HIGH RIPPLE-REJECTION AND LOW DROPOUT CMOS VOLTAGE REGULATOR

S-L2980 Series

The S-L2980 series is a positive voltage regulator with a low dropout voltage, high output voltage accuracy, and low current consumption developed based on CMOS technology.
A built-in low on-resistance transistor provides a low dropout voltage and a large output current. A shutdown circuit ensures long battery life.
Various types of output capacitors can be used in the S-L2980 series compared with the conventional CMOS voltage regulators. A small ceramic capacitor can also be used.

■ Features

- Output voltage: 1.5 V to 6.0 V, selectable in 0.1 V steps
- High accuracy output voltage: ±2.0 % accuracy
- Low dropout voltage: 120 mV typ. (at 3.0 V output product, I_{OUT}=50 mA)
- Low current consumption: During operation: 90 μA typ., 140 μA max.
  During shutdown: 0.1 μA typ., 1.0 μA max.
- High peak current capability: 150 mA output is possible. (at $V_{IN} \geq V_{OUT(S)}$+1.0 V)*1
- Built-in shutdown circuit: Ensure long battery life.
- Low ESR capacitor: A 1.0 μF capacitor can be used as the output capacitor.
  (A 2.2 μF capacitor can be used as the output capacitor for the products whose output voltage is 1.7 V or less.)
- High ripple rejection: 70 dB typ. (at 1.0 kHz)
- Small package: SOT-23-5
- Lead-free products

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

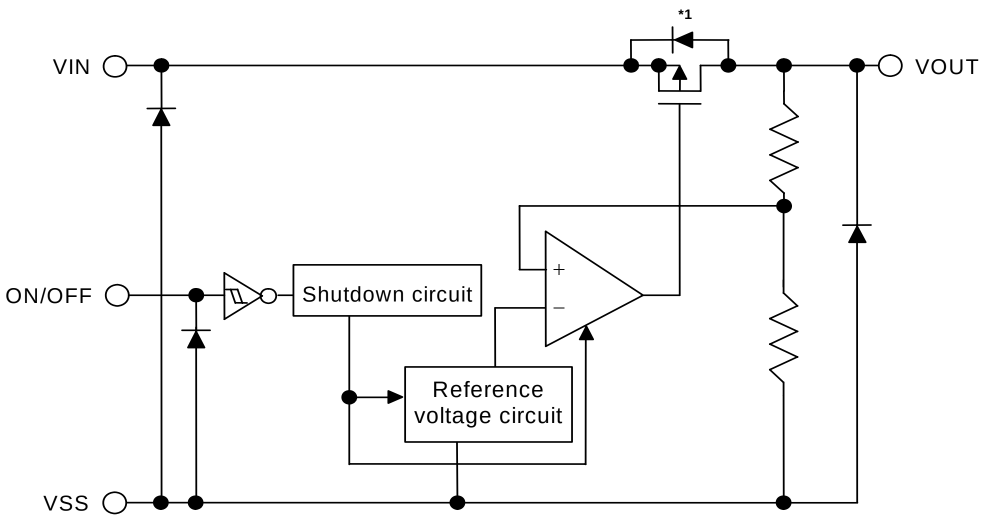
■ Applications

- Power supply for battery-powered devices
- Power supply for personal communication devices
- Power supply for home electric/electronic appliances
- Power supply for cellular phones

■ Package

Package Name	Drawing Code		
	Package	Tape	Reel
SOT-23-5	MP005-A	MP005-A	MP005-A

■ Block Diagram



***1.** Parasitic diode

Figure 1

■ Product Name Structure

- The product types and output voltage for S-L2980 Series can be selected at the user's request. Refer to the "**1. Product Name**" for the construction of the product name and "**2. Product Name List**" for the full product names.

1. Product Name

S-L2980 x xx MC - TF - G

- TF: IC direction in tape specifications*1
- MC: Package name (abbreviation)
  MC: SOT-23-5
- xx: Output voltage
  15 to 60
  (e.g. When the output voltage is 1.5 V, it is expressed as 15.)
- x: Product type*2
  A: ON/OFF pin positive logic
  B: ON/OFF pin negative logic

***1.** Refer to the taping specifications.
***2.** Refer to the "**3. Shutdown Pin (ON/OFF Pin)**" in the "**■ Operation**".

2. Product Name List

Table 1

Output Voltage	SOT-23-5
1.5 V ±2.0 %	S-L2980A15MC-TF-G
1.6 V ±2.0 %	S-L2980A16MC-TF-G
1.7 V ±2.0 %	S-L2980A17MC-TF-G
1.8 V ±2.0 %	S-L2980A18MC-TF-G
1.9 V ±2.0 %	S-L2980A19MC-TF-G
2.0 V ±2.0 %	S-L2980A20MC-TF-G
2.1 V ±2.0 %	S-L2980A21MC-TF-G
2.2 V ±2.0 %	S-L2980A22MC-TF-G
2.3 V ±2.0 %	S-L2980A23MC-TF-G
2.4 V ±2.0 %	S-L2980A24MC-TF-G
2.5 V ±2.0 %	S-L2980A25MC-TF-G
2.6 V ±2.0 %	S-L2980A26MC-TF-G
2.7 V ±2.0 %	S-L2980A27MC-TF-G
2.8 V ±2.0 %	S-L2980A28MC-TF-G
2.9 V ±2.0 %	S-L2980A29MC-TF-G
3.0 V ±2.0 %	S-L2980A30MC-TF-G
3.1 V ±2.0 %	S-L2980A31MC-TF-G
3.2 V ±2.0 %	S-L2980A32MC-TF-G
3.3 V ±2.0 %	S-L2980A33MC-TF-G
3.4 V ±2.0 %	S-L2980A34MC-TF-G
3.5 V ±2.0 %	S-L2980A35MC-TF-G
3.6 V ±2.0 %	S-L2980A36MC-TF-G
3.7 V ±2.0 %	S-L2980A37MC-TF-G
3.8 V ±2.0 %	S-L2980A38MC-TF-G
3.9 V ±2.0 %	S-L2980A39MC-TF-G
4.0 V ±2.0 %	S-L2980A40MC-TF-G
4.1 V ±2.0 %	S-L2980A41MC-TF-G
4.2 V ±2.0 %	S-L2980A42MC-TF-G
4.3 V ±2.0 %	S-L2980A43MC-TF-G
4.4 V ±2.0 %	S-L2980A44MC-TF-G
4.5 V ±2.0 %	S-L2980A45MC-TF-G
4.6 V ±2.0 %	S-L2980A46MC-TF-G
4.7 V ±2.0 %	S-L2980A47MC-TF-G
4.8 V ±2.0 %	S-L2980A48MC-TF-G
4.9 V ±2.0 %	S-L2980A49MC-TF-G
5.0 V ±2.0 %	S-L2980A50MC-TF-G
5.1 V ±2.0 %	S-L2980A51MC-TF-G
5.2 V ±2.0 %	S-L2980A52MC-TF-G
5.3 V ±2.0 %	S-L2980A53MC-TF-G
5.4 V ±2.0 %	S-L2980A54MC-TF-G
5.5 V ±2.0 %	S-L2980A55MC-TF-G
5.6 V ±2.0 %	S-L2980A56MC-TF-G
5.7 V ±2.0 %	S-L2980A57MC-TF-G
5.8 V ±2.0 %	S-L2980A58MC-TF-G
5.9 V ±2.0 %	S-L2980A59MC-TF-G
6.0 V ±2.0 %	S-L2980A60MC-TF-G

Remark Please contact our sales office for type B products.

■ Pin Configurations

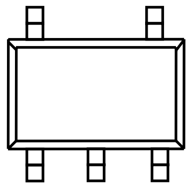


Figure 2

Table 2

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

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

■ Absolute Maximum Ratings

Table 3

(Ta=25 °C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Unit
Input voltage	V_{IN}	V_{SS}–0.3 to V_{SS}+12	V
	$V_{ON/OFF}$	V_{SS}–0.3 to V_{SS}+12	V
Output voltage	V_{OUT}	V_{SS}–0.3 to V_{IN}+0.3	V
Power dissipation	P_D	300 (When not mounted on board)	mW
		600*1	mW
Operating ambient temperature	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.

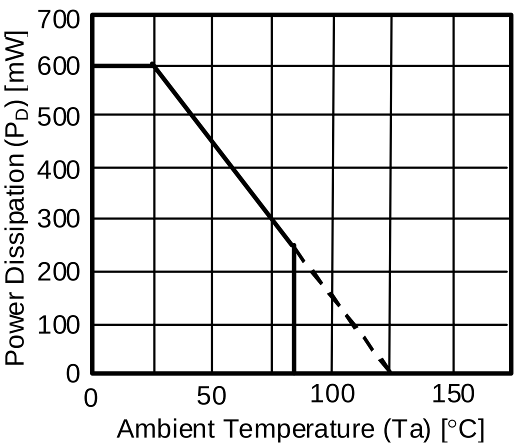


Figure 3 Power Dissipation of Package (When Mounted on Board)

■ Electrical Characteristics

Table 4

(Ta=25 °C unless otherwise specified)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit	Test circuit
Output voltage*1	$V_{OUT(E)}$	V_{IN} =$V_{OUT(S)}$+1.0 V, I_{OUT}=50 mA		$V_{OUT(S)}$ × 0.98	$V_{OUT(S)}$	$V_{OUT(S)}$ × 1.02	V	1
Output current*2	I_{OUT}	V_{IN} ≥$V_{OUT(S)}$+1.0 V		150*5	—	—	mA	3
Dropout voltage*3	V_{drop}	I_{OUT} = 50 mA	1.5 V ≤$V_{OUT(S)}$ ≤1.7 V	—	0.17	0.33	V	1
			1.8 V ≤$V_{OUT(S)}$ ≤1.9 V	—	0.16	0.29	V	1
			2.0 V ≤$V_{OUT(S)}$ ≤2.4 V	—	0.15	0.26	V	1
			2.5 V ≤$V_{OUT(S)}$ ≤2.9 V	—	0.13	0.20	V	1
			3.0 V ≤$V_{OUT(S)}$ ≤3.2 V	—	0.12	0.15	V	1
			3.3 V ≤$V_{OUT(S)}$ ≤6.0 V	—	0.11	0.14	V	1
Line regulation	$\frac{\Delta V_{OUT1}}{\Delta V_{IN} \bullet V_{OUT}}$	$V_{OUT(S)}$+0.5 V ≤V_{IN} ≤10 V, I_{OUT}=50 mA		—	0.05	0.2	%/V	1
Load regulation	ΔV_{OUT2}	V_{IN}=$V_{OUT(S)}$+1.0 V, 1.0 mA ≤I_{OUT} ≤80 mA		—	12	40	mV	1
Output voltage temperature coefficient*4	$\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$	V_{IN}=$V_{OUT(S)}$+1.0 V, I_{OUT} =50 mA, –40°C ≤Ta ≤85°C		—	±100	—	ppm/°C	1
Current consumption during operation	I_{SS1}	V_{IN}=$V_{OUT(S)}$+1.0 V, ON/OFF pin=ON, No load		—	90	140	μA	2
Current consumption when shutdown	I_{SS2}	V_{IN}=$V_{OUT(S)}$+1.0 V, ON/OFF pin =OFF, No load		—	0.1	1.0	μA	2
Input voltage	V_{IN}	—		2.0	—	10	V	—
ON/OFF pin input voltage "H"	V_{SH}	V_{IN}=$V_{OUT(S)}$+1.0 V, R_L=1.0 kΩ		1.5	—	—	V	4
ON/OFF pin input voltage "L"	V_{SL}	V_{IN}=$V_{OUT(S)}$+1.0 V, R_L=1.0 kΩ		—	—	0.3	V	4
ON/OFF pin input current "H"	I_{SH}	V_{IN}=$V_{OUT(S)}$+1.0 V, $V_{ON/OFF}$=7.0 V		–0.1	—	0.1	μA	4
ON/OFF pin input current "L"	I_{SL}	V_{IN}=$V_{OUT(S)}$+1.0 V, $V_{ON/OFF}$=0 V		–0.1	—	0.1	μA	4
Ripple rejection	$\lvert RR \rvert$	V_{IN}=$V_{OUT(S)}$+1.0 V, f = 1.0 kHz, ΔV_{rip}=0.5 V rms, I_{OUT}=50 mA	1.5 V ≤$V_{OUT(S)}$ ≤3.3 V	—	70	—	dB	5
			3.4 V ≤$V_{OUT(S)}$ ≤5.0 V	—	65	—	dB	5
			5.1 V ≤$V_{OUT(S)}$ ≤6.0 V	—	60	—	dB	5

***1.** $V_{OUT(S)}$: Specified output voltage
$V_{OUT(E)}$: Actual output voltage at the fixed load
The output voltage when fixing I_{OUT}(=50 mA) and inputting $V_{OUT(S)}$+1.0 V

***2.** Output current at which output voltage becomes 95 % of V_{OUT} after gradually increasing output current.

***3.** V_{drop}=V_{IN1}–(V_{OUT}×0.98)
V_{IN1} is the input voltage at which output voltage becomes 98 % of V_{OUT} after gradually decreasing input voltage.

***4.** Temperature change ratio in the output voltage [mV/°C] is calculated by using the following equation.

$$\frac{\Delta V_{OUT}}{\Delta Ta}\left[mV/°C\right]^{*1} = V_{OUT(S)}\left[V\right]^{*2} \times \frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}\left[ppm/°C\right]^{*3} \div 1000$$

***1.** Temperature change ratio of the output voltage
***2.** Specified output voltage
***3.** Output voltage temperature coefficient

***5.** The output current can be supplied at least to this value.
Due to restrictions on the package power dissipation, this value may not be satisfied.
Attention should be paid to the power dissipation of the package when the load is large.
This specification is guaranteed by design.

■ Test Circuits

1.

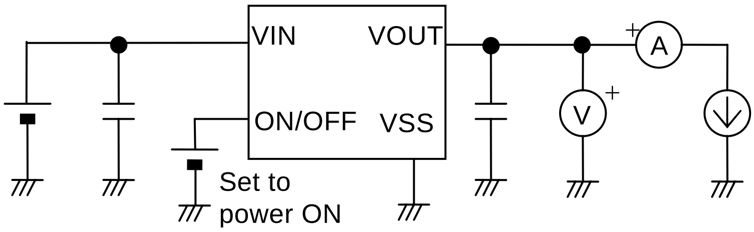


Figure 4

2.

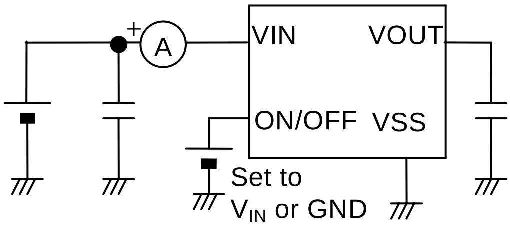


Figure 5

3.

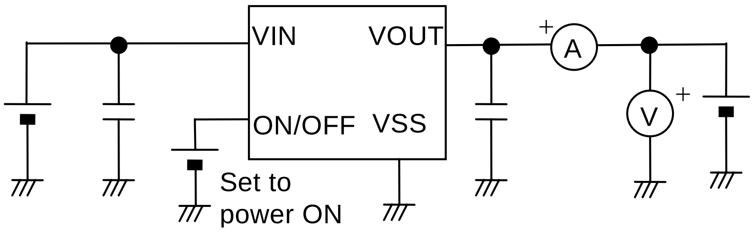


Figure 6

4.

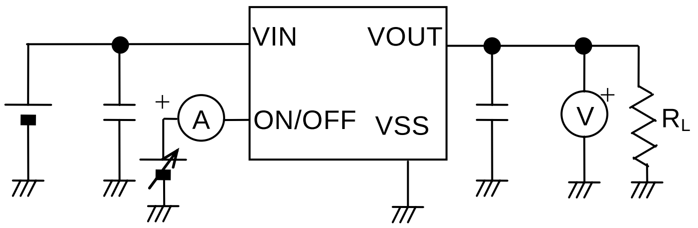


Figure 7

5.

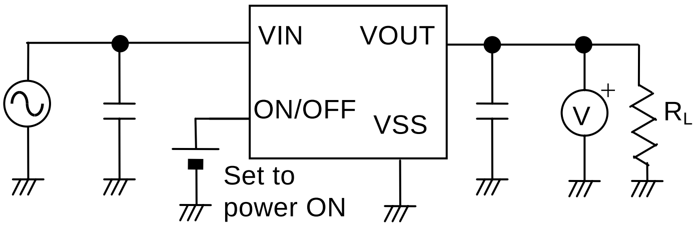
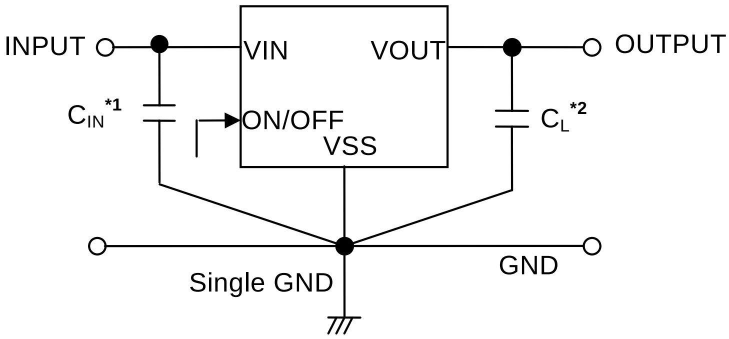


Figure 8

■ Standard Circuit



***1.** C_{IN} is a capacitor used to stabilize input.

***2.** A ceramic capacitor of 1.0 μF or more can be used for C_L, provided that A ceramic capacitor of 2.2 μF or more can be used for the product whose output voltage is 1.7 V or less.

Figure 9

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

■ Application Conditions

Input capacitor (C_{IN}):	0.47 μF or more
Input series resistance (R_{IN}):	10 Ω or less
Output capacitor (C_L):	1.0 μF or more*1
Equivalent Series Resistance (ESR) for output capacitor:	10 Ω or less

***1.** If the product whose output voltage is 1.7 V or less will be used, C_L is 2.2 μF or more.

■ Technical Terms

1. Low Dropout Voltage Regulator

The low dropout voltage regulator is a voltage regulator whose dropout voltage is low due to its built-in low on-resistance transistor.

2. Low ESR

Low ESR means the Equivalent Series Resistance of a capacitor is small. The low ESR ceramics output capacitor (C_L) can be used in the S-L2980 Series. A capacitor whose ESR is 10Ω or less can be used.

3. Output Voltage (V_{OUT})

The accuracy of the output voltage is ensured at ± 2.0 % under the specified conditions of fixed input voltage*1, fixed output current, and fixed temperature.

***1.** Differs depending upon the product.

Caution If the above conditions change, the output voltage value may vary and exceed the accuracy range of the output voltage. Refer to the "■ Electrical Characteristics" and "■ Typical Characteristics" for details.

4. Line Regulation $\left(\frac{\Delta V_{OUT1}}{\Delta V_{IN} \bullet V_{OUT}}\right)$

Indicates the dependency of the output voltage on the input voltage. That is, the value shows how much the output voltage changes due to a change in the input voltage with the output current remaining unchanged.

5. Load Regulation (ΔV_{OUT2})

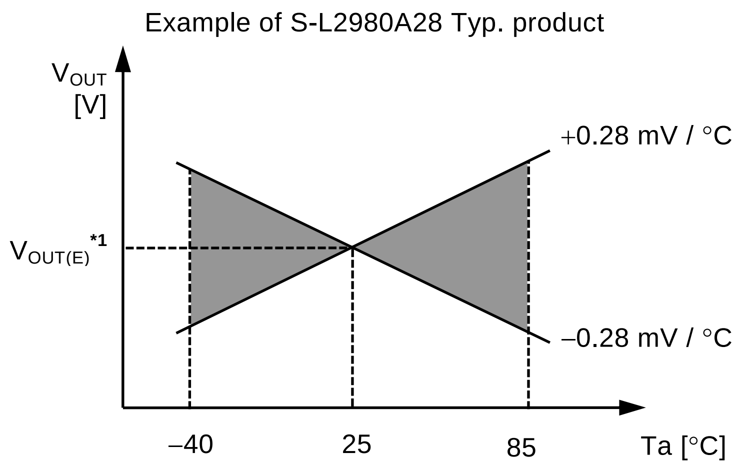
Indicates the dependency of the output voltage on the output current. That is, the value shows how much the output voltage changes due to a change in the output current with the input voltage remaining unchanged.

6. Dropout Voltage (V_{drop})

Indicates the difference between the input voltage (V_{IN1}) and output voltage when the output voltage falls to 98 % of the output voltage ($V_{OUT(E)}$) by gradually decreasing the input voltage.
$V_{drop}=V_{IN1}-(V_{OUT(E)}\times 0.98)$

7. Temperature Coefficient of Output Voltage $\left(\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}\right)$

The shadowed area in **Figure 10** is the range where V_{OUT} varies in the operating temperature range when the temperature coefficient of the output voltage is ±100 ppm/°C.



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

Figure 10

Temperature change ratio in the output voltage [mV/°C] is calculated by using the following equation.

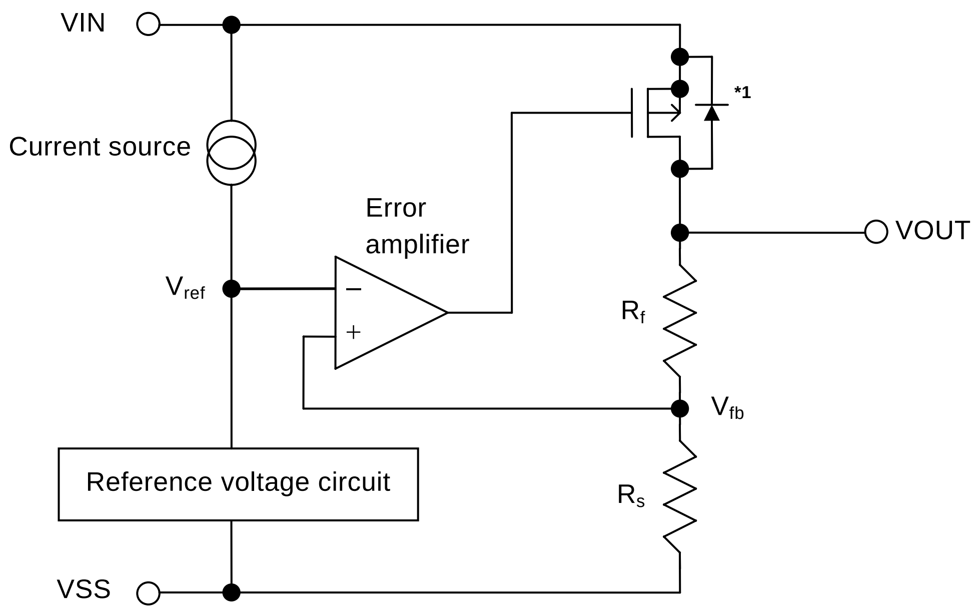
$$\frac{\Delta V_{OUT}}{\Delta Ta}\left[\text{mV/°C}\right]^{*1} = V_{OUT(S)}\left[\text{V}\right]^{*2} \times \frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}\left[\text{ppm/°C}\right]^{*3} \div 1000$$

***1.** Temperature change ratio of the output voltage
***2.** Specified output voltage
***3.** Output voltage temperature coefficient

■ Operation

1. Basic Operation

Figure 11 shows the block diagram of the S-L2980 Series.
The error amplifier compares the reference voltage (V_{ref}) with the V_{fb}, which is the output voltage resistance-divided by the feedback resistors R_s and R_f. It supplies the output transistor with the gate voltage necessary to ensure certain output voltage free of any fluctuations of input voltage and temperature.



***1.** Parasitic diode

Figure 11

2. Output Transistor

The S-L2980 Series uses a low on-resistance P-channel MOS FET as the output transistor.
Be sure that V_{OUT} does not exceed V_{IN}+0.3 V to prevent the voltage regulator from being broken due to inverse current flowing from VOUT pin through a parasitic diode to VIN pin.

3. Shutdown Pin (ON/OFF Pin)

This pin starts and stops the regulator.
When the ON/OFF pin is turned to the shutdown level, the operation of all internal circuits stops, the built-in P-channel MOS FET output transistor between VIN pin and VOUT pin is turned off to make current consumption drastically reduced. The VOUT pin becomes the Vss level due to internally divided resistance of several hundreds kΩ between the VOUT pin and VSS pin.
Furthermore, the structure of the ON/OFF pin is as shown in **Figure 12**. Since the ON/OFF pin is neither pulled down nor pulled up internally, do not use it in the floating state. In addition, please note that current consumption increases if a voltage of 0.3 V to VIN–0.3 V is applied to the ON/OFF pin.
When the ON/OFF pin is not used, connect it to the VIN pin in case the logic type is “A” and to the VSS pin in case of “B”.

Table 5

Logic type	ON/OFF pin	Internal circuit	VOUT pin voltage	Current consumption
A	“H”: Power on	Operating	Set value	I_{SS1}
A	“L”: Power off	Stop	V_{SS} level	I_{SS2}
B	“H”: Power off	Stop	V_{SS} level	I_{SS2}
B	“L”: Power on	Operating	Set value	I_{SS1}

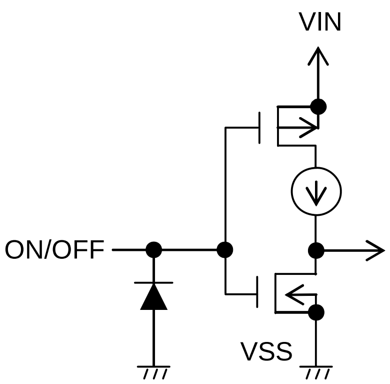


Figure 12

■ Selection of Output Capacitor (C_L)

The S-L2980 series needs an output capacitor between VOUT pin and VSS pin for phase compensation.
A ceramic capacitor whose capacitance is 1.0 μF or more[*1] can be used. When an OS (Organic Semi-conductor) capacitor, a tantalum capacitor or an aluminum electrolyte capacitor is used, the capacitance should be 2.2 μF or more and the ESR should be 10 Ω or less.
The value of the output overshoot or undershoot transient response varies depending on the value of the output capacitor.
Sufficient evaluation including temperature dependency in the actual environment is needed.

***1.** If the product whose output voltage is 1.7 V or less will be used, the capacitance should be 2.2 μF or more.

■ Precautions

- Wiring patterns for VIN pin, VOUT pin and GND pin should be designed 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 capacitors to these pins should be as short as possible.

- Note that output voltage may increase when a series regulator is used at low load current (1.0 mA or less).

- Generally a series regulator may cause oscillation, depending on the selection of external parts. The following conditions are recommended for this IC. However, be sure to perform sufficient evaluation under the actual usage conditions for selection, including evaluation of temperature characteristics.

Input capacitor (C_{IN}):	0.47 μF or more
Output capacitor (C_L):	1.0 μF or more*1
Equivalent Series Resistance (ESR):	10 Ω or less
Input series resistance (R_{IN}):	10 Ω or less

***1.** If the product whose output voltage will be is 1.7 V or less is used, the capacitance should be 2.2 μF or more.

- A voltage regulator may oscillate when the impedance of the power supply is high and the input capacitor is small or not connected.

- The application condition for input voltage, output voltage and load current should not exceed the package power dissipation.

- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.

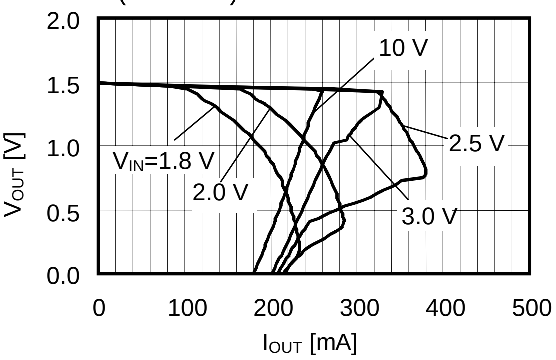
- In determining output current attention should be paid to the output current value specified in the **Table 4** for "■ **Electrical Characteristics**" and the footnote ***5**.

- 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.

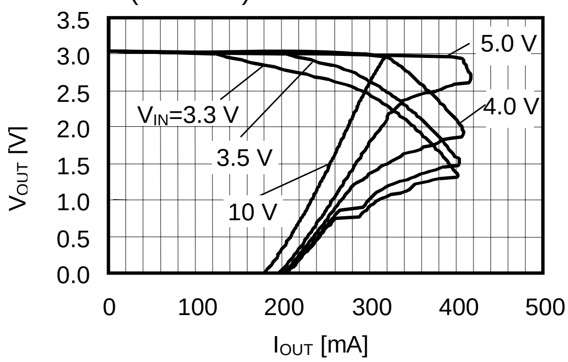
■ Typical Characteristics

1. Output voltage versus Output current (When load current increases)

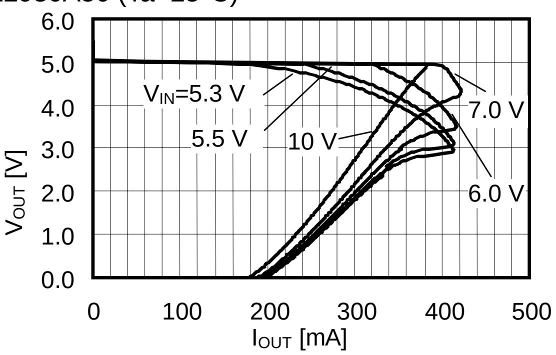
S-L2980A15 (Ta=25°C)



S-L2980A30 (Ta=25°C)



S-L2980A50 (Ta=25°C)

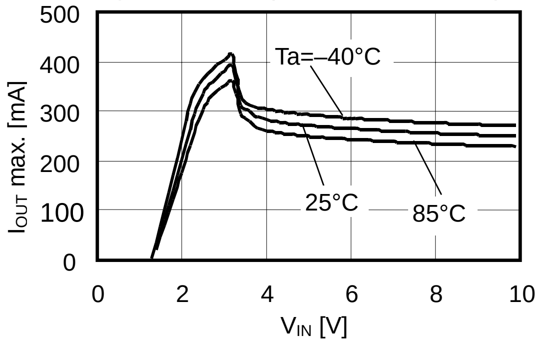


Remark In determining output current, attention should be paid to the followings.

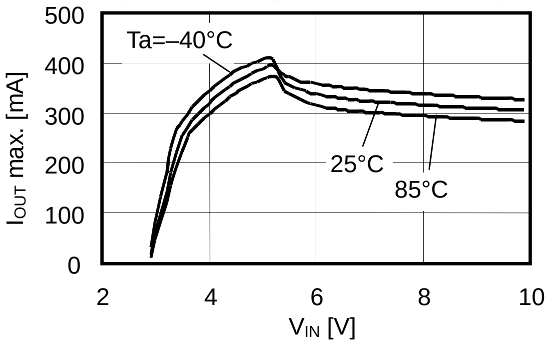
1) The minimum output current value and footnote ***5** in the **Table 4** for the "■ **Electrical Characteristics**".
2) The package power dissipation

2. Maximum output current versus Input voltage

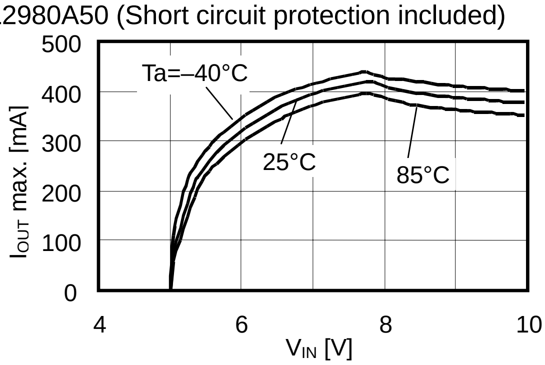
S-L2980A15 (Short-circuit protection included)



S-L2980A30 (Short-circuit protection included)



S-L2980A50 (Short circuit protection included)

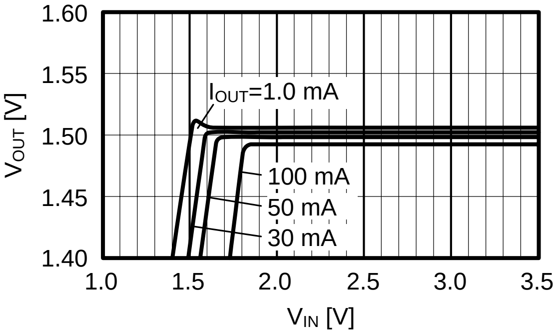


Remark In determining output current, attention should be paid to the followings.

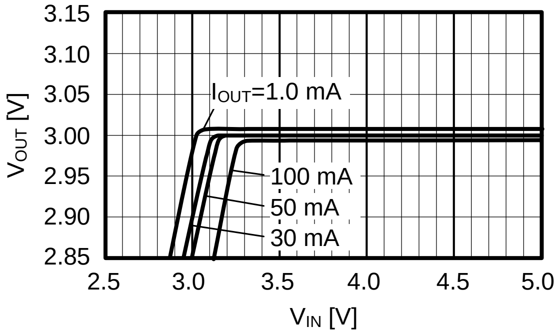
1) The minimum output current value and footnote ***5** in the **Table 4** for the "■ **Electrical Characteristics**".
2) The package power dissipation

3. Output voltage versus Input voltage

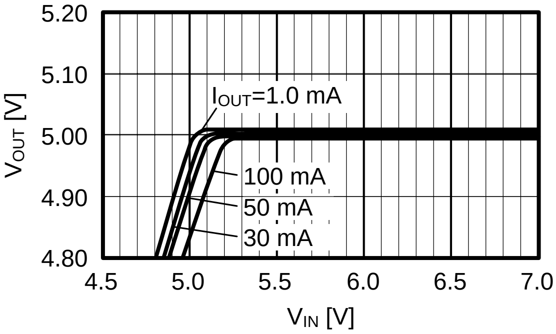
S-L2980A15 (Ta=25°C)



S-L2980A30 (Ta=25°C)

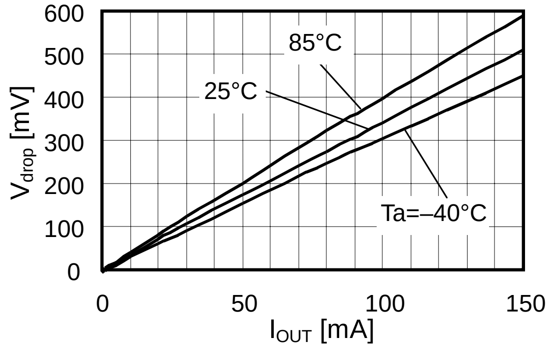


S-L2980A50 (Ta=25°C)

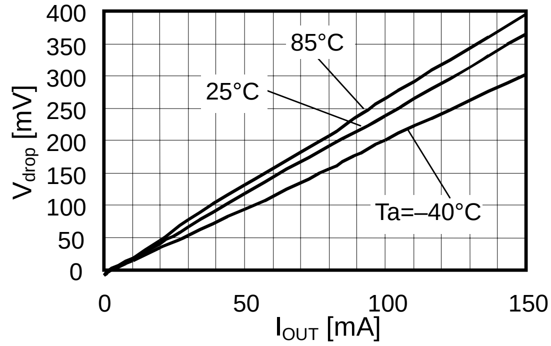


4. Dropout voltage versus Output voltage

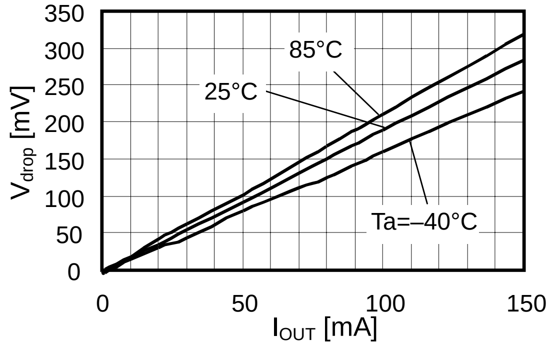
S-L2980A15



S-L2980A30

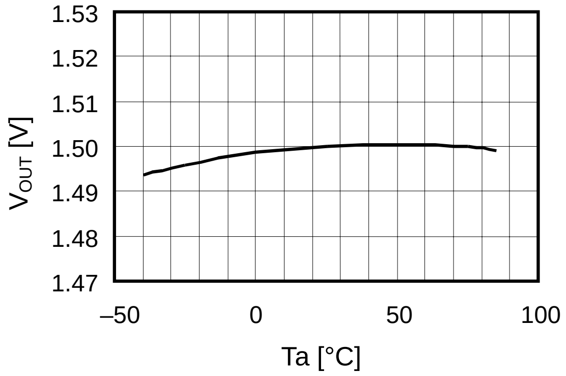


S-L2980A50

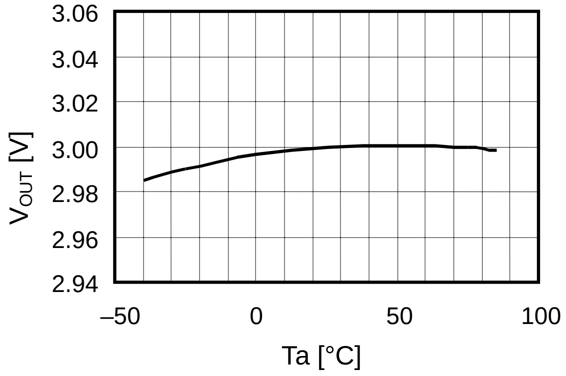


5. Output voltage versus Ambient Temperature

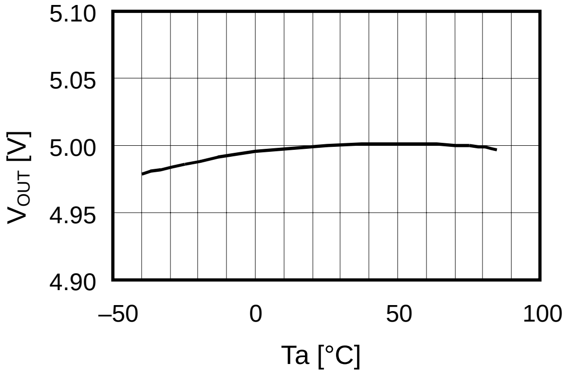
S-L2980A15



S-L2980A30

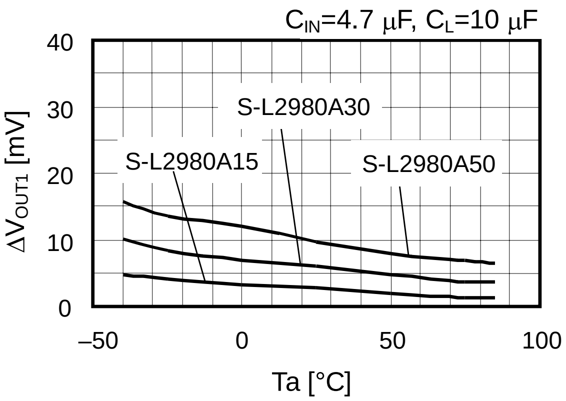


S-L2980A50



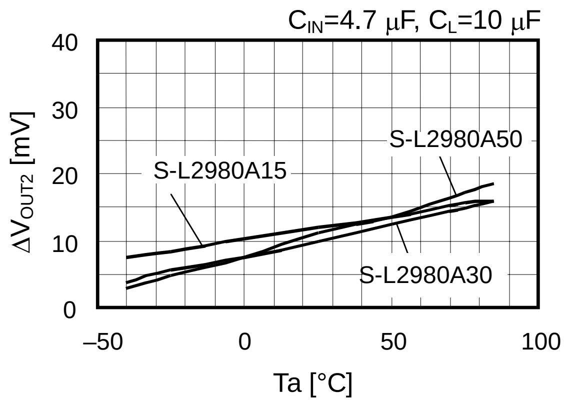
6. Line regulation versus Ambient Temperature

S-L2980Axx



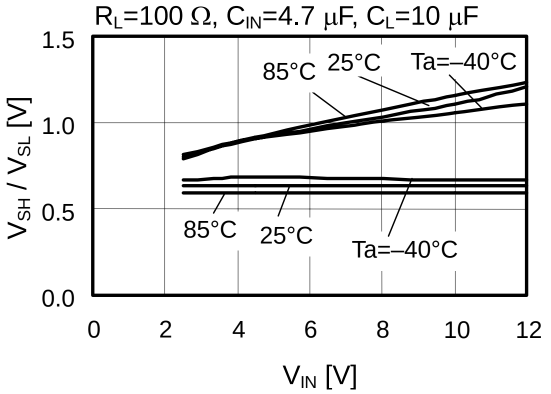
7. Load regulation versus Ambient Temperature

S-L2980Axx



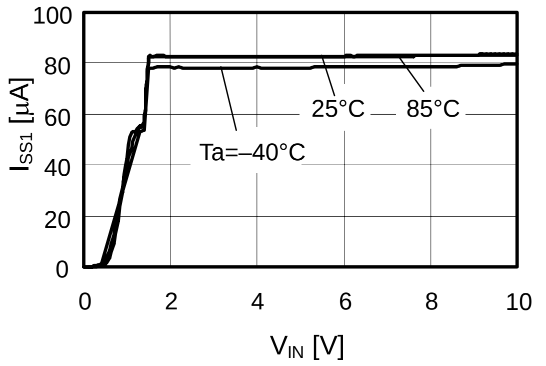
8. Threshold voltage of ON/OFF pin versus Input voltage

S-L2980A15

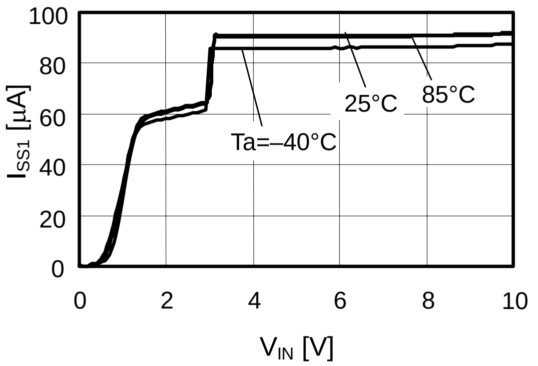


9. Current consumption versus Input voltage

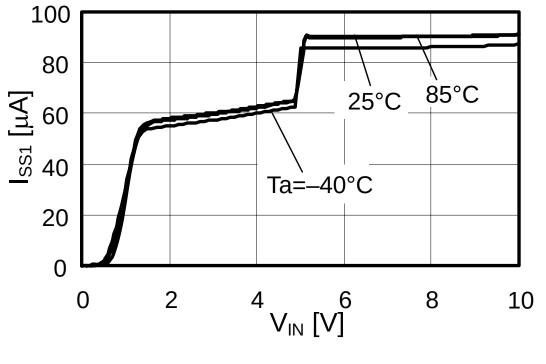
S-L2980A15



S-L2980A30

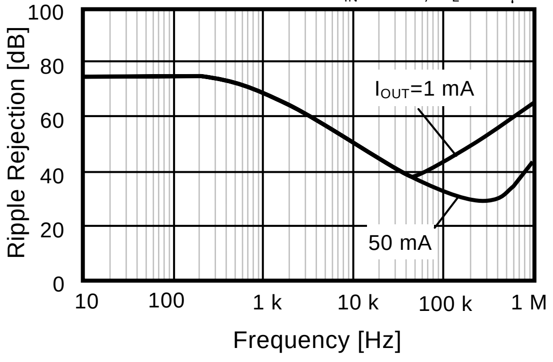


S-L2980A50

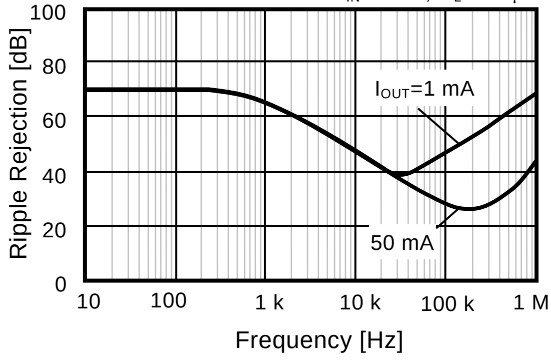


10. Ripple rejection

S-L2980A30 (Ta=25°C)

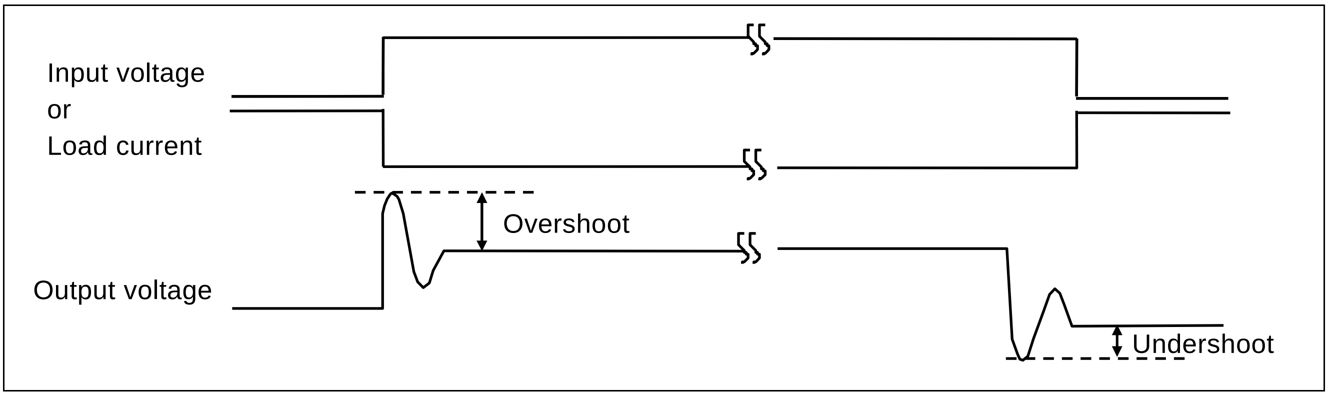


S-L2980A50 (Ta=25°C)



■ Reference Data

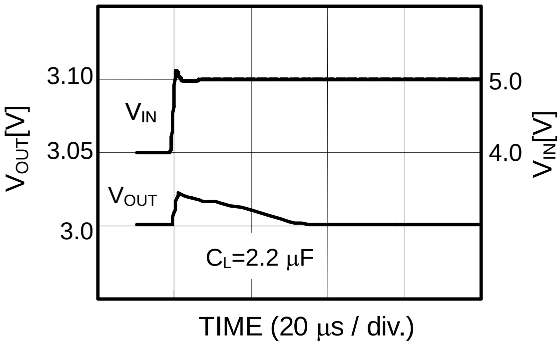
1. Transient Response Characteristics (S-L2980A30MC, Typical data, Ta=25°C)



1-1. Power Source Fluctuation

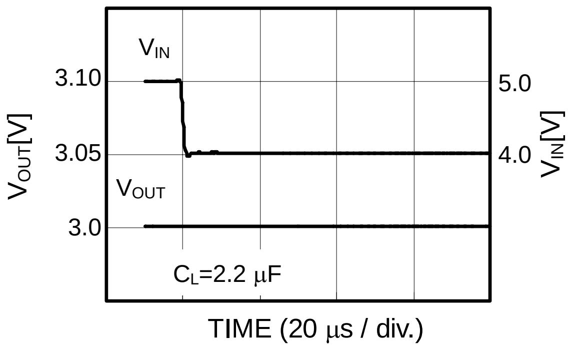
Overshoot

V_{IN}, $V_{ON/OFF}$=4.0 →5.0 V, I_{OUT}=1.0 mA



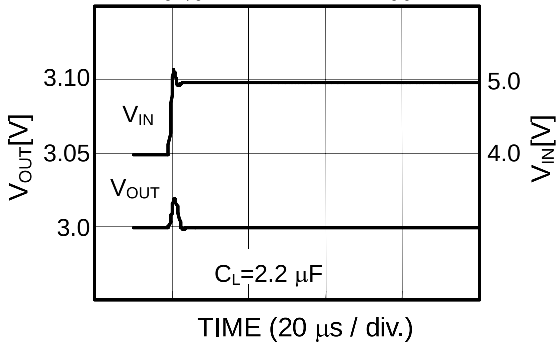
Undershoot

V_{IN}, $V_{ON/OFF}$=5.0→4.0 V, I_{OUT}=1.0 mA



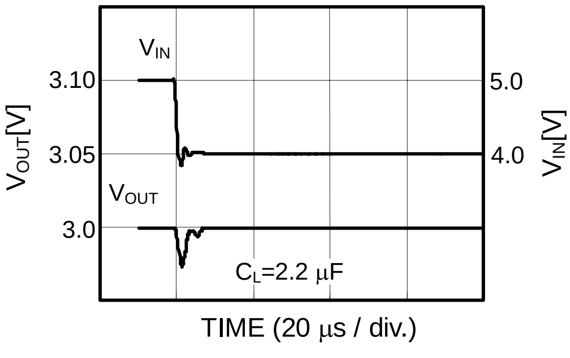
Overshoot

V_{IN}, $V_{ON/OFF}$=4.0→5.0 V, I_{OUT}=50 mA



Undershoot

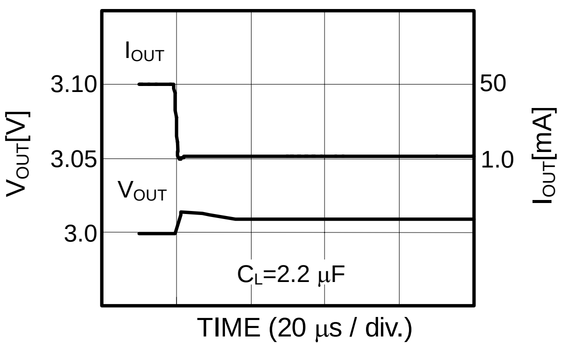
V_{IN}, $V_{ON/OFF}$=5.0→4.0 V, I_{OUT}=50 mA



1-2. Load Fluctuation

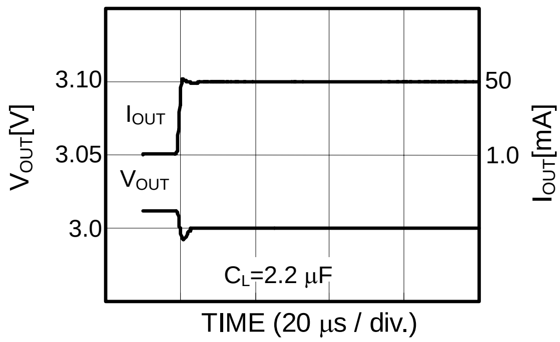
Overshoot

V_{IN}, $V_{ON/OFF}$=4.0 V, I_{OUT}=50 mA→1.0 mA



Undershoot

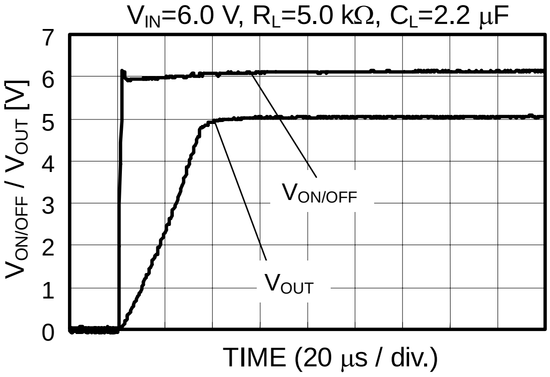
V_{IN}, $V_{ON/OFF}$=4.0 V, I_{OUT}=1.0 mA→50 mA



1-3. ON/OFF Switching (S-L2980A50MC, Typical data, Ta=25°C)

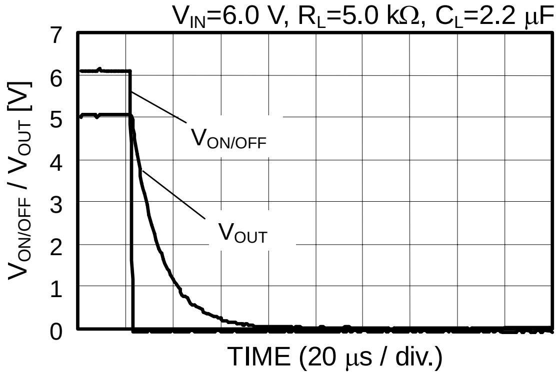
Overshoot

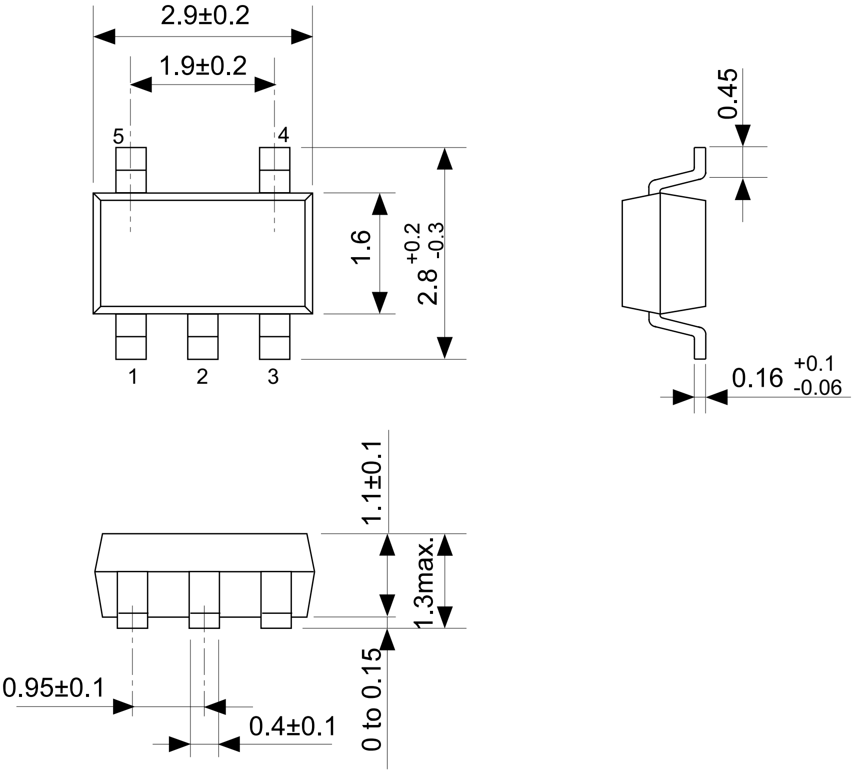
V_{IN}=6.0 V, R_L=5.0 kΩ, C_L=2.2 μF



Undershoot

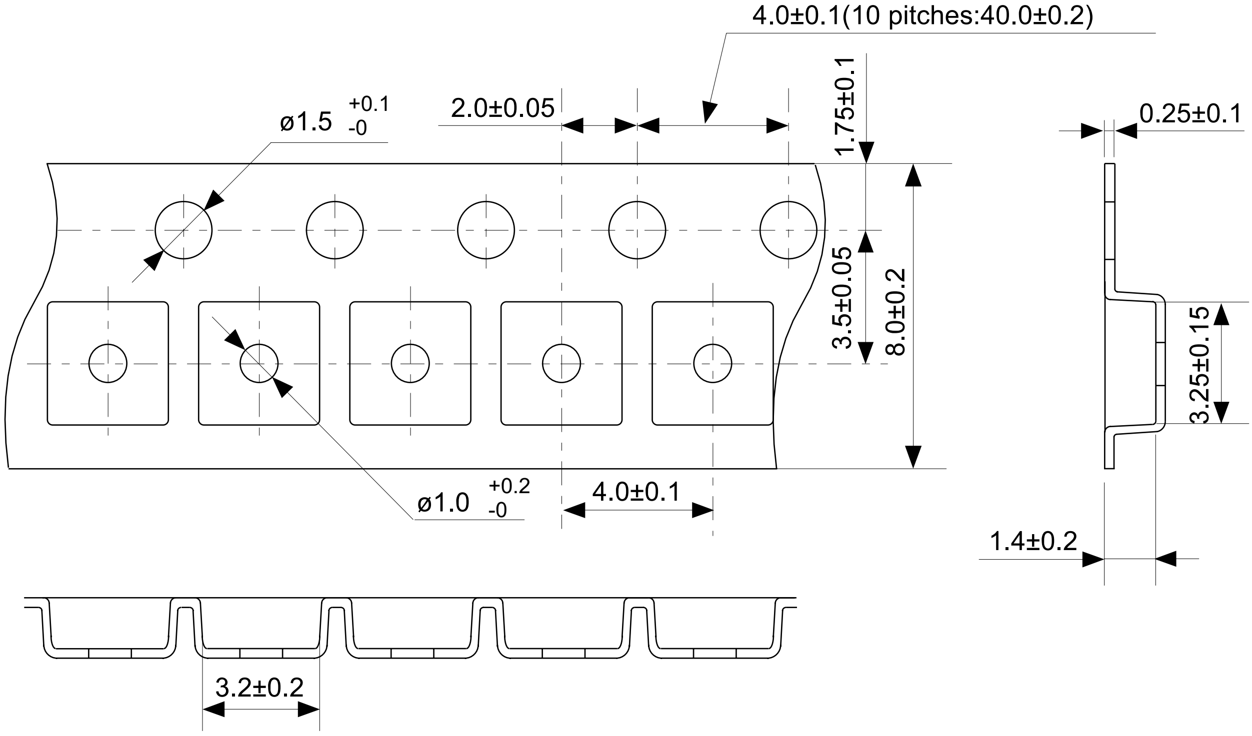
V_{IN}=6.0 V, R_L=5.0 kΩ, C_L=2.2 μF

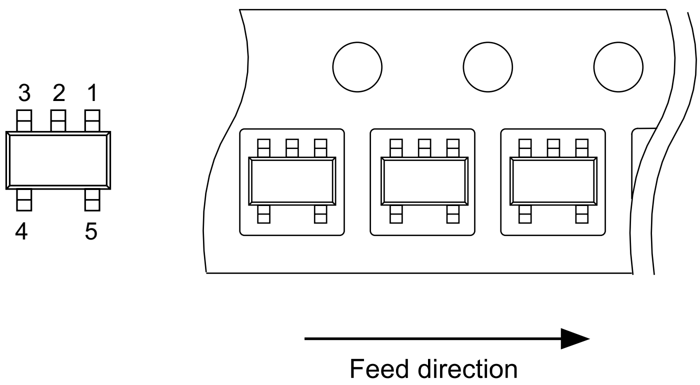




No. MP005-A-P-SD-1.2

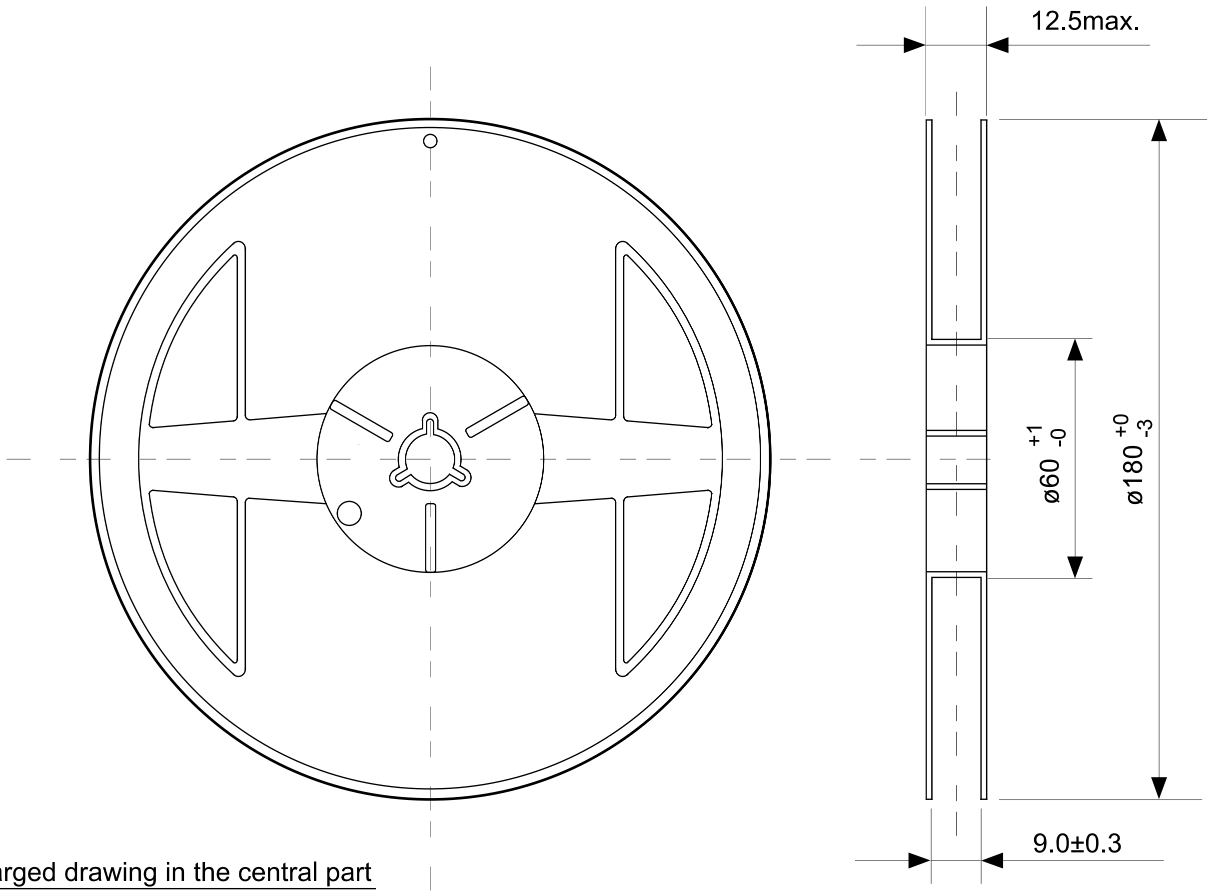
TITLE	SOT235-A-PKG Dimensions
No.	MP005-A-P-SD-1.2
SCALE	
UNIT	mm
Seiko Instruments Inc.	



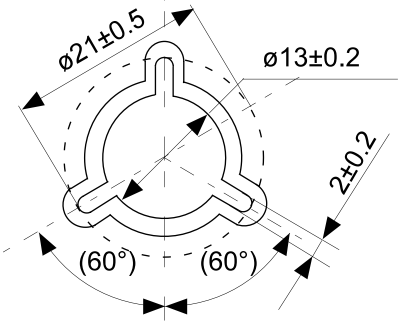


No. MP005-A-C-SD-2.1

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



Enlarged drawing in the central part



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.			