WIDE INPUT VOLTAGE RANGE, 150mA ULDO REGULATOR

Description

The AP2204 series is a positive voltage regulator IC fabricated by high voltage EPNP process.

The AP2204 has features of wide input voltage range, high accuracy, high ripple rejection, low dropout voltage, low noise, current limit and ultra-low quiescent current which make it ideal for use in various USB and portable devices.

The IC consists of a voltage reference, an error amplifier, a resistor network for setting output voltage, a current limit circuit for current protection, and a chip enable circuit.

The AP2204 has 1.5V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V, 5.0V fixed voltage versions and adjustable voltage version.

The AP2204 is available in space-saving SOT-23-5, SOT-89 and PSOP-8 packages.

Features

- Wide Input Voltage Range: 2.6V to 24V
- Wide Output Voltage Range: 1.24V to 22V
- Excellent Ripple Rejection: 60dB @ f = 1kHz
- Low Dropout Voltage: V_{DROP} = 100mV @ I_{OUT} = 100μA
- Low Ground Current
- High Output Voltage Accuracy
- Compatible with Low ESR Ceramic Capacitor
- Excellent Line/Load Regulation
- Thermal Shutdown Function
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e. parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please contact us or your local Diodes representative.**
  https://www.diodes.com/quality/product-definitions/

Applications

- Battery-powered Equipment
- Laptop, Palmtops, Notebook Computers
- Portable Information Appliances

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments

(Top View)
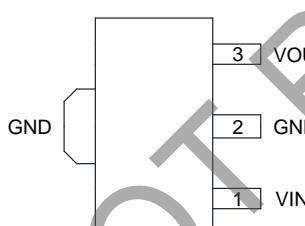
SOT-89 (Option 1)
R (Note 4)

3 VOUT
2 GND
1 VIN
GND
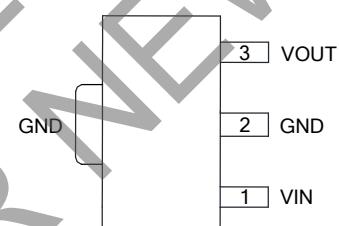
(Top View)

SOT-89 (Option 2)
R (Note 4)

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2 GND
1 VIN
GND
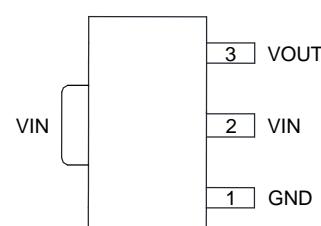
(Top View)

SOT-89 (Option 2)
RA (Note 5)

3 VOUT
2 VIN
1 GND
VIN
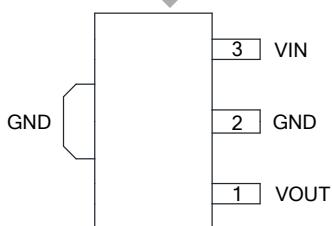
(Top View)

SOT-89 (Option 1)
RB (Note 4)

3 VIN
2 GND
1 VOUT
GND

(Top View)

SOT-89 (Option 2)
RB (Note 4)

3 VIN
2 GND
1 VOUT
GND

(Top View)

SOT-23-5

VIN 1
GND 2
EN 3
5 VOUT
4 ADJ/NC

(Top View)

PSOP-8

VOUT 1
NC 2
NC 3
ADJ/NC 4
Exposed Pad (Note 6)
8 VIN
7 GND
6 NC
5 EN
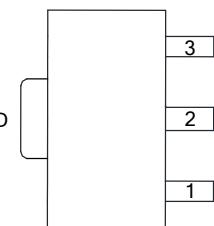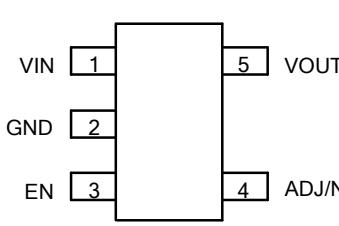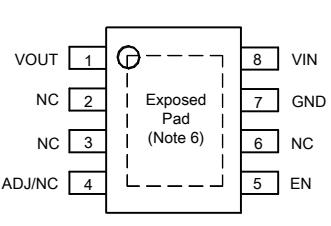
Notes:
4. The substrate/exposed pad should be connected to GND.
5. The substrate/exposed pad should be connected to VIN.
6. The exposed pad should be connected to GND for better dissipation.

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Typical Applications Circuit

$$V_{OUT}=V_{REF}(1+(R1/R2))$$

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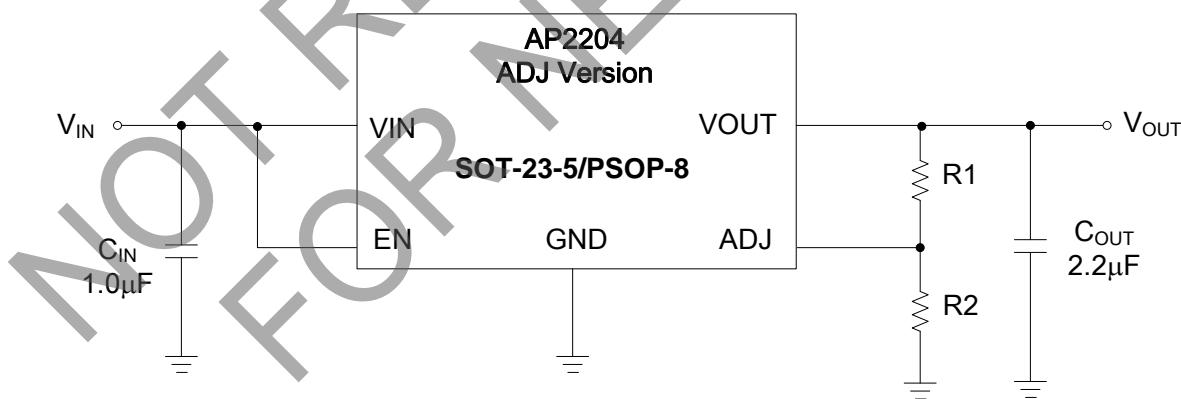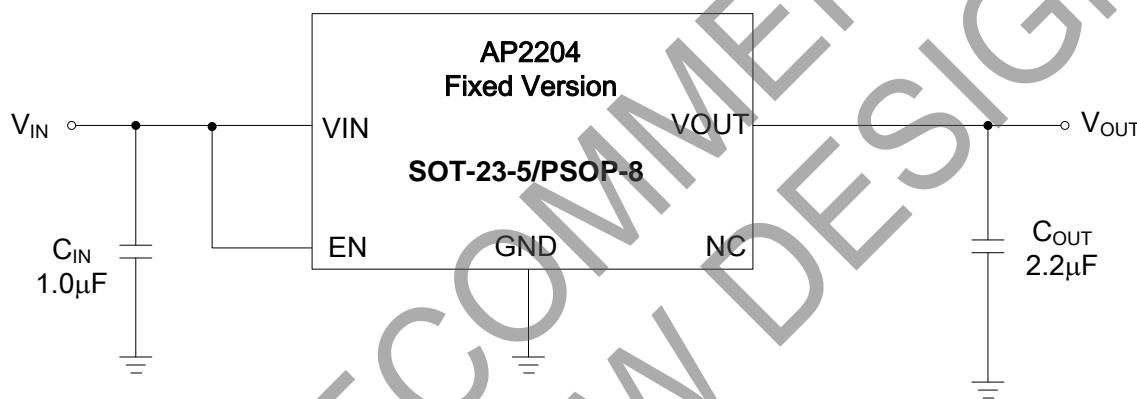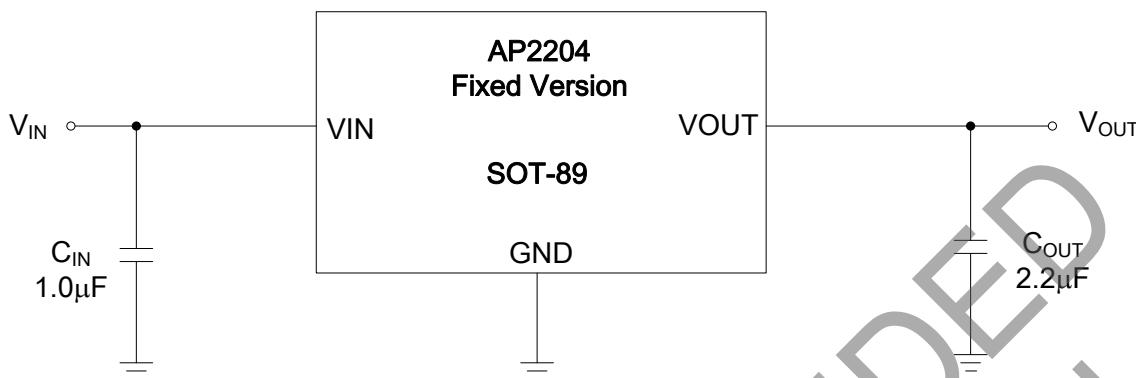
Pin Descriptions

Pin Number					Pin Name	Function
SOT-23-5	PSOP-8	SOT-89				
		R	RA	RB		
1	8	1	2	3	VIN	Input voltage
2	7	2	1	2	GND	Ground
3	5	—	—	—	EN	Enable input

4	4	—	—	—	ADJ/NC	ADJ- Adjust output for ADJ version
						NC- Not connected for fixed version, Not Connected internally.
						  Recommend connection to GND to maximize PCB copper
						  for thermal dissipation.

5	1	3	3	1	VOUT	Regulated output voltage

Functional Block Diagram

A (B) {C} [D] <E>
A for SOT-23-5
B for SOT-89 (R)
C for SOT-89 (RA)
D for PSOP-8
E for SOT-89 (RB)

Fixed Output Voltage

A (B)
A for SOT-23-5
B for PSOP-8

Adjustable Output Voltage

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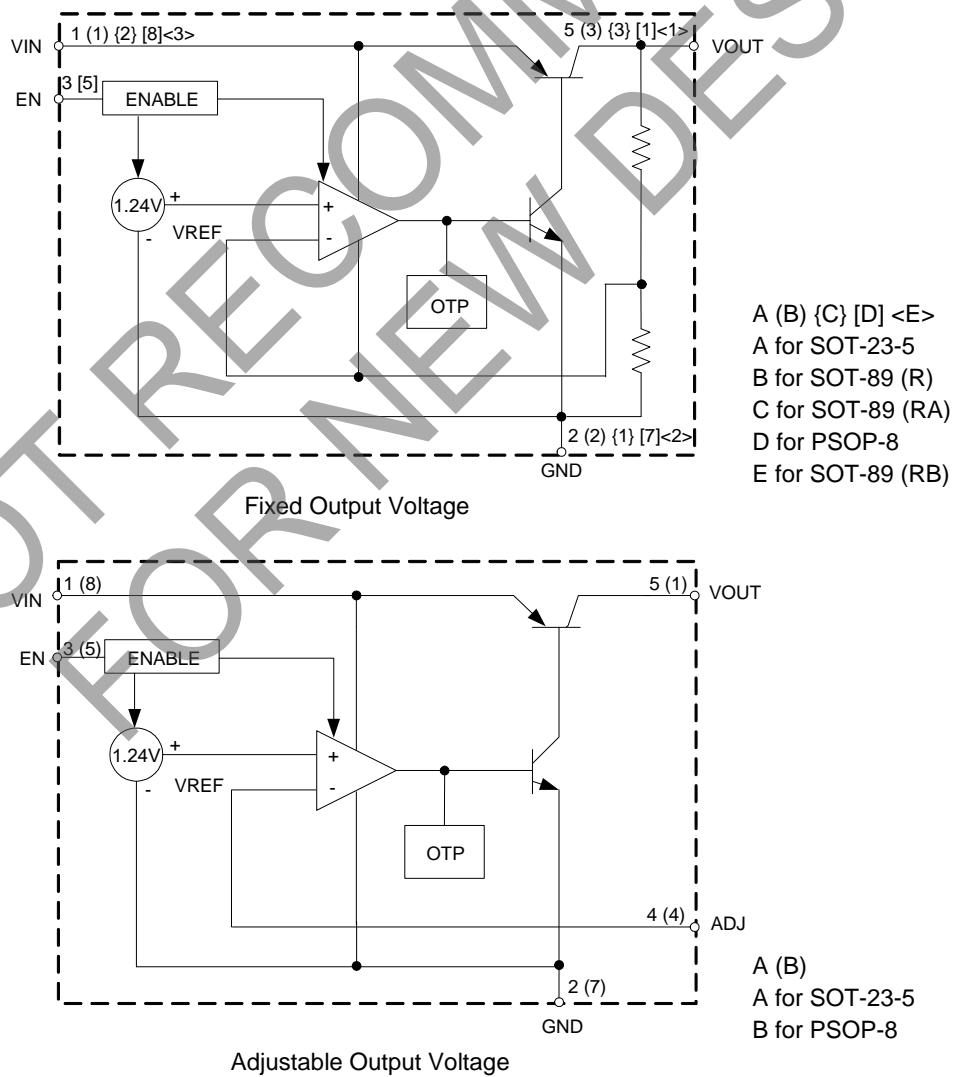
Absolute Maximum Ratings (Note 7)

Symbol	Parameter	Rating		Unit
V$_{IN}$	Supply Input Voltage	38		V
V$_{CE}$	Enable Input Voltage	38		V
I$_{OUT}$	Output Current	250		mA
T$_{LEAD}$	Lead Temperature (Soldering, 10sec)	+260		°C
T$_J$	Operating Junction Temperature	+150		°C
θ$_{JA}$	Thermal Resistance	SOT-23-5	250	°C/W
		SOT-89	165	
		PSOP-8 (Note 8)	51	
T$_{STG}$	Storage Temperature Range	-65 to +150		°C
—	ESD (Machine Model)	275		V
—	ESD (Human Body Model)	2000		V

Notes: 7. Stresses greater than those listed under "*Absolute Maximum Ratings*" can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "*Recommended Operating Conditions*" is not implied. Exposure to "*Absolute Maximum Ratings*" for extended periods can affect device reliability.
8. θ$_{JA}$ is measured with the component mounted on a 2-Layer FR-4 PCB board with 1.5cm*1.5cm thermal sink pad in free air.

Recommended Operating Conditions

| Symbol	Parameter	Min	Max	Unit
V$_{IN}$	Supply Input Voltage	2.6 (Note 9)	24	V
T$_J$	Operating Junction Temperature	-40	+125	°C

Note: 9. Minimum recommended input voltage is the larger of 2.6V or V$_{OUT}$ + 1V. Below this value the device may enter drop-out conditions and cease to regulate the output voltage correctly.

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Electrical Characteristics (@V_{IN} = V_{OUT}+1V, T_J = +25°C, I_{OUT} = 100µA, C_{IN} = 1.0µF, C_{OUT} = 2.2µF, **Bold** typeface applies over -40°C ≤ T_J ≤ +125°C, unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{OUT}	Output Voltage	Variation from Specified V_{OUT}	V_{OUT} ×98%	—	V_{OUT} ×102%	V
V_{REF}	Reference Voltage	—	1.215	1.24	1.265	V
V_{IN}	Input Voltage	—	—	—	24	V
$I_{OUT(max)}$	Maximum Output Current	V_{IN}-V_{OUT} = 1V, V_{OUT} = 98% × V_{OUT}	150	200	—	mA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT}+1V ≤ V_{IN} ≤ 24V	—	0.05	—	%
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	1mA ≤ I_{OUT} ≤ 150mA	—	0.5	—	%
V_{DROP}	Dropout Voltage	I_{OUT} = 100µA	—	100	150	mV
		I_{OUT} = 50mA	—	270	350	
		I_{OUT} = 100mA	—	320	460	
		I_{OUT} = 150mA	—	360	500	
I_{GND}	Ground Current	I_{OUT} = 0A	—	20	—	µA
		I_{OUT} = 100µA	—	50	—	
		I_{OUT} = 50mA	—	0.5	—	mA
		I_{OUT} = 100mA	—	1.3	—	
		I_{OUT} = 150mA	—	2.5	—	
I_{STD}	Standby Current	V_{IN} = V_{OUT}+1V V_{EN} in OFF Mode	—	0.01	1.0	µA
PSRR	Power Supply Rejection Ration	Ripple 0.5V_{P-P} V_{IN} = V_{OUT}+1V	f = 100Hz	—	60	—	dB
			f = 1kHz	—	60	—	
$\Delta V_{OUT}/(V_{OUT}×\Delta T)$	Output Voltage Temperature Coefficient	I_{OUT} = 100µA, -40 °C ≤ T_J ≤ +125°C	—	**±100**	—	ppm/°C
V_{NOI}	RMS Output Noise	T_J = +25°C, 10Hz ≤ f ≤ 100kHz	—	30	—	µV$_{rms}$
I_{ADJ}	ADJ Pin Current	I_{OUT} = 100µA	—	0.5	—	µA
I_{EN}	EN Pin Current	V_{EN} = V_{OUT}+1V	—	1	—	µA
—	EN "High" Voltage	EN Input Voltage "High"	2.0	—	—	V
—	EN "Low" Voltage	EN Input Voltage "Low"	—	—	0.4	V
θ_{JC}	Thermal Resistance (Junction to Case)	SOT-23-5	—	43	—	°C/W
		SOT-89	—	27	—	
		PSOP-8	—	22	—	

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## Performance Characteristics

### Output Voltage vs. Output Current
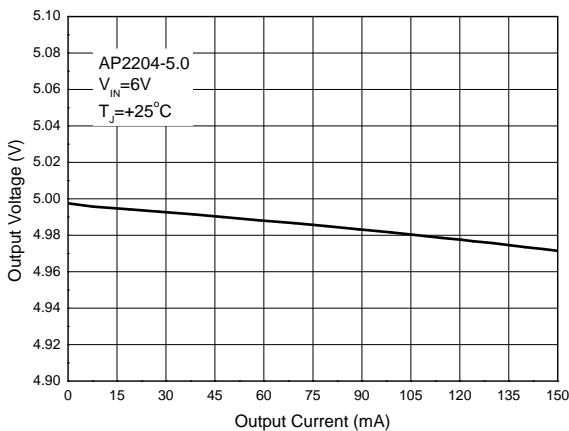
Output Voltage vs. Output Current
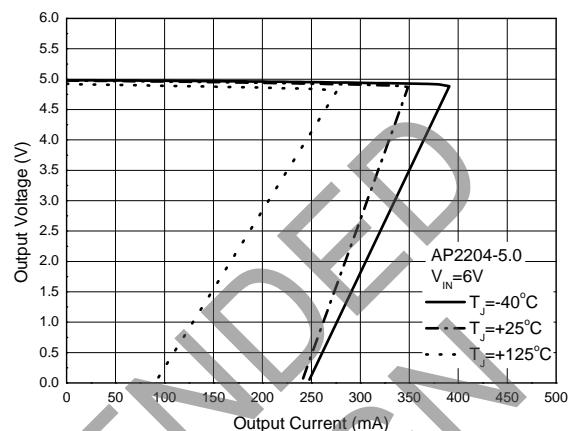

Output Voltage vs. Output Current
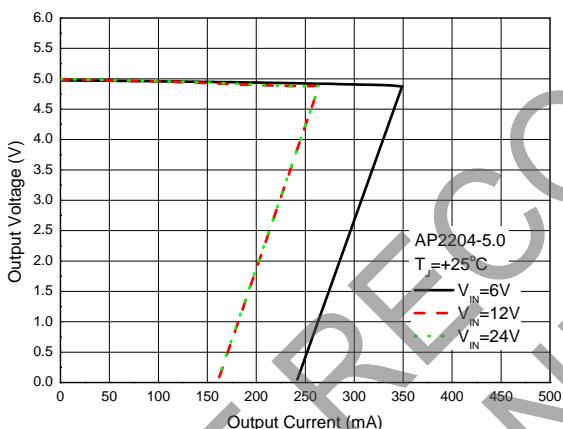
Dropout Voltage vs. Output Current
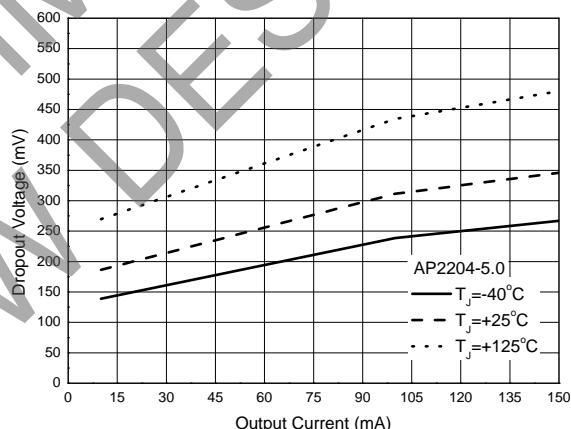

Dropout Voltage vs. Junction Temperature

### Output Voltage vs. Input Voltage

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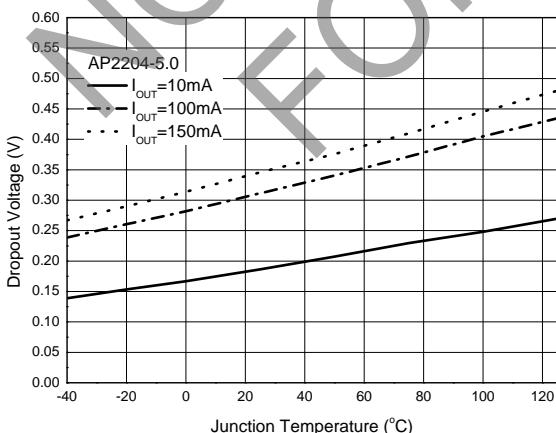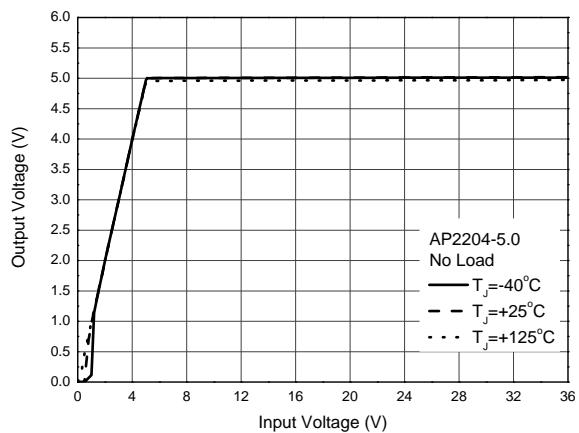
Performance Characteristics (continued)

### Output Voltage vs. Input Voltage
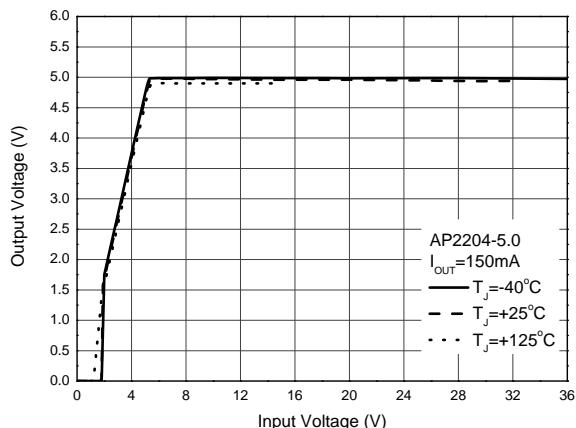
Output Voltage vs. Junction Temperature
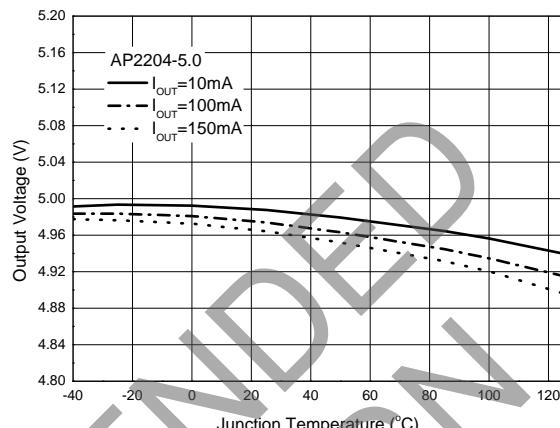

Supply Current vs. Input Voltage
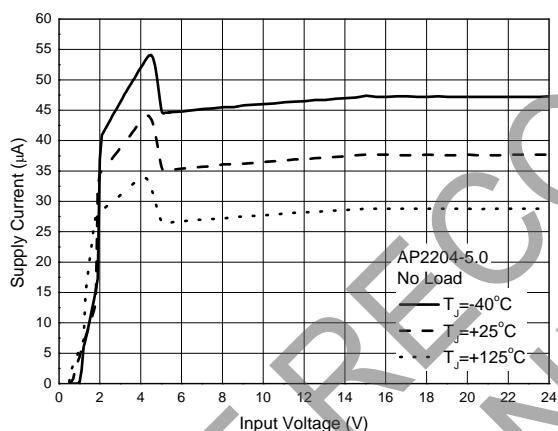
Ground Current vs. Junction Temperature
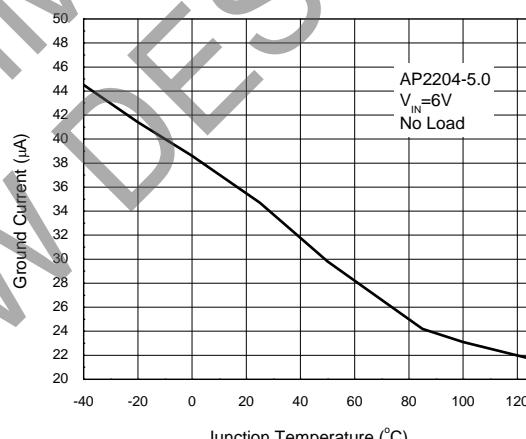

Ground Current vs. Output Current
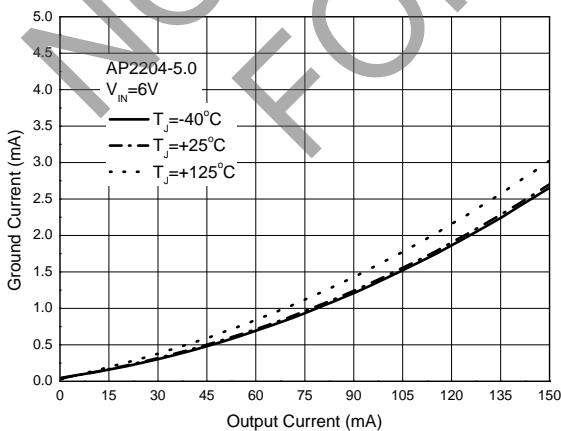

Enable Current vs. Enable Input Voltage

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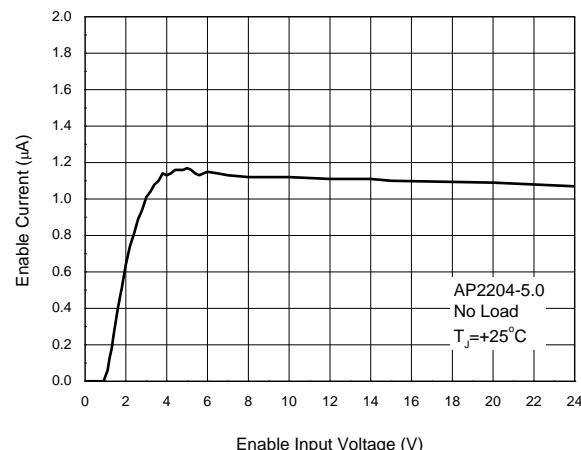
Performance Characteristics (continued)

Line Transient
**(Conditions: V_IN=V_EN=3.5V to 8V, C_IN=1.0µF, C_OUT=2.2µF, I_OUT=1mA)**
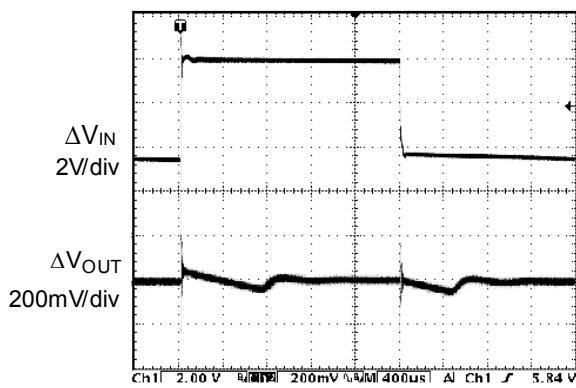
Line Transient
(Conditions: V_IN=V_EN=5V to 15V, C_IN=1.0µF, C_OUT=2.2µF, I_OUT=1mA)
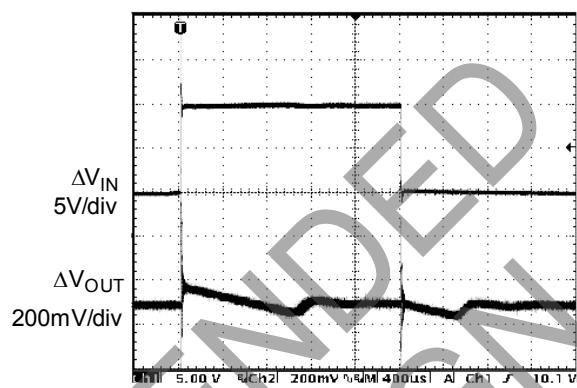
Load Transient
(Conditions: V_IN=5V, C_IN=1.0µF, C_OUT=2.2µF, I_OUT=1mA to 50mA)
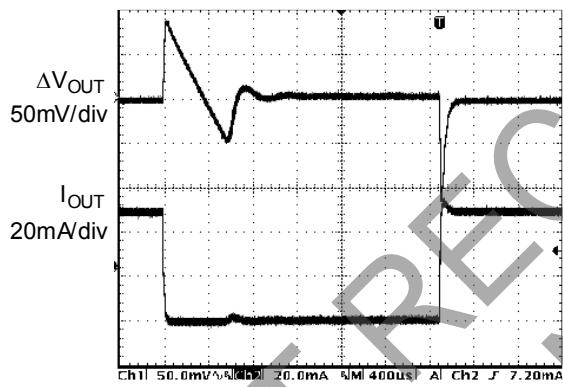
Load Transient
(Conditions: V_IN=5V, C_IN=1.0µF, C_OUT=2.2µF, I_OUT=1mA to 150mA)
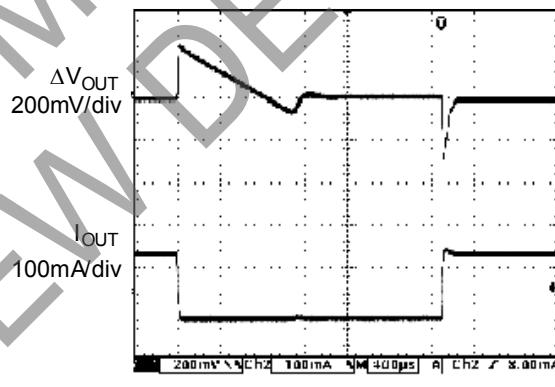
Enable Input Response

Start-up Response

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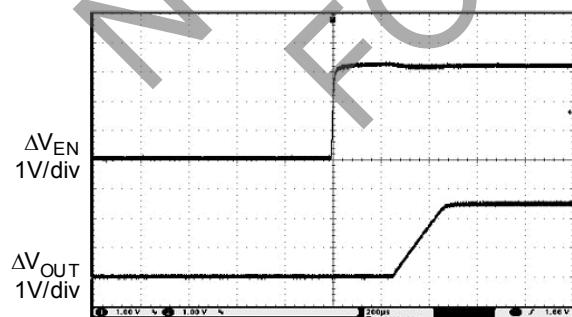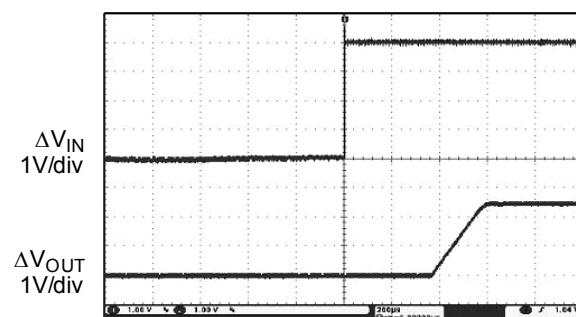
Performance Characteristics (continued)

PSRR vs. Frequency
(Conditions: V_PP=2V, I_OUT=10mA)
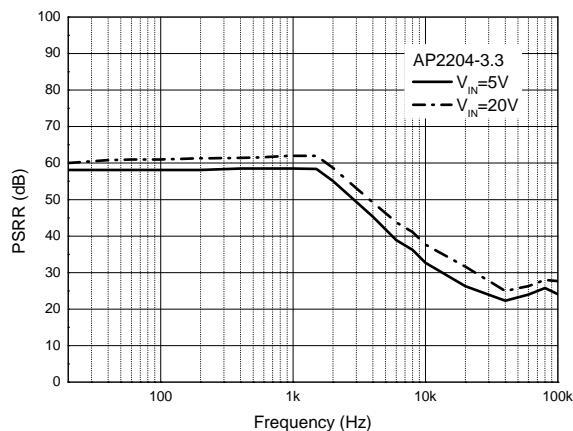
Output Voltage vs. Output Current
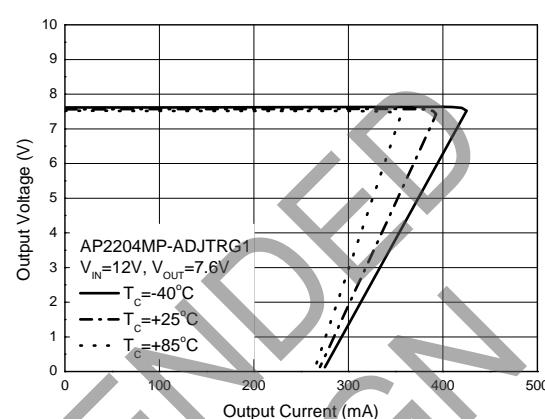
Maximum Output Current vs. Case Temperature
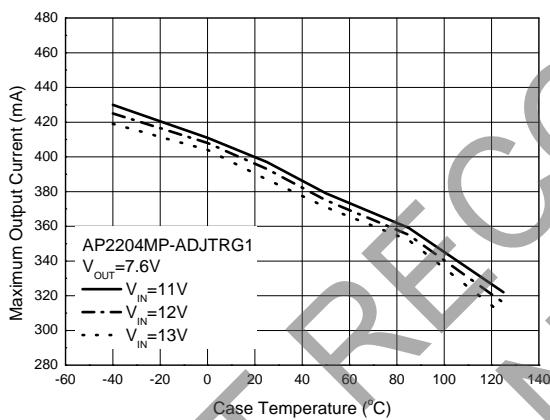
Case Temperature vs. Output Current

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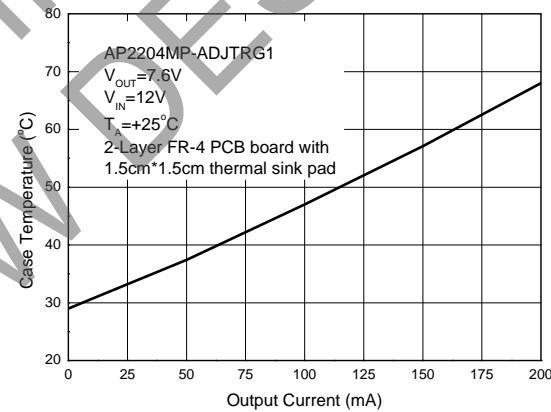
## Ordering Information

AP2204 X - X X X

Product Name	Package	Output Voltage	Packing	RoHS/Green
	K : SOT-23-5 R/RA/RB : SOT-89 MP : PSOP-8	ADJ : Adjustable Output 1.5 : Fixed Output 1.5V 1.8 : Fixed Output 1.8V 2.5 : Fixed Output 2.5V 2.8 : Fixed Output 2.8V 3.0 : Fixed Output 3.0V 3.3 : Fixed Output 3.3V 5.0 : Fixed Output 5.0V	TR : Tape & Reel	G1 : RoHS Compliant and Green

Package	Temperature Range	Output Voltage	Part Number	Marking ID	Packing
SOT-23-5	-40 to +85°C	ADJ	AP2204K-ADJTRG1	GAF	3000/7" Tape & Reel
		1.5V	AP2204K-1.5TRG1	GBH	3000/7" Tape & Reel
		1.8V	AP2204K-1.8TRG1	GAG	3000/7" Tape & Reel
		2.5V	AP2204K-2.5TRG1	GAD	3000/7" Tape & Reel
		2.8V	AP2204K-2.8TRG1	GAE	3000/7" Tape & Reel
		3.0V	AP2204K-3.0TRG1	GEF	3000/7" Tape & Reel
		3.3V	AP2204K-3.3TRG1	GAH	3000/7" Tape & Reel
		5.0V	AP2204K-5.0TRG1	GAI	3000/7" Tape & Reel
SOT-89	-40 to +85°C	1.5V (R)	AP2204R-1.5TRG1	G22C	1000/7" Tape & Reel
		1.8V (R)	AP2204R-1.8TRG1	G31C	1000/7" Tape & Reel
		2.5V (R)	AP2204R-2.5TRG1	G22D	1000/7" Tape & Reel
		2.8V (R)	AP2204R-2.8TRG1	G22E	1000/7" Tape & Reel
		3.0V (R)	AP2204R-3.0TRG1	G22F	1000/7" Tape & Reel
		3.3V (R)	AP2204R-3.3TRG1	G31D	1000/7" Tape & Reel
		5.0V (R)	AP2204R-5.0TRG1	G31E	1000/7" Tape & Reel
SOT-89	-40 to +85°C	3.3V (RA)	AP2204RA-3.3TRG1	G37O	1000/7" Tape & Reel
		5.0V (RA)	AP2204RA-5.0TRG1	G41O	1000/7" Tape & Reel
SOT-89	-40 to +85°C	3.3V (RB)	AP2204RB-3.3TRG1	G37R	1000/7" Tape & Reel
		5.0V (RB)	AP2204RB-5.0TRG1	G41R	1000/7" Tape & Reel
PSOP-8	-40 to +85°C	ADJ	AP2204MP-ADJTRG1	2204MP-ADJG1	4000/13" Tape & Reel

Marking Information

(1) SOT-23-5

(Top View)

⚠ **XXX**
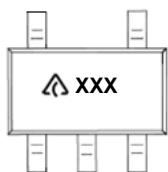
⚠ : Logo
XXX: Marking ID (See Ordering Information)

(2) SOT-89

(Top View)   **(Top View)**

⚠ XXXX   ⚠ XXXX

| 1 | 2 | 3 | | 1 | 2 | 3 |
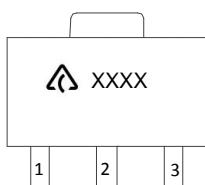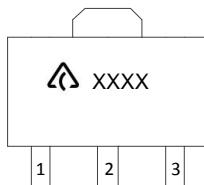
First Line: Logo and Marking ID
(See Ordering Information)

(3) PSOP-8

(Top View)

⚠2204MP
-ADJG1
○ YWWAXX
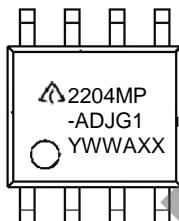
First and Second Lines: Logo and Marking ID
(See Ordering Information)
Third Line: Date Code
Y: Year
WW: Work Week of Molding
A: Assembly House Code
XX: 7th and 8th Digits of Batch Number

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Package Outline Dimensions (All dimensions in mm(inch).)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1)   Package Type: SOT-23-5

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Package Outline Dimensions (All dimensions in mm(inch).) (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(2)   Package Type: SOT-89

4.400(0.173)
4.600(0.181)

Option 1

3.950(0.156)
4.250(0.167)

2.300(0.091)
2.600(0.102)

0.900(0.035)
1.200(0.047)

0.320(0.013)
0.540(0.021)

0.320(0.013)
0.540(0.021)

0.480(0.019)
0.620(0.024)

3.000(0.118)
TYP

1.400(0.055)
1.600(0.063)

2.060(0.081)REF

3°
10°

0.350(0.014)
0.450(0.018)

3°

R0.150(0.006)

10°

Option 1

1.550(0.061)REF

1.030(0.041)REF

45°

0.320(0.013)REF

1.620(0.064)REF

2.210(0.087)REF

1.500(0.059)
1.800(0.071)

Option 2

R 0.200(0.008)

2.630(0.104)
2.930(0.115)

1.620(0.064)
1.830(0.072)

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Package Outline Dimensions (All dimensions in mm(inch).) (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3)   Package Type: PSOP-8

3.800(0.150)
4.000(0.157)

2.110(0.083)
2.710(0.107)

2.750(0.108)
3.402(0.134)

0.300(0.012)
0.510(0.020)

5.800(0.228)
6.200(0.244)

1.270(0.050)
TYP

4.700(0.185)
5.100(0.201)

0.050(0.002)
0.150(0.006)

1.350(0.053)
1.550(0.061)

0°
8°

0.400(0.016)
1.270(0.050)

0.150(0.006)
0.250(0.010)

Note: Eject hole, oriented hole and mold mark is optional.

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Suggested Pad Layout

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(1)   Package Type: SOT-23-5
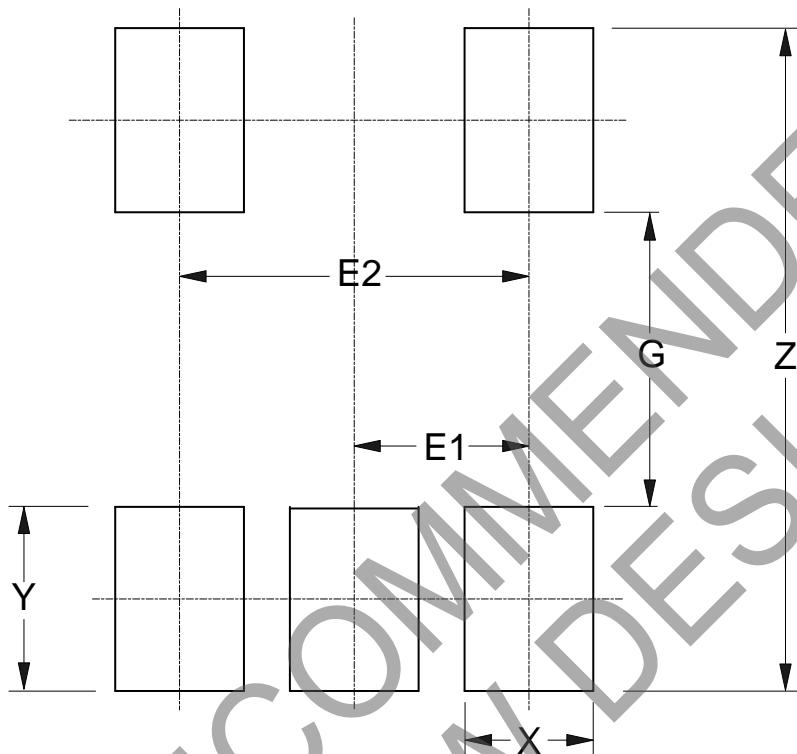
Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E1 (mm)/(inch)	E2 (mm)/(inch)
Value	3.600/0.142	1.600/0.063	0.700/0.028	1.000/0.039	0.950/0.037	1.900/0.075

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Suggested Pad Layout (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(2)   Package Type: SOT-89
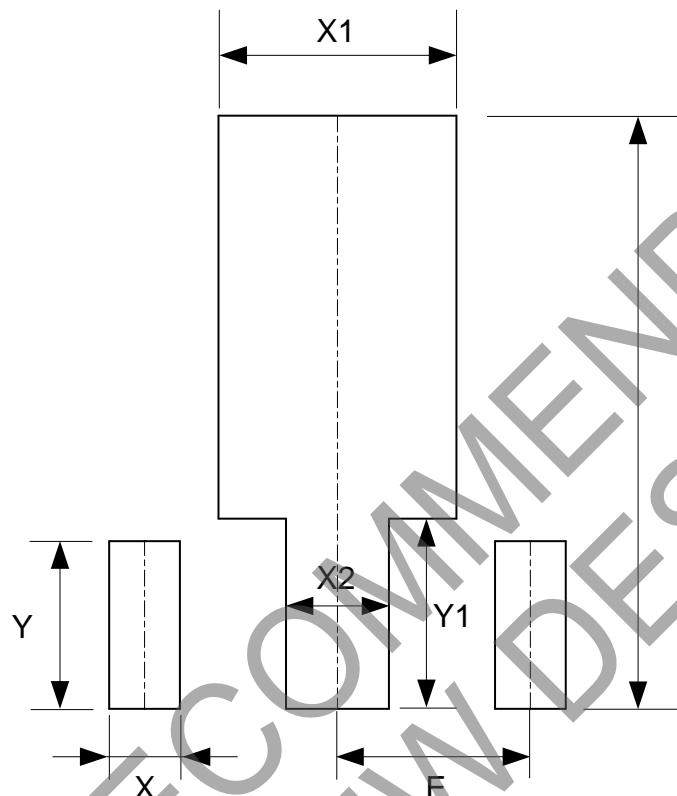
Dimensions	Z (mm)/(inch)	X (mm)/(inch)	X1 (mm)/(inch)	X2 (mm)/(inch)	Y (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	4.600/0.181	0.550/0.022	1.850/0.073	0.800/0.031	1.300/0.051	1.475/0.058	1.500/0.059

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Suggested Pad Layout (continued)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3)   Package Type: PSOP-8
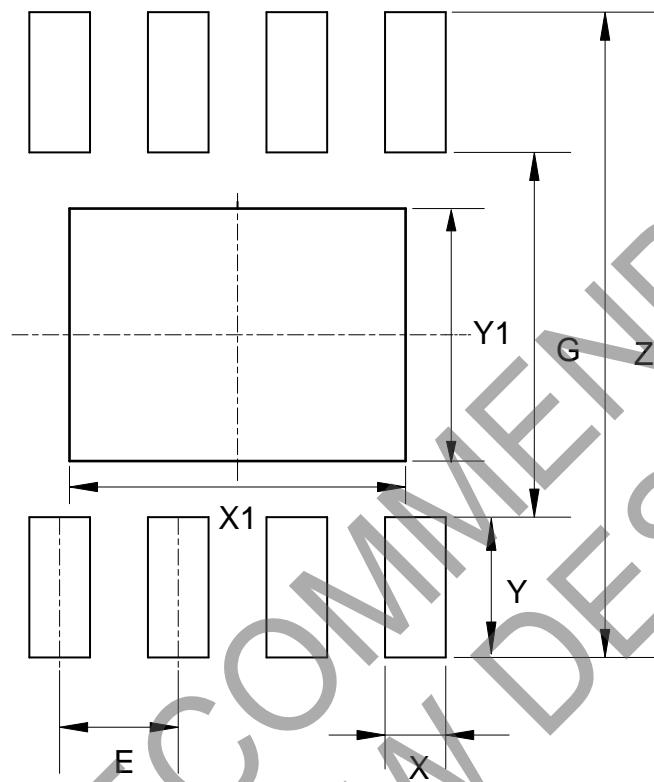
Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	X1 (mm)/(inch)	Y1 (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	3.600/0.142	2.700/0.106	1.270/0.050

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