HIGH RIPPLE-REJECTION CMOS LOW DROPOUT VOLTAGE REGULATOR

S-L2980 Series

The S-L2980 series is a low dropout voltage regulator designed for use in battery powered devices and developed using CMOS technology. On-chip low on-resistance transistor can provide low dropout voltage and large output current. A power-off switch ensures long battery life.

Various types of output capacitors can be used in the S-L2980 series compared with the former CMOS voltage regulators. A small ceramic capacitor can also be used.

■ Features

- Low dropout voltage:
  Typically 120mV @ 50mA load for 3.0 V output
- Low current consumption:
  Typically 90 µA, 140 µA max. at operation
- Sleep mode: Quiescence current
  Typically 0.1 µA, 1 µA max. at power off
- Output voltage: 1.5 V to 6.0 V, 0.1 V step
- High accuracy output voltage: ±2.0%
- High peak current capability:
  150 mA @ $V_{IN} \geq V_{OUT}(S)$ +1 V [Note]
- Ripple rejection: 70 dB typ. @1 kHz
- Built-in power-off circuit:
- Low ESR capacitor:
  A 2.2 µF ceramic capacitor can be used as the output capacitor.
- Ultra compact package: SOT-23-5, 5-Pin SON(A)

Note: Attention should be paid to power dissipation of the package when the load is large.

■ Applications

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

■ Package

SOT-23-5	(Package drawing code, MP005-A)
5-Pin SON(A)	(Package drawing code, PN005-A)

■ Block Diagram

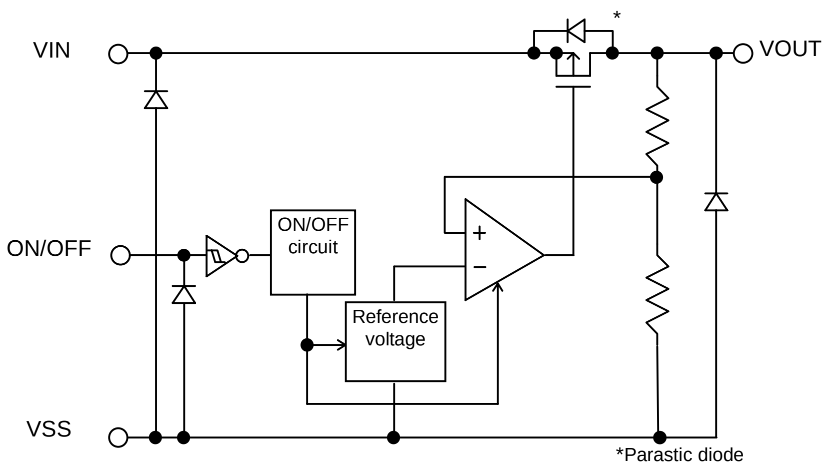


Figure 1 Block Diagram

■ Selection Guide

Product Name

S-L2980xxxxx - xxxTF

- IC direction in tape specifications
- Product code
- Package code
  - MC: SOT-23-5
  - PN: 5-Pin SON(A)
- Output voltage x 10
  - 15 to 60 (1.5V to 6.0V)
- Logic type
  - A: ON/$\overline{\text{OFF}}$ pin positive logic
  - B: $\overline{\text{ON}}$/OFF pin negative logic

Product List

Table 1

Output Voltage	SOT-23-5	5-Pin SON(A)
1.5 V ± 2.0%	—	S-L2980A15PN-C6ATF
1.7 V ± 2.0%	S-L2980A17MC-C6CTF	S-L2980A17PN-C6CTF
1.8 V ± 2.0%	S-L2980A18MC-C6DTF	S-L2980A18PN-C6DTF
1.9 V ± 2.0%	—	S-L2980A19PN-C6ETF
2.5 V ± 2.0%	S-L2980A25MC-C6KTF	S-L2980A25PN-C6KTF
2.7 V ± 2.0%	S-L2980A27MC-C6MTF	S-L2980A27PN-C6MTF
2.8 V ± 2.0%	S-L2980A28MC-C6NTF	S-L2980A28PN-C6NTF
2.9 V ± 2.0%	—	S-L2980A29PN-C6OTF
3.0 V ± 2.0%	S-L2980A30MC-C6PTF	S-L2980A30PN-C6PTF
3.1 V ± 2.0%	S-L2980A31MC-C6QTF	—
3.2 V ± 2.0%	S-L2980A32MC-C6RTF	—
3.3 V ± 2.0%	S-L2980A33MC-C6STF	S-L2980A33PN-C6STF
3.8 V ± 2.0%	S-L2980A38MC-C6XTF	S-L2980A38PN-C6XTF
4.0 V ± 2.0%	S-L2980A40MC-C6ZTF	S-L2980A40PN-C6ZTF
4.1 V ± 2.0%	S-L2980A41MC-C7ATF	—
4.4 V ± 2.0%	S-L2980A44MC-C7DTF	—
4.5 V ± 2.0%	—	S-L2980A45PN-C7ETF
4.8 V ± 2.0%	S-L2980A48MC-C7HTF	—
5.0 V ± 2.0%	S-L2980A50MC-C7JTF	S-L2980A50PN-C7JTF

Note:
Contact SII sales office for products with output voltage not specified above.

■ Pin Configurations

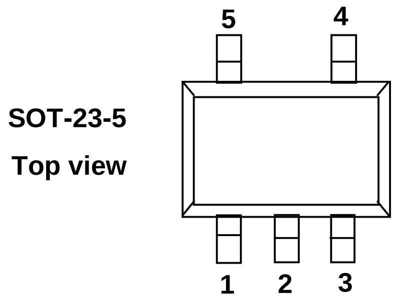


Figure 2

Table 2 Pin Assignment

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

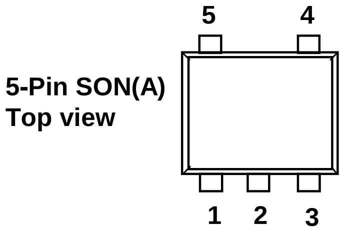


Figure 3

Table 3 Pin Assignment

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

Note NC pin is electrically open. NC pin can be connected to VIN or VSS.

■ Absolute Maximum Ratings

Table 4 Absolute Maximum Ratings (Ta=25°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating		Units
Input voltage	V_{IN}	V_{SS}-0.3 to V_{IN}+12		V
	$V_{ON/OFF}$	V_{SS}-0.3 to V_{IN}+12		V
Output voltage	V_{OUT}	V_{SS}-0.3 to V_{IN}+0.3		V
Power dissipation	P_D	SOT-23-5	250	mW
		5-Pin SON(A)	100	
Operating temperature range	T_{opr}	-40 to +85		°C
Storage temperature range	T_{stg}	-40 to +125		°C

Note:
Although the IC contains protection circuit against static electricity, excessive static electricity or voltage which exceeds the limit of the protection circuit should not be applied to.

■ Electrical Characteristics

1. S-L2980Axx, S-L2980Bxx

Table 5 Electrical Characteristics (Ta=25°C unless otherwise specified)

Item	Symbol	Conditions		Min.	Typ.	Max.	Units	Test circuits
Output voltage 1)	$V_{OUT}(E)$	$V_{IN}=V_{OUT}(S)+1$ V, $I_{OUT}=50$ mA		$V_{OUT}(S) \times 0.98$	$V_{OUT}(S)$	$V_{OUT}(S) \times 1.02$	V	1
Output current 2)	I_{OUT}	$V_{IN}=V_{OUT}(S)+1$ V		150 5)	–	–	mA	3
Dropout voltage 3)	Vdrop	I_{OUT} = 50mA	$1.5V \le V_{OUT}(S) \le 1.7V$	–	0.17	0.33	V	1
			$1.8V \le V_{OUT}(S) \le 1.9V$	–	0.16	0.29	V	1
			$2.0V \le V_{OUT}(S) \le 2.4V$	–	0.15	0.26	V	1
			$2.5V \le V_{OUT}(S) \le 2.9V$	–	0.13	0.20	V	1
			$3.0V \le V_{OUT}(S) \le 3.2V$	–	0.12	0.15	V	1
			$3.3V \le V_{OUT}(S) \le 6.0V$	–	0.11	0.14	V	1
Line regulation	$\frac{\Delta V_{OUT1}}{\Delta V_{IN} \bullet V_{OUT}}$	$V_{OUT}(S) + 0.5\ V \le V_{IN} \le 10$ V, I_{OUT} = 50 mA		–	0.05	0.2	%/V	1
Load regulation	ΔV_{OUT2}	$V_{IN}=V_{OUT}(S)+1$ V 1mA$\le I_{OUT} \le$ 80 mA,		–	12	40	mV	1
Output voltage temperature coefficient 4)	$\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$	$V_{IN} = V_{OUT}(S) + 1$ V, I_{OUT} = 50mA -40°C ≤ Ta ≤ 85°C			±100	–	ppm /°C	1
Current consumption during operation	I_{SS1}	$V_{IN} = V_{OUT}(S)$ +1 V, ON/OFF pin = ON , no load		–	90	140	µA	2
Current consumption when power off	I_{SS2}	$V_{IN} = V_{OUT}(S)$ +1 V, ON/OFF pin = OFF, no load			0.1	1.0	µA	2
Input voltage	V_{IN}			2.0	–	10	V	1
Power-off pin input voltage "H"	V_{SH}	$V_{IN} = V_{OUT}(S) + 1$ V, R_L = 1kΩ, Checked by V_{OUT} level.		1.5	–	–	V	4
Power-off pin input voltage "L"	V_{SL}	$V_{IN} = V_{OUT}(S) + 1$ V, R_L = 1kΩ, Checked by V_{OUT} level.		–	–	0.3	V	4
Power off pin input current "H"	I_{SH}	$V_{IN} = V_{OUT}(S) + 1$ V, $V_{ON/OFF}$ = 7 V		–	–	0.1	µA	4
Power off pin input current "L"	I_{SL}	$V_{IN} = V_{OUT}(S) + 1$ V, $V_{ON/OFF}$ = 0 V		–	–	–0.1	µA	4
Ripple rejection	$\lvert RR \rvert$	$V_{IN} = V_{OUT}(S) + 1V$ f = 1 kHz ΔVrip=0.5 Vrms I_{OUT}=50 mA	$1.5\ V \le V_{OUT}(S) \le 3.3\ V$	–	70	–	dB	5
			$3.4\ V \le V_{OUT}(S) \le 5.0\ V$	–	65	–	dB	5
			$5.1\ V \le V_{OUT}(S) \le 6.0\ V$	–	60	–	dB	5

1) $V_{OUT}(S)$ = Specified output voltage
$V_{OUT}(E)$ = Actual output voltage at the fixed load (I_{OUT}=50 mA) and $V_{OUT}(S)$+1.0 V input.
2) Output current at which output voltage becomes 95% of V_{OUT} after gradually increasing output current.
3) Vdrop = V_{IN1}–(V_{OUT} × 0.98), where V_{IN1} is the input voltage at which output voltage becomes 98% of V_{OUT} after gradually decreasing input voltage.
4) A change in temperatures [mV/°C] is calculated using the following equation.

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

↑ Change in temperature of output voltage ↑ Specified output voltage ↑ Output voltage temperature coefficient

5) The output current can be supplied at least to this value.

■ Test Circuits

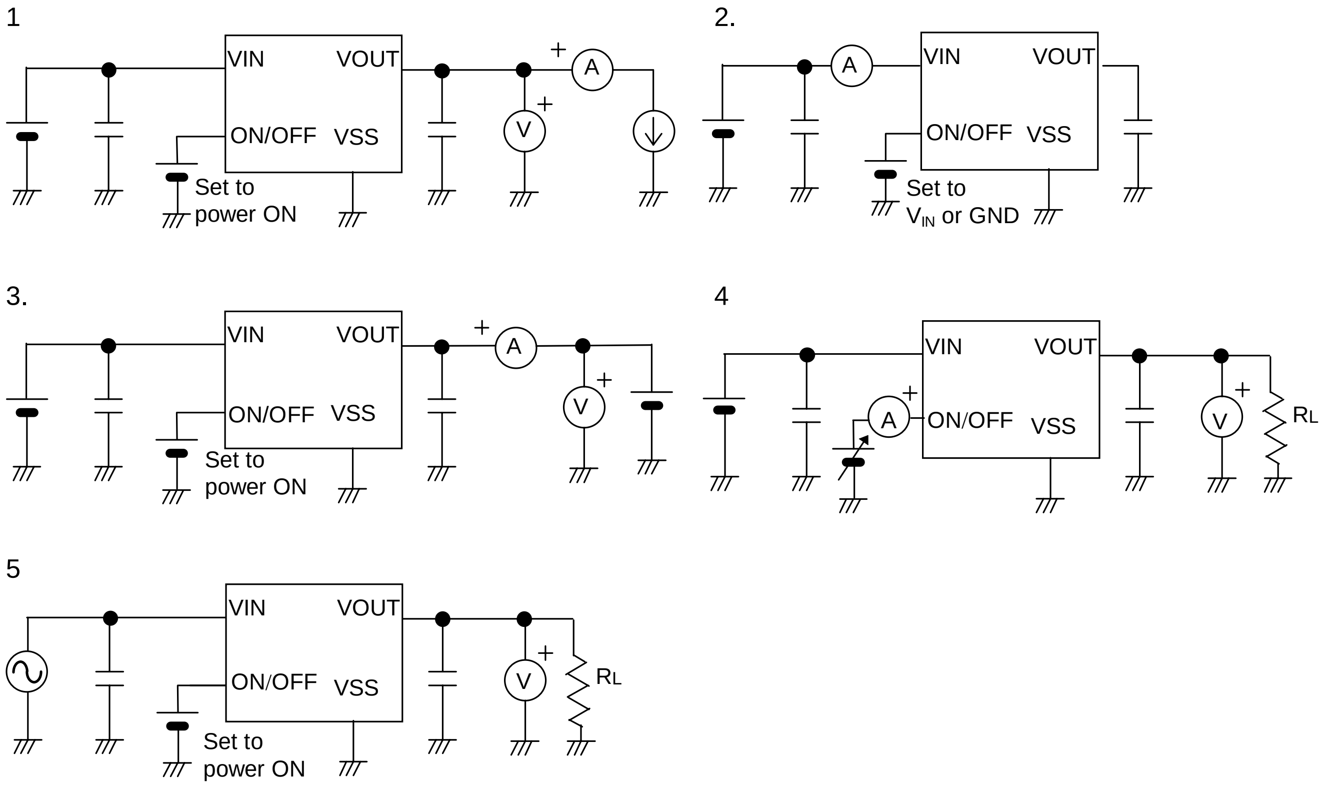


Figure 4 Test Circuits

■ Standard Circuit

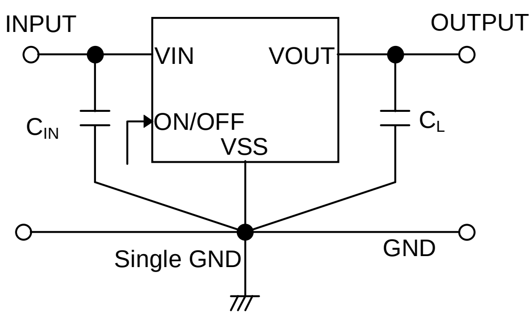


Figure 5 Standard Circuit

In addition to a tantalum capacitor, a ceramic capacitor of 2.2 µF or more can be used for C_L.
C_{IN} is a capacitor used to stabilize input.

■ Application Conditions

Input capacitor (C_{IN}) : 0.47µF or more
Input series resistance (R_{IN}) : 10Ω or less
Output capacitor (C_L) : 2.2µF or more
Equivalent Series Resistance (ESR) for output capacitor: 10Ω or less

■ Explanation for Terms

1. Low dropout voltage regulator
   The low dropout voltage regulator is a voltage regulator whose dropout voltage is low due to its on-chip 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.
   The ESR of the output capacitor (C_L) should be 10Ω or less.

3. Output voltage (V_{OUT})
   The accuracy of the output voltage is ensured at ± 2.0% under the specified conditions of input voltage, which differ depending upon the product, fixed output current, and fixed temperature.

   Note:
   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 attached characteristics data for details.

4. Line regulations ($\frac{\Delta V_{OUT1}}{\Delta V_{IN} \bullet V_{OUT}}$)
   Indicate the input voltage dependencies of 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.

5. Load regulation (ΔV_{OUT2})
   Indicates the output current dependencies of output voltage. That is, the values show how much the output voltage changes due to a change in the output current with the input voltage remained unchanged.

6. Dropout voltage (Vdrop)
   Indicates a difference between input voltage (V_{IN1}) and output voltage when output voltage falls by 98 % of V_{OUT} by gradually decreasing the input voltage.
   Vdrop = V_{IN1}-[V_{OUT} × 0.98]

7. Temperature coefficient of output voltage [$\Delta V_{OUT}/(\Delta Ta \bullet V_{OUT})$]
   The shadowed area in Figure 6 is the range where V_{OUT} varies in the operating temperature range when the temperature coefficient of the output voltage is ±100 ppm/°C.

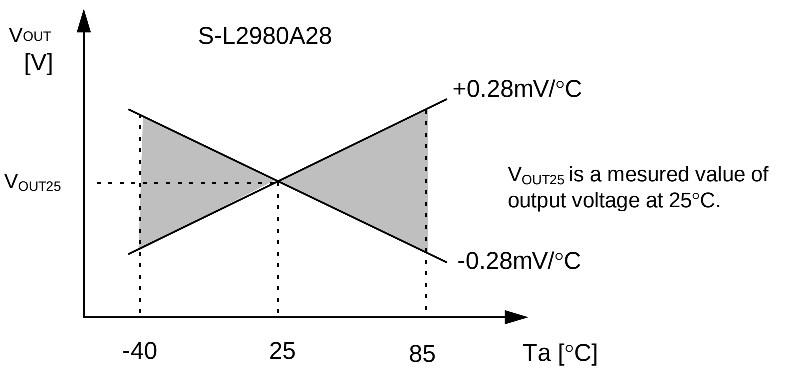


Figure 6

A change in temperatures of output voltage [mV/°C] is calculated using the following equation.

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

Change in temperatures of output voltage ↑ Specified output voltage ↑ Output voltage temperature coefficient ↑

■ Operation

1. Basic operation
   Figure 7 shows the block diagram of the S-L2980 Series.
   The error amplifier compares a reference voltage V_{REF} with part of the output voltage divided by the feedback resistors Rs and Rf. It supplies the output transistor with the gate voltage, necessary to ensure certain output voltage free of any fluctuations of input voltage and temperature.

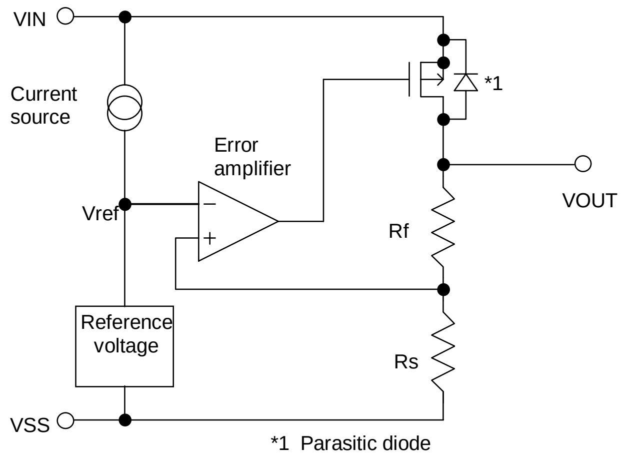


Figure 7 Block Diagram

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 V_{OUT} pin through a parasitic diode to VIN pin.

3. ON/OFF Pin (Power Off Pin)
   This pin starts and stops the regulator.
   When the ON/OFF pin is switched to the power off level, the operation of all internal circuits stops, the built-in P-channel MOSFET output transistor between VIN and VOUT is switched off to make current consumption drastically reduced. Sleep mode is thus attained. The VOUT pin becomes the Vss level due to internally divided resistance of several MΩ between VOUT and VSS.
   Furthermore, the structure of the ON/OFF pin is as shown in Figure 8. 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 V_{IN}-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".

Logic type	ON/OFF pin	Internal circuit	VOUT pin voltage	Current consumption
A	"H" : Power on	Operating	Set value	Iss_1
A	"L" : Power off	Stop	V_{SS} level	Iss_2
B	"H" : Power off	Stop	V_{SS} level	Iss_2
B	"L" : Power on	Operating	Set value	Iss_1

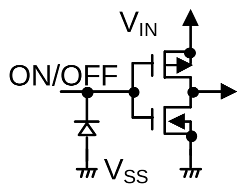


Figure 8 ON/OFF Pin

■ Selection of Output Capacitor (C_L)

The S-L2980 series needs an output capacitor between VOUT pin and VSS pin for phase compensation. When a ceramic or OS (Organic Semiconductor) capacitor is used, the capacitance should be 2.2 μF or more. When a tantalum 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.

Special attention should be paid when an aluminum electrolyte capacitor is used, since an increase of ESR at low temperature might lead to the oscillation of the regulator. Sufficient performance evaluation including temperature dependency is thus needed.

Overshoot and undershoot characteristics differ depending upon the magnitude of the output capacitor in use. Evaluation in the actual environment is needed.

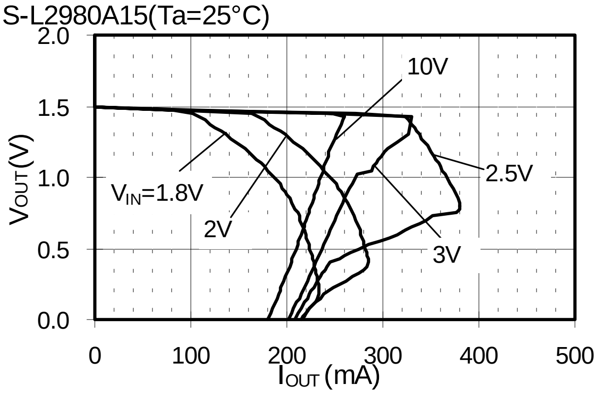
■ Notice

- Wiring patterns for VIN, VOUT and GND pins should be designed to hold low impedance. When mounting an output capacitor, 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 increase when a voltage regulator is used at low load current (less than 1 mA).
- To prevent oscillation, it is recommended to use the external components under the following conditions.
  - ♦ Input capacitor : 0.47 μF or more
  - ♦ Output capacitor (C_L): 2.2 μF or more
  - ♦ Equivalent Series Resistance (ESR): 10 Ω or less
  - ♦ Input series resistance (RIN): 10 Ω or less
- 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.
- 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.
- In determining output current attention should be paid to the output current value specified in the table 5 for electrical characteristics and the footnote 5) of the table.

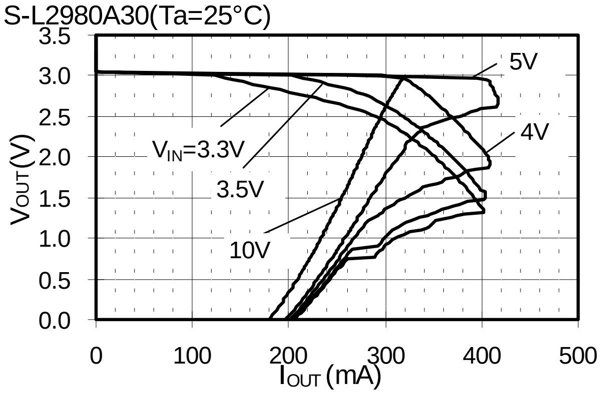
■ Typical Characteristics

(1) OUTPUT VOLTAGE versus OUTPUT CURRENT (when load current increases)

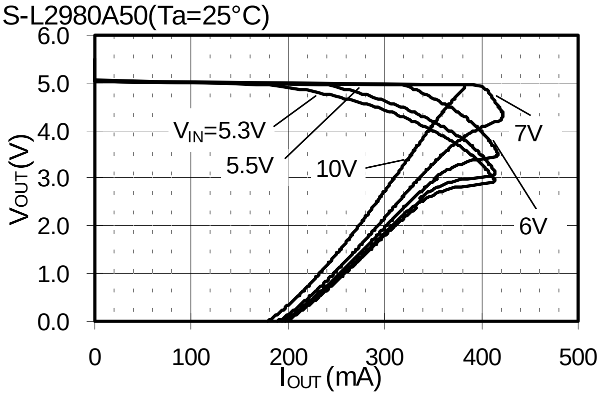
S-L2980A15(Ta=25°C)



S-L2980A30(Ta=25°C)



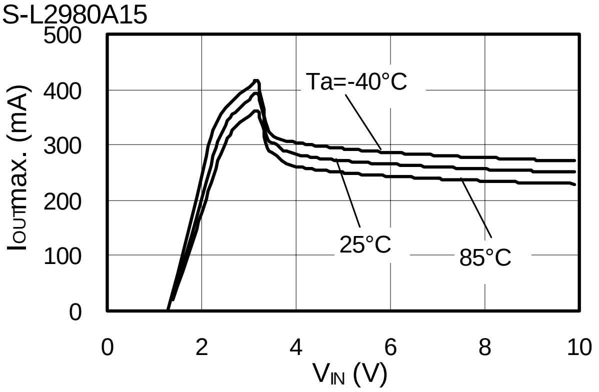
S-L2980A50(Ta=25°C)



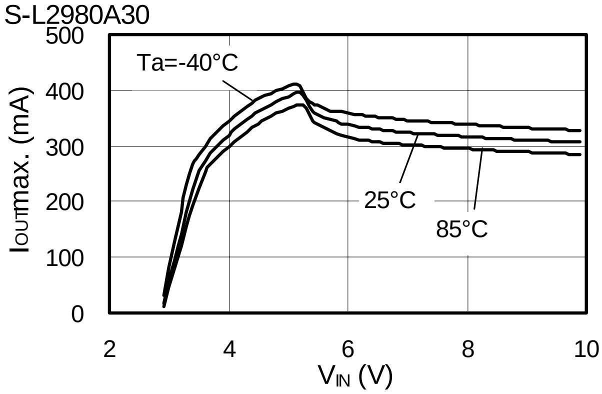
The application condition for input voltage, output voltage and load current should not exceed the package power dissipation. In determining output current attention should be paid to the output current value specified in the table for electrical characteristics and the footnote 5) of the table.

(2) MAXIMUM OUTPUT CURRENT versus INPUT VOLTAGE

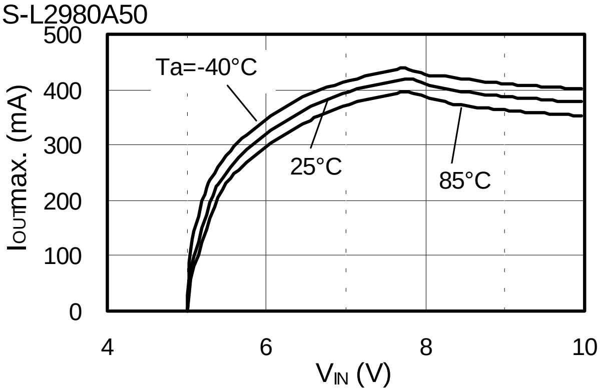
S-L2980A15



S-L2980A30



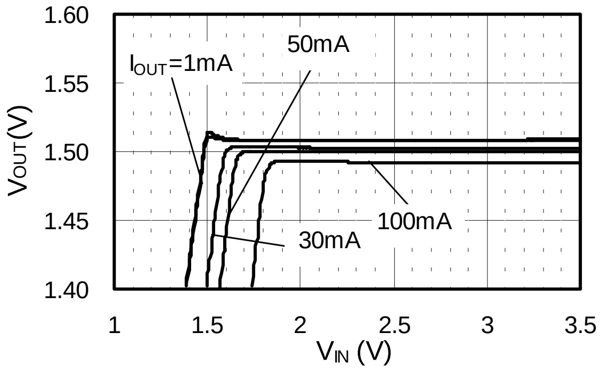
S-L2980A50



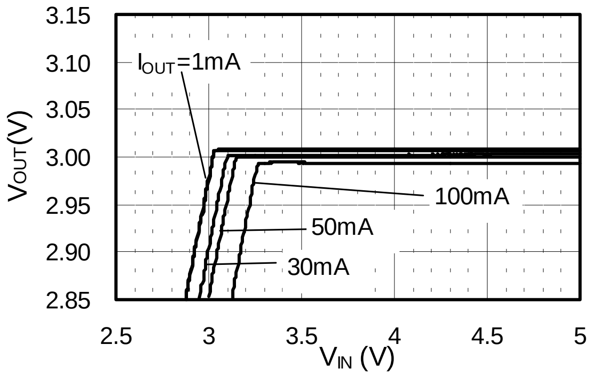
The application condition for input voltage, output voltage and load current should not exceed the package power dissipation. In determining output current attention should be paid to the output current value specified in the table for electrical characteristics and the footnote 5) of the table.

(3) OUTPUT VOLTAGE versus INPUT VOLTAGE

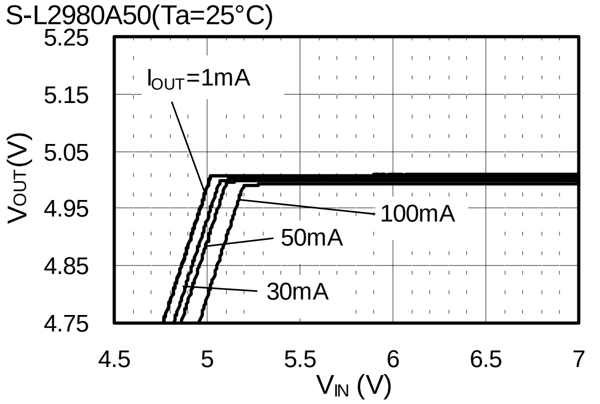
S-L2980A15(Ta=25°C)



S-L2980A30(Ta=25°C)

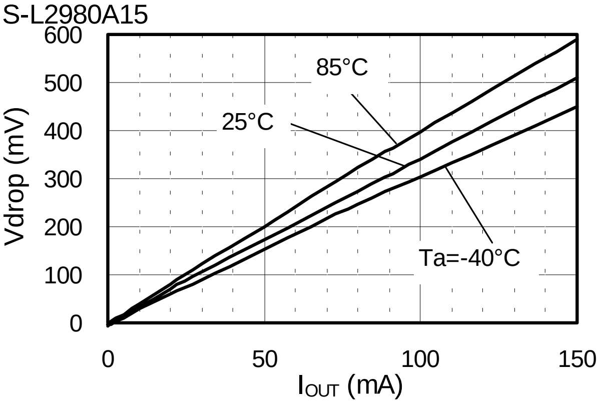


S-L2980A50(Ta=25°C)

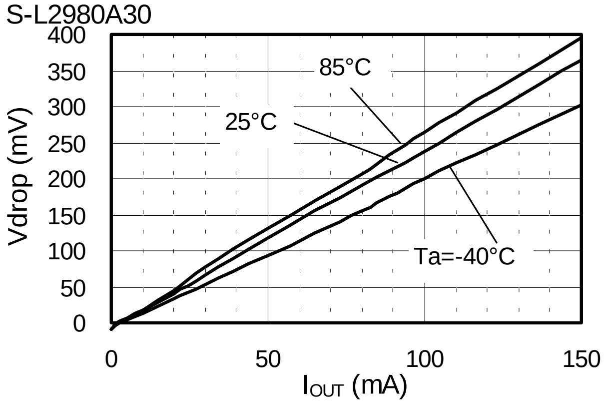


(4) DROPOUT VOLTAGE versus OUTPUT CURRENT

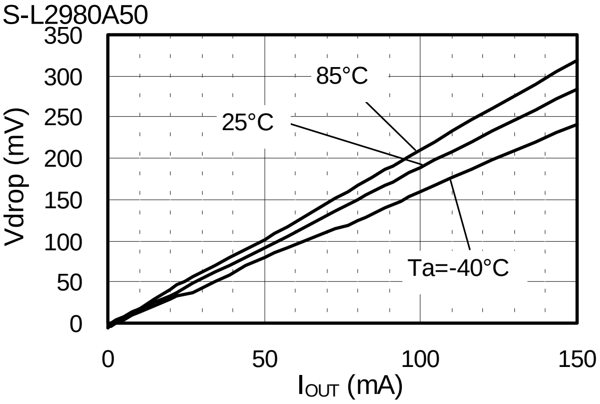
S-L2980A15



S-L2980A30

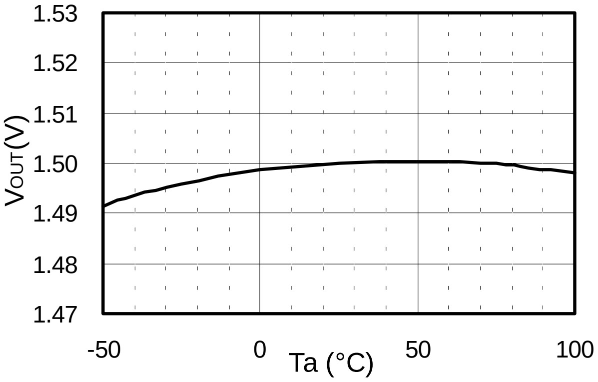


S-L2980A50

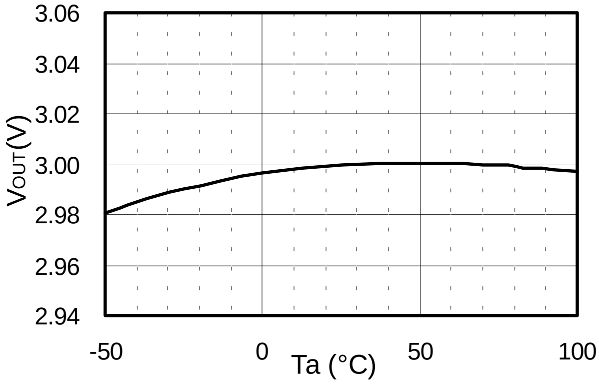


(5) OUTPUT VOLTAGE versus AMBIENT TEMPERATURE

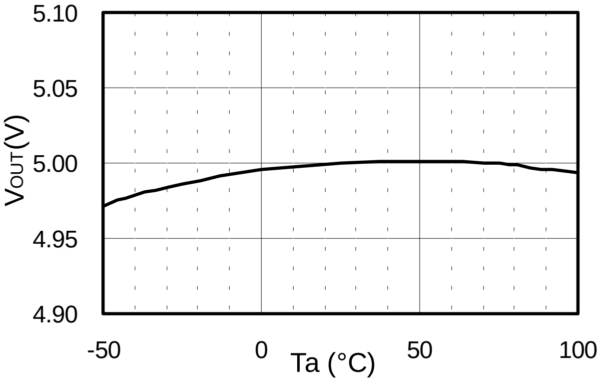
S-L2980A15



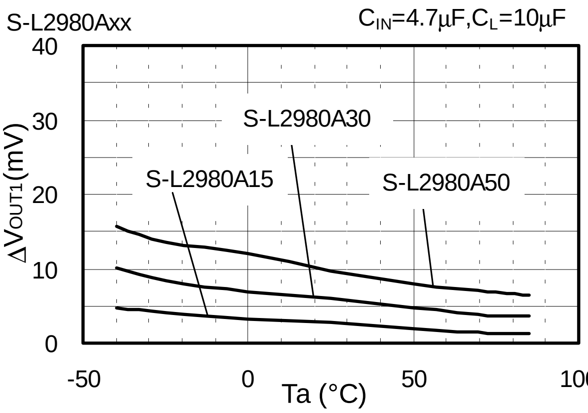
S-L2980A30



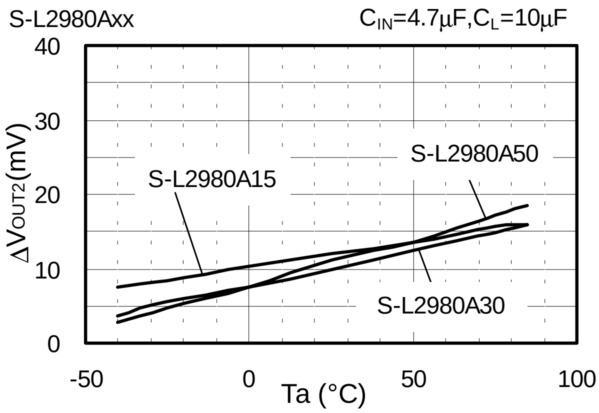
S-L2980A50



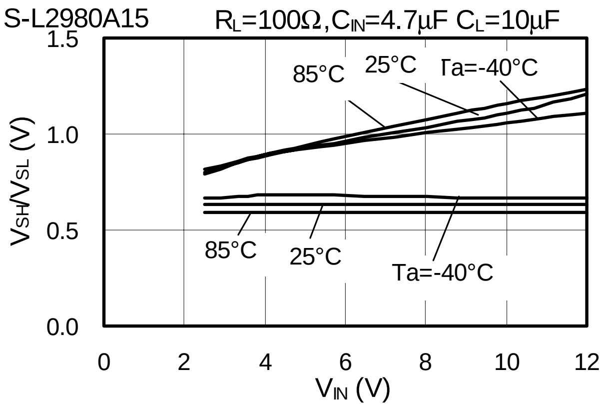
(6) LINE REGULATION versus AMBIENT TEMPERATURE



(7) LOAD REGULATION versus AMBIENT TEMPERATURE

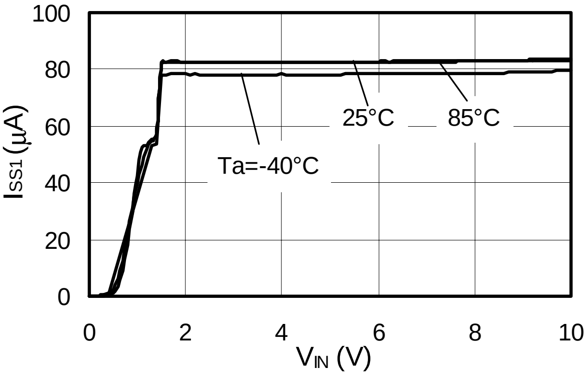


(8) THRESHOLD VOLTAGE OF ON/OFF PIN versus INPUT VOLTAGE

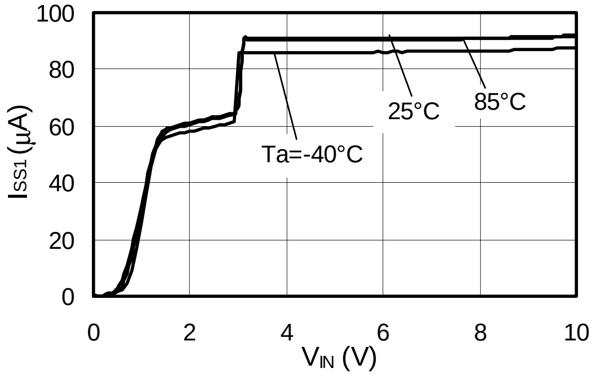


(9) CURRENT CONSUMPTION versus INPUT VOLTAGE

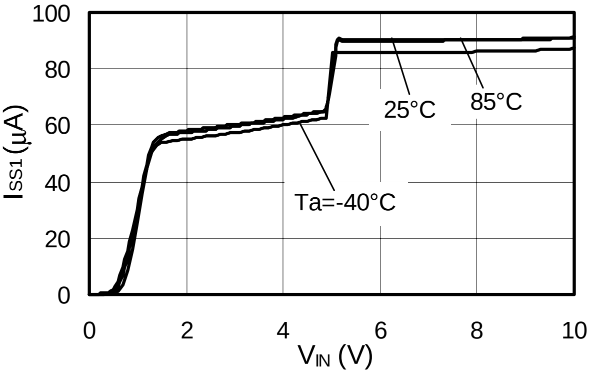
S-L2980A15



S-L2980A30

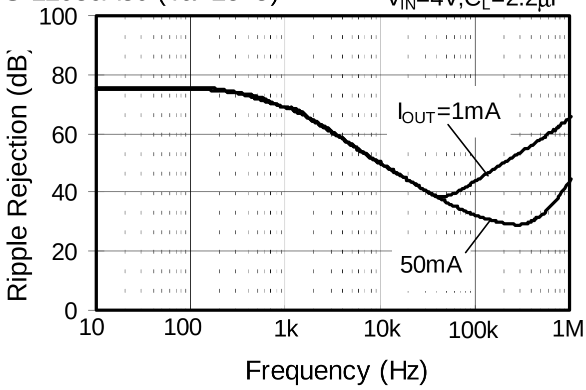


S-L2980A50

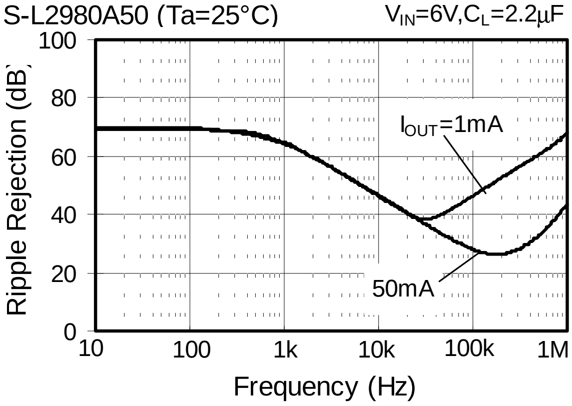


(10)RIPPLE REJECTION

S-L2980A30 (Ta=25°C) V_{IN}=4V,C_L=2.2µF

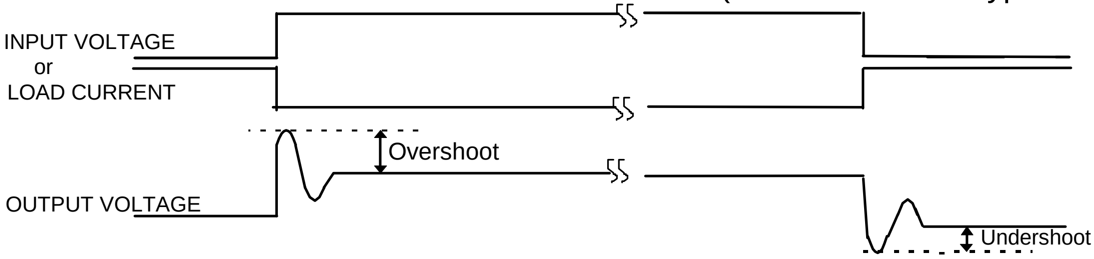


S-L2980A50 (Ta=25°C) V_{IN}=6V,C_L=2.2µF



REFERENCE DATA

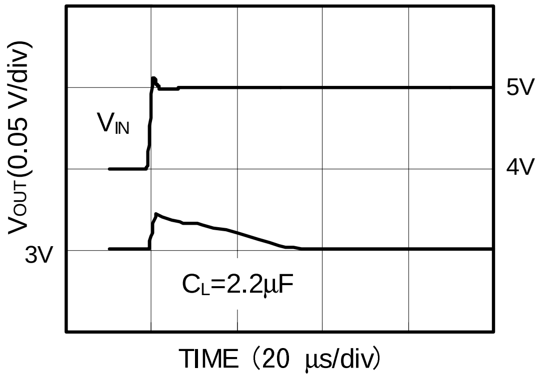
■ TRANSIENT RESPONSE CHARACTERISTICS (S-L2980A30MC Typical data: Ta=25°C)



(1)POWER SOURCE FLUCTUATION

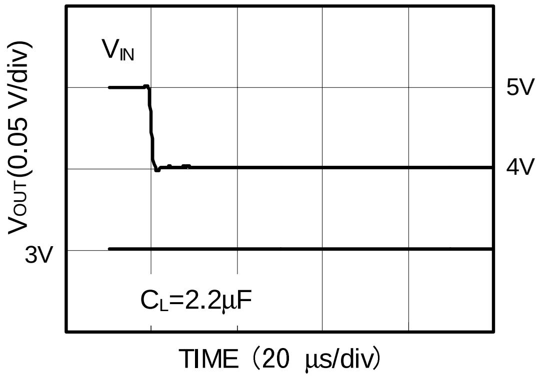
Overshoot

V_{IN},ON/OFF=4→5V, I_{OUT}=1mA



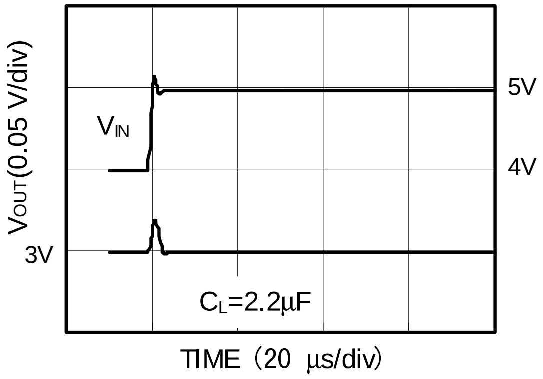
Undershoot

V_{IN},ON/OFF=5→4V, I_{OUT}=1mA



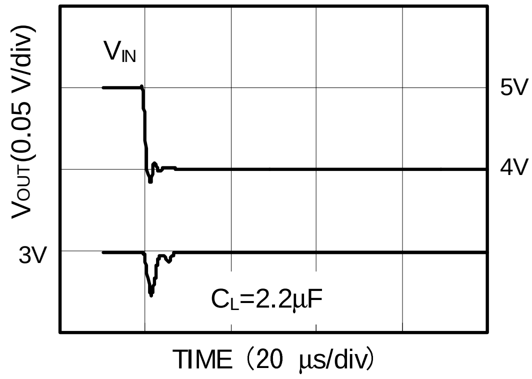
Overshoot

V_{IN},ON/OFF=4→5V, I_{OUT}=50mA



Undershoot

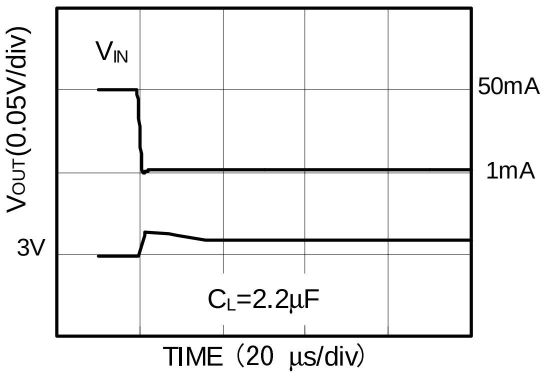
V_{IN},ON/OFF=5→4V, I_{OUT}=50mA



(2)LOAD FLUCTUATION

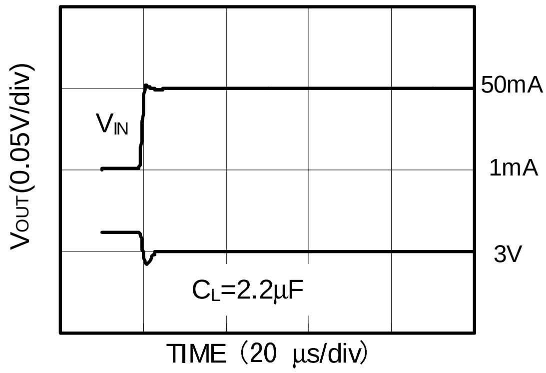
Overshoot

V_{IN},ON/OFF=4V, I_{OUT}=50mA→1mA



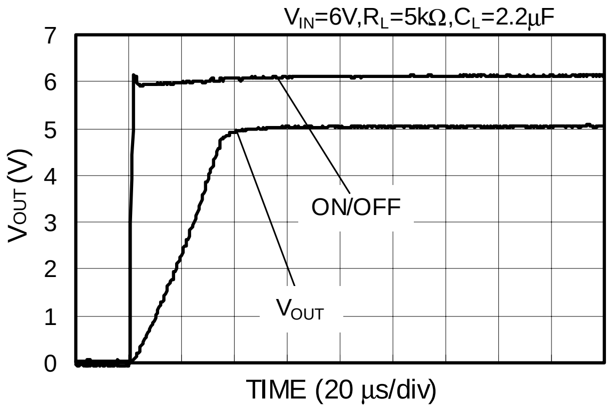
Undershoot

V_{IN},ON/OFF=4V, I_{OUT}=50mA→1mA

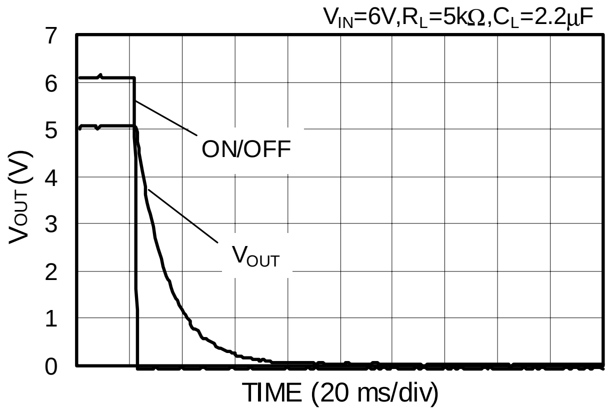


(3) ON/OFF SWITCHING

Overshoot



Undershoot

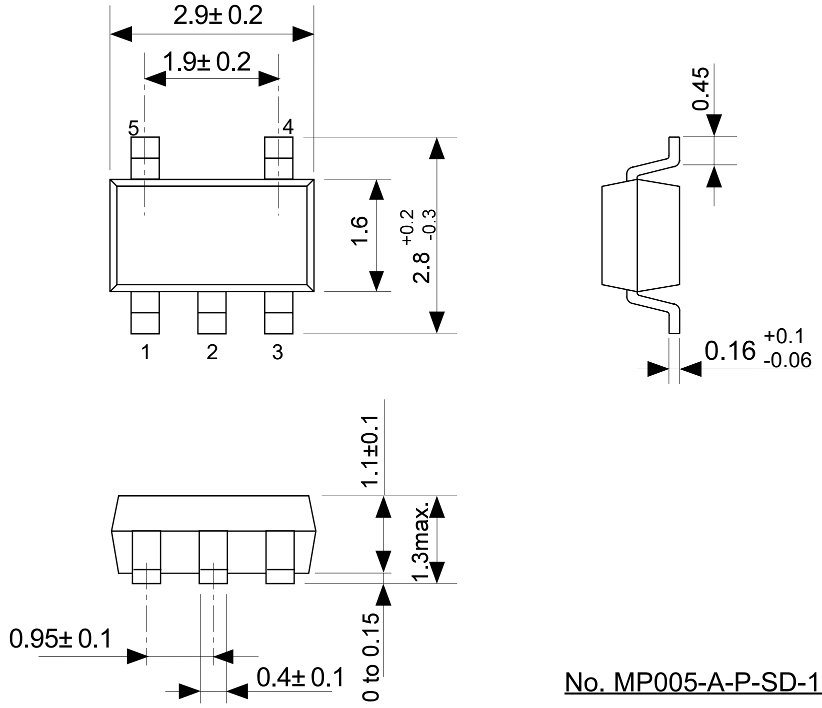


■ SOT-23-5

MP005-A 010907

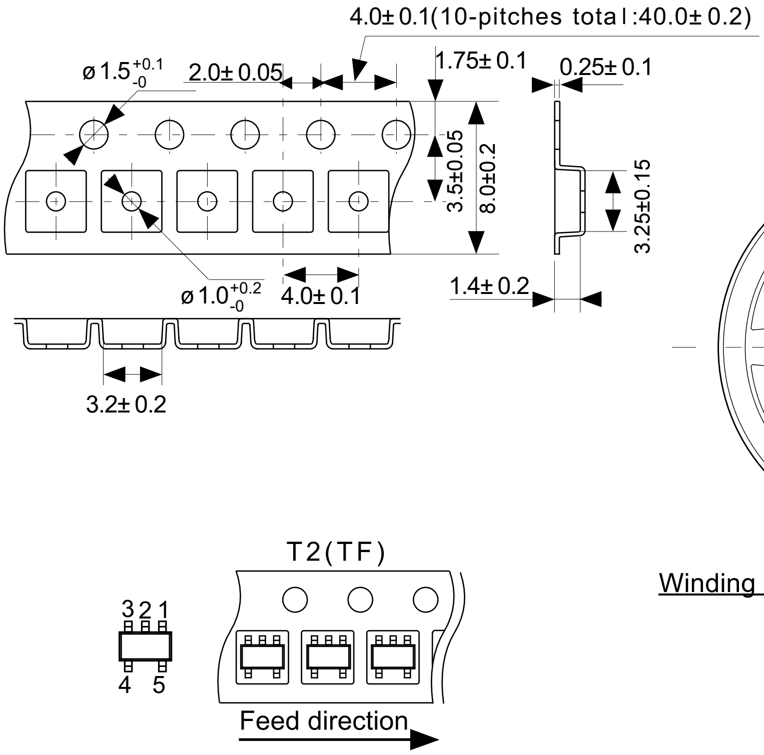
● Dimensions

Unit : mm



No. MP005-A-P-SD-1.1

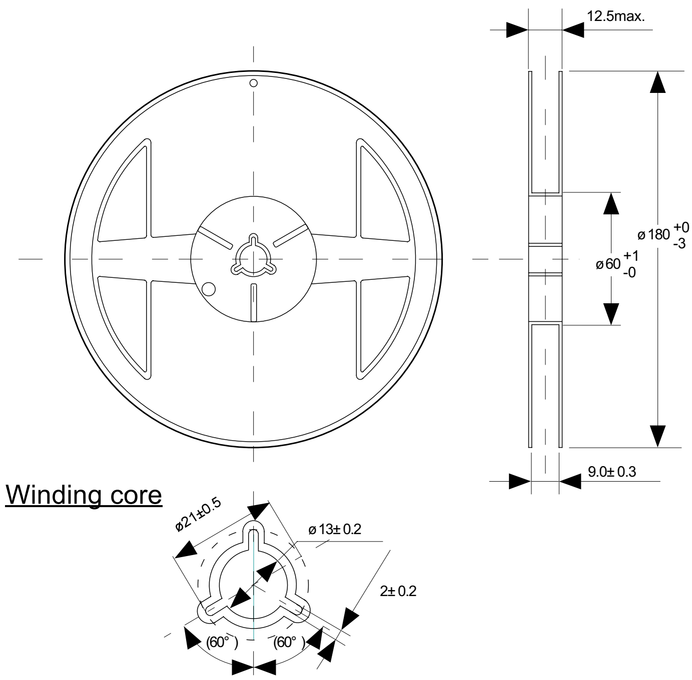
● Tape Specifications



No. : MP005-A-C-SD-2.0

● Reel Specifications

3000 pcs./reel



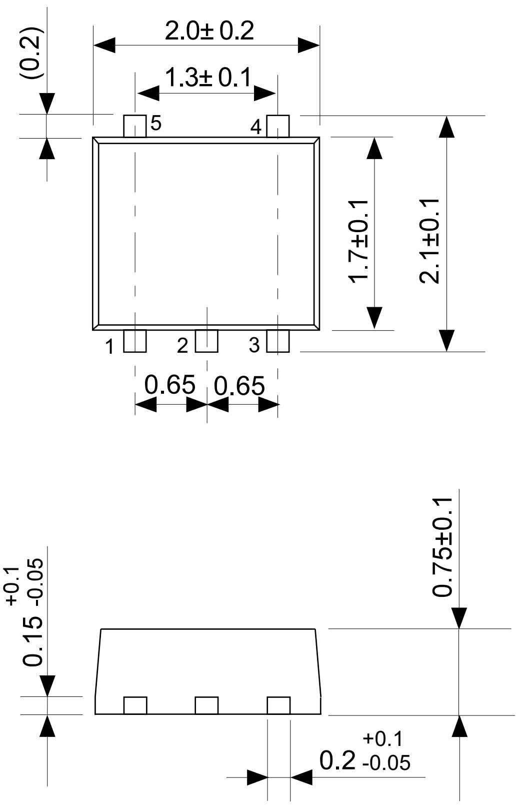
No. MP005-A-R-SD-1. 0

■ 5-Pin SON(A) [SON5A(2017)]

PN005-A **Rev.1.0** 020205

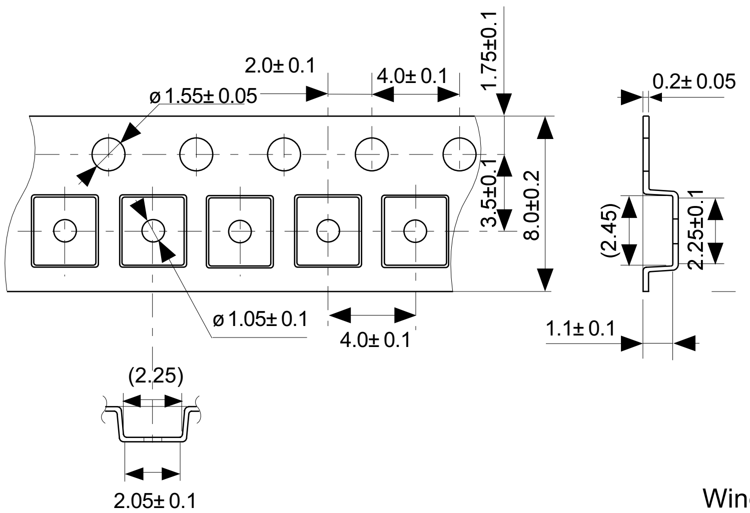
●Dimensions

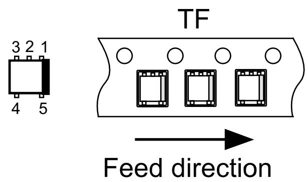
Unit:mm



No. PN005-A-P-SD-1.0

●Taping Specifications

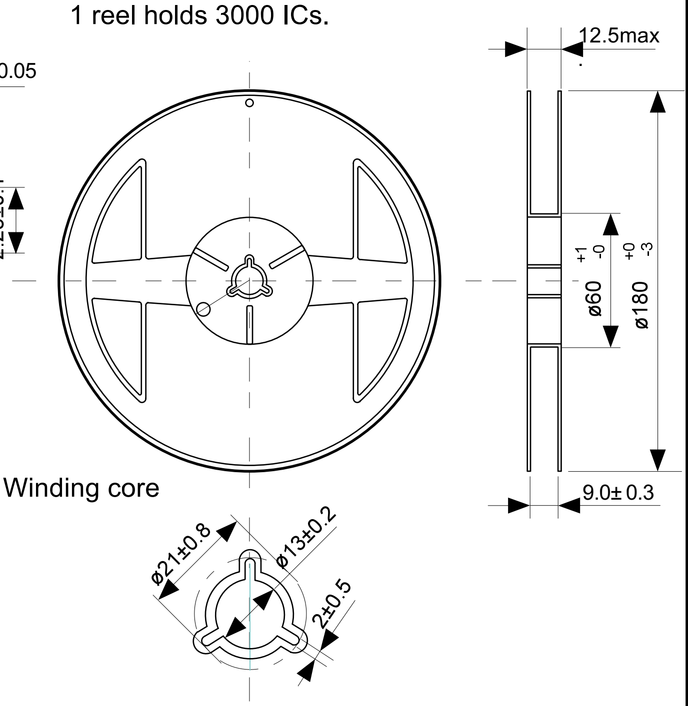




No. PN005-A-C-SD-1.0

●Reel Specifications

1 reel holds 3000 ICs.



No. PN005-A-R-SD-1.0