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HIGH OPERATING VOLTAGE CMOS VOLTAGE REGULATOR

The S-812C Series is a high-withstand voltage regulator IC which is developed by using the CMOS technology. This IC is suitable for applications which require withstand because its maximum voltage for operation is as high as 16 V, also for portable device having the low current consumption because this IC not only has the low current consumption but also a power-off circuit. This IC operates stably due to the internal phase compensation circuit so that users are able to use ceramic capacitor as the output capacitor.

■ Features

- Low current consumption: Current at operation: Typ. 1.0 μ A, Max. 1.8 μ A (product with 3.0 V)
- Output voltage: 2.0 to 6.0 V, selectable in 0.1 V step.
- Output voltage accuracy: $\pm 2.0\%$
- Output current: 50 mA capable (3.0 V output product, $V_{IN}=5$ V) ^{*1}
75 mA capable (5.0 V output product, $V_{IN}=7$ V) ^{*1}
- Dropout voltage: Typ. 120 mV ($V_{OUT} = 5.0$ V, $I_{OUT} = 10$ mA)
- Built-in Power-off circuit: Selectable if power-off function is available or not.
Active high or low in the regulator is selectable.
- Short-circuit protection: Selectable with/without short-circuit protection.
Short-circuited current 40 mA Typ.: in the product with protection.
- Operation voltage: 16 V max.
- Lead-free, Sn 100%, halogen-free ^{*2}

*1. Attention should be paid to the power dissipation of the package when the load is large.

*2. Refer to “**■ Product Name Structure**” for details.

■ Applications

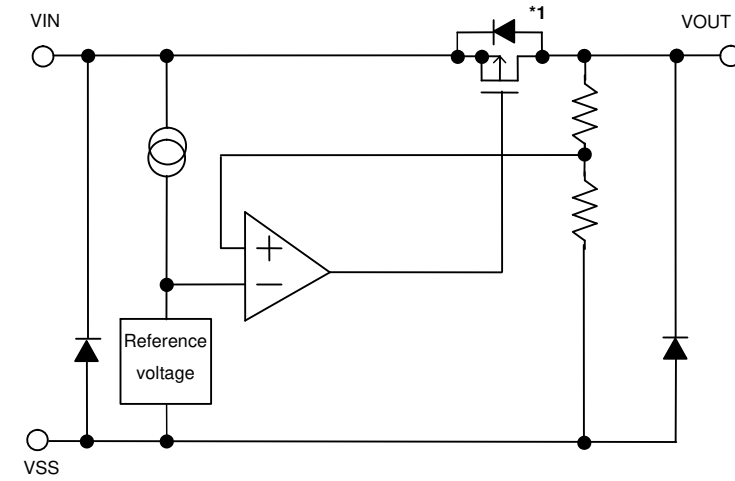
- Power source for home electric/electronic appliances
- Power source for battery-powered devices
- Power source for communication devices

■ Packages

- SNT-6A(H)
- SOT-23-5
- SOT-89-3
- SOT-89-5
- TO-92

■ **Block Diagrams**

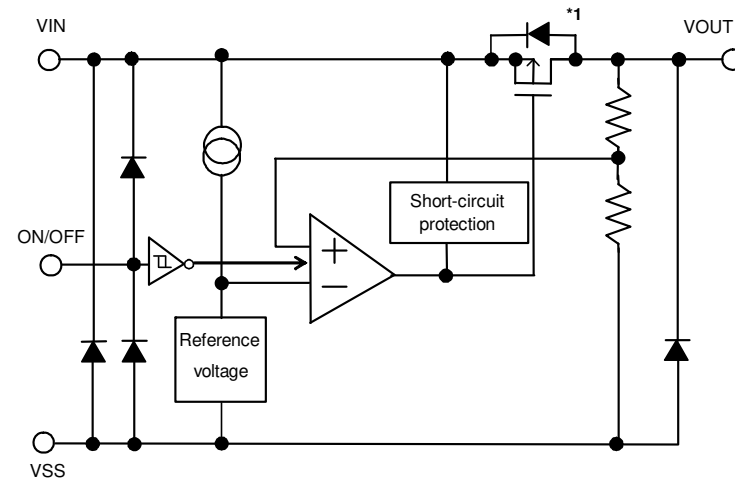
1. S-812CxxA Series (No short-circuit protection and power-off function)



*1. Parasitic diode

Figure 1

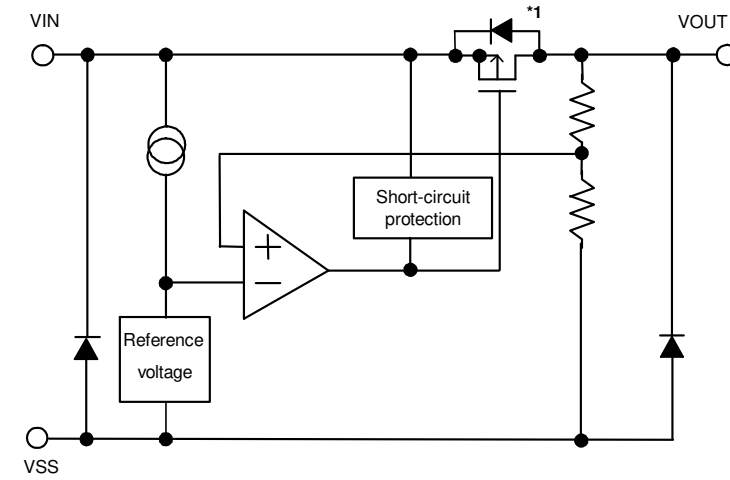
2. S-812CxxB Series (Short-circuit protection and power-off function)



*1. Parasitic diode

Figure 2

3. S-812CxxE Series (Short-circuit protection and no power-off function)



*1. Parasitic diode

Figure 3

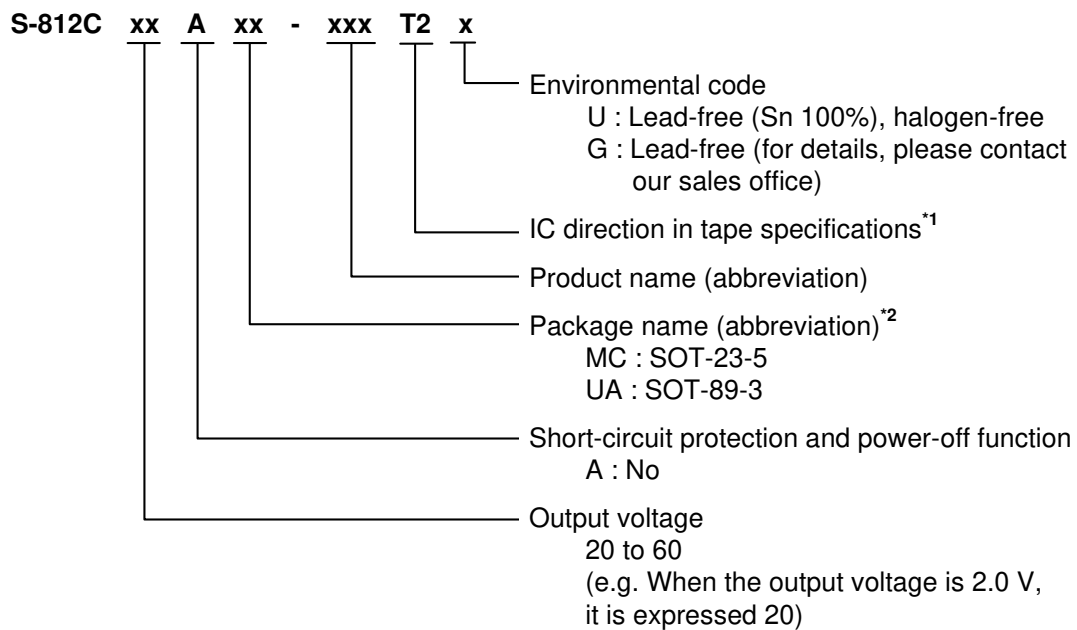
■ **Product Name Structure**

Users can select the product type, output voltage, and package type for the S-812C Series. Refer to the “**1. Product Name**” for the construction of the product name, “**2. Package**” regarding the package drawings and “**3. Product Name List**” for the full product names.

1. Product name

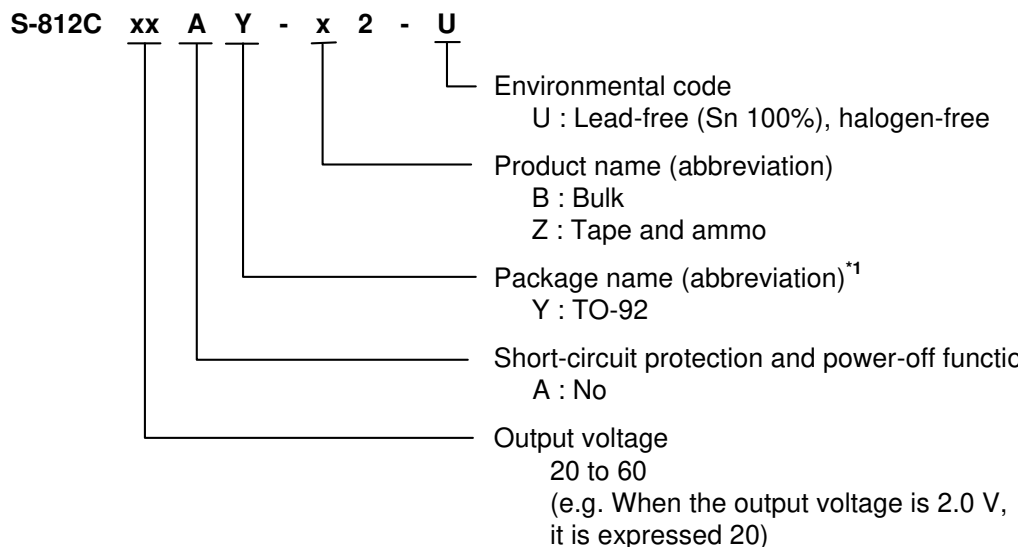
1.1 S-812CxxA series

1.1.1 Package SOT-23-5, SOT-89-3



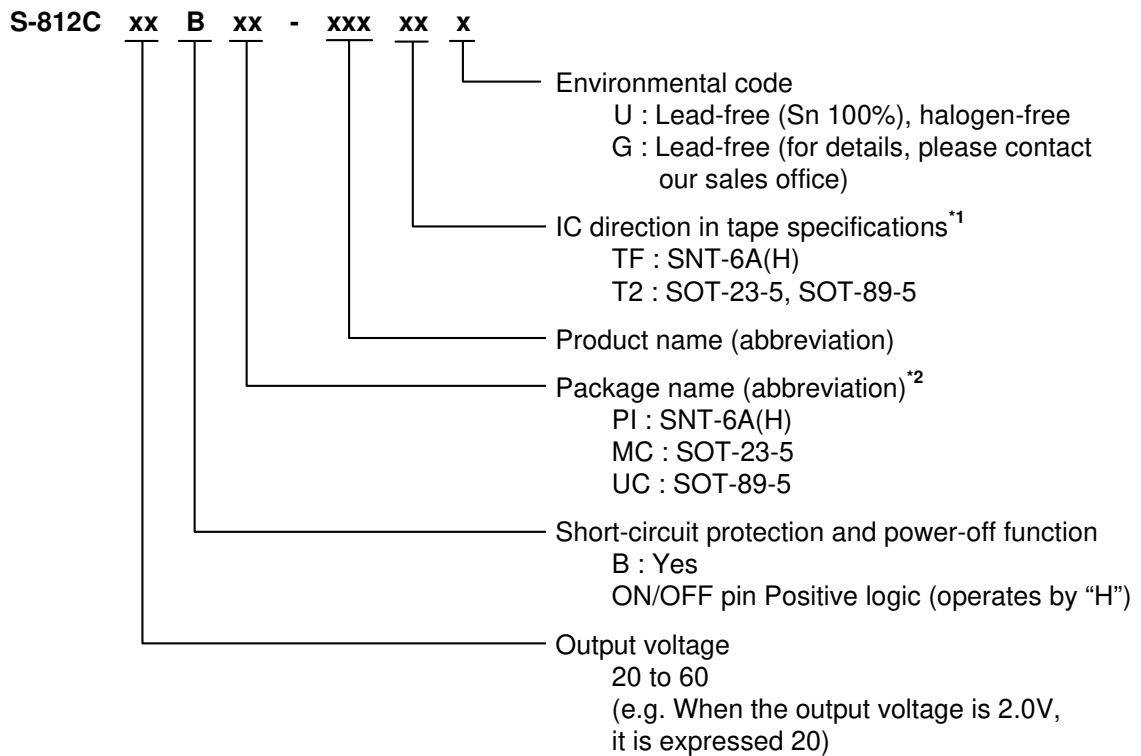
*1. Refer to the tape specifications.
 *2. Refer to the “**3. Product name list**”.

1.1.2 Package TO-92



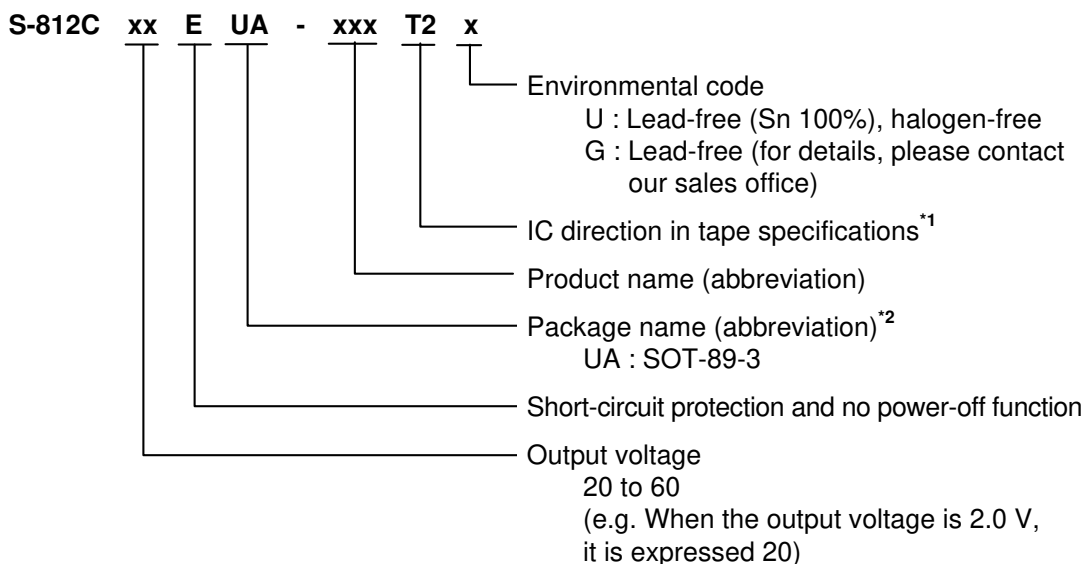
*1. Refer to the “**3. Product name list**”.

1.2 S-812CxxB series



*1. Refer to the tape specifications.
*2. Refer to the "3. Product name list".

1.3 S-812CxxE series



*1. Refer to the tape specifications.
*2. Refer to the "3. Product name list".

2. Package

Package name	Drawing code				
	Package	Tape	Reel	Zigzag	Land
SNT-6A(H)	PI006-A-P-SD	PI006-A-C-SD	PI006-A-R-SD	—	PI006-A-L-SD
SOT-23-5	MP005-A-P-SD	MP005-A-C-SD	MP005-A-R-SD	—	—
SOT-89-3	UP003-A-P-SD	UP003-A-C-SD	UP003-A-R-SD	—	—
SOT-89-5	UP005-A-P-SD	UP005-A-C-SD	UP005-A-R-SD	—	—
TO-92 (Bulk)	YS003-D-P-SD	—	—	—	—
TO-92 (Tape and ammo)	YZ003-E-P-SD	YZ003-E-C-SD	—	YZ003-E-Z-SD	—

HIGH OPERATING VOLTAGE CMOS VOLTAGE REGULATOR

Rev.6.1_00

S-812C Series

3. Product name list

3.1 S-812CxxA Series (No short-circuit protection, power-off function)

Table 1

Output voltage	SOT-23-5	SOT-89-3	SOT-89-5	TO-92 ^{*1}
2.0 V±2.0 %	S-812C20AMC-C2AT2x	S-812C20AUA-C2AT2x	—	S-812C20AY-n2-U
2.1 V±2.0 %	S-812C21AMC-C2BT2x	S-812C21AUA-C2BT2x	—	S-812C21AY-n2-U
2.2 V±2.0 %	S-812C22AMC-C2CT2x	S-812C22AUA-C2CT2x	—	S-812C22AY-n2-U
2.3 V±2.0 %	S-812C23AMC-C2DT2x	S-812C23AUA-C2DT2x	—	S-812C23AY-n2-U
2.4 V±2.0 %	S-812C24AMC-C2ET2x	S-812C24AUA-C2ET2x	—	S-812C24AY-n2-U
2.5 V±2.0 %	S-812C25AMC-C2FT2x	S-812C25AUA-C2FT2x	—	S-812C25AY-n2-U
2.6 V±2.0 %	S-812C26AMC-C2GT2x	S-812C26AUA-C2GT2x	—	S-812C26AY-n2-U
2.7 V±2.0 %	S-812C27AMC-C2HT2x	S-812C27AUA-C2HT2x	—	S-812C27AY-n2-U
2.8 V±2.0 %	S-812C28AMC-C2IT2x	S-812C28AUA-C2IT2x	—	S-812C28AY-n2-U
2.9 V±2.0 %	S-812C29AMC-C2JT2x	S-812C29AUA-C2JT2x	—	S-812C29AY-n2-U
3.0 V±2.0 %	S-812C30AMC-C2KT2x	S-812C30AUA-C2KT2x	—	S-812C30AY-n2-U
3.1 V±2.0 %	S-812C31AMC-C2LT2x	S-812C31AUA-C2LT2x	—	S-812C31AY-n2-U
3.2 V±2.0 %	S-812C32AMC-C2MT2x	S-812C32AUA-C2MT2x	—	S-812C32AY-n2-U
3.3 V±2.0 %	S-812C33AMC-C2NT2x	S-812C33AUA-C2NT2x	—	S-812C33AY-n2-U
3.4 V±2.0 %	S-812C34AMC-C2OT2x	S-812C34AUA-C2OT2x	—	S-812C34AY-n2-U
3.5 V±2.0 %	S-812C35AMC-C2PT2x	S-812C35AUA-C2PT2x	—	S-812C35AY-n2-U
3.6 V±2.0 %	S-812C36AMC-C2QT2x	S-812C36AUA-C2QT2x	—	S-812C36AY-n2-U
3.7 V±2.0 %	S-812C37AMC-C2RT2x	S-812C37AUA-C2RT2x	—	S-812C37AY-n2-U
3.8 V±2.0 %	S-812C38AMC-C2ST2x	S-812C38AUA-C2ST2x	—	S-812C38AY-n2-U
3.9 V±2.0 %	S-812C39AMC-C2TT2x	S-812C39AUA-C2TT2x	—	S-812C39AY-n2-U
4.0 V±2.0 %	S-812C40AMC-C2UT2x	S-812C40AUA-C2UT2x	—	S-812C40AY-n2-U
4.1 V±2.0 %	S-812C41AMC-C2VT2x	S-812C41AUA-C2VT2x	—	S-812C41AY-n2-U
4.2 V±2.0 %	S-812C42AMC-C2WT2x	S-812C42AUA-C2WT2x	—	S-812C42AY-n2-U
4.3 V±2.0 %	S-812C43AMC-C2XT2x	S-812C43AUA-C2XT2x	—	S-812C43AY-n2-U
4.4 V±2.0 %	S-812C44AMC-C2YT2x	S-812C44AUA-C2YT2x	—	S-812C44AY-n2-U
4.5 V±2.0 %	S-812C45AMC-C2ZT2x	S-812C45AUA-C2ZT2x	—	S-812C45AY-n2-U
4.6 V±2.0 %	S-812C46AMC-C3AT2x	S-812C46AUA-C3AT2x	—	S-812C46AY-n2-U
4.7 V±2.0 %	S-812C47AMC-C3BT2x	S-812C47AUA-C3BT2x	—	S-812C47AY-n2-U
4.8 V±2.0 %	S-812C48AMC-C3CT2x	S-812C48AUA-C3CT2x	—	S-812C48AY-n2-U
4.9 V±2.0 %	S-812C49AMC-C3DT2x	S-812C49AUA-C3DT2x	—	S-812C49AY-n2-U
5.0 V±2.0 %	S-812C50AMC-C3ET2x	S-812C50AUA-C3ET2x	—	S-812C50AY-n2-U
5.1 V±2.0 %	S-812C51AMC-C3FT2x	S-812C51AUA-C3FT2x	—	S-812C51AY-n2-U
5.2 V±2.0 %	S-812C52AMC-C3GT2x	S-812C52AUA-C3GT2x	—	S-812C52AY-n2-U
5.3 V±2.0 %	S-812C53AMC-C3HT2x	S-812C53AUA-C3HT2x	—	S-812C53AY-n2-U
5.4 V±2.0 %	S-812C54AMC-C3IT2x	S-812C54AUA-C3IT2x	—	S-812C54AY-n2-U
5.5 V±2.0 %	S-812C55AMC-C3JT2x	S-812C55AUA-C3JT2x	—	S-812C55AY-n2-U
5.6 V±2.0 %	S-812C56AMC-C3KT2x	S-812C56AUA-C3KT2x	—	S-812C56AY-n2-U
5.7 V±2.0 %	S-812C57AMC-C3LT2x	S-812C57AUA-C3LT2x	—	S-812C57AY-n2-U
5.8 V±2.0 %	S-812C58AMC-C3MT2x	S-812C58AUA-C3MT2x	—	S-812C58AY-n2-U
5.9 V±2.0 %	S-812C59AMC-C3NT2x	S-812C59AUA-C3NT2x	—	S-812C59AY-n2-U
6.0 V±2.0 %	S-812C60AMC-C3OT2x	S-812C60AUA-C3OT2x	—	S-812C60AY-n2-U

*1. "n" changes according to the packing form in TO-92.

B: Bulk, Z: Tape and ammo.

Remark 1. Please contact our sales office for products with an output voltage value other than those specified above.

2. x: G or U

3. Please select products of environmental code = U for Sn 100%, halogen-free products.

3. 2 S-812CxxB Series (Short-circuit protection and power-off function)

Table 2

Output voltage	SNT-6A(H)	SOT-23-5	SOT-89-5
2.0 V±2.0 %	S-812C20BPI-C4ATFx	S-812C20BMC-C4AT2x	—
2.1 V±2.0 %	S-812C21BPI-C4BTFx	S-812C21BMC-C4BT2x	—
2.2 V±2.0 %	S-812C22BPI-C4CTFx	S-812C22BMC-C4CT2x	—
2.3 V±2.0 %	S-812C23BPI-C4DTFx	S-812C23BMC-C4DT2x	—
2.4 V±2.0 %	S-812C24BPI-C4ETFx	S-812C24BMC-C4ET2x	—
2.5 V±2.0 %	S-812C25BPI-C4FTFx	S-812C25BMC-C4FT2x	—
2.6 V±2.0 %	S-812C26BPI-C4GTFx	S-812C26BMC-C4GT2x	—
2.7 V±2.0 %	S-812C27BPI-C4HTFx	S-812C27BMC-C4HT2x	—
2.8 V±2.0 %	S-812C28BPI-C4ITFx	S-812C28BMC-C4IT2x	—
2.9 V±2.0 %	S-812C29BPI-C4JTFx	S-812C29BMC-C4JT2x	—
3.0 V±2.0 %	S-812C30BPI-C4KTFx	S-812C30BMC-C4KT2x	—
3.1 V±2.0 %	S-812C31BPI-C4LTFx	S-812C31BMC-C4LT2x	—
3.2 V±2.0 %	S-812C32BPI-C4MTFx	S-812C32BMC-C4MT2x	—
3.3 V±2.0 %	S-812C33BPI-C4NTFx	S-812C33BMC-C4NT2x	S-812C33BUC-C4NT2x
3.4 V±2.0 %	S-812C34BPI-C4OTFx	S-812C34BMC-C4OT2x	—
3.5 V±2.0 %	S-812C35BPI-C4PTFx	S-812C35BMC-C4PT2x	—
3.6 V±2.0 %	S-812C36BPI-C4QTFx	S-812C36BMC-C4QT2x	—
3.7 V±2.0 %	S-812C37BPI-C4RTFx	S-812C37BMC-C4RT2x	—
3.8 V±2.0 %	S-812C38BPI-C4STFx	S-812C38BMC-C4ST2x	—
3.9 V±2.0 %	S-812C39BPI-C4TTFx	S-812C39BMC-C4TT2x	—
4.0 V±2.0 %	S-812C40BPI-C4UTFx	S-812C40BMC-C4UT2x	—
4.1 V±2.0 %	S-812C41BPI-C4VTFx	S-812C41BMC-C4VT2x	—
4.2 V±2.0 %	S-812C42BPI-C4WTFx	S-812C42BMC-C4WT2x	—
4.3 V±2.0 %	S-812C43BPI-C4XTFx	S-812C43BMC-C4XT2x	—
4.4 V±2.0 %	S-812C44BPI-C4YTFx	S-812C44BMC-C4YT2x	—
4.5 V±2.0 %	S-812C45BPI-C4ZTFx	S-812C45BMC-C4ZT2x	—
4.6 V±2.0 %	S-812C46BPI-C5ATFx	S-812C46BMC-C5AT2x	—
4.7 V±2.0 %	S-812C47BPI-C5BTFx	S-812C47BMC-C5BT2x	—
4.8 V±2.0 %	S-812C48BPI-C5CTFx	S-812C48BMC-C5CT2x	—
4.9 V±2.0 %	S-812C49BPI-C5DTFx	S-812C49BMC-C5DT2x	—
5.0 V±2.0 %	S-812C50BPI-C5ETFx	S-812C50BMC-C5ET2x	S-812C50BUC-C5ET2x
5.1 V±2.0 %	S-812C51BPI-C5FTFx	S-812C51BMC-C5FT2x	—
5.2 V±2.0 %	S-812C52BPI-C5GTFx	S-812C52BMC-C5GT2x	—
5.3 V±2.0 %	S-812C53BPI-C5HTFx	S-812C53BMC-C5HT2x	—
5.4 V±2.0 %	S-812C54BPI-C5ITFx	S-812C54BMC-C5IT2x	—
5.5 V±2.0 %	S-812C55BPI-C5JTFx	S-812C55BMC-C5JT2x	—
5.6 V±2.0 %	S-812C56BPI-C5KTFx	S-812C56BMC-C5KT2x	—
5.7 V±2.0 %	S-812C57BPI-C5LTFx	S-812C57BMC-C5LT2x	—
5.8 V±2.0 %	S-812C58BPI-C5MTFx	S-812C58BMC-C5MT2x	—
5.9 V±2.0 %	S-812C59BPI-C5NTFx	S-812C59BMC-C5NT2x	—
6.0 V±2.0 %	S-812C60BPI-C5OTFx	S-812C60BMC-C5OT2x	—

Remark 1. Please contact our sales office for products with an output voltage value other than those specified above.

2. x: G or U

3. Please select products of environmental code = U for Sn 100%, halogen-free products.

HIGH OPERATING VOLTAGE CMOS VOLTAGE REGULATOR
S-812C Series

Rev.6.1_00

3.3 S-812CxxE Series (Short-circuit protection, no power-off function)

Table 3

Output voltage	SOT-23-5	SOT-89-3	SOT-89-5	TO-92 ^{*1}
3.3 V±2.0 %	—	S-812C33EUA-C5PT2x	—	—
3.6 V±2.0 %	—	S-812C36EUA-C5RT2x	—	—
4.0 V±2.0 %	—	S-812C40EUA-C5QT2x	—	—

*1. "n" changes according to the packing form in TO-92.

B: Bulk, Z: Tape and ammo.

Remark 1. Please contact our sales office for products with an output voltage value other than those specified above.

2. x: G or U

3. Please select products of environmental code = U for Sn 100%, halogen-free products.

■ **Pin Configurations**

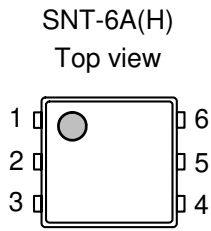


Figure 4

Table 4

Pin No.	Symbol	Description
1	NC ^{*1}	No connection
2	VIN	Input voltage pin
3	VOUT	Output voltage pin
4	VSS	GND pin
5	VIN	Input voltage pin
6	ON/OFF	Power-off pin

*1. The NC pin is electrically open.
 The NC pin can be connected to VIN or VSS.

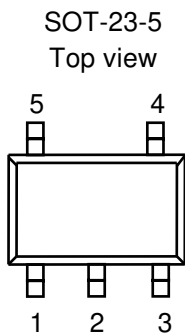


Figure 5

Table 5

Pin No.	Symbol	Description
1	VSS	GND pin
2	VIN	Input voltage pin
3	VOUT	Output voltage pin
4	NC ^{*1}	No connection
5	ON/OFF	Power-off pin (B type)
	NC ^{*1}	No connection (A type, E type)

*1. The NC pin is electrically open.
 The NC pin can be connected to VIN or VSS.

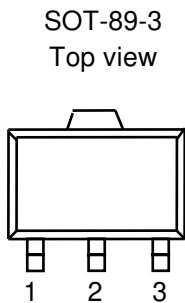


Figure 6

Table 6

Pin No.	Symbol	Description
1	VSS	GND pin
2	VIN	Input voltage pin
3	VOUT	Output voltage pin

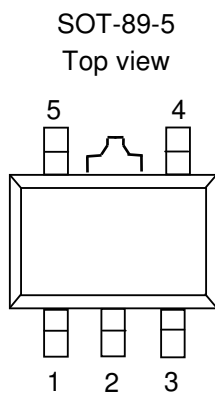


Figure 7

Table 7

Pin No.	Symbol	Description
1	VOUT	Output voltage pin
2	VIN	Input voltage pin
3	VSS	GND pin
4	ON/OFF	Power-off pin (B type)
	NC ^{*1}	No connection (A type, E type)
5	NC ^{*1}	No connection

*1. The NC pin is electrically open.
 The NC pin can be connected to VIN or VSS.

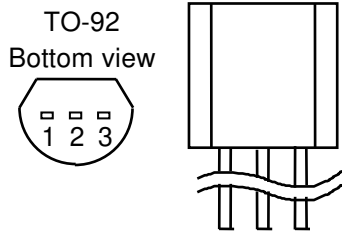


Figure 8

Table 8

Pin No.	Symbol	Description
1	VSS	GND pin
2	VIN	Input voltage pin
3	VOU	Output voltage pin

■ **Absolute Maximum Ratings**

Table 9

(Ta=25°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Units	
Input voltage	V _{IN}	V _{SS} -0.3 to V _{SS} +18	V	
	V _{ON/OFF}	V _{SS} -0.3 to V _{IN} +0.3	V	
Output voltage	V _{OUT}	V _{SS} -0.3 to V _{IN} +0.3	V	
Power dissipation	P _D	SNT-6A(H)	500 ^{*1}	mW
		SOT-23-5	250 (When not mounted on board)	mW
		SOT-89-3	600 ^{*1}	mW
		SOT-89-5	500 (When not mounted on board)	mW
		TO-92	1000 ^{*1}	mW
			400 (When not mounted on board)	mW
Operating temperature range	T _{opr}	-40 to +85	°C	
Storage temperature	T _{stg}	-40 to +125	°C	

*1. When mounted on board
[Mounted board]

- (1) Board size : 114.3 mm × 76.2 mm × t1.6 mm
- (2) Board name : JEDEC STANDARD51-7

Caution The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

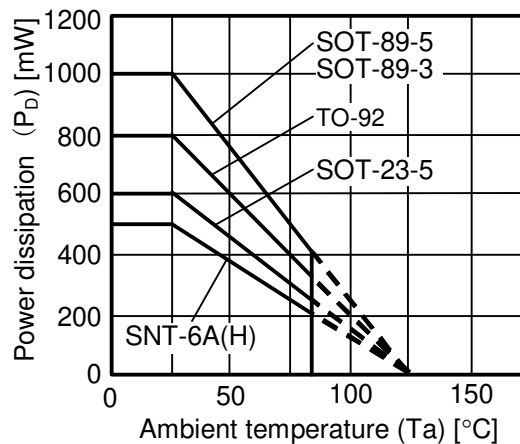


Figure 9 Power Dissipation of The Package (When mounted on Board)

■ **Electrical Characteristics**

Table 10

(Ta=25°C unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units	Test circuits	
Output voltage ^{*1}	V _{OUT(E)}	V _{IN} = V _{OUT(S)} +2 V, I _{OUT} = 10mA	$\frac{V_{OUT(S)}}{\times 0.98}$	V _{OUT(S)}	$\frac{V_{OUT(S)}}{\times 1.02}$	V	1	
Output current ^{*2}	I _{OUT}	V _{OUT(S)} +2V ≤ V _{IN} ≤16V	2.0V ≤ V _{OUT(S)} ≤ 2.9V	30	–	–	mA	3
			3.0V ≤ V _{OUT(S)} ≤ 3.9V	50	–	–	mA	3
			4.0V ≤ V _{OUT(S)} ≤ 4.9V	65	–	–	mA	3
			5.0V ≤ V _{OUT(S)} ≤ 6.0V	75	–	–	mA	3
Dropout voltage ^{*3}	V _{drop}	I _{OUT} = 10mA	2.0V ≤ V _{OUT(S)} ≤ 2.4V	–	0.46	0.95	V	1
			2.5V ≤ V _{OUT(S)} ≤ 2.9V	–	0.32	0.68	V	1
			3.0V ≤ V _{OUT(S)} ≤ 3.4V	–	0.23	0.41	V	1
			3.5V ≤ V _{OUT(S)} ≤ 3.9V	–	0.19	0.35	V	1
			4.0V ≤ V _{OUT(S)} ≤ 4.4V	–	0.16	0.30	V	1
			4.5V ≤ V _{OUT(S)} ≤ 4.9V	–	0.14	0.27	V	1
			5.0V ≤ V _{OUT(S)} ≤ 5.4V	–	0.12	0.25	V	1
5.5V ≤ V _{OUT(S)} ≤ 6.0V	–	0.11	0.23	V	1			
Line regulation 1	Δ V _{OUT1}	V _{OUT(S)} + 1 V ≤ V _{IN} ≤ 16 V, I _{OUT} = 1mA	–	5	20	mV	1	
Line regulation 2	Δ V _{OUT2}	V _{OUT(S)} + 1 V ≤ V _{IN} ≤ 16 V, I _{OUT} = 1μA	–	5	20	mV	1	
Load regulation	Δ V _{OUT3}	V _{IN} = V _{OUT(S)} + 2V	2.0V ≤ V _{OUT(S)} ≤ 2.9V, 1μA ≤ I _{OUT} ≤ 20mA	–	6	30	mV	1
			3.0V ≤ V _{OUT(S)} ≤ 3.9V, 1μA ≤ I _{OUT} ≤ 30mA	–	10	45	mV	1
			4.0V ≤ V _{OUT(S)} ≤ 4.9V, 1μA ≤ I _{OUT} ≤ 40mA	–	13	65	mV	1
			5.0V ≤ V _{OUT(S)} ≤ 6.0V, 1μA ≤ I _{OUT} ≤ 50mA	–	17	80	mV	1
Output voltage temperature coefficient ^{*4}	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT}}$	V _{IN} = V _{OUT(S)} + 1 V, I _{OUT} = 10mA, -40°C ≤ Ta ≤ 85°C	–	±100	–	ppm/°C	1	
Current consumption	I _{SS}	V _{IN} = V _{OUT(S)} +2, no load	2.0V ≤ V _{OUT(S)} ≤ 2.7V	–	0.9	1.6	μA	2
			2.8V ≤ V _{OUT(S)} ≤ 3.7V	–	1.0	1.8	μA	2
			3.8V ≤ V _{OUT(S)} ≤ 5.1V	–	1.2	2.1	μA	2
			5.2V ≤ V _{OUT(S)} ≤ 6.0V	–	1.5	2.5	μA	2
Input voltage	V _{IN}	–	–	–	16	V	1	
Applied to products with Power-off Function								
Current consumption at power-off	I _{SS2}	V _{IN} = V _{OUT(S)} + 2V, V _{ON/OFF} = 0V, no load	–	0.1	0.5	μA	2	
Power-off pin Input voltage for high level	V _{SH}	V _{IN} = V _{OUT(S)} + 2V, R _L = 1kΩ, determined by V _{OUT} output level	2.0	–	–	V	4	
Power-off pin Input voltage for low level	V _{SL}	V _{IN} = V _{OUT(S)} + 2V, R _L = 1kΩ, determined by V _{OUT} output level	–	–	0.4	V	4	
Power-off pin Input current at high level	I _{SH}	V _{IN} = 7V, V _{ON/OFF} = 7V	-0.1	–	0.1	μA	4	
Power-off pin Input current at low level	I _{SL}	V _{IN} = V _{OUT(S)} + 2V, V _{ON/OFF} = 0V	-0.1	–	0.1	μA	4	
Applied to products with Short-circuit Protection								
Short-circuit current	I _{OS}	V _{IN} = V _{OUT(S)} + 2 V, V _{OUT} = 0 V	–	40	–	mA	3	

- *1. $V_{OUT(S)}$: Specified output voltage
 $V_{OUT(E)}$: Effective output voltage
 i.e., the output voltage when fixing $I_{OUT}(=10 \text{ mA})$ and inputting $V_{OUT(S)}+2.0 \text{ V}$.
- *2. Output current at which output voltage becomes 95% of $V_{OUT(E)}$ after gradually increasing output current.
- *3. $V_{drop} = V_{IN1} - (V_{OUT(E)} \times 0.98)$, where V_{IN1} is the input voltage at which output voltage reaches 98% of $V_{OUT(E)}$ after gradually decreasing input voltage.
- *4. The ratio of temperature change in output voltage [mV/°C] is calculated using the following equation.

$$\frac{\Delta V_{OUT}}{\Delta T_a} [\text{mV}/^\circ\text{C}]^{*1} = V_{OUT(S)} [\text{V}]^{*2} \times \frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT}} [\text{ppm}/^\circ\text{C}]^{*3} \div 1000$$

- *1. The ratio of temperature change in output voltage
 *2. Specified output voltage
 *3. Output voltage temperature coefficient

■ **Test Circuits**

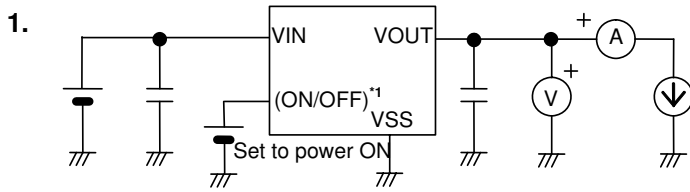


Figure 10

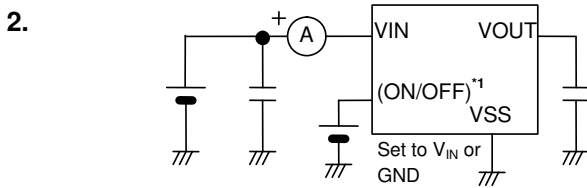


Figure 11

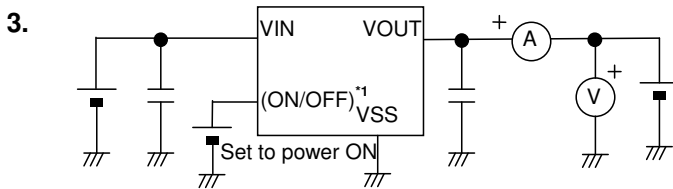


Figure 12

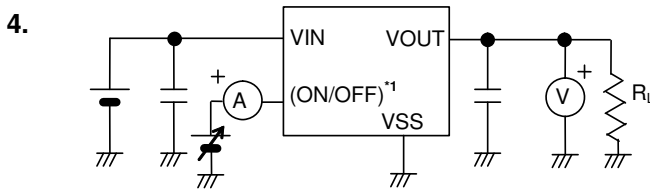
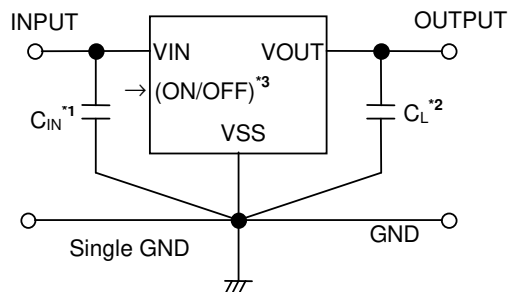


Figure 13

*1. In case of product with power-off function.

■ **Standard Circuit**



*1. C_{IN} is a capacitor for stabilizing the input.

*2. In addition to tantalum capacitor, ceramic capacitor can be used for C_L .

*3. Control this ON/OFF pin in the product with power-off function.

Figure 14

Caution The above connection diagram and constant will not guarantee successful operation. Perform through evaluation using the actual application to set the constant.

■ Technical Terms

1. Output capacitors (C_L)

Generally in voltage regulator, output capacitor is used to stabilize regulation and to improve the characteristics of transient response. The S-812C Series operates stably without output capacitor C_L . Thus the output capacitor C_L is used only for improvement of the transient response. In the applications that users will use the S-812C Series, and they are not cautious about the transient response, it is possible to omit an output capacitor. If using an output capacitor for this IC, users are able to use devices such as ceramic capacitor which has small ESR (Equivalent Series Resistance).

2. Output voltage (V_{OUT})

The accuracy of the output voltage $\pm 2.0\%$ is assured under the specified conditions for input voltage, which differs depending upon the product items, output current, and temperature.

Caution If the above conditions change, the output voltage value may vary and go out of the accuracy range of the output voltage. See the electrical characteristics and characteristics data for details.

3. Line regulations 1 and 2 (ΔV_{OUT1} , ΔV_{OUT2})

Indicate the dependency of the output voltage against the input voltage. That is, the value shows how much the output voltage changes due to a change in the input voltage after fixing output current constant.

4. Load regulation (ΔV_{OUT3})

Indicates the dependency of the output voltage against the output current. That is, the value shows how much the output voltage changes due to a change in the output current after fixing output current constant.

5. Dropout voltage (V_{drop})

Indicates the difference between the output voltage and the input voltage V_{IN1} , which is the input voltage (V_{IN}) when; decreasing input voltage V_{IN} gradually until the output voltage has dropped to the value of 98% of output voltage $V_{OUT(E)}$, which is at $V_{IN} = V_{OUT(S)} + 1.0$ V.

$$V_{drop} = V_{IN1} - (V_{OUT(E)} \times 0.98)$$

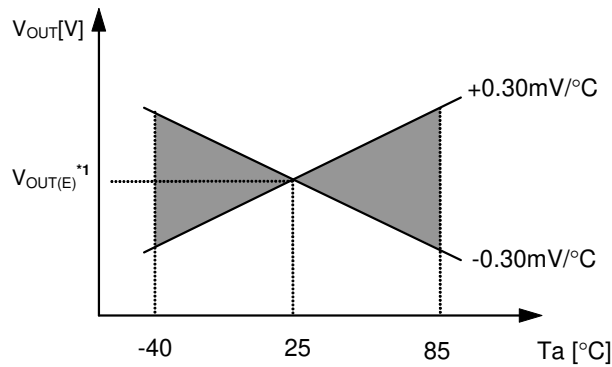
6. Temperature coefficient of output voltage $\left(\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT}} \right)$

The shadowed area in **Figure 15** is the range where V_{OUT} varies in the operating temperature range when the temperature coefficient of the output voltage is ± 100 ppm/ $^{\circ}\text{C}$.

The ratio of temperature change in output voltage [mV/ $^{\circ}\text{C}$] is calculated from the following equation.

$$\frac{\Delta V_{OUT}}{\Delta T_a} [\text{mV}/^{\circ}\text{C}]^{*1} = V_{OUT(S)} [\text{V}]^{*2} \times \frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT}} [\text{ppm}/^{\circ}\text{C}]^{*3} \div 1000$$

- *1. The ratio of temperature change in output voltage
- *2. Specified output voltage
- *3. Output voltage temperature coefficient



*1. $V_{OUT(E)}$ is a measured value of output voltage at 25 $^{\circ}\text{C}$.

Figure 15 Ex. S-812C30A Typ.

■ **Operation**

1. Basic Operation

Figure 16 shows the block diagram of the S-812C Series.

The error amplifier compares the reference voltage (V_{ref}) with V_{fb} , which is the output voltage resistance-divided by feedback resistors R_s and R_f . It supplies the gate voltage necessary to maintain the constant output voltage which is not influenced by the input voltage and temperature change, to the output transistor.

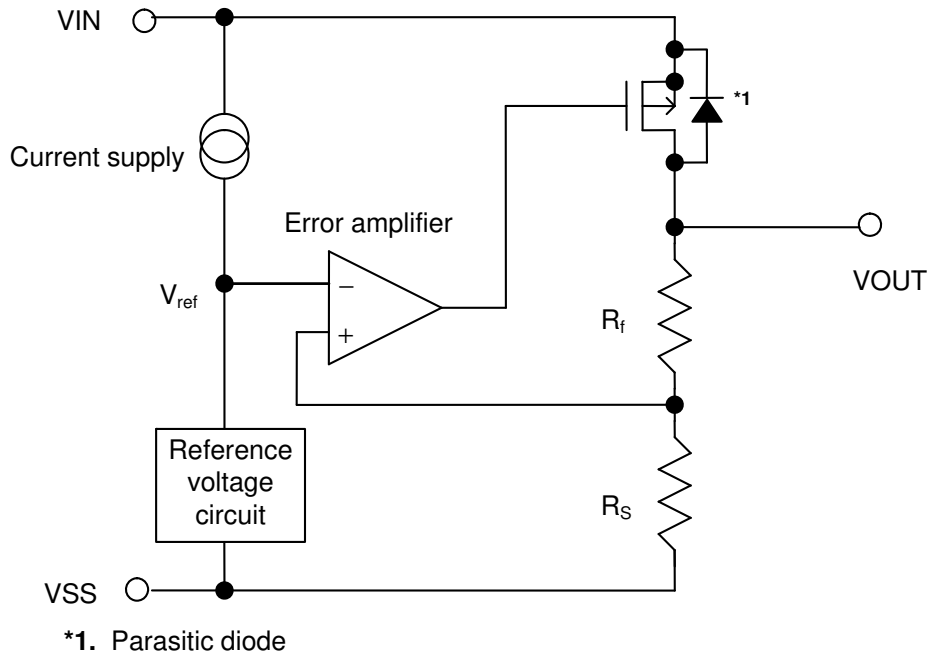


Figure 16

2. Output Transistor

In the S-812C Series, a low on-resistance P-channel MOS FET is used as the output transistor.

Be sure that V_{OUT} does not exceed $V_{IN} + 0.3$ V to prevent the voltage regulator from being damaged due to inverse current which flows, because of a parasitic diode between the VIN and VOUT pin.

3. Power-off function (ON/OFF pin)

This function starts and stops the regulator.

When the ON/OFF pin is set to power-off level, the entire internal circuit stops operating, and the built-in P-channel MOS FET output transistor between the VIN and VOUT pin is turned off, in order to reduce the current consumption significantly. The VOUT pin is set to the VSS level by the internal dividing resistor of several MΩ between the VOUT and VSS pin.

The ON/OFF pin is configured as shown in **Figure 17**. Since the ON/OFF pin is neither pulled down nor pulled up internally, do not use it in the floating state. Note that if applying the voltage of $V_{IN} + 0.3$ V or more, the current flows to V_{IN} via a parasitic diode in the IC.

When not using the power-off pin in the product with the power-off function, connect the ON/OFF pin to the VIN pin (in positive logic), or to the VSS pin (in negative logic).

The output voltage may increase by stopping regulation when a lower current (less than 100 μA) is applied.

If the output voltage increased during power-off, pull the VOUT pin down to the VSS pin and set the ON/OFF pin to the power-down level.

Table 11

Logic Type	ON/OFF Pin	Internal Circuits	VOUT Pin Voltage	Current Consumption
B	“L”: Power off	Stop	V_{SS} level	I_{SS2}
B	“H”: Power on	Operation	Set value	I_{SS}

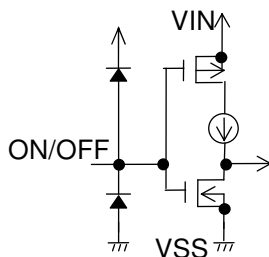


Figure 17

4. Short-circuit protection circuit

In the S-812C Series, users are able to select whether to set the short circuit protection, which protects the output capacitor from short-circuiting the VOUT and VSS pin.

The short circuit protection circuit controls the output current against voltage V_{OUT} , as seen in “**Characteristics (Typical Data) 1**”, and limits the output current at approx. 40 mA even if the VOUT and VSS pins are short-circuited.

However, this short circuit protection circuit does not work as for thermal protection. Pay attention to the conditions of input voltage and load current so that, under the usage condition including short circuit, the loss of the IC will not exceed power dissipation of the package.

Even if pins are not short-circuited, this protection circuit works to limit the current to the specified value, in order to protect the output capacitor, when the output current and the potential difference between input and output voltages increase.

In the product without the short circuit protection circuit, the S-812C Series allows the relatively larger current because this protection circuit is detached.

■ **Selection of External Components**

1. **Output Capacitor (C_L)**

The S-812C Series has an internal phase compensation circuit which stabilizes the operation regardless of the change of output load. Therefore it is possible for users to have a stable operation without an output capacitor (C_L). However, the values of output overshoot and undershoot, which are the characteristics of transient response, vary depending on the output capacitor. In selecting the value of output capacitor, refer to the data on C_L dependency in “■ **Reference data 1. Transient response characteristics**”.

Set ESR 10 Ω or less when using a tantalum capacitor or an aluminum electrolytic capacitor. Pay attention at low temperature, that aluminum electrolytic capacitor especially may oscillate because ESR increases. Evaluate sufficiently including the temperature characteristics in use.

■ **Application Circuit**

1. **Output Current Boost Circuit**

As shown in **Figure 18**, the output current can be boosted by externally attaching a PNP transistor. Between the input voltage V_{IN} and the VIN pin (for power supply) in the S-812C Series, if setting the base-emitter voltage V_{BE} which fully switches the PNP transistor on, S-812C Series controls the base current in a PNP transistor so that the output voltage V_{OUT} reaches the level of voltage which is set by the S-812C Series.

Since the output current boosting circuit in **Figure 18** does not have the good characteristics of transient response, under the usage condition, confirm if output fluctuation due to power-on, and fluctuations of power supply and load affect on the operation or not before use.

Note that the short-circuit protection circuit in the S-812C Series does not work as short-circuit protection for this boost circuit.

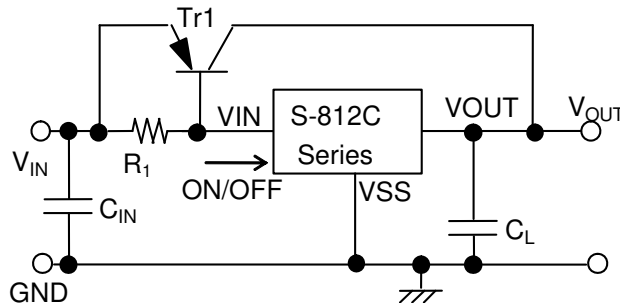


Figure 18

2. Constant Current Circuit

This circuit can be used as a constant current circuit if making the composition seen in **Figure 19** and **20**. Constant current I_o is calculated from the following equation:

$$I_o = (V_{OUT(E)} \div R_L) + I_{SS}$$

($V_{OUT(E)}$ = effective output voltage)

Note that by using a circuit in **Figure 19**, it is impossible to set the better driving ability to the constant amperage (I_o) than the S-812C Series basically has.

To gain the driving ability which exceeds the S-812C Series, there's a way to combine a constant current circuit and a current boosting circuit, as seen in **Figure 20**.

The maximum input voltage for a constant current circuit is 16 V + the voltage for device (V_o).

It is not recommended to add a capacitor between the VIN (power supply) and VSS pin or the VOUT (output) and VSS pin because the rush current flows at power-on.

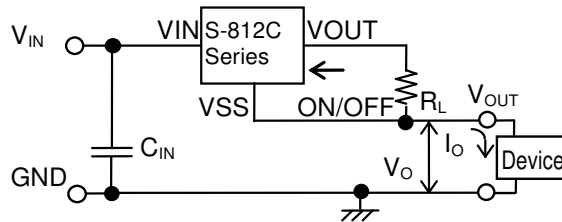


Figure 19 Constant Current Circuit

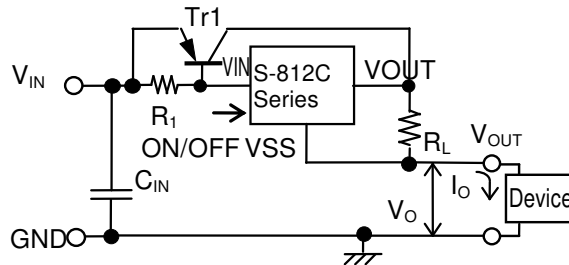


Figure 20 Constant Current Boost Circuit

3. Output Voltage Adjustment Circuit

(Only for S-812CxxA Series (No short-circuit protection, power-off function))

By using the composition seen in **Figure 21**, users are able to increase the output voltage. The value of output voltage V_{OUT1} is calculated from the following equation:

$$V_{OUT1} = V_{OUT(E)} \times (R_1 + R_2) \div R_1 + R_2 \times I_{SS}$$

($V_{OUT(E)}$ = effective output voltage)

Set the value of resistors R1 and R2 so that the S-812C Series is not affected by current consumption I_{SS} .

Capacitor C_1 reduces output fluctuation due to power-on, power fluctuation and load fluctuation. Set the value according to the actual evaluation.

It is not recommended to add a capacitor between the VIN (power supply) and VSS pin or the VOUT (output) and VSS pin because it causes output fluctuation and output oscillation due to power-on.

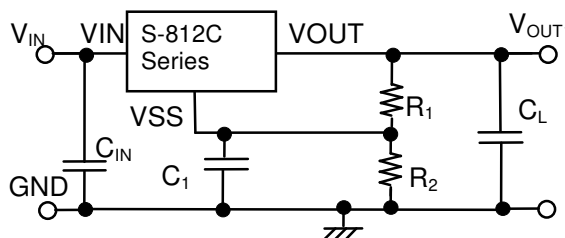


Figure 21

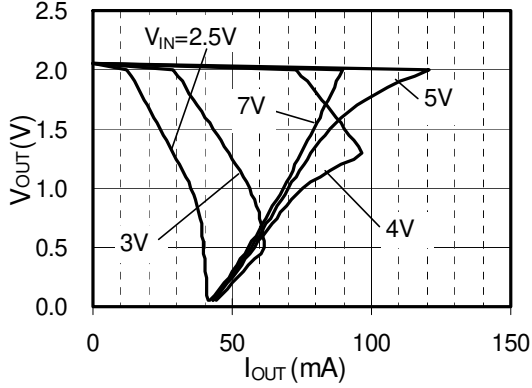
■ Precautions

- Wiring patterns for the VIN, VOUT and GND pins should be designed so that the impedance is low. When mounting an output capacitor between the VOUT and VSS pins (C_L) and a capacitor for stabilizing the input between VIN and VSS pins (C_{IN}), the distance from the capacitors to these pins should be as short as possible.
- Note that output voltage may be increased at low load current of less than 1 μ A.
- At low load current less than 100 μ A output voltage may increase when the regulating operation is halted by the ON/OFF pin.
- To prevent oscillation, it is recommended to use the external parts under the following conditions.
 - Equivalent Series Resistance (ESR): 10 Ω or less (in case of using output capacitor)
 - Input series resistance (R_{IN}): 10 Ω or less
- A voltage regulator may oscillate when power source impedance is high and input capacitor is low or not connected.
- Pay attention to the operating conditions for input/output voltage and load current so that the power loss in the IC does not exceed the power dissipation of the package.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- SII claims no responsibility for any and all disputes arising out of or in connection with any infringement of the products including this IC upon patents owned by a third party.

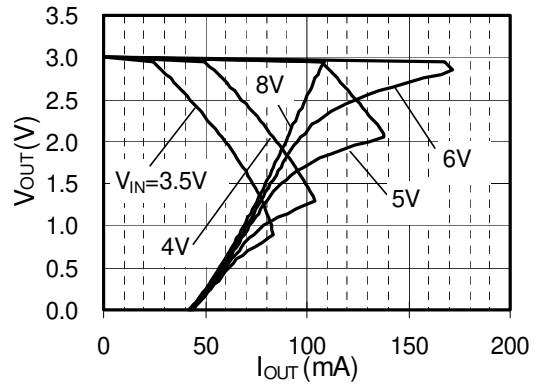
■ Characteristics (Typical Data)

1. Output Voltage vs Output Current (When load current increases)

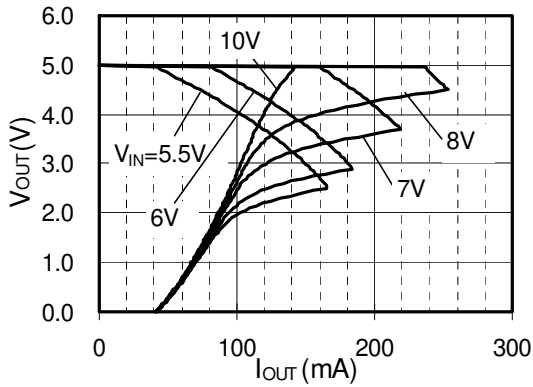
S-812C20B (Ta=25°C) Short-circuit protection



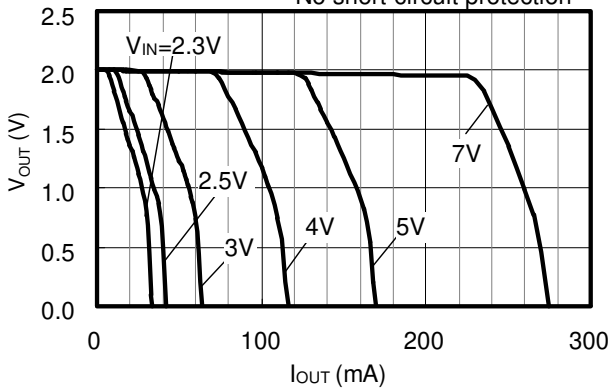
S-812C30B (Ta=25°C) Short-circuit protection



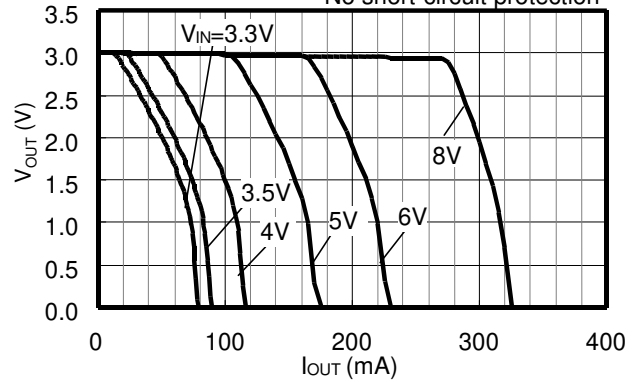
S-812C50B (Ta=25°C) Short-circuit protection



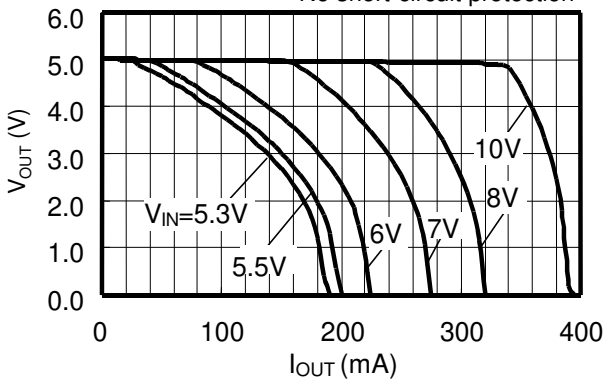
S-812C20A (Ta=25°C) No short-circuit protection



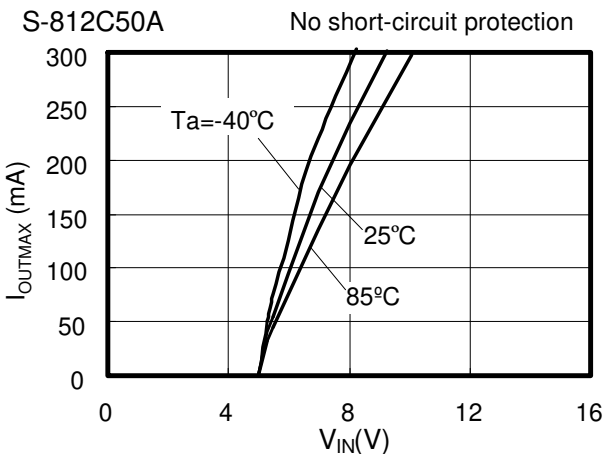
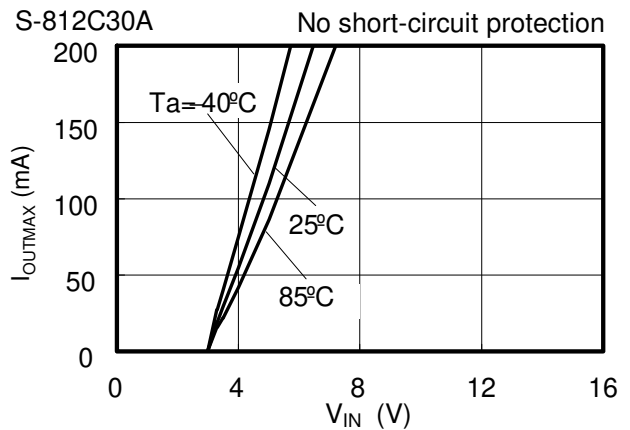
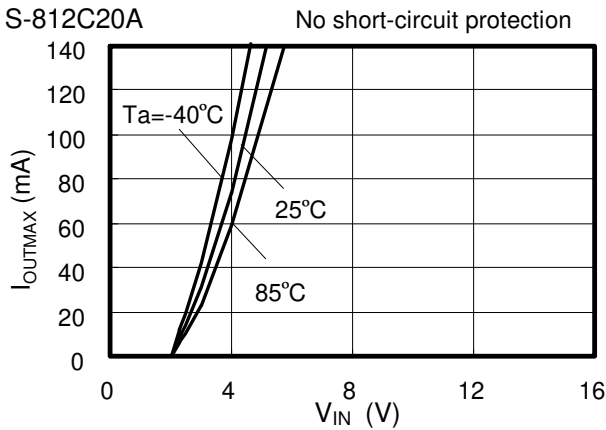
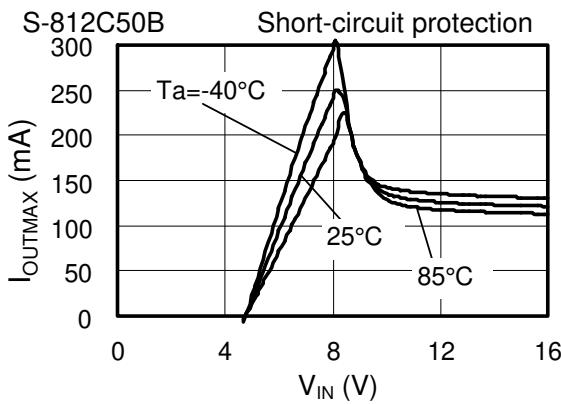
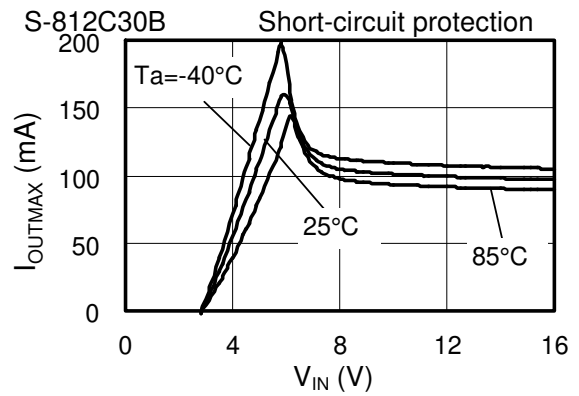
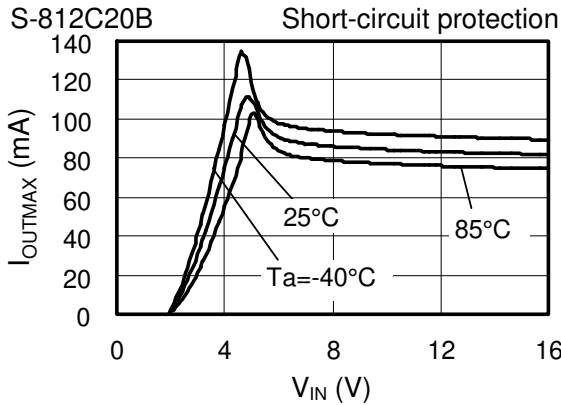
S-812C30A (Ta=25°C) No short-circuit protection



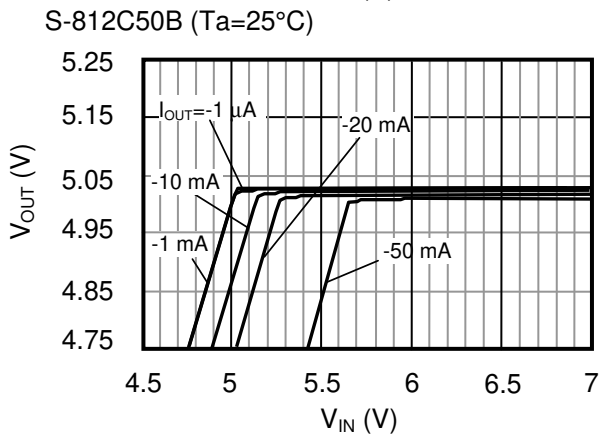
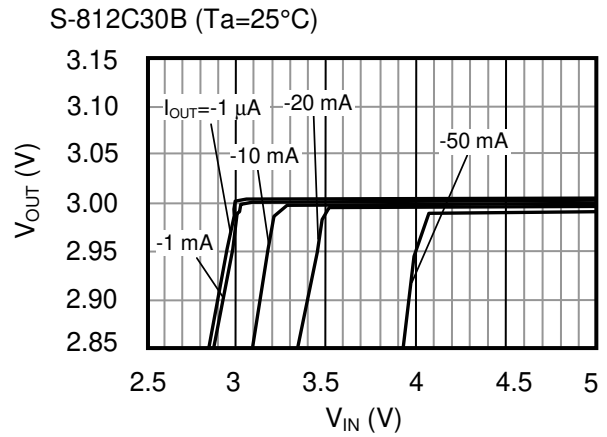
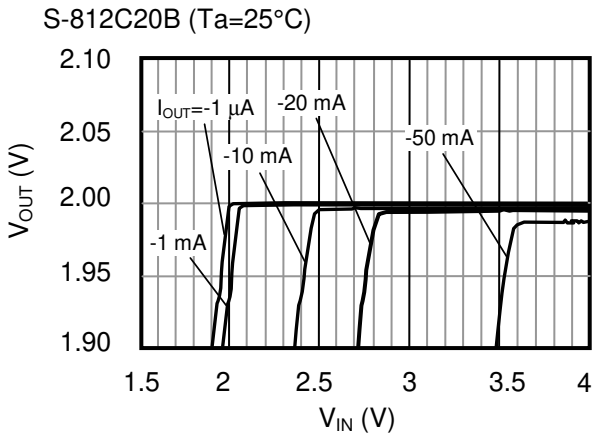
S-812C50A (Ta=25°C) No short-circuit protection



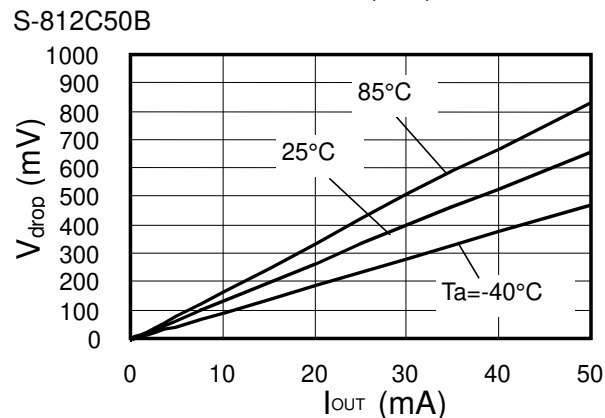
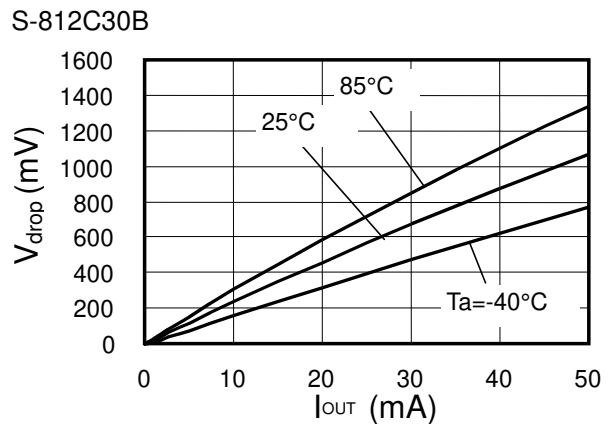
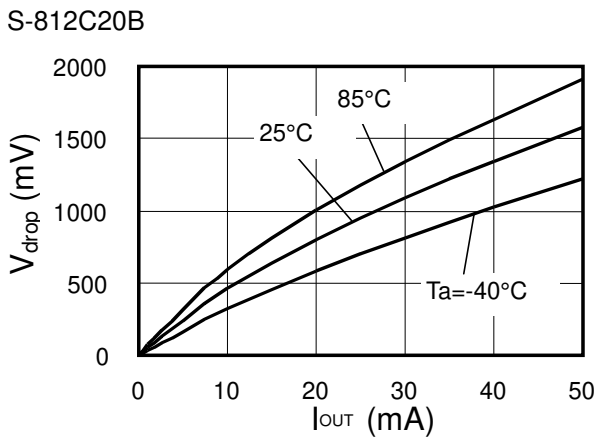
2. Maximum Output Current vs Input Voltage



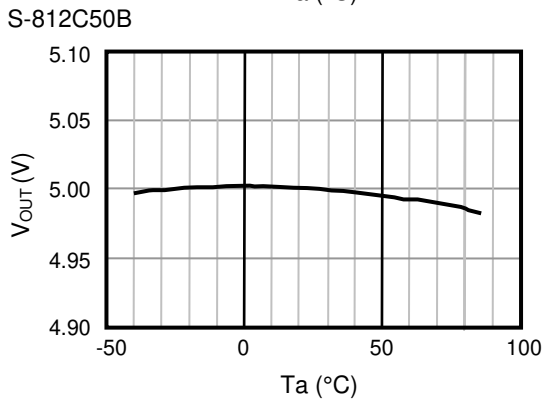
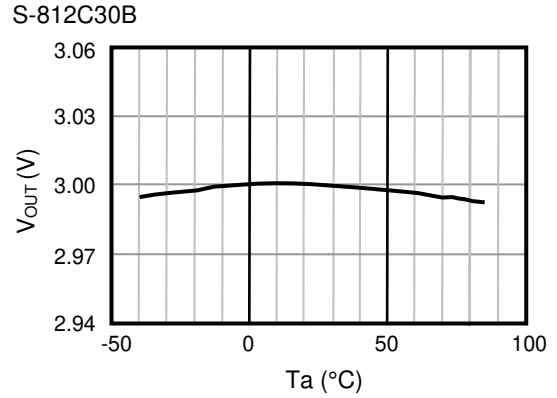
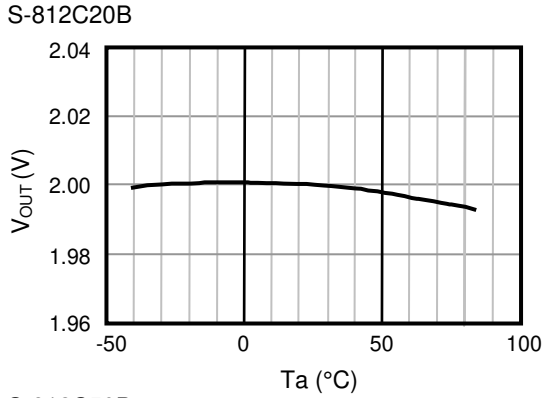
3. Maximum Output Current vs. Input Voltage



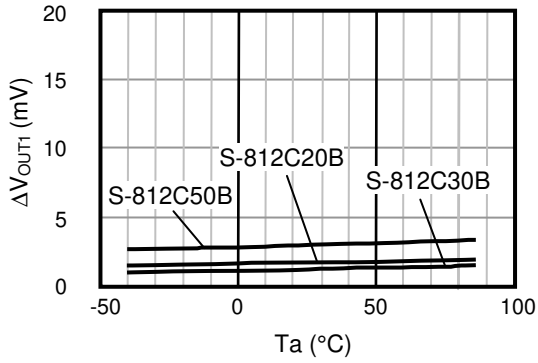
4. Dropout Voltage vs Output Current



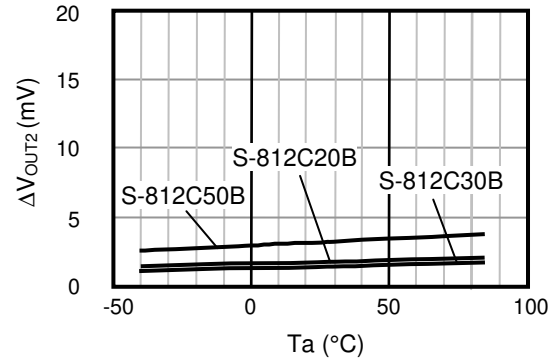
5. Output Voltage vs Ambient Temperature



6. Line Regulation 1 vs Ambient Temperature



7. Line Regulation 2 vs Ambient Temperature



8. Load Regulation vs Ambient Temperature

