CMOS 3CH-LDOs for RF Unit

NO. EA-063-0204

R5320x Series

OUTLINE

The R5320x Series are CMOS-based multi voltage regulator ICs with high output voltage accuracy, extremely low supply current, low noise, low ON-resistance and high ripple rejectio. The R5320x Series contain three voltage regulators. Each of these voltage regulators in the R5320x Series consists of a voltage reference unit, an error amplifier, resistors for setting output voltage, a current limit circuit and a chip enable circuit.

The chip enable function contributes to prolong battery life. Further, regulators in the R5320x Series are with low dropout voltage, excellent load transient response and line transient response, thus the R5320x Series are very suitable for the power supply for hand-held communication equipment.

The output voltage of each regulator is fixed with high accuracy by laser trim.

Since the package for these ICs is SSOP8G and SON8, high density mounting of the ICs on boards is possible.

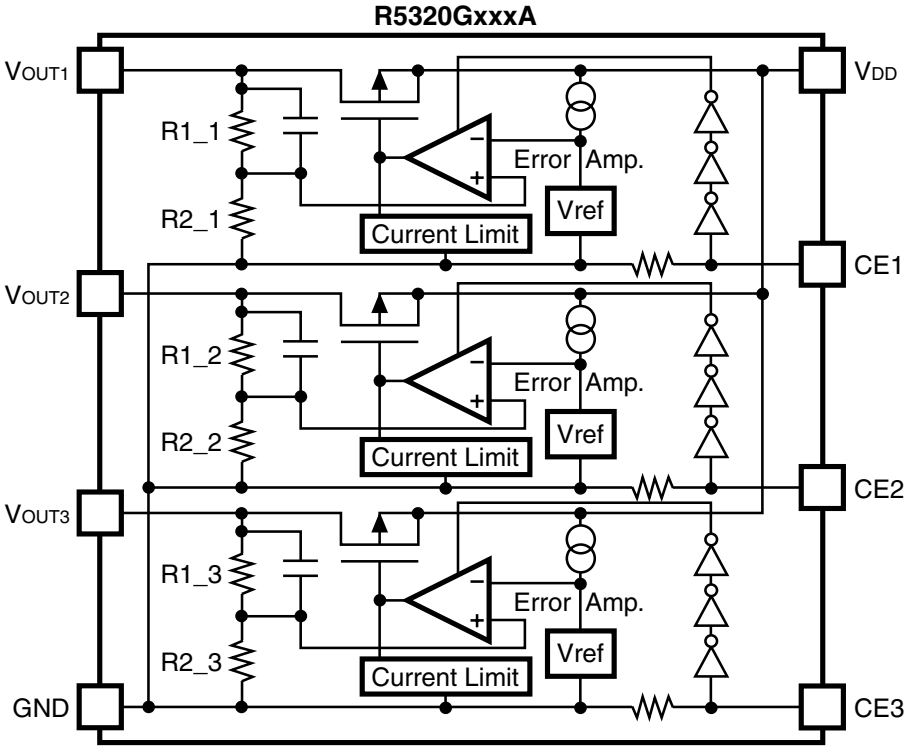
FEATURES

- Ultra-Low Supply Current .....Typ. 70μA:VR1, Typ. 70μA:VR2, Typ. 70μA:VR3
- Low Standby Current.....Typ. 0.1μA:VR1, Typ. 0.1μA:VR2, Typ. 0.1μA:VR3
- Low Dropout Voltage .....Typ. 0.22V (VR1) 0.16V (VR2,VR3)
  I_{OUT}=150mA:VR1,80mA:VR2,VR3 (ex. for 3.0V Output Type)
- High Ripple Rejection .....Typ.70dB (f=1kHz)
- High Output Voltage Accuracy .....±2.0%
- Excellent Load Transient Response and Line Transient Response
- Small Package.....8-Pin SSOP (0.65mm pitch), 8-pin SON8
- Input Voltage.....Max. 6V

APPLICATIONS

- Power source for cellular phones such as GSM,CDMA and Personal Handy-phone System.
- Power source for electrical appliances such as cameras, VCRs, camcorders, etc.
- Power source for battery-powered equipment.

BLOCK DIAGRAM



SELECTION GUIDE

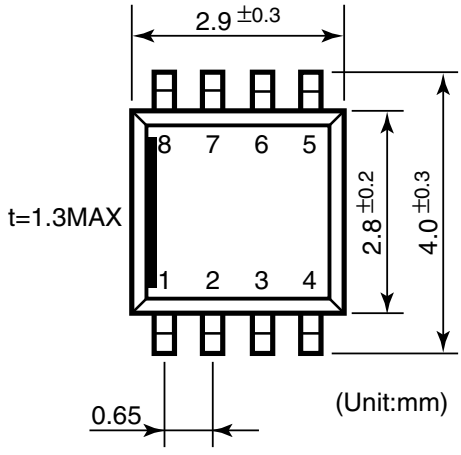
The selection can be made by designating the part number as shown below :

R5320xxxxx-TR ←Part Number
↑ ↑ ↑
a b c

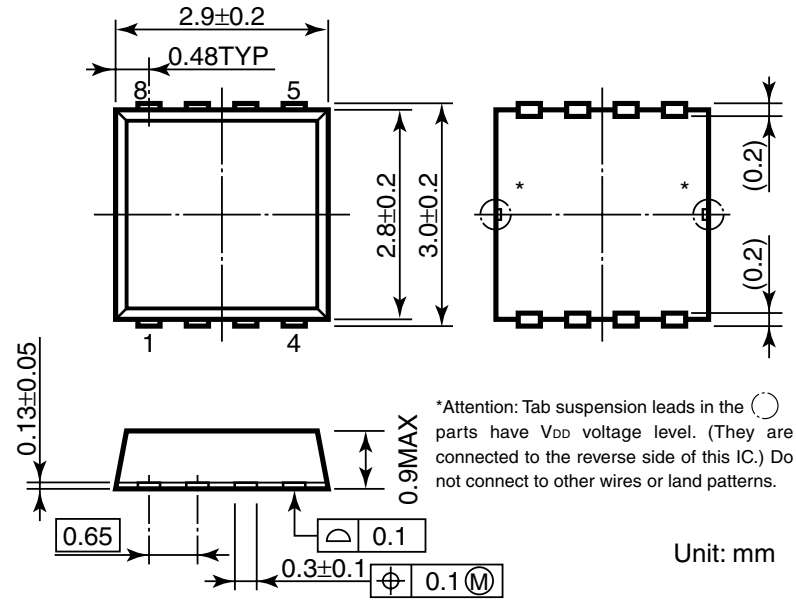
Code	Descriptions
a	Designation of Package Typ; G: SSOP8G D: SON8
b	Serial Number for Voltage setting from 001
c	Alphabetical Code for Mask Versions A: Standard

PIN CONFIGURATION

SSOP8G PACKAGE



SON8 PACKAGE



*Attention: Tab suspension leads in the ◌ parts have V_{DD} voltage level. (They are connected to the reverse side of this IC.) Do not connect to other wires or land patterns.

Unit: mm

PIN DESCRIPTIONS

R5320G (SSOP8G)

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

R5320D (SSOP8G)

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

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
CE	Input Voltage (CE Pin)	-0.3 ~ V_{IN}+0.3	V
V_{OUT}	Output Voltage	-0.3 ~ V_{IN}+0.3	V
I_{OUT1}	Output Current (V_{OUT1})	200	mA
I_{OUT2}	Output Current (V_{OUT2})	100	mA
I_{OUT3}	Output Current (V_{OUT3})	100	mA
PD	Power Dissipation	300	mW
Topt	Operating Temperature Range	-40 ~ 85	°C
Tstg	Storage Temperature Range	-55 ~ 125	°C

ELECTRICAL CHARACTERISTICS

- **R5320xxxxA**

VR1 Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤50mA	×0.98		×1.02	V
I_{OUT}	Output Current	V_{IN}-V_{OUT}=1.0V	150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤80mA		12	40	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristic by Output Voltage (VR1)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		70	120	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6V I_{OUT}=30mA		0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz, sinusoidal 0.5Vp-p V_{IN}-V_{OUT}=1.0V, V_{OUT}≥1.9V		70		dB
		1.5V≤V_{IN}≤1.8V		60		
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=50mA -40°C≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		50		mA
R_{DN}	CE Pull-down Resistance		2.5	5.0	10	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.00		0.25	V
en	Output Noise	BW=10Hz-100kHz		60		μVrms

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE(VR1)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Conditions	Typ.	Max.
1.5≤V_{OUT}<1.6	I_{OUT}=150mA	0.55	0.65
1.6≤V_{OUT}<1.7		0.45	0.60
1.7≤V_{OUT}<2.0		0.35	0.60
2.0≤V_{OUT}<2.5		0.35	0.55
2.5≤V_{OUT}<2.8		0.30	0.45
2.8≤V_{OUT}<3.4		0.22	0.35
3.4≤V_{OUT}<5.0		0.20	0.30

VR2 Topt=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	80			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤50mA		12	40	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristics by Output Voltage (VR2)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		70	120	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6V I_{OUT}=30mA		0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz, sinusoidal 0.5Vp-p V_{IN}-V_{OUT}=1.0V, V_{OUT}≥1.9V		70		dB
		1.5V≤V_{IN}≤1.8V		60		
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=30mA -40°C≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		50		mA
R_{DN}	CE Pull-down Resistance		2.5	5.0	10.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.00		0.25	V
en	Output Noise	BW=10Hz-100kHz		60		μVrms

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE (VR2)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Conditions	Typ.	Max.
1.5≤V_{OUT}<1.6	I_{OUT}=80mA	0.55	0.65
1.6≤V_{OUT}<1.7		0.45	0.60
1.7≤V_{OUT}<1.8		0.35	0.55
1.8≤V_{OUT}<1.9		0.30	0.45
1.9≤V_{OUT}<2.0		0.25	0.45
2.0≤V_{OUT}<2.5		0.22	0.38
2.5≤V_{OUT}<2.8		0.20	0.38
2.8≤V_{OUT}<3.4		0.16	0.24
3.4≤V_{OUT}≤5.0		0.12	0.24

VR3 Topt=25°C

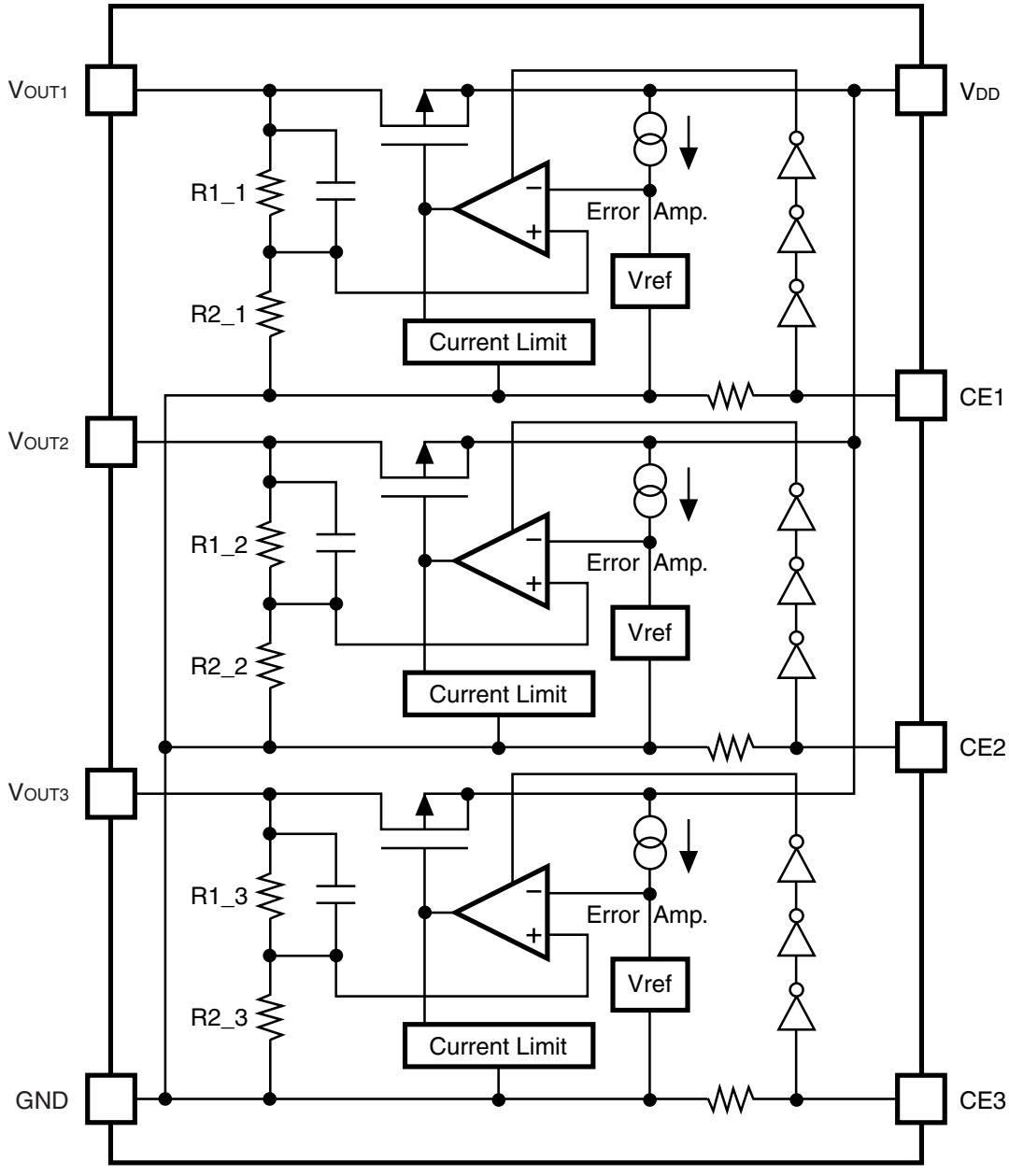
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}-V_{OUT}=1.0V 1mA≤30mA	×0.98		×1.02	V
I_{OUT}	Output Current	V_{IN}-V_{OUT}=1.0V	80			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN}-V_{OUT}=1.0V 1mA≤I_{OUT}≤50mA		12	40	mV
V_{DIF}	Dropout Voltage	Refer to Electrical Characteristics by Dropout Voltage (VR3)				
I_{SS}	Supply Current	V_{IN}-V_{OUT}=1.0V		70	120	μA
Istandby	Supply Current (Standby)	V_{IN}-V_{OUT}=1.0V V_{CE}=GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+0.5V≤V_{IN}≤6V I_{OUT}=30mA		0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz, sinusoidal 0.5Vp-p V_{IN}-V_{OUT}=1.0V, V_{OUT}≥1.9V		70		dB
		1.5V≤V_{IN}≤1.8V		60		
V_{IN}	Input Voltage		2.0		6.0	V
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	I_{OUT}=30mA -40°C≤Topt≤85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		50		mA
R_{DN}	CE Pull-down Resistance		2.5	5.0	10.0	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.00		0.25	V
en	Output Noise	BW=10Hz-100kHz		60		μVrms

- **ELECTRICAL CHARACTERISTICS by OUTPUT VOLTAGE (VR3)**

Topt=25°C

Output Voltage V_{OUT} (V)	Dropout Voltage V_{DIF} (V)		
	Conditions	Typ.	Max.
1.5≤V_{OUT}<1.6	I_{OUT}=80mA	0.55	0.65
1.6≤V_{OUT}<1.7		0.45	0.60
1.7≤V_{OUT}<1.8		0.35	0.55
1.8≤V_{OUT}<1.9		0.30	0.45
1.9≤V_{OUT}<2.0		0.25	0.45
2.0≤V_{OUT}<2.5		0.24	0.38
2.5≤V_{OUT}<2.8		0.22	0.28
2.8≤V_{OUT}<3.4		0.16	0.24
3.4≤V_{OUT}≤5.0		0.15	0.24

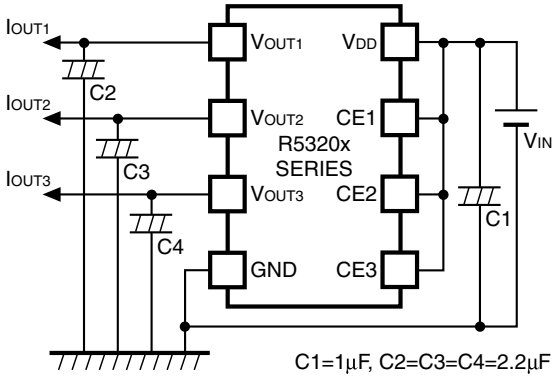
OPERATION



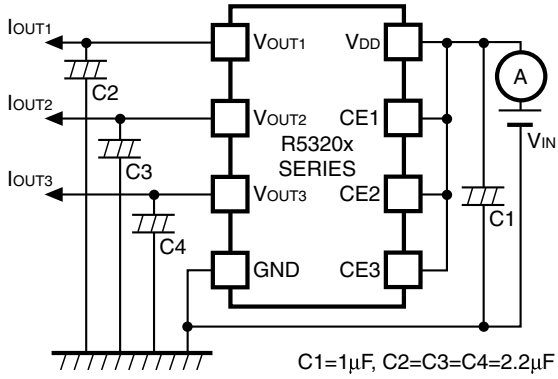
Fluctuation of each regulator's output voltage, or $V_{OUT1, 2, 3}$ is detected individually. Then it is put back to an error amplifier through feedback resistors, or R1_1, R2_1, R1_2, R2_2, R1_3, R2_3 and compared with a reference voltage and compensated for the result and make a constant voltage.

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

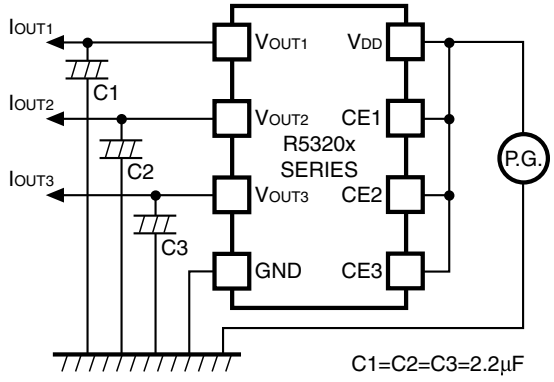
TEST CIRCUITS



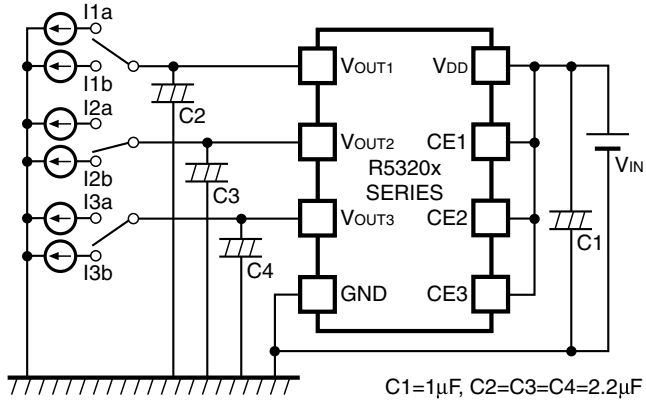
Basic Test Circuit



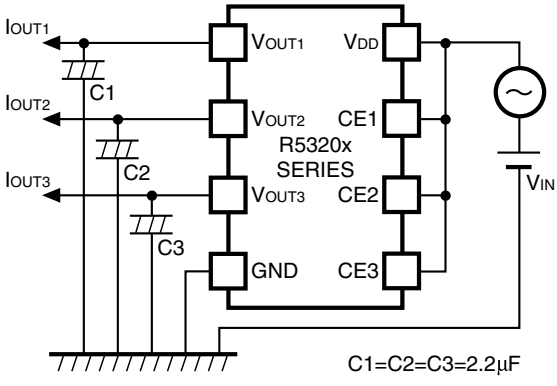
Test Circuit for Supply Current



Test Circuit for Line Transient Response



Test Circuit for Load Transient Response

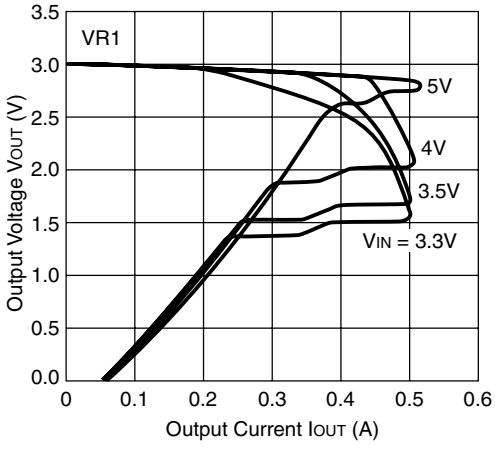


Test Circuit for Ripple Rejection

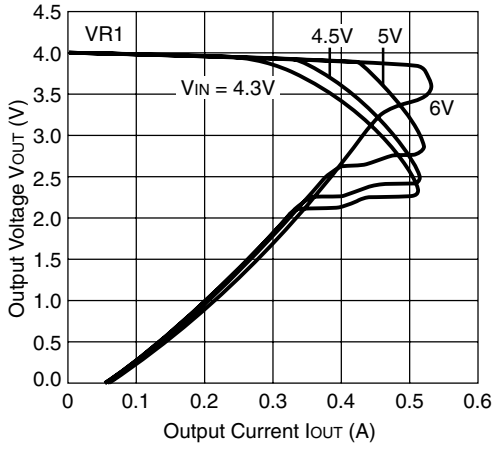
TYPICAL CHARACTERESTICS

1) Output Voltage vs. Output Current

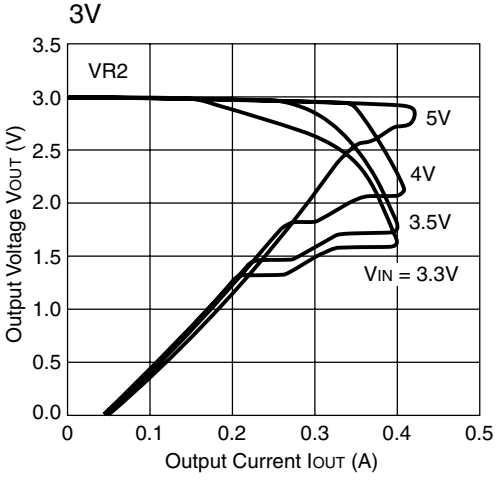
3V



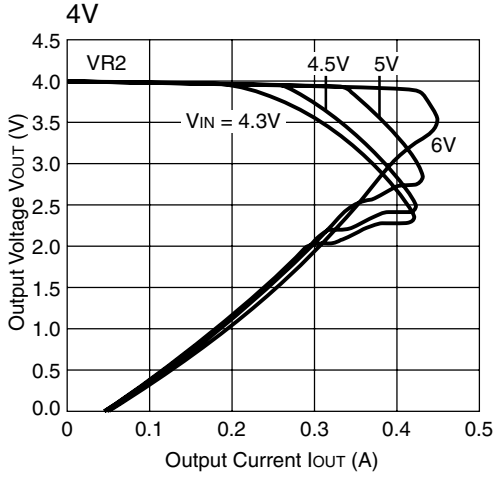
4V



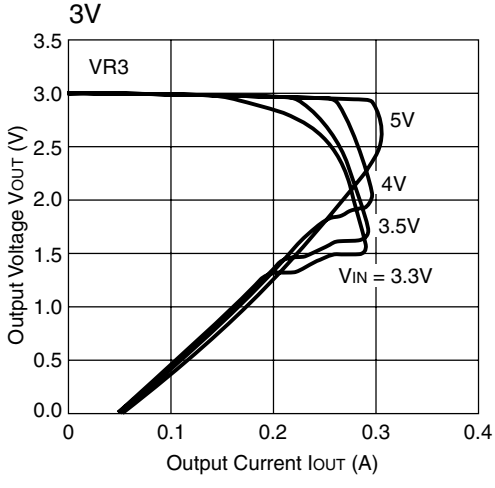
3V



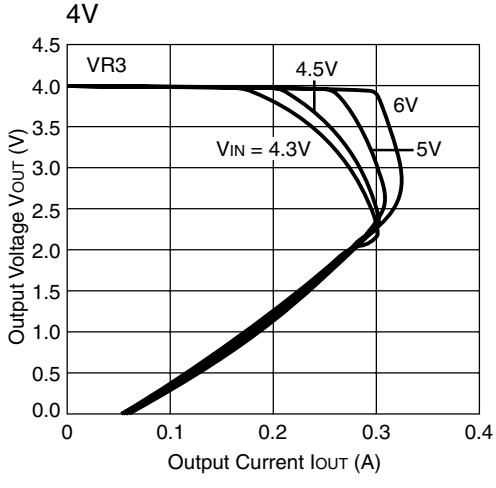
4V



3V

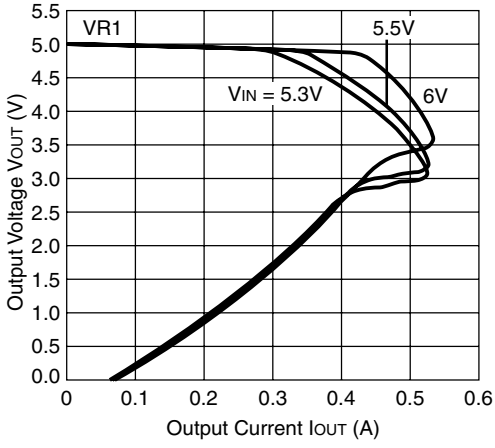


4V

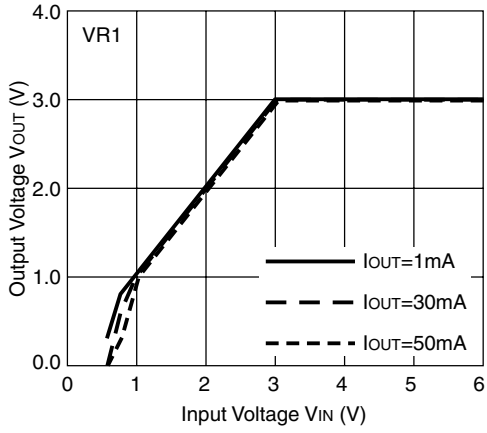


2) Output Voltage vs. Input Voltage

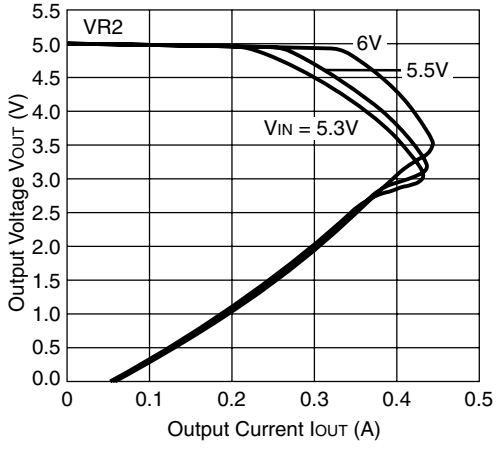
5V



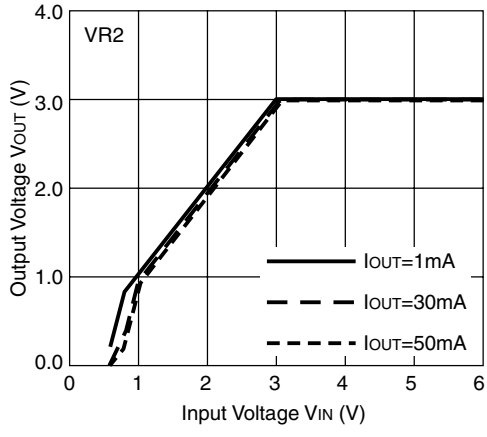
3V



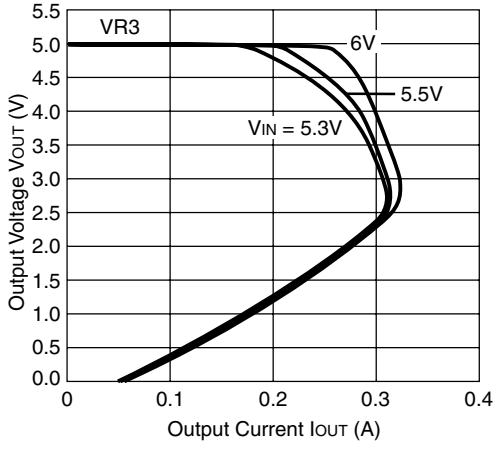
5V



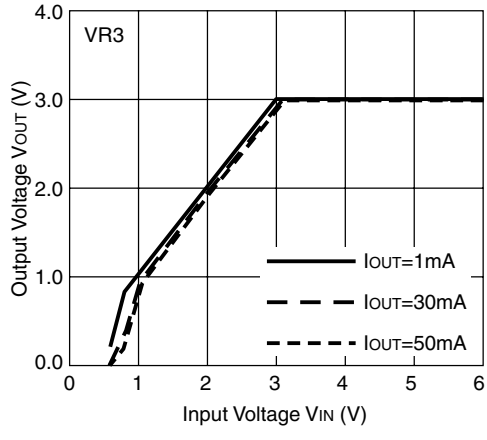
3V



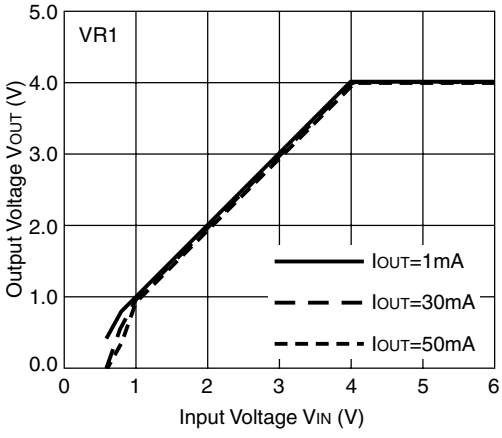
5V



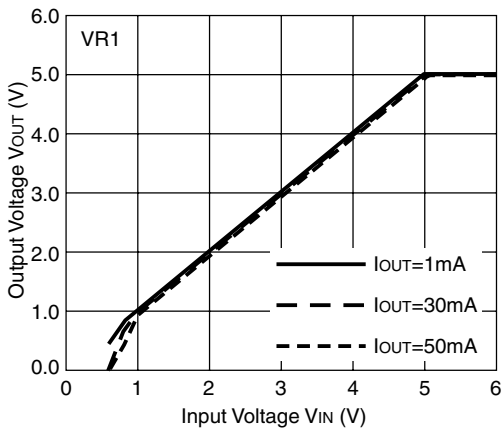
3V



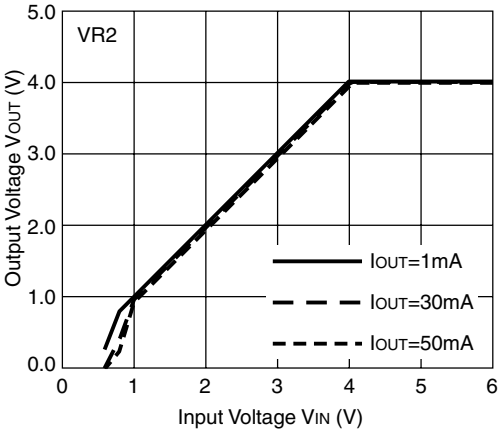
4V



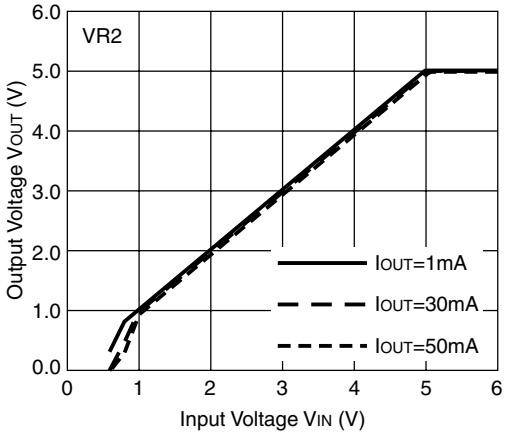
5V



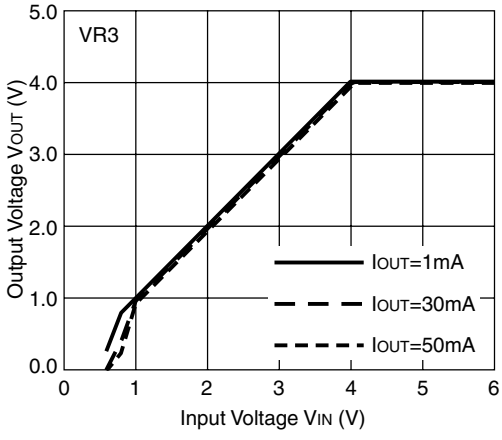
4V



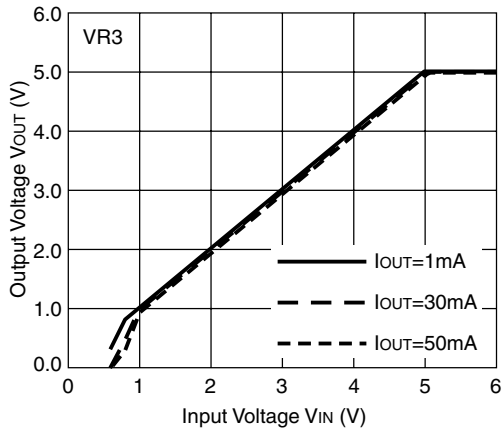
5V



4V



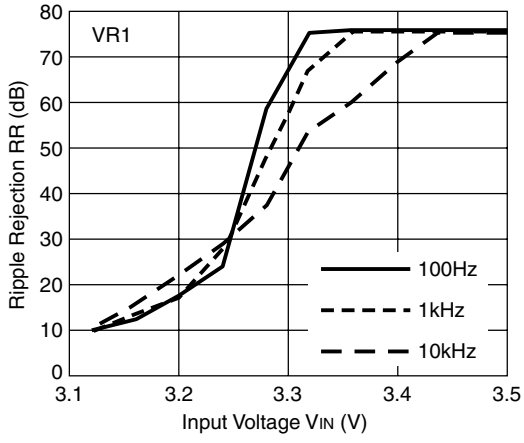
5V

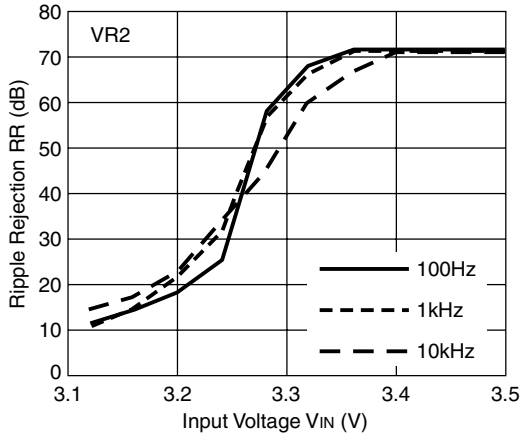


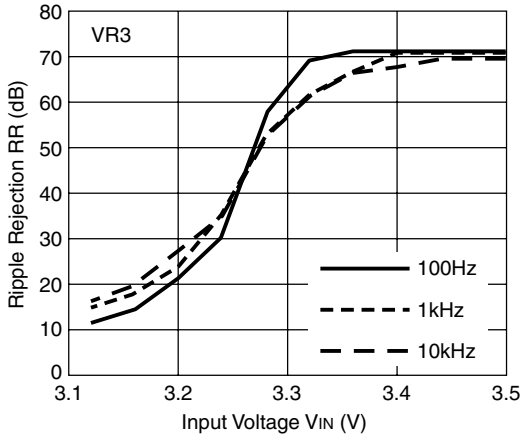
3) Ripple Rejection vs. Input Voltage (DC Bias)

3V

I_{OUT} = 10mA
C_{OUT} = tantal 2.2 µF

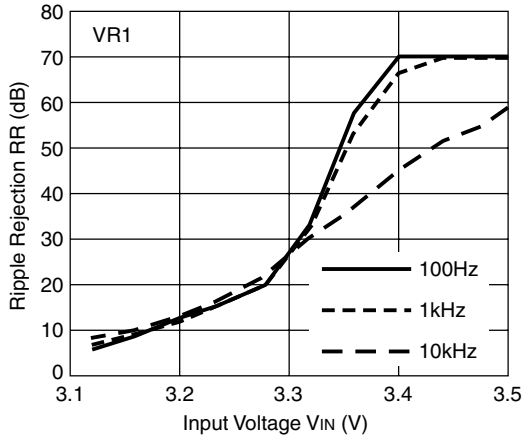


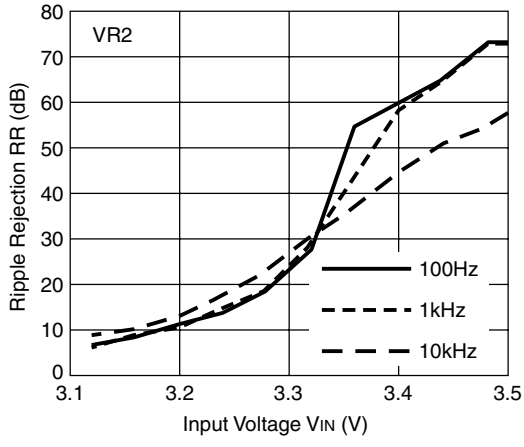


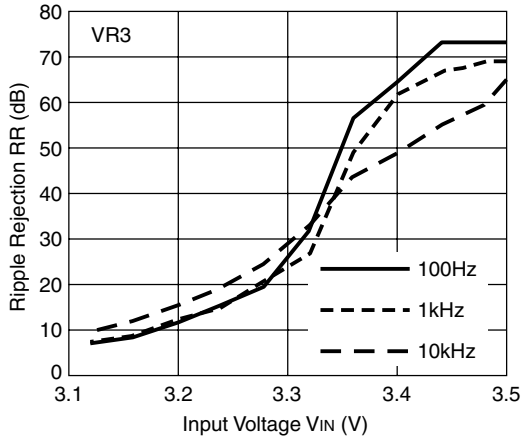


3V

I_{OUT} = 50mA
C_{OUT} = tantal 2.2 µF

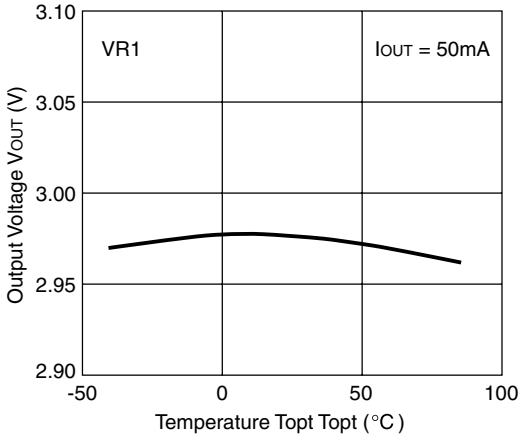




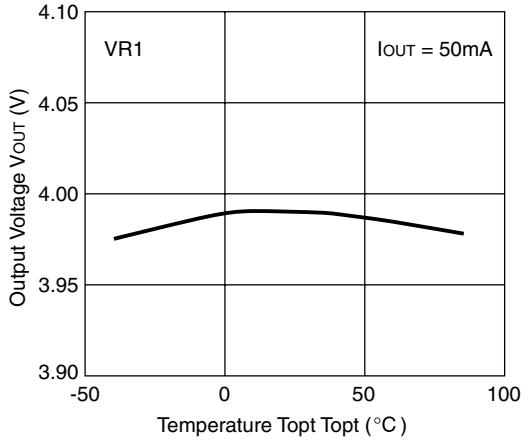


4) Output Voltage vs. Temperature

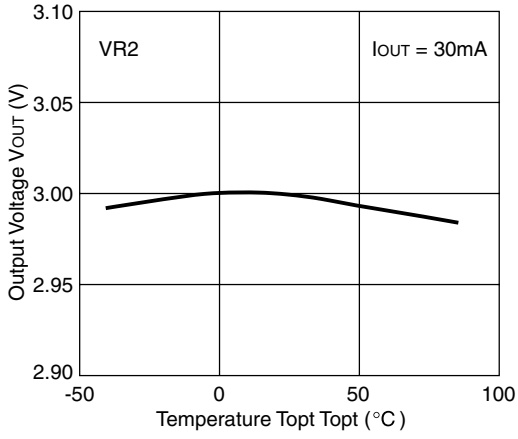
3V



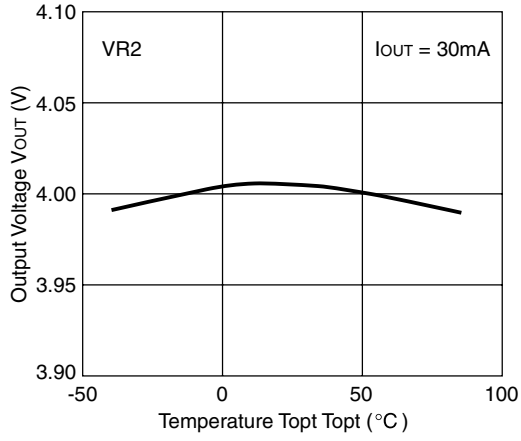
4V



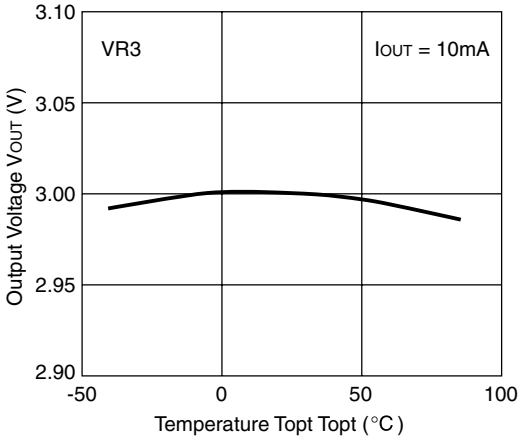
3V



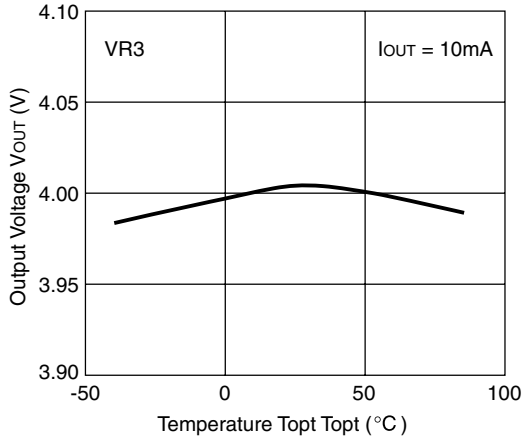
4V



3V

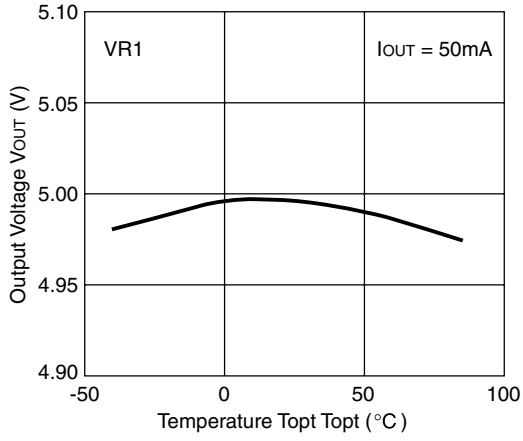


4V

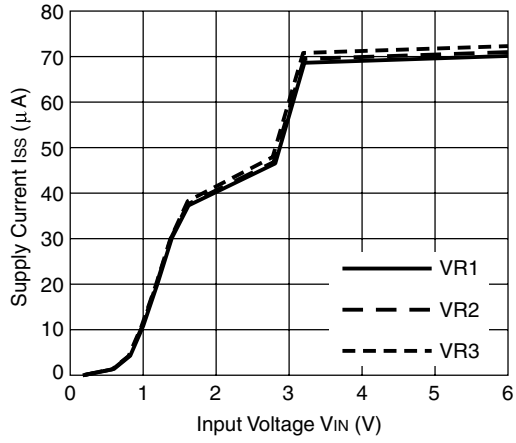


5) Supply Current vs. Input Voltage

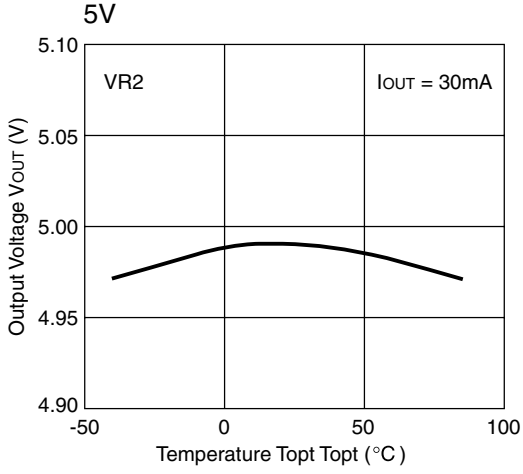
5V



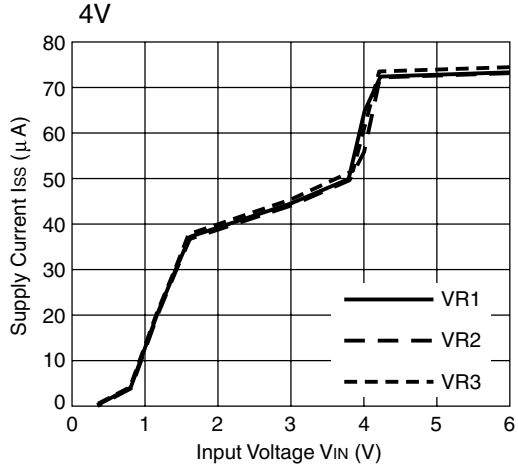
3V



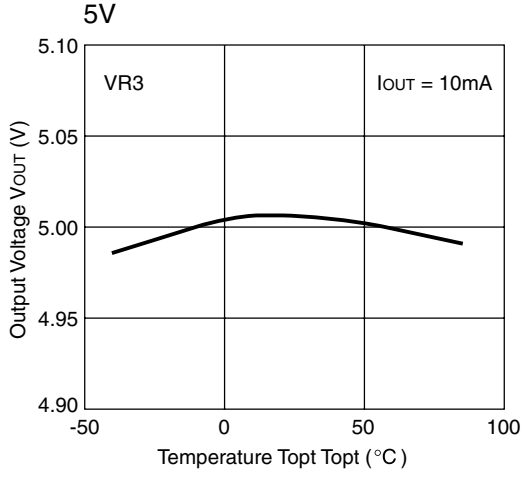
5V



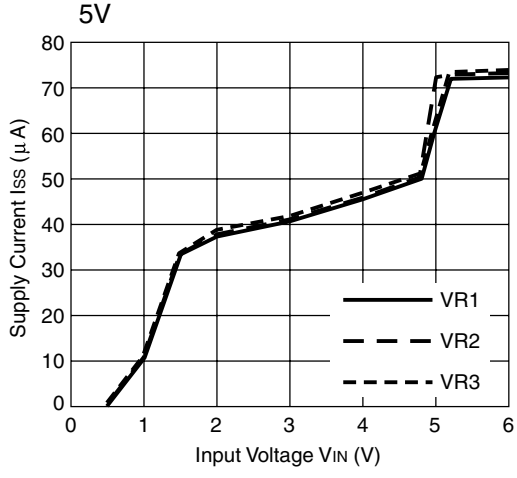
4V



5V

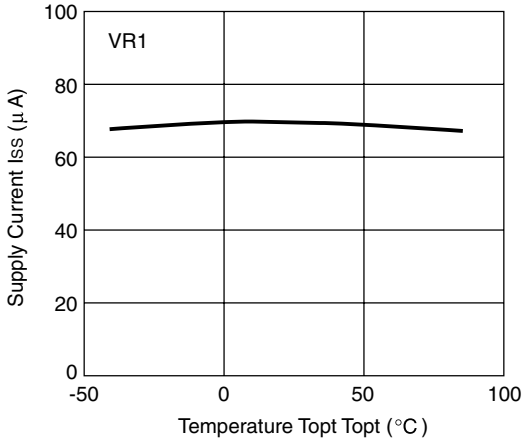


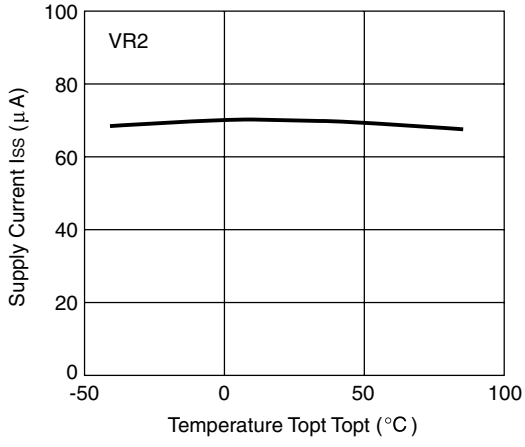
5V

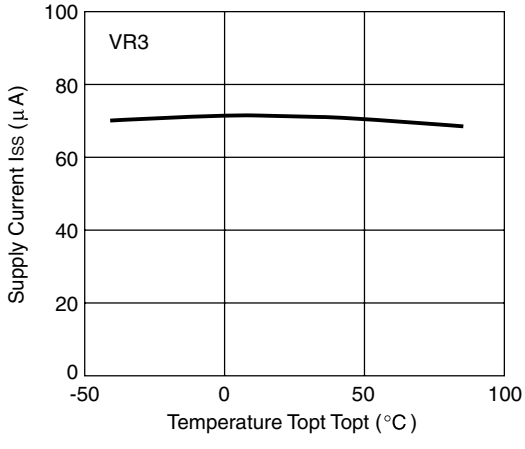


6) Supply Current vs. Temperature

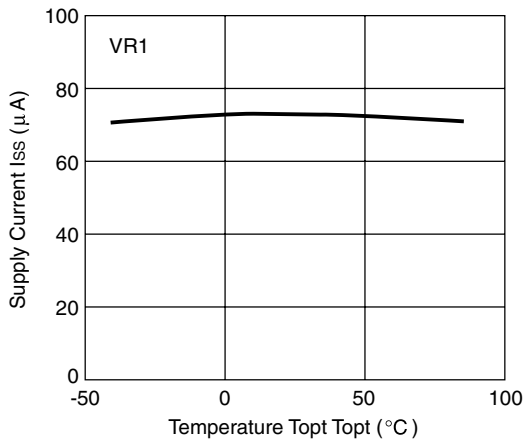
3V

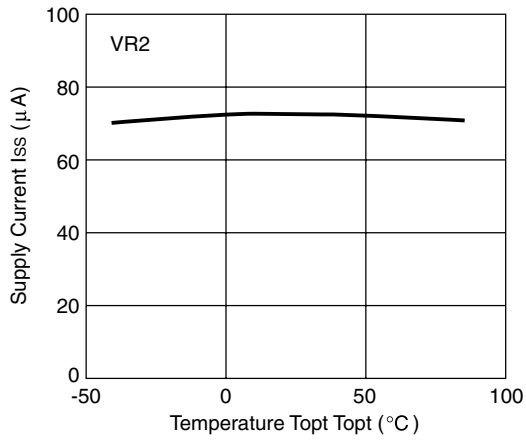


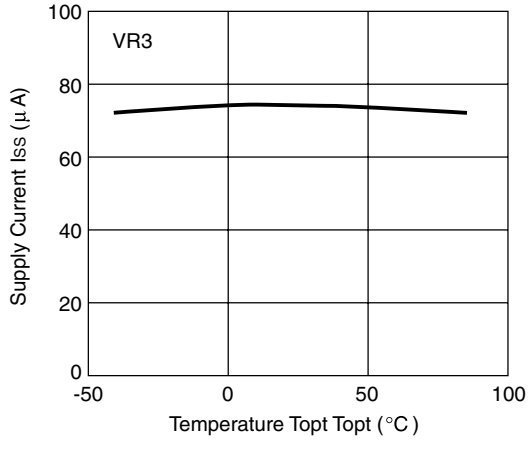




4V

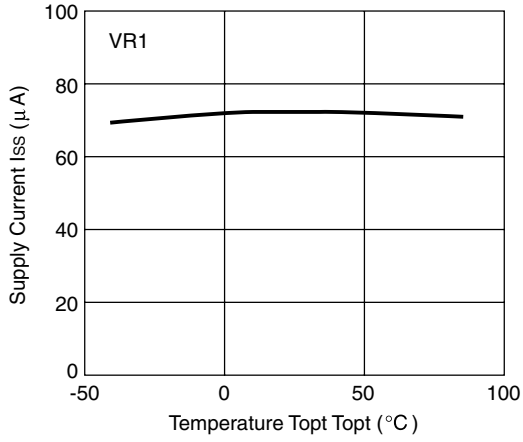


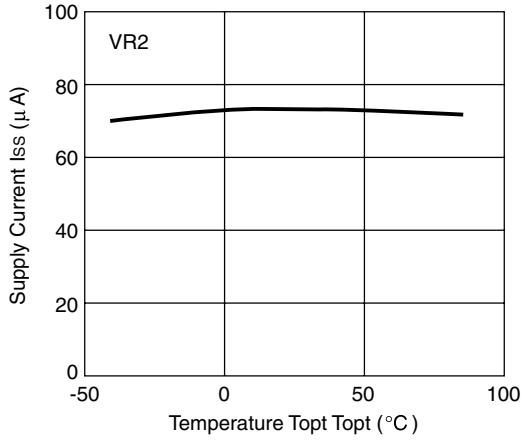


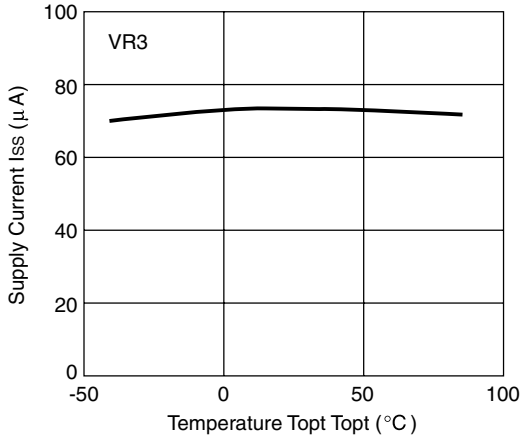


7) Dropout Voltage vs. Set Output Voltage

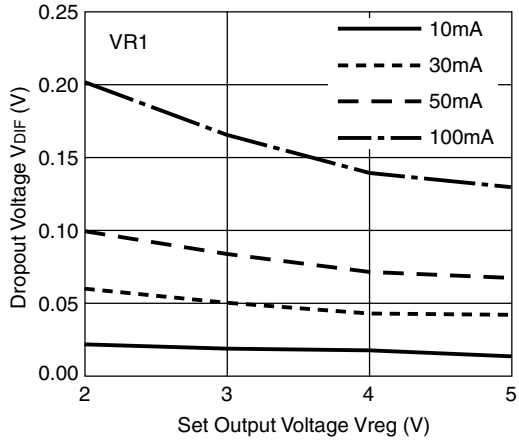
5V

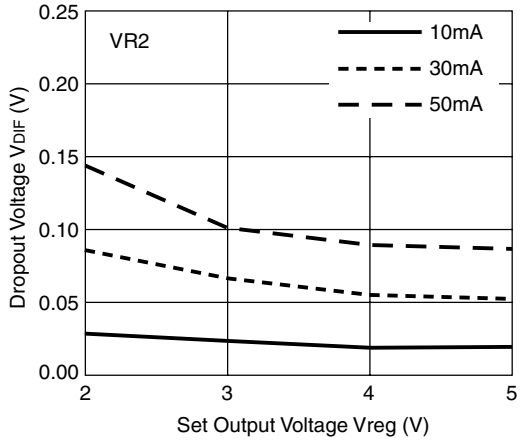


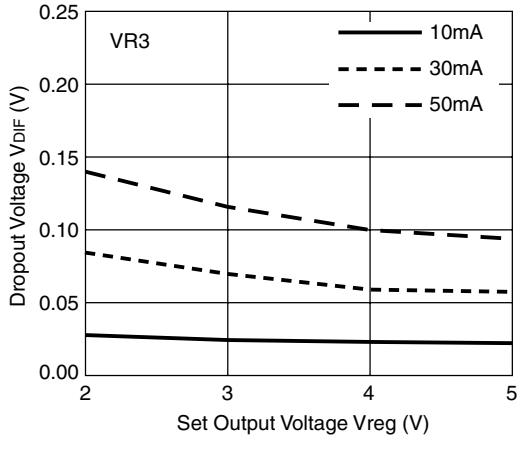




3V



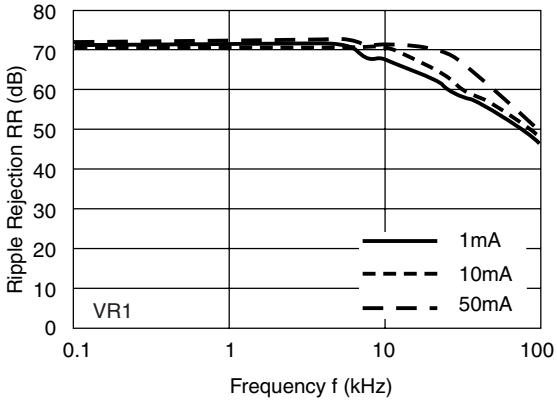


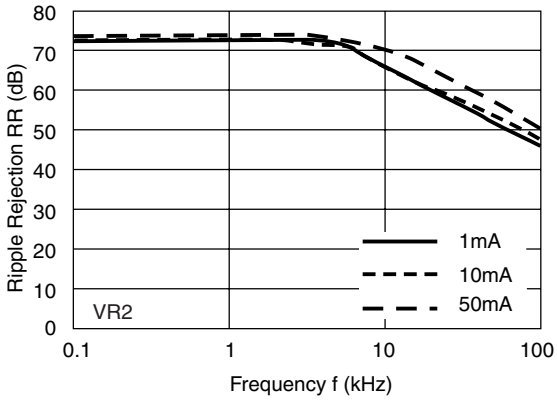


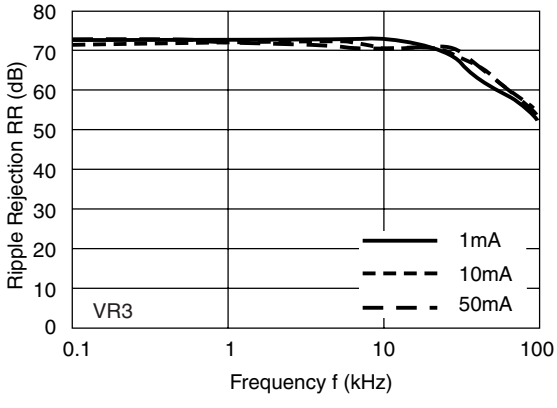
8) Ripple Rejection vs. Frequency

3V

C_{OUT} = 0.47µF

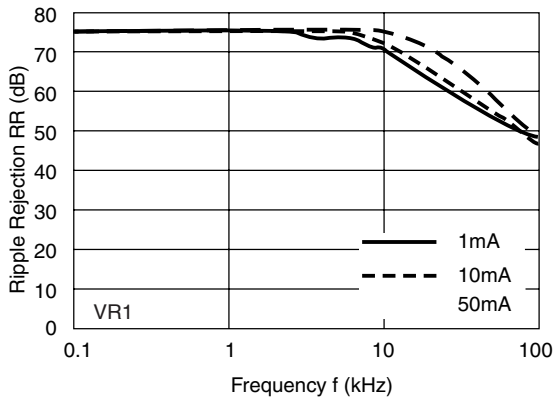


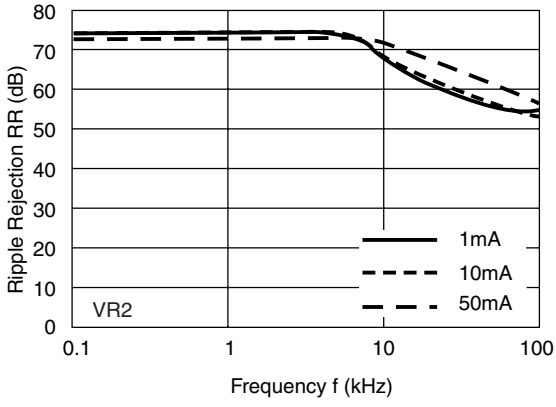


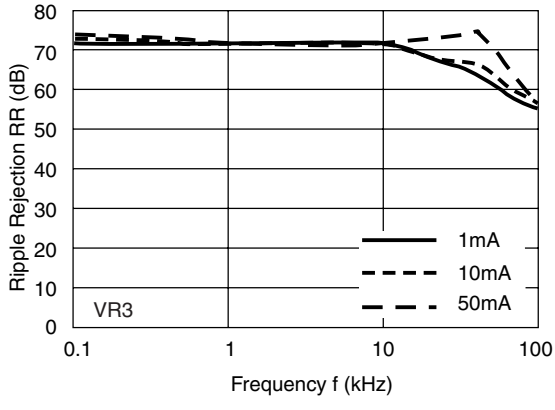


3V

C_{OUT} = 2.2µF

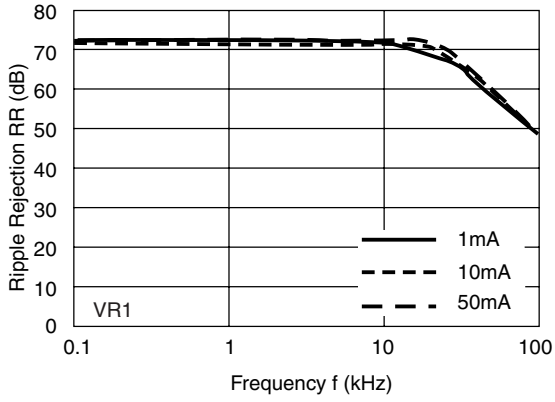


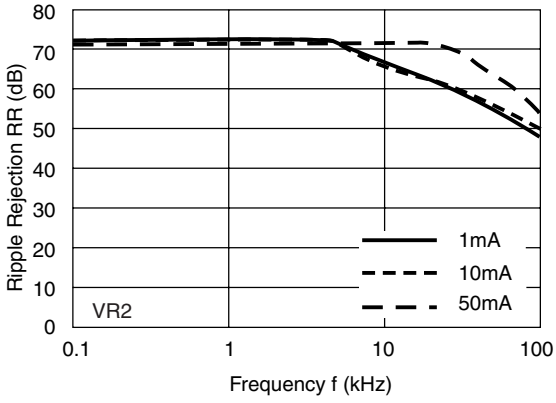


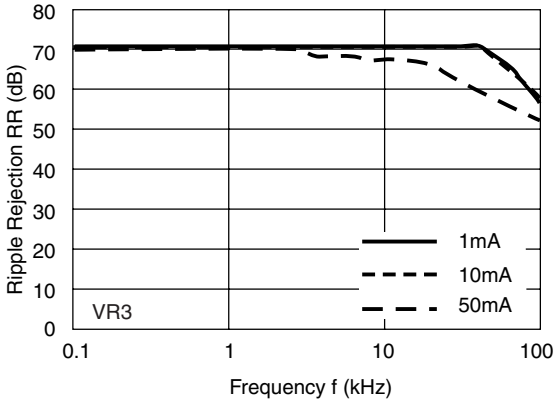


4V

COUT = 0.47µF

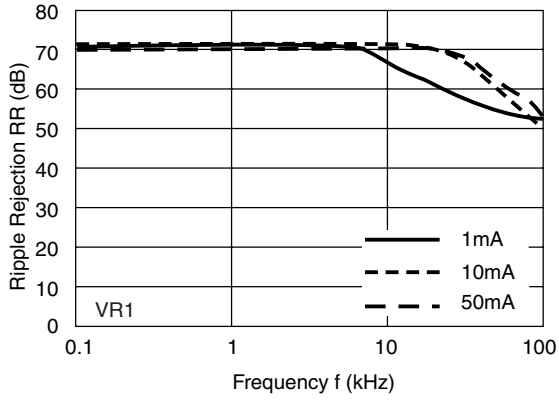


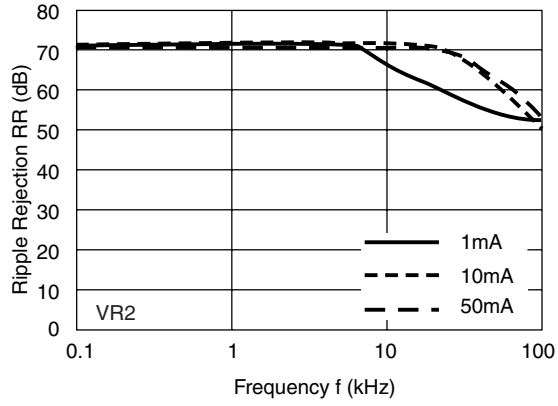


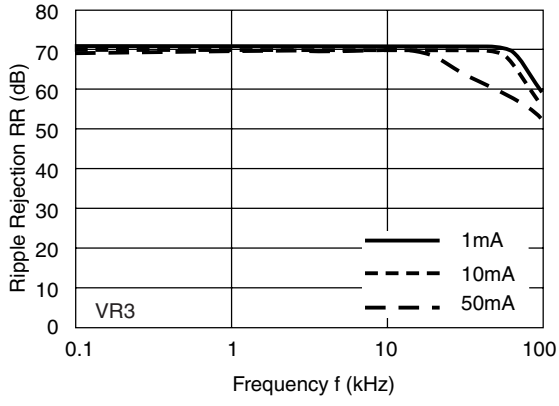


4V

COUT = 2.2µF

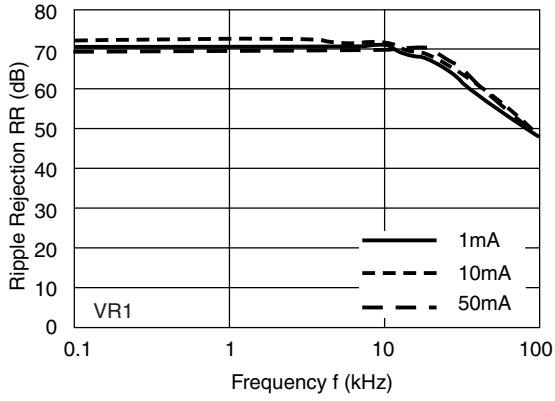






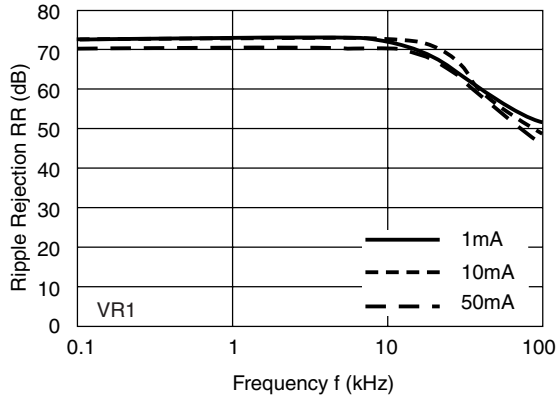
5V

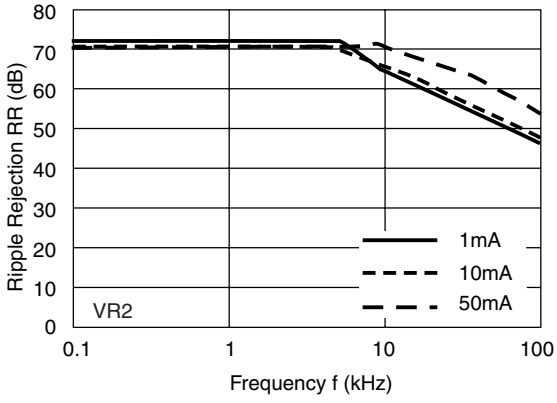
COUT = 0.47µF

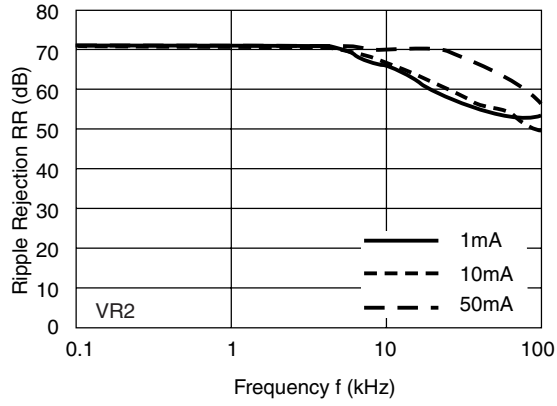


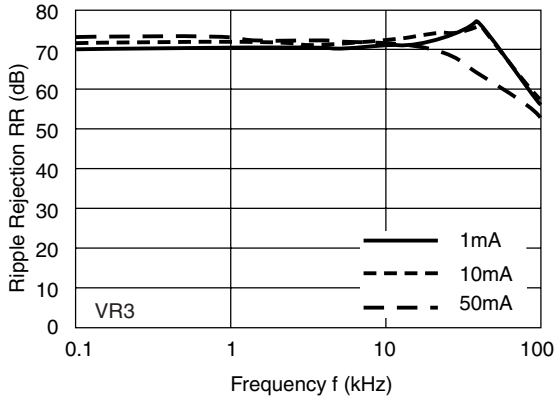
5V

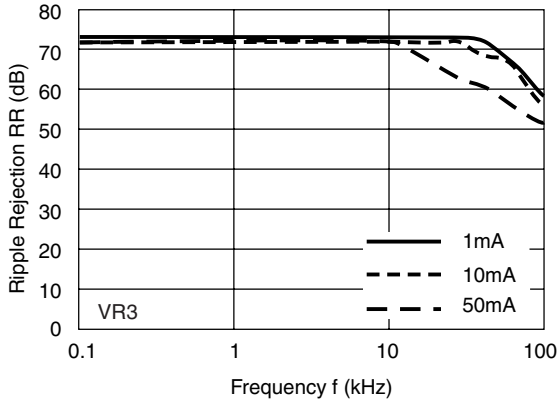
COUT = 2.2µF





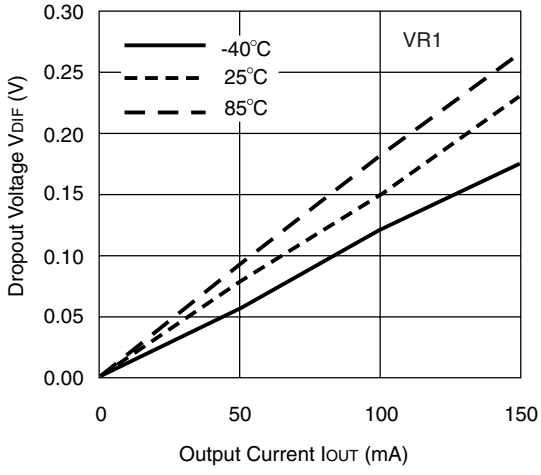




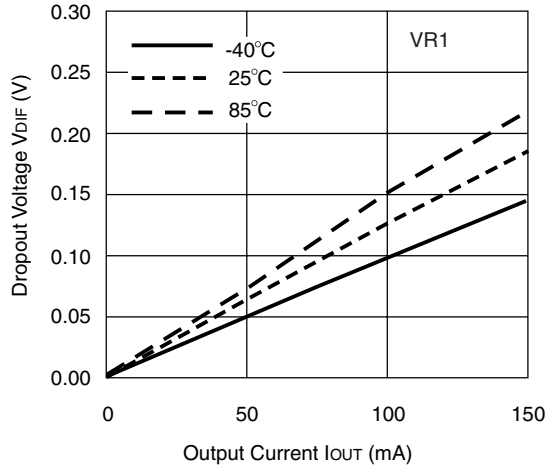


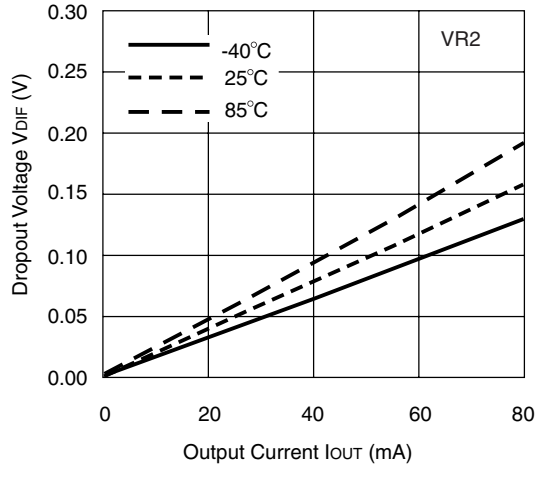
9) Dropout Voltage vs. Output Current

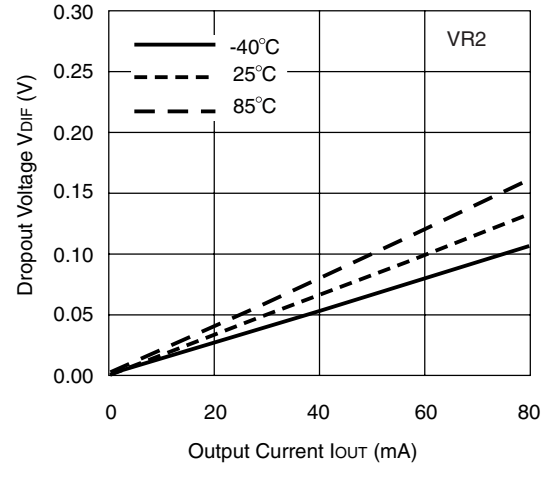
3V

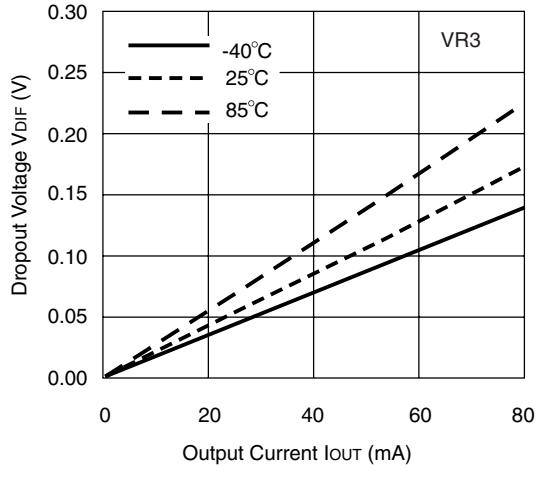


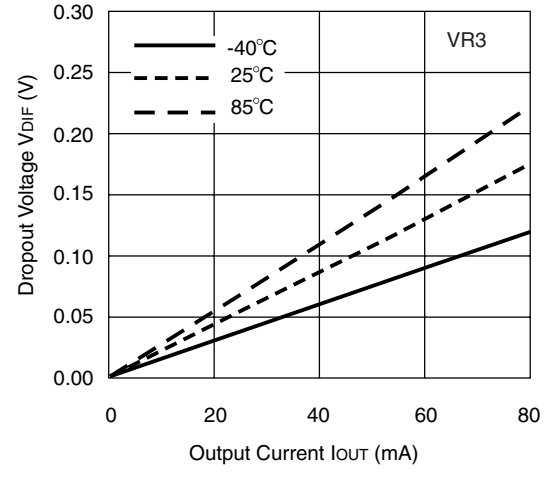
4V



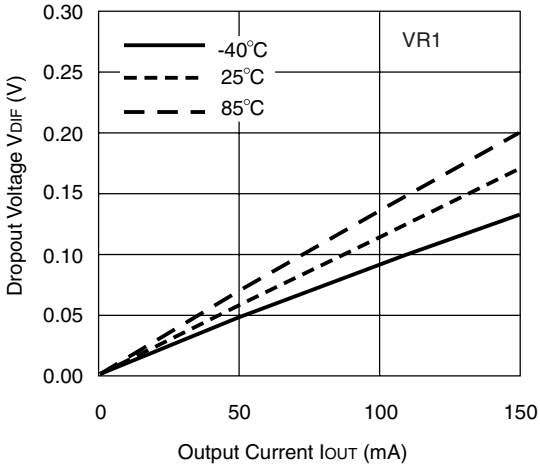


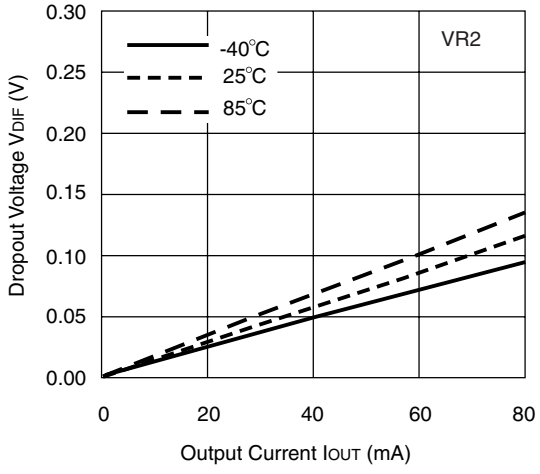


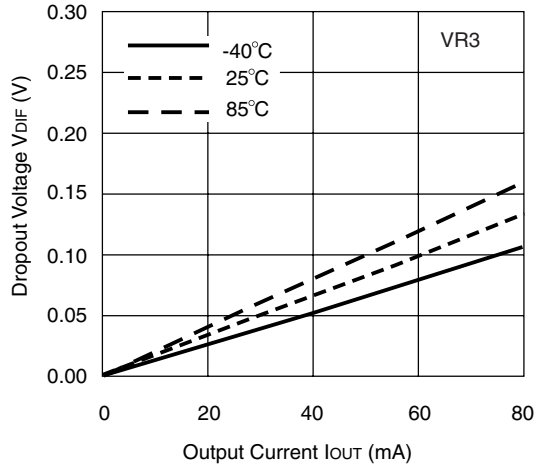




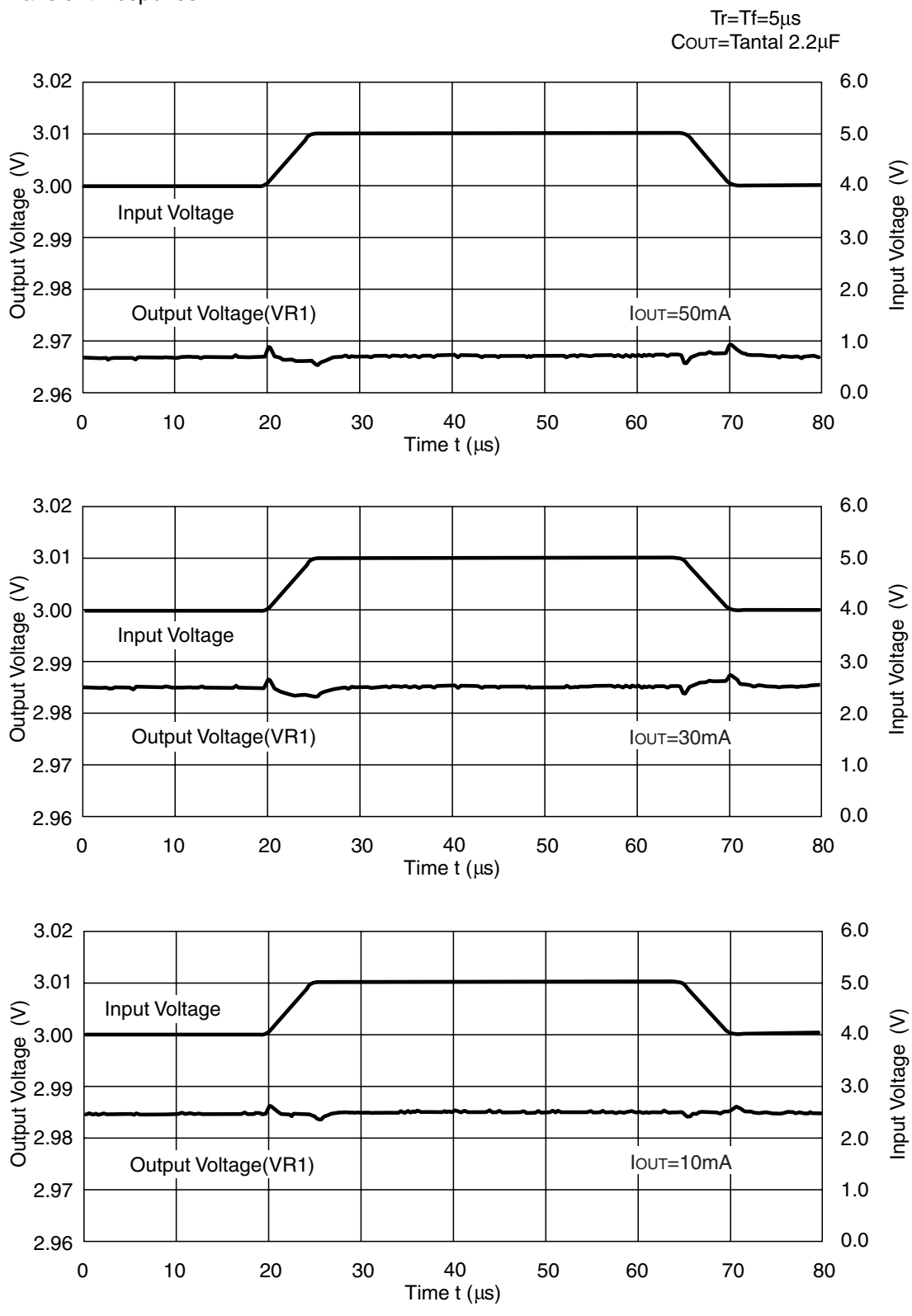
5V

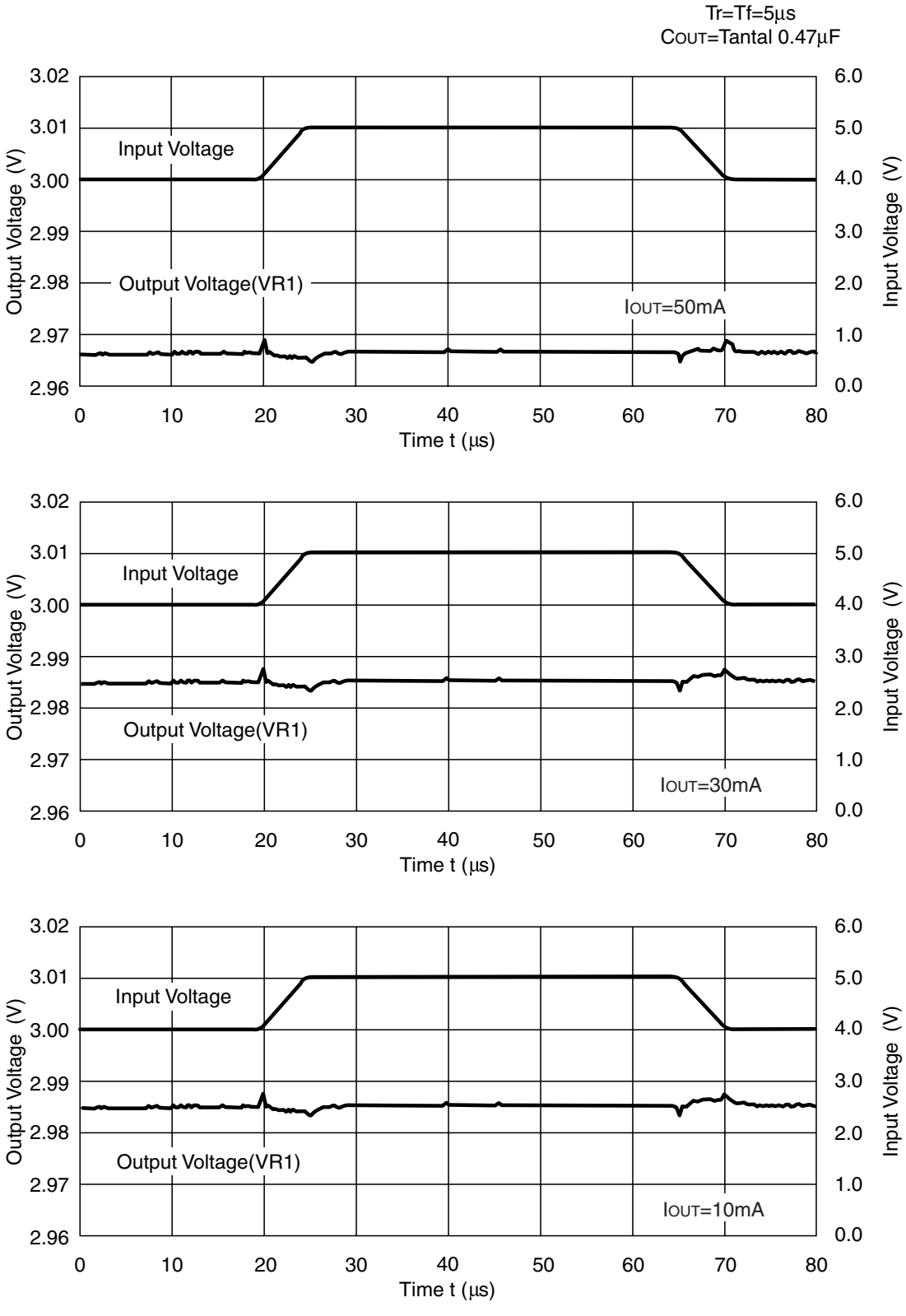

VR1
-40°C
25°C
85°C
Dropout Voltage VDIF (V)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
Output Current IOUT (mA)

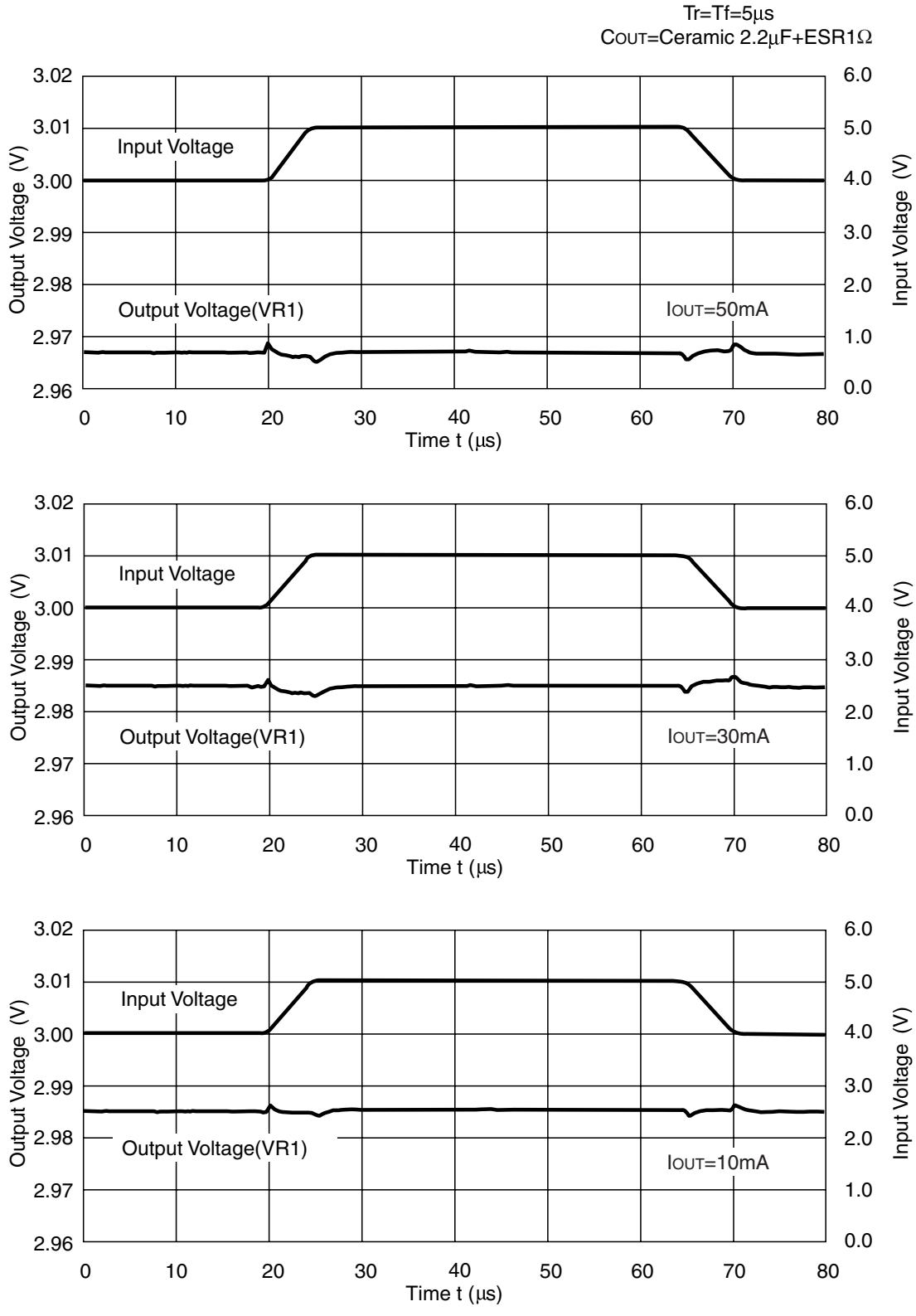

VR2
-40°C
25°C
85°C
Dropout Voltage VDIF (V)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
20
40
60
80
Output Current IOUT (mA)


VR3
-40°C
25°C
85°C
Dropout Voltage VDIF (V)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
20
40
60
80
Output Current IOUT (mA)

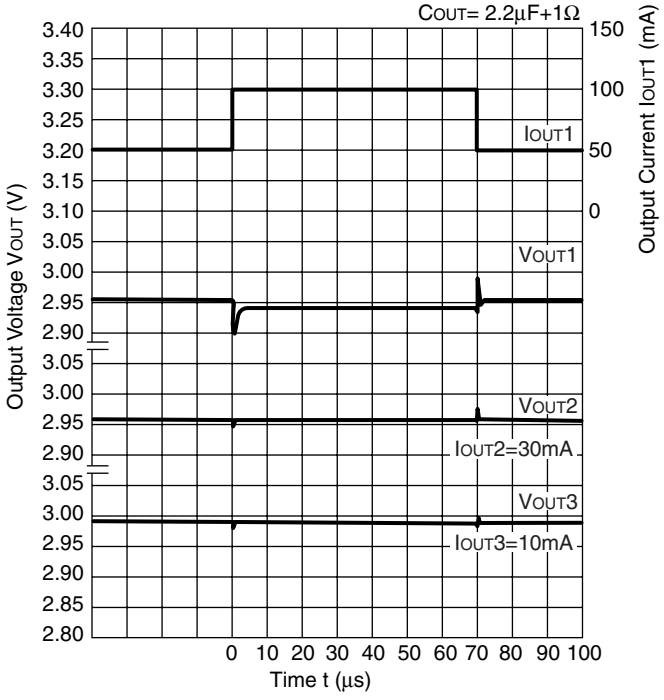
10) Line Transient Response

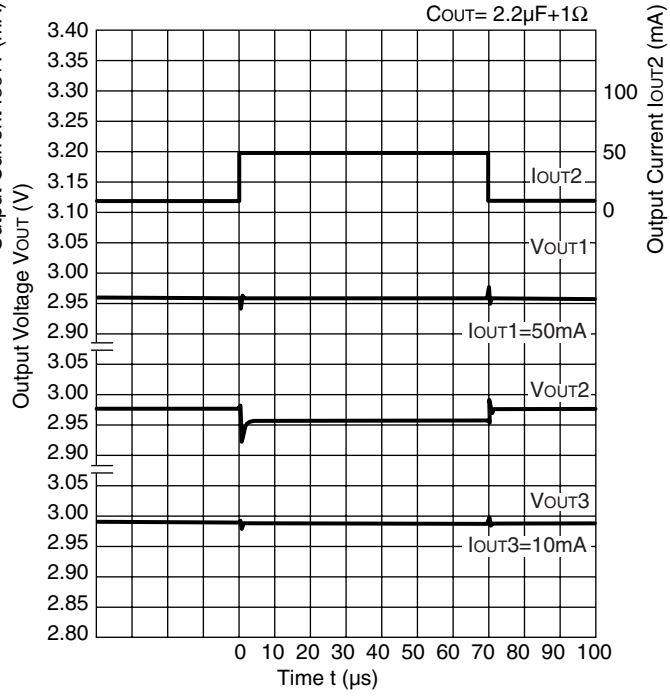


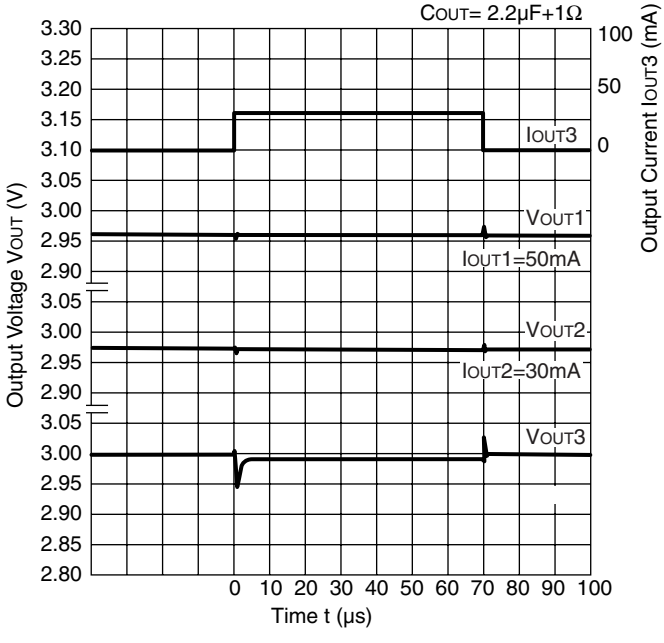

Tr=Tf=5µs
COUT=Tantal 0.47µF
Input Voltage
Output Voltage(VR1)
IOUT=50mA
Output Voltage (V)
Input Voltage (V)
Time t (µs)
Input Voltage
Output Voltage(VR1)
IOUT=30mA
Output Voltage (V)
Input Voltage (V)
Time t (µs)
Input Voltage
Output Voltage(VR1)
IOUT=10mA
Output Voltage (V)
Input Voltage (V)
Time t (µs)


Tr=Tf=5µs
COUT=Ceramic 2.2µF+ESR1Ω
Input Voltage
Output Voltage(VR1)
IOUT=50mA
IOUT=30mA
IOUT=10mA
Output Voltage (V)
Input Voltage (V)
Time t (µs)
3.02
3.01
3.00
2.99
2.98
2.97
2.96
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
10
20
30
40
50
60
70
80

11) Load Transient Response



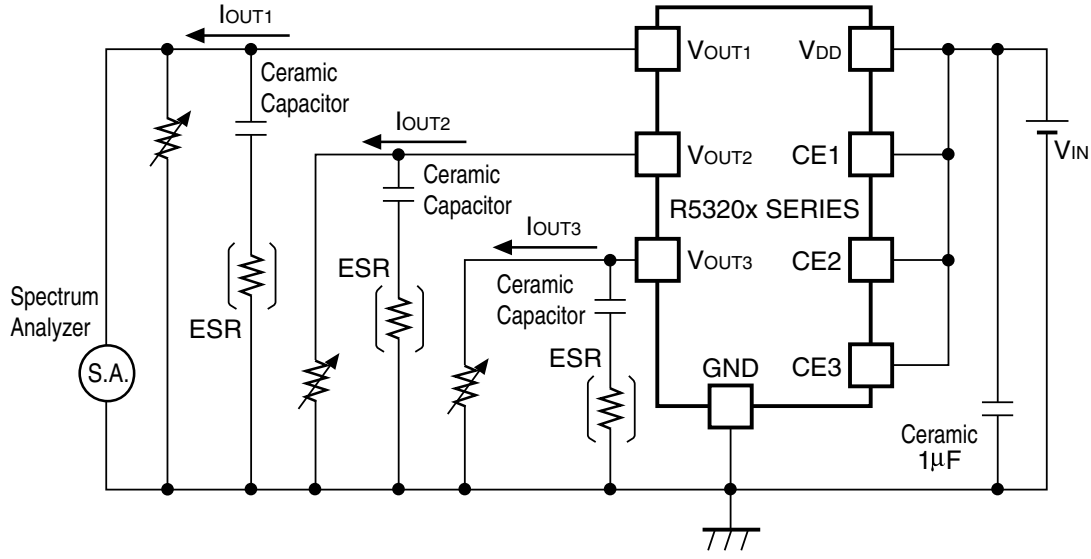




TECHNICAL NOTES

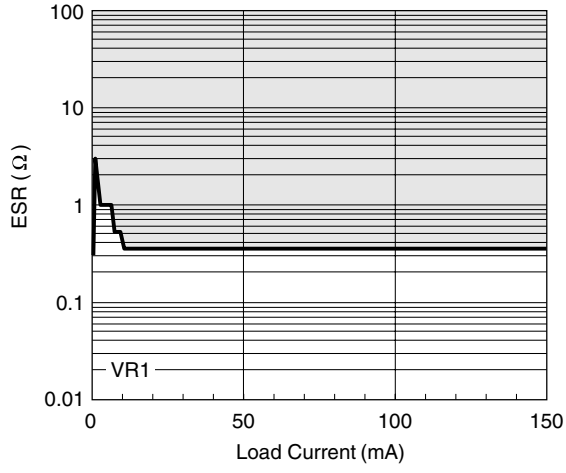
To use this IC with ceramic capacitors, ESR should be set in the range of the following graphs.

Test circuit for Noise level measurement is shown below;

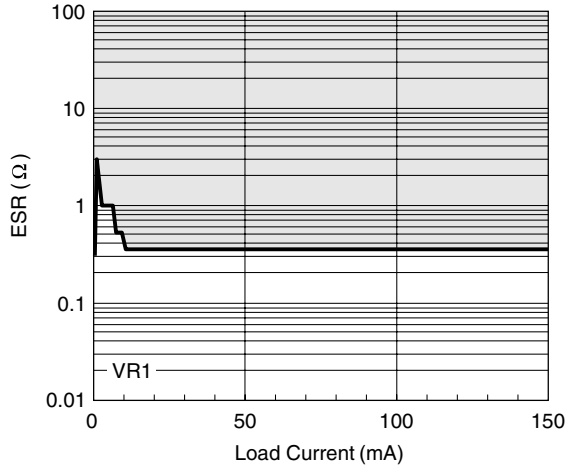


Noise level is measured with a spectrum analyzer and hatched area shows stable areas of which noise level is approximately equal or less than 40μV (Avg.). The relation between Load Current (I_{OUT}) and Equivalent Series Resistors (ESR) value of external output capacitor with the stable area is shown below;

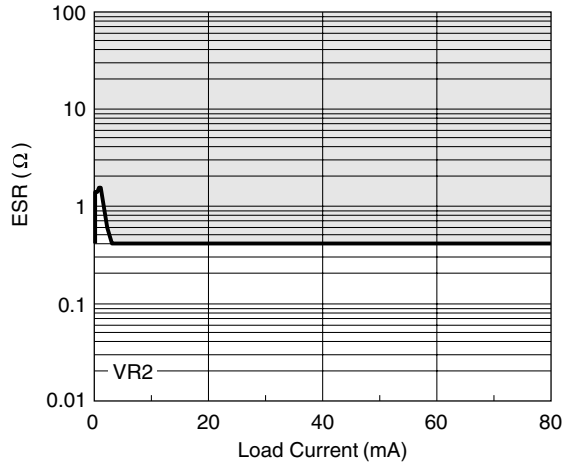
Ceramic Capacitor 1 µF

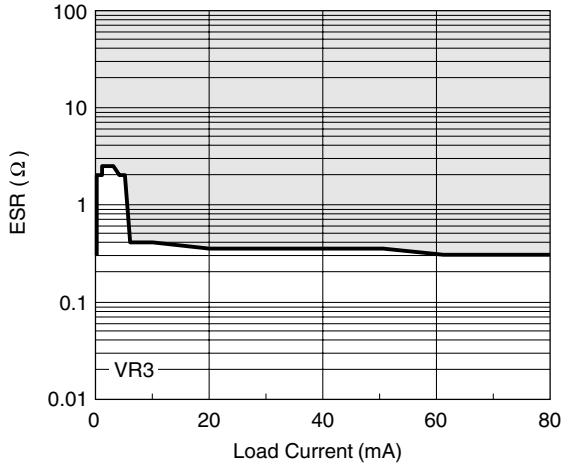


Ceramic Capacitor 2.2 µF

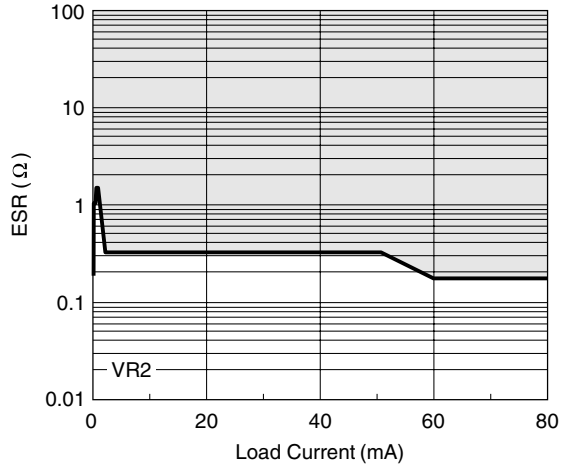


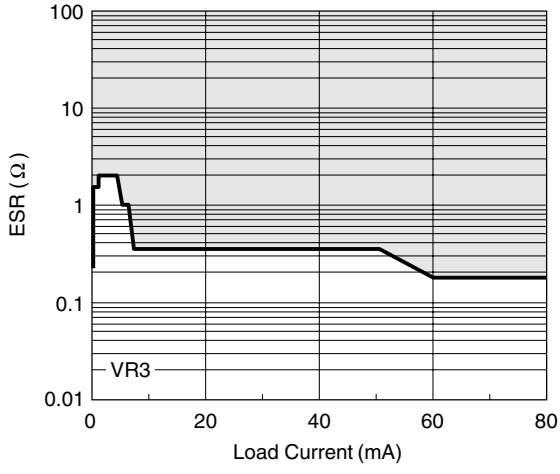
Ceramic Capacitor 1 μF





Ceramic Capacitor 2.2 μF





Measuring Conditions

Frequency Band : 10Hz to 1MHz

Temperature : 25°C