

HIGH OPERATING VOLTAGE CMOS VOLTAGE REGULATOR **S-812C Series**

The S-812C series is a family of high-voltage positive regulators developed using CMOS technology. The maximum operating voltage of 16V makes the S-812C series best in high-voltage applications. Not only current consumption is small but also shutdown function is included, the regulator is also suitable in constructing low-power portable devices. Combination of power-off function and short-current protection can be selected.

■ Features

- Low current consumption Operating current: Typ. 1.0 μ A, Max. 1.8 μ A (3.0 V)
- Output voltage: 2.0 to 6.0 V, selectable in 0.1 V steps
- 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)
- Power-off function: Polarity for shutdown switch or removal of the shutdown function can be selected.
- Short-circuit protection: Product with/without short-circuit protection is available.
Short-circuited current : 40 mA typ. for products with protection
- Operating voltage: 16 V maximum.

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

■ Applications

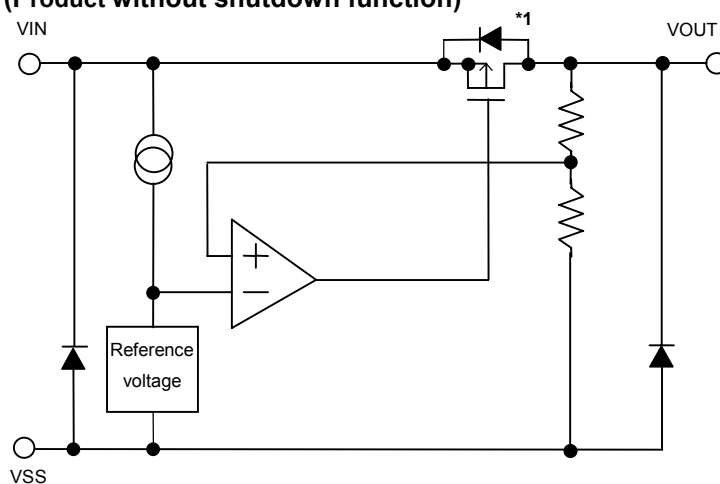
- Power source for home electric/electronic appliances
- Power source for battery-powered devices
- Power source for personal communication devices

■ Package

Package name	Drawing code			
	Package	Tape	Reel	Zigzag
SOT-23-5	MP005-A	MP005-A	MP005-A	—
SOT-89-3	UP003-A	UP003-A	UP003-A	—
SOT-89-5	UP005-A	UP005-A	UP005-A	—
TO-92(Bulk)	YS003-B	—	—	—
TO-92(Tape and reel)	YF003-A	YF003-A	YF003-A	—
TO-92(Tape and ammo)	YF003-A	YZ003-C	—	YZ003-C

Block Diagrams

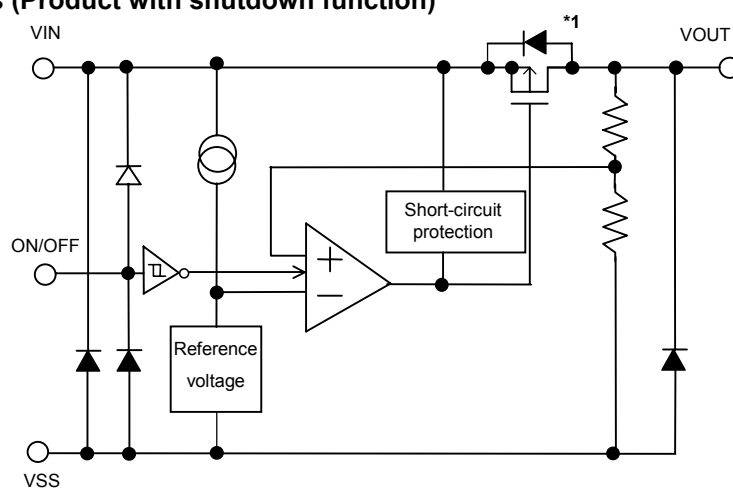
1. S-812CxxA Series (Product without shutdown function)



*1. Parasitic diode

Figure 1

2. S-812CxxB Series (Product with shutdown function)



*1. Parasitic diode

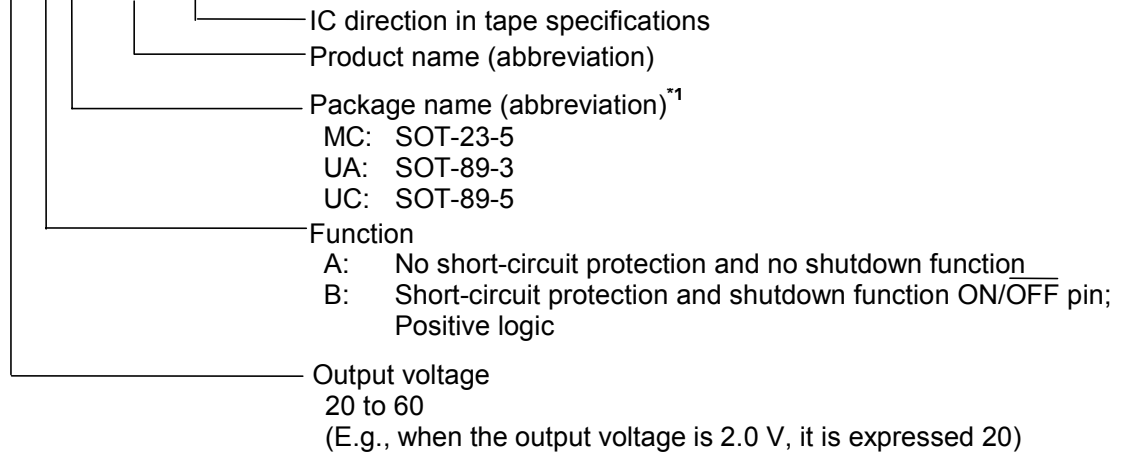
Figure 2

■ Product Code Structure

1. Product name

1.1 Package SOT-23-5, SOT-89-3 and SOT-89-5

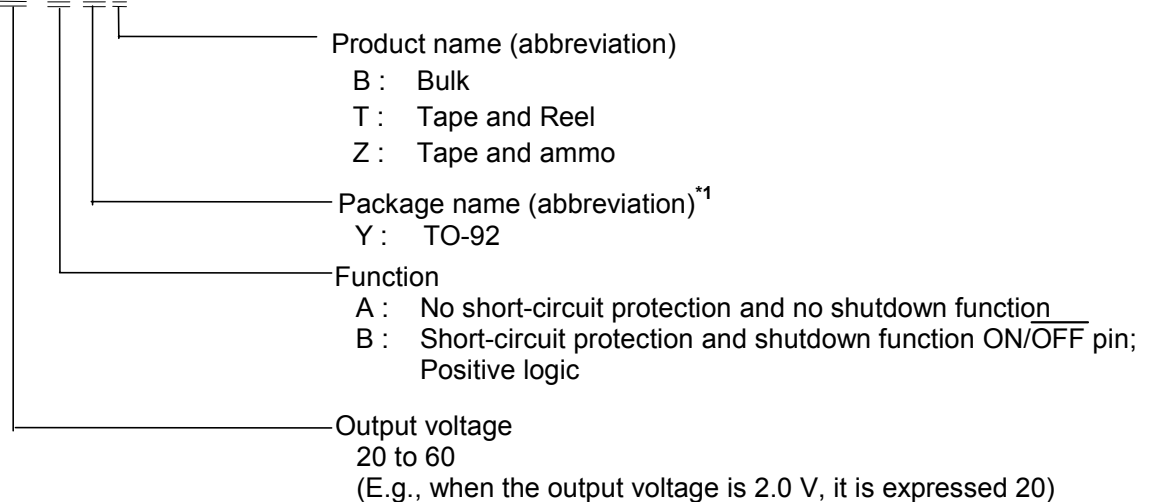
S-812C xx x xx - xxx - T2



*1. Refer to the "Product name list".

1.2 Package TO-92

S-812C xx x Y-x



*1. Refer to the "Product name list".

2. Product name list

2.1 S-812CxxA Series (No short-circuit protection and no shutdown function)

Table 1

Output voltage	SOT-23-5	SOT-89-3	SOT-89-5	TO-92 ^{*1}
2.0 V±2.0 %	S-812C20AMC-C2A-T2	S-812C20AUA-C2A-T2	—	S-812C20AY-x
2.1 V±2.0 %	S-812C21AMC-C2B-T2	S-812C21AUA-C2B-T2	—	S-812C21AY-x
2.2 V±2.0 %	S-812C22AMC-C2C-T2	S-812C22AUA-C2C-T2	—	S-812C22AY-x
2.3 V±2.0 %	S-812C23AMC-C2D-T2	S-812C23AUA-C2D-T2	—	S-812C23AY-x
2.4 V±2.0 %	S-812C24AMC-C2E-T2	S-812C24AUA-C2E-T2	—	S-812C24AY-x
2.5 V±2.0 %	S-812C25AMC-C2F-T2	S-812C25AUA-C2F-T2	—	S-812C25AY-x
2.6 V±2.0 %	S-812C26AMC-C2G-T2	S-812C26AUA-C2G-T2	—	S-812C26AY-x
2.7 V±2.0 %	S-812C27AMC-C2H-T2	S-812C27AUA-C2H-T2	—	S-812C27AY-x
2.8 V±2.0 %	S-812C28AMC-C2I-T2	S-812C28AUA-C2I-T2	—	S-812C28AY-x
2.9 V±2.0 %	S-812C29AMC-C2J-T2	S-812C29AUA-C2J-T2	—	S-812C29AY-x
3.0 V±2.0 %	S-812C30AMC-C2K-T2	S-812C30AUA-C2K-T2	—	S-812C30AY-x
3.1 V±2.0 %	S-812C31AMC-C2L-T2	S-812C31AUA-C2L-T2	—	S-812C31AY-x
3.2 V±2.0 %	S-812C32AMC-C2M-T2	S-812C32AUA-C2M-T2	—	S-812C32AY-x
3.3 V±2.0 %	S-812C33AMC-C2N-T2	S-812C33AUA-C2N-T2	—	S-812C33AY-x
3.4 V±2.0 %	S-812C34AMC-C2O-T2	S-812C34AUA-C2O-T2	—	S-812C34AY-x
3.5 V±2.0 %	S-812C35AMC-C2P-T2	S-812C35AUA-C2P-T2	—	S-812C35AY-x
3.6 V±2.0 %	S-812C36AMC-C2Q-T2	S-812C36AUA-C2Q-T2	—	S-812C36AY-x
3.7 V±2.0 %	S-812C37AMC-C2R-T2	S-812C37AUA-C2R-T2	—	S-812C37AY-x
3.8 V±2.0 %	S-812C38AMC-C2S-T2	S-812C38AUA-C2S-T2	—	S-812C38AY-x
3.9 V±2.0 %	S-812C39AMC-C2T-T2	S-812C39AUA-C2T-T2	—	S-812C39AY-x
4.0 V±2.0 %	S-812C40AMC-C2U-T2	S-812C40AUA-C2U-T2	—	S-812C40AY-x
4.1 V±2.0 %	S-812C41AMC-C2V-T2	S-812C41AUA-C2V-T2	—	S-812C41AY-x
4.2 V±2.0 %	S-812C42AMC-C2W-T2	S-812C42AUA-C2W-T2	—	S-812C42AY-x
4.3 V±2.0 %	S-812C43AMC-C2X-T2	S-812C43AUA-C2X-T2	—	S-812C43AY-x
4.4 V±2.0 %	S-812C44AMC-C2Y-T2	S-812C44AUA-C2Y-T2	—	S-812C44AY-x
4.5 V±2.0 %	S-812C45AMC-C2Z-T2	S-812C45AUA-C2Z-T2	—	S-812C45AY-x
4.6 V±2.0 %	S-812C46AMC-C3A-T2	S-812C46AUA-C3A-T2	—	S-812C46AY-x
4.7 V±2.0 %	S-812C47AMC-C3B-T2	S-812C47AUA-C3B-T2	—	S-812C47AY-x
4.8 V±2.0 %	S-812C48AMC-C3C-T2	S-812C48AUA-C3C-T2	—	S-812C48AY-x
4.9 V±2.0 %	S-812C49AMC-C3D-T2	S-812C49AUA-C3D-T2	—	S-812C49AY-x
5.0 V±2.0 %	S-812C50AMC-C3E-T2	S-812C50AUA-C3E-T2	—	S-812C50AY-x
5.1 V±2.0 %	S-812C51AMC-C3F-T2	S-812C51AUA-C3F-T2	—	S-812C51AY-x
5.2 V±2.0 %	S-812C52AMC-C3G-T2	S-812C52AUA-C3G-T2	—	S-812C52AY-x
5.3 V±2.0 %	S-812C53AMC-C3H-T2	S-812C53AUA-C3H-T2	—	S-812C53AY-x
5.4 V±2.0 %	S-812C54AMC-C3I-T2	S-812C54AUA-C3I-T2	—	S-812C54AY-x
5.5 V±2.0 %	S-812C55AMC-C3J-T2	S-812C55AUA-C3J-T2	—	S-812C55AY-x
5.6 V±2.0 %	S-812C56AMC-C3K-T2	S-812C56AUA-C3K-T2	—	S-812C56AY-x
5.7 V±2.0 %	S-812C57AMC-C3L-T2	S-812C57AUA-C3L-T2	—	S-812C57AY-x
5.8 V±2.0 %	S-812C58AMC-C3M-T2	S-812C58AUA-C3M-T2	—	S-812C58AY-x
5.9 V±2.0 %	S-812C59AMC-C3N-T2	S-812C59AUA-C3N-T2	—	S-812C59AY-x
6.0 V±2.0 %	S-812C60AMC-C3O-T2	S-812C60AUA-C3O-T2	—	S-812C60AY-x

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

B: Bulk, T: Tape and Reel, Z: Tape and ammo.

Remark Please contact the SII marketing department for products with an output voltage over than those specified above.

2.2 S-812CxxB Series (Short-circuit protection and shutdown function)**Table 2**

Output voltage	SOT-23-5	SOT-89-5
2.0 V $\pm$ 2.0 %	S-812C20BMC-C4A-T2	—
2.1 V $\pm$ 2.0 %	S-812C21BMC-C4B-T2	—
2.2 V $\pm$ 2.0 %	S-812C22BMC-C4C-T2	—
2.3 V $\pm$ 2.0 %	S-812C23BMC-C4D-T2	—
2.4 V $\pm$ 2.0 %	S-812C24BMC-C4E-T2	—
2.5 V $\pm$ 2.0 %	S-812C25BMC-C4F-T2	—
2.6 V $\pm$ 2.0 %	S-812C26BMC-C4G-T2	—
2.7 V $\pm$ 2.0 %	S-812C27BMC-C4H-T2	—
2.8 V $\pm$ 2.0 %	S-812C28BMC-C4I-T2	—
2.9 V $\pm$ 2.0 %	S-812C29BMC-C4J-T2	—
3.0 V $\pm$ 2.0 %	S-812C30BMC-C4K-T2	—
3.1 V $\pm$ 2.0 %	S-812C31BMC-C4L-T2	—
3.2 V $\pm$ 2.0 %	S-812C32BMC-C4M-T2	—
3.3 V $\pm$ 2.0 %	S-812C33BMC-C4N-T2	S-812C33BUC-C4N-T2
3.4 V $\pm$ 2.0 %	S-812C34BMC-C4O-T2	—
3.5 V $\pm$ 2.0 %	S-812C35BMC-C4P-T2	—
3.6 V $\pm$ 2.0 %	S-812C36BMC-C4Q-T2	—
3.7 V $\pm$ 2.0 %	S-812C37BMC-C4R-T2	—
3.8 V $\pm$ 2.0 %	S-812C38BMC-C4S-T2	—
3.9 V $\pm$ 2.0 %	S-812C39BMC-C4T-T2	—
4.0 V $\pm$ 2.0 %	S-812C40BMC-C4U-T2	—
4.1 V $\pm$ 2.0 %	S-812C41BMC-C4V-T2	—
4.2 V $\pm$ 2.0 %	S-812C42BMC-C4W-T2	—
4.3 V $\pm$ 2.0 %	S-812C43BMC-C4X-T2	—
4.4 V $\pm$ 2.0 %	S-812C44BMC-C4Y-T2	—
4.5 V $\pm$ 2.0 %	S-812C45BMC-C4Z-T2	—
4.6 V $\pm$ 2.0 %	S-812C46BMC-C5A-T2	—
4.7 V $\pm$ 2.0 %	S-812C47BMC-C5B-T2	—
4.8 V $\pm$ 2.0 %	S-812C48BMC-C5C-T2	—
4.9 V $\pm$ 2.0 %	S-812C49BMC-C5D-T2	—
5.0 V $\pm$ 2.0 %	S-812C50BMC-C5E-T2	S-812C50BUC-C5E-T2
5.1 V $\pm$ 2.0 %	S-812C51BMC-C5F-T2	—
5.2 V $\pm$ 2.0 %	S-812C52BMC-C5G-T2	—
5.3 V $\pm$ 2.0 %	S-812C53BMC-C5H-T2	—
5.4 V $\pm$ 2.0 %	S-812C54BMC-C5I-T2	—
5.5 V $\pm$ 2.0 %	S-812C55BMC-C5J-T2	—
5.6 V $\pm$ 2.0 %	S-812C56BMC-C5K-T2	—
5.7 V $\pm$ 2.0 %	S-812C57BMC-C5L-T2	—
5.8 V $\pm$ 2.0 %	S-812C58BMC-C5M-T2	—
5.9 V $\pm$ 2.0 %	S-812C59BMC-C5N-T2	—
6.0 V $\pm$ 2.0 %	S-812C60BMC-C5O-T2	—

Remark Please contact the SII marketing department for products with an output voltage over than those specified above.

Pin Configuration

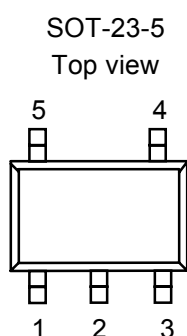


Figure 3

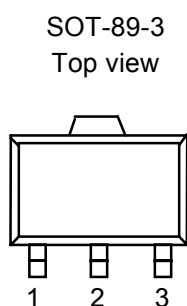


Figure 4

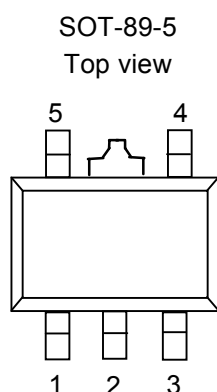


Figure 5

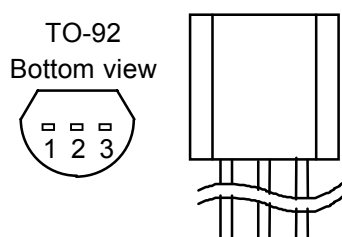


Figure 6

Table 3

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	Shutdown pin
	NC ^{*1}	No connection

*1. The NC pin is electrically open.
The NC pin can be connected to VIN or VSS,
The Shutdown pin becomes N.C. pin, when the
shutdown function is removed.

Table 4

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

Table 5

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

*1. The NC pin is electrically open.
The NC pin can be connected to VIN or VSS,
The Shutdown pin becomes N.C. pin, when the
shutdown function is removed.

Table 6

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

■ Absolute Maximum Ratings

Table 7

(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		
Output voltage	V _{OUT}	V _{SS} -0.3 to V _{IN} +0.3		
Power dissipation	P _D	SOT-23-5	250	mW
		SOT-89-3	500	
		SOT-89-5	500	
		TO-92	400	
Operating temperature range	T _{opr}	-40 to +85		°C
Storage temperature range	T _{sta}	-40 to +125		

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.

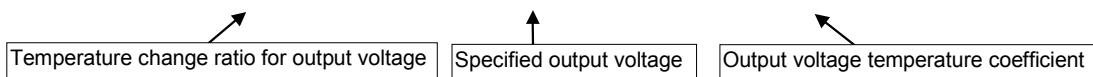
■ **Electrical Characteristics**

Table 8 (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		V _{OUT(S)} × 0.98	V _{OUT(S)}	V _{OUT(S)} × 1.02	V	1
Output current ^{*2}	I _{OUT}	V _{OUT(S)} +2V ≤ V _{IN} ≤16V	2.0V ≤ V _{OUT(S)} ≤ 2.9V 3.0V ≤ V _{OUT(S)} ≤ 3.9V 4.0V ≤ V _{OUT(S)} ≤ 4.9V 5.0V ≤ V _{OUT(S)} ≤ 5.9V	30 50 65 75	— — — —	— — — —	mA	3
Dropout voltage ^{*3}	V _{drop}	I _{OUT} = 10mA	2.0V ≤ V _{OUT(S)} ≤ 2.4V 2.5V ≤ V _{OUT(S)} ≤ 2.9V 3.0V ≤ V _{OUT(S)} ≤ 3.4V 3.5V ≤ V _{OUT(S)} ≤ 3.9V 4.0V ≤ V _{OUT(S)} ≤ 4.4V 4.5V ≤ V _{OUT(S)} ≤ 4.9V 5.0V ≤ V _{OUT(S)} ≤ 5.4V 5.5V ≤ V _{OUT(S)} ≤ 6.0V	— — — — — — — —	0.46 0.32 0.23 0.19 0.16 0.14 0.12 0.11	0.95 0.68 0.41 0.35 0.30 0.27 0.25 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	
Line regulation 2	Δ V _{OUT2}	V _{OUT(S)} + 1 V ≤ V _{IN} ≤ 16 V, I _{OUT} = 1μA		—	5	20		
Load regulation	Δ V _{OUT3}	V _{IN} = V _{OUT(S)} + 2 V	2.0V ≤ V _{OUT(S)} ≤ 2.9V, 1μA ≤ I _{OUT} ≤ 20mA	—	6	30		
			3.0V ≤ V _{OUT(S)} ≤ 3.9V, 1μA ≤ I _{OUT} ≤ 30mA	—	10	45		
			4.0V ≤ V _{OUT(S)} ≤ 4.9V, 1μA ≤ I _{OUT} ≤ 40mA	—	13	65		
			5.0V ≤ V _{OUT(S)} ≤ 5.9V, 1μA ≤ I _{OUT} ≤ 50mA	—	17	80		
Output voltage temperature coefficient ^{*4}	$\frac{\Delta V_{OUT}}{\Delta T_a \bullet V_{OUT}}$	V _{IN} = V _{OUT(S)} + 1 V, I _{OUT} = 10mA -40°C ≤ Ta ≤ 85°C		—	±100	—	ppm /°C	
Current consumption	I _{SS}	V _{IN} = V _{OUT(S)} +2V, 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		
			3.8V ≤ V _{OUT(S)} ≤ 5.1V	—	1.2	2.1		
			5.2V ≤ V _{OUT(S)} ≤ 6.0V	—	1.5	2.5		
Input voltage	V _{IN}	—		—	—	16	V	1
Applied to products with Shutdown 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
Shutdown pin Input voltage for high level	V _{SH}	V _{IN} = V _{OUT(S)} + 2V, R _L = 1kΩ, judged by V _{OUT} output level		2.0	—	—	V	4
Shutdown pin Input voltage for low level	V _{SL}	V _{IN} = V _{OUT(S)} + 2V, R _L = 1kΩ, judged by V _{OUT} output level		—	—	0.4		
Shutdown pin Input current at high level	I _{SH}	V _{IN} =V _{OUT(S)} + 2V, V _{ON/OFF} = 7V		-0.1	—	0.1	μA	
Shutdown pin Input current at low level	I _{SL}	V _{IN} =V _{OUT(S)} + 2V, V _{ON/OFF} = 0V		-0.1	—	0.1	μA	
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 becomes 98% of $V_{OUT(E)}$ after gradually decreasing input voltage.
- *4. Temperature change ratio for the output voltage [$\text{mV}/^{\circ}\text{C}$] is calculated using the following equation.

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



Test Circuits

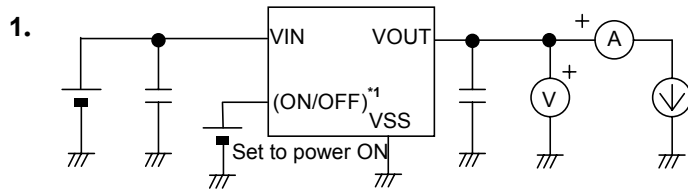


Figure 7

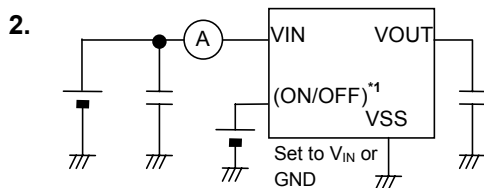


Figure 8

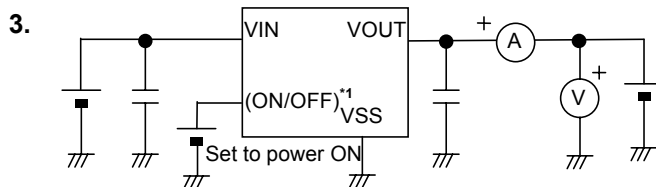


Figure 9

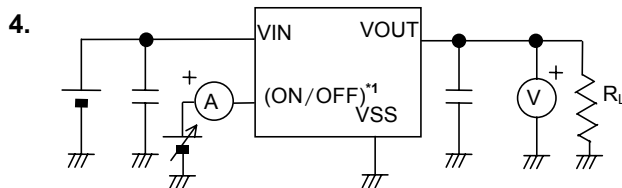
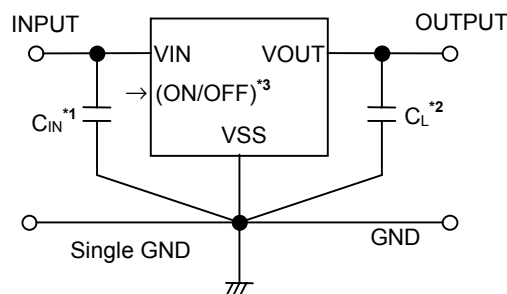


Figure 10

*1. In case of product with shutdown function.

Standard Circuit



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

*2. A ceramic capacitor can be used for C_L besides a tantalum capacitor.

*3. In case of product with shutdown function.

Figure 11

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)

Output capacitors are generally used to stabilize regulation operation and to improve transient response characteristics. But the S-812C series can provide stable operation without output capacitors. Capacitors are used only to improve transient response characteristics. Output capacitors can hence be removed in applications in which transient response can be negligible. When an output capacitor is used, a low ESR (Equivalent Series Resistance) capacitor like ceramic capacitor can also be used.

2. Output voltage (V_{OUT})

The accuracy of the output voltage is $\pm 2.0\%$ guaranteed 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})

These parameters indicate the input voltage dependence on the output voltage. That is, the values show how much the output voltage changes due to a change in the input voltage with the output current remained unchanged.

4. Load regulation (ΔV_{OUT3})

This parameter indicates the output current dependence on the output voltage. That is, the value shows how much the output voltage changes due to a change in the output current with the input voltage remained unchanged.

5. Dropout voltage (V_{drop})

This parameter indicates the difference between the input voltage (V_{IN1}) and the output voltage when output voltage falls to 98 % of $V_{OUT(E)}$ by gradually decreasing the input voltage (V_{IN}).

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

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

The output voltage lies in the shaded area in the whole operating temperature shown in figure 12 when the temperature coefficient of the output voltage is ± 100 ppm/ $^{\circ}\text{C}$.

Temperature change ratio for output voltage [mV/ $^{\circ}\text{C}$] is calculated by using the following equation.

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

$\uparrow$

Temperatures change ratio for output voltage

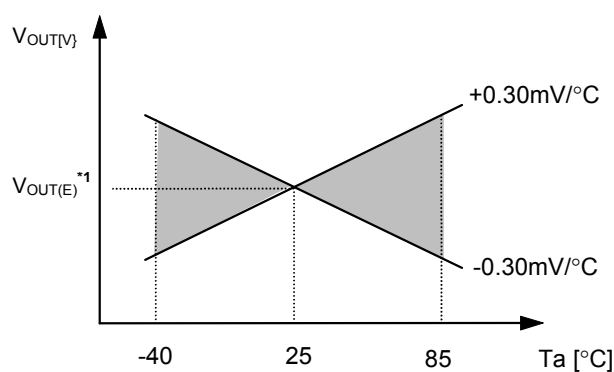
$\uparrow$

Specified output voltage

$\uparrow$

Output voltage temperature coefficient

Ex. S-812C30A Typ.



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

Figure 12

■ Description of Operation

1. Basic Operation

Figure 13 shows the block diagram of the S-812C series. The error amplifier compares a reference voltage V_{ref} with a part of the output voltage divided by the feedback resistors R_s and R_f , and supplies the gate voltage to the output transistor, necessary to ensure certain output voltage independent from change of input voltage and temperature.

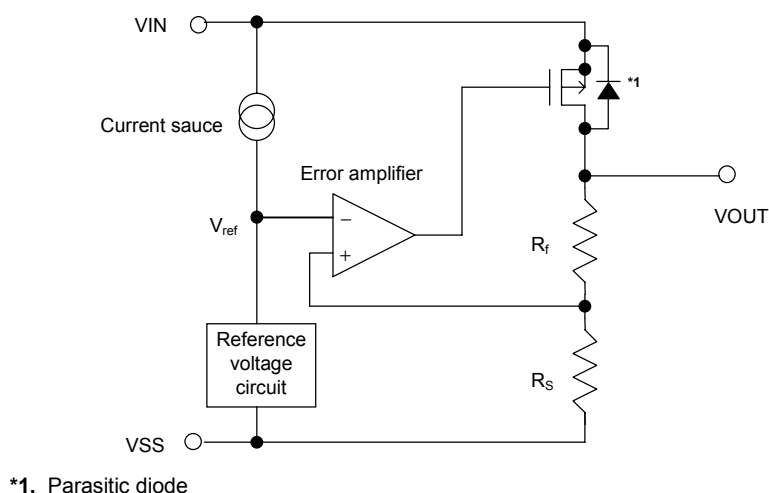


Figure 13

2. Output Transistor

The S-812C Series uses a Pch MOS FET as the output transistor. The voltage at V_{OUT} must not exceed $V_{IN}+0.3V$. When the V_{OUT} voltage becomes higher than that of V_{IN} , reverse current flows and may break the regulator since a parasitic diode between V_{OUT} and V_{IN} exists inevitably.

3. Shutdown function (ON/OFF pin)

The ON/OFF pin controls the start and stop of the regulation operation.

When the ON/OFF pin is set to shutdown level, halting whole internal circuit and turning off the Pch MOS FET between VIN and VOUT, current consumption is drastically reduced. The voltage of the VOUT pin becomes VSS level due to the internal resistance divider of several MΩ between VOUT and VSS.

The ON/OFF pin should not be left afloat since no pull-up nor pull-down is made internally as shown in figure 14. Note also that a current will flow to the VIN side via the parasitic diode inside the IC if a voltage of $V_{IN} + 0.3$ V or more is applied. When the shutdown function is not used, connect the pin to the VIN pin in case of positive logic and to the VSS pin in case of negative logic.

When a regulation operation at light load less than 100 μA is halted, output voltage may increase. If the increase of the output voltage should be avoided, pull down the VOUT pin to the VSS level as soon as ON/OFF pin goes to the shutdown level.

Table 9

Logic Type	ON/OFF Pin	Internal Circuits	VOUT Pin Voltage	Current Consumption
B	"L": Power off	Stopped	V _{SS} level	I _{SS2}
B	"H": Power on	Operating	Set value	I _{SS1}

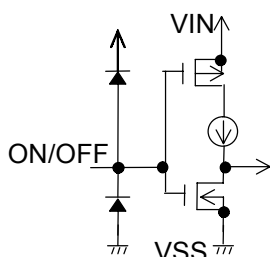


Figure 14

4. Short-circuit protection

Installation of the short-circuit protection which protects the output transistor against short-circuit between VOUT and VSS can be selected in the S-812C series. The short-circuit protection controls output current as shown in the typical characteristics, (1) OUTPUT VOLTAGE versus OUTPUT CURRENT, and suppresses output current at about 40 mA even if VOUT and VSS pins are short-circuited.

The short-circuit protection can not at the same time be a thermal protection. Attention should be paid to the Input voltage and the load current under the actual condition so as not to exceed the power dissipation of the package including the case for short-circuit.

When the output current is large and the difference between input and output voltage is large even if not shorted, the short-circuit protection may work and the output current is suppressed to the specified value. Products without short-circuit protection can provide comparatively large current by removing a short-circuit protection.

■ Selection of External Components

Output Capacitor (C_L)

The S-812C series can provide stable operation without output capacitor (C_L) since the regulator has an internal phase compensation circuit to stabilize operation when the load changes. The transient response of the regulator, however, changes with the output capacitor and the magnitude of overshoot and undershoot on output voltage accordingly changes. Please refer to C_L dependence data in “Transient Response Characteristics” to select suitable value for the capacitor.

When a tantalum or an aluminum electrolytic capacitor is used, the ESR of the capacitor shall be 10Ω or less. When an aluminum electrolytic capacitor is used attention should be especially paid to since the ESR of the aluminum electrolytic capacitor increases at low temperature and possibility of oscillation becomes large. Sufficient evaluation including temperature characteristics is indispensable.

■ Application Circuit

1. Output Current Boosting Circuit

As shown in Figure 15, the output current can be boosted by externally attaching a PNP transistor. The S-812C controls the base current of the PNP transistor so that the output voltage V_{OUT} becomes the voltage specified in the S-812C if the sufficient base-emitter voltage V_{BE} to turn on the PNP transistor is obtained between input voltage V_{IN} and S-812C power source pin VIN.

As the transient response characteristics of the circuit shown in figure 15 is not enough in some applications, evaluation for output variation due to power-on, power line variation and load variation in actual condition is needed before massproduction.

Note that the short-circuit protection incorporated in the S-812C series does not work as a short-circuit protection for the boost circuit.

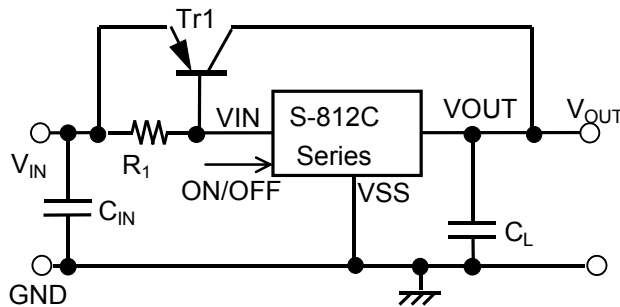


Figure 15

2. Constant Current Circuit

The S-812C series can be served in a constant current circuit as shown in the figure 16. Constant current I_o is calculated from the following equation:

$$I_o = (V_{OUT(E)} \div R_L) + I_{SS}, \text{ where } V_{OUT(E)} \text{ is the effective output voltage.}$$

Please note that in case of the circuit shown in the figure 16 the magnitude of the constant current I_o is limited by the driving ability of the S-812C.

The circuit shown in the figure 17 can, however, provide the current beyond the driving ability of the S-812C by combining a constant current circuit with a current boost circuit. The maximum input voltage for the constant current circuit is the sum of the voltage V_O of the device and 16 V. It is not recommended to attach a capacitor between the S-812C power source VIN and VSS pins or between output VOUT and VSS pins because rush current flows at power-on.

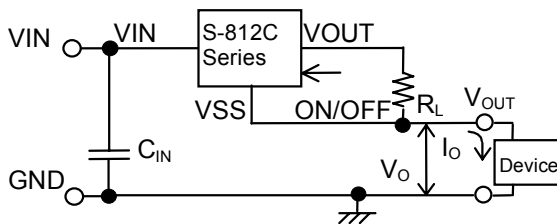


Figure 16 Constant Current Circuit

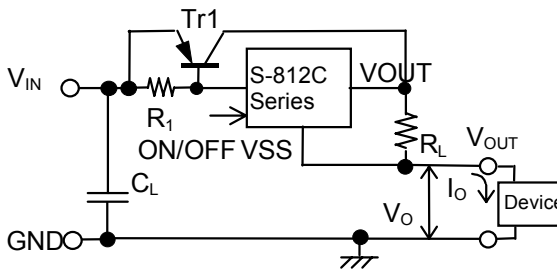


Figure 17 Constant Current Boost Circuit

3. Output Voltage Adjustment Circuit

The output voltage can be increased using the configuration shown in the figure 18. The output Voltage V_{OUT1} can be calculated using the following equation;

$$V_{OUT1} = V_{OUT(E)} \times (R_1 + R_2) \div R_1 + R_2 \times I_{SS}, \text{ where } V_{OUT(E)} \text{ is the effective output voltage.}$$

Value of R_1 and R_2 should be determined so as not to be affected by the current consumption I_{SS} .

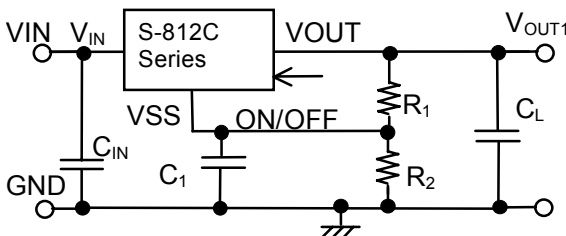


Figure 18

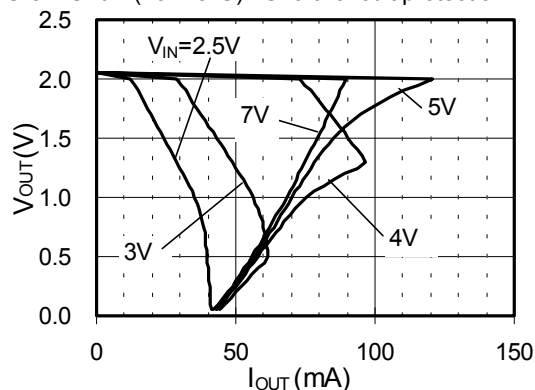
■ Precautions

- Design wiring patterns for VIN, VOUT and GND pins to hold low impedance.
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 capacitor to the VOUT pin and to the VSS pin should be as short as possible.
- Note that output voltage may be increased at low load current of less than 1 μ A.
- To prevent oscillation, it is recommended to use the external parts under the following conditions.
Equivalent Series Resistance (ESR): 30 Ω or less
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.
- The application condition for input voltage and load current should not exceed the package power dissipation.
- 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.

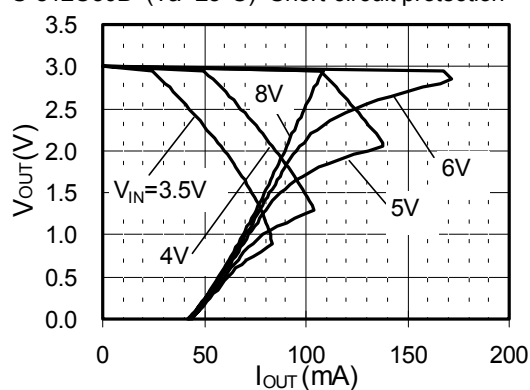
Typical Operating Characteristics

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

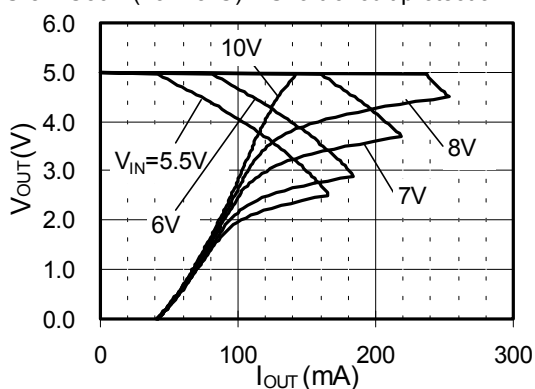
S-812C20B (Ta=25°C) Short-circuit protection



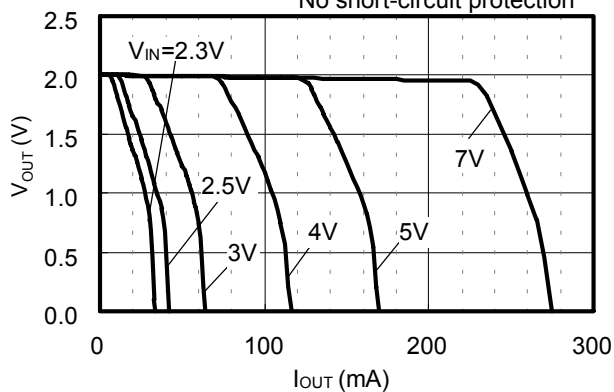
S-812C30B (Ta=25°C) Short-circuit protection



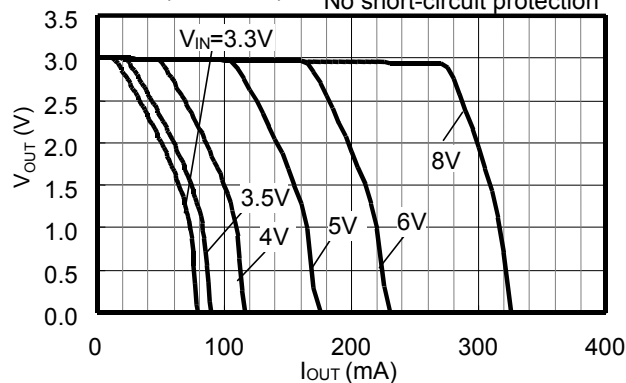
S-812C50B (Ta=25°C) Short-circuit protection



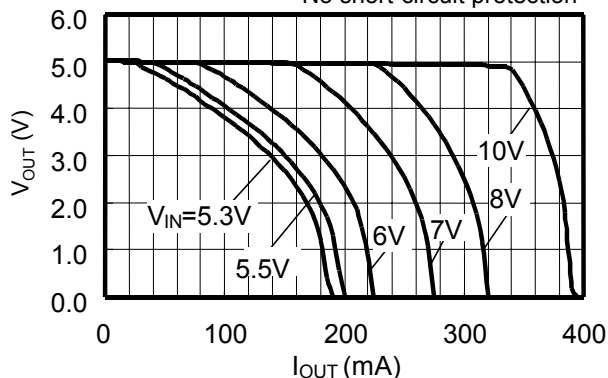
S-812C20A (Ta=25°C) No short-circuit protection



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

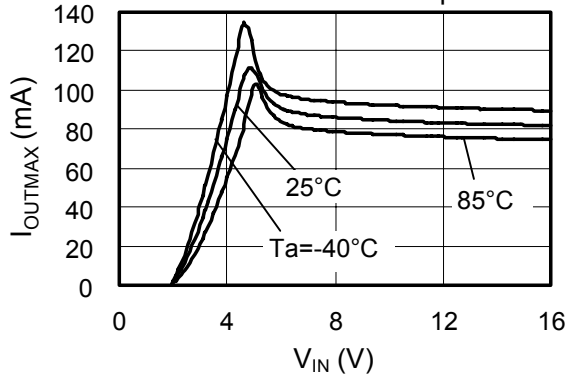


S-812C50A (Ta=25°C) No short-circuit protection

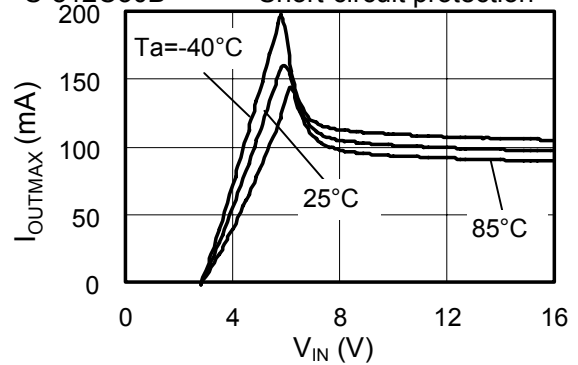


(2) Maximum Output Current vs Input Voltage

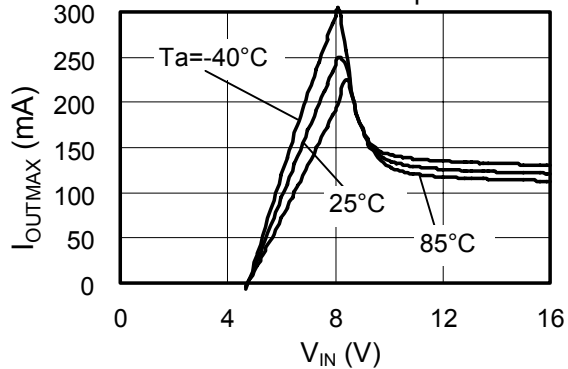
S-812C20B Short-circuit protection



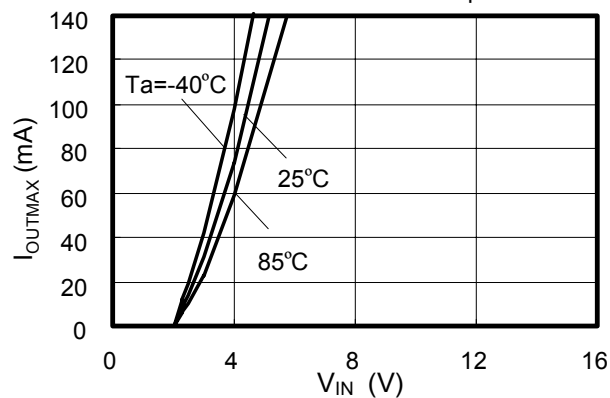
S-812C30B Short-circuit protection



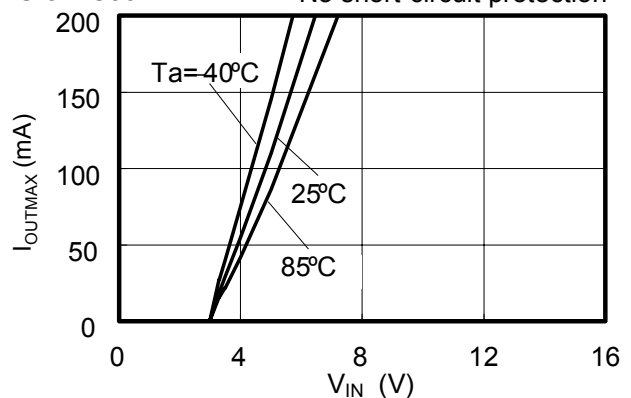
S-812C50B Short-circuit protection



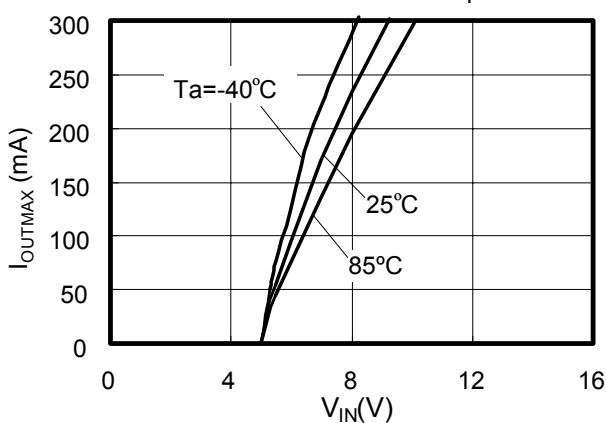
S-812C20A No short-circuit protection



S-812C30A No short-circuit protection

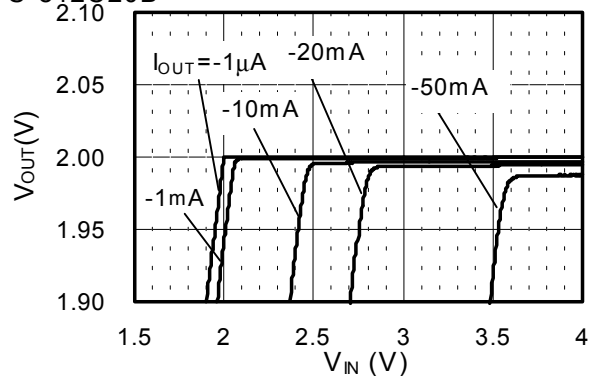


S-812C50A No short-circuit protection

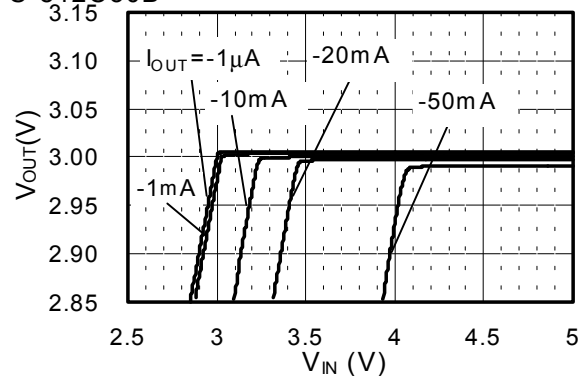


(3) Maximum Output Current vs. Input Voltage

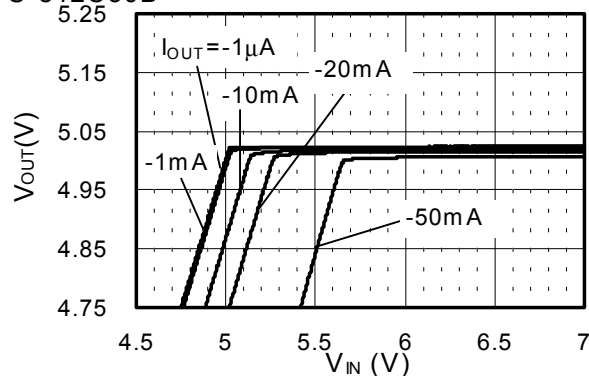
S-812C20B



S-812C30B

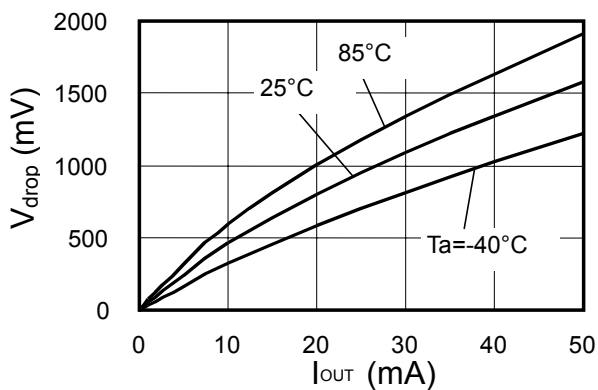


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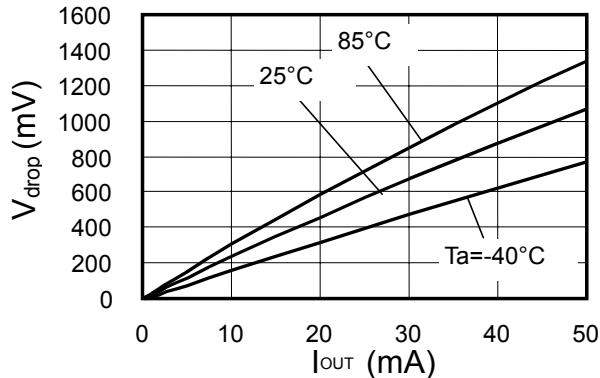


(4) Dropout Voltage vs Output Current

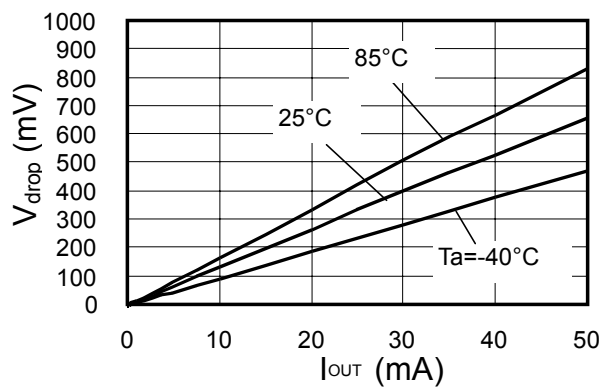
S-812C20B



S-812C30B

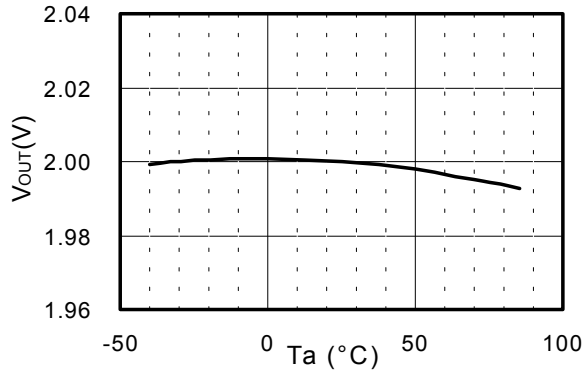


S-812C50B

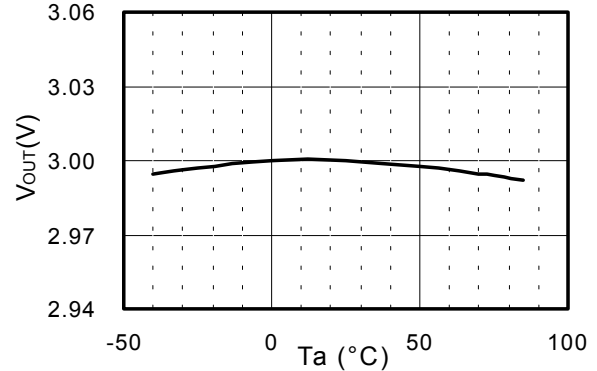


(5) Output Voltage vs Ambient Temperature

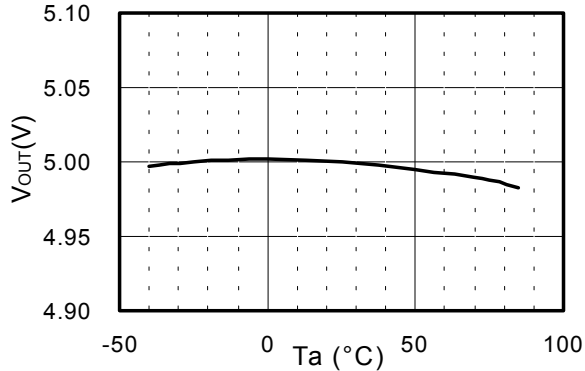
S-812C20B



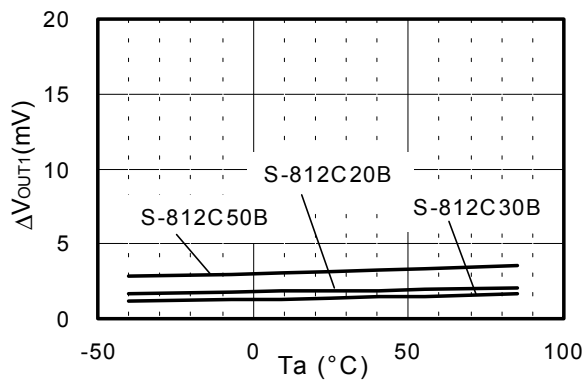
S-812C30B



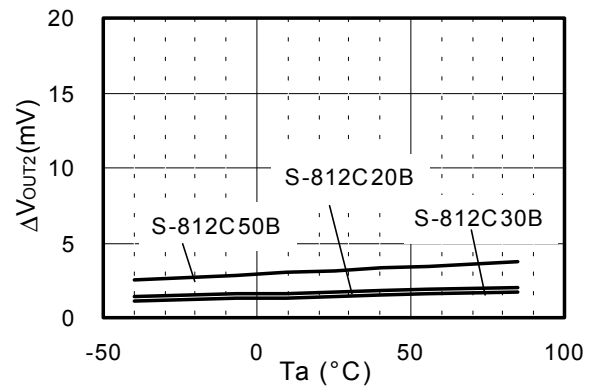
S-812C50B



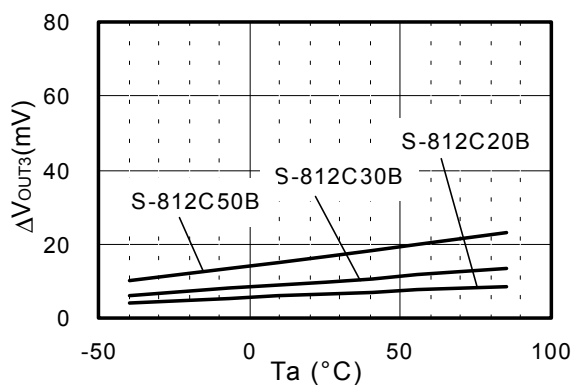
(6) Line Regulation 1 vs Ambient Temperature



(7) Line Regulation 2 vs Ambient Temperature

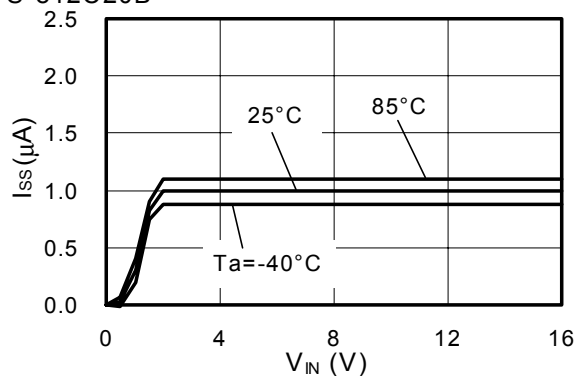


(8) Load Regulation vs Ambient Temperature

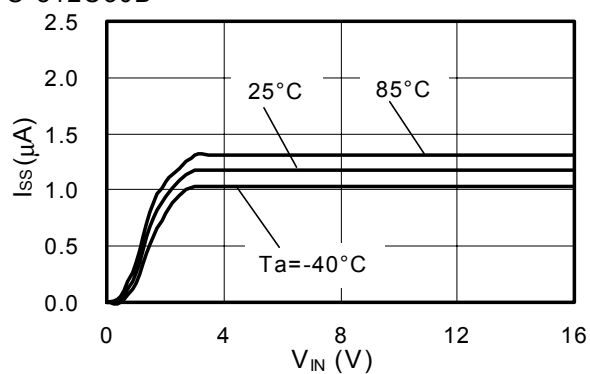


(9) Current Consumption vs Input Voltage

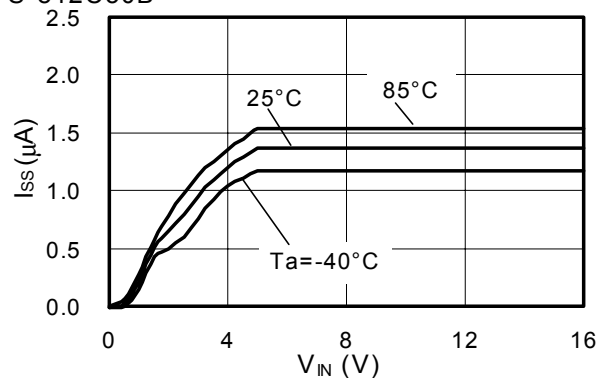
S-812C20B



S-812C30B

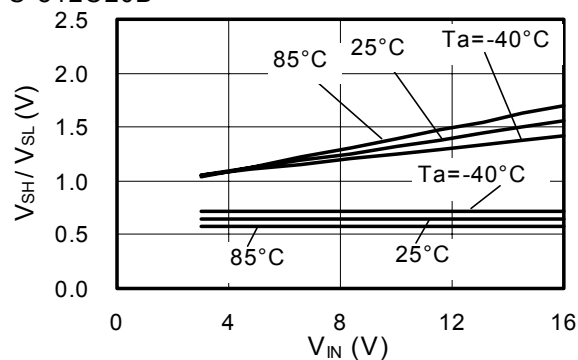


S-812C50B



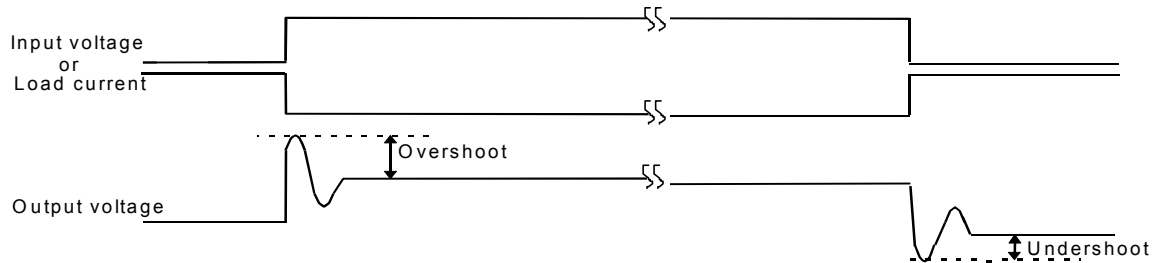
(10) Power-off Pin Input Threshold vs Input Voltage

S-812C20B

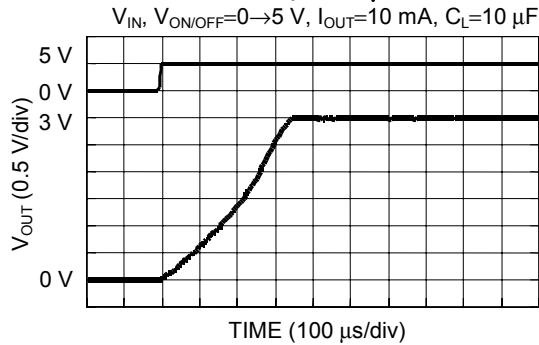


REFERENCE DATA

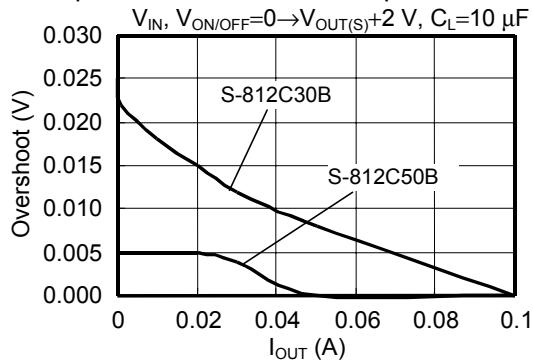
■ **Transient Response Characteristics (Typical data: $T_a=25^\circ\text{C}$)**



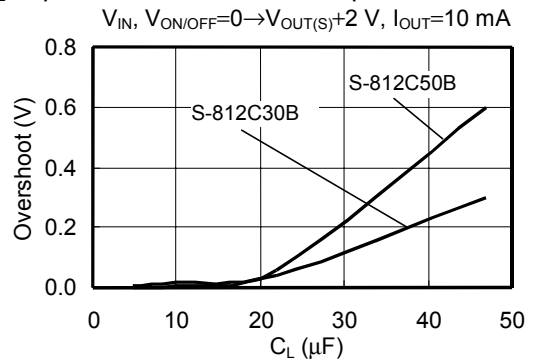
(1) Power-on : S-812C30B ($C_L=10\mu\text{F}$; ceramic capacitor)



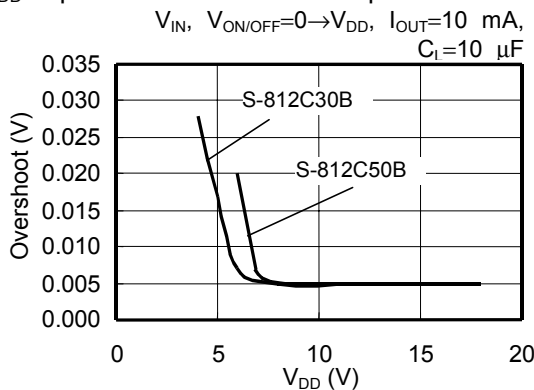
Load dependence of overshoot at power-on



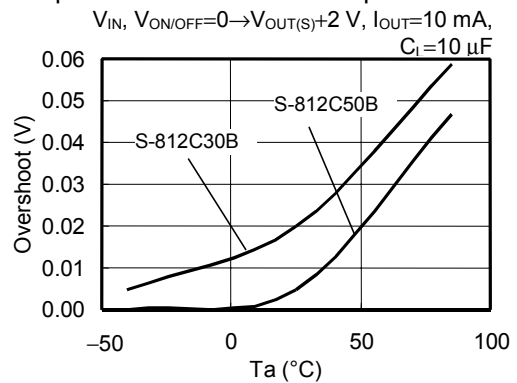
C_L dependence of overshoot at power-on



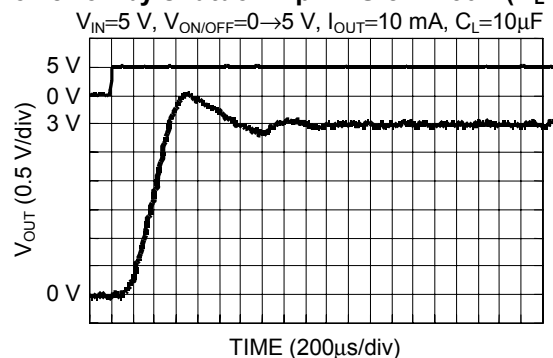
V_{DD} dependence of overshoot at power-on



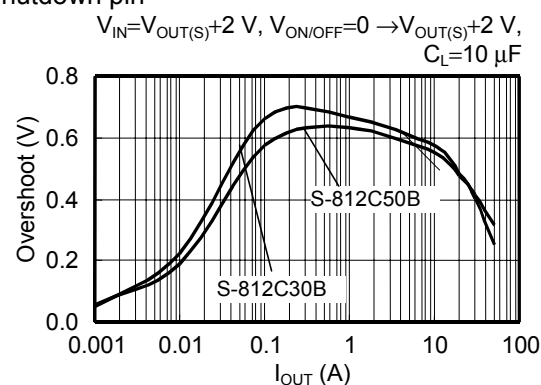
" T_a " dependence of overshoot at power-on



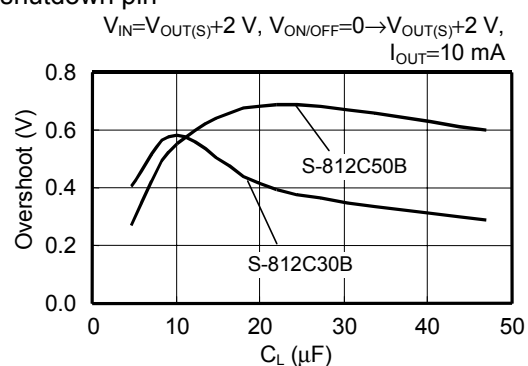
(2) Power-on by shutdown pin : S-812C30A ($C_L=10\mu\text{F}$; ceramic capacitor)



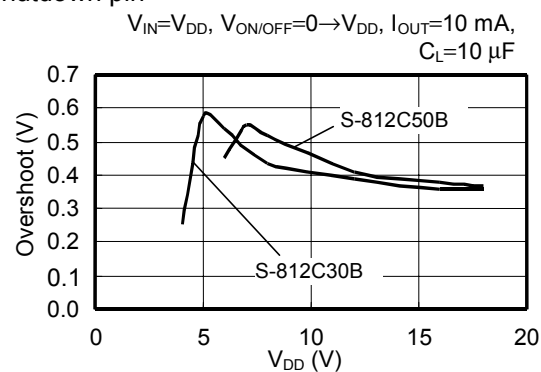
Load dependence of overshoot at power-on by shutdown pin



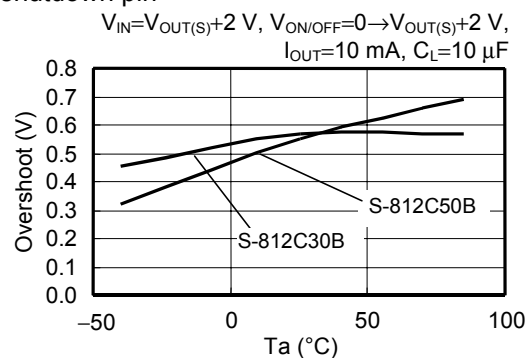
C_L dependence of overshoot at power-on by shutdown pin



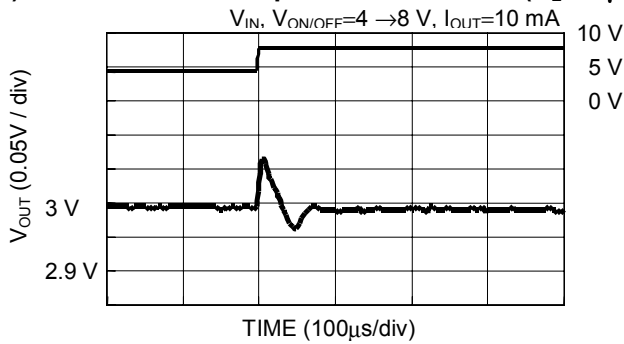
V_{DD} dependence of overshoot at power-on by shutdown pin



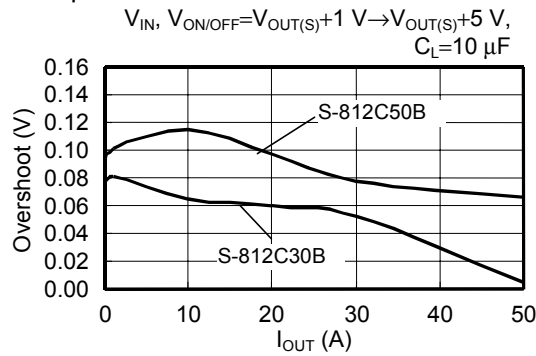
“Ta” dependence of overshoot at power-on by shutdown pin



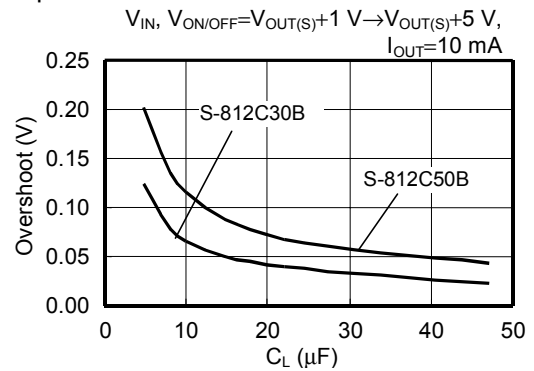
(3) Line Transient Response : S-812C30B ($C_L=10\mu\text{F}$; ceramic capacitor)



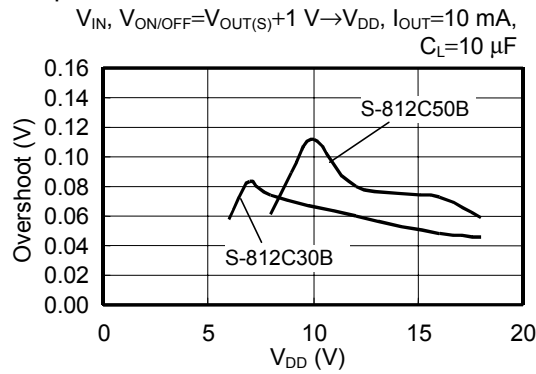
Load dependence of overshoot at line transient



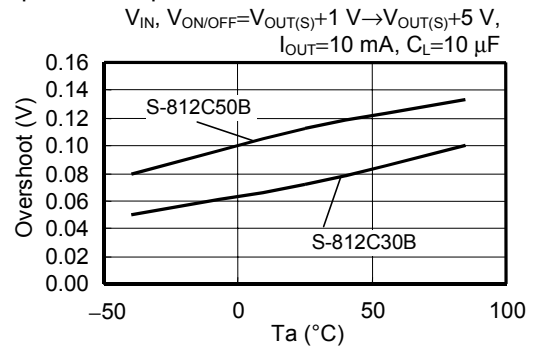
C_L dependence of overshoot at line transient

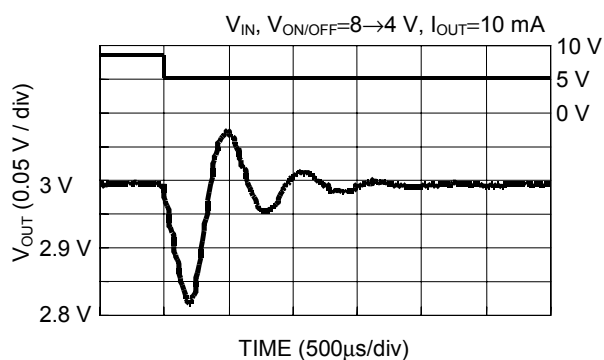


V_{DD} dependence of overshoot at line transient

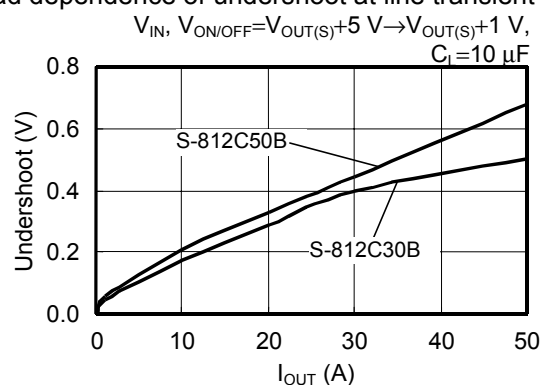


Temperature dependence of overshoot at line transient

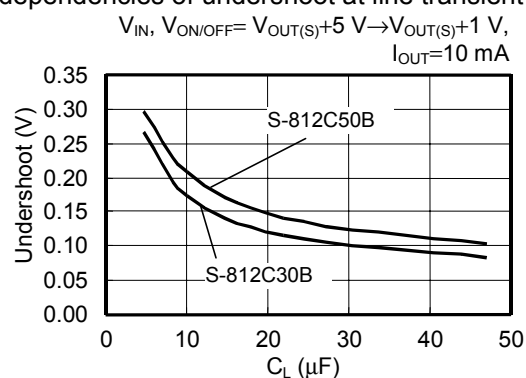




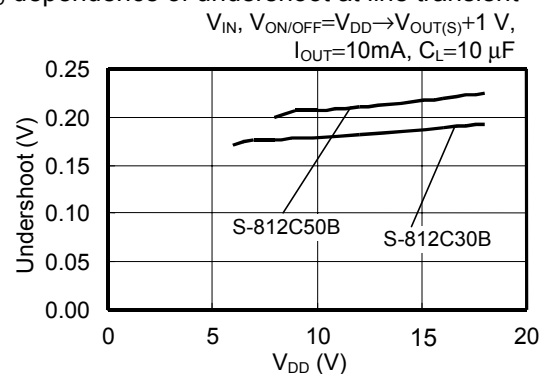
Load dependence of undershoot at line transient



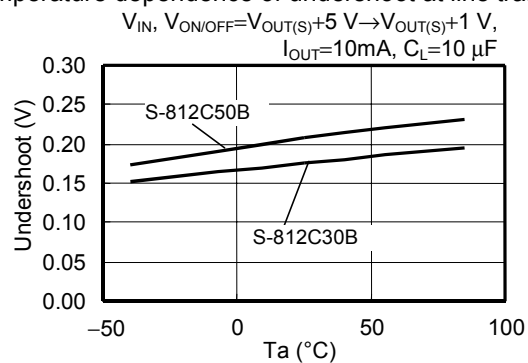
C_L dependencies of undershoot at line transient



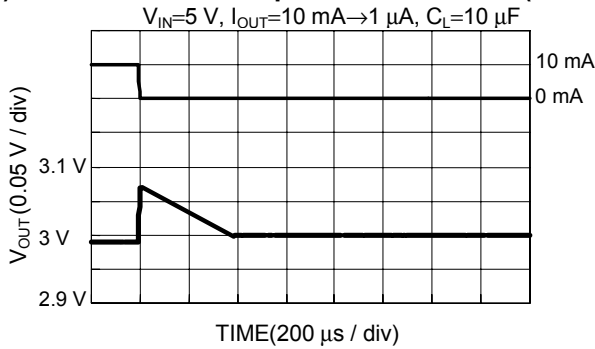
V_{DD} dependence of undershoot at line transient



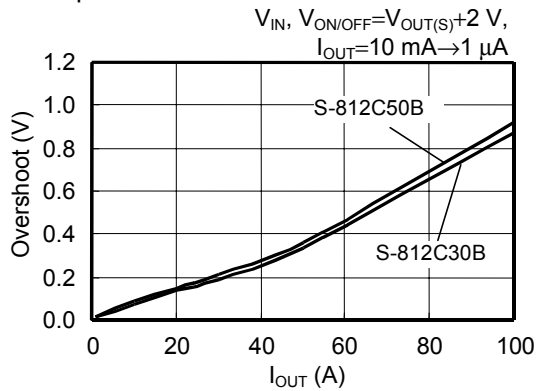
Temperature dependence of undershoot at line transient



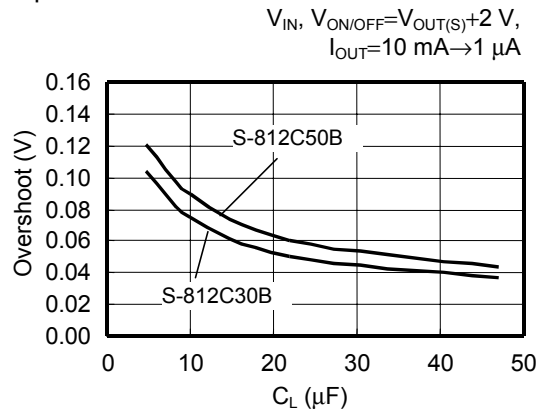
(4) Load Transient Response : S-812C30B ($C_L=10\mu\text{F}$; ceramic capacitor)



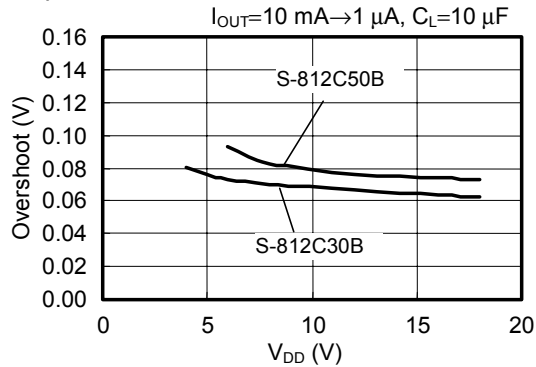
Load dependence of overshoot at load transient



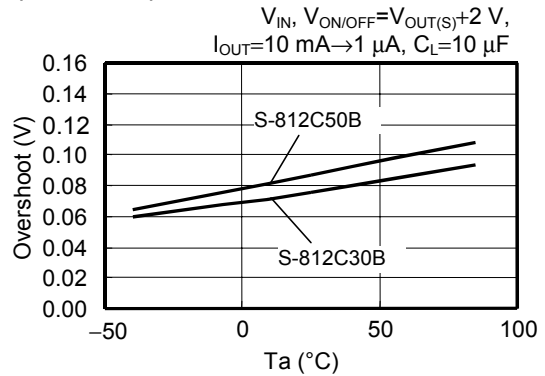
C_L dependence of overshoot at load transient

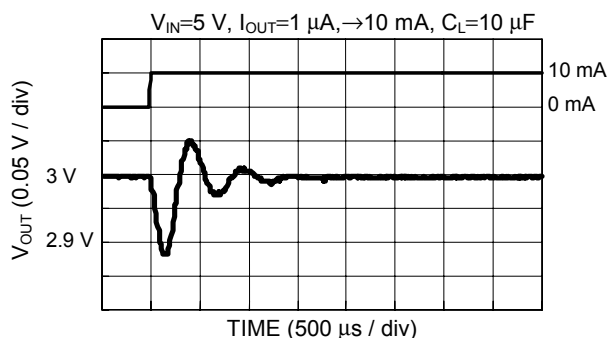


V_{DD} dependence of overshoot at load transient

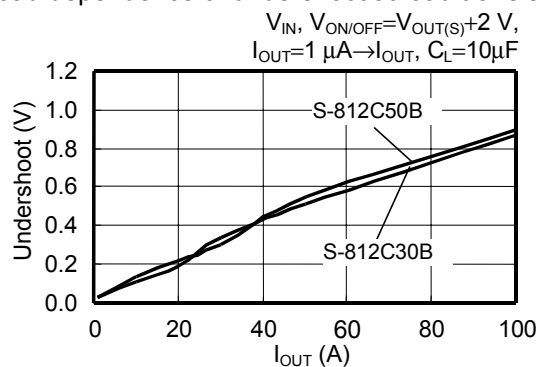


Temperature dependence of overshoot at load transient

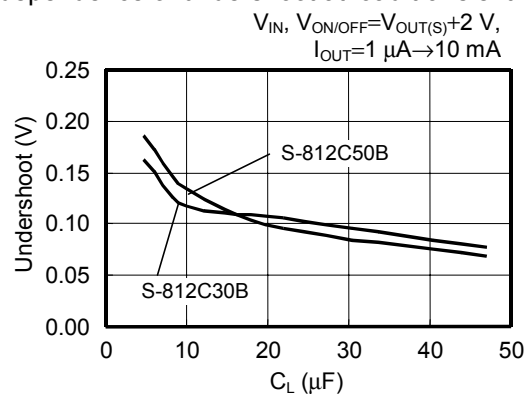




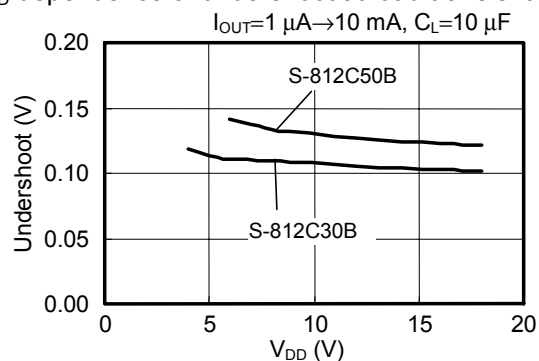
Load dependence of undershoot at load transient



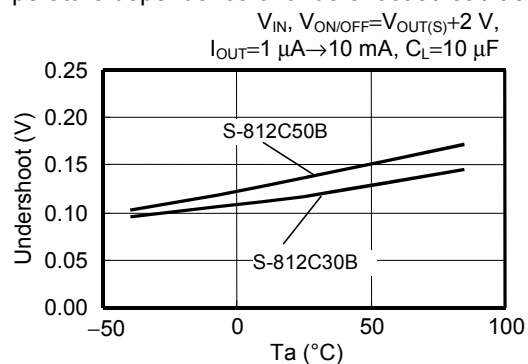
C_L dependence of undershoot at load transient

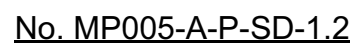


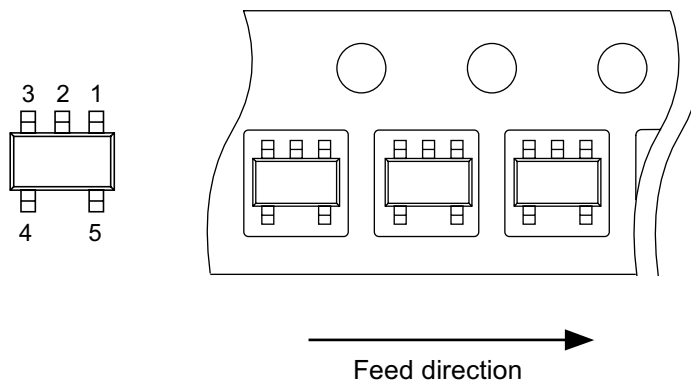
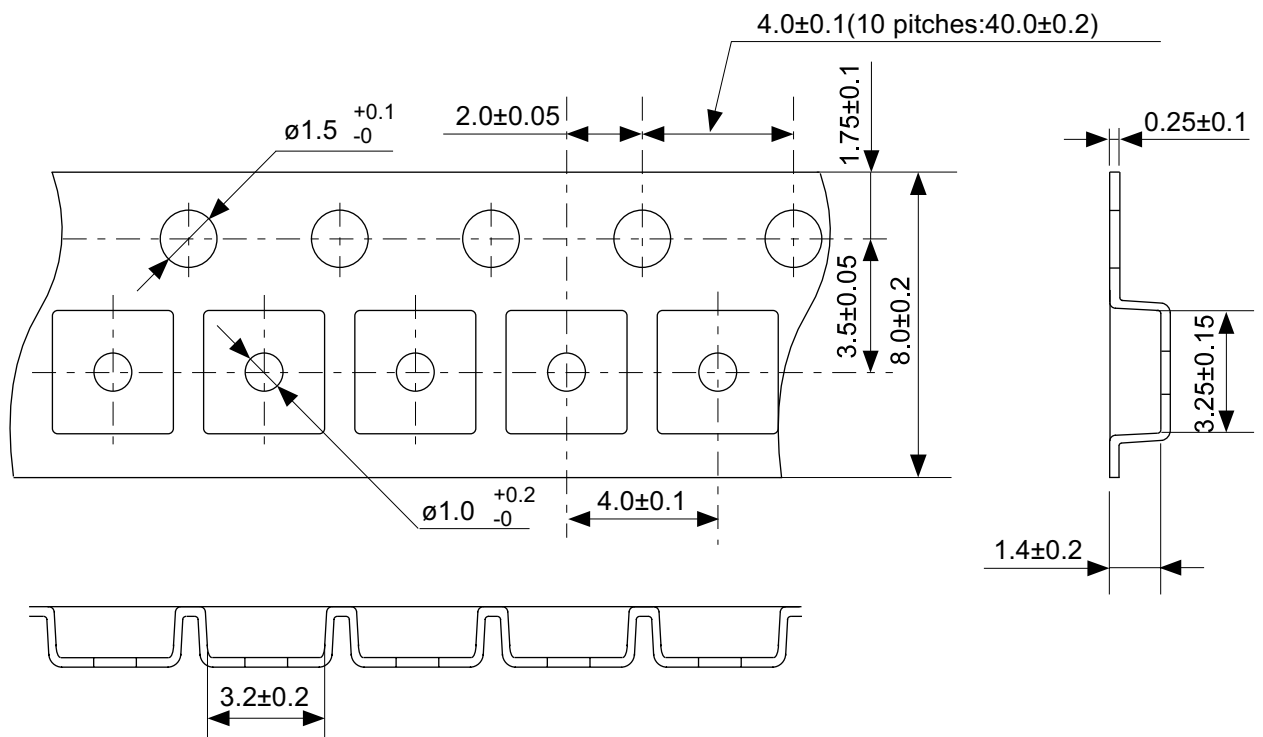
V_{DD} dependence of undershoot at load transient



Temperature dependence of undershoot at load transient

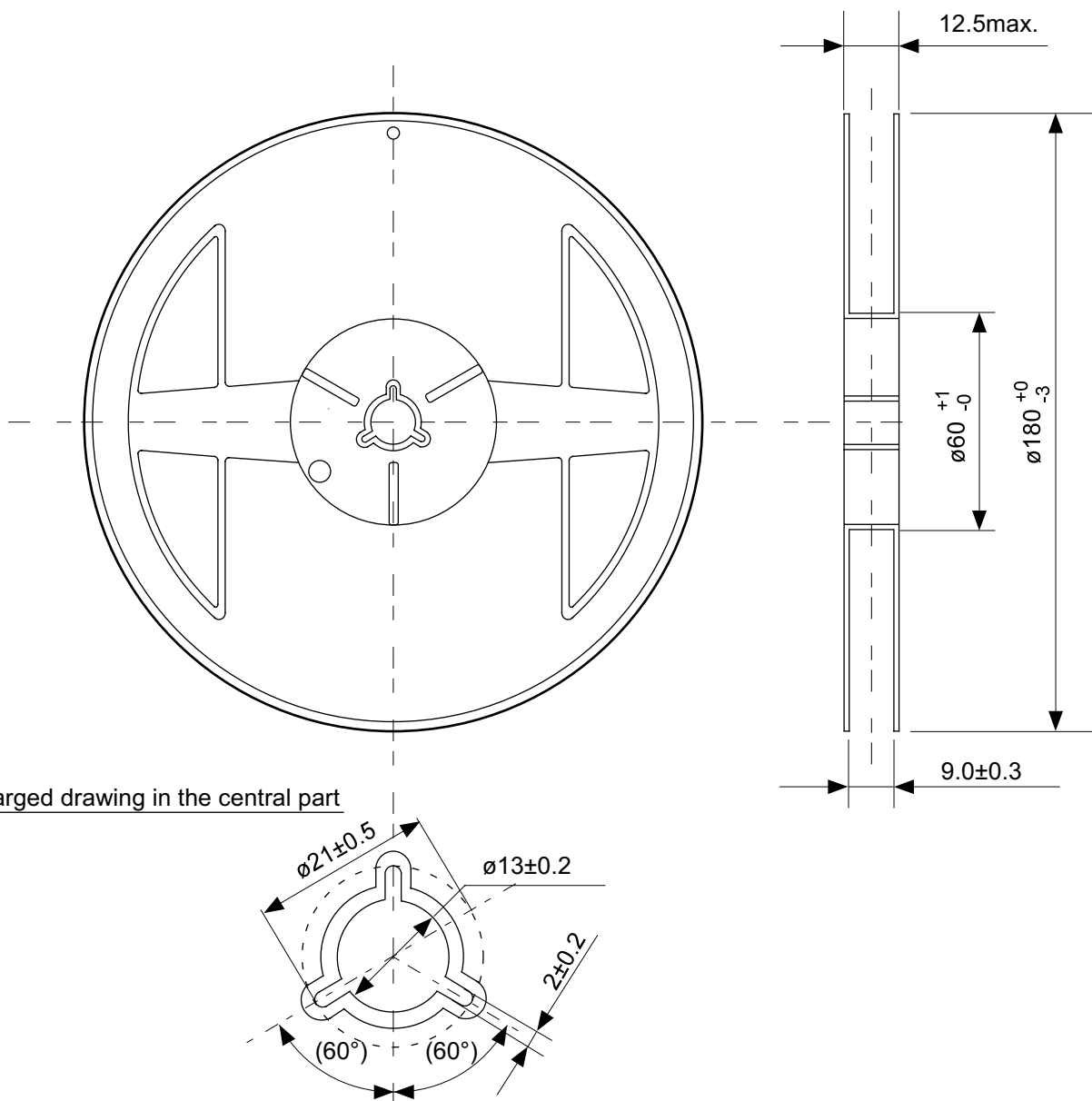






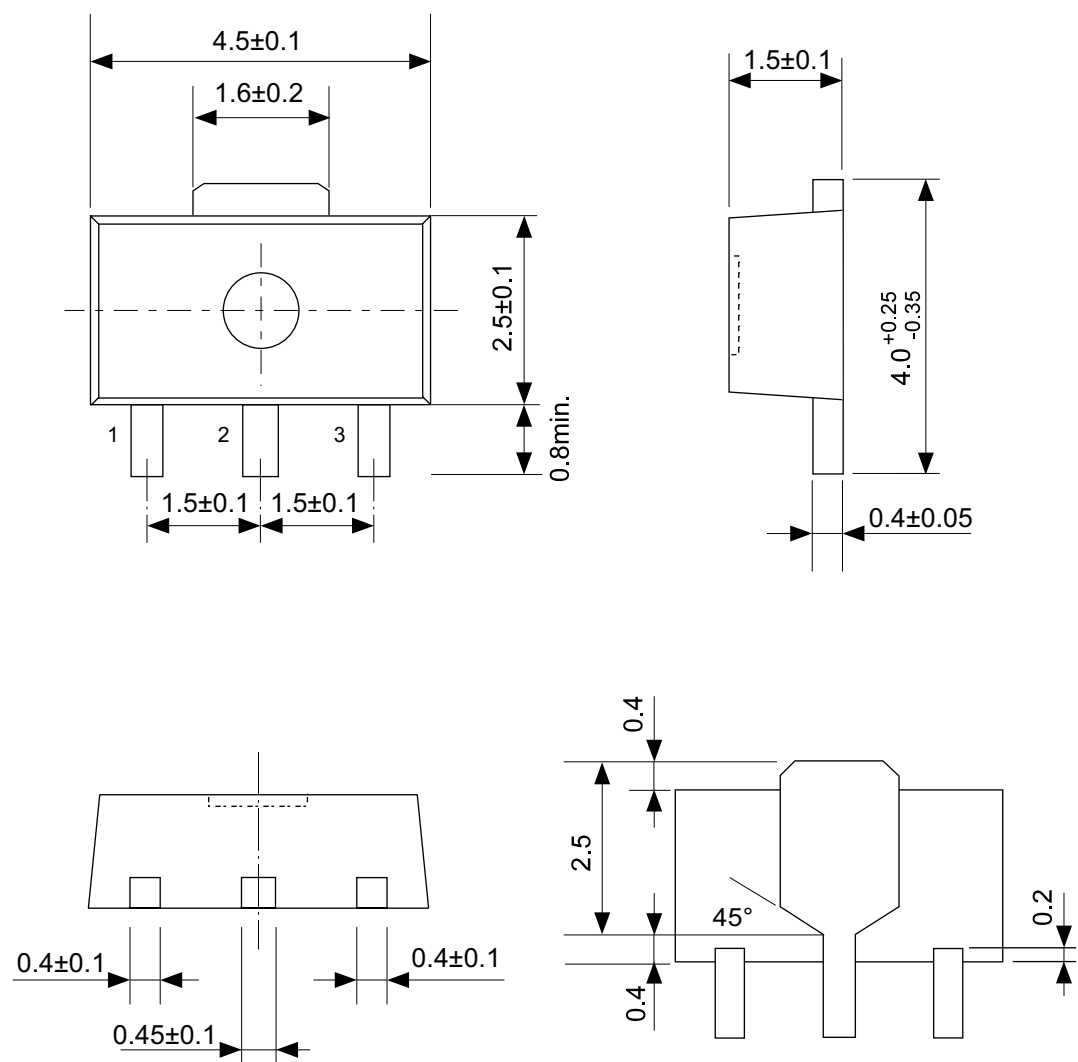
No. MP005-A-C-SD-2.1

TITLE	SOT235-A-Carrier Tape
No.	MP005-A-C-SD-2.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



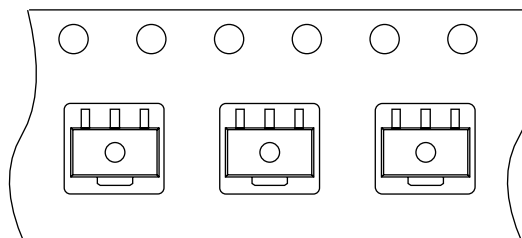
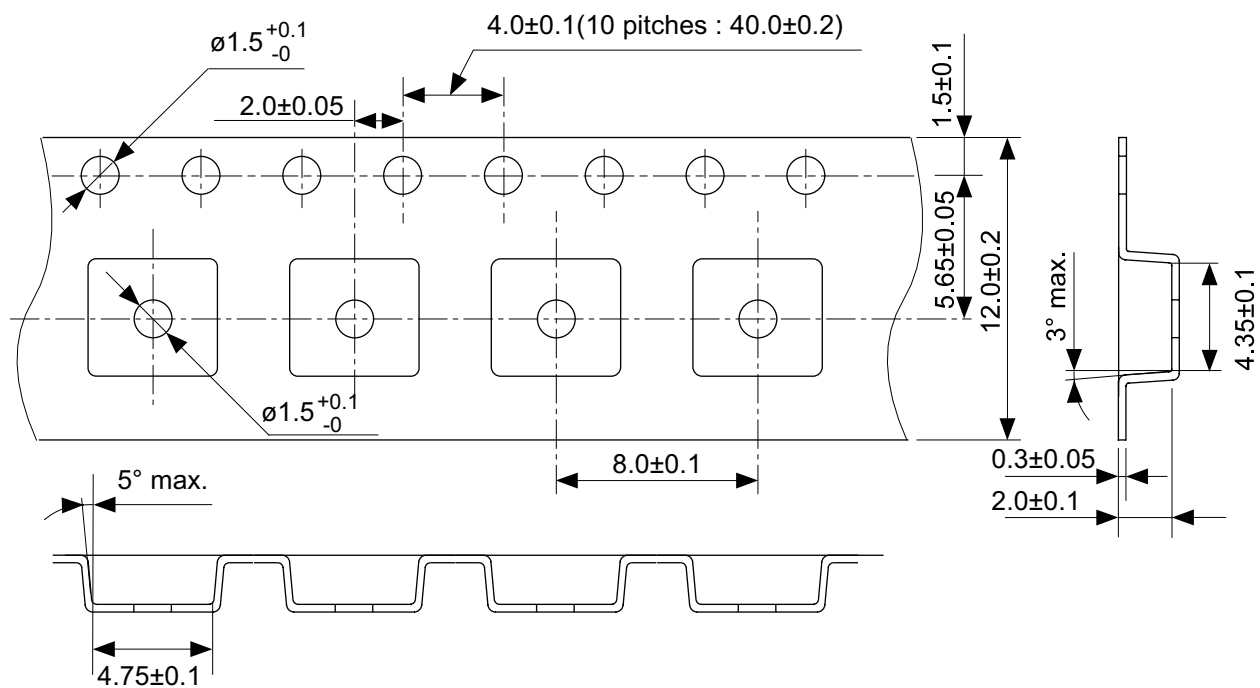
No. MP005-A-R-SD-1.1

TITLE	SOT235-A-Reel		
No.	MP005-A-R-SD-1.1		
SCALE		QTY.	3,000
UNIT	mm		
Seiko Instruments Inc.			



No. UP003-A-P-SD-1.1

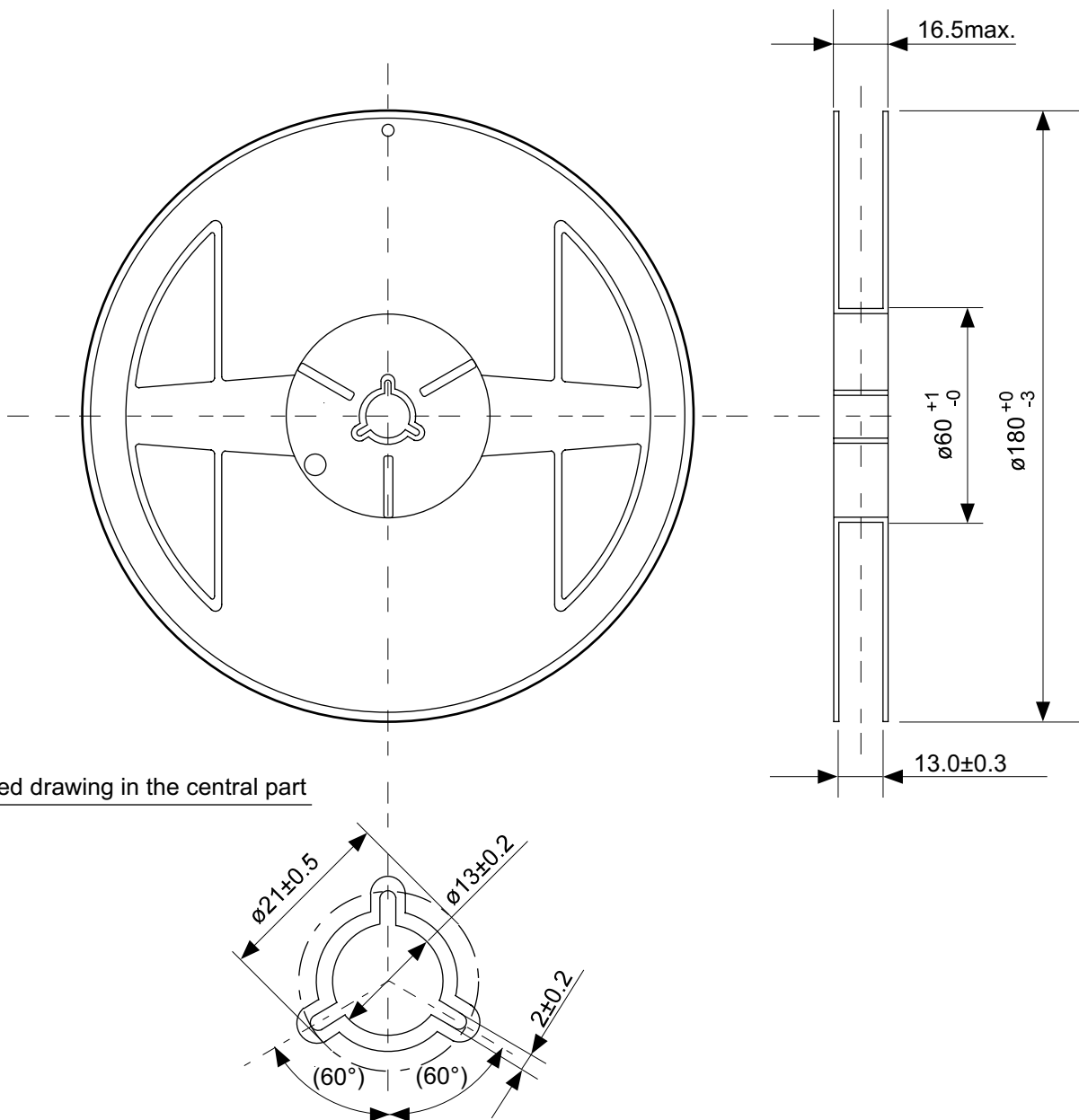
TITLE	SOT893-A-PKG Dimensions
No.	UP003-A-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



Feed direction

No. UP003-A-C-SD-1.1

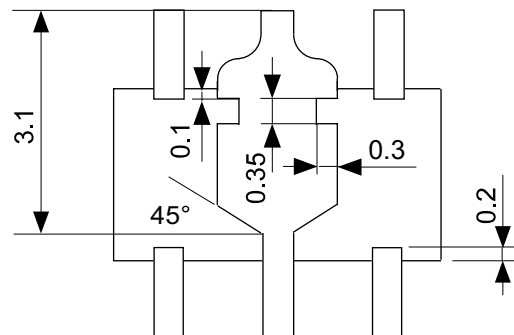
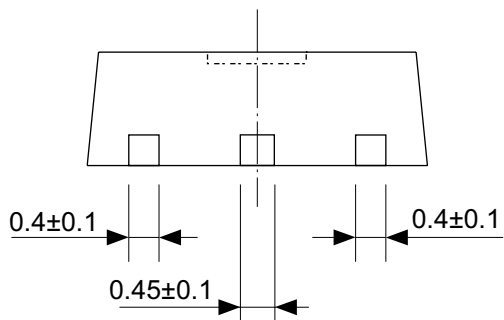
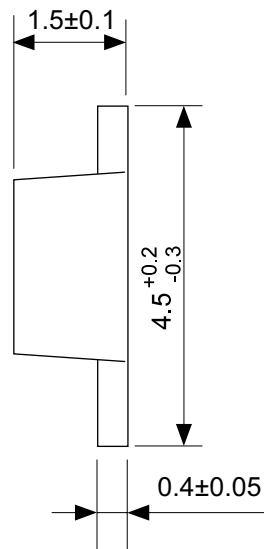
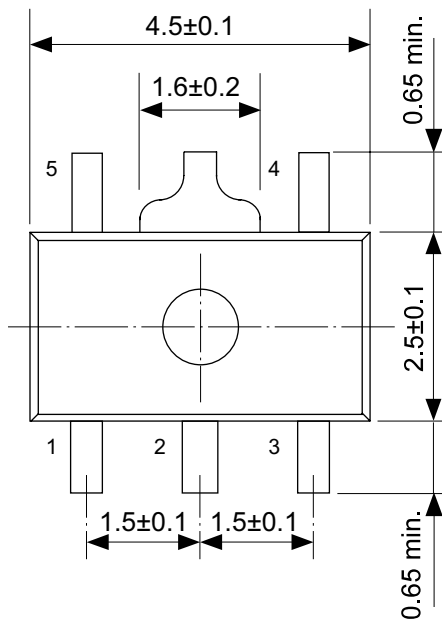
TITLE	SOT893-A-Carrier Tape
No.	UP003-A-C-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



Enlarged drawing in the central part

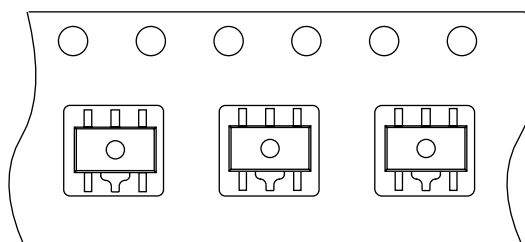
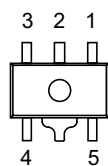
No. UP003-A-R-SD-1.1

TITLE	SOT893-A-Reel		
No.	UP003-A-R-SD-1.1		
SCALE		QTY.	1,000
UNIT	mm		
Seiko Instruments Inc.			



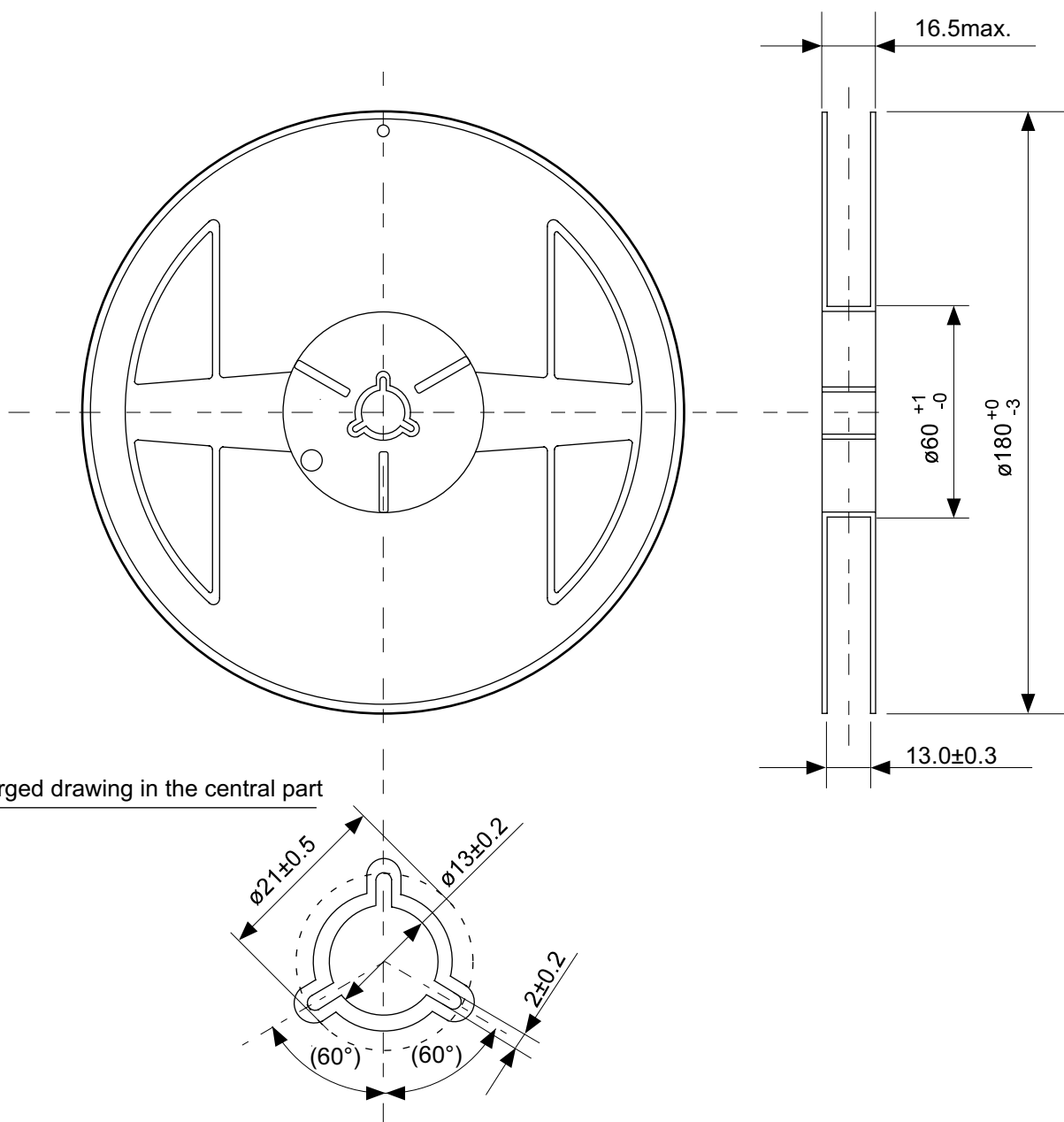
No. UP005-A-P-SD-1.1

TITLE	SOT895-A-PKG Dimensions
No.	UP005-A-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



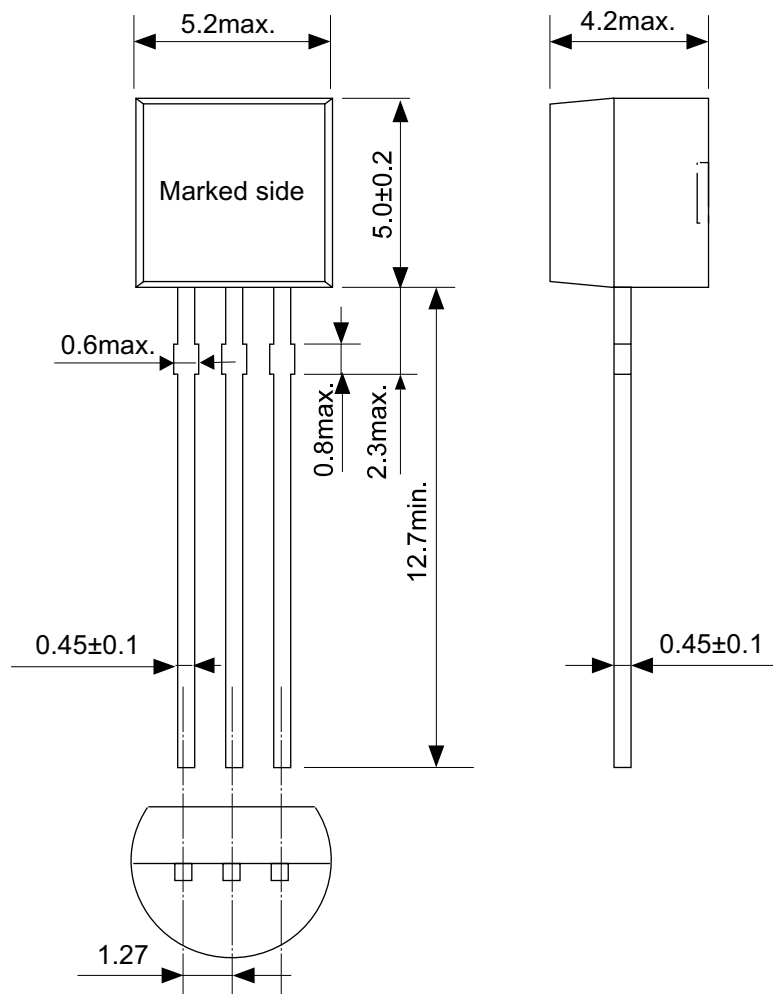
No. UP005-A-C-SD-1.1

TITLE	SOT895-A-Carrier Tape
No.	UP005-A-C-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



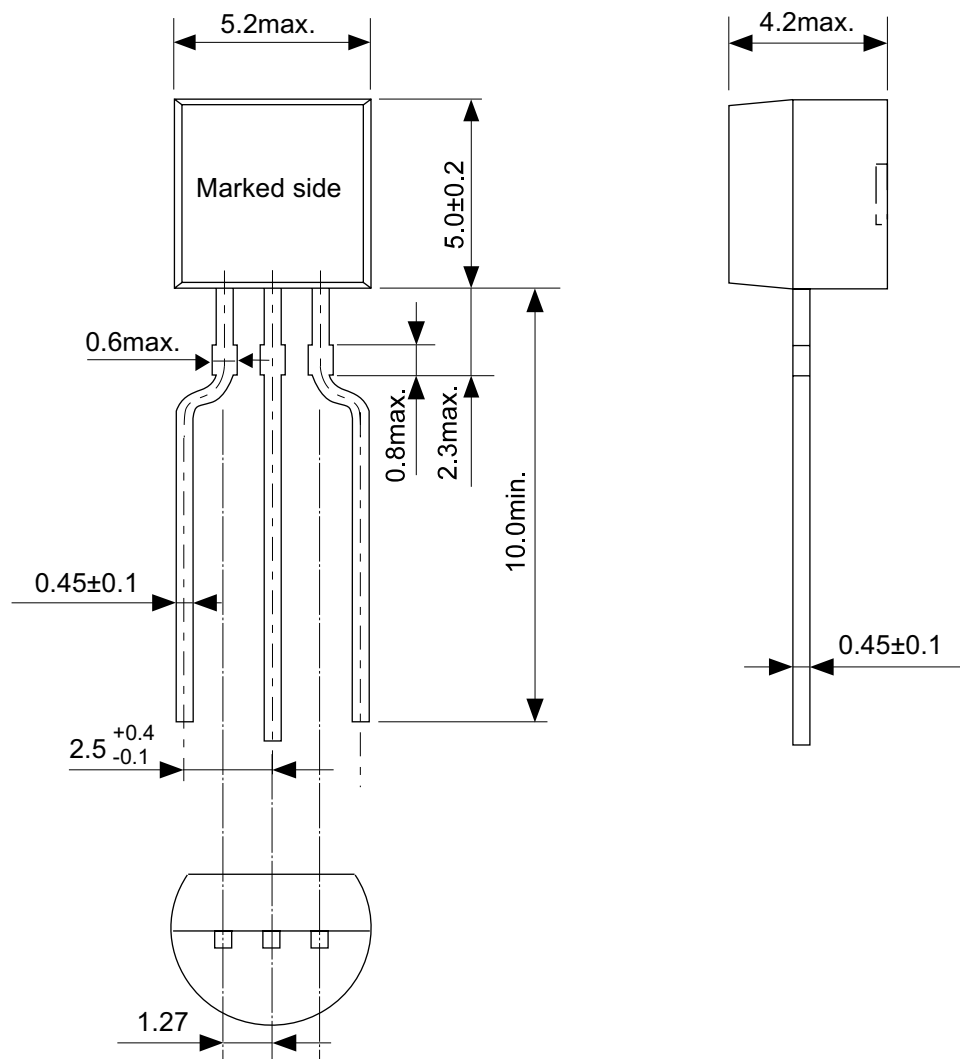
No. UP005-A-R-SD-1.1

TITLE	SOT895-A-Reel		
No.	UP005-A-R-SD-1.1		
SCALE		QTY.	1,000
UNIT	mm		
Seiko Instruments Inc.			



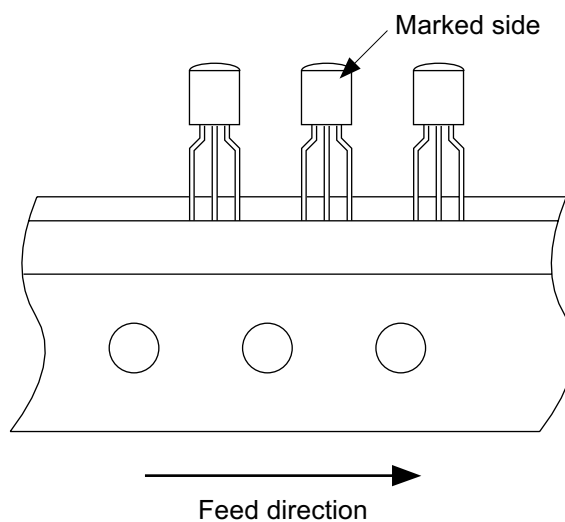
No. YS003-B-P-SD-1.1

TITLE	TO92-B-PKG Dimensions
No.	YS003-B-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	

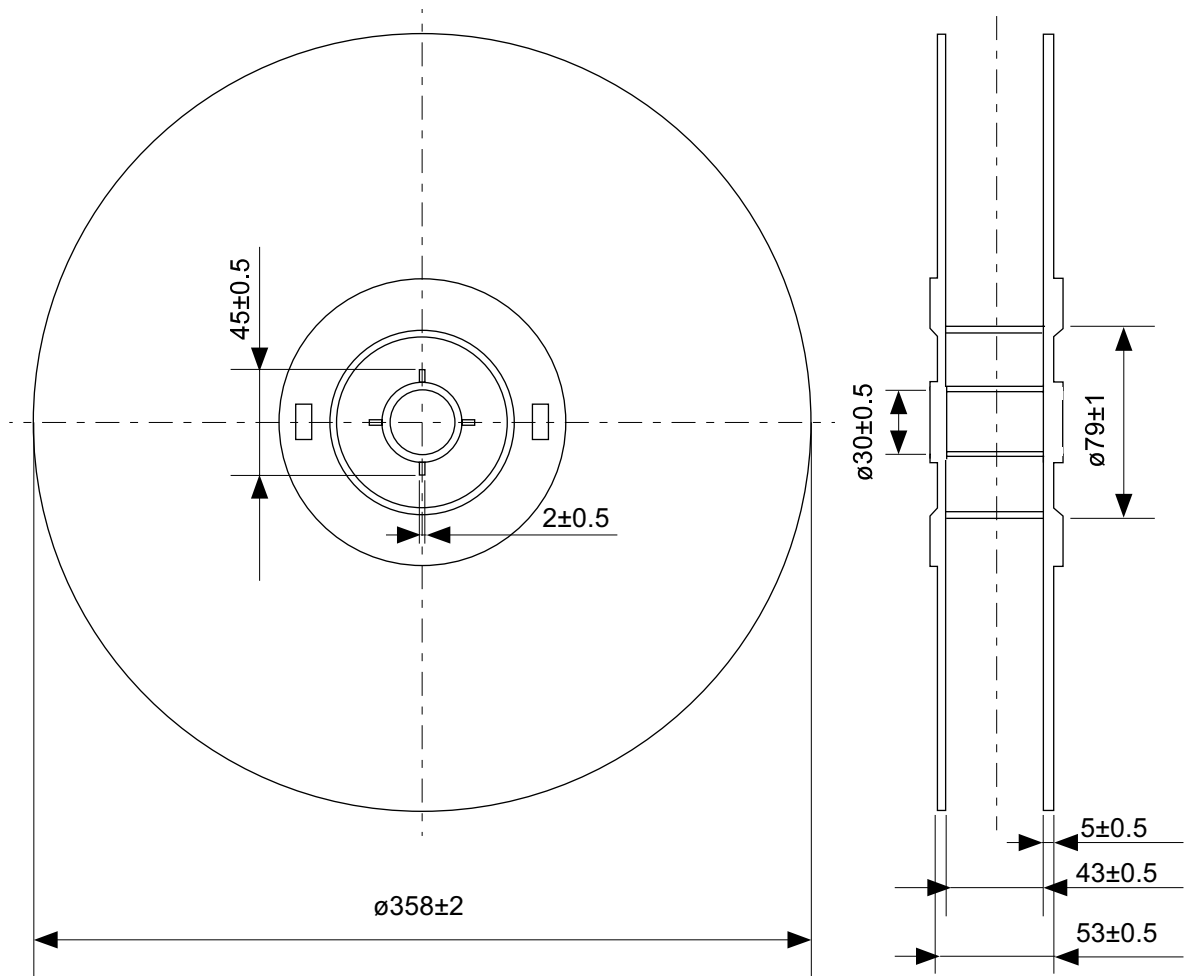


No. YF003-A-P-SD-1.1

TITLE	TO92-A-PKG Dimensions
No.	YF003-A-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	

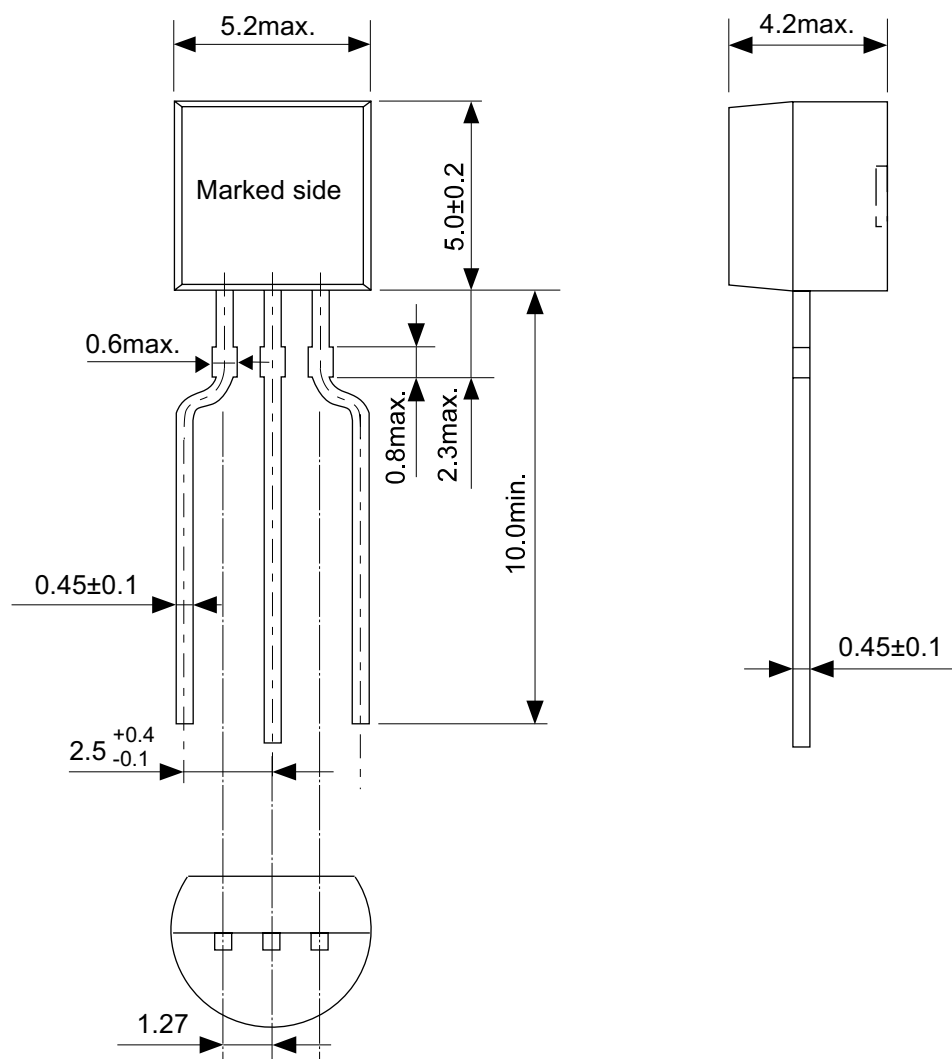


TITLE	TO92-A-Radial Tape
No.	YF003-A-C-SD-4.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



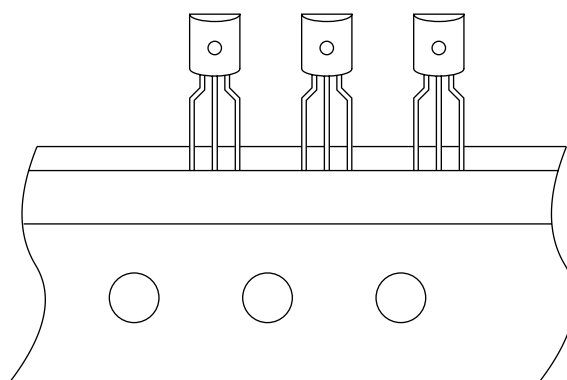
No. YF003-A-R-SD-2.1

TITLE	TO92-A-Reel		
No.	YF003-A-R-SD-2.1		
SCALE		QTY.	2,000
UNIT	mm		
Seiko Instruments Inc.			

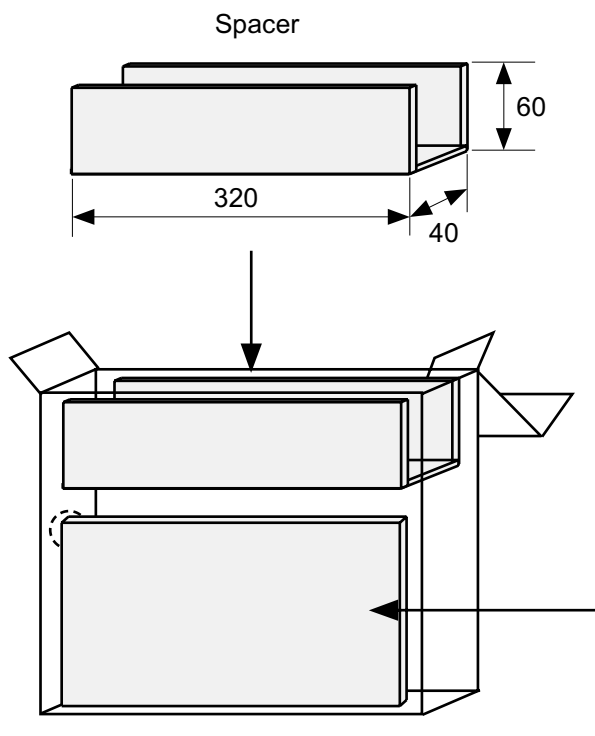


No. YF003-A-P-SD-1.1

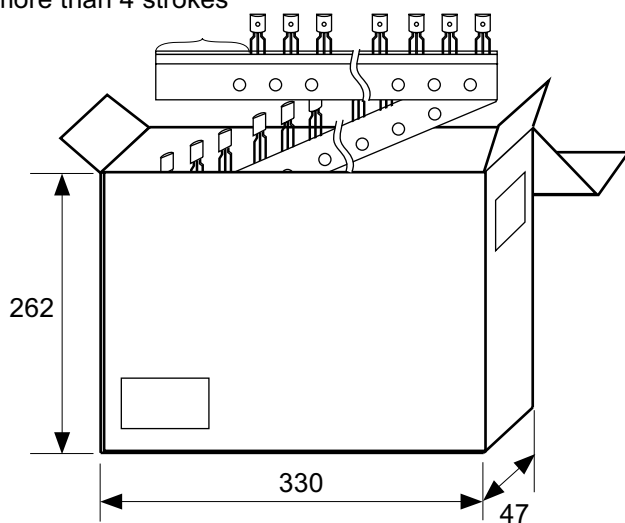
TITLE	TO92-A-PKG Dimensions
No.	YF003-A-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



TITLE	TO92-C-Radial Tape
No.	YZ003-C-C-SD-3.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



Space more than 4 strokes



No. YZ003-C-Z-SD-2.1

TITLE	TO92-C-Ammo Packing		
No.	YZ003-C-Z-SD-2.1		
SCALE		QTY.	2,500
UNIT	mm		
Seiko Instruments Inc.			

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