300mA Linear Regulator with Enable and Fast Discharge Function

Features

- **AP6203B With Fast Discharge Function**
- **Operating Voltage Range：+2.2V to +7.0V**
- **Output Voltages：+1.2V to +5.0V with 100mV**
- **Maximum Output Current：300 mA**
- **Dropout Voltage：120mV @ 100mA**
- **Low Current Consumption 15μA (Typ.)**
- **Shutdown Current：0.1μA (Typ.)**
- **±2% Output Voltage Accuracy (special ±1% highly accurate)**
- **Low ESR Capacitor Compatible**
- **High Ripple Rejection：70 dB**
- **Output Current Limit Protection (450mA)**
- **Short Circuit Protection (150mA)**
- **Thermal Overload Shutdown Protection**
- **Control Output ON/OFF Function**
- **SOT-23-5 and UFN-6 Packages**
- **RoHS Compliant and 100% Lead (Pb)-Free**

General Description

The AP6203B is a 4-Low (Low-dropout, Low -quiescent Current, Low-noise, Low-cost) linear regulator with ON/OFF control and AP6203B can discharge output capacitor charge fast. The device operates in the input voltage range from +2.2V to +7.0V and delivers 300mA output current.

The high-accuracy output voltage is preset at an internally trimmed voltage 1.2V, 1.5V, 1.8V, 2.5V, 2.8V, 3.0V or 3.3V. Other output voltages can be mask-optioned from 1.2V to 5.0V with 100mV increment, except the AP6203B-LL which has 2.85V output voltage.

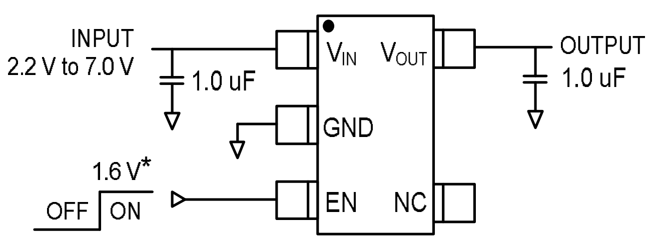
The AP6203B consists of a 1.0V reference compare amplifier, a P-channel pass transistor, and an enable/disable logic circuit. Other features include soft start function, short-circuit protection, and thermal shutdown protection.

The AP6203B is also compatible with low ESR ceramic capacitors which give added output stability. This stability can be maintained even during load fluctuations due to the excellent transient response of the chip. The AP6203B devices are available in SOT-23-5 and UFN-6 packages.

Applications

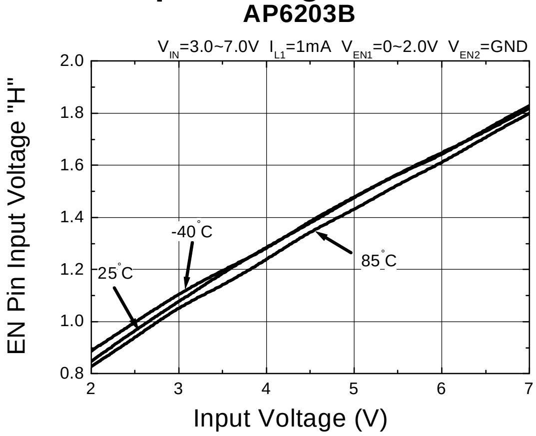
- Battery-Powered Devices
- Personal Communication Devices
- Mobile Phones, Cordless Phone
- Portable Games
- Cameras, Video Recorders
- Portable AV Equipment

Simplified Application Circuit

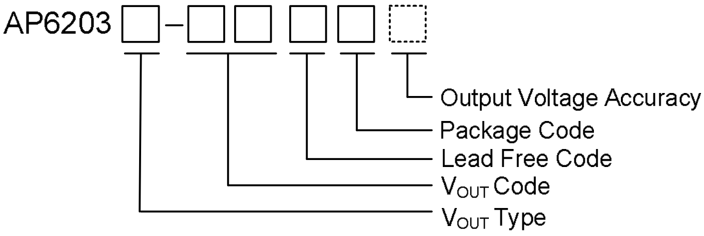


Note：* $V_{IN} \leqq 5V$

EN Pin Input Voltage



Ordering Information



Vout Type：

B：With Enable and Fast Discharge Function

Vout Code：

Exam. 18=1.8V、**25=**2.5V、**33=**3.3V

Lead Free Code：

P：Commercial Standard, Lead (Pb) Free And Phosphorous (P) Free Package

Package Code：

A：SOT-23-5　　**U**：UFN-6

Output Voltage Accuracy：

1：±1%

Absolute Maximum Ratings

Parameter		Symbol	Ratings	Units
Input Voltage V_{IN} to GND		V_{IN}	7.0	V
Output Current Limit, I_{LIMIT}		I_{OUT}	0.5	A
Junction Temperature		T_J	+155	°C
Thermal Resistance	SOT-23-5	θ_{JA}	250	°C/W
Power Dissipation	SOT-23-5	P_D	400	mW
	UFN-6		500	
Operating Ambient Temperature		T_{OPR}	-40 ~ +125	°C
Storage Temperature		T_{STG}	-55 ~ +150	°C
Lead Temperature (soldering, 10sec)			+260	°C

Note：

* The power dissipation values are based on the condition that junction temperature T_J and ambient temperature T_A difference is 100°C.

* Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum -rated conditions for extended periods may affect device reliability.

* The power dissipation of UFN-6 would be 500 mW normally with the 05.X0.5 square inches cooper area connected to the bottom pad. However, it could be up to 1000mW with larger cooper area.

Electrical Characteristics

(V_{IN}=5V, T_A=25℃, unless otherwise noted.)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage		2.2		7.0	V
V_{OUT}	Output Voltage	$V_{IN} = V_{OUT}$+0.8V	-1% -2%	V_{OUT}	+1% +2%	V
I_{MAX}	Output Current (see note *1)	$V_{OUT}+0.8V \leqq V_{IN} \leqq 7.0V$, $2.2V \leqq V_{IN}$	300			mA
V_{DROP}	Dropout Voltage	I_{OUT}=300mA, $2.8V \leqq V_{IN}$, $25°C \leqq T_A \leqq 80°C$		550	650	mV
		I_{OUT}=180mA, $2.8V \leqq V_{IN}$		240	280	mV
		I_{OUT}=150mA, $2.8V \leqq V_{IN}$		160	180	mV
ΔV_{LINE}	Line Regulation	$V_{OUT}+0.5V \leqq V_{IN} \leqq 7V$, I_{OUT}=1mA		0.2	0.3	%/V
		$V_{OUT}+0.15V \leqq V_{IN} \leqq 5V$, I_{OUT}=1mA, $V_{IN} \geqq 2.8V$			0.2	%/V
ΔV_{LOAD}	Load Regulation	$V_{IN}=V_{OUT}$+1V, $1mA \leqq I_{OUT} \leqq 100mA$		0.01	0.02	%/mA
I_Q	Ground Pin Current	V_{IN}=5V, EN=5V, No Load		15	30	µA
		V_{IN}=5V, EN=5V, I_{OUT}=150mA		30	60	µA
I_{SD}	Shutdown Current	$V_{IN}=V_{OUT}$+1V, EN=0V, No Load		0.1	1.0	µA
V_{IH}	EN Pin Input Voltage "H"	$V_{IN} \leqq 5V$ (see note *2 & 3)	1.6			V
		$5V < V_{IN} \leqq 7V$ (see note *2 & 3)	1.85			V
V_{IL}	EN Pin Input Voltage "L"	$V_{IN} \leqq 5V$ (see note *2 & 3)			0.25	V
		$5V < V_{IN} \leqq 7V$ (see note *2 & 3)			0.35	V
I_{EN}	EN Pin Leakage Current	V_{IN}=(Vout+0.15) to 5V, $V_{EN} > V_{IH}$		0.1	0.15	µA
I_{SC}	Short Circuit Current			150		mA
PSRR	Ripple Rejection	I_{OUT}=30mA, F=1KHz		70		dB
		I_{OUT}=30mA, F=10KHz		65		dB
e_N	Output Noise	I_{OUT}=100mA , F=1KHz, C_{OUT}=10uF		40		µV(rms)
T_{SD}	Thermal Shutdown Temperature			150		°C
T_{HYS}	Thermal Shutdown Hysteresis			20		°C
R_{DIS}	Discharge Resistor	V_{EN}=0V		30	100	Ω
T_{DIS}	Discharge Time	V_{OUT}=3.3V to 0V, C_{OUT}=1uF		70	100	µs

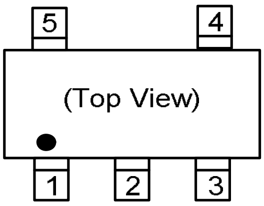
Note：

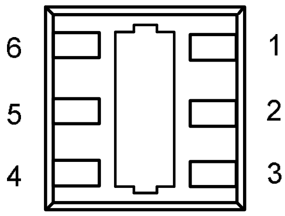
*1) Measured using a double sided board with 1" x 2" square inches of copper area connected to the GND pins for "heat spreading".

*2) EN pin input voltage must be always less than or equal to input voltage.

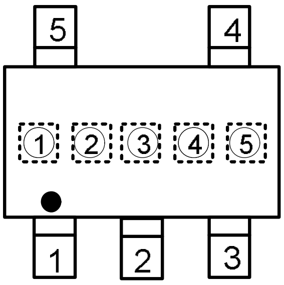
*3) The V_{IH} and V_{IL} voltage change with the V_{IN} supply. Please check P.1 & P.19.

Pin Description

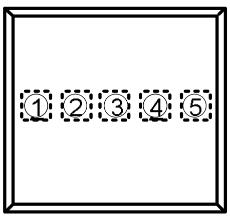
Part NO.	Part NO.	Pin	Symbol	Pin Description
 SOT-23-5	AP6203B-XXXA	1	V_{IN}	Regulator Input Pin.
		2	GND	Ground Pin.
		3	EN	Chip Enable Pin.
		4	NC	No Connection.
		5	V_{OUT}	Regulator Output Pin.

Part NO.	Part NO.	Pin	Symbol	Pin Description
 UFN-6 (Bottom View)	AP6203B-XXXU	1	V_{IN}	Regulator Input Pin.
		2,4	NC	No Connection.
		3	V_{OUT}	Regulator Output Pin.
		5	GND	Ground Pin.
		6	EN	Chip Enable Pin.

Package Marking Information



SOT-23-5
(Top View)



UFN-6

①、② Represents Products Series

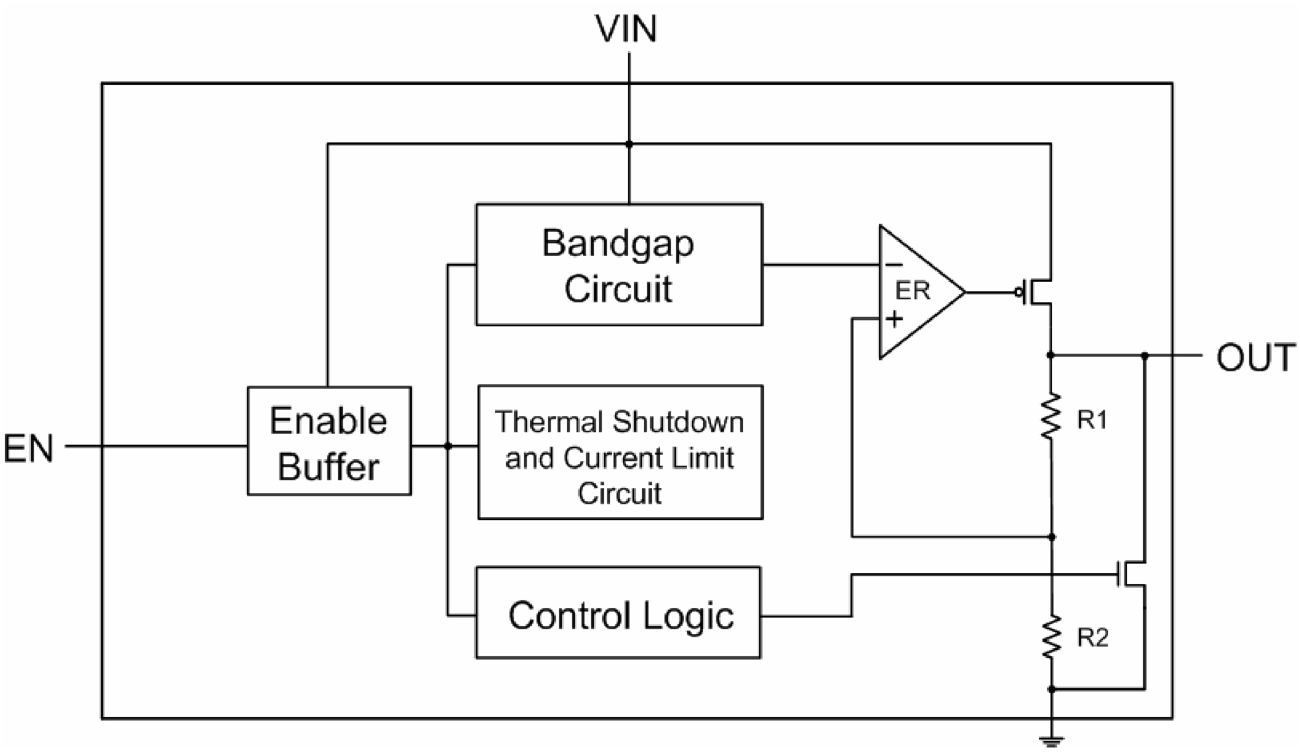
Mark	Products Series
3B	AP6203B-XXPA/U

③ Represents Type of Regulator

Mark	Products Series
5	AP6203B-12PA/U
8	AP6203B-15PA/U
A	AP6203B-18PA/U
G	AP6203B-25PA/U
J	AP6203B-27PA/U
K	AP6203B-28PA/U
M	AP6203B-30PA/U
Q	AP6203B-33PA/U
V	AP6203B-36PA/U
S	AP6203B-42PA/U

④、⑤ Represents Production Date Code

AP6203B Function Block Diagram



Detail Description

The AP6203B is a low-dropout linear regulator. The device provides preset 2.5V, 2.85V and 3.3V output voltages for output current up to 300mA. Other mask options for special output voltages from 1.2V to 5.0V with 100mV increment are also available. As illustrated in function block diagram, it consists of a 1.0V reference, error amplifier, a P-channel pass transistor, an ON/OFF control logic and an internal feedback voltage divider.

The 1.0V band gap reference is connected to the error amplifier, which compares this reference with the feedback voltage and amplifies the voltage difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled lower, which allows more current to pass to the output pin and increases the output voltage. If the feedback voltage is too high, the pass transistor gate is pulled up to decrease the output voltage.

The output voltage is feed back through an internal resistive divider connected to OUT pin. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

Internal P-channel Pass Transistor

The AP6203B features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces quiescent current. PNP-based regulators also waste considerable current in dropout when the pass transistor saturates, and use high base-drive currents under large loads. The AP6203B does not suffer from these problems and consumes only 15μA (Typ.) of current consumption under heavy loads as well as in dropout conditions.

Enable Function

EN pin starts and stops the regulator. When the EN pin is switched to the power off level, the operation of all internal circuit stops, the build-in P-channel MOSFET output transistor between pins V_{IN} and V_{OUT} is switched off, allowing current consumption to be drastically reduced. The V_{OUT} pin enters the GND level through the internal discharge path between V_{OUT} and GND pins.

Fast Discharge Function

The AP6203B has fast discharge Function on EN pin disable. When user turns off AP6203B, its internal pull-low resistor will discharge output capacitor charge. It'll avoid other device to arise wrong motions.

Output Voltage Selection

The AP6203B output voltage is preset at an internally trimmed voltage 2.5V, 2.85V or 3.3V. The output voltage also can be mask-optioned from 1.2V to 5.0V with 100mV increment by special order. The first two digits of part number suffix identify the output voltage (see Ordering Information). For example, the AP6203B-33 has a preset 3.3V output voltage.

Current Limit

The AP6203B also includes a fold back current limiter. It monitors and controls the pass transistor's gate voltage, estimates the output current, and limits the output current within 0.5A.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the AP6203B. When the junction temperature exceeds T_J = +150°C, a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor on again after the junction temperature cools down by 20°C, resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the AP6203B in the event of fault conditions. For continuous operation, the absolute maximum operating junction temperature rating of T_J = +125°C should not be exceeded.

Operating Region and Power Dissipation

Maximum power dissipation of the AP6203B depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the devices is $P = I_{OUT} \times (V_{IN}-V_{OUT})$. The resulting maximum power dissipation is:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} + \theta_{CA}} = \frac{(T_J - T_A)}{\theta_{JA}}$$

Where (T_J-T_A) is the temperature difference between the AP6203B die junction and the surrounding air, θ_{JC} is the thermal resistance of the package chosen, and θ_{CA} is the thermal resistance through the printed circuit board, copper traces and other materials to the surrounding air. For better heat-sinking, the copper area should be equally shared between the IN, OUT, and GND pins.

The thermal resistance θ_{JA} of SOT-23-5 package of AP6203B is 250°C/W. Based on a maximum operating junction temperature 125°C with an ambient of 25°C, the maximum power dissipation will be:

$$P_{MAX} = \frac{(T_J - T_A)}{\theta_{JC} + \theta_{CA}} = \frac{(125 - 25)}{250} = 0.40W$$

Thermal characteristics were measured using a double sided board with 1” x 2” square inches of copper area connected to the GND pin for “heat spreading”.

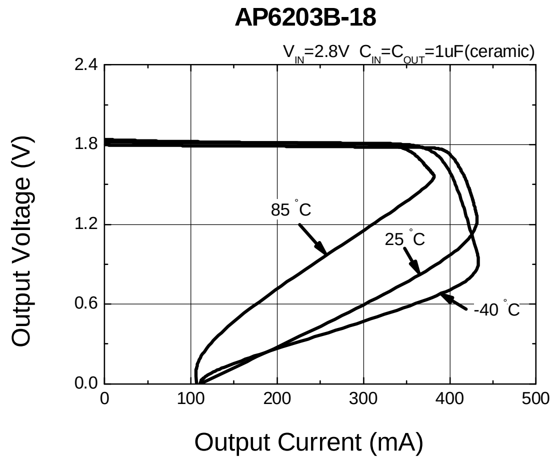
Dropout Voltage

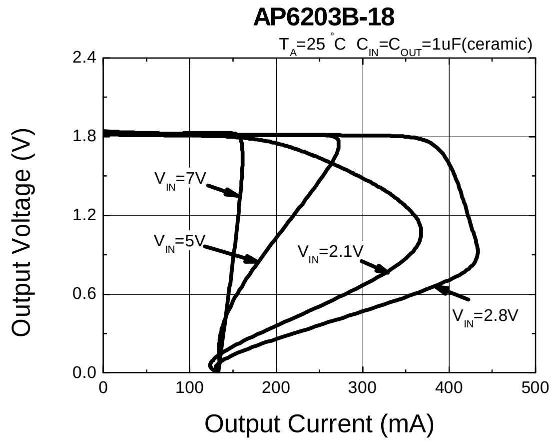
A regulator’s minimum input-output voltage differential, or dropout voltage, determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The AP6203B use a P- channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance $R_{DS(ON)}$ multiplied by the load current.

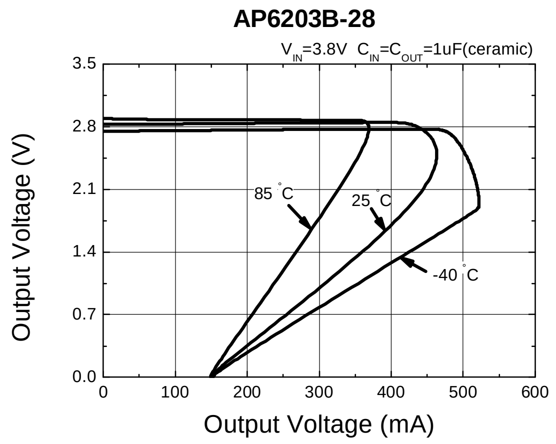
$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

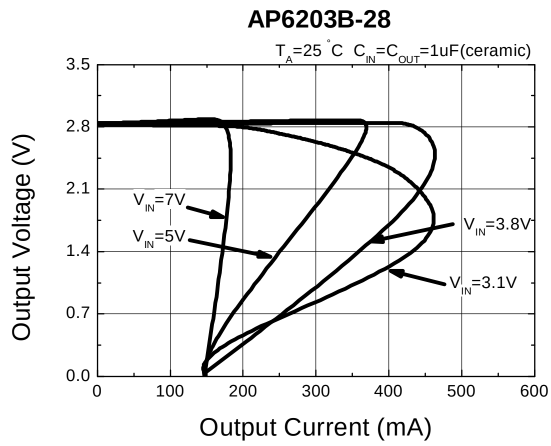
Typical Operating Characteristics

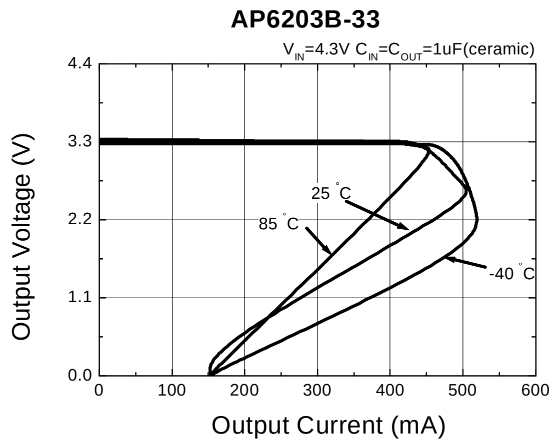
(1) Output Voltage vs. Output Current

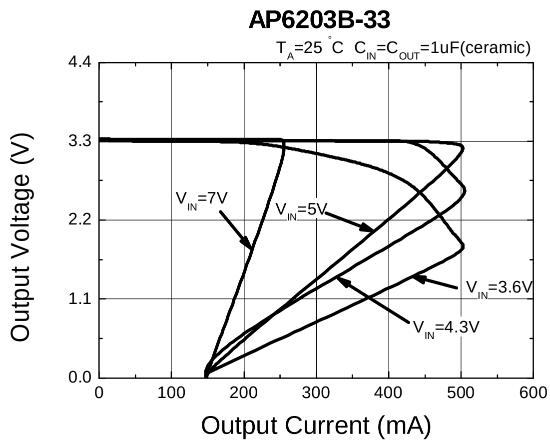




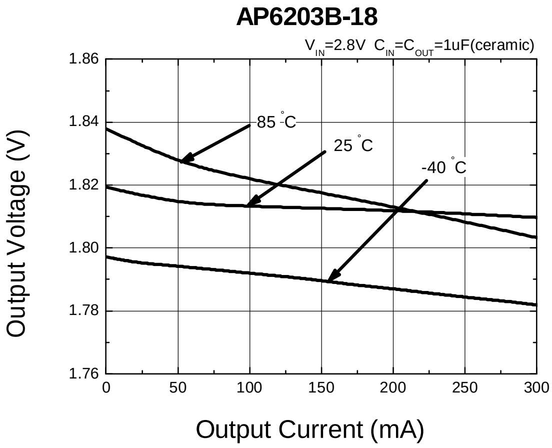


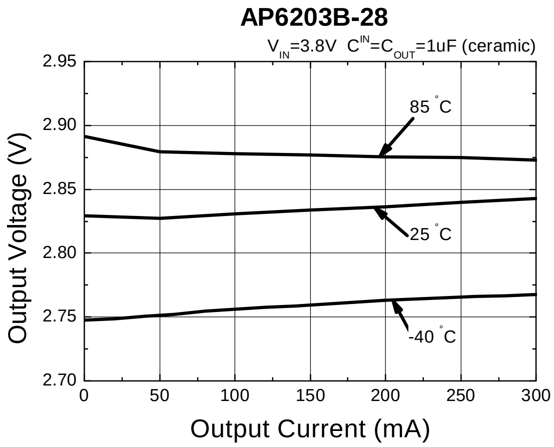


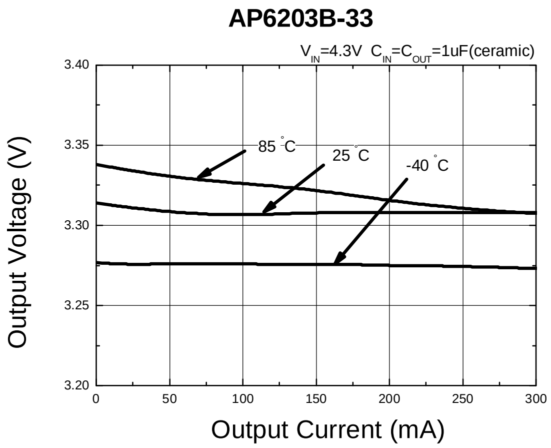




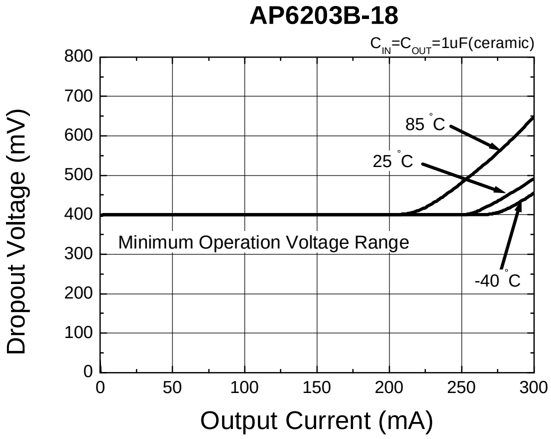
(1) Output Voltage vs. Output Current (Continued)

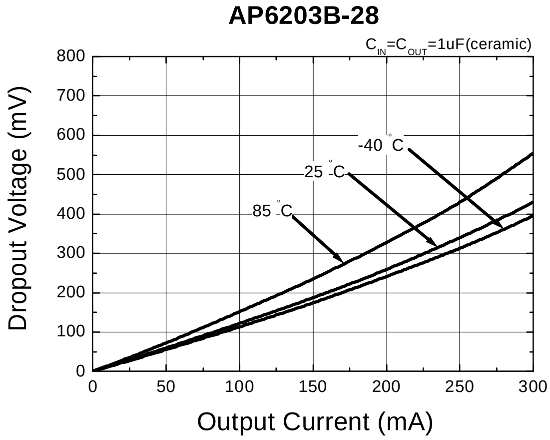


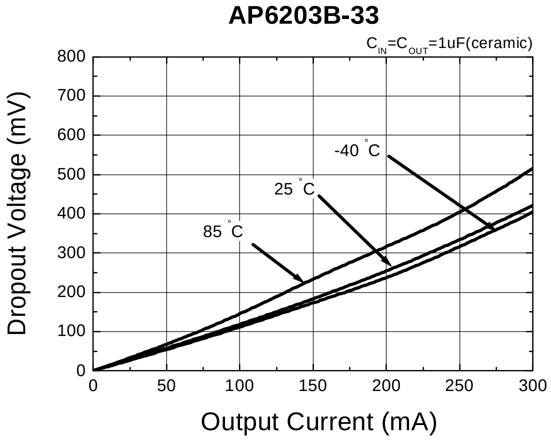




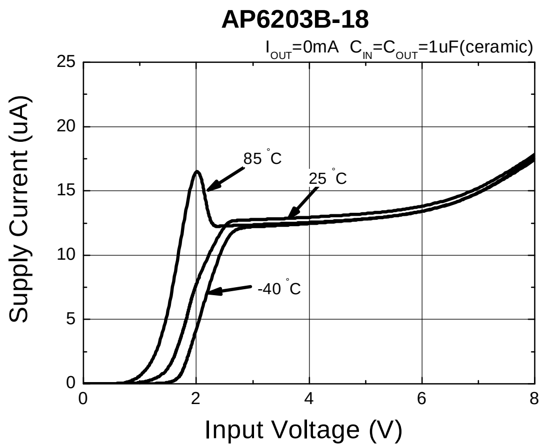
(2) Dropout Voltage vs. Output Current

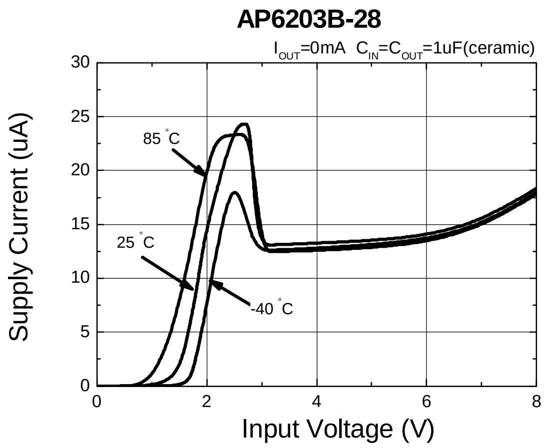


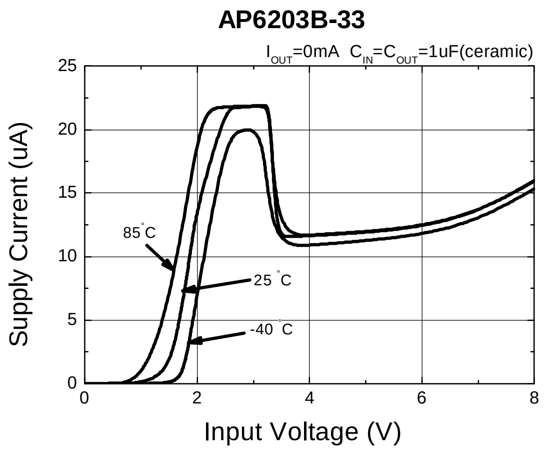




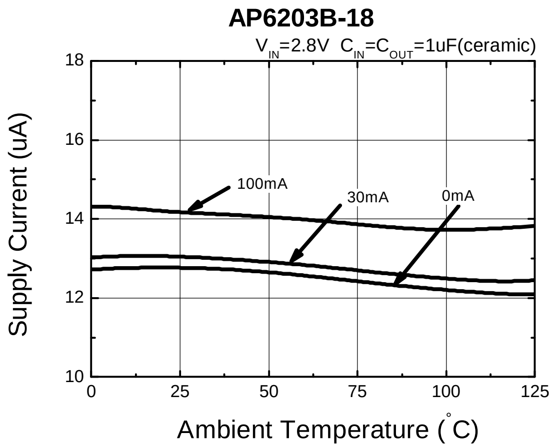
(3) Supply Current vs. Input Voltage

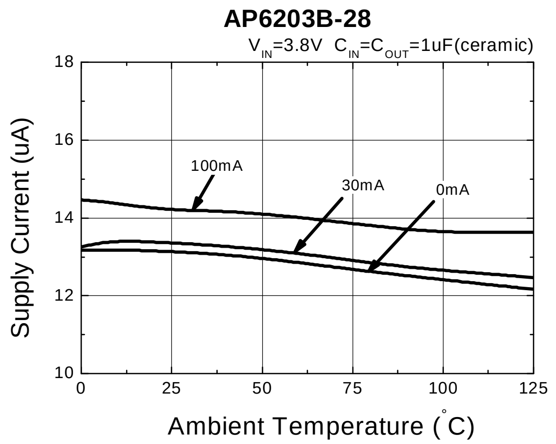


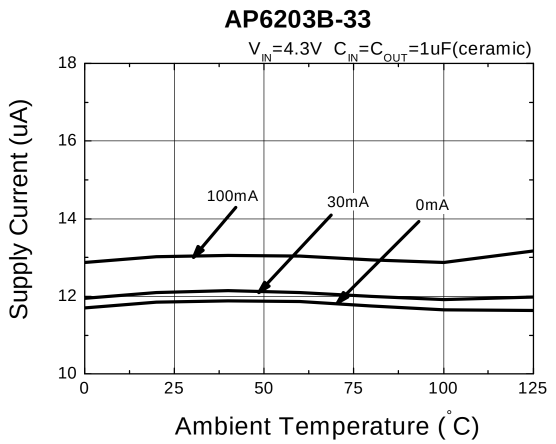




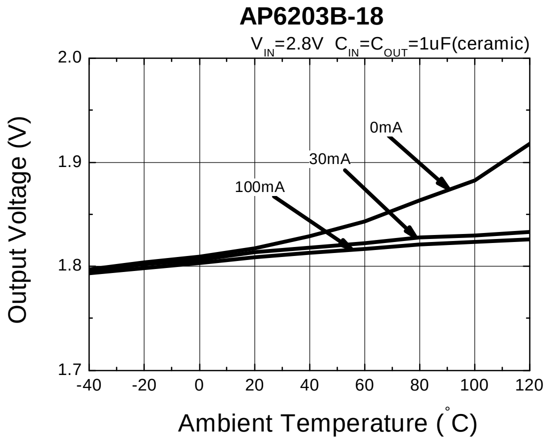
(4) Supply Current vs. Ambient Temperature

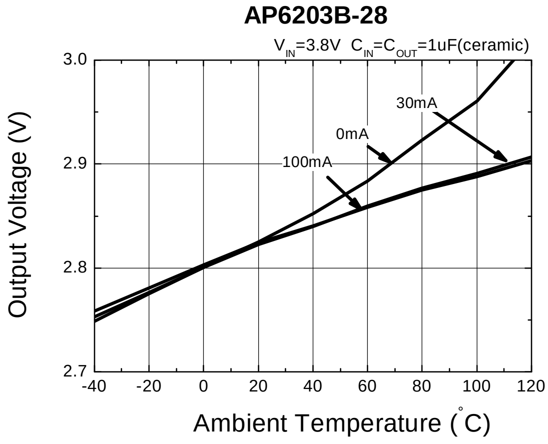


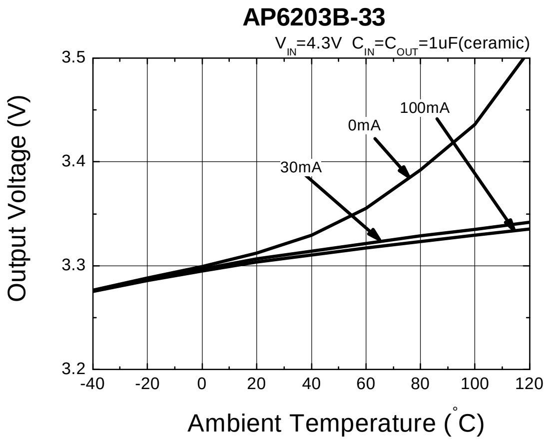




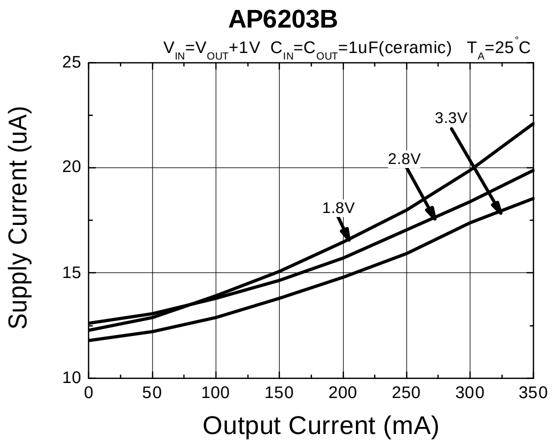
(5) Output Voltage vs. Ambient Temperature



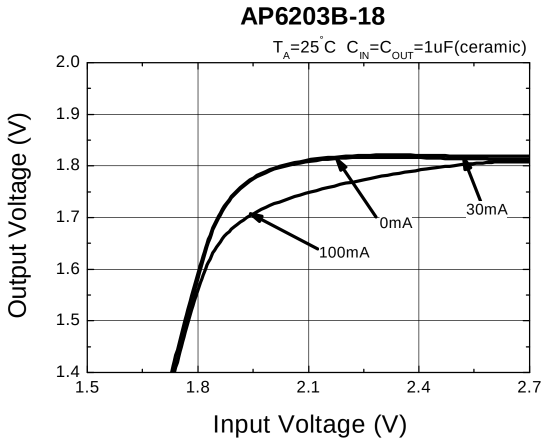


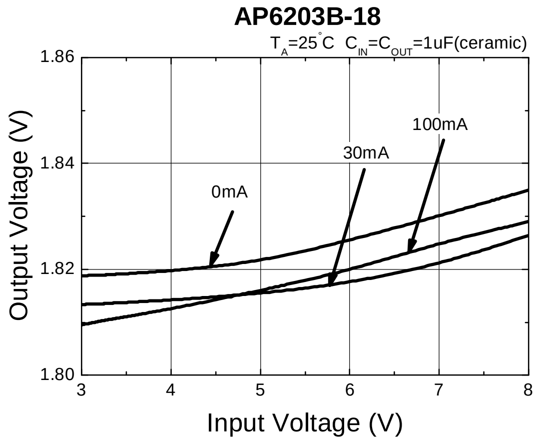


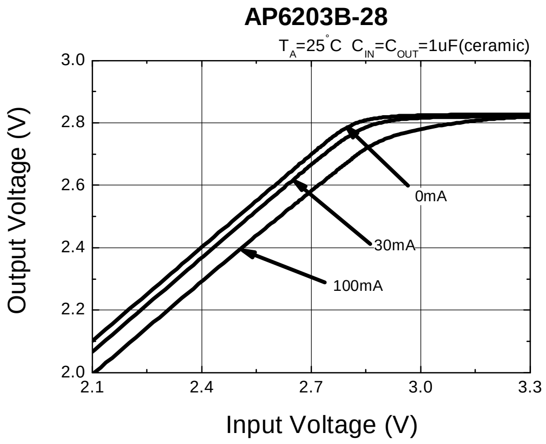
(6) Supply Current vs. Output Current

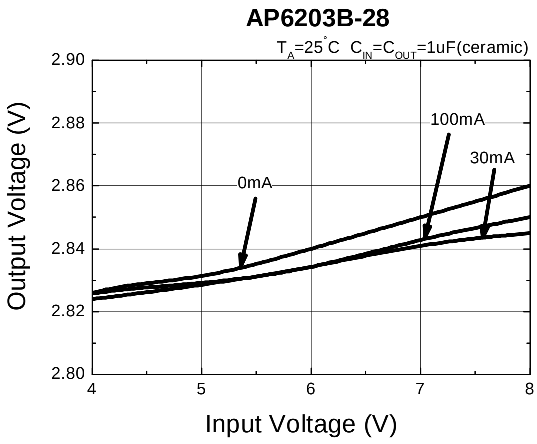


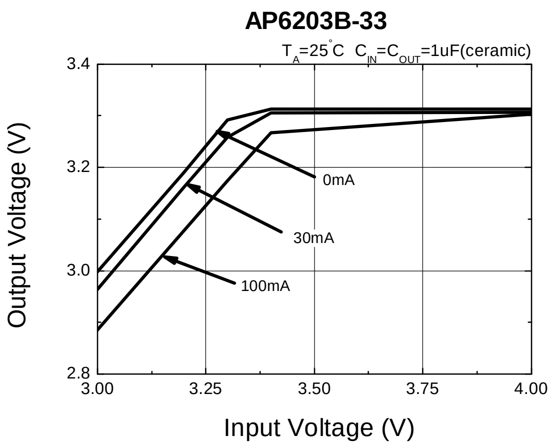
(7) Output Voltage vs. Input Voltage

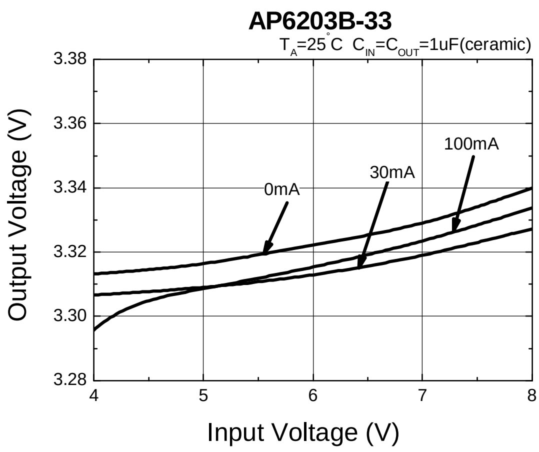








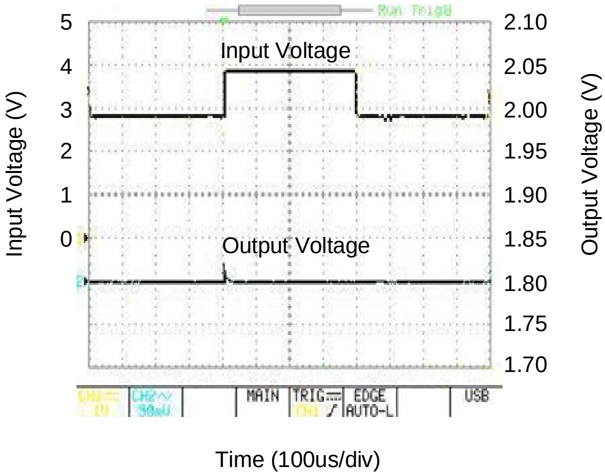




(8) Input Transient Response

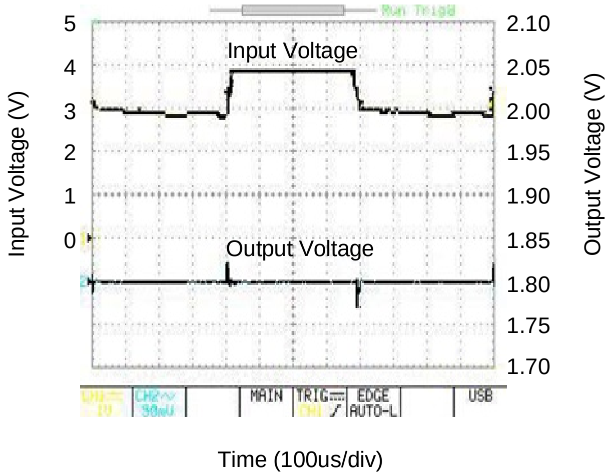
AP6203B-18

I_{OUT}=1mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



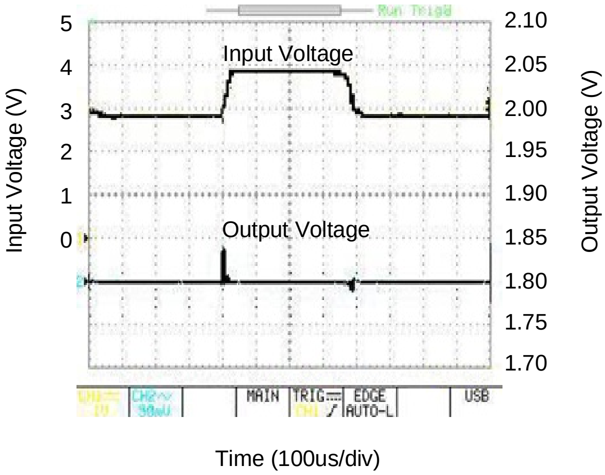
AP6203B-18

I_{OUT}=30mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



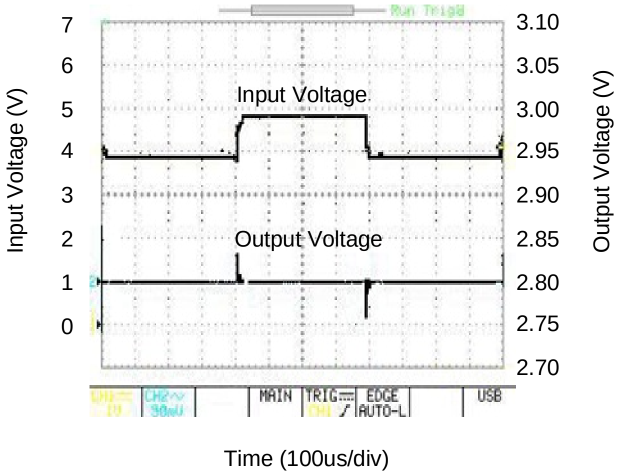
AP6203B-18

I_{OUT}=100mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



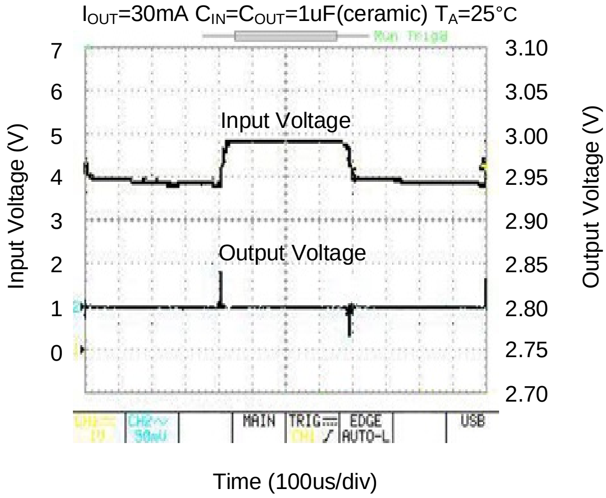
AP6203B-28

I_{OUT}=1mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



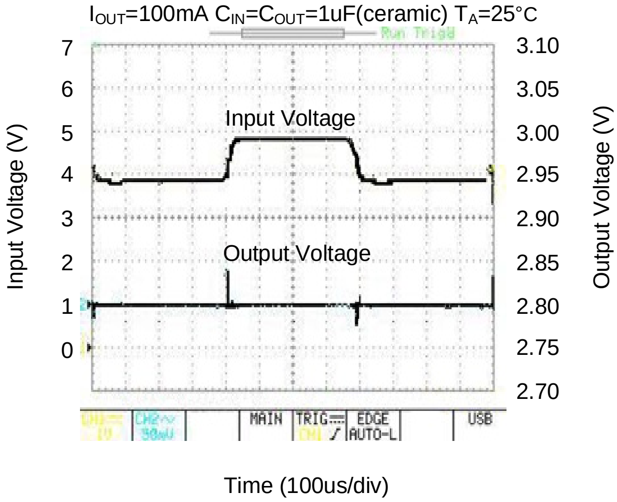
AP6203B-28

I_{OUT}=30mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



AP6203B-28

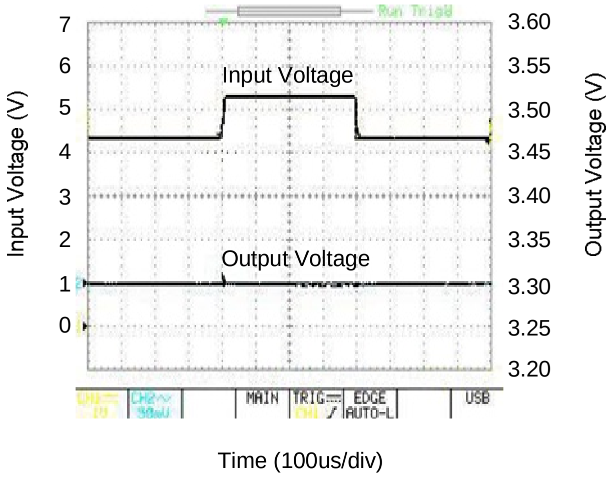
I_{OUT}=100mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



(8) Input Transient Response (Continued)

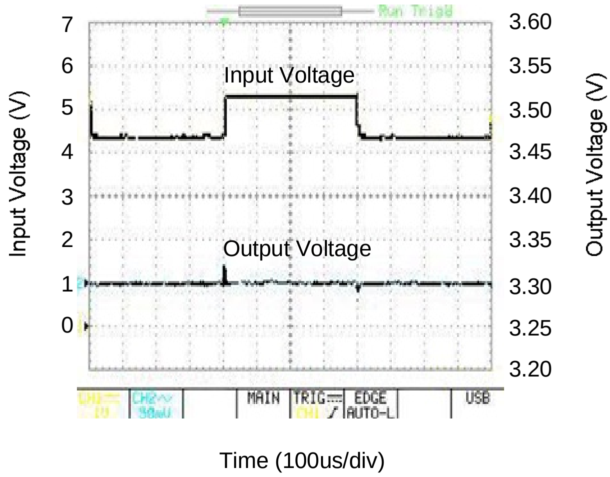
AP6203B-33

I_{OUT}=1mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



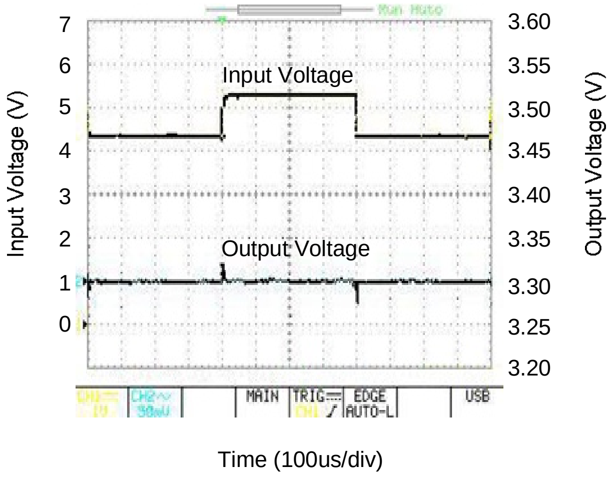
AP6203B-33

I_{OUT}=30mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

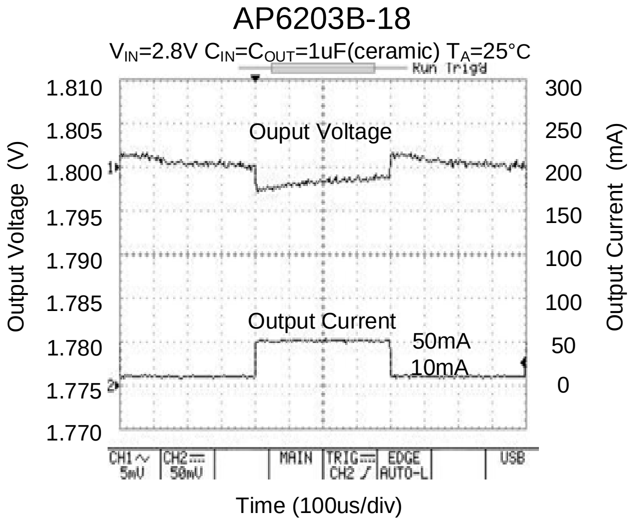


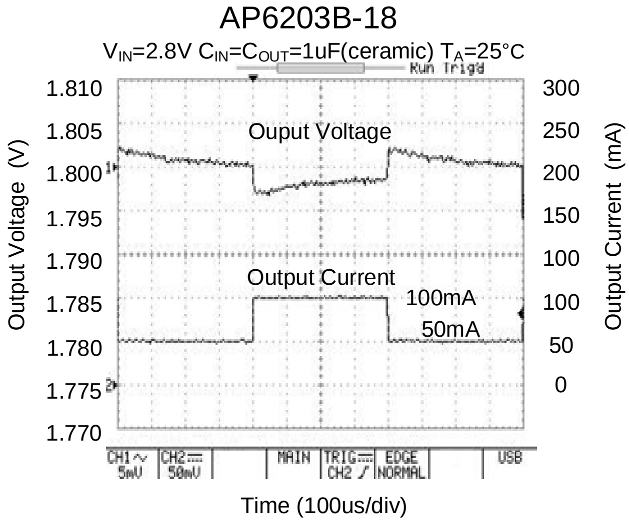
AP6203B-33

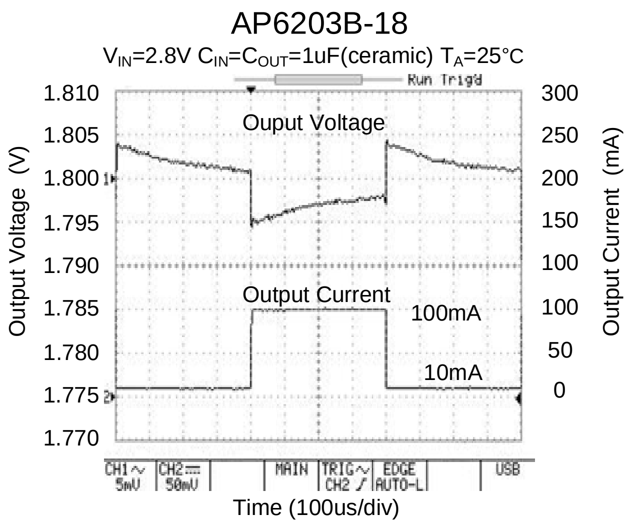
I_{OUT}=100mA C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

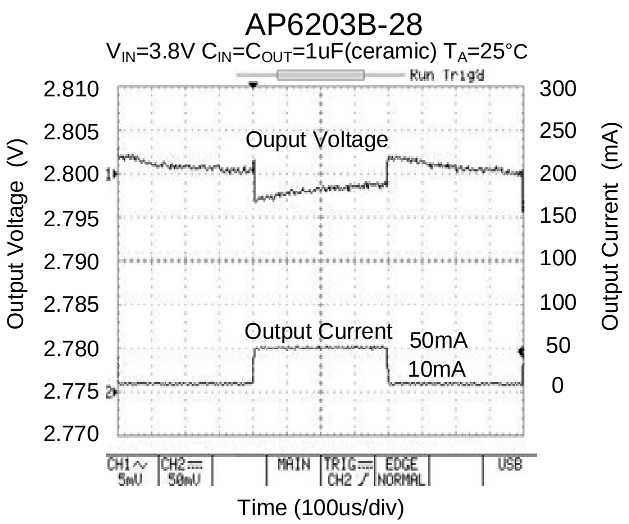


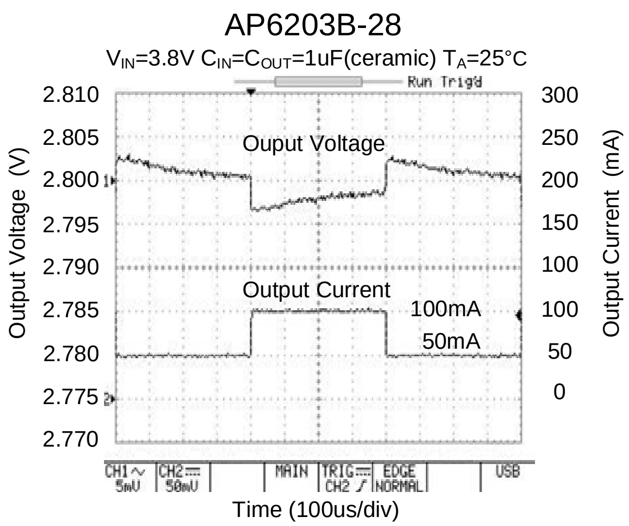
(9) Load Transient Response

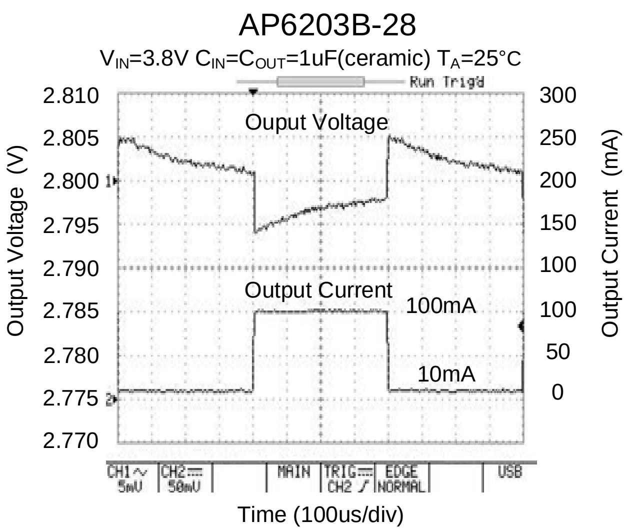








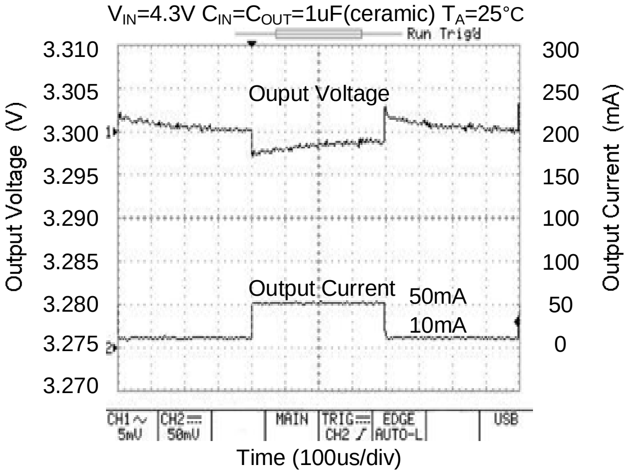




(9) Load Transient Response (Continued)

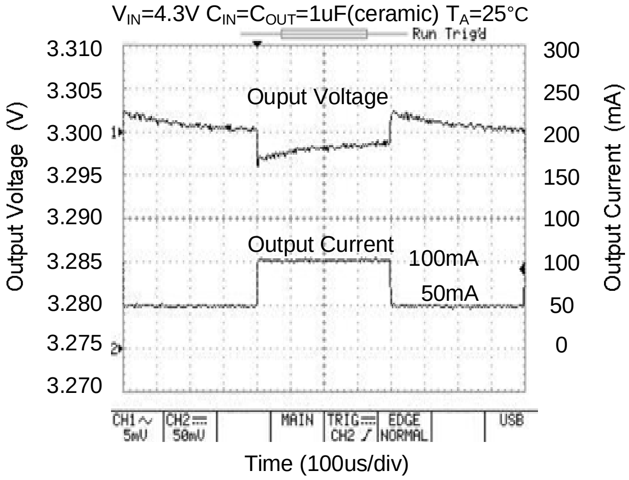
AP6203B-33

V_{IN}=4.3V C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



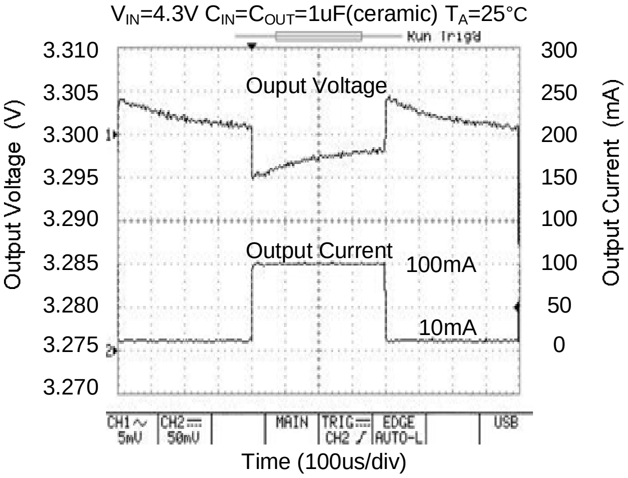
AP6203B-33

V_{IN}=4.3V C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

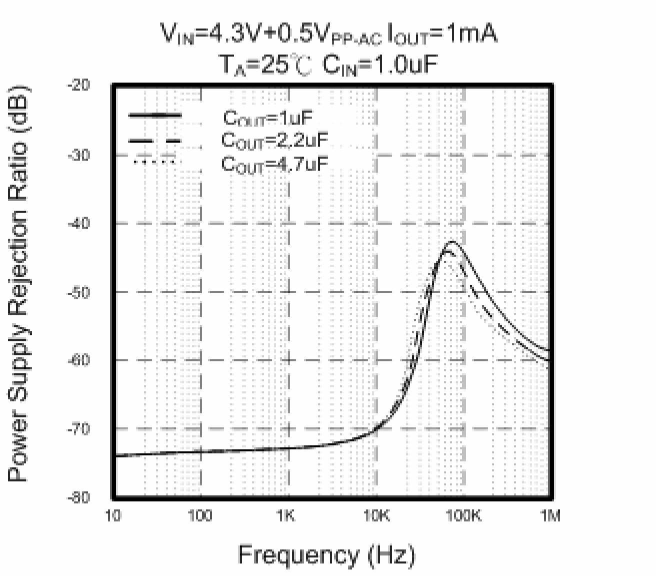


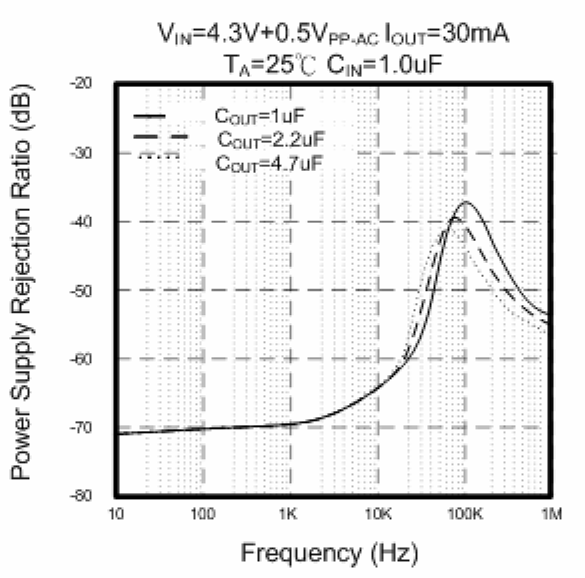
AP6203B-33

V_{IN}=4.3V C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

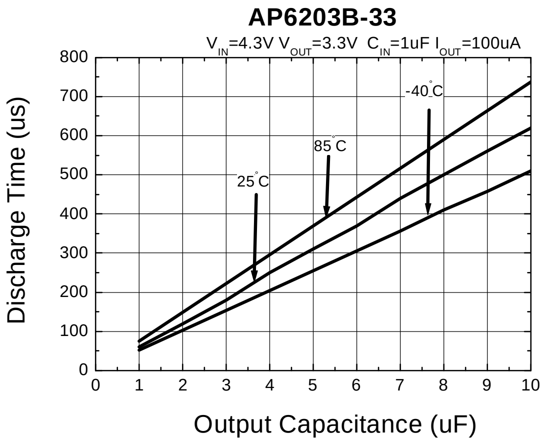


(10) Power Supply Rejection Ratio

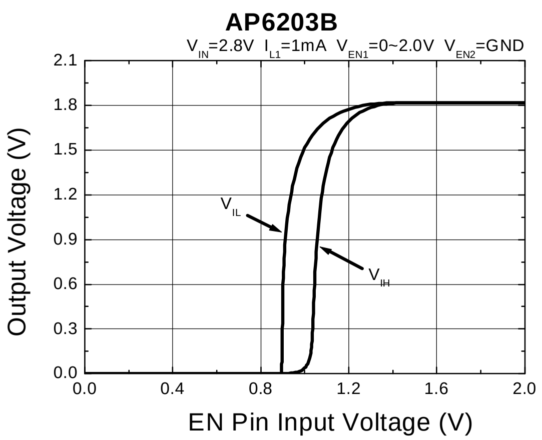


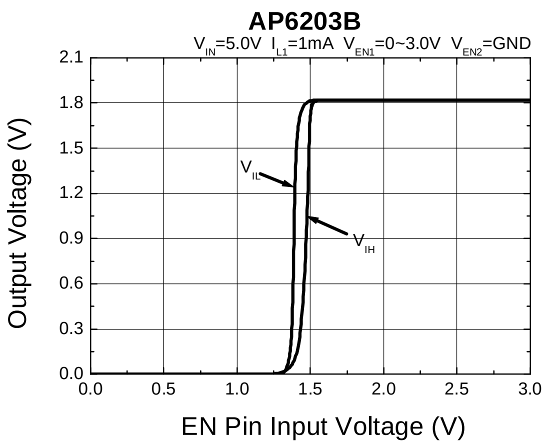


(11) Discharge Time vs. Output Capacitance



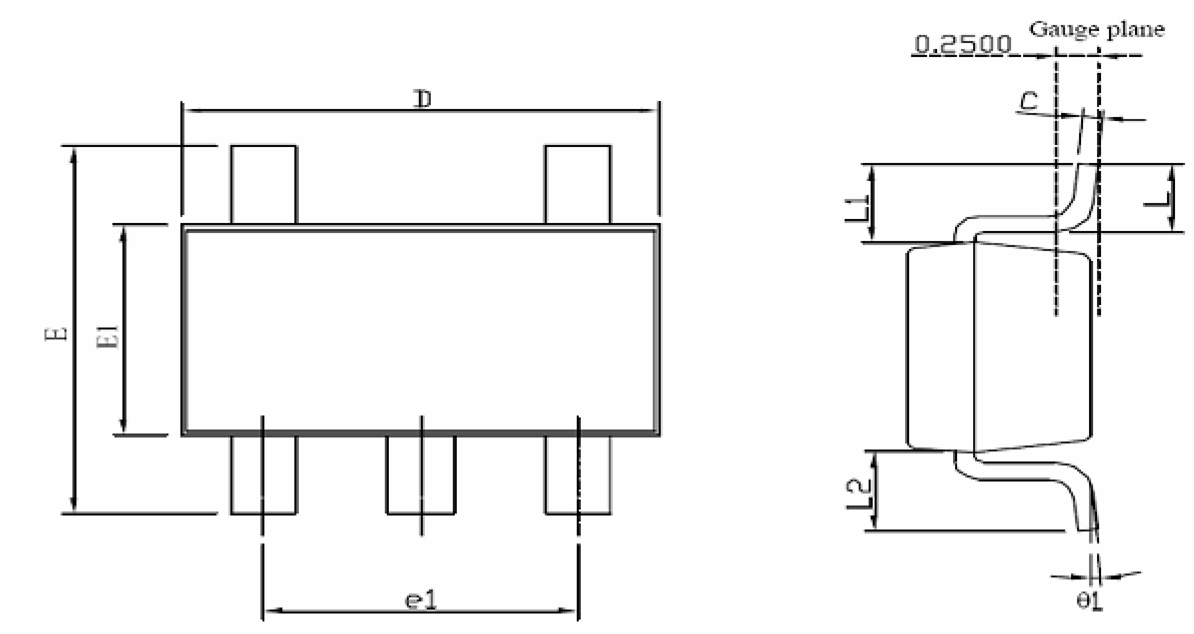
(12) EN Pin Input Voltage v.s Output Voltage

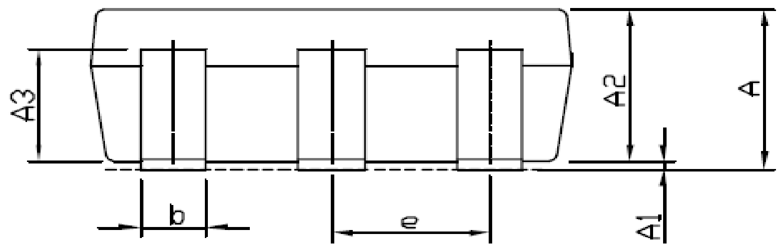




Package Outline

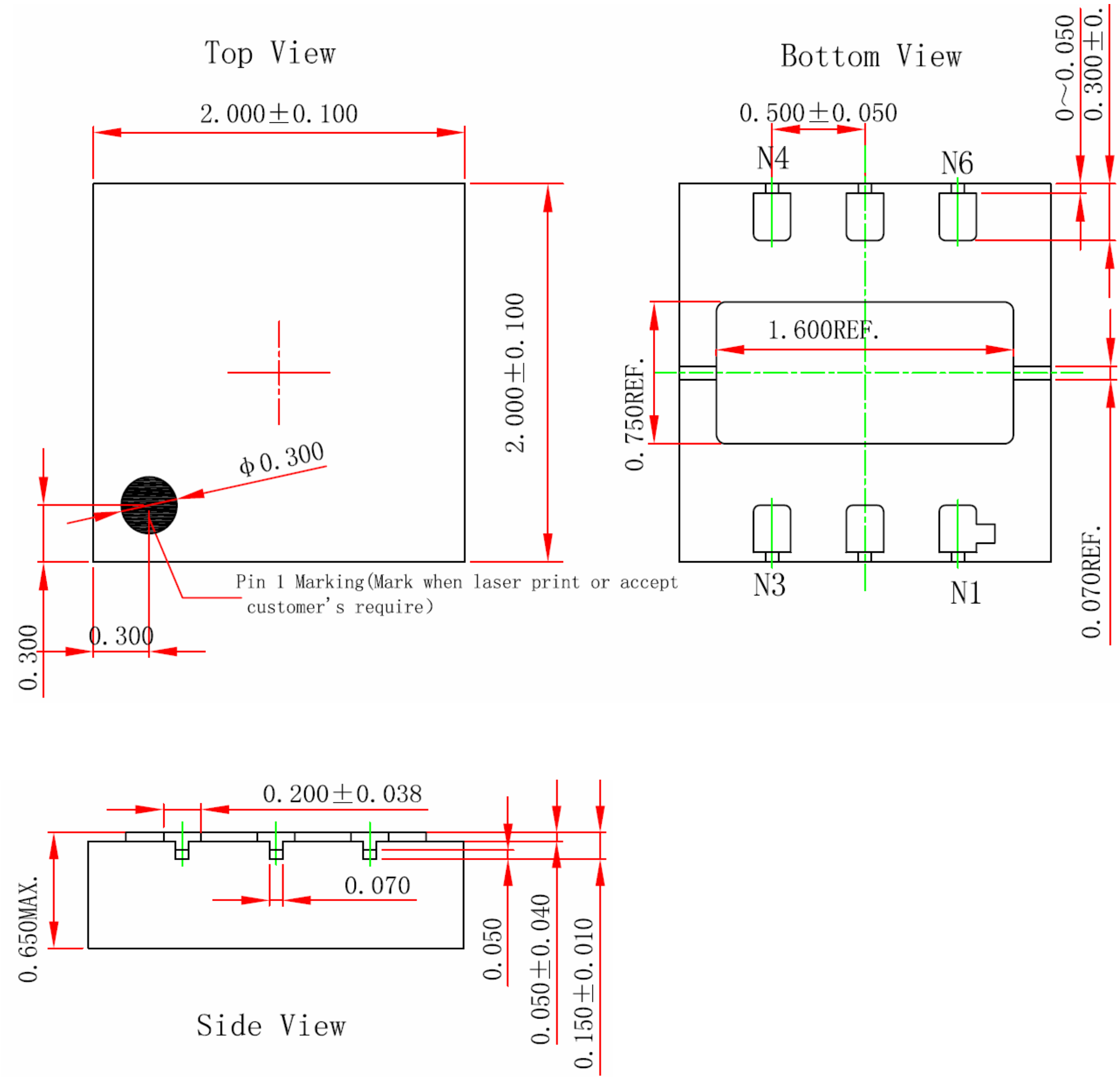
A) SOT-23-5





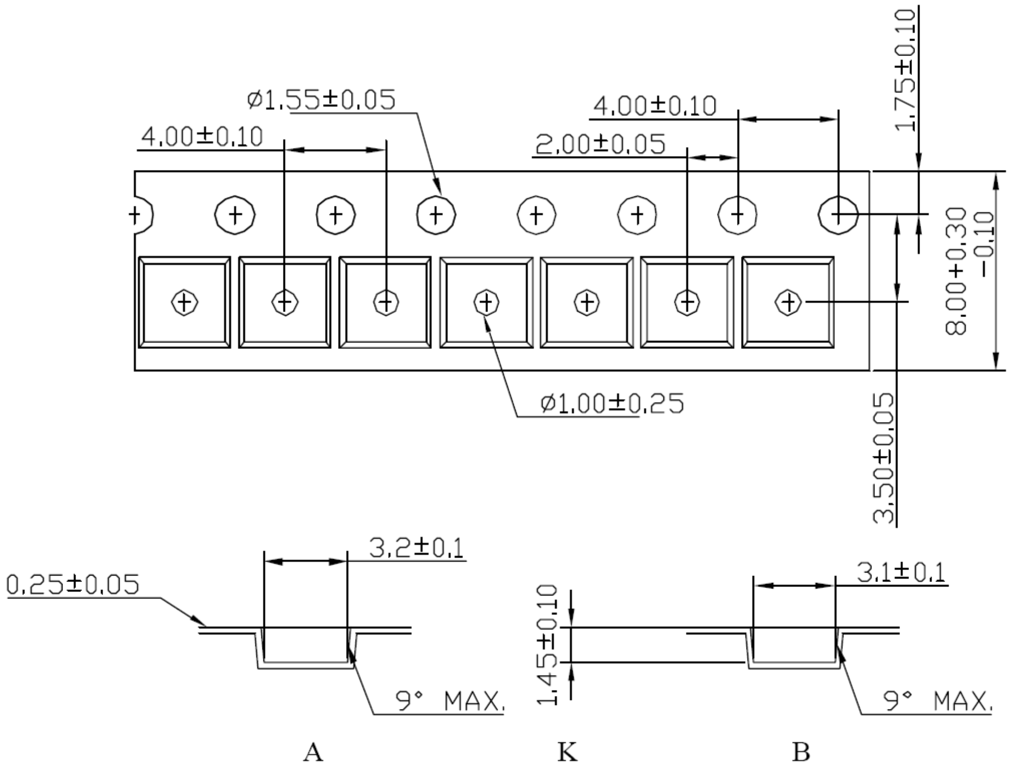
Symbols	Dimensions in Millimeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	---	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E1	1.40	1.60	1.80
e1	---	1.90(TYP)	---
E	2.60	2.80	3.00
L	0.37	---	---
$\theta 1$	1°	5°	9°
e	---	0.95(TYP)	---
L1	---	0.6(REF)	---
LI-L2	---	---	0.12

B) UFN-6

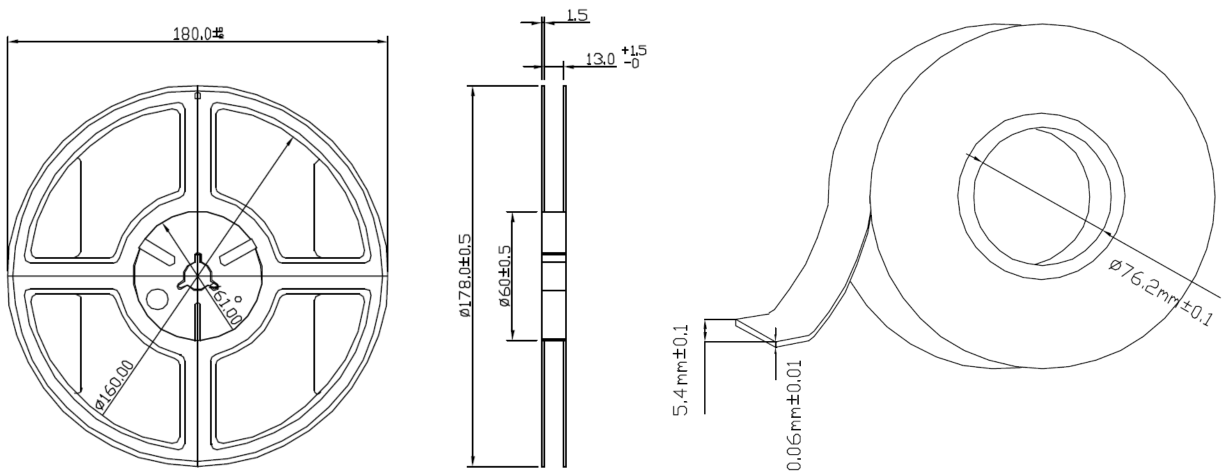

Top View
2.000±0.100
2.000±0.100
φ0.300
0.300
0.300
Pin 1 Marking(Mark when laser print or accept customer's require)
Bottom View
0.500±0.050
N4
N6
N3
N1
1.600REF.
0.750REF.
0~0.050
0.300±0.
0.070REF.
0.200±0.038
0.070
0.650MAX.
0.050
0.050±0.040
0.150±0.010
Side View

Carrier Tape & Reel Dimensions

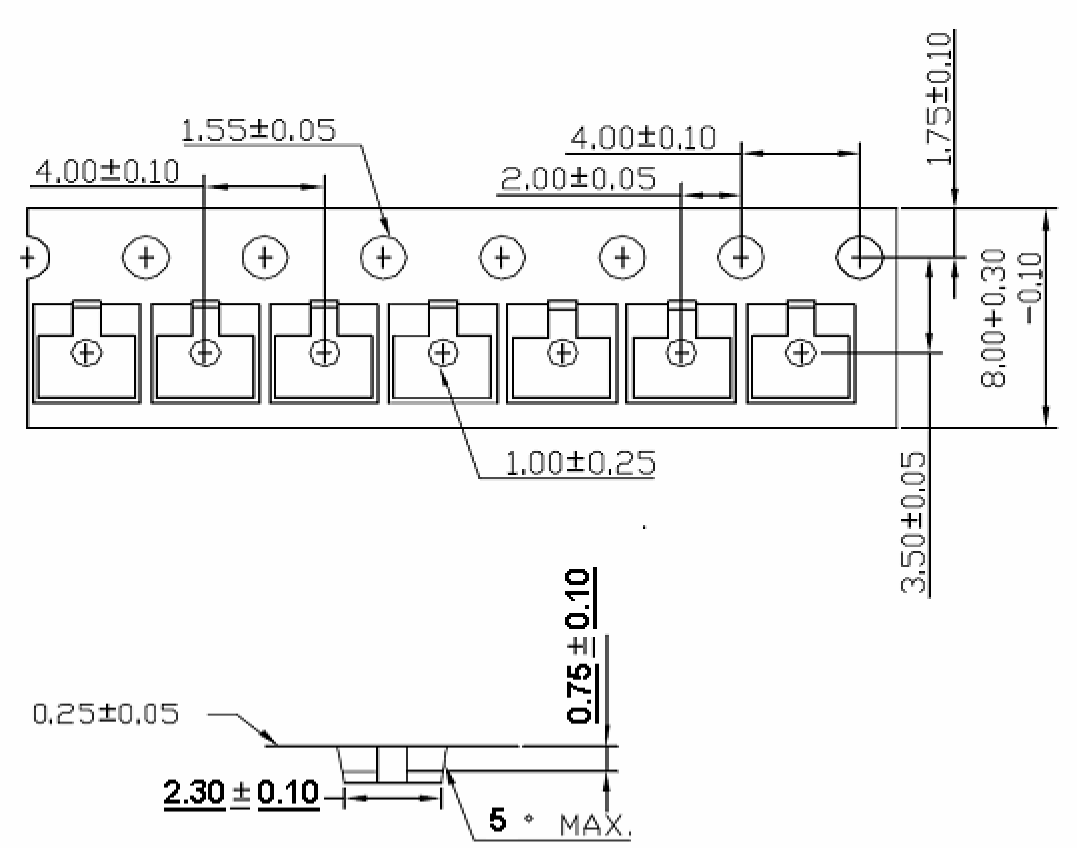
A) SOT-23-5



Notes:
1. Material: black advantek polystyrene.
2. Dim in mm.
3. 10 sprocket hole pitch cumulative tolerance ±0.2.
4. Camber not to exceed 1 mm in 100mm.
5. Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole.
6. Surface resistance less than or equal to 1.0x10e3~10 ohms/sq.
7. A and B measured on a plane 0.3mm above the bottom of the pocket.
8. K measured from a plane on the inside bottom of the pocket to the to surface of the carrier.

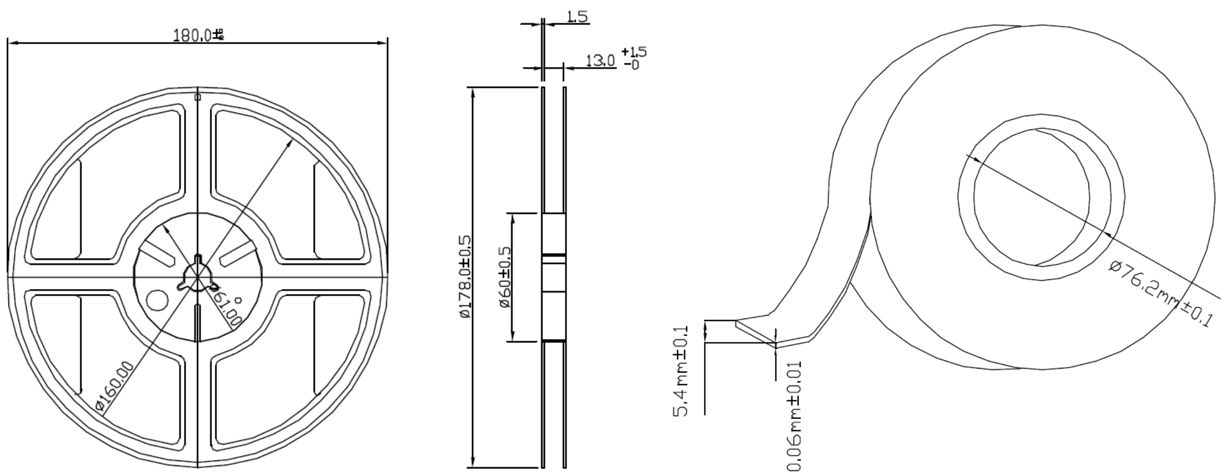


B) UFN-6

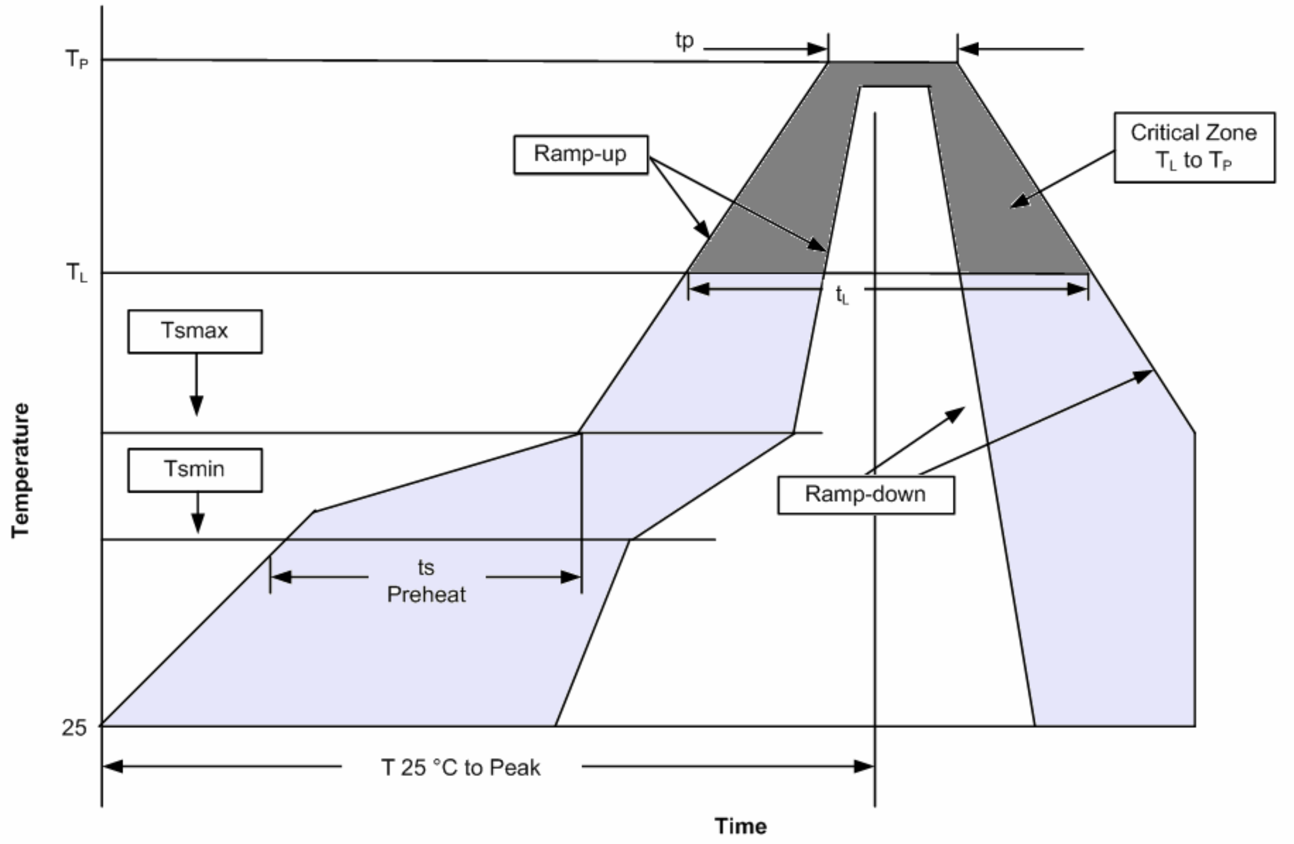


Notes:

1. Material: black advantek polystyrene.
2. Cover tape width：5.40 ±0.10.
3. Cover tape color：transparent.
4. Surface resistance less than or equal to 1.0x10e4~11 ohms/sq.
5. 10 sprocket hole pitch cumulative tolerance ±0.20 max.
6. Camber not to exceed 1 mm in 100mm.
7. MOLS# WBFBP -06C(2.0X2.0X0.5)
8. Dim in mm.



Reflow Condition (IR/Convection or VPR Reflow)



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max	3°C/second max
Preheat - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak/Classification Temperature (Tp)	See table 1	See table 2
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max	6°C/second max
Time 25°C to Peak Temperature	6 minutes max	8 minutes max

Notes：
1) All temperatures refer to topside of the package.
2) Measured on the body surface.

Classification Reflow Profiles (Continued)

Table 1. Sn-Pb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	**Volume mm³ <350**	**Volume mm³ ≧350**
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≧2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 2. Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	**Volume mm³ <350**	**Volume mm³ 350~2000**	**Volume mm³ ≧2000**
<2.5 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6-2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≧2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

Notes：

* Tolerance: The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.