SUPER-SMALL PACKAGE CMOS VOLTAGE REGULATOR S-817 Series

The S-817 is an ultra compact 3-Pin positive voltage regulator developed using CMOS technology. Housing into a miniaturized 2.0 × 2.1 mm SC-82AB package, the S-817 offers key advantages for small, portable applications.
The S-817 allows many types of output capacitors including ceramic capacitors and ensures highly-stable operations at light load as low as 1 μA.

■ Features

- Ultra-low current consumption: Operating current: Typ. 1.2 μA, Max. 2.5 μA
- Output voltage: 1.1 to 6.0 V, selectable in 0.1 V steps.
- Output voltage accuracy: ±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. 160 mV (V_{OUT} = 5.0 V, I_{OUT} = 10 mA)
- Low ESR capacitor (e.g., a ceramic capacitor of 0.1 μF or more) can be used as an output capacitor.
- Short circuit protection for: Series A
- Excellent Line Regulation: Stable operation at light load of 1 μA

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

■ Applications

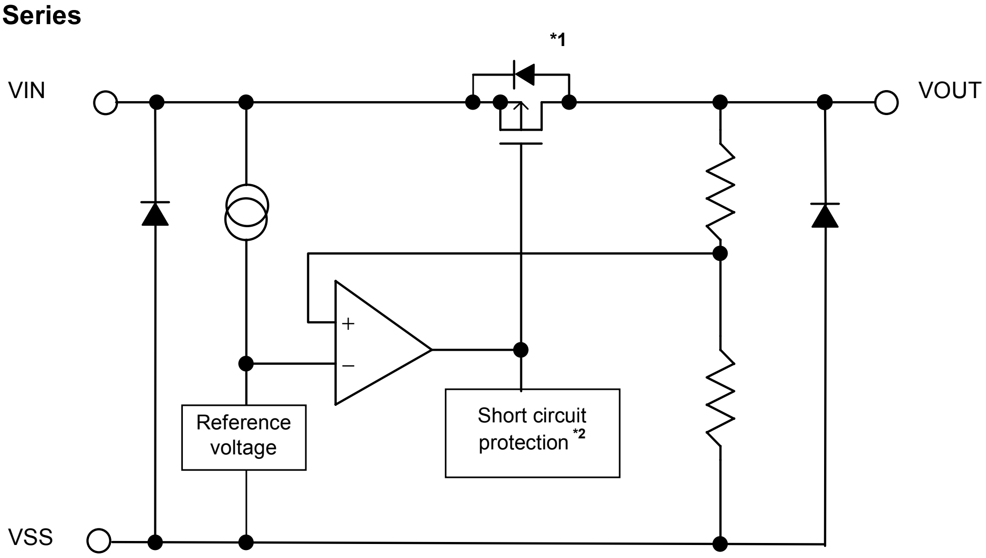
- Power source for battery-powered devices
- Power source for personal communication devices
- Power source for home electric/electronic appliances

■ Package

Package name	Drawing code			
	Package	Tape	Reel	Zigzag
SC-82AB	NP004-A	NP004-A	NP004-A	—
SOT-23-5	MP005-A	MP005-A	MP005-A	—
SOT-89-3	UP003-A	UP003-A	UP003-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

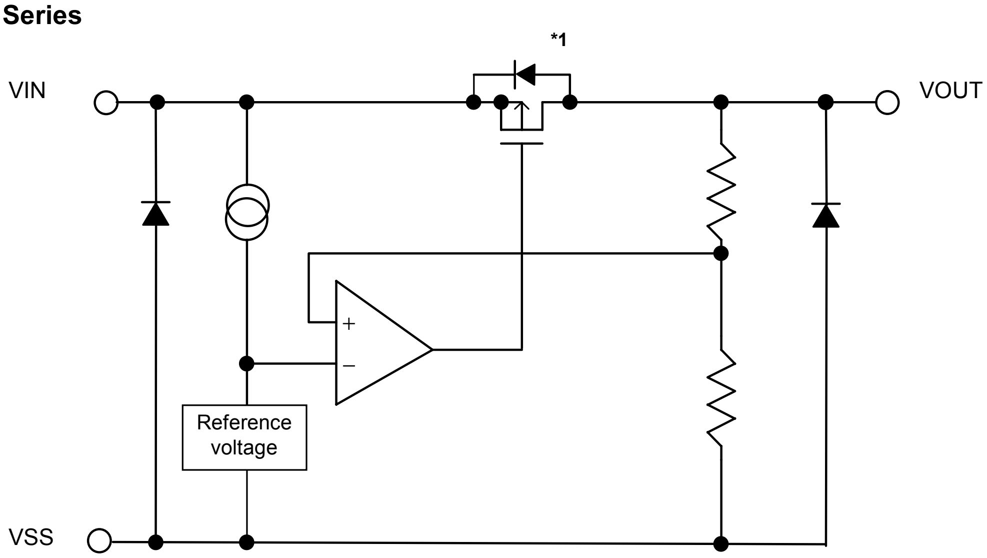
1. S-817A Series



***1.** Parasitic diode

Figure 1

2. S-817B Series



***1.** Parasitic diode

Figure 2

■ Product Code Structure

1. Product name

1.1 Package SC-82A, SOT-23-5 & SOT-89-3

S-817x xx Axx - xxx - T2

- T2: IC direction in tape specifications*1
- xxx: Product name (abbreviation)
- xx: Package name (abbreviation)*2
  - NB: SC-82AB
  - MC: SOT-23-5
  - UA: SOT-89-3
- xx: Output voltage
  - 11 to 60
  - (E.g., when the output voltage is 1.5 V, it is expressed 15)
- x: Short circuit protection
  - A = Yes
  - B = No

***1.** Refer to the specifications at the end of this book.
***2.** Refer to the “Product name list”.

1.2 Package TO-92

S-817x xx AY - x

- x: Product name (abbreviation)
  - B: Bulk
  - Z: Tape and ammo
  - T: Tape and Reel
- Y: Package name (abbreviation)*1
  - Y: TO-92
- xx: Output voltage
  - 11 to 60
  - (E.g., when the output voltage is 1.5 V, it is expressed 15)
- x: Short circuit protection
  - A = Yes
  - B = No

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

2. Product name list

2.1 S-817A series

Table 1

Output voltage	SC-82AB	SOT-23-5
1.1 V ±2.0 %	S-817A11ANB-CUA-T2	—
1.2 V ±2.0 %	S-817A12ANB-CUB-T2	—
1.3 V ±2.0 %	S-817A13ANB-CUC-T2	—
1.4 V ±2.0 %	S-817A14ANB-CUD-T2	S-817A14AMC-T2
1.5 V ±2.0 %	S-817A15ANB-CUE-T2	—
1.6 V ±2.0 %	S-817A16ANB-CUF-T2	S-817A16AMC-T2
1.7 V ±2.0 %	—	—
1.8 V ±2.0 %	S-817A18ANB-CUH-T2	—
1.9 V ±2.0 %	S-817A19ANB-CUI-T2	—
2.0 V ±2.0 %	S-817A20ANB-CUJ-T2	—
2.1 V ±2.0 %	S-817A21ANB-CUK-T2	—
2.2 V ±2.0 %	S-817A22ANB-CUL-T2	—
2.4 V ±2.0 %	S-817A24ANB-CUN-T2	—
2.5 V ±2.0 %	S-817A25ANB-CUO-T2	—
2.6 V ± 2.0 %	S-817A26ANB-CUP-T2	—
2.7 V ±2.0 %	S-817A27ANB-CUQ-T2	—
2.8 V ±2.0 %	S-817A28ANB-CUR-T2	—
2.9 V ±2.0 %	S-817A29ANB-CUS-T2	—
3.0 V ±2.0 %	S-817A30ANB-CUT-T2	—
3.2 V ±2.0 %	S-817A32ANB-CUV-T2	—
3.3 V ±2.0 %	S-817A33ANB-CUW-T2	—
3.4 V ±2.0 %	—	—
3.5 V ±2.0 %	S-817A35ANB-CUY-T2	—
3.6 V ±2.0 %	S-817A36ANB-CUZ-T2	—
3.7 V ±2.0 %	S-817A37ANB-CVA-T2	—
3.8 V ±2.0 %	—	—
4.0 V ±2.0 %	S-817A40ANB-CVD-T2	—
4.2 V ±2.0 %	S-817A42ANB-CVF-T2	—
4.3 V ±2.0 %	S-817A43ANB-CVG-T2	—
4.5 V ±2.0 %	S-817A45ANB-CVI-T2	—
4.8 V ±2.0 %	S-817A48ANB-CVL-T2	—
5.0 V ±2.0 %	S-817A50ANB-CVN-T2	—
5.2 V ± 2.0 %	—	—
5.3 V ±2.0 %	—	—
5.6 V ±2.0 %	S-817A56ANB-CVT-T2	—
6.0 V ±2.0 %	—	—

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

2.2 S-817B series

Table 2

Output voltage	SOT-23-5	SOT-89-3	TO-92*1
1.1 V±2.0 %	S-817B11AMC-CWA-T2	S-817B11AUA-CWA-T2	S-817B11AY-x
1.2 V±2.0 %	S-817B12AMC-CWB-T2	S-817B12AUA-CWB-T2	—
1.3 V±2.0 %	S-817B13AMC-CWC-T2	—	—
1.5 V±2.0 %	S-817B15AMC-CWE-T2	S-817B15AUA-CWE-T2	S-817B15AY-x
1.6 V±2.0 %	S-817B16AMC-CWF-T2	S-817B16AUA-CWF-T2	—
1.7 V±2.0 %	S-817B17AMC-CWG-T2	—	—
1.8 V±2.0 %	S-817B18AMC-CWH-T2	S-817B18AUA-CWH-T2	—
1.9 V±2.0 %	—	S-817B19AUA-CWI-T2	—
2.0 V±2.0 %	S-817B20AMC-CWJ-T2	S-817B20AUA-CWJ-T2	—
2.2 V±2.0 %	S-817B22AMC-CWL-T2	—	—
2.5 V±2.0 %	S-817B25AMC-CWO-T2	S-817B25AUA-CWO-T2	S-817B25AY-x
2.7 V±2.0 %	—	S-817B27AUA-CWQ-T2	—
2.8 V±2.0 %	S-817B28AMC-CWR-T2	—	—
3.0 V±2.0 %	S-817B30AMC-CWT-T2	S-817B30AUA-CWT-T2	S-817B30AY-x
3.3 V±2.0 %	S-817B33AMC-CWW-T2	S-817B33AUA-CWW-T2	S-817B33AY-x
3.5 V±2.0 %	S-817B35AMC-CWY-T2	S-817B35AUA-CWY-T2	—
3.6 V±2.0 %	—	S-817B36AUA-CWZ-T2	—
3.7 V±2.0 %	S-817B37AMC-CXA-T2	S-817B37AUA-CXA-T2	S-817B37AY-x
3.8 V±2.0 %	S-817B38AMC-CXB-T2	S-817B38AUA-CXB-T2	—
4.0 V±2.0 %	S-817B40AMC-CXD-T2	S-817B40AUA-CXD-T2	S-817B40AY-x
4.2 V±2.0 %	S-817B42AMC-CXF-T2	—	—
4.3 V±2.0 %	—	S-817B43AUA-CXG-T2	—
4.5 V±2.0 %	—	S-817B45AUA-CXI-T2	—
5.0 V±2.0 %	S-817B50AMC-CXN-T2	S-817B50AUA-CXN-T2	S-817B50AY-x
5.2 V±2.0 %	—	S-817B52AUA-CXP-T2	S-817B52AY-x
5.3 V±2.0 %	—	S-817B53AUA-CXQ-T2	—
5.6 V±2.0 %	—	S-817B56AUA-CXT-T2	—
6.0 V±2.0 %	—	S-817B60AUA-CXX-T2	S-817B60AY-x

***1.** X changes according to the packing form in TO-92. Standard forms are B; Bulk and Z; Zigzag (tape and ammo).

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

■ Pin Configuration

SC-82AB
Top view

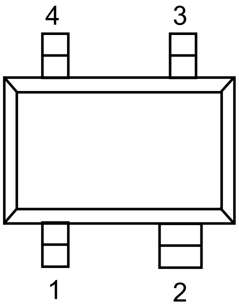


Figure 3

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

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

SOT-23-5
Top view

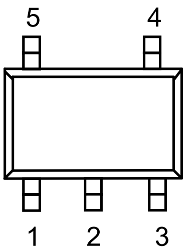


Figure 4

Table 4

Pin No.	Symbol	Description
1	VSS	GND pin
2	VIN	Input voltage pin
3	VOUT	Output voltage pin
4	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,

SOT-89-3
Top view

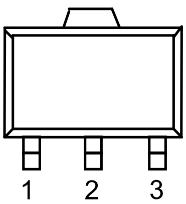


Figure 5

Table 5

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

TO-92
Bottom view

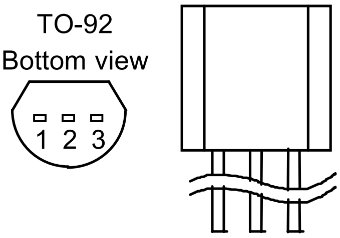


Figure 6

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}+12		V
Output voltage	V_{OUT}	V_{SS}−0.3 to V_{IN}+0.3		
Power dissipation	P_D	SC-82AB	150	mW
		SOT-23-5	250	
		SOT-89-3	500	
		TO-92	400	
Operating temperature range	T_{opr}	−40 to +85		°C
Storage temperature range	T_{stg}	−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

1. S-817A series

Table 8 (Ta=25°C unless otherwise specified)

Item	Symbol	Conditions		Min.	Typ.	Max.	Units	Test circuits
Output voltage *1	$V_{OUT(E)}$	$V_{IN}=V_{OUT(S)}+2$ V, $I_{OUT}=10$ mA		$V_{OUT(S)} \times 0.98$	$V_{OUT(S)}$	$V_{OUT(S)} \times 1.02$	V	1
Output current *2	I_{OUT}	$V_{OUT(S)}+2$ V $\leq V_{IN} \leq 10$ V	$1.1\ V \leq V_{OUT(S)} \leq 1.9\ V$	20	–	–	mA	3
			$2.0\ V \leq V_{OUT(S)} \leq 2.9\ V$	35	–	–		
			$3.0\ V \leq V_{OUT(S)} \leq 3.9\ V$	50	–	–		
			$4.0\ V \leq V_{OUT(S)} \leq 4.9\ V$	65	–	–		
			$5.0\ V \leq V_{OUT(S)} \leq 6.0\ V$	75	–	–		
Dropout voltage *3	V_{drop}	I_{OUT} = 10 mA	$1.1\ V \leq V_{OUT(S)} \leq 1.4\ V$	–	0.92	1.58	V	1
			$1.5\ V \leq V_{OUT(S)} \leq 1.9\ V$	–	0.58	0.99		
			$2.0\ V \leq V_{OUT(S)} \leq 2.4\ V$	–	0.40	0.67		
			$2.5\ V \leq V_{OUT(S)} \leq 2.9\ V$	–	0.31	0.51		
			$3.0\ V \leq V_{OUT(S)} \leq 3.4\ V$	–	0.25	0.41		
			$3.5\ V \leq V_{OUT(S)} \leq 3.9\ V$	–	0.22	0.35		
			$4.0\ V \leq V_{OUT(S)} \leq 4.4\ V$	–	0.19	0.30		
			$4.5\ V \leq V_{OUT(S)} \leq 4.9\ V$	–	0.18	0.27		
			$5.0\ V \leq V_{OUT(S)} \leq 5.4\ V$	–	0.16	0.25		
			$5.5\ V \leq V_{OUT(S)} \leq 6.0\ V$	–	0.15	0.23		
Line regulation 1	ΔV_{OUT1}	$V_{OUT(S)} + 1\ V \leq V_{IN} \leq 10\ V$, $I_{OUT} = 1$ mA		–	5	20	mV	
Line regulation 2	ΔV_{OUT2}	$V_{OUT(S)} + 1\ V \leq V_{IN} \leq 10\ V$, $I_{OUT} = 1\ \mu A$		–	5	20		
Load regulation	ΔV_{OUT3}	$V_{IN}=V_{OUT(S)}+2$ V	$1.1\ V \leq V_{OUT(S)} \leq 1.9\ V$, $1\ \mu A \leq I_{OUT} \leq 10$ mA	–	5	20		
			$2.0\ V \leq V_{OUT(S)} \leq 2.9\ V$, $1\ \mu A \leq I_{OUT} \leq 20$ mA	–	10	30		
			$3.0\ V \leq V_{OUT(S)} \leq 3.9\ V$, $1\ \mu A \leq I_{OUT} \leq 30$ mA	–	20	45		
			$4.0\ V \leq V_{OUT(S)} \leq 4.9\ V$, $1\ \mu A \leq I_{OUT} \leq 40$ mA	–	25	65		
			$5.0\ V \leq V_{OUT(S)} \leq 6.0\ V$, $1\ \mu A \leq I_{OUT} \leq 50$ mA	–	35	80		
Output voltage temperature coefficient *4	$\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$	$V_{IN} = V_{OUT(S)} + 1$ V, $I_{OUT} = 10$ mA, $-40°C \leq Ta \leq 85°C$		–	±100	–	ppm/°C	
Current consumption	I_{SS}	$V_{IN} = V_{OUT(S)} + 2$ V, no load		–	1.2	2.5	μA	2
Input voltage	V_{IN}	–		–	–	10	V	1
Short current limit	I_{OS}	$V_{IN} = V_{OUT(S)} + 2$ V, V_{OUT} pin = 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 mA) and inputting $V_{OUT(S)}$+2.0 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 [mV/°C] is calculated using the following equation.

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

Temperature change ratio for output voltage
Specified output voltage
Output voltage temperature coefficient

2. S-817B series

Table 9 (Ta=25°C unless otherwise specified)

Item	Symbol	Conditions		Min.	Typ.	Max.	Units	Test circuits
Output voltage *1	$V_{OUT(E)}$	$V_{IN}=V_{OUT(S)}+2$ V, $I_{OUT}=10$ mA		$V_{OUT(S)}$ × 0.98	$V_{OUT(S)}$	$V_{OUT(S)}$ × 1.02	V	1
Output current *2	I_{OUT}	$V_{OUT(S)}+2$ V ≤ V_{IN}≤10 V	1.1 V ≤ $V_{OUT(S)}$ ≤ 1.9 V	20	–	–	mA	3
			2.0 V ≤ $V_{OUT(S)}$ ≤ 2.9 V	35	–	–		
			3.0 V ≤ $V_{OUT(S)}$ ≤ 3.9 V	50	–	–		
			4.0 V ≤ $V_{OUT(S)}$ ≤ 4.9 V	65	–	–		
			5.0 V ≤ $V_{OUT(S)}$ ≤ 6.0 V	75	–	–		
Dropout voltage *3	V_{drop}	I_{OUT} = 10 mA	1.1 V ≤ $V_{OUT(S)}$ ≤ 1.4 V	–	0.92	1.58	V	1
			1.5 V ≤ $V_{OUT(S)}$ ≤ 1.9 V	–	0.58	0.99		
			2.0 V ≤ $V_{OUT(S)}$ ≤ 2.4 V	–	0.40	0.67		
			2.5 V ≤ $V_{OUT(S)}$ ≤ 2.9 V	–	0.31	0.51		
			3.0 V ≤ $V_{OUT(S)}$ ≤ 3.4 V	–	0.25	0.41		
			3.5 V ≤ $V_{OUT(S)}$ ≤ 3.9 V	–	0.22	0.35		
			4.0 V ≤ $V_{OUT(S)}$ ≤ 4.4 V	–	0.19	0.30		
			4.5 V ≤ $V_{OUT(S)}$ ≤ 4.9 V	–	0.18	0.27		
			5.0 V ≤ $V_{OUT(S)}$ ≤ 5.4 V	–	0.16	0.25		
			5.5 V ≤ $V_{OUT(S)}$ ≤ 6.0 V	–	0.15	0.23		
Line regulation 1	Δ V_{OUT1}	$V_{OUT(S)}$ + 1 V ≤ V_{IN} ≤ 10 V, I_{OUT} = 1 mA		–	5	20	mV	
Line regulation 2	Δ V_{OUT2}	$V_{OUT(S)}$ + 1 V ≤ V_{IN} ≤ 10 V, I_{OUT} = 1 µA		–	5	20		
Load regulation	Δ V_{OUT3}	$V_{IN}=V_{OUT(S)}+2$ V	1.1 V ≤ $V_{OUT(S)}$ ≤ 1.9 V, 1 µA ≤ I_{OUT} ≤ 10 mA	–	5	20		
			2.0 V ≤ $V_{OUT(S)}$ ≤ 2.9 V, 1 µA ≤ I_{OUT} ≤ 20 mA	–	10	30		
			3.0 V ≤ $V_{OUT(S)}$ ≤ 3.9 V, 1 µA ≤ I_{OUT} ≤ 30 mA	–	20	45		
			4.0 V ≤ $V_{OUT(S)}$ ≤ 4.9 V, 1 µA ≤ I_{OUT} ≤ 40 mA	–	25	65		
			5.0 V ≤ $V_{OUT(S)}$ ≤ 6.0 V, 1 µA ≤ I_{OUT} ≤ 50 mA	–	35	80		
Output voltage temperature coefficient *4	$\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$	V_{IN} = $V_{OUT(S)}$ + 1 V, I_{OUT} = 10 mA –40°C ≤ Ta ≤ 85°C		–	±100	–	ppm /°C	
Current consumption	I_{SS}	V_{IN} = $V_{OUT(S)}$ + 2 V, no load		–	1.2	2.5	µA	2
Input voltage	V_{IN}	–		–	–	10	V	1

***1.** $V_{OUT(S)}$=Specified output voltage
$V_{OUT(E)}$=Effective output voltage, i.e., the output voltage when fixing I_{OUT}(=10 mA) and inputting $V_{OUT(S)}$+2.0 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 [mV/°C] is calculated using the following equation.

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

Temperature change ratio for output voltage | Specified output voltage | Output voltage temperature coefficient

■ Test Circuits

1.

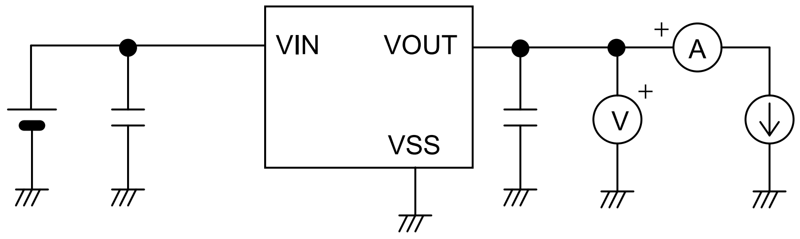


Figure 7

2.

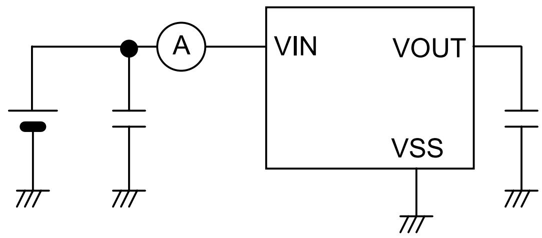


Figure 8

3.

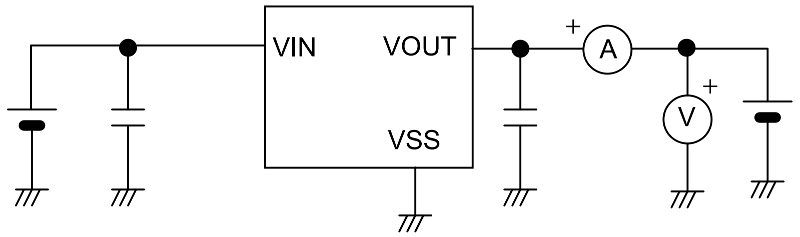
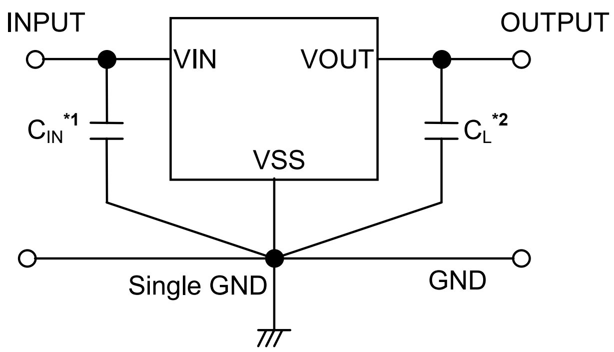


Figure 9

■ Standard Circuit



***1.** C_{IN} is a capacitor used to stabilize input.
***2.** A ceramic capacitor of 0.1 μF or more can be used for C_L.

Figure 10

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. Low ESR

ESR is the abbreviation for Equivalent Series Resistance.
Low ESR output capacitors (C_L) can be used in the S-817 Series.

2. Output voltage (V_{OUT})

The accuracy of the output voltage is ±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})

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.

4. Load regulation (ΔV_{OUT3})

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.

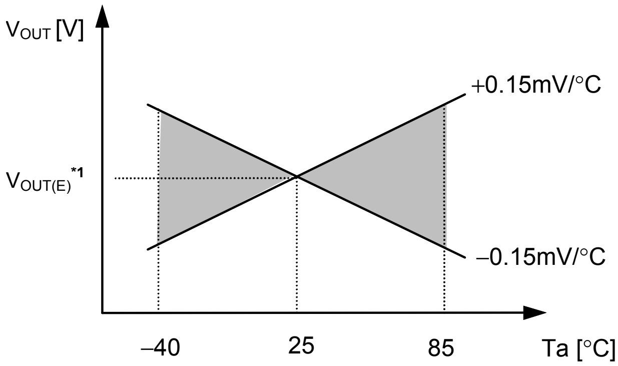
5. Dropout voltage (V_{drop})

Indicates a difference between input voltage (V_{IN1}) and output voltage when output voltage falls by 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 $\left(\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}} \right)$

The output voltage lies in the shaded area in the whole operating temperature shown in Figure 11 when the temperature coefficient of the output voltage is ±100 ppm/°C.

Ex. S-817A15A Typ.



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

Figure 11

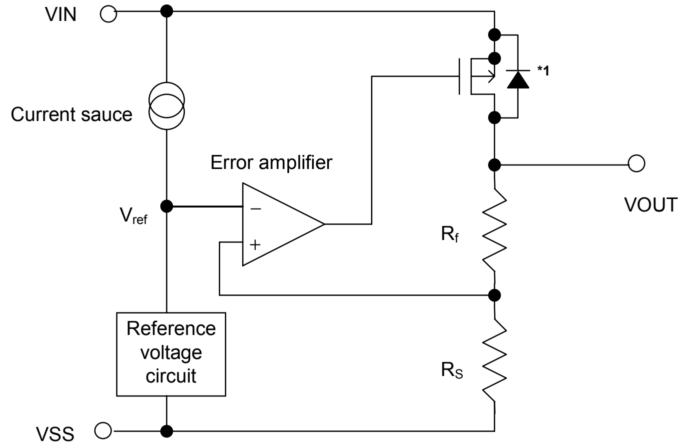
Temperature change ratio for output voltage [mV/°C] is calculated by using the following equation.

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

- $\frac{\Delta V_{OUT}}{\Delta Ta}$: Temperatures change ratio for output voltage
- $V_{OUT(S)}$: Specified output voltage
- $\frac{\Delta V_{OUT}}{\Delta Ta \bullet V_{OUT}}$: Output voltage temperature coefficient

■ Operation

1. Basic Operation



***1.** Parasitic diode

Figure 12

Figure 12 shows the block diagram of the S-817 series. he 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.

2. Output Transistor

The S-817 series uses a 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 damaged due to inverse current flowing from VOUT pin through a parastic diode to VIN pin.

3. Short Circuit Protection

The S-817A series incorporates a short circuit protection to protect the output transistor against short circuit between VOUT pin and VSS pin. 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 be a thermal protection at the same time. 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 Output Capacitor (C_L)

To stabilize operation against variation in output load, a capacitor (C_L) must be mounted between VOUT and VSS in the S-817 series because the phase is compensated with the help of the internal phase compensation circuit and the ESR of the output capacitor.

When selecting a ceramic or an OS capacitor, capacitance should be 0.1 μF or more, and when selecting a tantalum or an aluminum electrolytic capacitor, capacitance should be 0.1 μF or more and ESR 30 Ω 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.
Overshoot and undershoot characteristics differ depending upon the type of the output capacitor.
Refer to C_L dependencies in “Transient Response Characteristics”.

■ Applied Circuits

1. Output Current Boosting Circuit

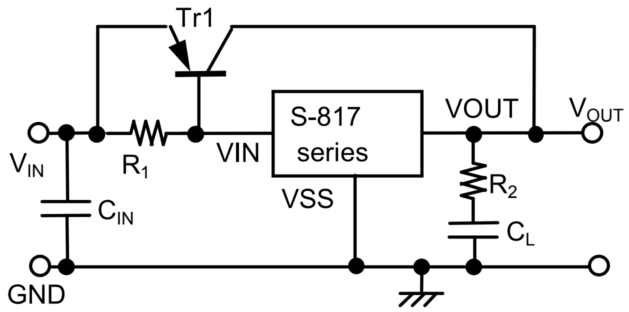


Figure 13

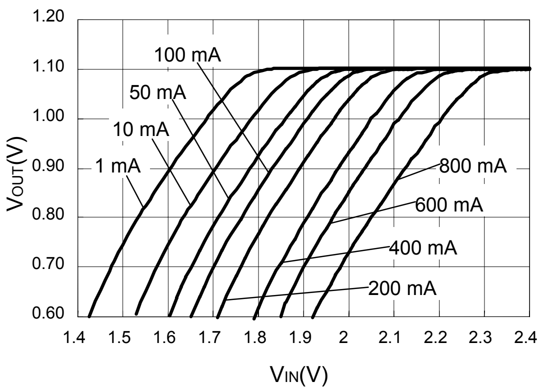
As shown in Figure 13, the output current can be boosted by externally attaching a PNP transistor. The base current of the PNP transistor is controlled so that output voltage V_{OUT} goes the voltage specified in the S-817 when base-emitter voltage V_{BE} necessary to turn on the PNP transistor is obtained between input voltage V_{IN} and S-817 power source pin VIN.
The following are tips and hints for selecting and ensuring optimum use of external parts

- PNP transistor Tr1:
  1. Set h_{FE} to approx. 100 to 400.
  2. Confirm that no problem occurs due to power dissipation under normal operation conditions.
- Resistor R_1:
  Generally set R_1 to 1 kΩ ÷ $V_{OUT (S)}$ (the voltage specified in the S-817 Series) or more.
  Output capacitor C_L:
  Output capacitor C_L is effective in minimizing output fluctuation at powering on or due to power or load fluctuation, but oscillation might occur. Always connect resistor R2 in series to output capacitor C_L.
- Resistor R_2: Set R_2 to 2 Ω × $V_{OUT(S)}$ or more.
- DO NOT attach a capacitor between the S-817 power source VIN and GND pins or between base and emitter of the PNP transistor to avoid oscillation.
- To improve transient response characteristics of the output current boosting circuit shown in Figure 13, check that no problem occurs due to output fluctuation at powering on or due to power or load fluctuation under normal operating conditions.
- Pay attention to the short current limit circuit incorporated into the S-817 Series because it does not function as a shortcircuiting protection circuit for this boosting circuit.

The following graphs show the examples of input-output voltage characteristics (Ta=25°C, typ.) in the output current boosting circuit:

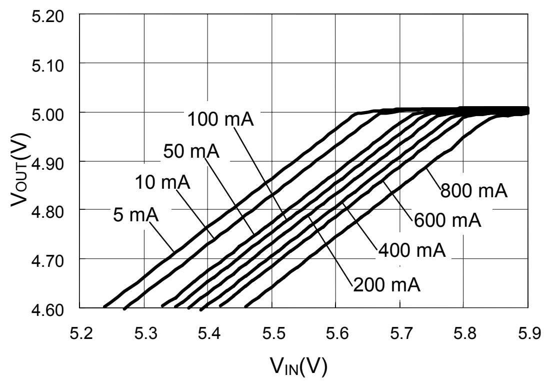
(1) S-817A11ANB/S-817B11AMC

Tr1 : 2SA1213Y, R_1 : 1 kΩ, C_L : 10 μF, R_2 : 2 Ω



(2) S-817A50ANB/S-817B50AMC

Tr1 : 2SA1213Y, R_1 : 200 Ω, C_L : 10 μF, R_2 : 10 Ω



2. Constant Current Circuit

(1) Constant Current Circuit

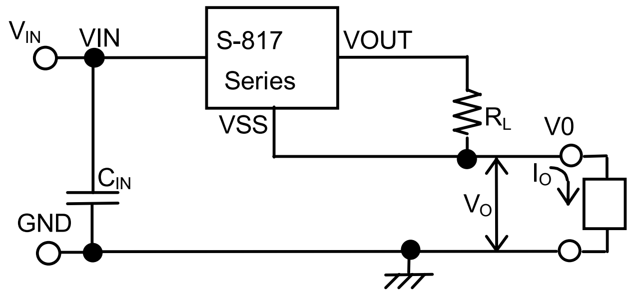


Figure 14

(2) Constant Current Boosting Circuit

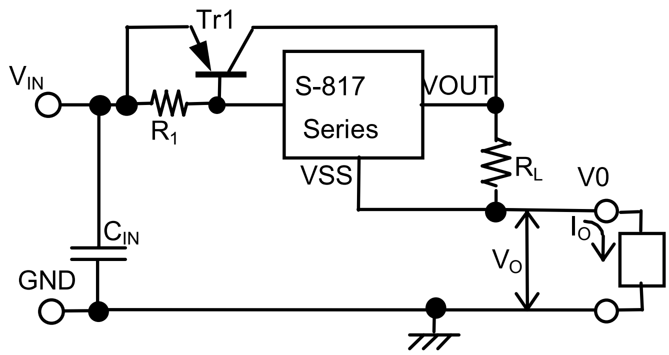


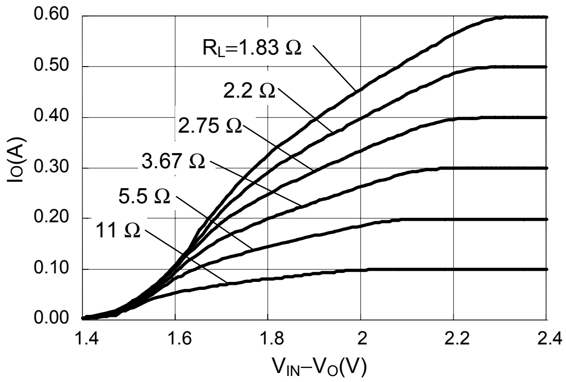
Figure 15

The S-817 Series can be configured as a constant current circuit. See Figure 14 & 15.
Constant amperage I_O is calculated using the following equation ($V_{OUT(E)}$: Effective output voltage):
$I_O = (V_{OUT(E)} \div R_L) + I_{SS}$.

Please note that it is impossible to set constant amperage I_O in case of circuit (1) of Figure 14 to the value exceeding the drive ability of the S-817.
However, circuit (2) of Figure 15 is an example to set constant amperage to the value exceeding the drive ability of the S-817. Circuit (2) incorporates a current boosting circuit. The maximum input voltage of the constant current circuit is the value obtained by adding 10 V to voltage V_O of the device. It is not recommended to attach a capacitor between the S-817 power source VIN and VSS pins or between output VOUT and VSS pins because rush current flows at powering on. An example of input voltage between V_{IN} and V_O in circuit (2) vs. I_O current characteristics

V_{IN}, V_O pins, Input voltage - I_O current

S-817A11ANB, S-817B11AMC, Tr : 2SK1213Y, R_1 : 1 kΩ, V_O=2 V



3. Output Voltage Adjustment Circuit

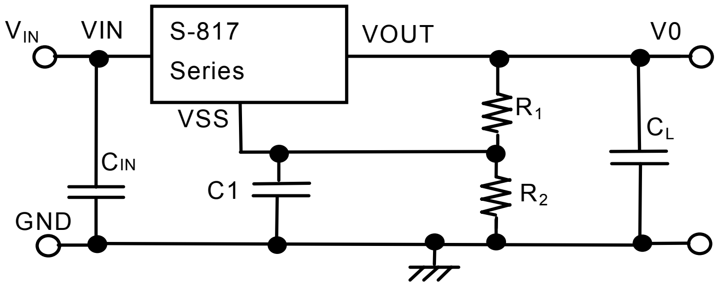


Figure 16

The output voltage can be boosted by using the configuration shown in Figure 16. The output Voltage V_O can be calculated using the following equation ($V_{OUT(E)}$:Effective output voltage):

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

Set R_1 and R_2 to high values of resistance so as not to be affected by current consumption ISS.
Capacitor C1 is effective in minimizing output fluctuation at powering on or due to power or load fluctuation. Determine the optimum value on your actual device. But it is not also recommended to attach a capacitor between the S-817 power source VIN and VSS pins or between output VOUT and VSS pins because output fluctuation or oscillation at powering on might occur. As shown in figure 16, a capacitor must be mounted between VIN and GND, and between VOUT and GND.

■ Precautions

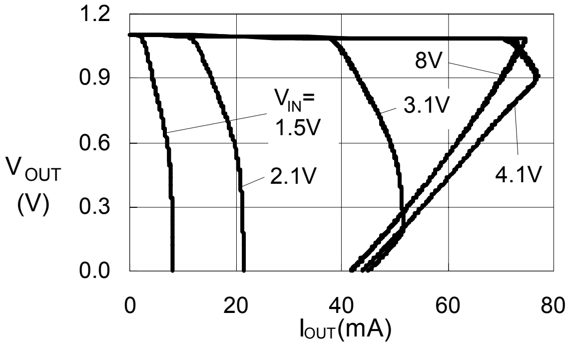
- Design wiring patterns for VIN, VOUT and GND pins to hold low impedance.
  When mounting an output capacitor between the VOUT and VSS pins (C_L) and a capacitor for stabilizing the input between VIN and VSS pins (C_{IN}), the distance from the capacitor to the VOUT pin and to the VSS pin should be as short as possible.
- Note that output voltage may be increased at low load current of less than 1 μA.
- To prevent oscillation, it is recommended to use the external parts under the following conditions.
  - Output capacitor (C_L): 0.1 μF or more
  - 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.
- 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.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.

■ Typical Operating Characteristics

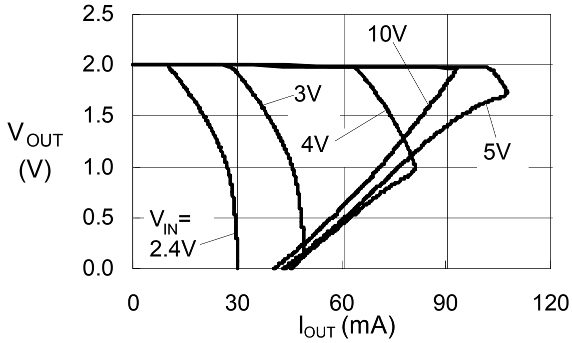
(1) Output Voltage vs. Output Current (when load current increases)

(a) S-817A Series

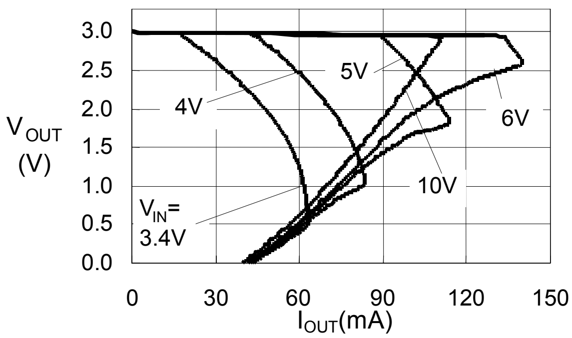
S-817A11A(Ta=25°C)



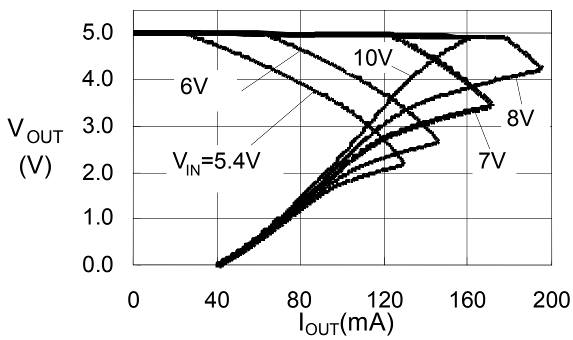
S-817A20A(Ta=25°C)



S-817A30A(Ta=25°C)

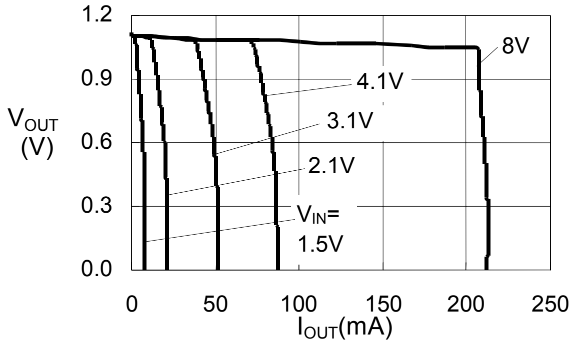


S-817A50A(Ta=25°C)

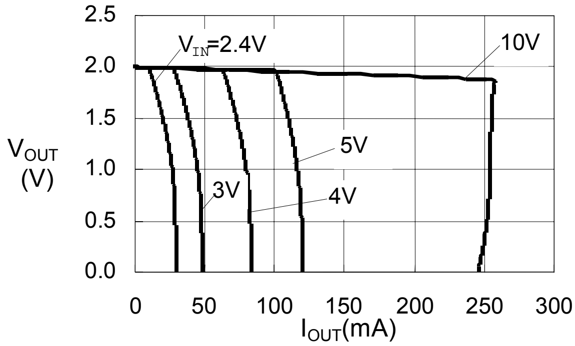


(b) S-817B series

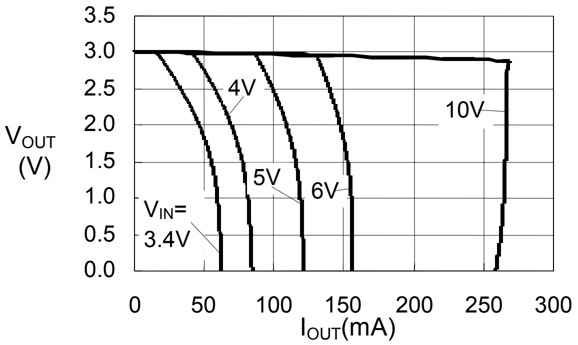
S-817B11A(Ta=25°C)



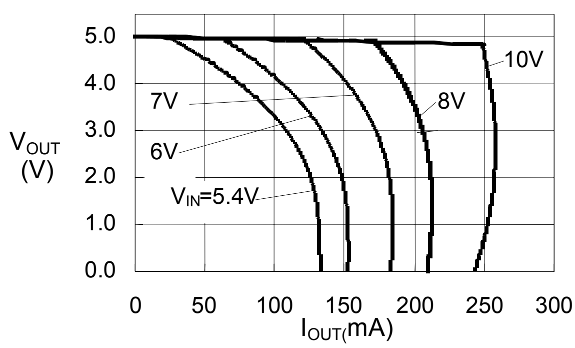
S-817B20A(Ta=25°C)



S-817B30A(Ta=25°C)

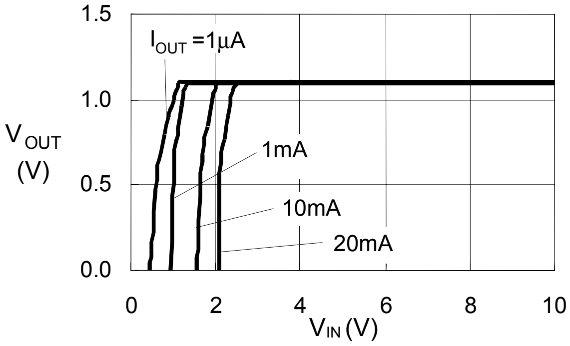


S-817B50A(Ta=25°C)

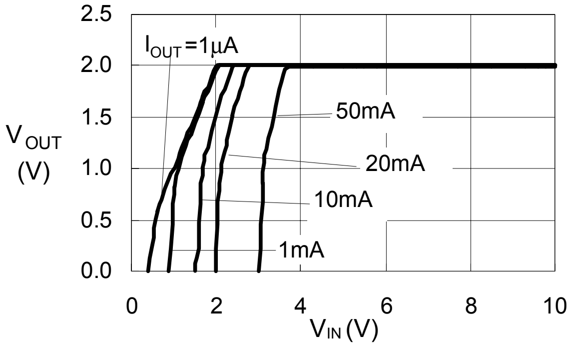


(2) Output Voltage vs. Input Voltage

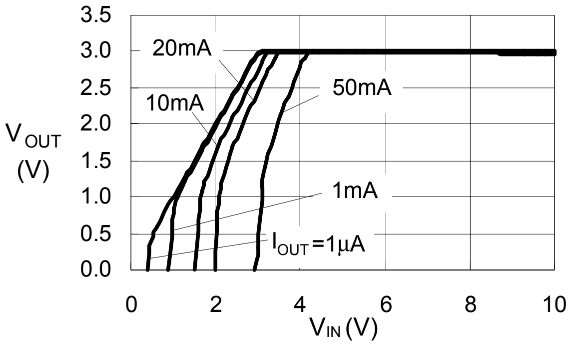
S-817A11A/S-817B11A(Ta=25°C)



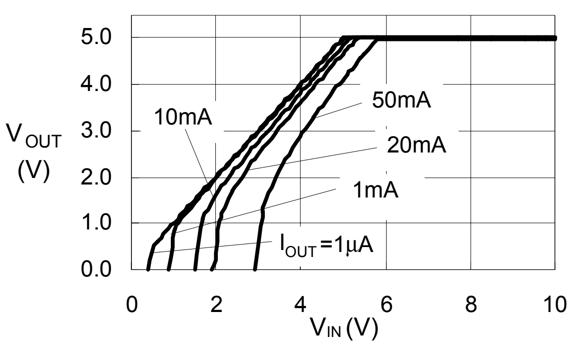
S-817A20A/S-817B20A(Ta=25°C)



S-817A30A/S-817B30A(Ta=25°C)



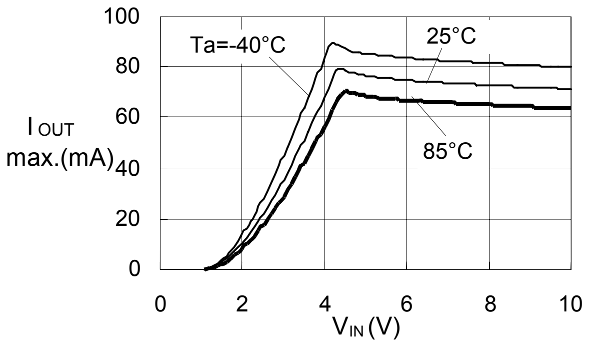
S-817A50A/S-817B50A(Ta=25°C)



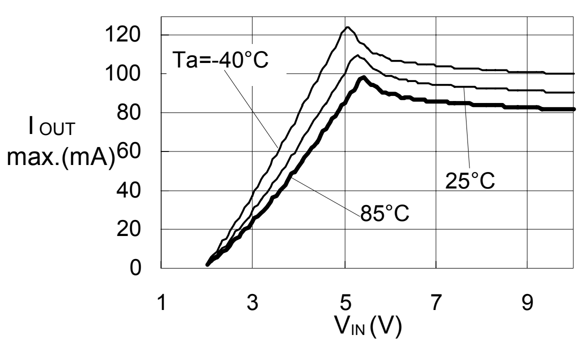
(3) Maximum Output Current vs. Input Voltage

(a) S-817A Series

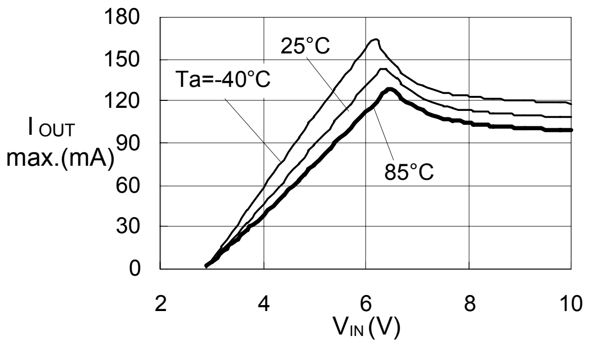
S-817A11A



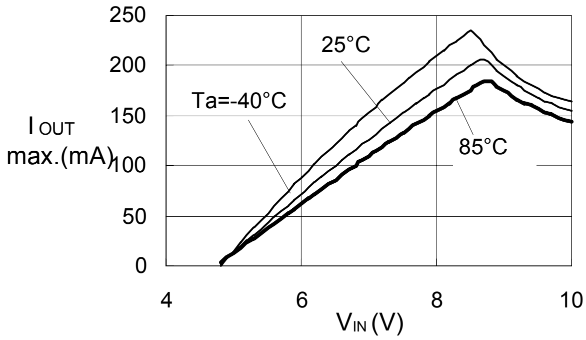
S-817A20A



S-817A30A

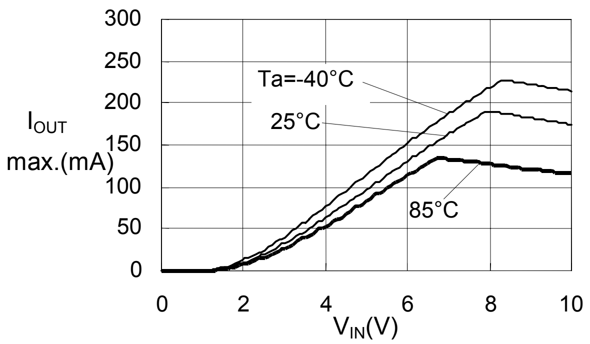


S-817A50A

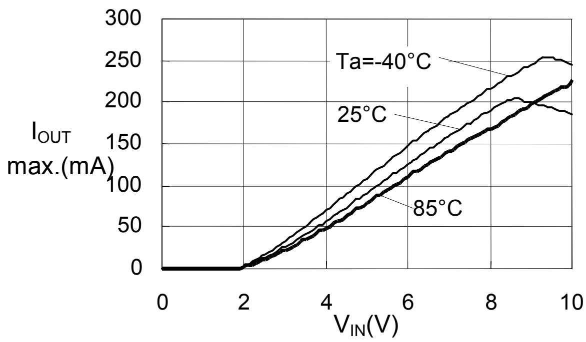


(b) S-817B Series

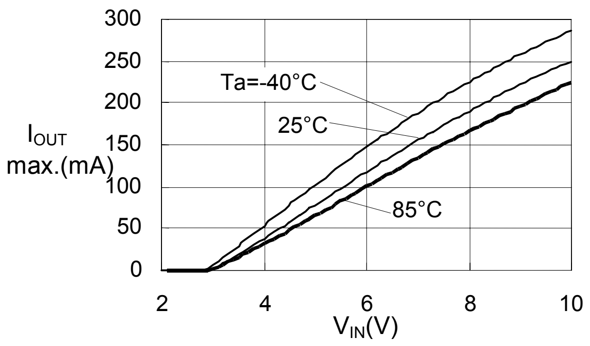
S-817B11A



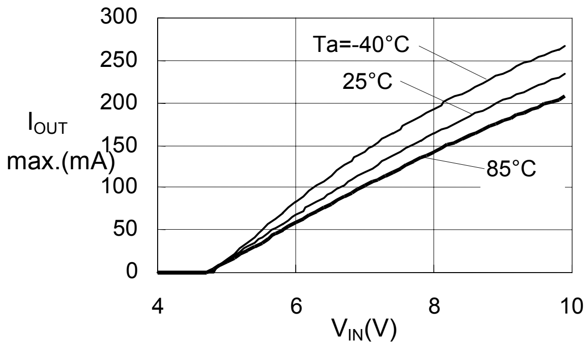
S-817B20A



S-817B30A

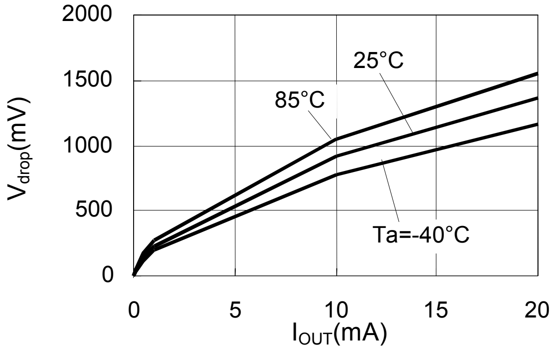


S-817B50A

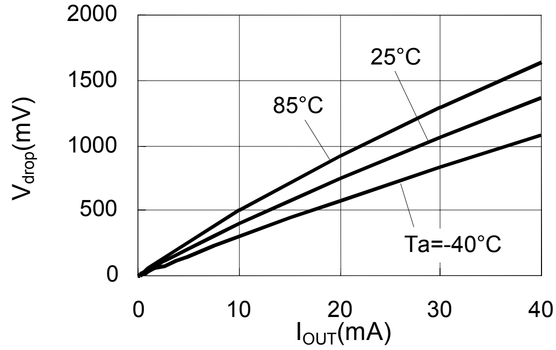


(4) Dropout Voltage vs. Output Current

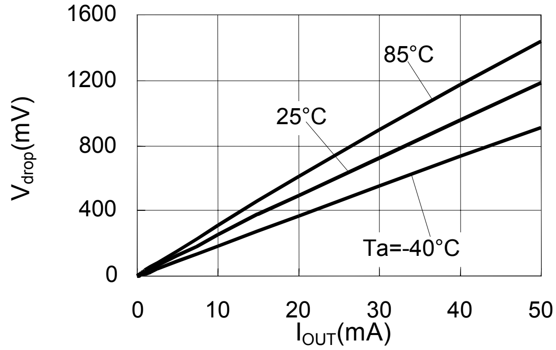
S-817A11A/S-817B11A



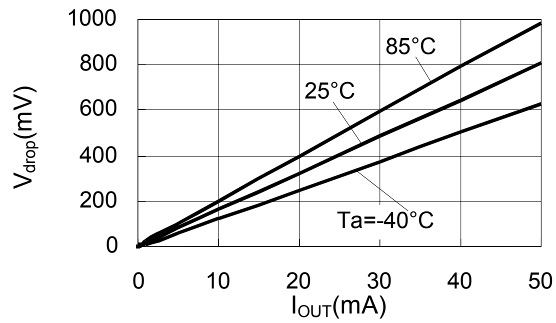
S-817A20A/S-817B20A



S-817A30A/S-817B30A

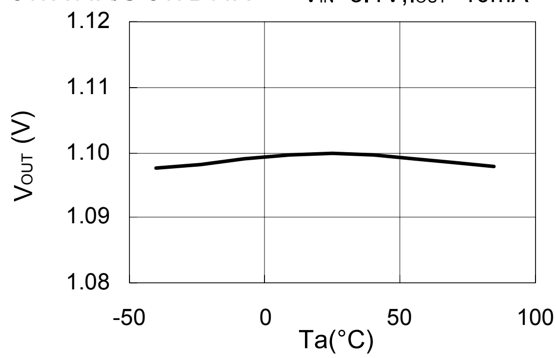


S-817A50A/S-817B50A

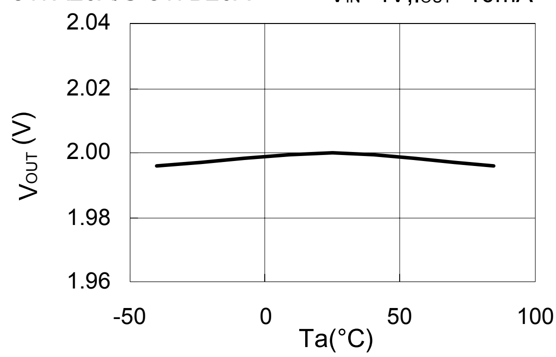


(5) Output Voltage vs. Ambient Temperature

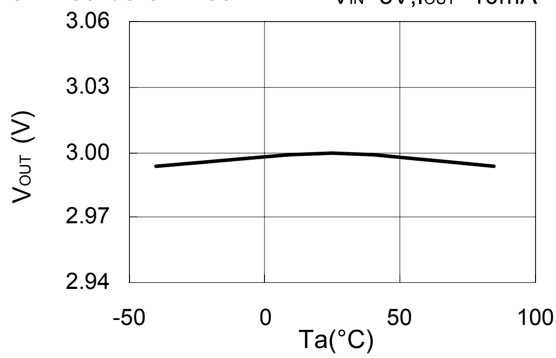
S-817A11A/S-817B11A V_{IN}=3.1V,I_{OUT}=10mA



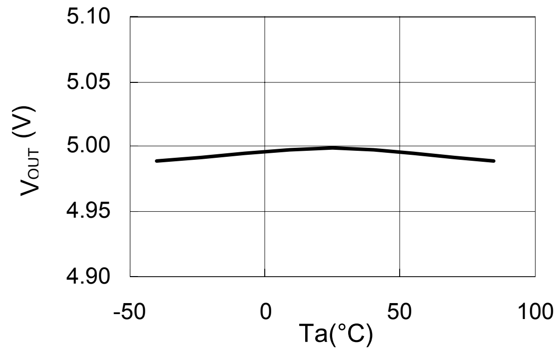
S-817A20A/S-817B20A V_{IN}=4V,I_{OUT}=10mA



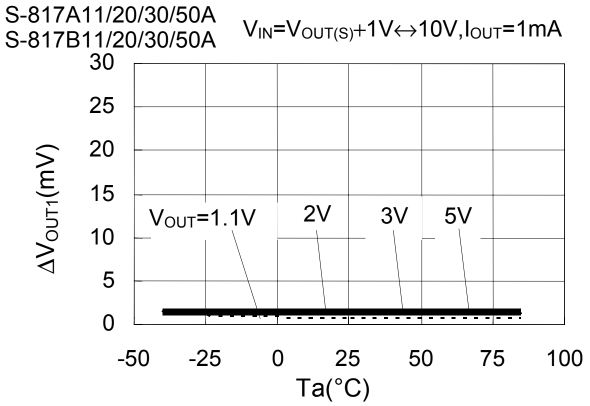
S-817A30A/S-817B30A V_{IN}=5V,I_{OUT}=10mA



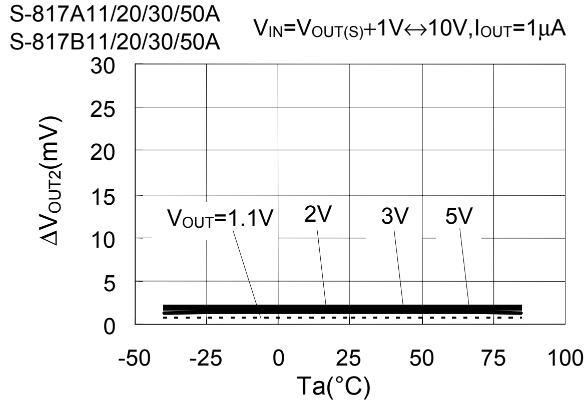
S-817A50A/S-817B50A V_{IN}=7V,I_{OUT}=10mA



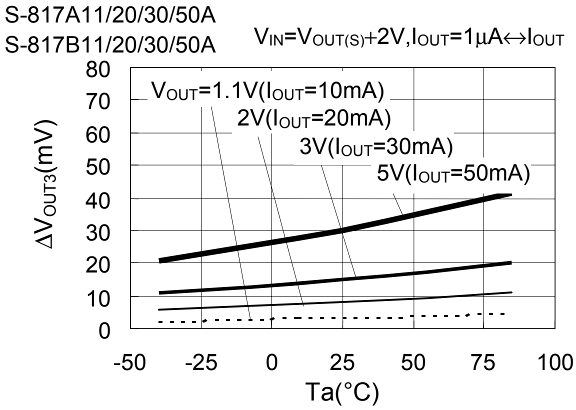
(6) Line Regulation 1 vs. Ambient Temperature



(7) Line Regulation 2 vs. Ambient Temperature

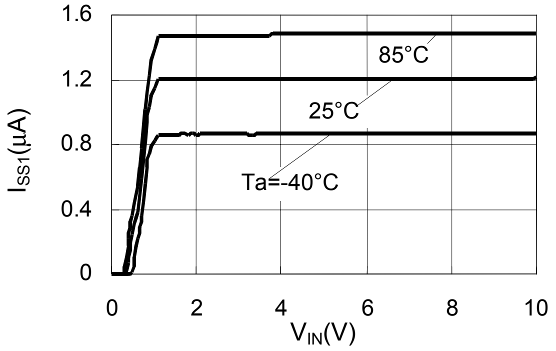


(8) Load Regulation vs. Ambient Temperature

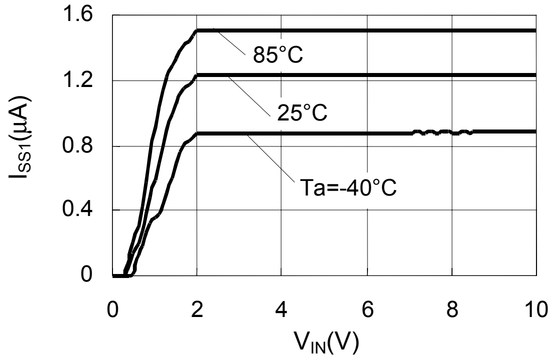


(9) Current Consumption vs. Input Voltage

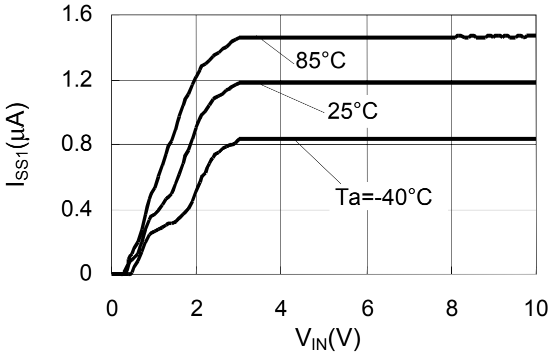
S-817A11A/S-817B11A



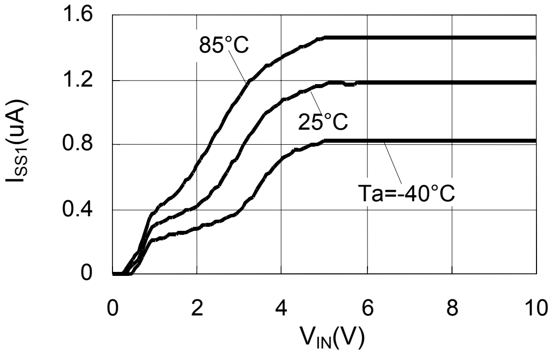
S-817A20A/S-817B20A



S-817A30A/S-817B30A

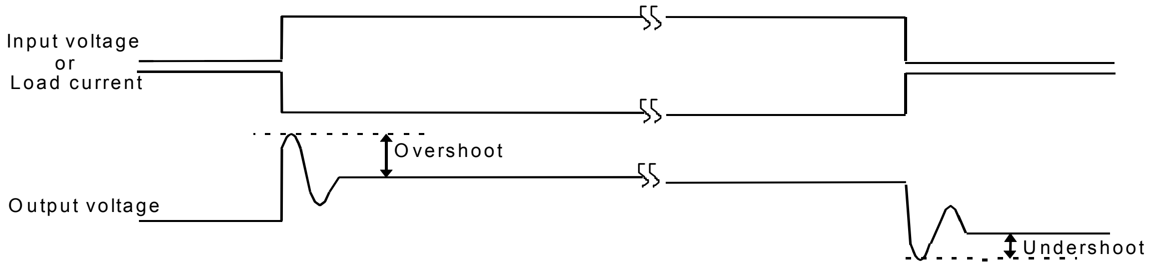


S-817A50A/S-817B50A

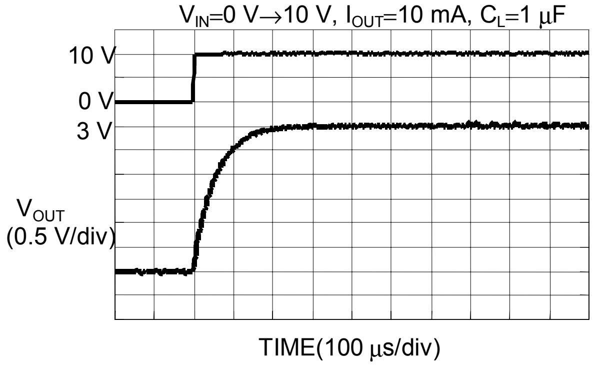


REFERENCE DATA

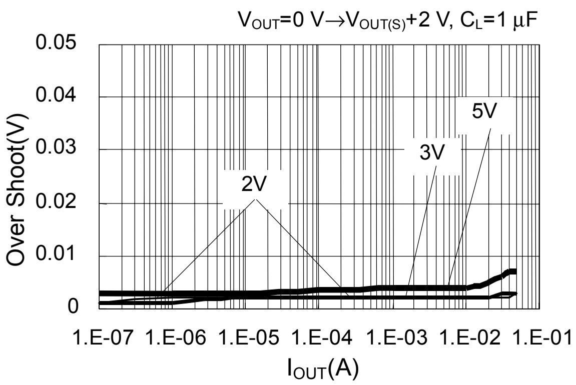
■ Transient Response Charcteristics (Typical data:Ta=25 °C)



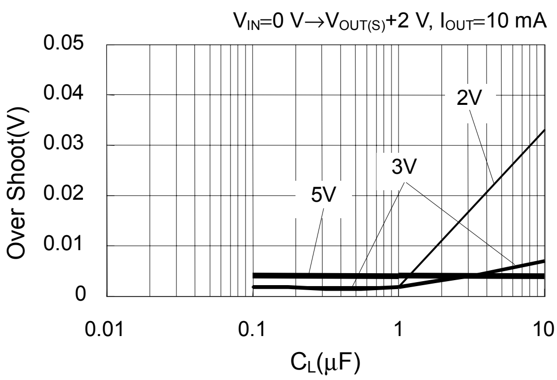
(1) At powering on S-817A30A (when using a ceramic capacitor, C_L=1 μF)



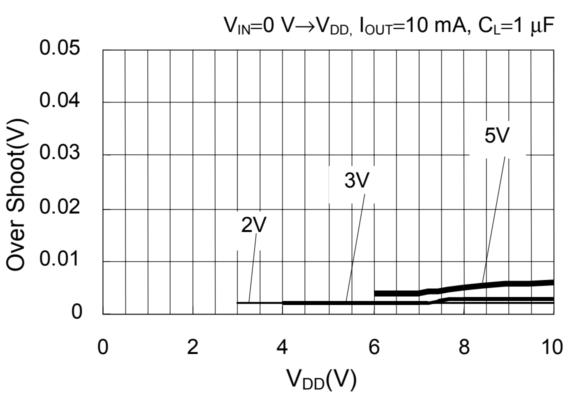
Load dependencies of overshoot at powering on



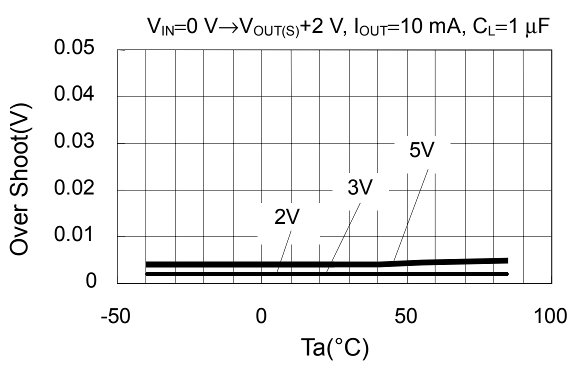
C_L dependencies of overshoot at powering on



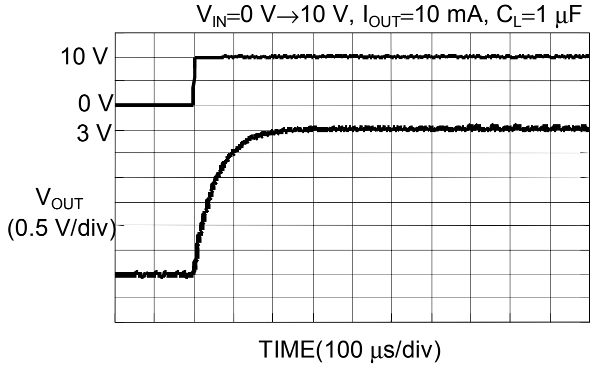
V_{DD} dependencies of overshoot at powering on



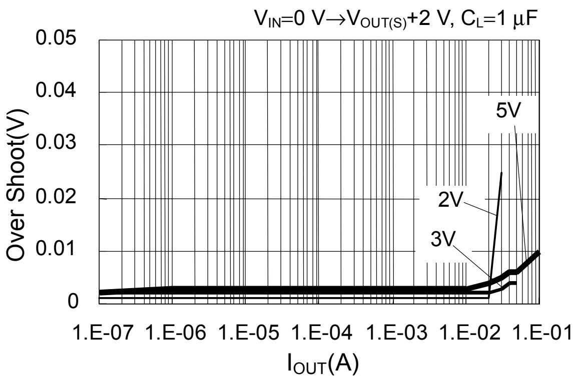
"Ta" dependencies of overshoot at powering on



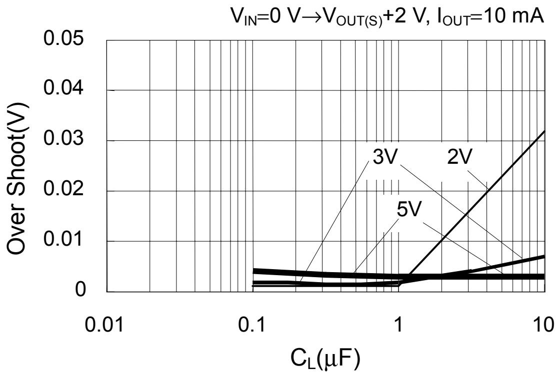
(2) At powering on S-817B30A (when using a ceramic capacitor, C_L=1 μF)



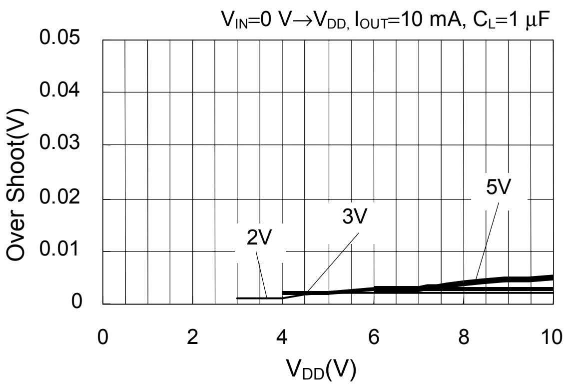
Load dependencies of overshoot at powering on



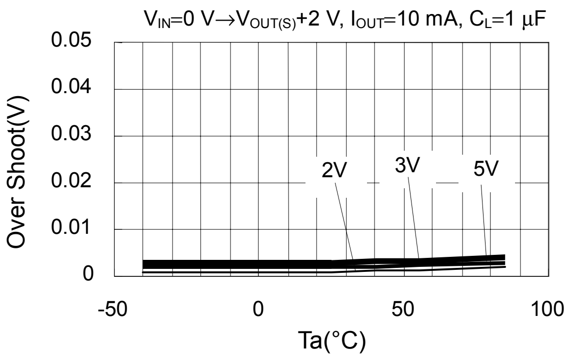
C_L dependencies of overshoot at powering on



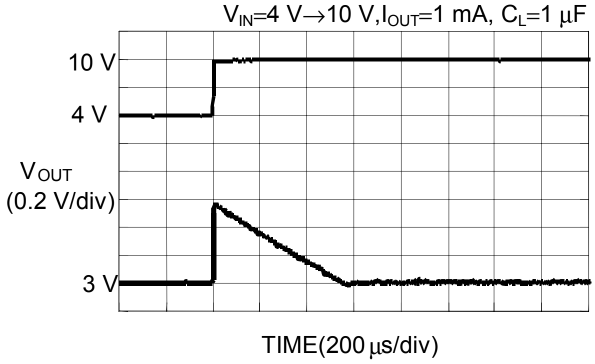
V_{DD} dependencies of overshoot at powering on



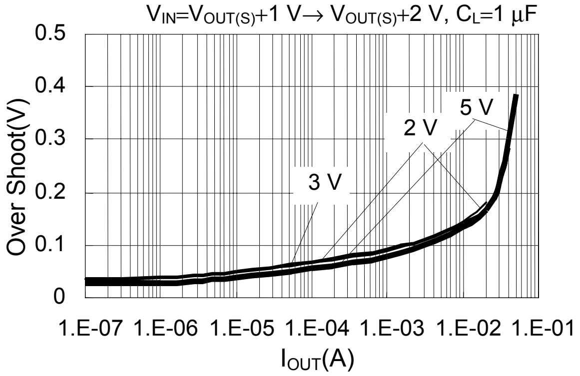
"Ta" dependencies of overshoot at powering on



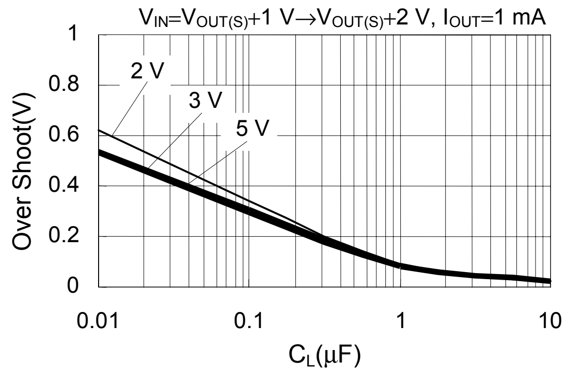
(3) Power fluctuation S-817A30A (when using a ceramic capacitor, C_L=1 μF)



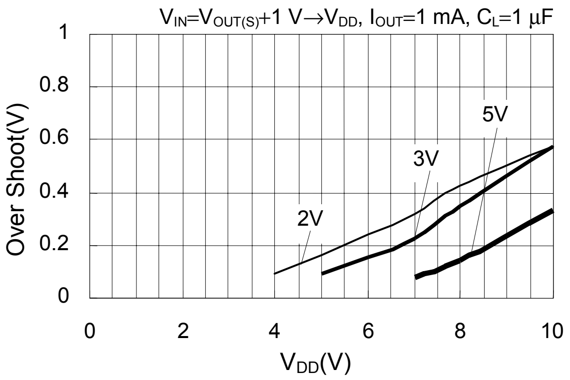
Load dependencies of overshoot at power fluctuation



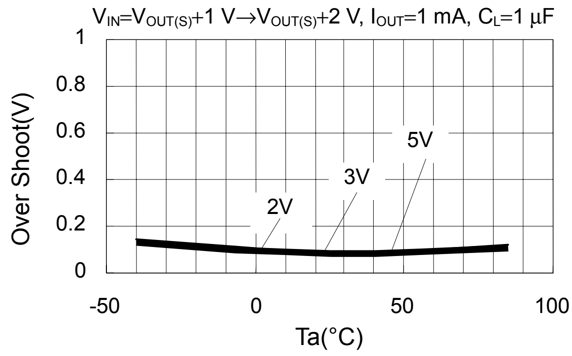
C_L dependencies of overshoot at power fluctuation

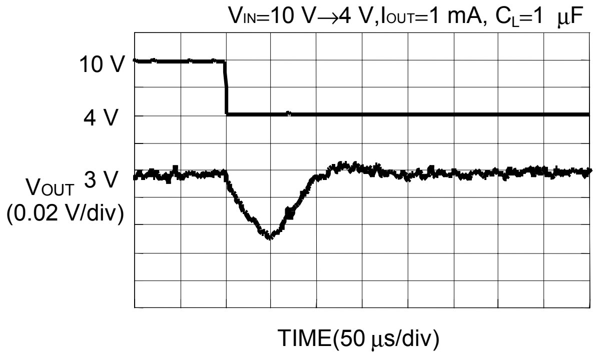


V_{DD} dependencies of overshoot at power fluctuation

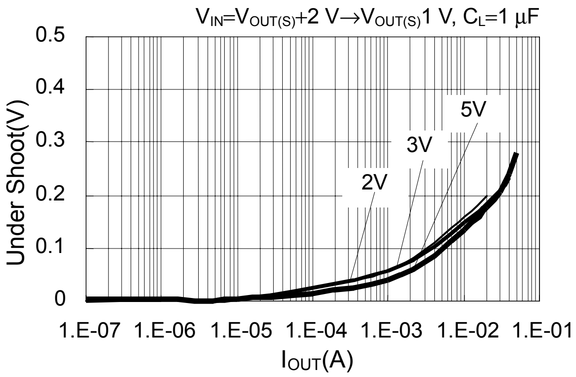


"Ta" dependencies of overshoot at power fluctuation

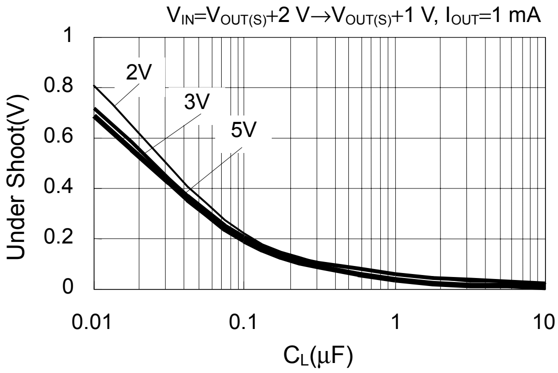




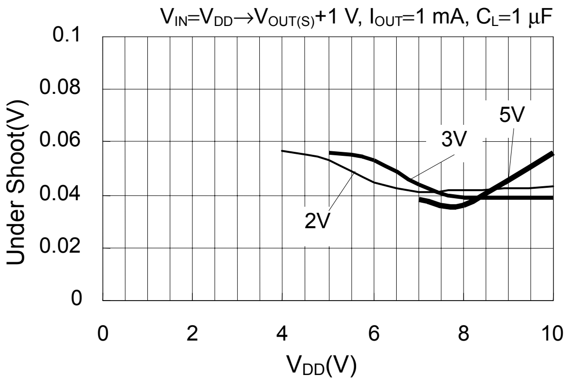
Load dependencies of undershoot at power fluctuation



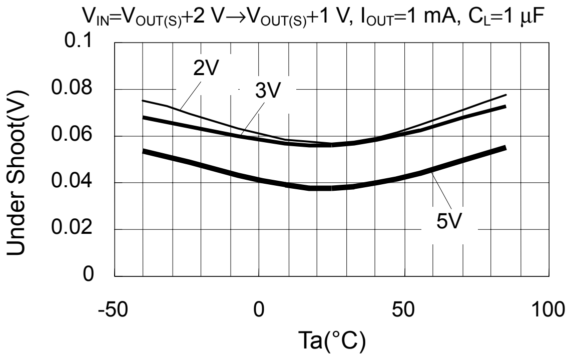
C_L dependencies of undershoot at power fluctuation



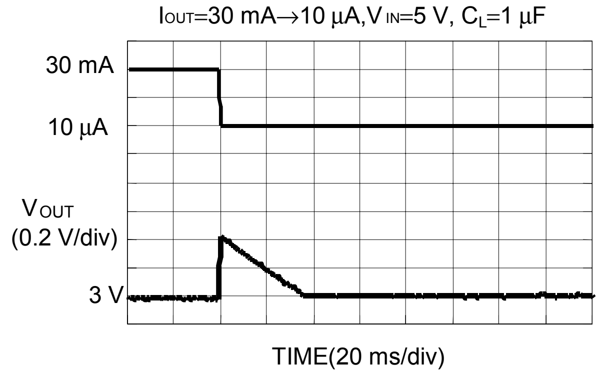
V_{DD} dependencies of undershoot at power fluctuation



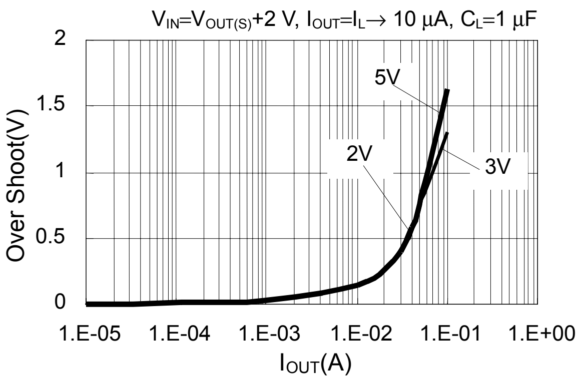
"Ta" dependencies of undershoot at power fluctuation



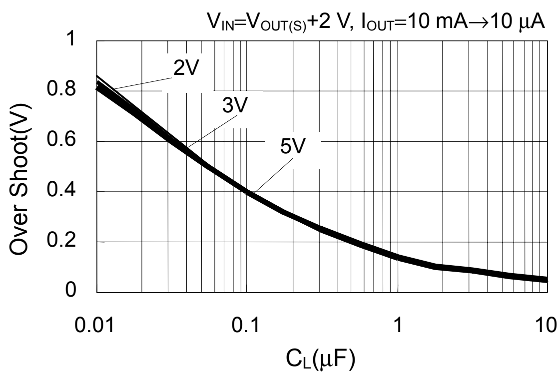
(4) Load fluctuation S-817A30A/S-817B30A (when using a ceramic capacitor, C_L=1 μF)



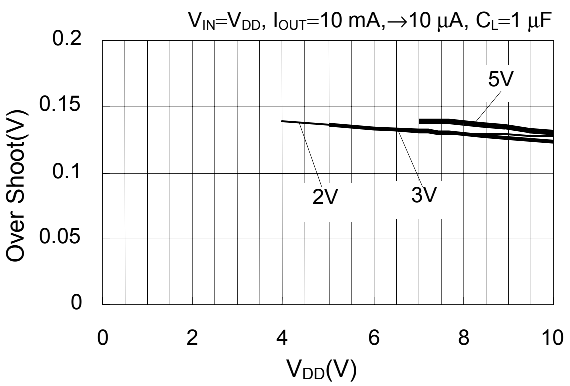
Load current dependencies of overshoot at load fluctuation



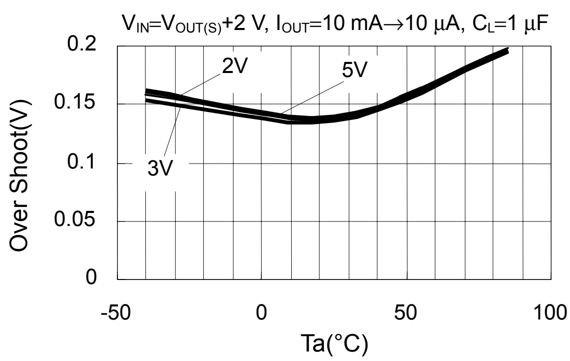
C_L dependencies of overshoot at load fluctuation

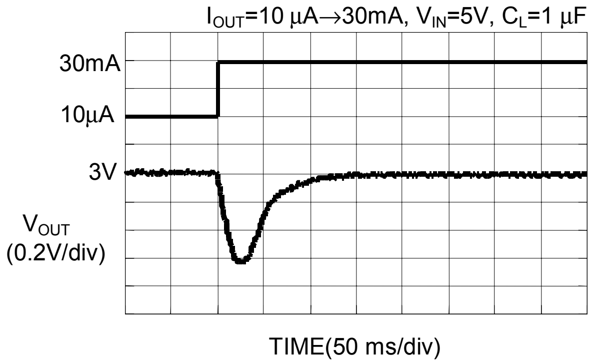


V_{DD} dependencies of overshoot at load fluctuation

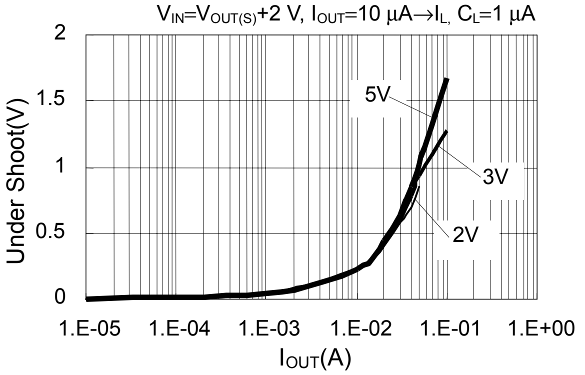


"Ta" dependencies of overshoot at load fluctuation

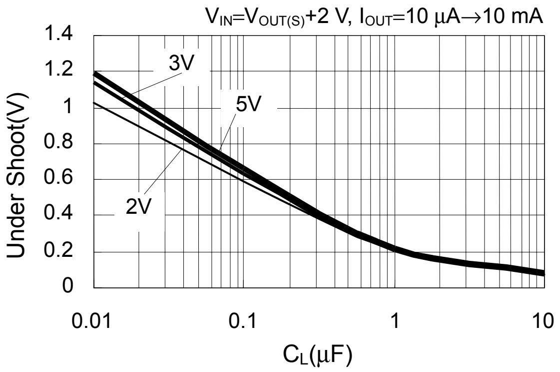




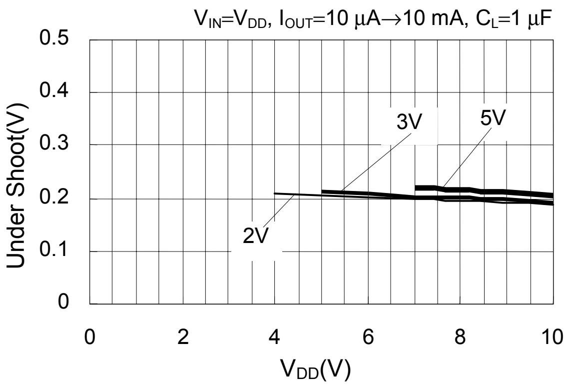
Load current dependencies of undershoot at load fluctuation



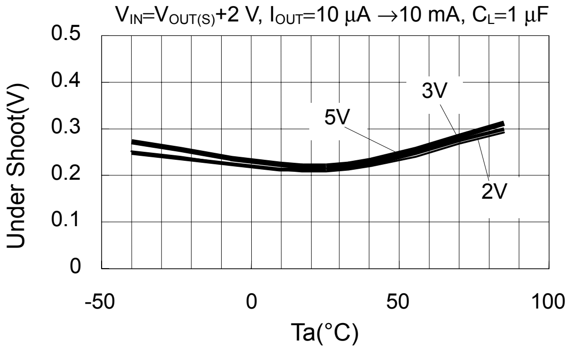
C_L dependencies of undershoot at load fluctuation

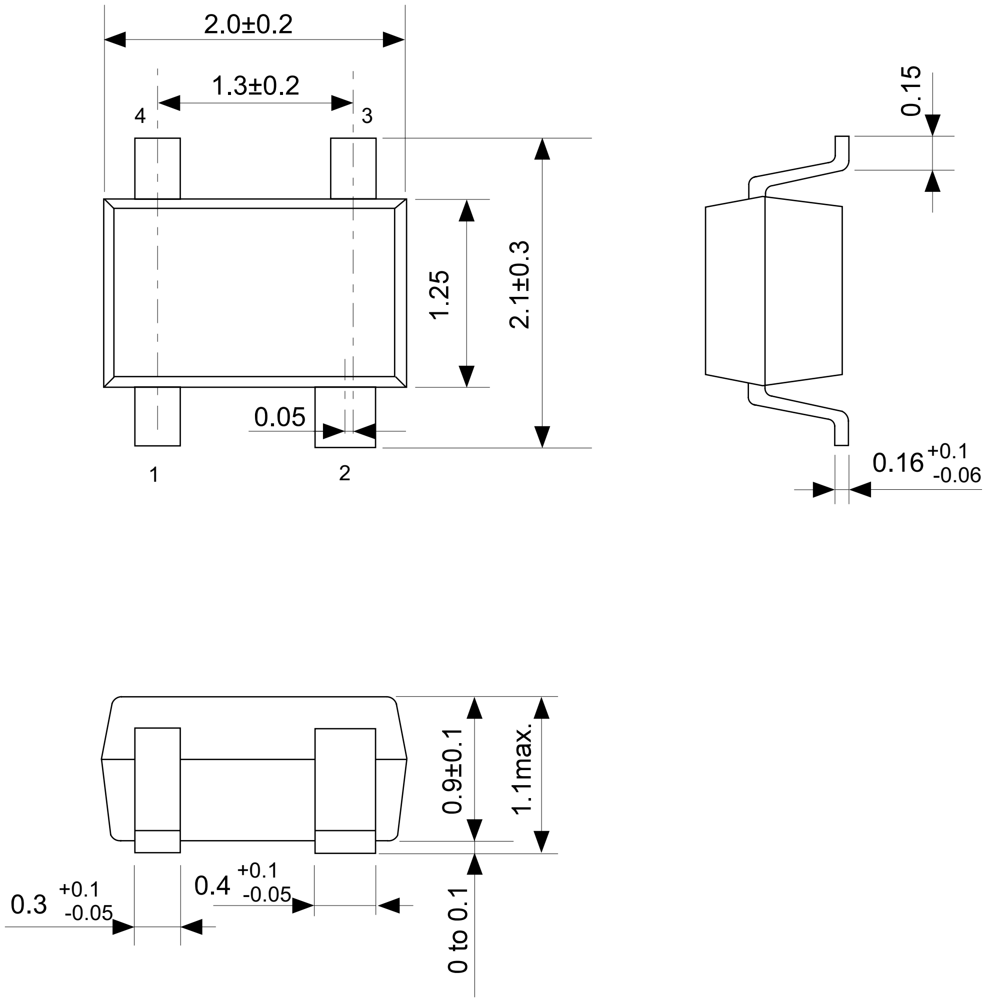


V_{DD} dependencies of undershoot at load fluctuation



"Ta" dependencies of undershoot at load fluctuation

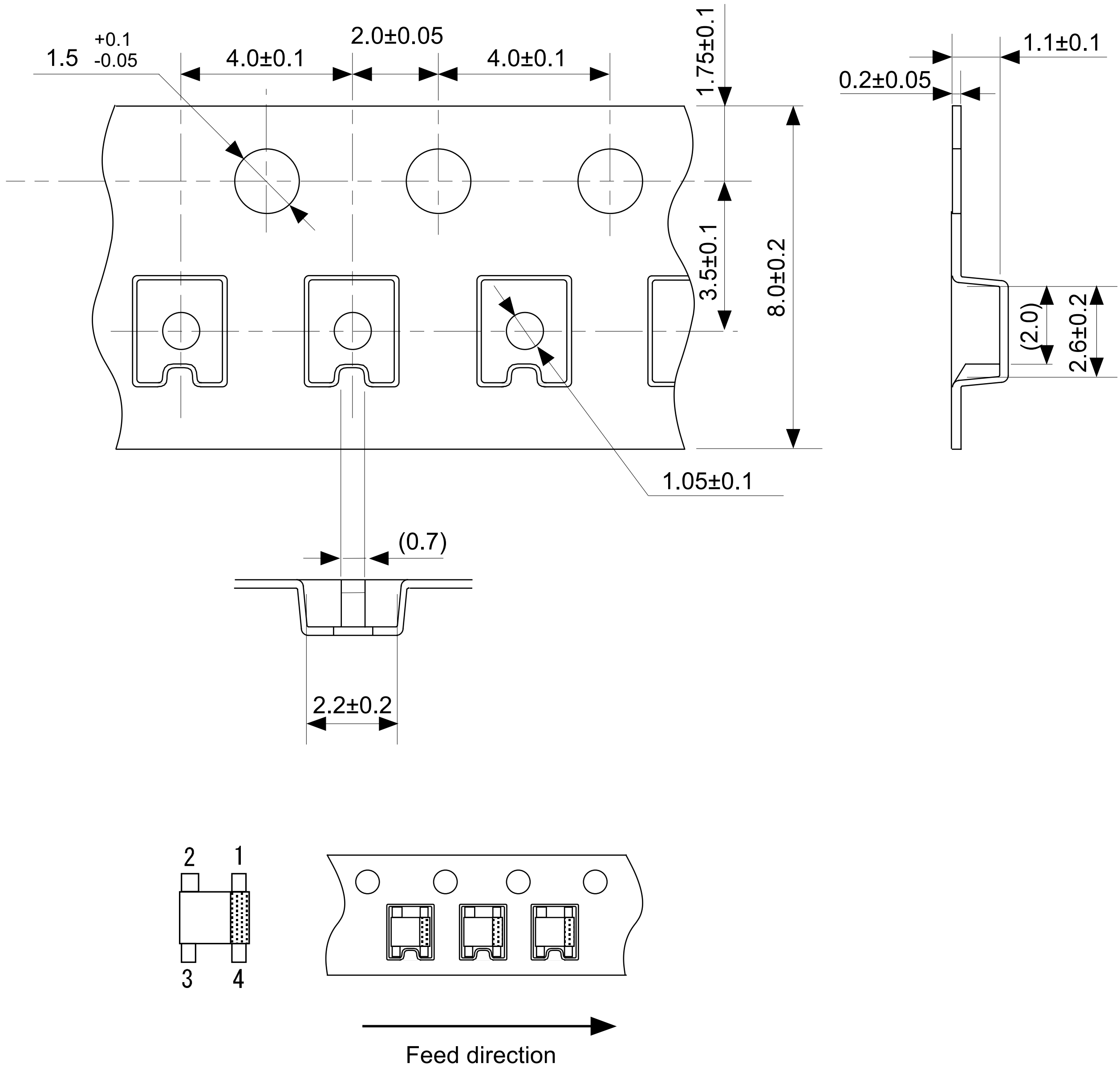




No. NP004-A-P-SD-1.1

TITLE	SC82AB-A-PKG Dimensions
No.	NP004-A-P-SD-1.1
SCALE	
UNIT	mm

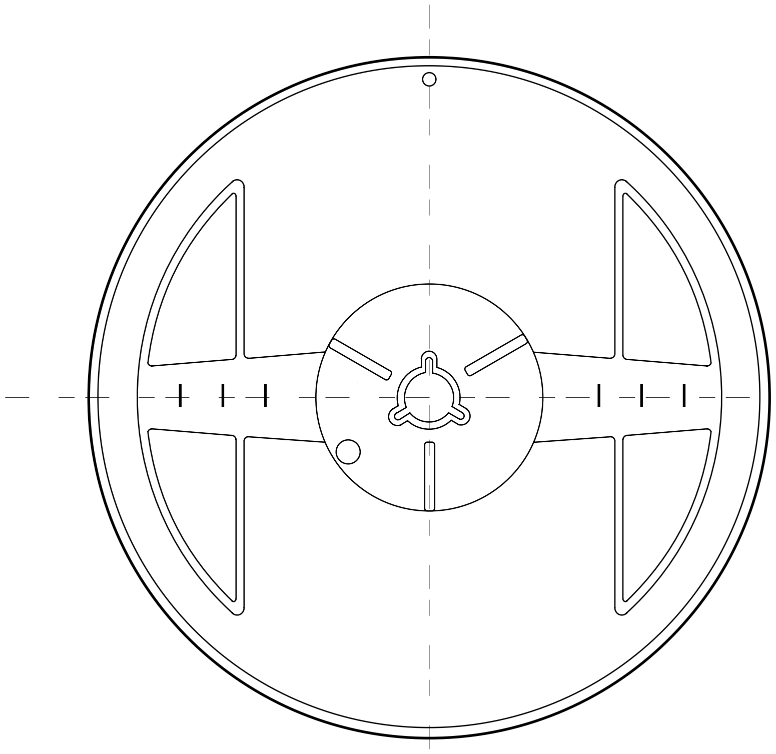
Seiko Instruments Inc.

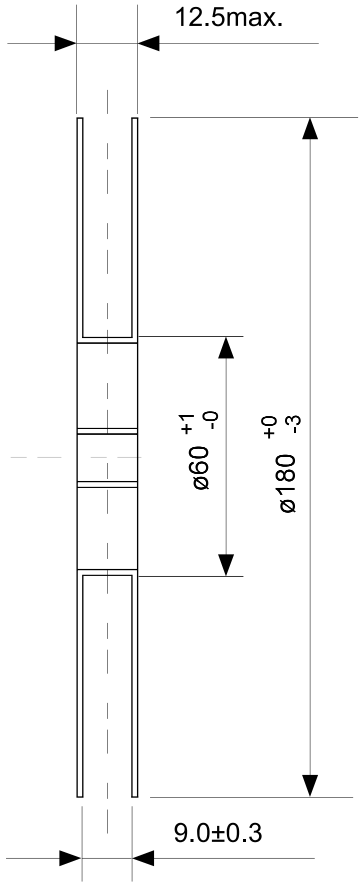


No. NP004-A-C-SD-2.1

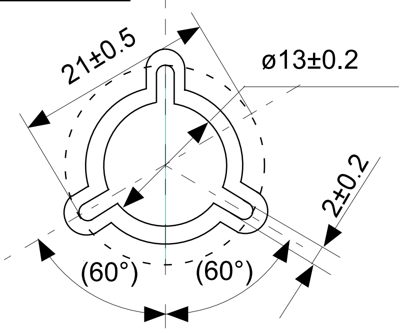
TITLE	SC82AB-A-Carrier Tape
No.	NP004-A-C-SD-2.1
SCALE	
UNIT	mm

Seiko Instruments Inc.





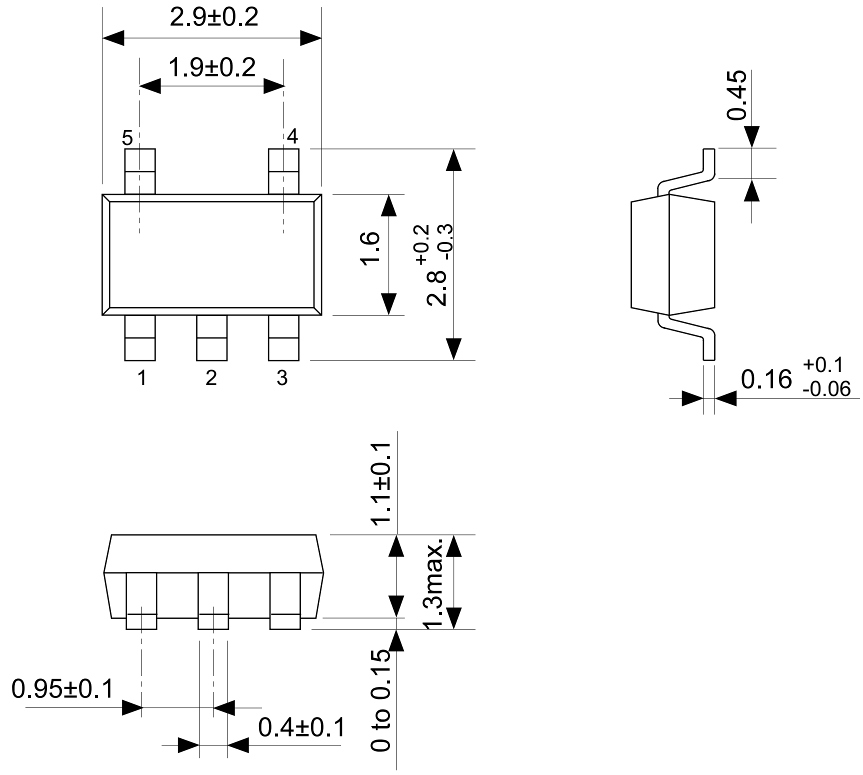
Enlarged drawing in the central part



No. NP004-A-R-SD-1.1

TITLE	SC82AB-A-Reel		
No.	NP004-A-R-SD-1.1		
SCALE		QTY.	3,000
UNIT	mm		

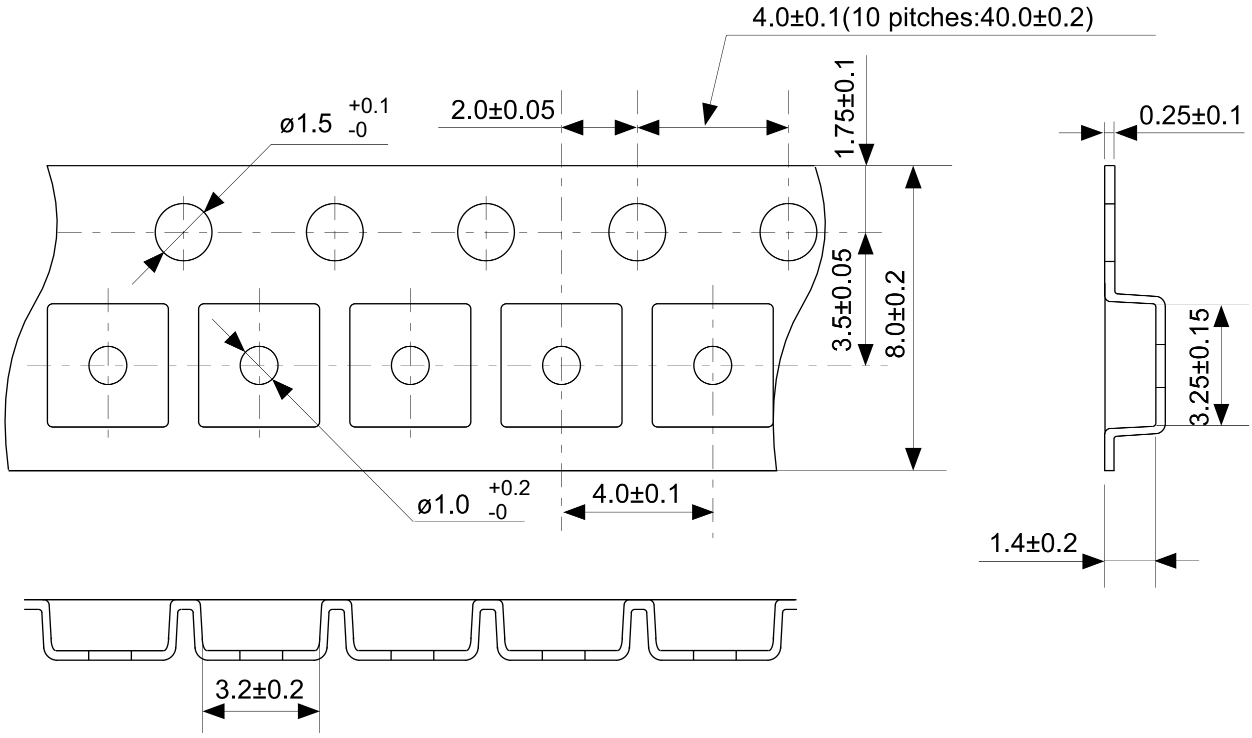
Seiko Instruments Inc.

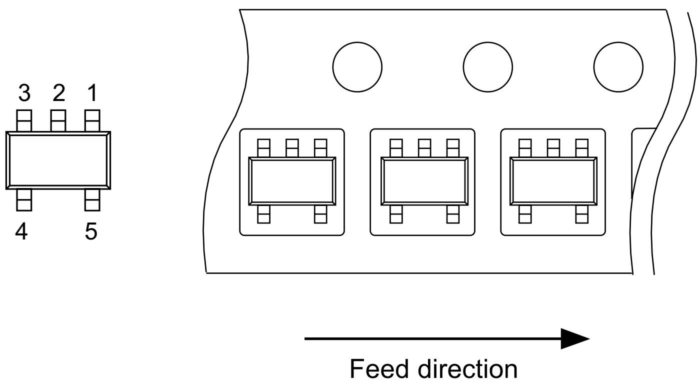


No. MP005-A-P-SD-1.2

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

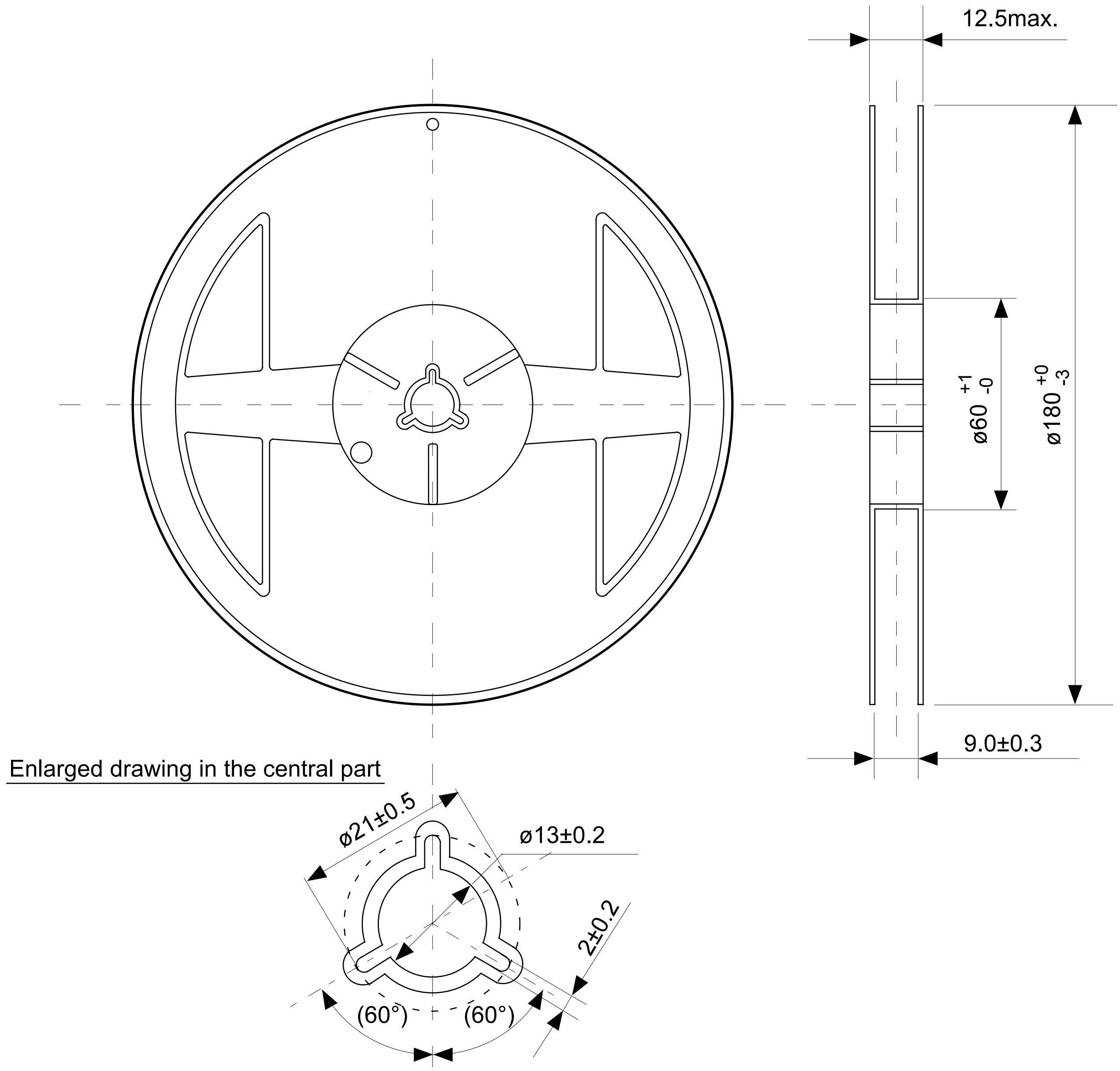
Seiko Instruments Inc.





No. MP005-A-C-SD-2.1

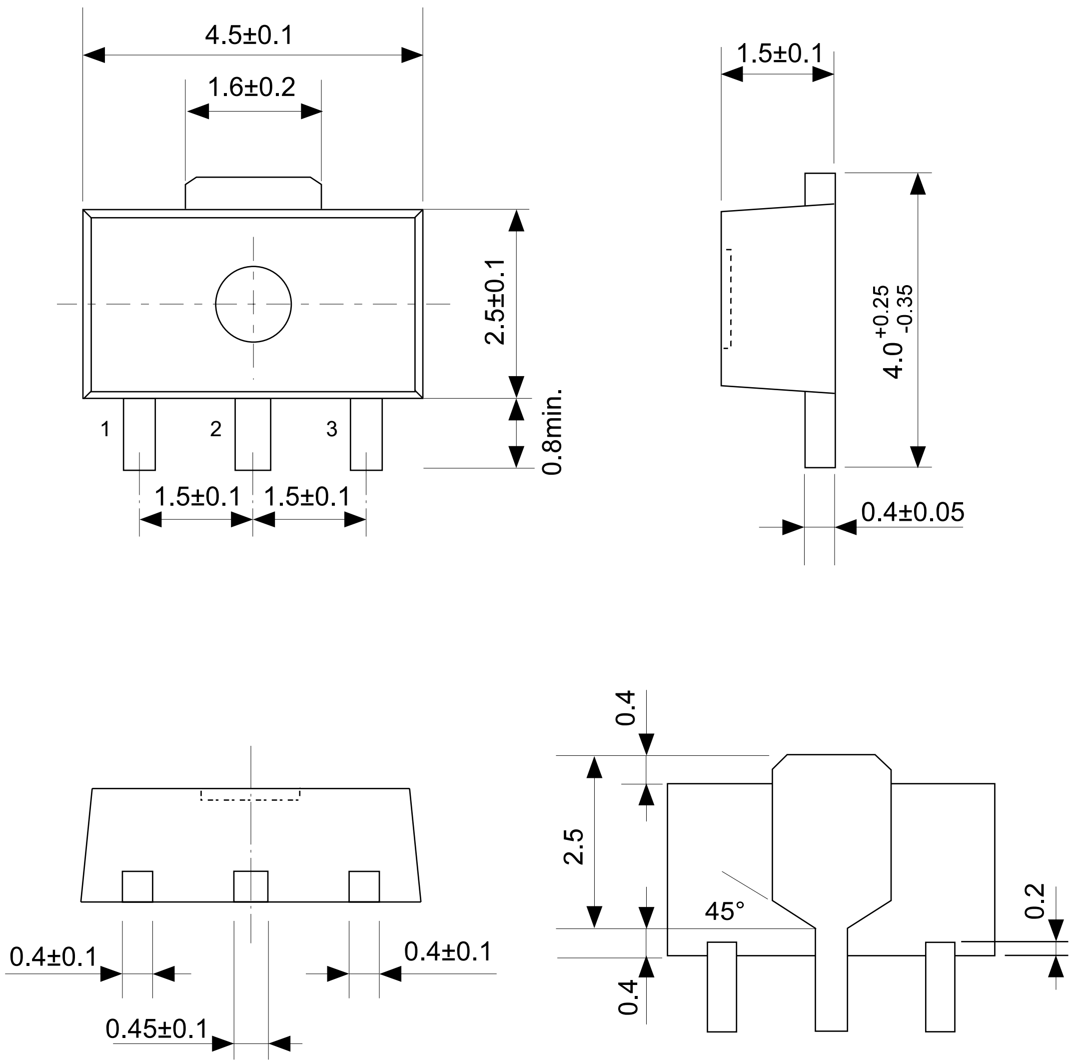
TITLE	SOT235-A-Carrier Tape
No.	MP005-A-C-SD-2.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	



No. MP005-A-R-SD-1.1

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

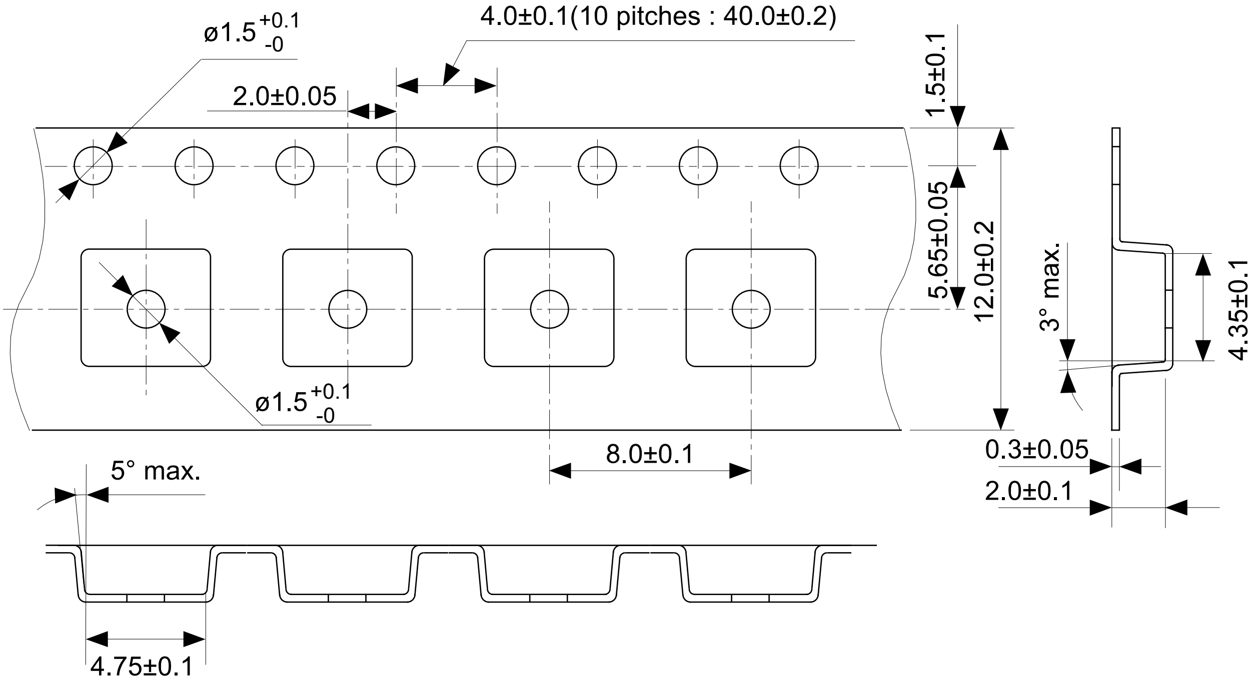
Seiko Instruments Inc.

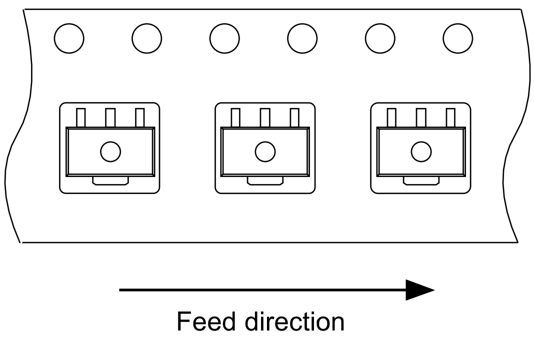


No. UP003-A-P-SD-1.1

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

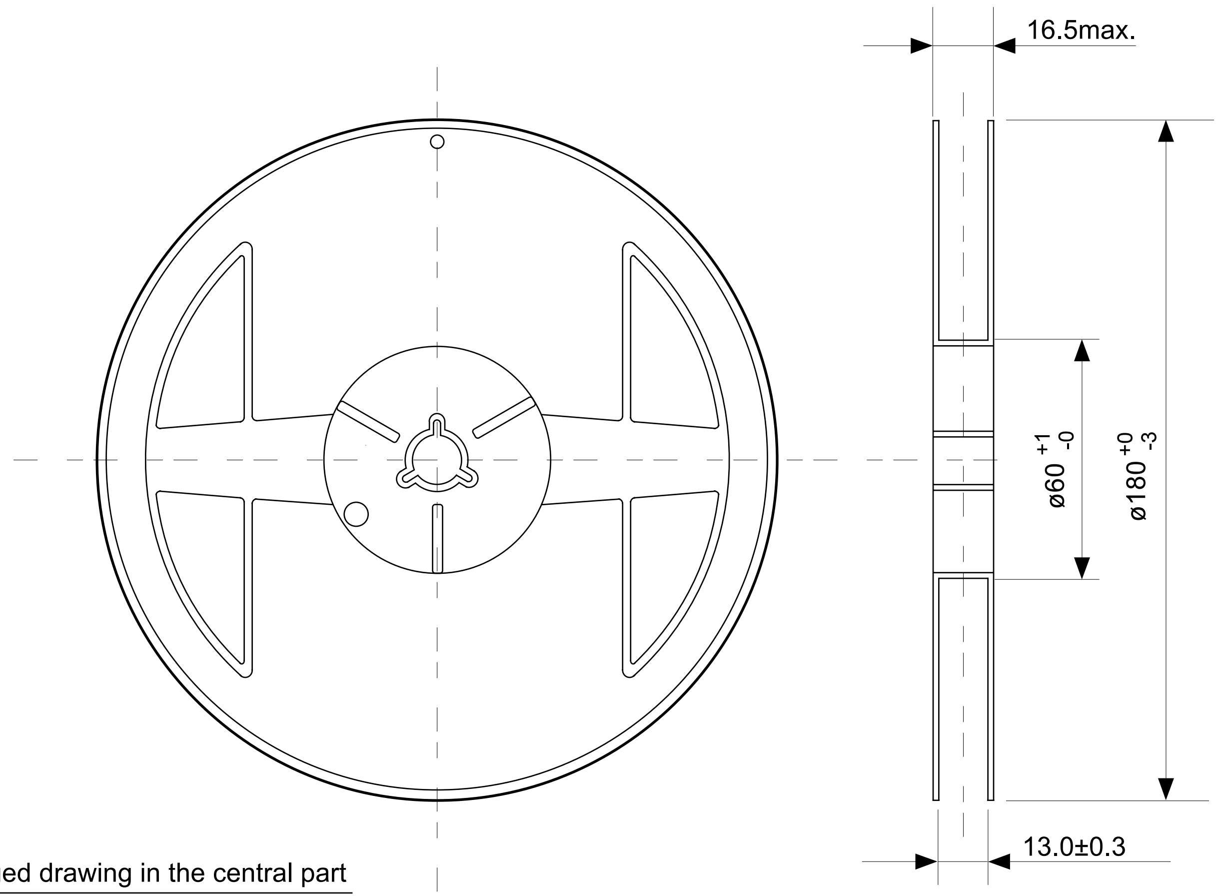
Seiko Instruments Inc.



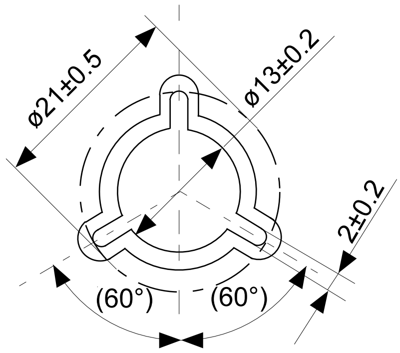


No. UP003-A-C-SD-1.1

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

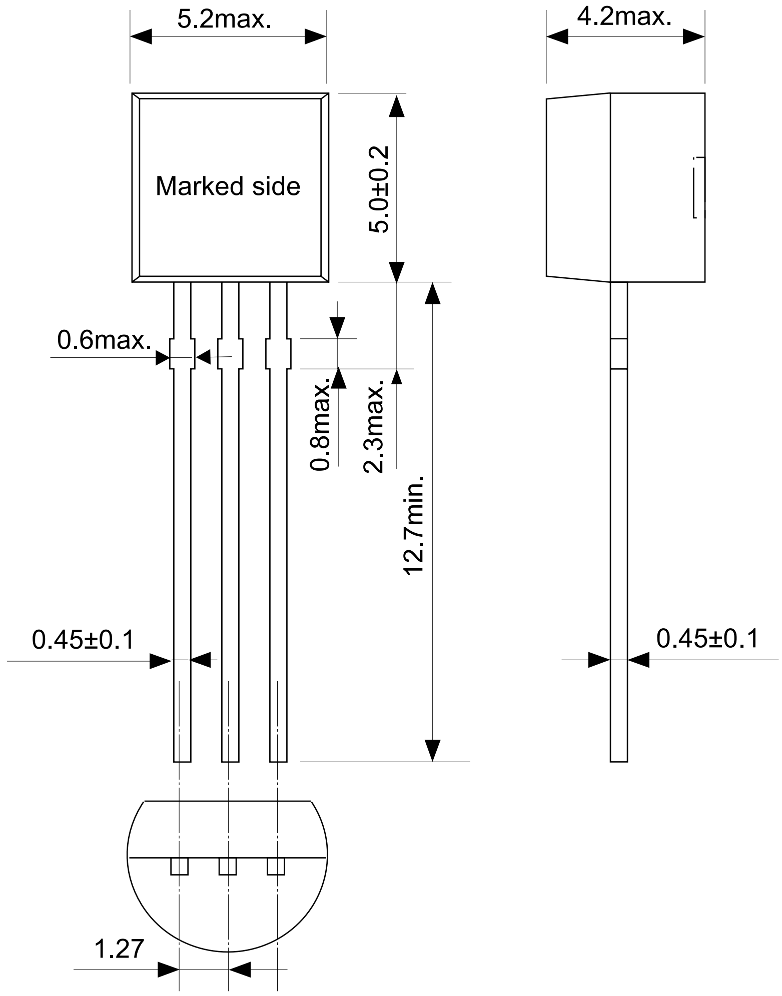


Enlarged drawing in the central part



No. UP003-A-R-SD-1.1

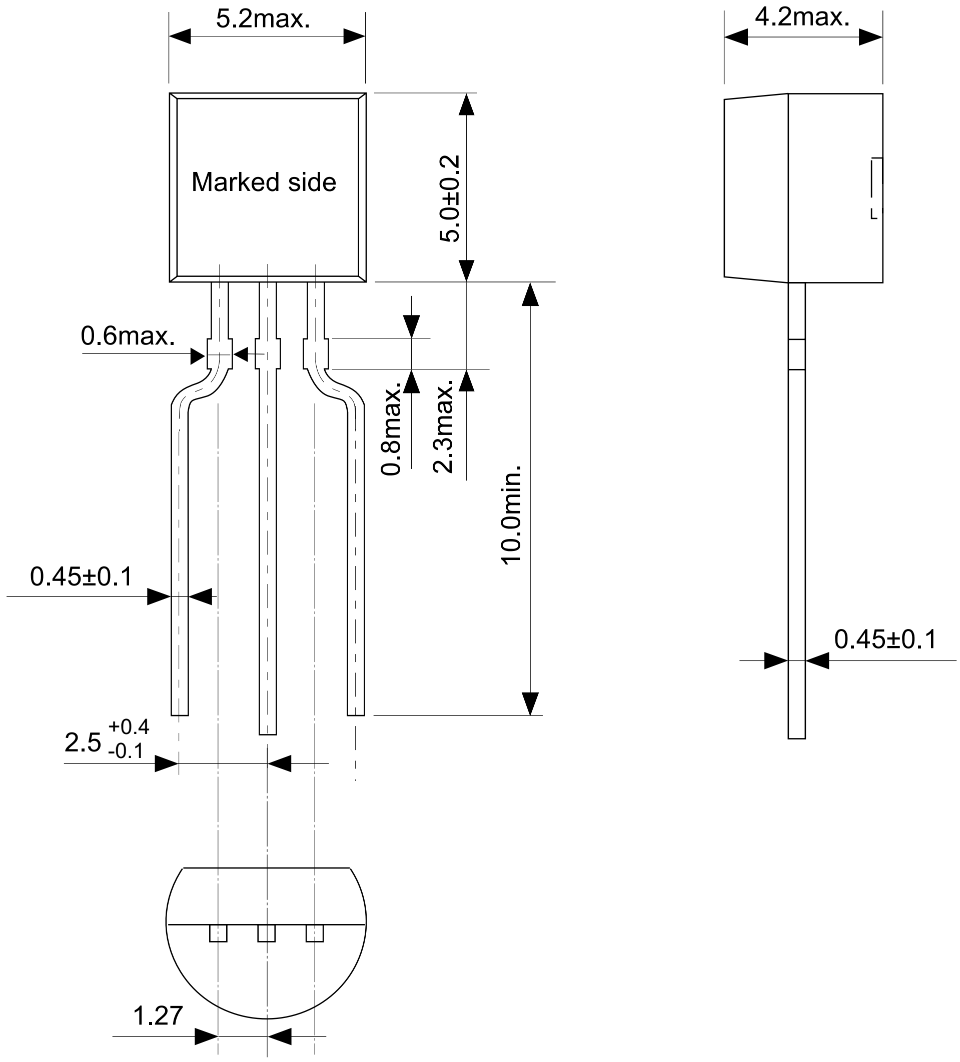
TITLE	SOT893-A-Reel		
No.	UP003-A-R-SD-1.1		
SCALE		QTY.	1,000
UNIT	mm		
Seiko Instruments Inc.			



No. YS003-B-P-SD-1.1

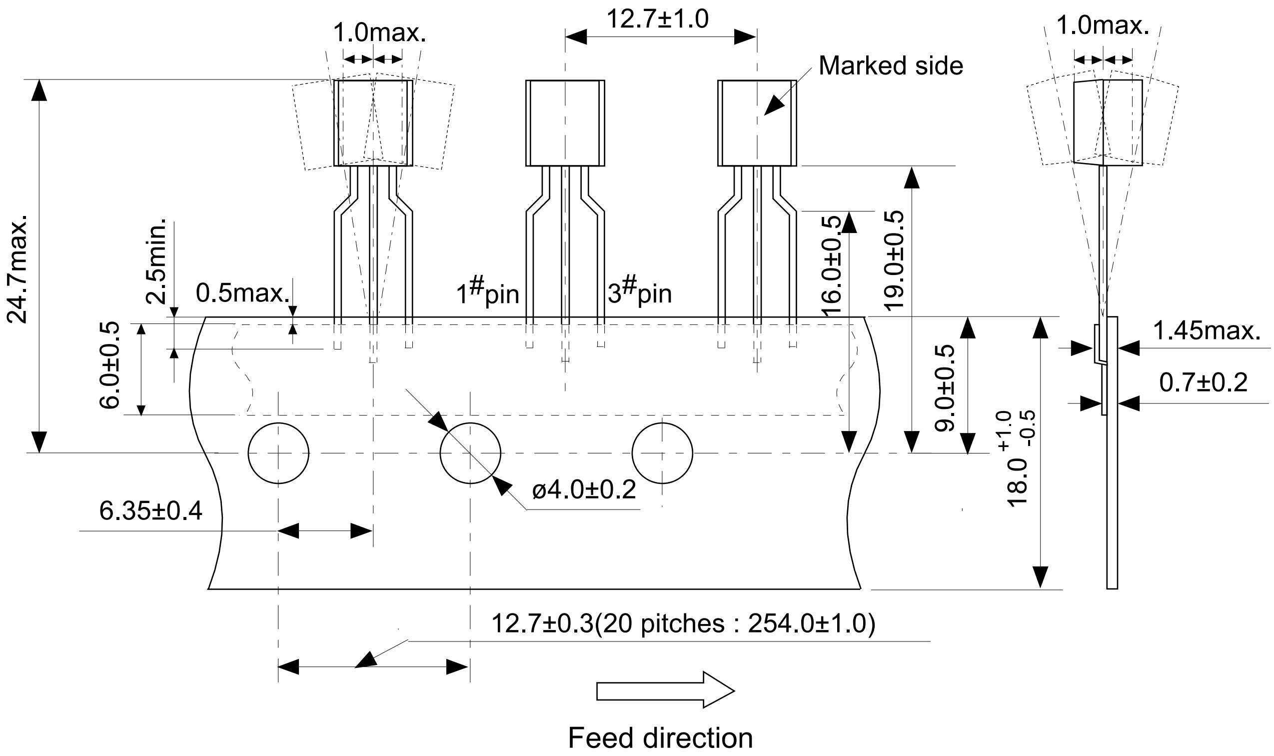
TITLE	TO92-B-PKG Dimensions
No.	YS003-B-P-SD-1.1
SCALE	
UNIT	mm

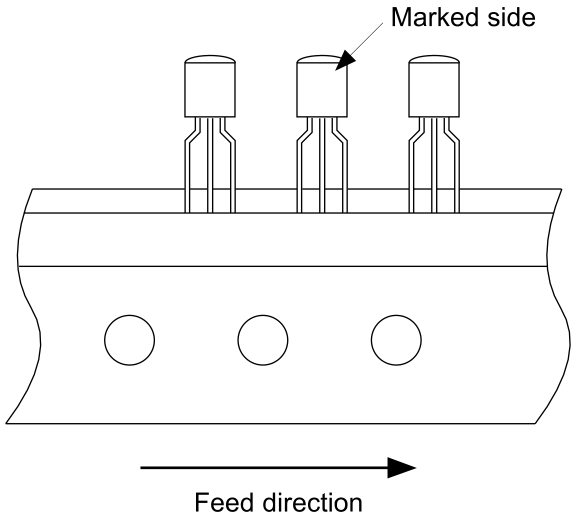
Seiko Instruments Inc.



No. YF003-A-P-SD-1.1

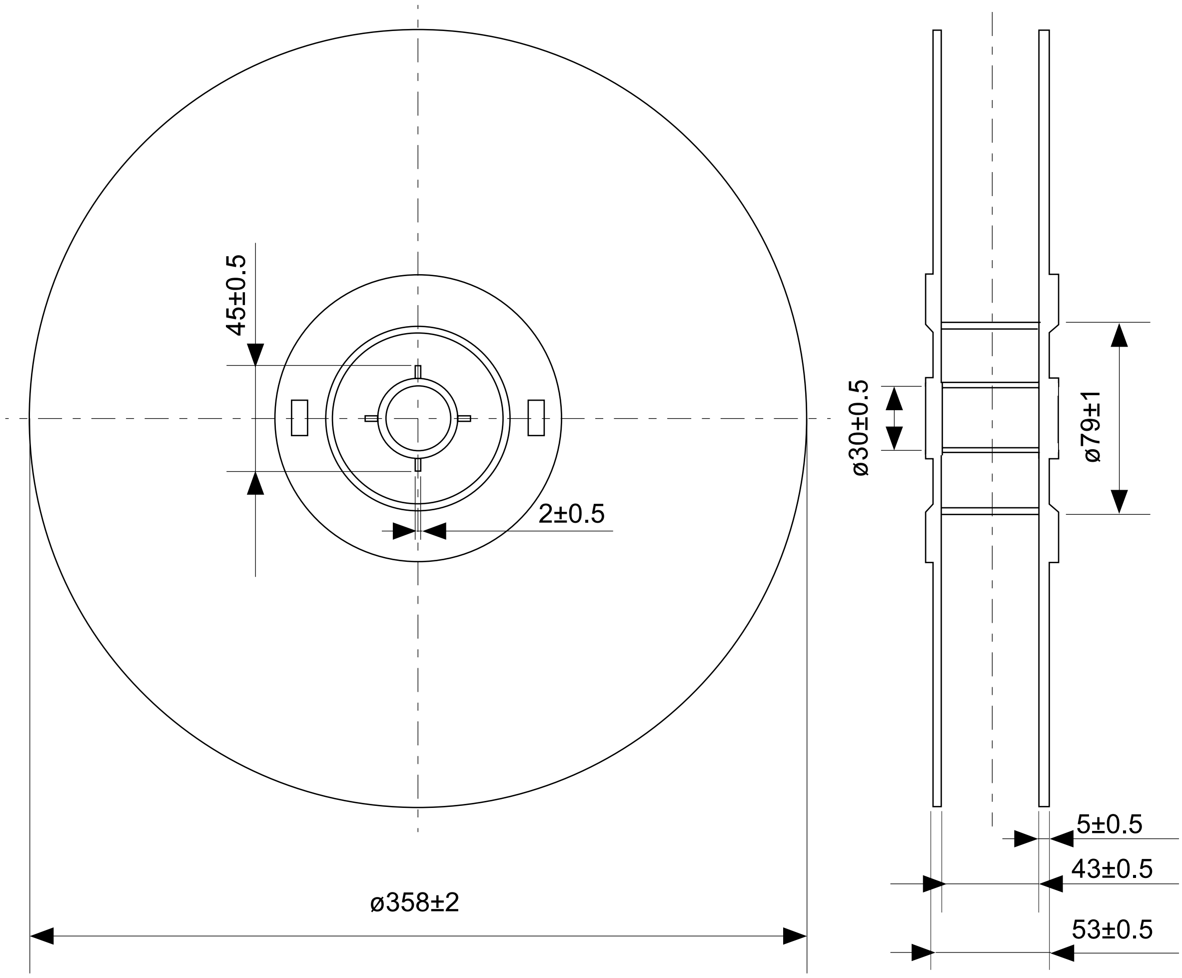
TITLE	TO92-A-PKG Dimensions
No.	YF003-A-P-SD-1.1
SCALE	
UNIT	mm
Seiko Instruments Inc.	





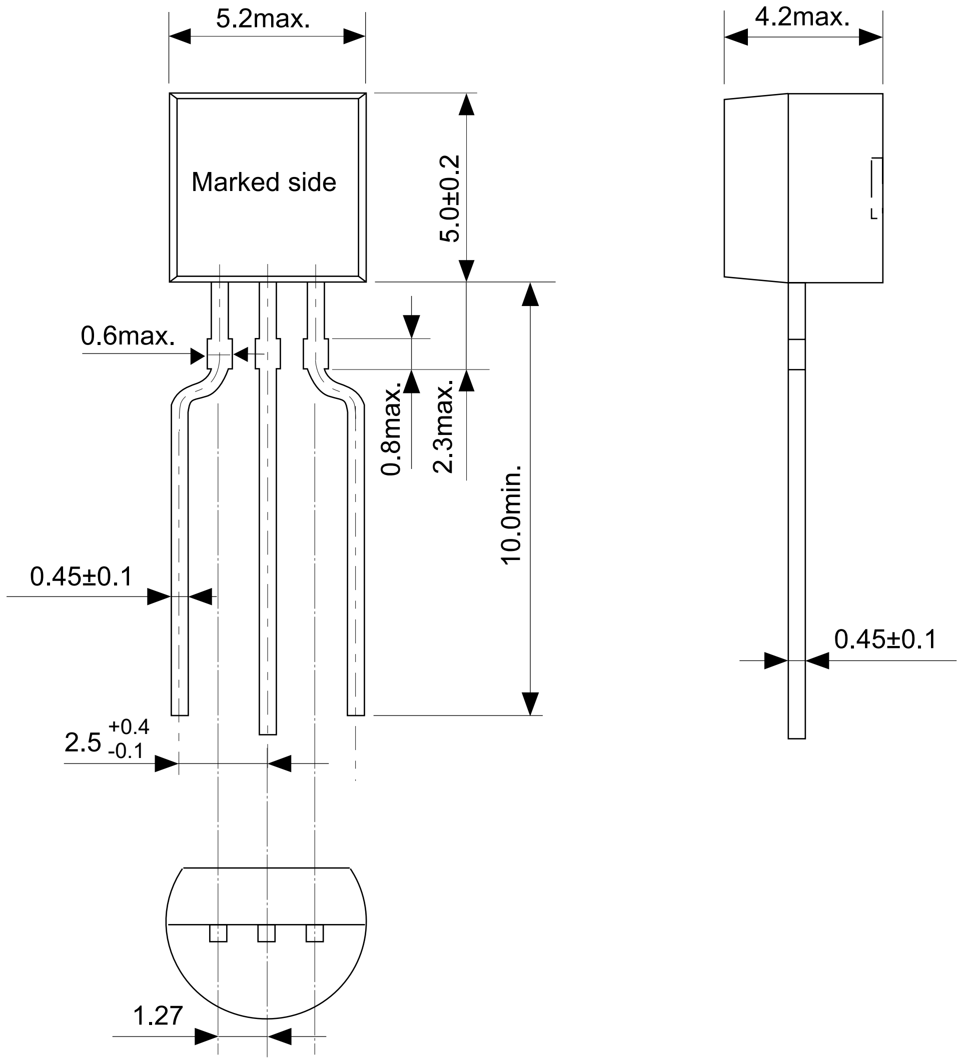
No. YF003-A-C-SD-4.1

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

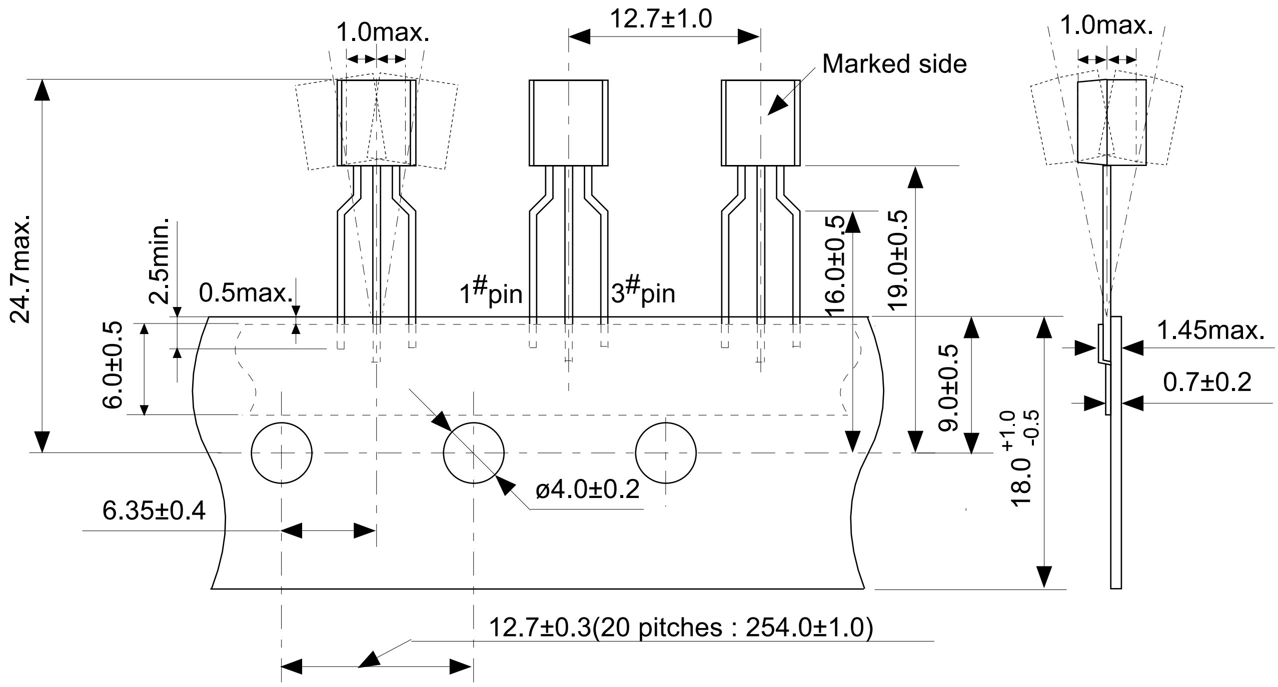
TITLE	TO92-A-Reel		
No.	YF003-A-R-SD-2.1		
SCALE		QTY.	2,000
UNIT	mm		
Seiko Instruments Inc.			

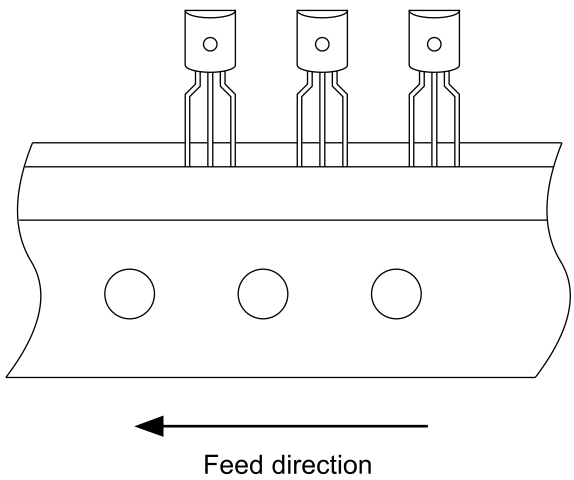


No. YF003-A-P-SD-1.1

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

Seiko Instruments Inc.

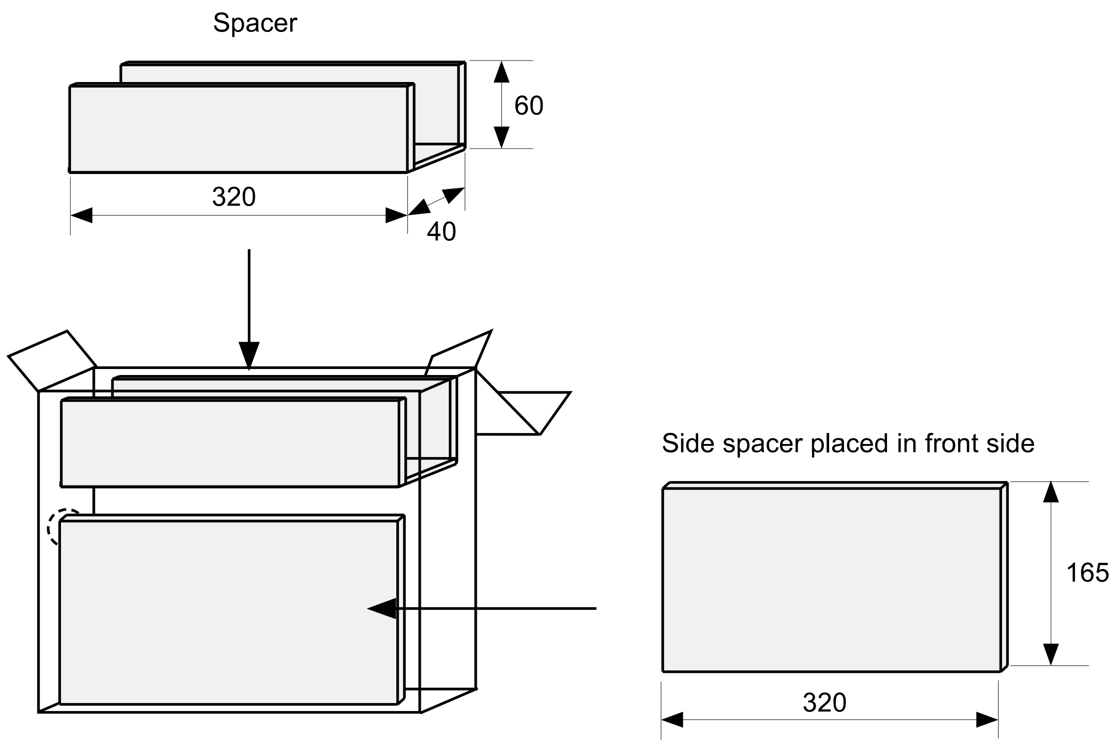


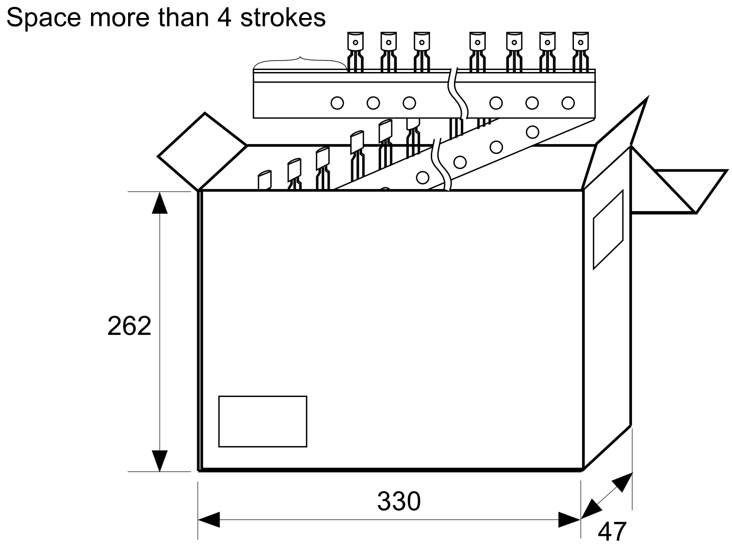


No. YZ003-C-C-SD-3.1

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

Seiko Instruments Inc.





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.