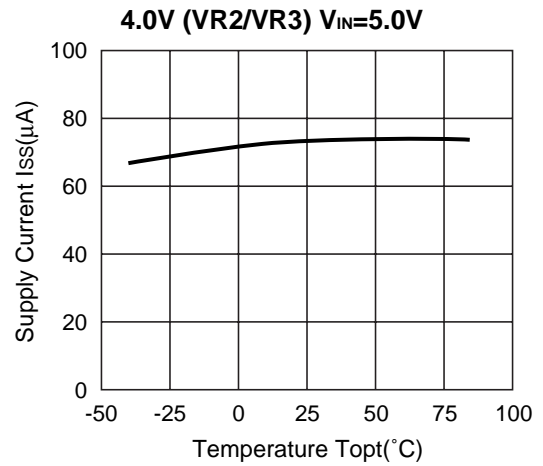
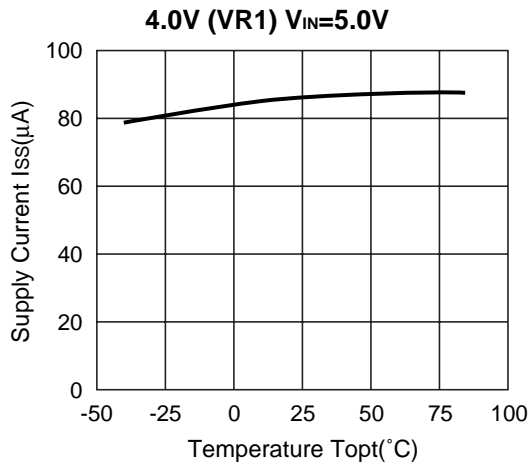
5) Supply Current vs. Input Voltage ($T_{opt}=25^{\circ}C$)



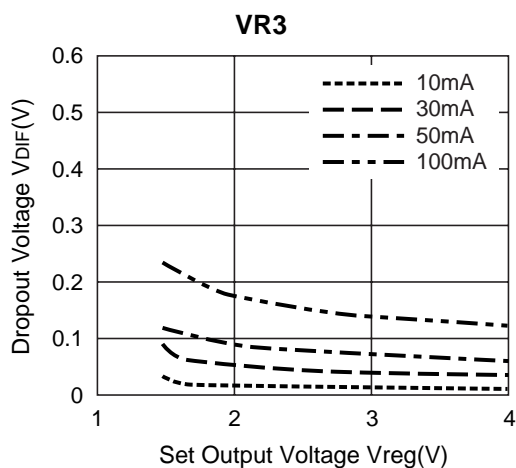
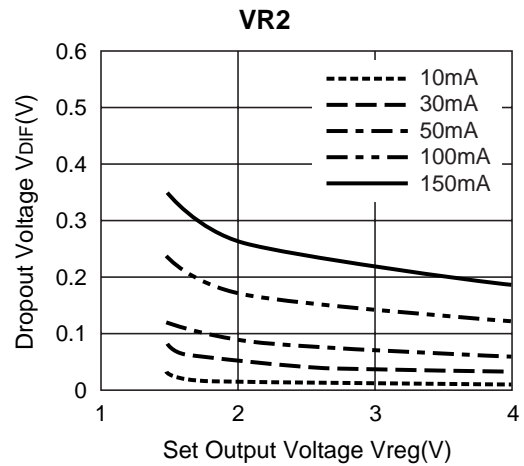
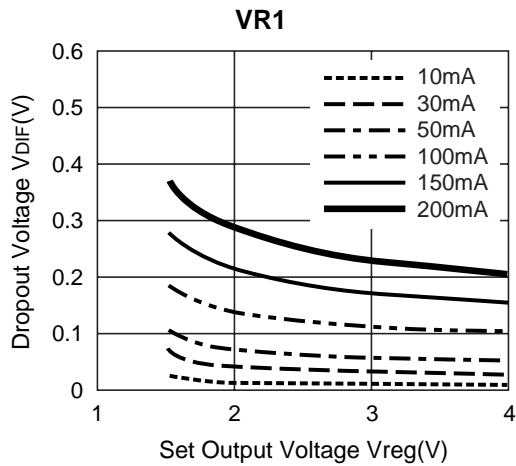


6) Supply Current vs. Temperature

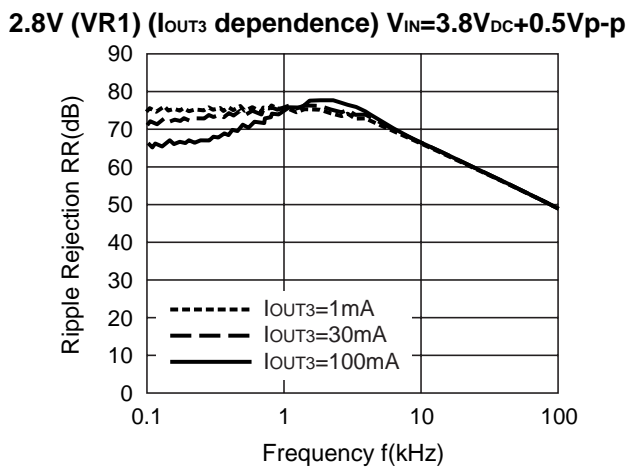
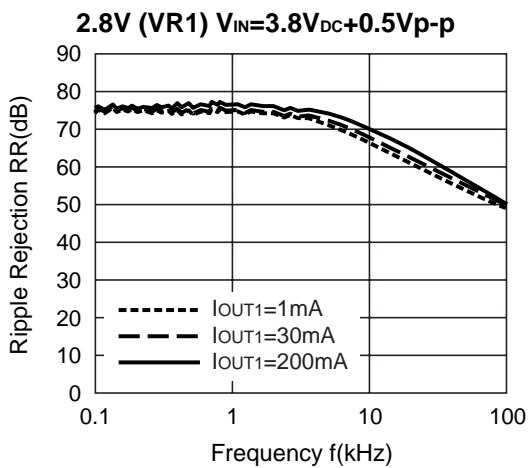
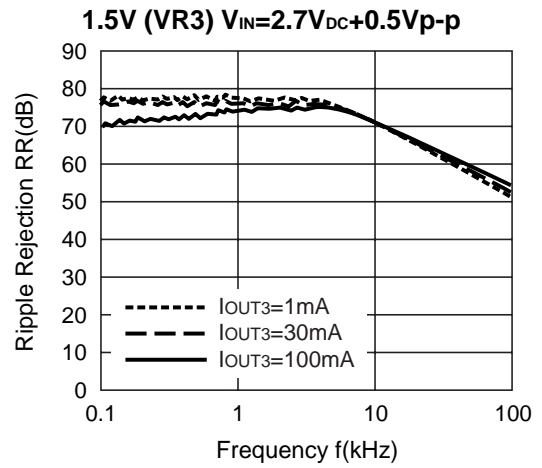
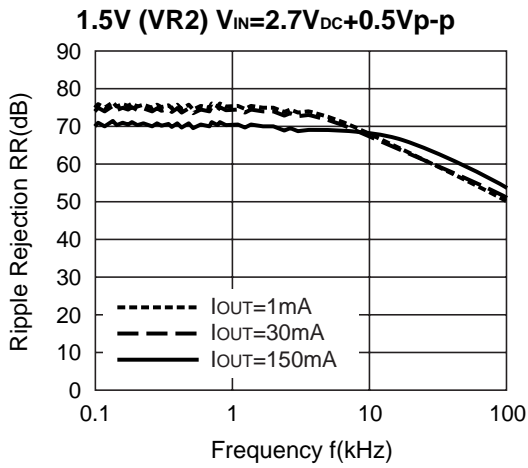
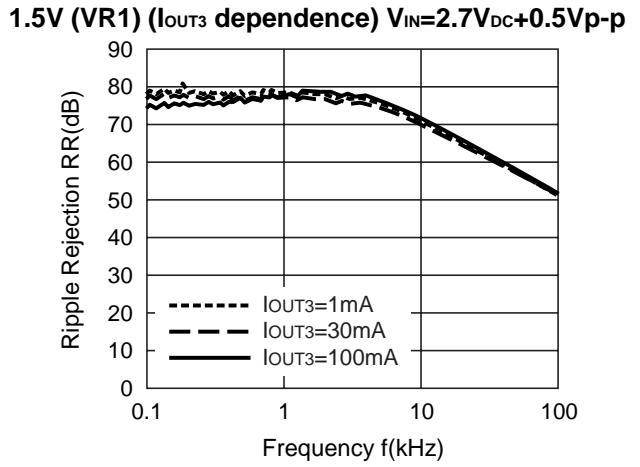
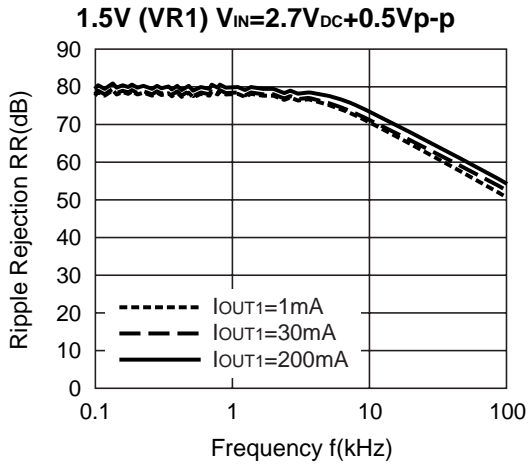


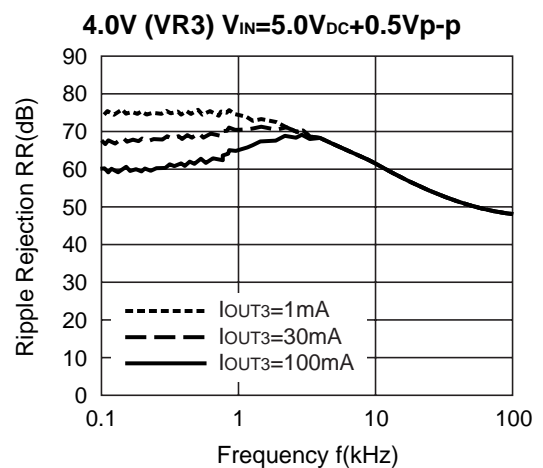
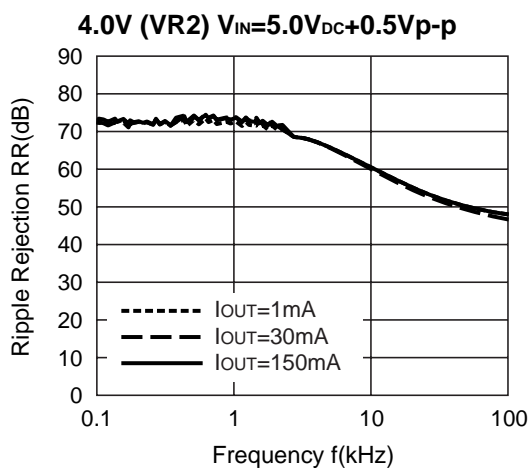
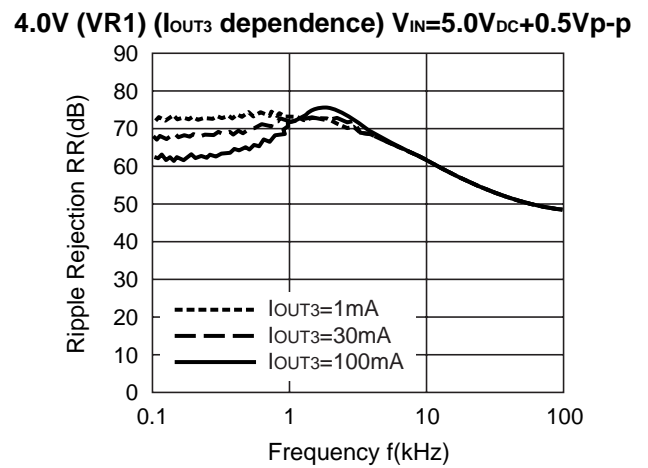
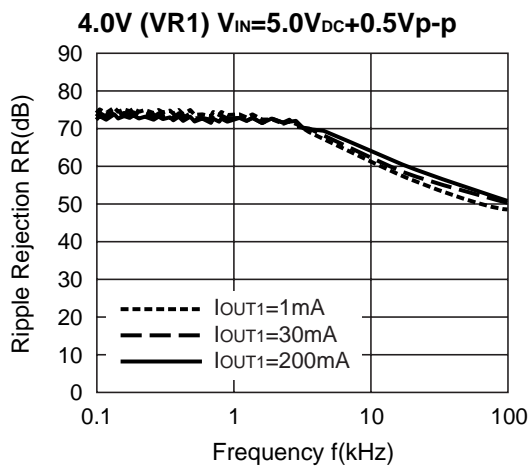
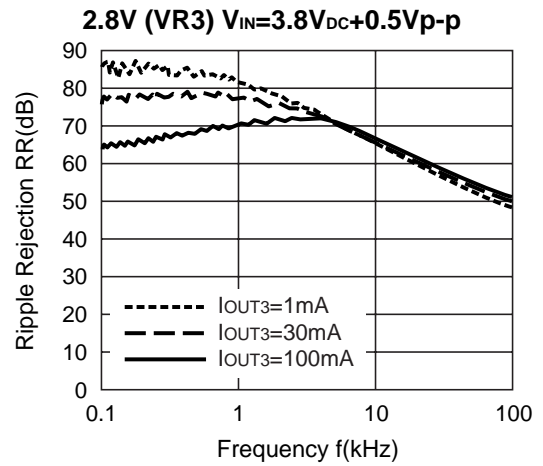
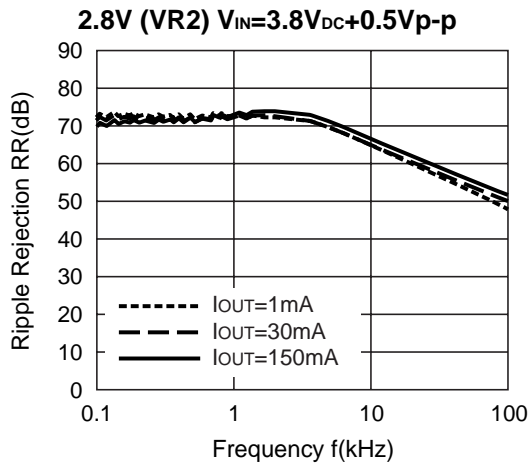


7) Dropout Voltage vs. Set Output Voltage (T_{opt}=25°C)

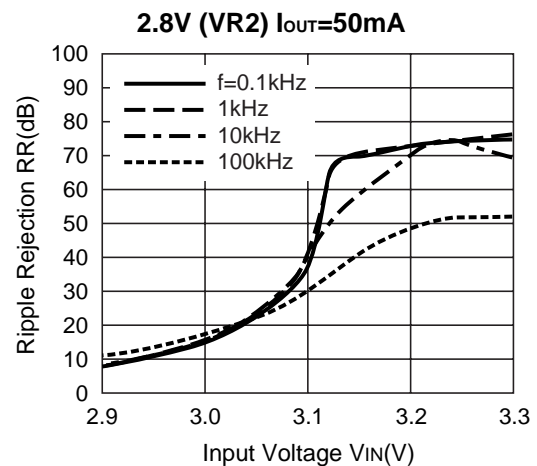
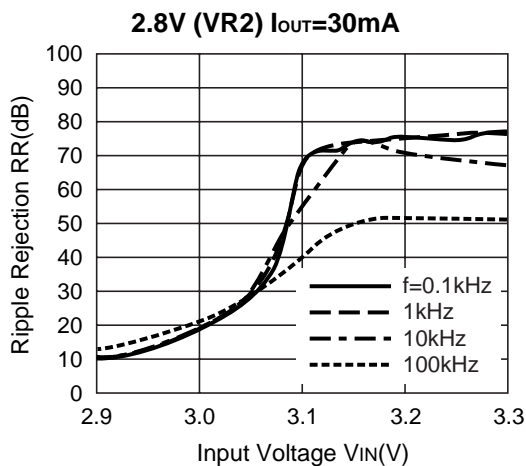
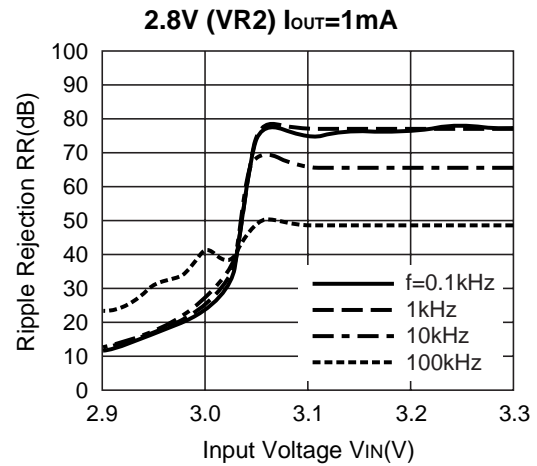
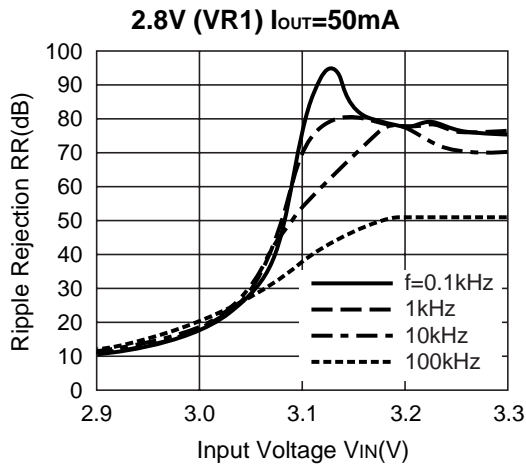
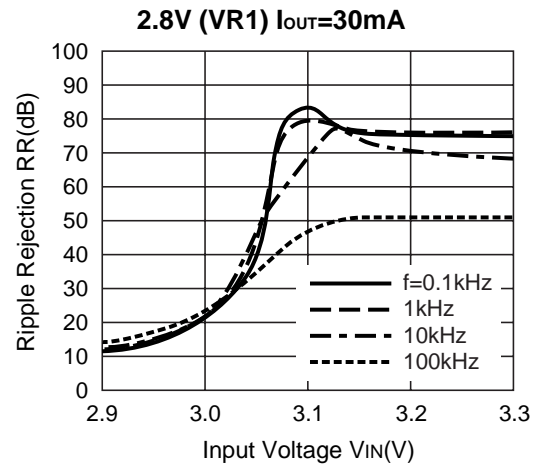
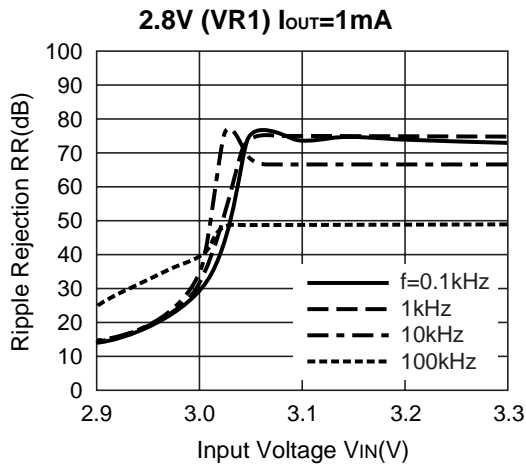


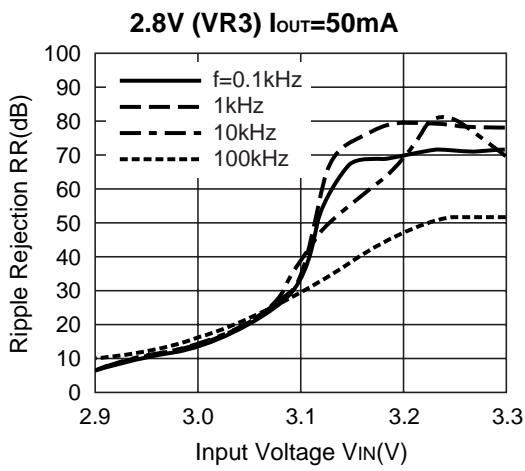
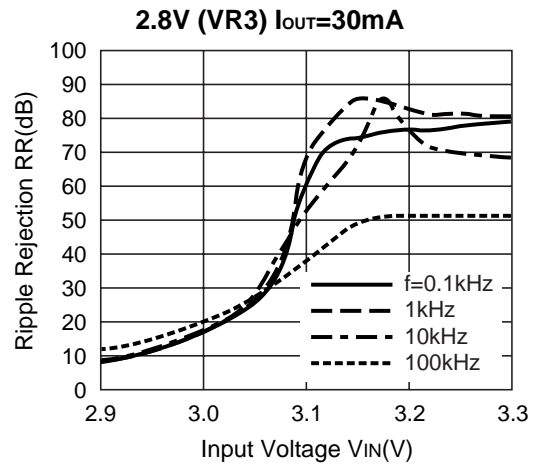
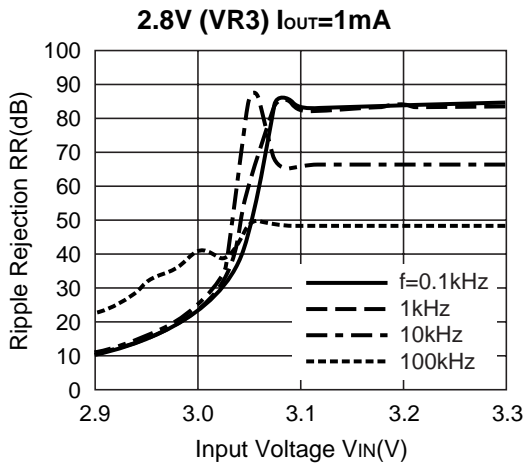
8) Ripple Rejection vs. Frequency (Topt=25°C, COUT=Ceramic 1.0μF)





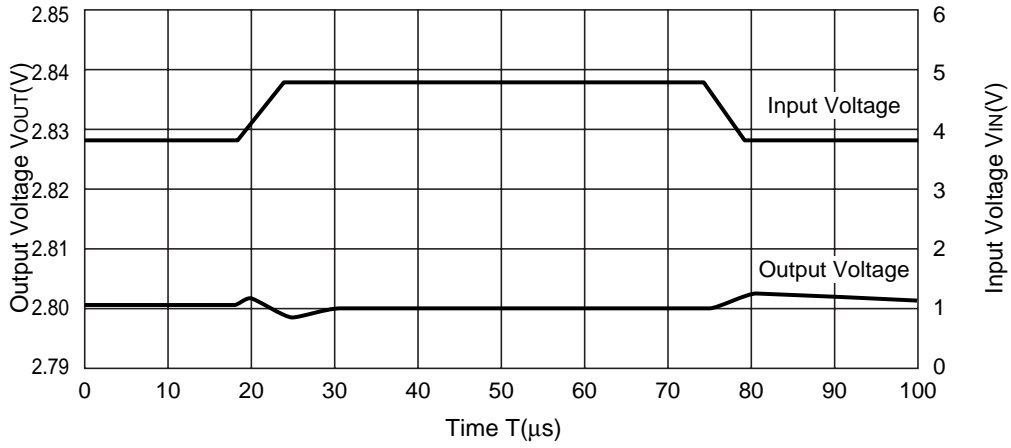
9) Ripple Rejection vs. DC Input Bias (T_{opt}=25°C, C_{OUT}=1.0μF)



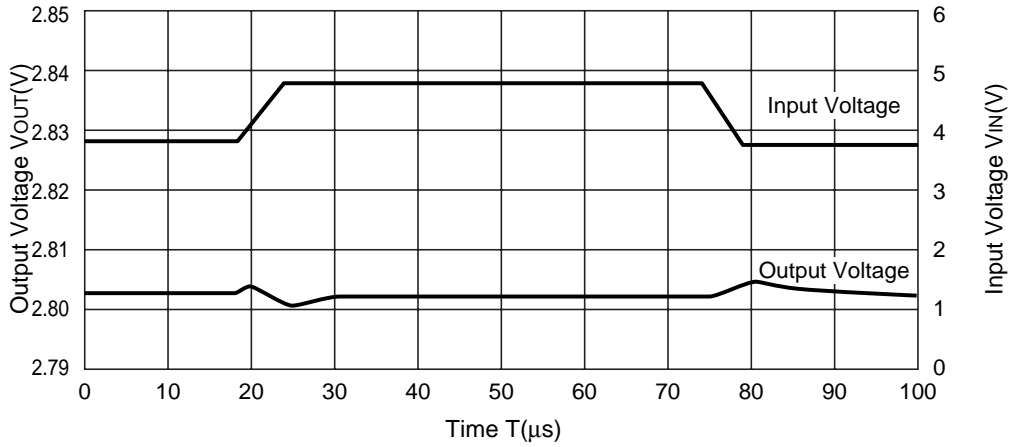


10) Line Transient Response ($I_{OUT}=30mA$, $C_{IN}=none$, $t_r=t_f=5\mu s$, $C_{OUT}=Ceramic\ 1\mu F$)

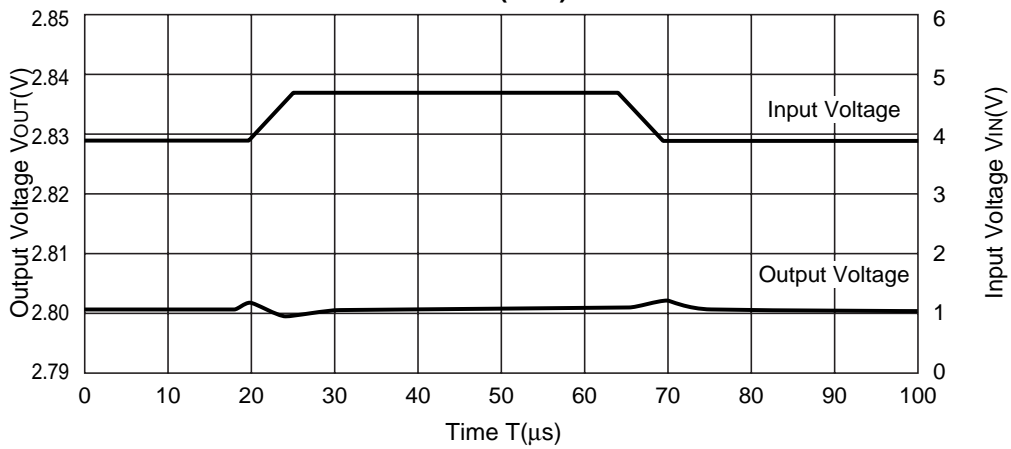
2.8V(VR1)



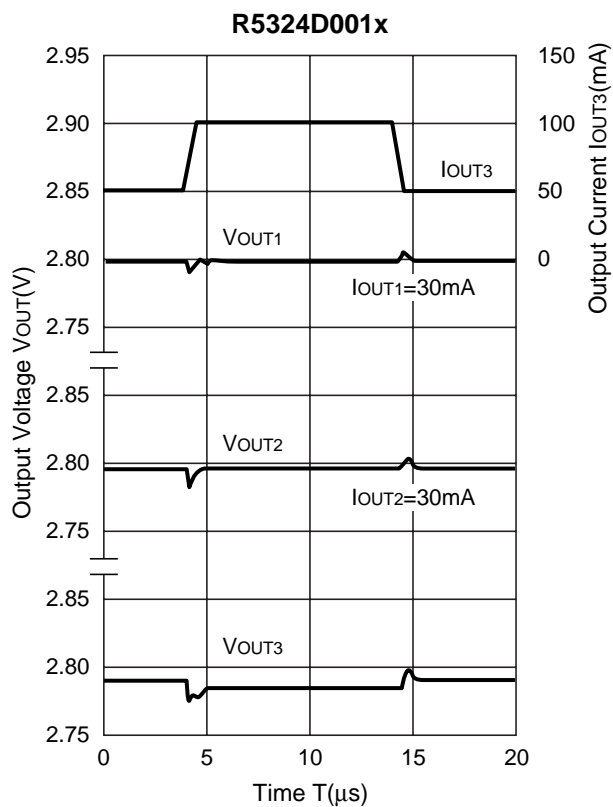
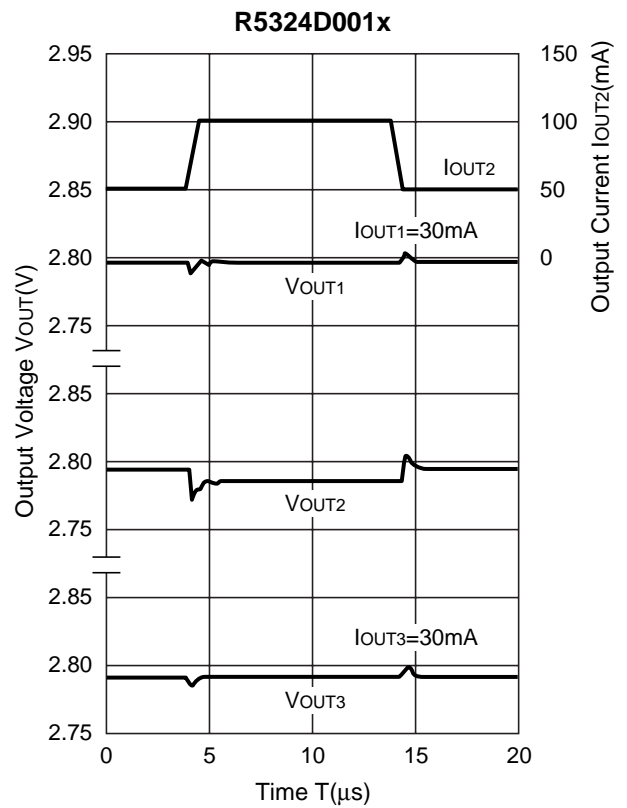
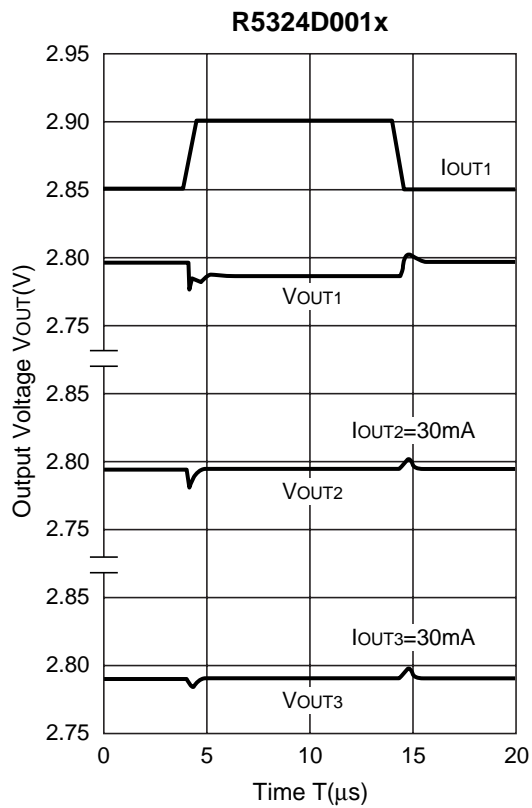
2.8V(VR2)



2.8V(VR3)



11) Load Transient Response (C_{IN} =Ceramic $1.0\mu\text{F}$, C_{OUT} =Ceramic $1.0\mu\text{F}$)



ESR vs. Output Current

When using these ICs, consider the following points:

The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.

The conditions when the white noise level is under $40\mu\text{V}$ (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band : 10Hz to 2MHz

Temperature : -40°C to 85°C

