Features

- 2.0µA Quiescent Current (Typ.)
- Operating Voltages Range：+1.8V to +6.0V
- Output Voltages Range：+1.2V to +5.0V with 100mV Increment
- Maximum Output Current：250 mA
- Low Dropout: 150 mV @ 100mA (V_{OUT}≧2.0 V)
- High Accuracy of Output Voltage
  ±2.0% : V_{OUT}≧2.5 V
  ±50mV : V_{OUT}≦2.5 V
- High Ripple Rejection：60 dB
- Output Current Limit Protection (350mA)
- Short Circuit Protection (200mA)
- Thermal Overload Shutdown Protection
- Low ESR Capacitor Compatible
- SOT23-3,SOT23-5,SOT89 and UDFN-6 Packages
- RoHS Compliant and Green (Halogen Free with Commercial Standard)

General Description

The EC6209 series is a positive voltage regulator with highly accurate output voltage and ultra-low quiescent current which is typically 2.0µA. The device is ideal for battery powered applications and handheld communication equipments which require low quiescent current.

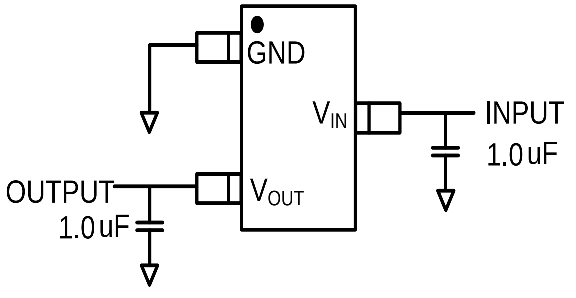
The EC6209 consists of a band-gap reference voltage source, an error amplifier, a P-channel pass transistor, a resistor-divider for setting output voltage, a current limiter, and temperature limit protection circuit. The high-accuracy output voltage is preset at an internally trimmed voltage 1.8V, 2.5V or 3.3V. Other output voltages can be mask-optioned from 1.2V to 5.0V with 100mV increment. (but only 1.28V in stead of 1.3V)

The EC6209 has been designed to be used with low cost ceramic capacitors and requires a minimum output capacitor of 1.0µF. The devices are available in SOT23-3, SOT23-5,SOT89, and UDFN-6 pack- ages.

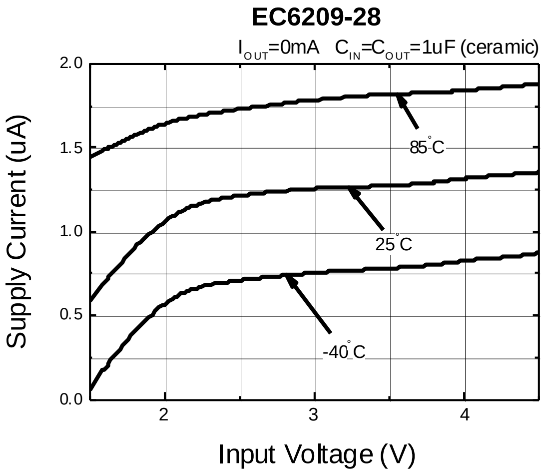
Applications

- DSC、PDA、MP3 Player
- Digital Video Recorder
- Battery Powered Instrument
- Portable Communication Device

Simplified Application Circuit



Supply Current Diagram



Ordering Information

EC6209 －□□－□□

- Lead Free Code
- Package Code
- V_{OUT} Code

Vout Code：

Exam. 18=1.8V、**25=**2.5V、**33=**3.3V

Lead Free Code：

G：Green (Halogen Free with Commercial Standard)

Package Code：

B1：SOT23-3 (A-type)
B2：SOT23-5
B1B: SOT23-3 (B-type)
B6：SOT89-3
BV：SOT23-5

FU：UDFN-6 (2 x 2 mm)

B2 & BV：see Page 4 Pin Assignment

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}	350	mA
Junction Temperature		T_J	+155	°C
Power Dissipation	SOT-23	P_D	300	mW
	SOT-89		550	mW
	UDFN-6		500	mW
Operating Ambient Temperature Range		TOPR	-40 ~ +125	°C
Storage Temperature Range		T_{STG}	-55 ~ +150	°C
Lead Temperature (soldering, 10sec)			+260	°C

Note:

*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.

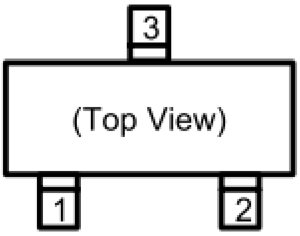
* The power dissipation of UDFN-6 would be 500 mW normally with the 0.5X0.5 square inches cooper area connected to the bottom pad. However, it could be up to 1000mW with larger cooper area.

Electrical Characteristics

(TA=25℃, unless otherwise noted.)

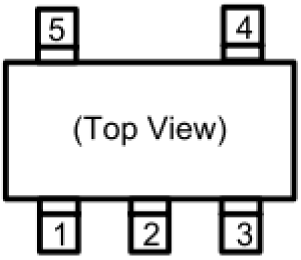
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
VIN	Input Voltage		1.8		6.0	V
ΔVOUT	Output Voltage Accuracy	VIN>VOUT+1.0V, VOUT	-2.4		+2.4	%
		VIN>VOUT+1.0V, VOUT ≧2.1V	-2.0		+2.0	%
IMAX	Output Current	VIN>VOUT+1.0V	250	300		mA
ISC	Short-Circuit Current	VOUT=0V, VIN>VOUT+0.48V		200	300	mA
IQ	Quiescent Current	ILOAD=0mA, VIN=VOUT +1.0V		2.0	4.5	µA
VDROP	Dropout Voltage	VIN=VOUT=3.3V, IOUT=100mA		280	350	mV
		VIN=VOUT=3.3V, IOUT=250mA		700	850	mV
ΔVLINE	Line Regulation	VIN = 4.0 ~ 5.5 V, ILOAD=1mA			0.10	%/V
ΔVLOAD	Load Regulation	IOUT=1mA to 100mA			0.01	%/mA
VIH	EN Pin Input Voltage “H”	VIH ≦ VIN	0.9	1.0	1.5	V
VIL	EN Pin Input Voltage “L”				0.8	V
IEN	EN Pin Leakage Current			0.01	0.1	µA
eN	Output Noise	F=1Hz to 10KHz, COUT=1µF		150		µVRMS
PSRR	Ripple Rejection	F=100Hz, COUT=1µF		50		dB
TSD	Thermal Shutdown Temper			155		°C
THYS	Thermal Shutdown Hystere			10		°C
TC	Output Voltage Temperature Coefficent	IOUT=1mA, -40°C ≤ TA ≤ 80°C		100		ppm/°C

Pin Assignment & Pin Description



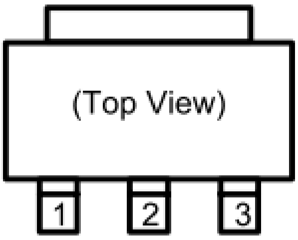
SOT 23-3

Pin Number		Pin Name	Functions
SOT23-3 (A Type)	SOT23-3 (B Type)		
1	3	GND	Ground
2	2	V_{OUT}	Output
3	1	V_{IN}	Power Input



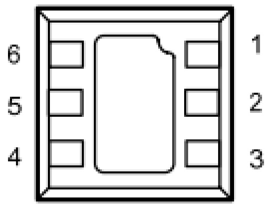
SOT 23-5

Pin Number		Pin Name	Functions
SOT23-5(B2)	SOT23-5(BV)		
1	5	V_{IN}	Power Input
2	2	GND	Ground
3	1	EN	Enable
4	3	NC	No connection
5	4	V_{OUT}	Output



SOT 89

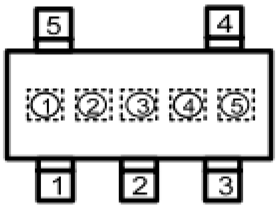
Pin Number	Pin Name	Functions
SOT89		
1	GND	Ground
2	V_{IN}	Power Input
3	V_{OUT}	Output



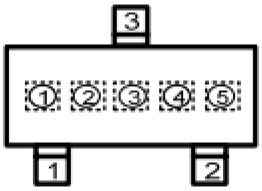
UFN-6
(Bottom View)

Pin Number	Pin Name	Functions
UDFN-6		
2	GND	Ground
4	V_{IN}	Power Input
6	V_{OUT}	Output
1,3,5	NC	No Connection

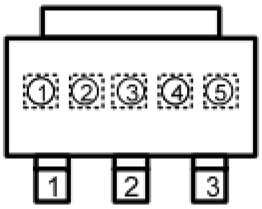
Package Marking Information



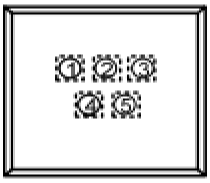
SOT 23-5
(Top View)



SOT 23-3
(Top View)



SOT 89
(Top View)



UFN-6
(Top View)

①、② Represents Products Series

Mark	Products Series
09	EC6209-XX-B1/B1B/B2/BV/B6/FU

③ Represents Type of Regulator

Mark	Products Series
5	EC6209-12-B1/B1B/B2/BV/B6/FU
7	EC6209-13-B1/B1B/B2/BV/B6/FU
8	EC6209-15-B1/B1B/B2/BV/B6/FU
A	EC6209-18-B1/B1B/B2/BV/B6/FU
G	EC6209-25-B1/B1B/B2/BV/B6/FU
3	EC6209-26-B1/B1B/B2/BV/B6/FU
J	EC6209-27-B1/B1B/B2/BV/B6/FU
K	EC6209-28-B1/B1B/ B2/BV/B6/FU
M	EC6209-30-B1/B1B/ B2/BV/B6/FU
Q	EC6209-33-B1/B1B/ B2/BV/B6/FU
T	EC6209-35-B1/B1B/B2/BV/B6/FU
V	EC6209-36-B1/B1B/B2/BV/B6/FU
S	EC6209-42-B1/B1B/B2/BV/B6/FU
Z	EC6209-50-B1/B1B/ B2/BV/B6/FU

④、⑤ Represents Production Date Code

Note：

* There are two under-lines on 4th & 5th digit for Green package.

* SOT23(B type) : There is a Top line on 1ST digit.

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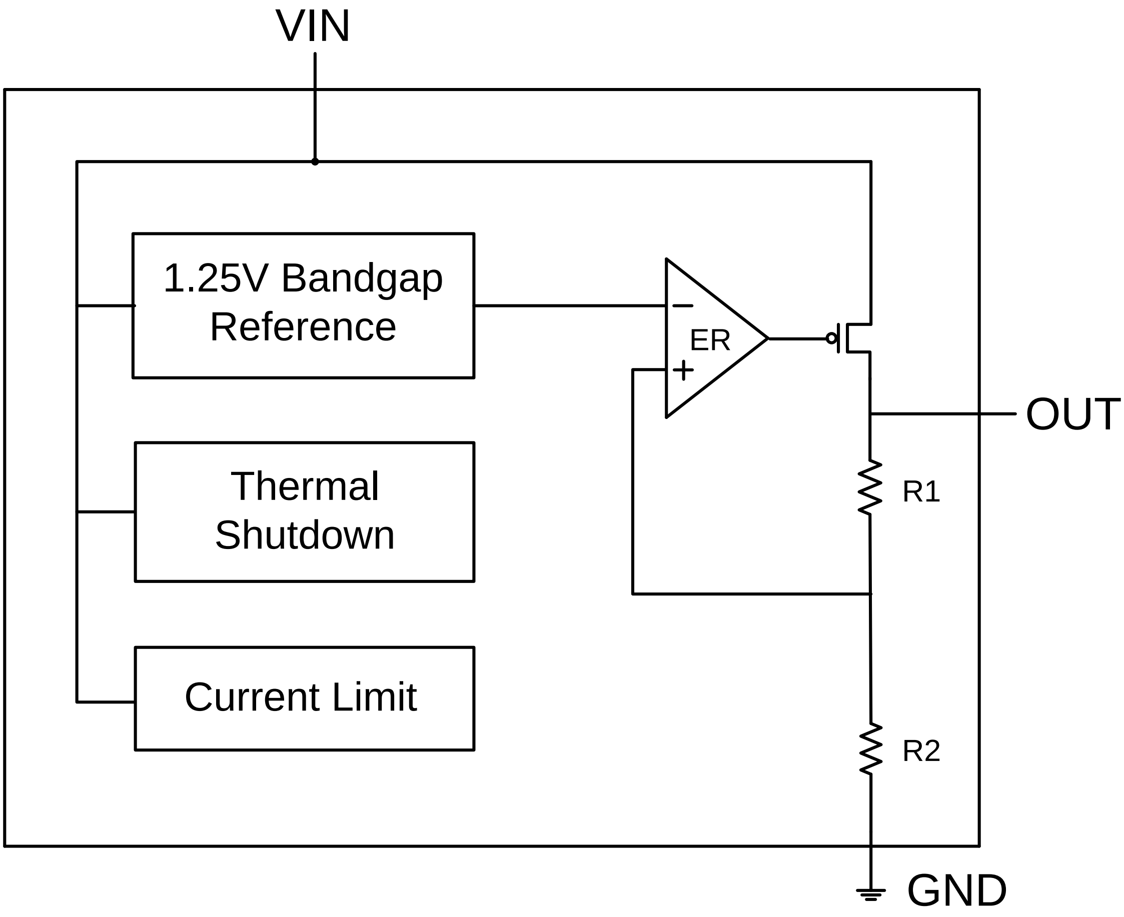
Function Block Diagram



Detail Description

The EC6209 is a low quiescent current LDO linear regulator. The device provides preset 1.8V, 2.5V and 3.3V output voltages for output current up to 350mA. Other mask options for special output voltages from 1.2V to 5.0V with 100mV increment are also available (but only 1.28V in stead of 1.3V). As illustrated in function block diagram, it consists of a 1.23V reference, error amplifier, a P-channel pass transistor, and an internal feedback voltage divider.

The 1.23V 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 feedback through an internal resistive divider connected to V_{OUT} pin. Additional blocks include with output current limiter and shutdown logic.

Internal P-channel Pass Transistor

The EC6209 features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFET require no base drive, which reduces quiescent current. PNP–based regulators also waste considerable current in dropout conditions when the pass transistor saturates, and use high base-drive currents under large loads. The EC6209 does not suffer from these problems and consumes only 2.0μA (Typical) of current consumption under light loads.

Output Voltage Selection

The EC6209 output voltage is preset at an internally trimmed voltage 1.8V, 2.5V or 3.3V. The output voltage also can be mask-optioned from 1.2V to 5.0V with 100mV increment by special order (but only 1.28V in stead of 1.3V). The first two digits of part number suffix identify the output voltage (see ***Ordering Information***). For example, EC6209- 33 has a preset 3.3V output voltage.

Current Limit

The EC6209 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 350mA.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the EC6209. When the junction temperature exceeds T_J = +155°C, a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor active again after the junction temperature cools down by 10°C, resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the EC6209 in the event of fault conditions. For continuous operation, the maximum operating junction temperature rating of T_J=+125°C should not be exceeded.

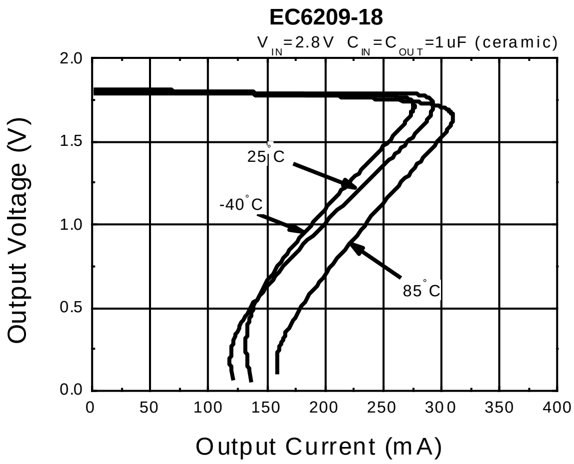
Dropout Voltage

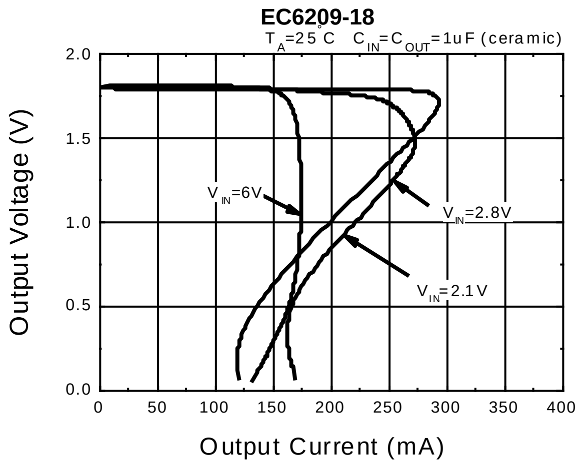
A regulator's minimum input-output voltage differential, or dropout voltage, determines the lowest us- able supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The EC6209 uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ($R_{DS(ON)}$) multiplied by the load current.

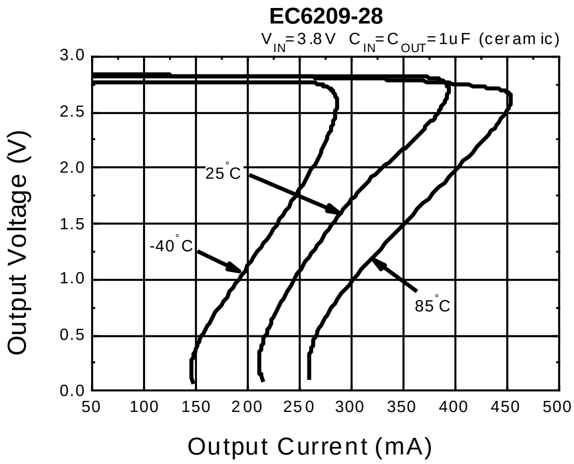
$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

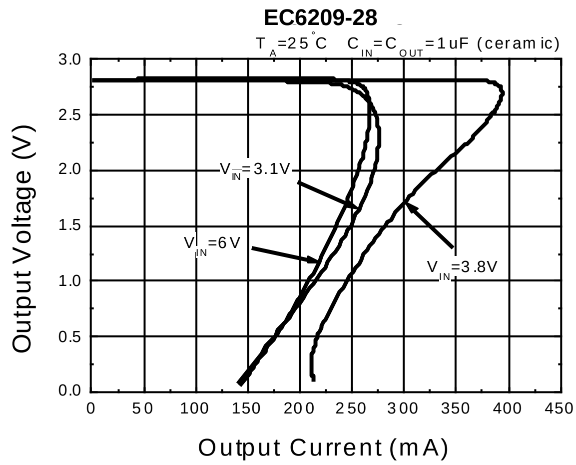
Typical Operating Characteristics

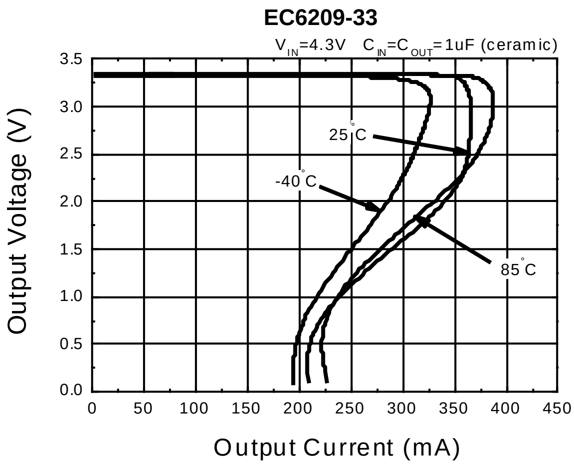
(1) Output Voltage vs. Output Current

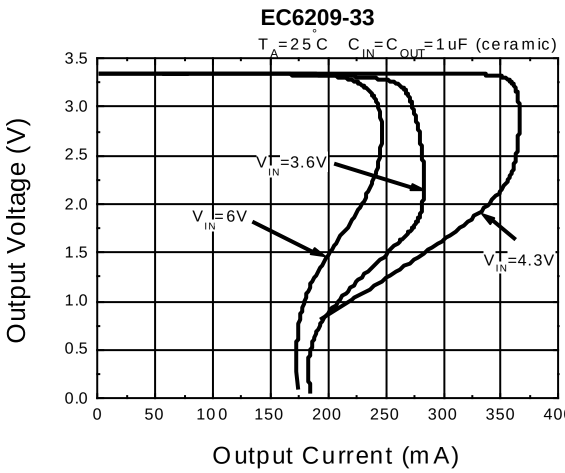












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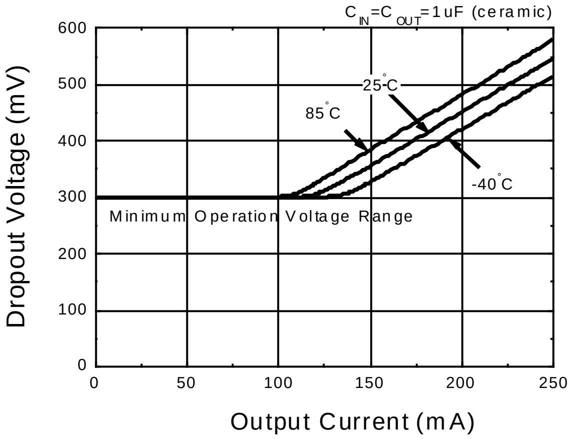
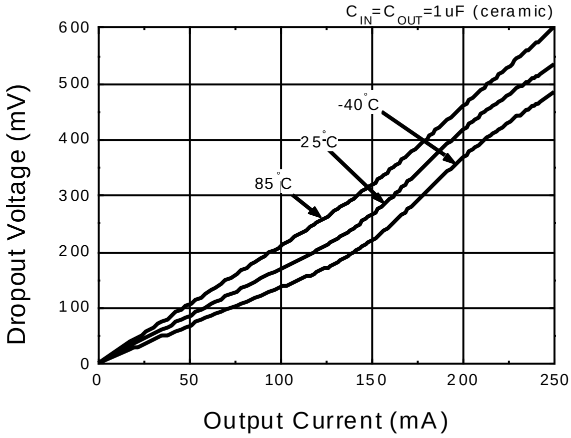
(2) Dropout Voltage vs. Output Current

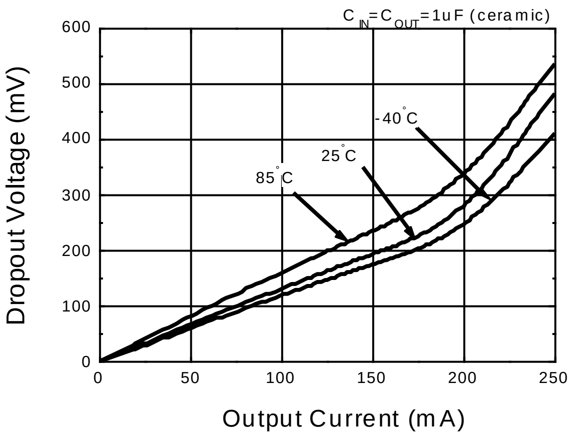
EC6209-15



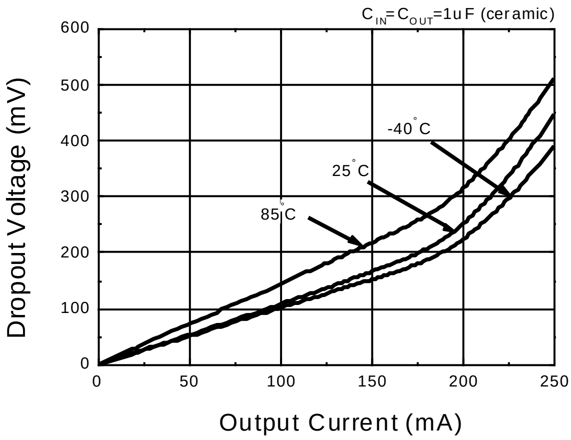
EC6209-18



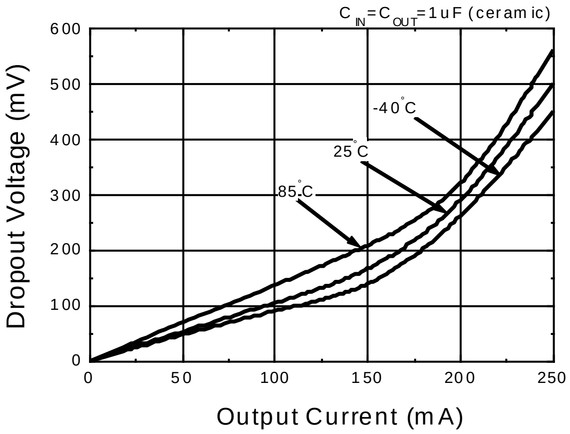
EC6209-25



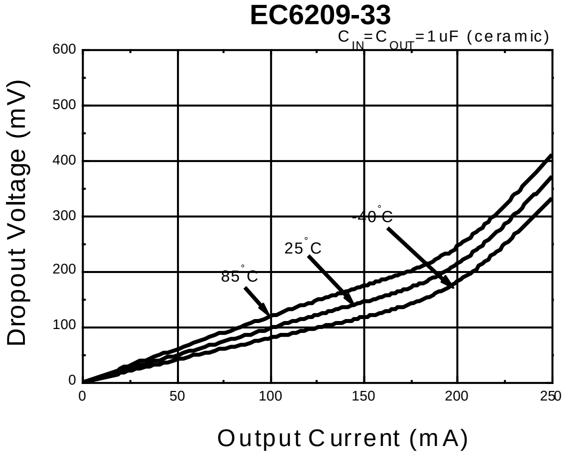
EC6209-28



EC6209-30

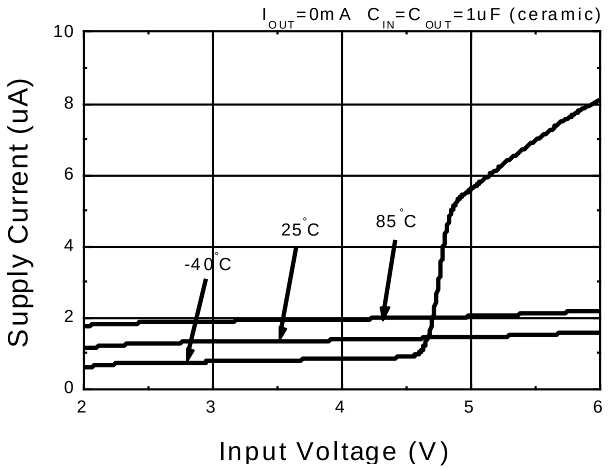


EC6209-33

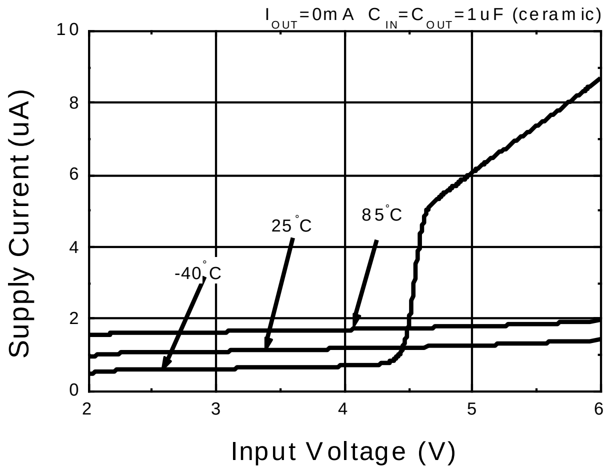


(3) Supply Current vs. Input Voltage

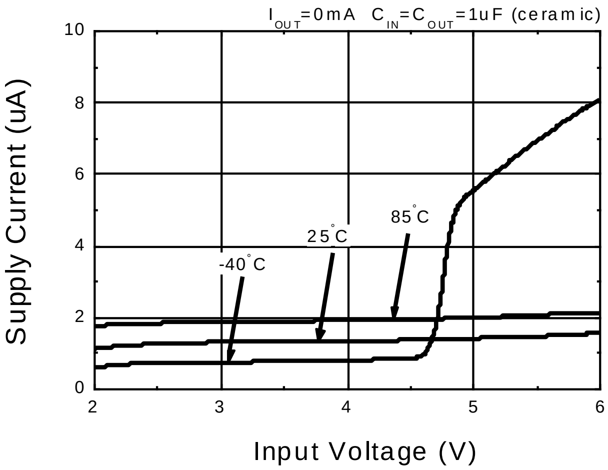
EC6209-15



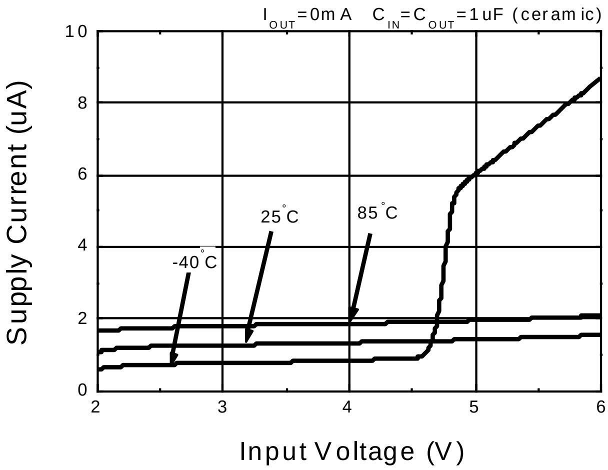
EC6209-18



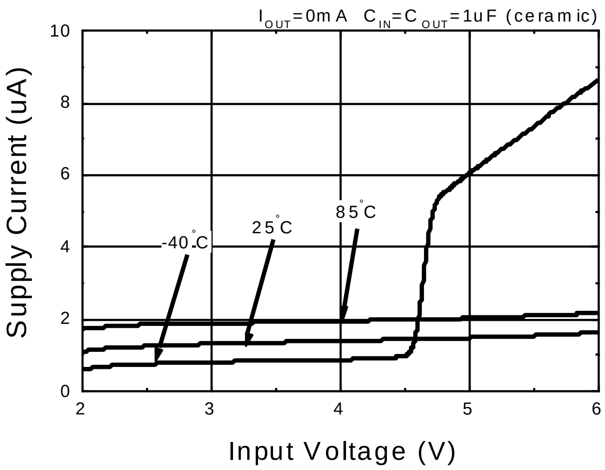
EC6209-25



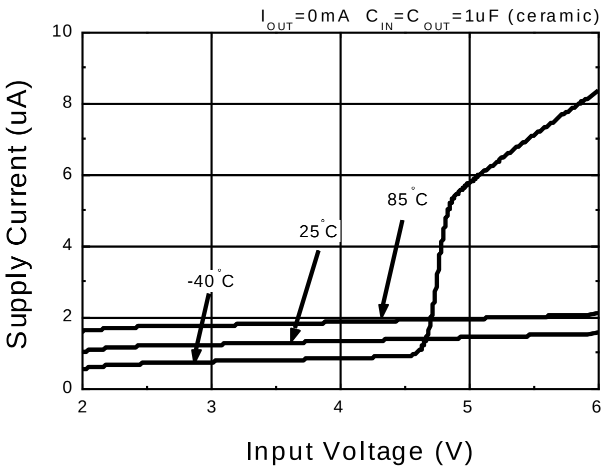
EC6209-28



EC6209-30



EC6209-33



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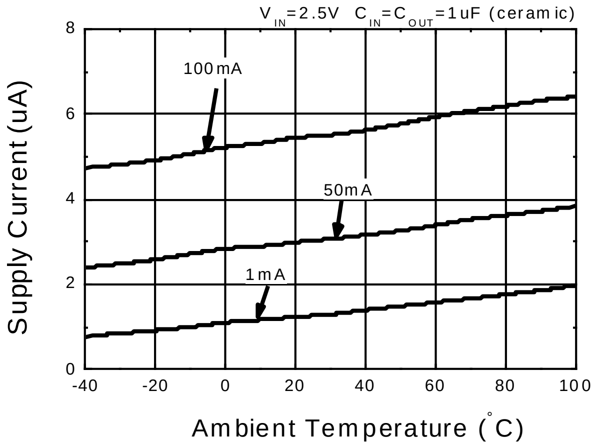
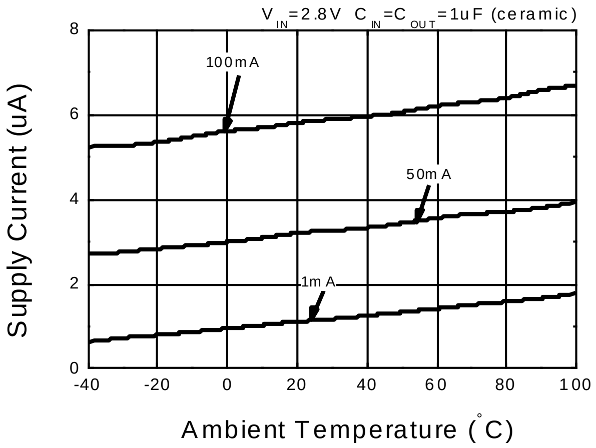
(4) Supply Current vs. Ambient Temperature

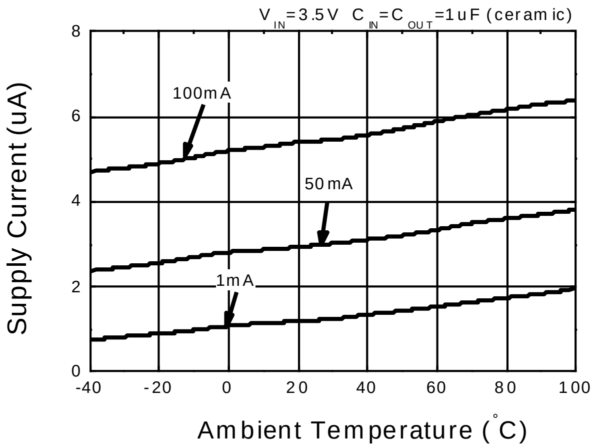
EC6209-15



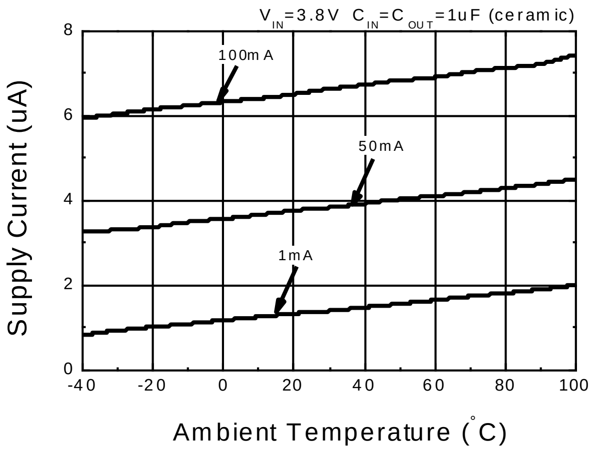
EC6209-18



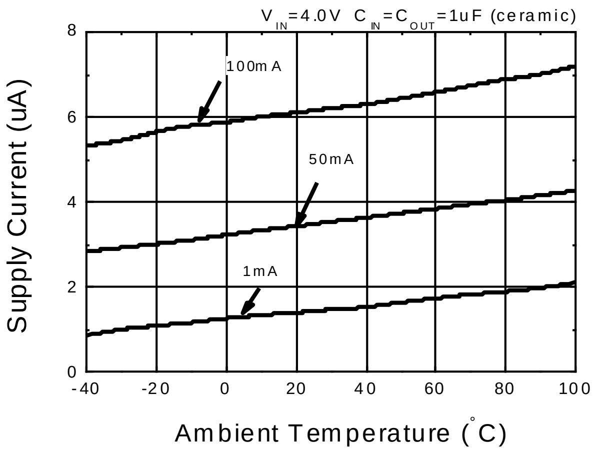
EC6209-25



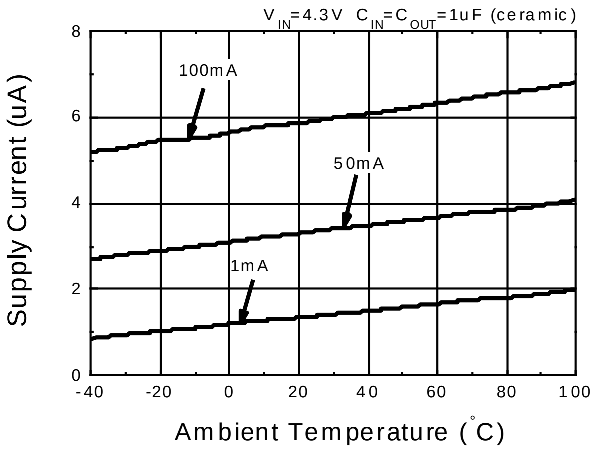
EC6209-28



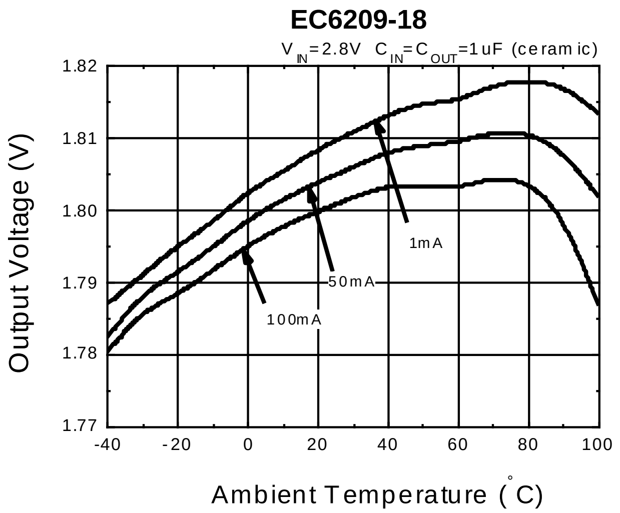
EC6209-30

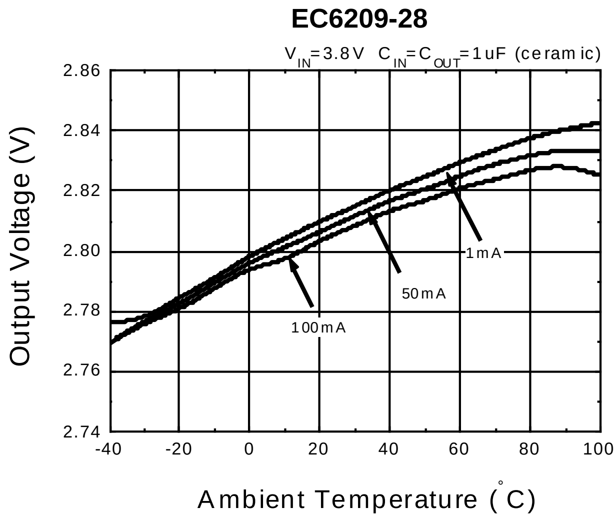


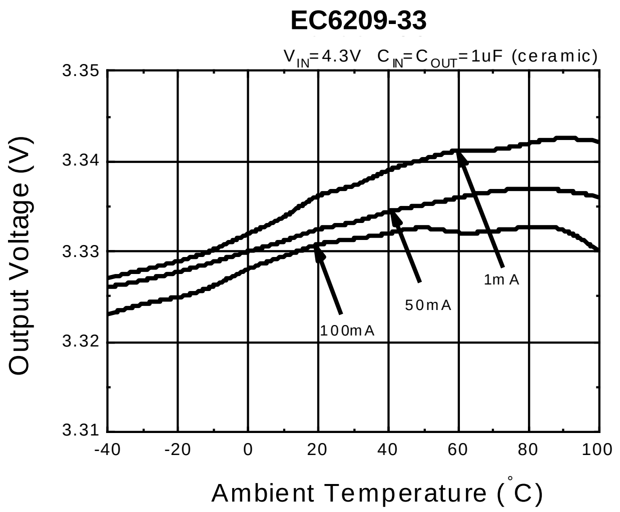
EC6209-33



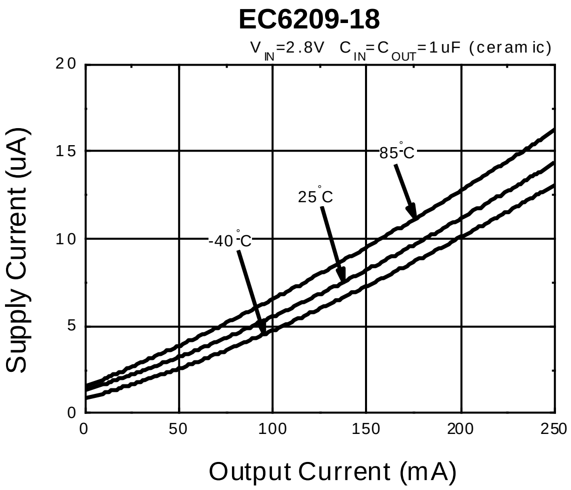
(5) Output Voltage vs. Ambient Temperature

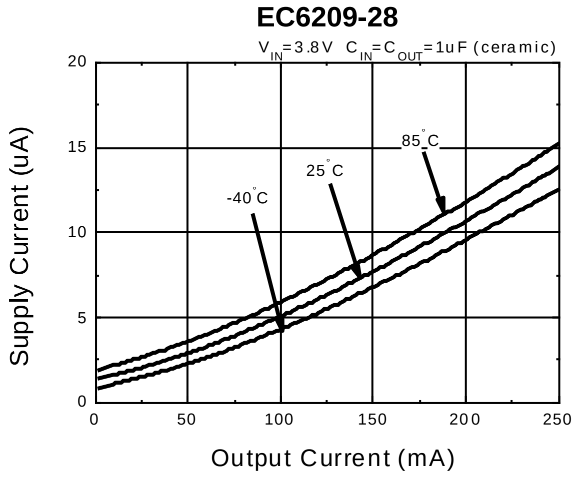


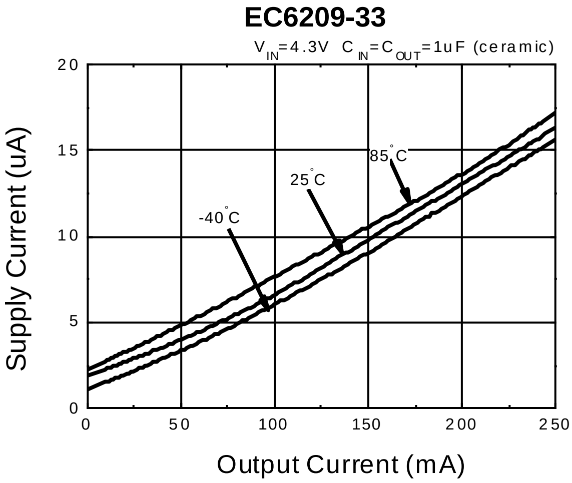




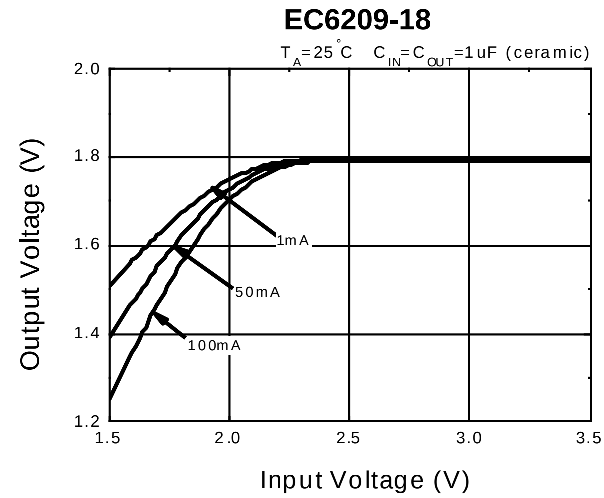
(6) Supply Current vs. Output Current

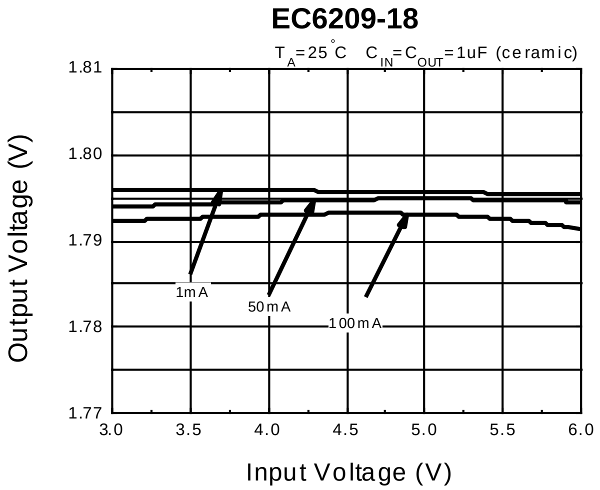


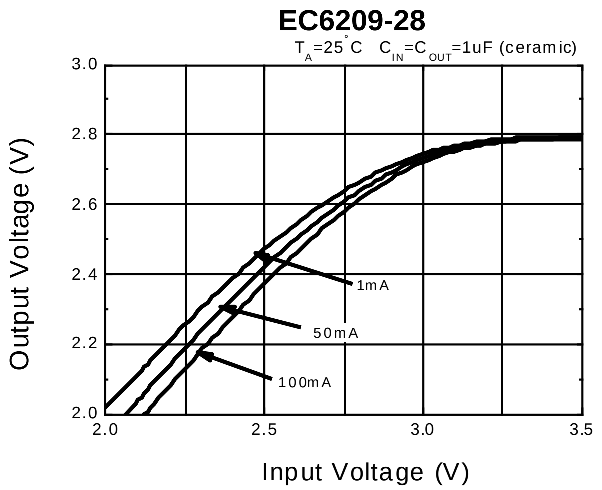


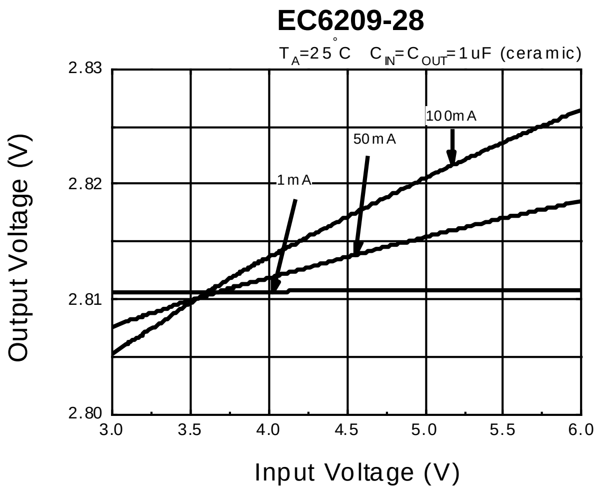


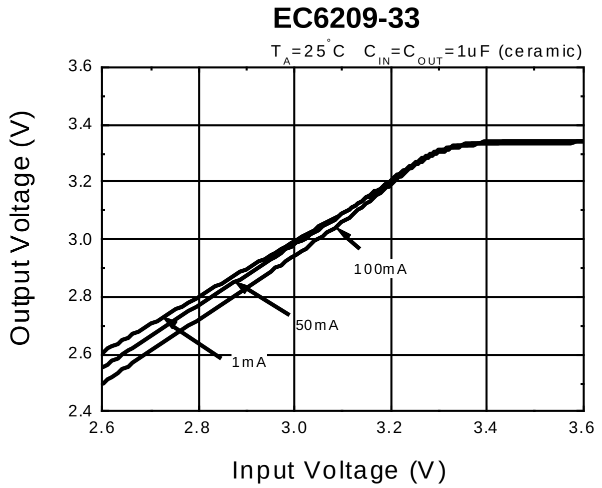
(7) Output Voltage vs. Input Voltage

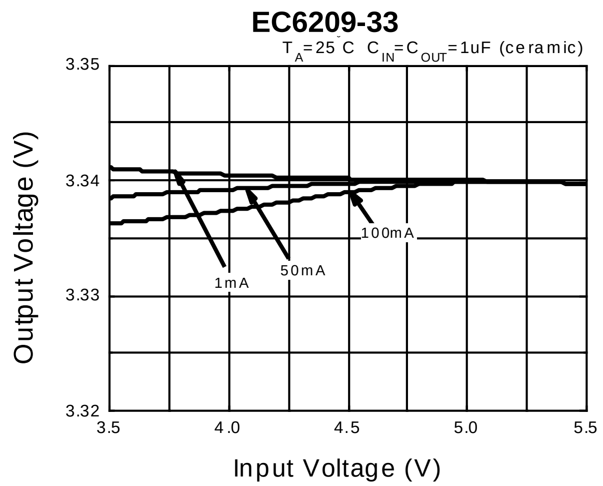












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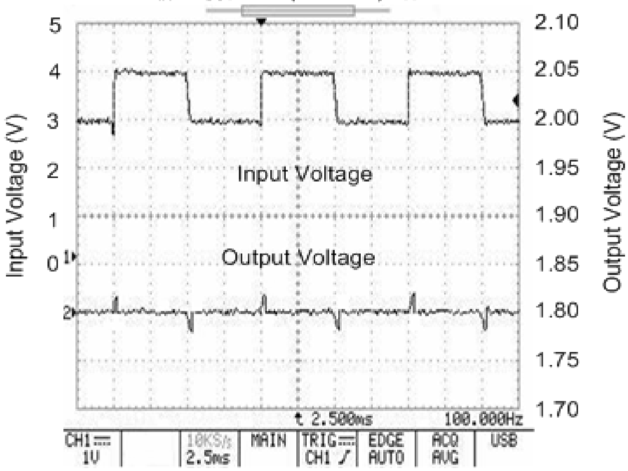
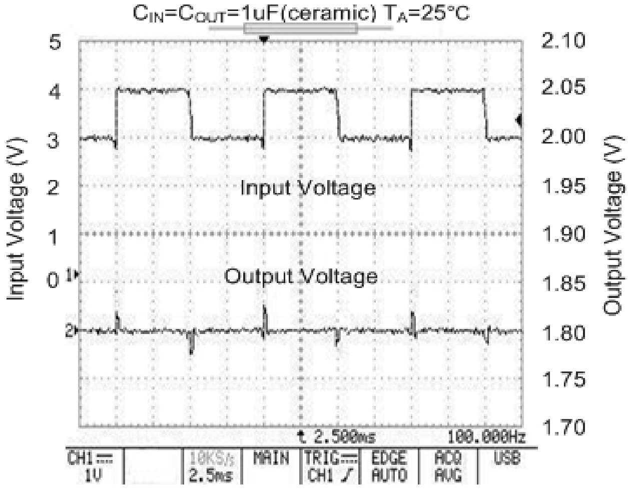
(8) Input Transient Response

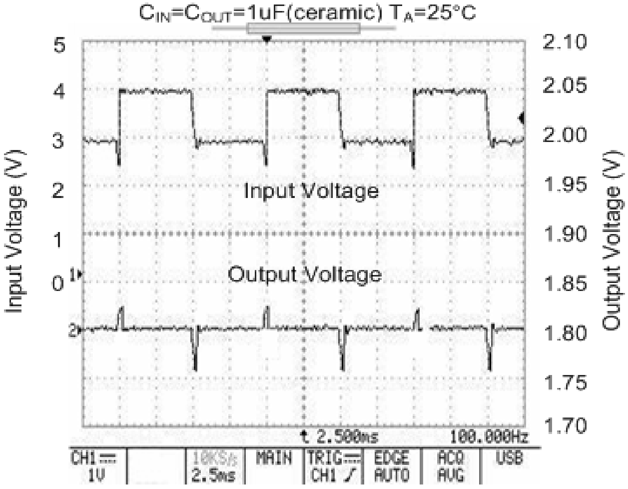
EC6209-18
V_{IN}=2.8~3.8V I_{OUT}=1mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



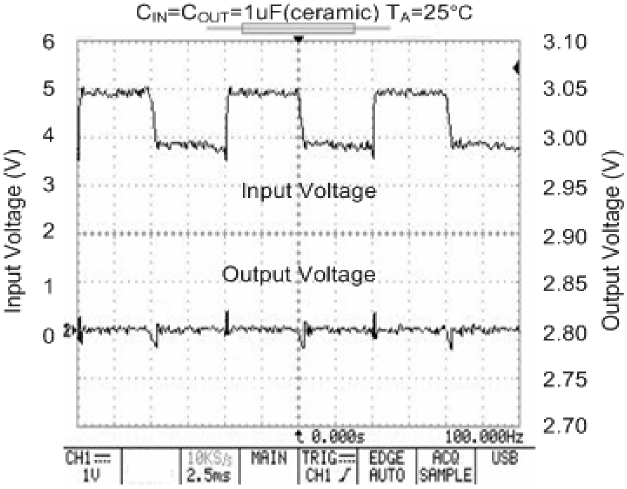
EC6209-18
V_{IN}=2.8~3.8V I_{OUT}=30mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



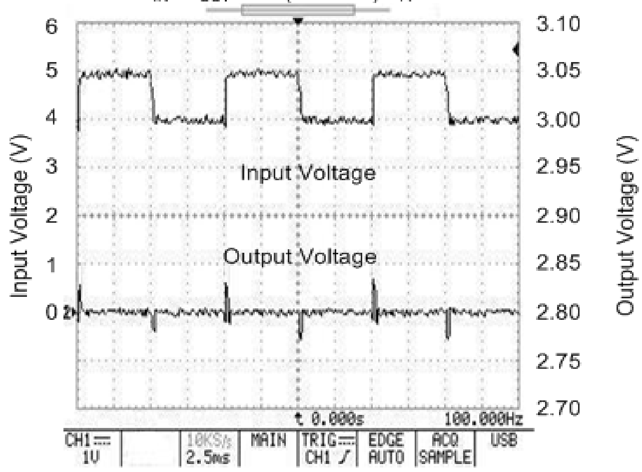
EC6209-18
V_{IN}=2.8~3.8V I_{OUT}=100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



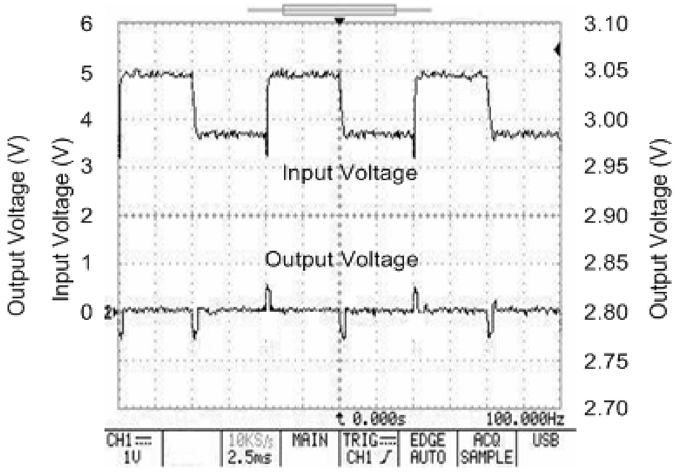
EC6209-28
V_{IN}=4~5V I_{OUT}=1mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



EC6209-28
V_{IN}=4~5V I_{OUT}=30mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

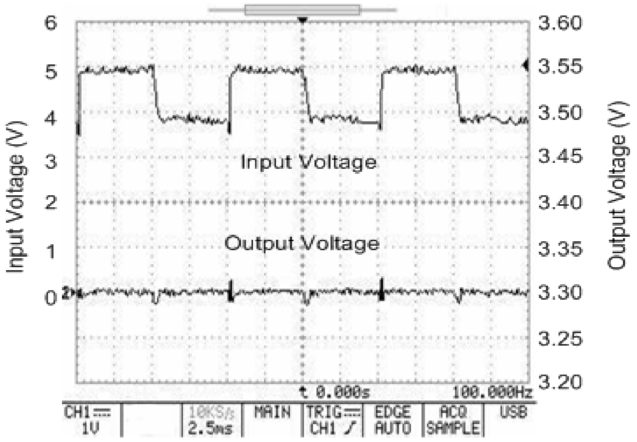


EC6209-28
V_{IN}=4~5V I_{OUT}=100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

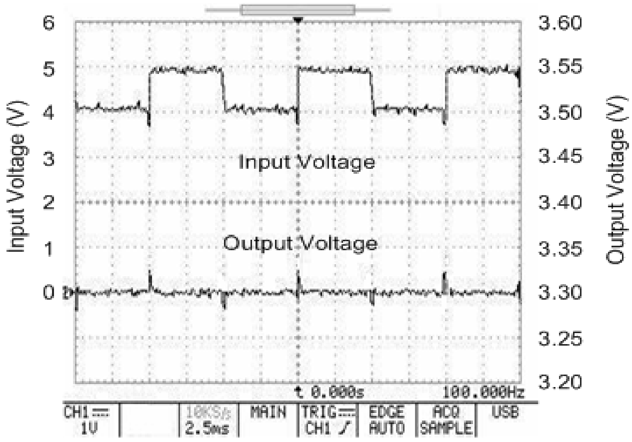


(9) Input Transient Response (Continued)

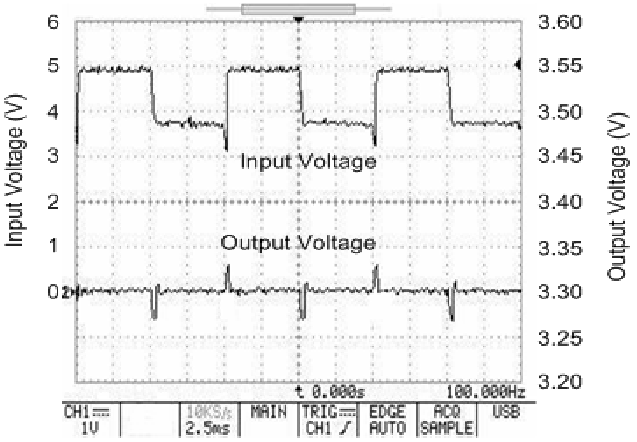
EC6209-33
V_{IN}=4~5V I_{OUT}=1mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



EC6209-33
V_{IN}=4~5V I_{OUT}=30mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

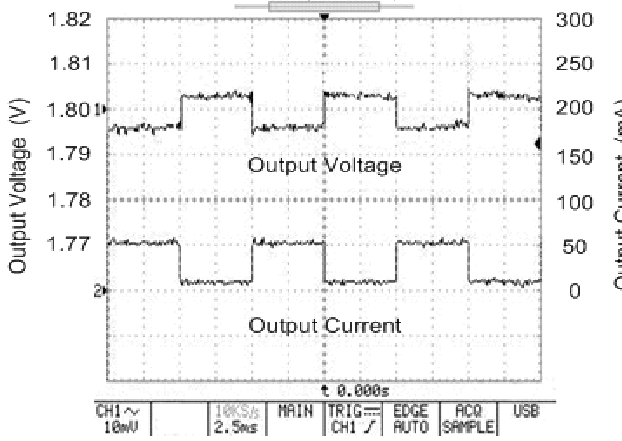


EC6209-33
V_{IN}=4~5V I_{OUT}=100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

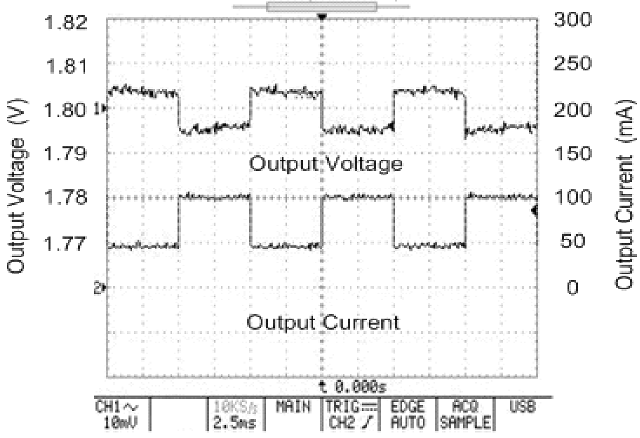


(10) Load Transient Response

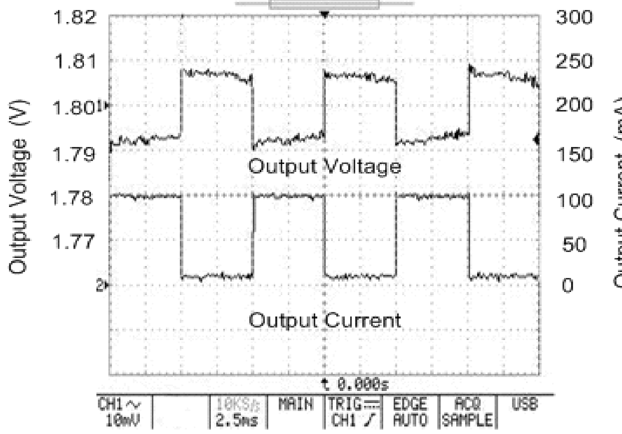
EC6209-18
V_{IN}=2.8V I_{OUT}=10mA~50mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



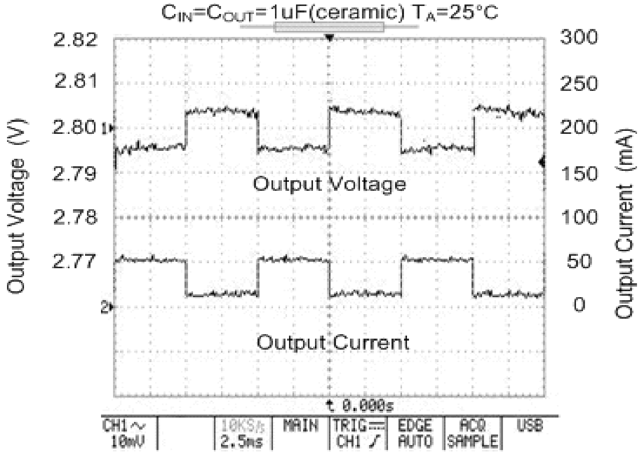
EC6209-18
V_{IN}=2.8V I_{OUT}=50mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



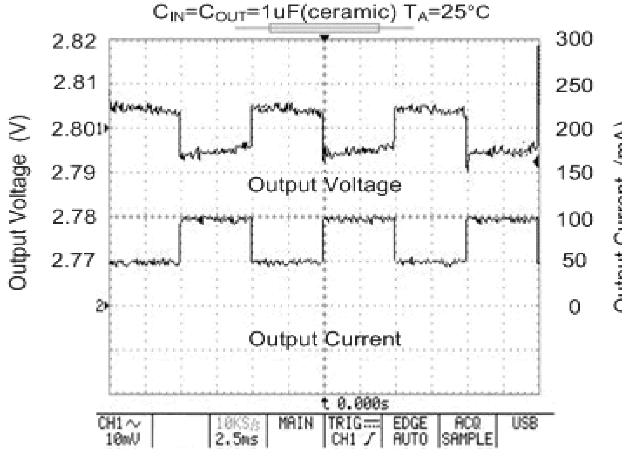
EC6209-18
V_{IN}=2.8V I_{OUT}=10mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



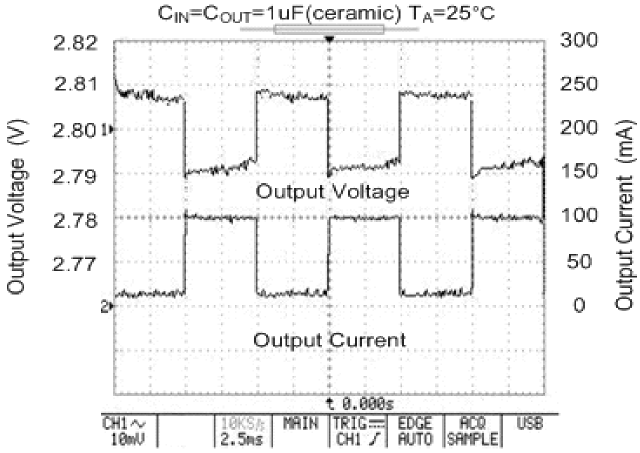
EC6209-28
V_{IN}=3.8V I_{OUT}=10mA~50mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



EC6209-28
V_{IN}=3.8V I_{OUT}=50mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



EC6209-28
V_{IN}=3.8V I_{OUT}=10mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



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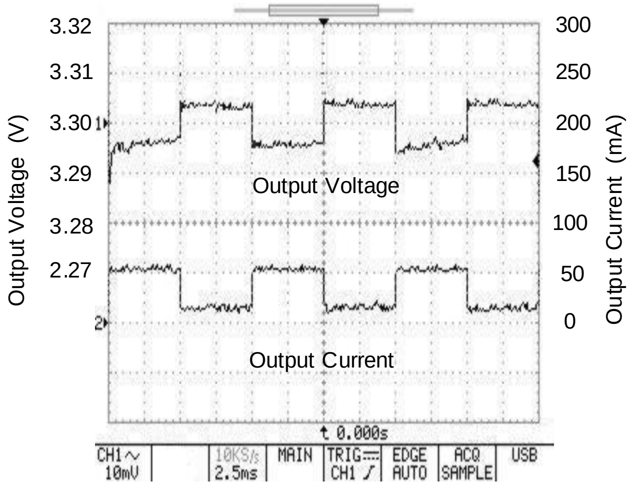
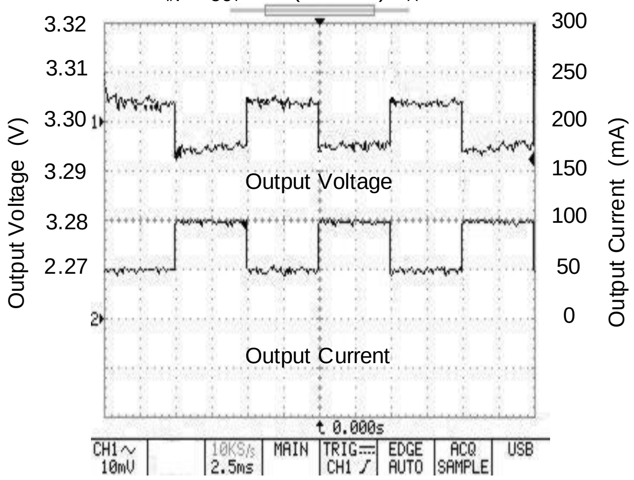
(11) Load Transient Response (Continued)

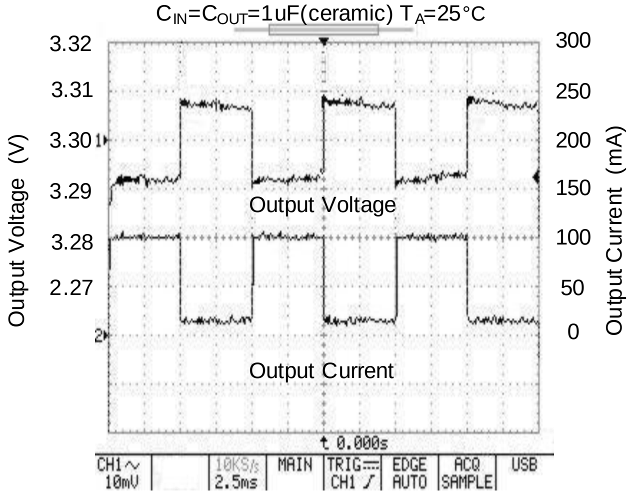
EC6209-33
V_{IN}=4.3V I_{OUT}=10mA~50mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C



EC6209-33
V_{IN}=4.3V I_{OUT}=50mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

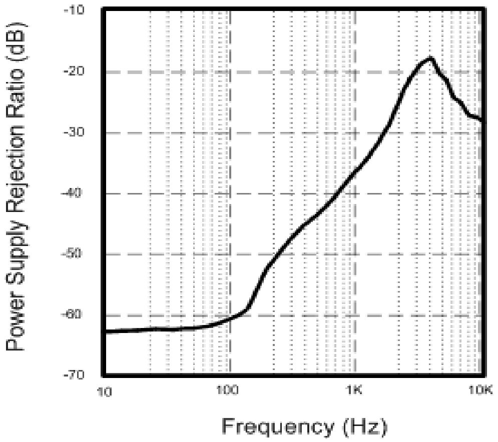


EC6209-33
V_{IN}=4.3V I_{OUT}=10mA~100mA
C_{IN}=C_{OUT}=1uF(ceramic) T_A=25°C

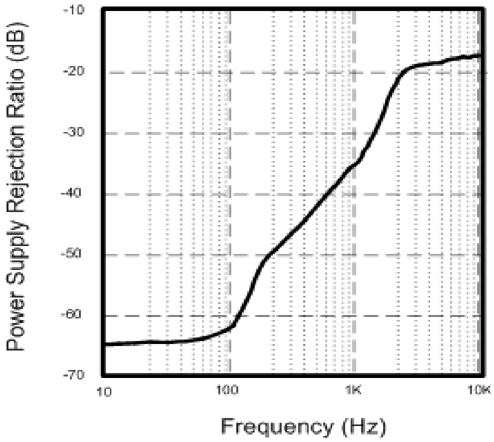


(12)Power Supply Rejection Ratio

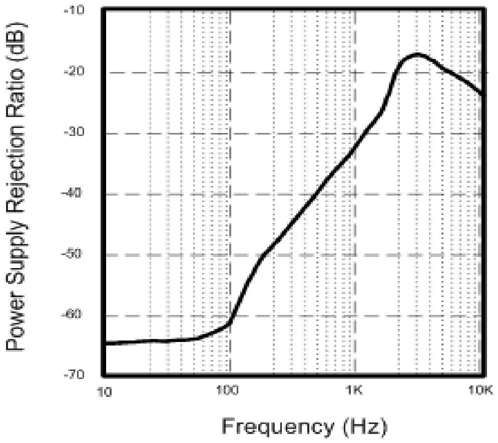
EC6209-18
V_{IN}=2.8V+0.5$V_{PP\text{-}AC}$ I_{OUT}=1mA
T_A=25℃ C_{IN}=1.0uF Cout=1.0uF



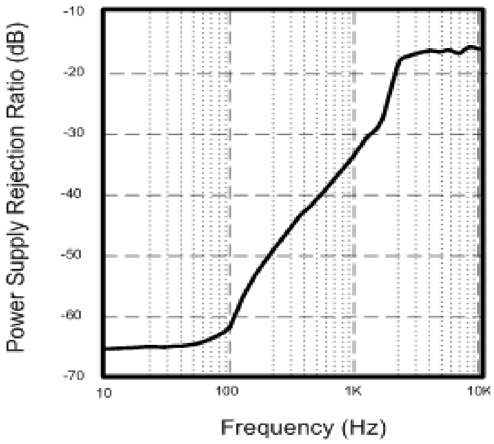
EC6209-18
V_{IN}=2.8V+0.5$V_{PP\text{-}AC}$ I_{OUT}=30mA
T_A=25℃ C_{IN}=1.0uF Cout=1.0uF



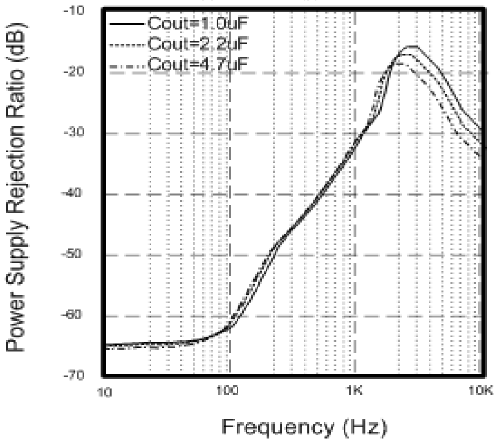
EC6209-28
V_{IN}=3.8V+0.5$V_{PP\text{-}AC}$ I_{OUT}=1mA
T_A=25℃ C_{IN}=1.0uF Cout=1.0uF



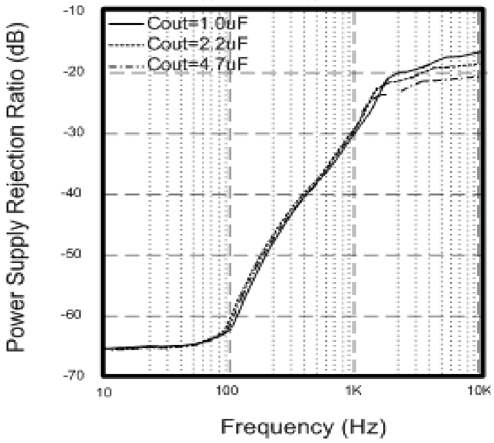
EC6209-28
V_{IN}=3.8V+0.5$V_{PP\text{-}AC}$ I_{OUT}=30mA
T_A=25℃ C_{IN}=1.0uF Cout=1.0uF



EC6209-33
V_{IN}=4.3V+0.5$V_{PP\text{-}AC}$ I_{OUT}=1mA
T_A=25℃ C_{IN}=1.0uF

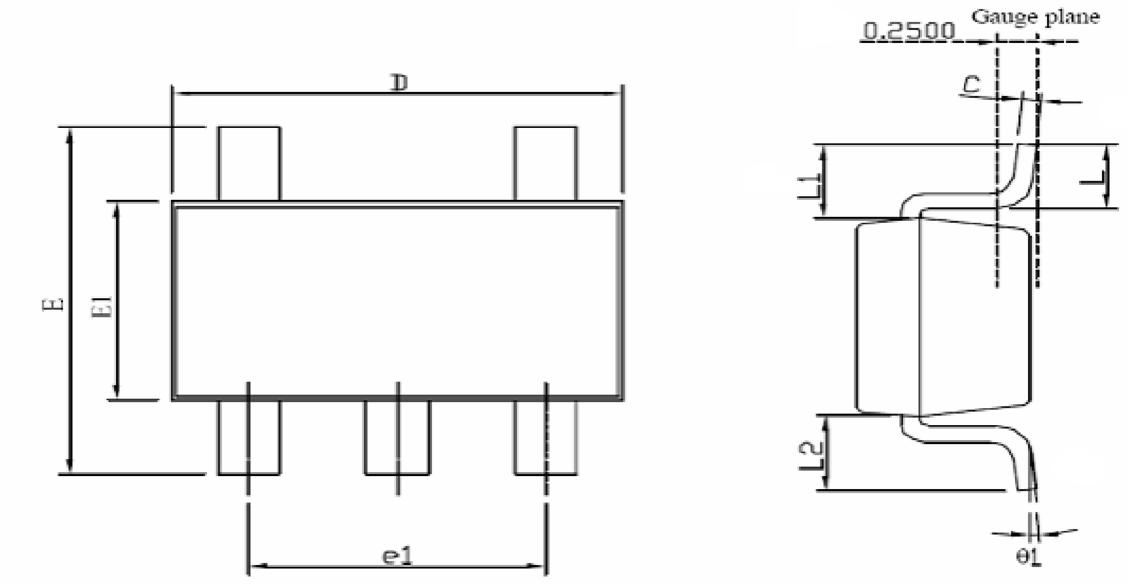


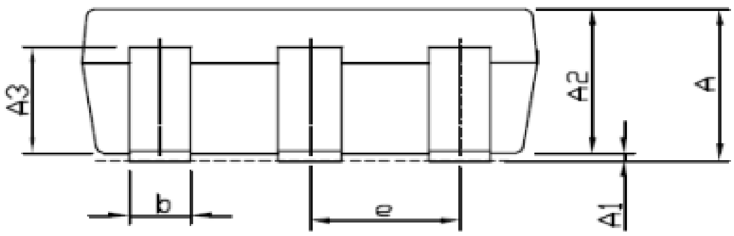
EC6209-33
V_{IN}=4.3V+0.5$V_{PP\text{-}AC}$ I_{OUT}=30mA
T_A=25℃ C_{IN}=1.0uF



Package Outline

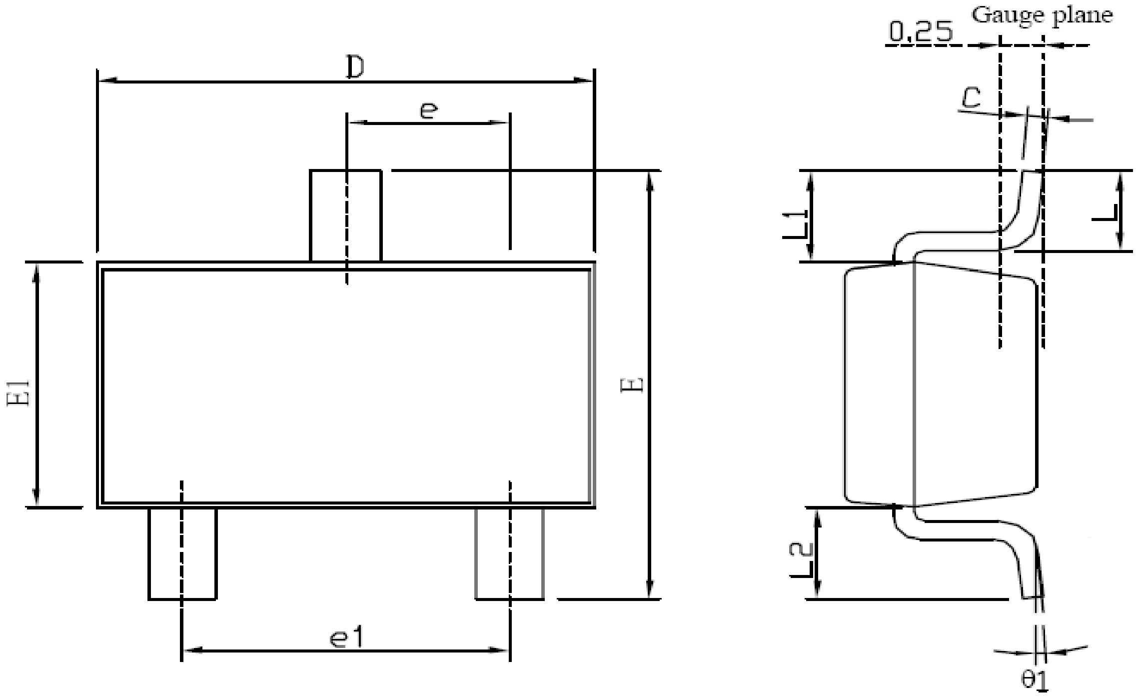
A) SOT23-5

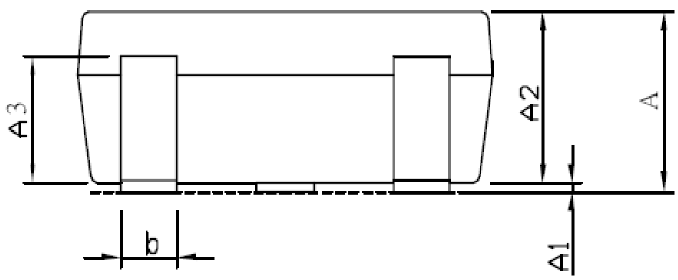




Symbols	Dimensions in Millimeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	---	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E1	1.40	1.60	1.80
e1	---	1.90(TYP)	---
E	2.60	2.80	3.00
L	0.37	---	---
θ1	1°	5°	9°
e	---	0.95(TYP)	---
L1	---	0.6(REF)	---
LI-L2	---	---	0.12

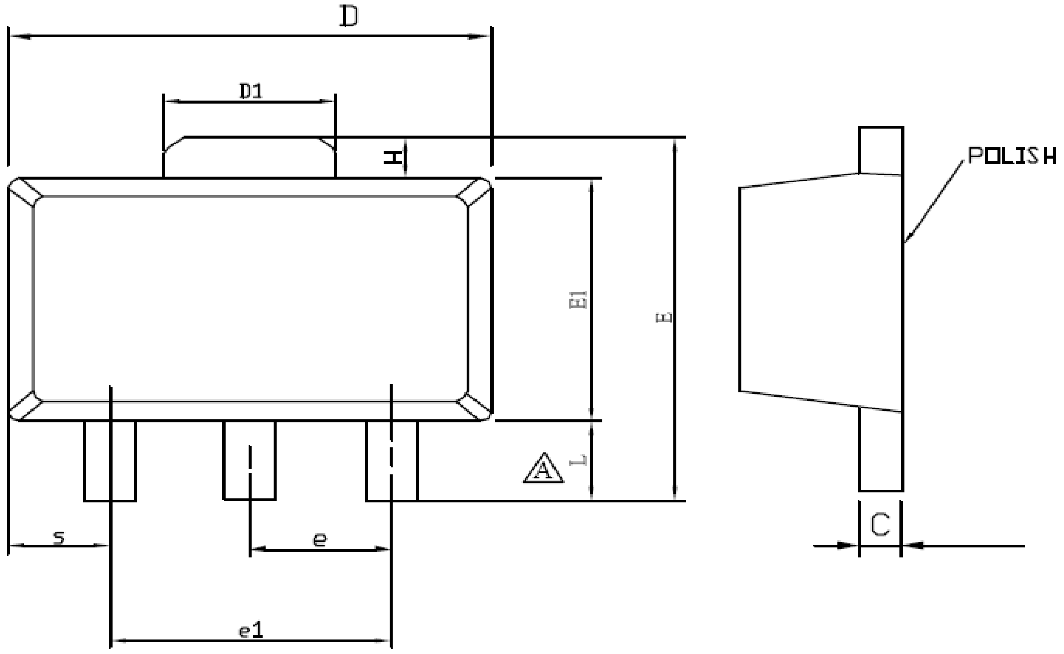
B)SOT23-3

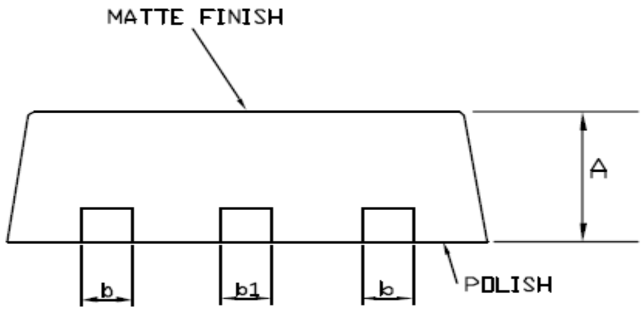




Symbols	Dimensions in Millmeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
θ1	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---	---	0.12

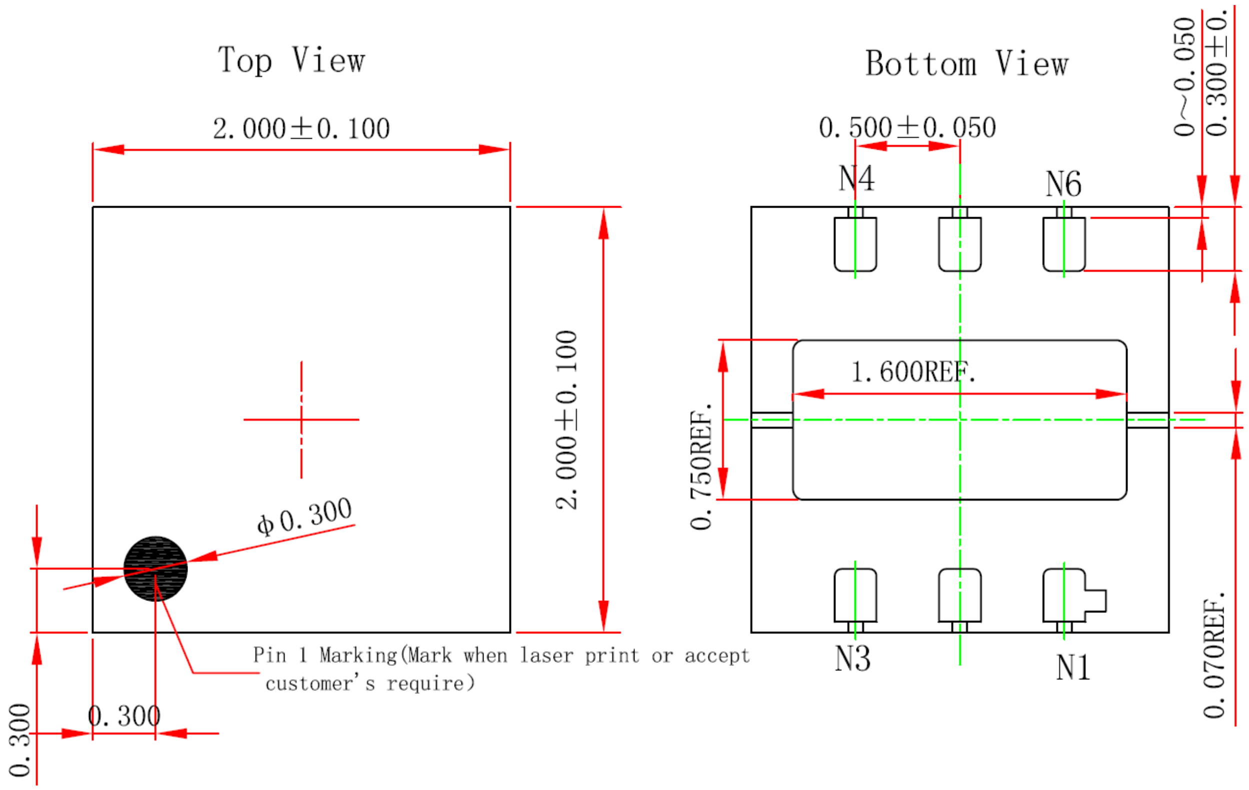
C) SOT89

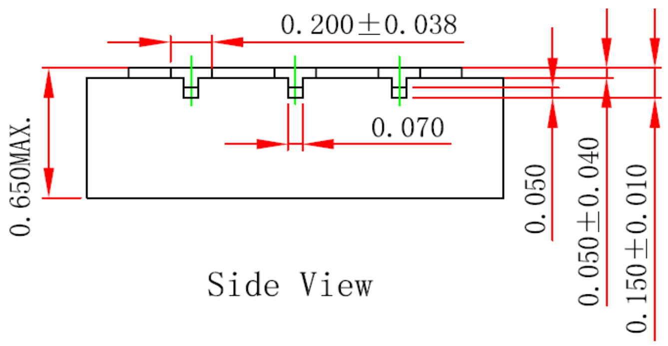




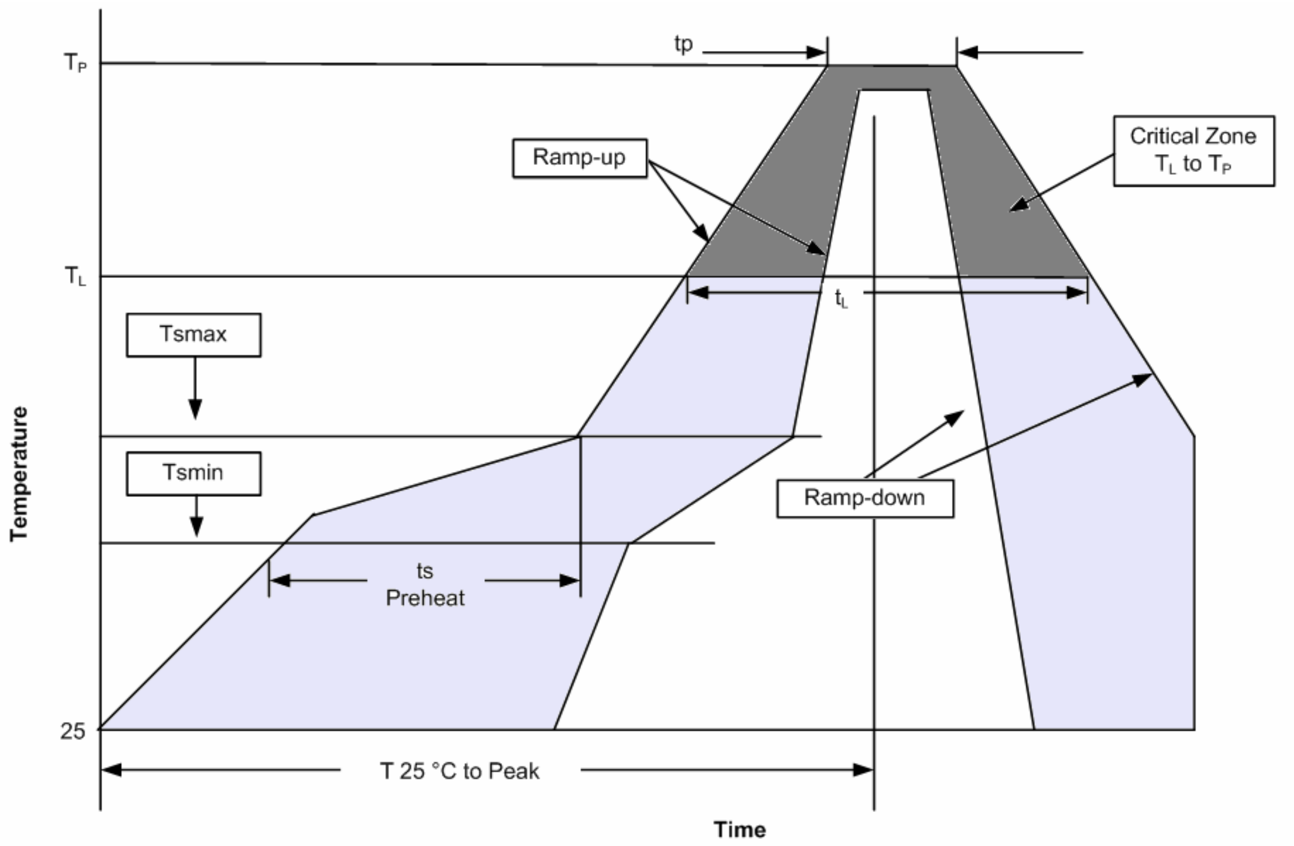
Symbol	Dimensions in millimeters			Dimensions in inches		
	Min	Nom	Max	Min	Nom	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.89	1.04	1.20	0.0350	0.041	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
E	3.64	---	4.25	0.143	---	0.167
E1	2.40	2.50	2.60	0.094	0.098	0.102
e1	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.0169	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e	1.40	1.50	1.60	0.054	0.059	0.063

D) UDFN-6


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


0.200±0.038
0.070
0.650MAX.
0.050
0.050±0.040
0.150±0.010
Side View

Reflow Condition (IR/Convection or VPR Reflow)



Classification Reflow Profiles

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