



**THE DATASHEET OF
AP4310EMTR-G1**



Description

The AP4310E is a monolithic IC specifically designed to regulate the output current and voltage levels of switching battery chargers and power supplies.

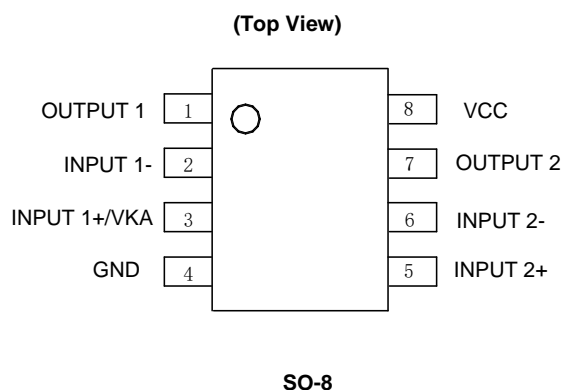
The device contains two Op Amps and a 2.5V precision shunt voltage reference. Op Amp 1 is designed for voltage control with its non-inverting input internally connected to the output of the shunt regulator. Op Amp 2 is for current control with both inputs uncommitted. The IC offers the power converter designer a control solution that features increased precision with a corresponding reduction in system complexity and cost. The AP4310E has more stringent reference voltage tolerance and offset.

The AP4310E is available in the standard SO-8 package.

Applications

- Battery chargers
- Switching power supplies

Pin Assignments

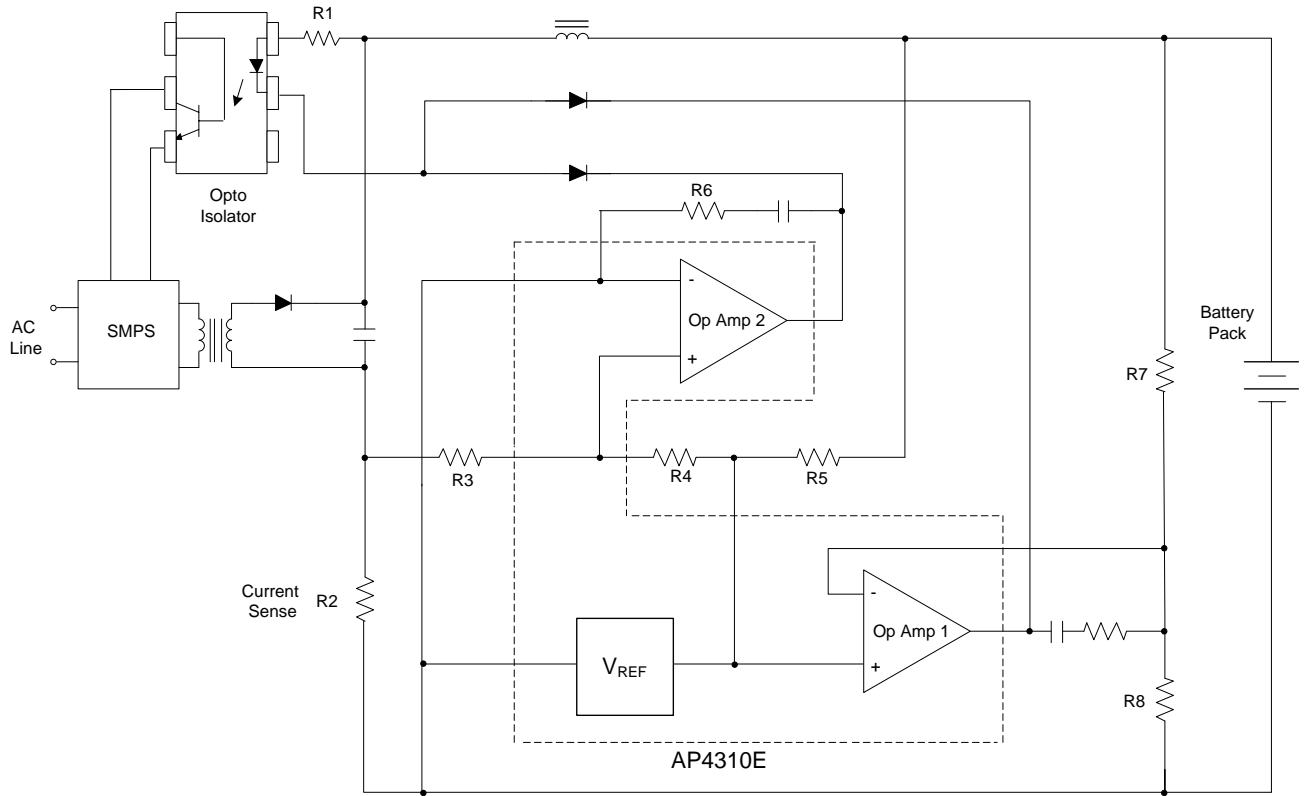


Features

- **OP Amp**
 - Input Offset Voltage: 0.5mV
 - Supply Current: 75 μ A per OP Amp at 5.0V Supply Voltage
 - Unity Gain Bandwidth: 1MHz
 - Output Voltage Swing: 0 to $V_{CC}-1.5V$
 - Power Supply Range: 3 to 36V
- **Voltage Reference**
 - Fixed Output Voltage Reference: 2.5V
 - Reference Voltage Tolerance: $\pm 0.4\%$
 - Sink Current Capability: 0.05 to 80mA
 - Typical Output Impedance: 0.2 Ω
- **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-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please [contact us](mailto:contact@diodes.com) or your local Diodes representative. <https://www.diodes.com/quality/product-definitions/>**

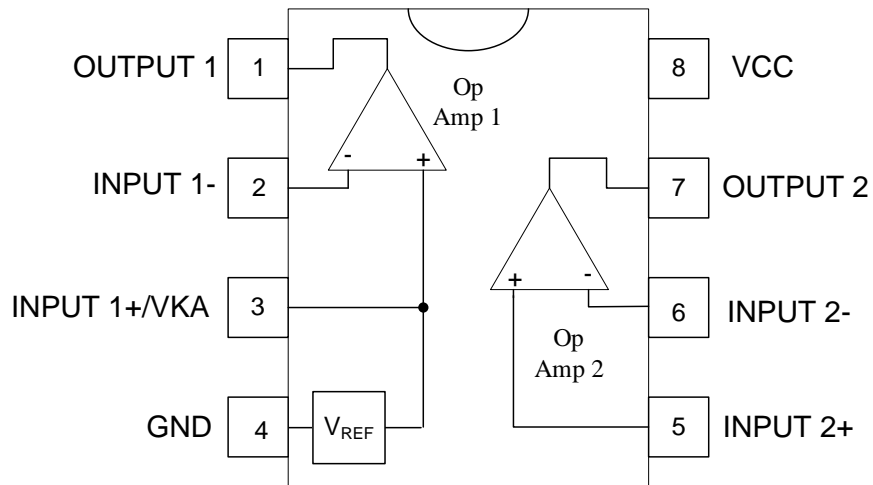
- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
 2. See <https://www.diodes.com/quality/lead-free/> for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen-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

Typical Applications Circuit



Application of AP4310E in a Constant Current and Constant Voltage Charger

Functional Block Diagram



Absolute Maximum Ratings (Note 4)

Symbol	Parameter	Rating	Unit
V _{CC}	Power Supply Voltage (V _{CC} to GND)	40	V
V _{IN}	Op Amp1 and 2 Input Voltage Range (Pins 2, 5, 6)	-0.3 to V _{CC} +0.3	V
V _{ID}	Op Amp 2 Input Differential Voltage (Pins 5, 6)	40	V
I _K	Voltage Reference Cathode Current (Pin 3)	100	mA
P _D	Power Dissipation (T _A = +25°C)	500	mW
T _J	Operating Junction Temperature	+150	°C
T _{STG}	Storage Temperature Range	-65 to +150	°C
T _{LEAD}	Lead Temperature (Soldering 10sec)	+260	°C
ESD	Human Body Model	2000	V
ESD	Charged Device Model	1000	V

Note: 4. 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.

Recommended Operating Conditions (Note 5)

Parameter	Min	Max	Unit
Supply Voltage	3	36	V
Ambient Temperature	-40	+105	°C

Note: 5. Qualified for SMD on the underside of a PCB by processing the PCB through a wave soldering operation.

Electrical Characteristics (@V_{CC} = 5V, T_A = +25°C, unless otherwise specified.)

Parameters	Conditions	Min	Typ	Max	Unit	
Total Supply Current, excluding Current in Voltage Reference	V _{CC} = 5V, no load, -40°C ≤ T _A ≤ +105°C	—	0.15	0.25	mA	
	V _{CC} = 30V, no load, -40°C ≤ T _A ≤ +105°C	—	0.20	0.30		
Voltage Reference Section						
Reference Voltage	I _K = 10mA	T _A = +25°C	2.49	2.50	2.51	V
		-40°C ≤ T _A ≤ +105°C	2.48	2.50	2.52	
Reference Voltage Deviation over Full Temperature Range	I _K = 10mA, T _A = -40°C to +105°C	—	5	24	mV	
Minimum Cathode Current for Regulation	—	—	0.01	0.05	mA	
Dynamic Impedance	I _K = 1mA to 80mA, f < 1kHz	—	0.2	0.5	Ω	
Op Amp 1 Section (V _{CC} = 5V, V _O = 1.4V, T _A = +25°C, unless otherwise noted.)						
Input Offset Voltage	T _A = +25°C	—	0.5	3	mV	
	T _A = -40°C to +105°C	—	—	5		
Input Offset Voltage Temperature Drift	T _A = -40°C to +105°C	—	7	—	μV/°C	
Input Bias Current (Inverting Input Only)	T _A = +25°C	—	20	150	nA	
Large Signal Voltage Gain	V _{CC} = 15V, R _L = 2kΩ, V _O = 1.4V to 11.4V	85	100	—	dB	
Power Supply Rejection Ratio	V _{CC} = 5V to 30V	70	90	—	dB	

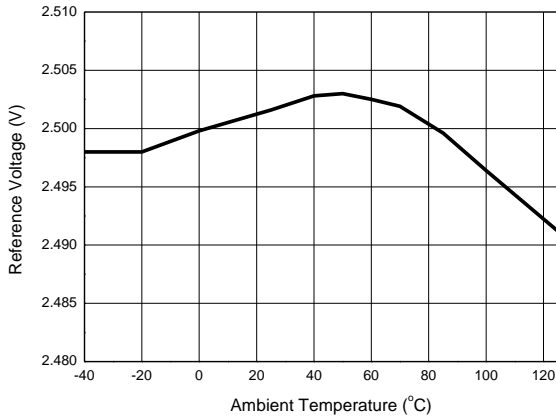
Electrical Characteristics (continued) (@V_{CC} = 5V, T_A = +25°C, unless otherwise specified.)

Parameters		Conditions	Min	Typ	Max	Unit
Output Current	Source	V _{CC} = 15V, V _{ID} = 1V, V _O = 2V	20	40	—	mA
	Sink	V _{CC} = 15V, V _{ID} = -1V, V _O = 2V	8	20	—	
Output Voltage Swing (High)		V _{CC} = 30V, R _L = 10kΩ, V _{ID} = 1V	27	28	—	V
Output Voltage Swing (Low)		V _{CC} = 30V, R _L = 10kΩ, V _{ID} = -1V	—	17	100	mV
Slew Rate		V _{CC} = 18V, R _L = 2kΩ, A _V = 1, V _{IN} = 0.5V to 2V, C _L = 100pF	0.2	0.5	—	V/μs
Unity Gain Bandwidth		V _{CC} = 30V, R _L = 2kΩ, C _L = 100pF	0.7	1.0	—	MHz
Op Amp 2 Section (V _{CC} = 5V, V _O = 1.4V, T _A = +25°C, unless otherwise noted.)						
Input Offset Voltage (Note 6)		T _A = +25°C, V _{CC} = 5V or 20V	—	0.5	2	mV
		T _A = -40°C to +105°C, V _{CC} = 5V or 20V	—	—	3	
Input Offset Voltage Temperature Drift		T _A = -40°C to +105°C	—	7	—	μV/°C
Input Offset Current		T _A = +25°C	—	2	30	nA
Input Bias Current		T _A = +25°C	—	20	150	nA
Input Voltage Range		V _{CC} = 0 to 36V	0	—	V _{CC} -1.5	V
Common Mode Rejection Ratio		T _A = +25°C, V _{CM} = 0 to 3.5V	70	85	—	dB
Large Signal Voltage Gain		V _{CC} = 15V, R _L = 2kΩ, V _O = 1.4V to 11.4V	85	100	—	dB
Power Supply Rejection Ratio		V _{CC} = 5V to 30V	70	90	—	dB
Output Current	Source	V _{CC} = 15V, V _{ID} = 1V, V _O = 2V	20	40	—	mA
	Sink	V _{CC} = 15V, V _{ID} = -1V, V _O = 2V	8	20	—	
Output Voltage Swing (High)		V _{CC} = 30V, R _L = 10kΩ, V _{ID} = 1V	27	28	—	V
Output Voltage Swing (Low)		V _{CC} = 30V, R _L = 10kΩ, V _{ID} = -1V	—	17	100	mV
Slew Rate		V _{CC} = 18V, R _L = 2kΩ, A _V = 1, V _{IN} = 0.5V to 2V, C _L = 100pF	0.2	0.5	—	V/μs
Unity Gain Bandwidth		V _{CC} = 30V, R _L = 2kΩ, C _L = 100pF	0.7	1.0	—	MHz

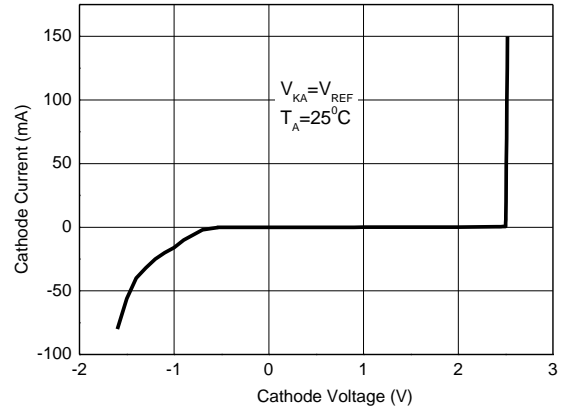
Note: 6. The full temperature feature is guaranteed by design.

Performance Characteristics

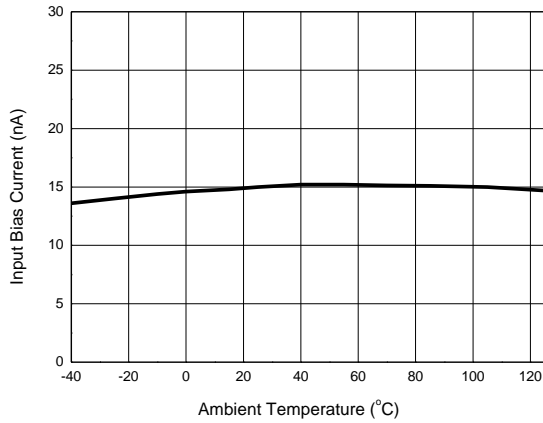
Reference Voltage vs. Ambient Temperature



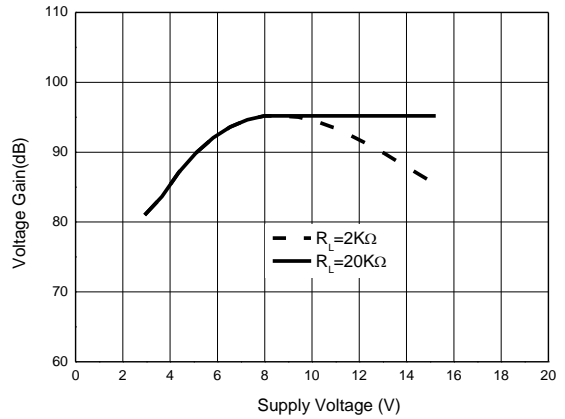
Cathode Current vs. Cathode Voltage



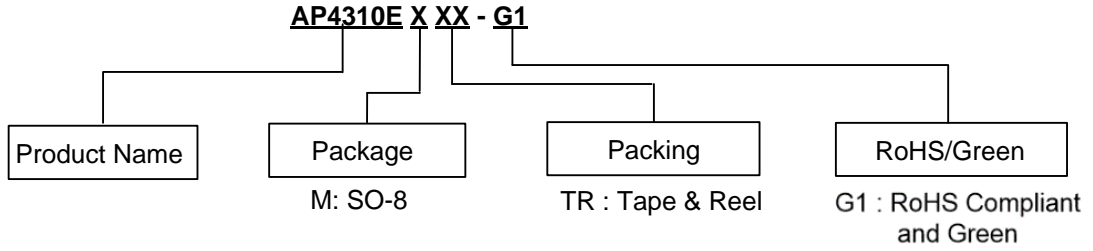
Input Bias Current vs. Ambient Temperature



Op Amp Voltage Gain



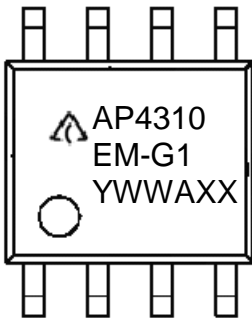
Ordering Information



Part Number	Temperature Range	Reference Voltage	Voltage Tolerance	Marking ID	Package	Packing	
						Qty.	Carrier
AP4310EMTR-G1	-40 to +105°C	2.5V	±0.4%	AP4310EM-G1	SO-8	4,000	Tape & Reel

Marking Information

(Top View)

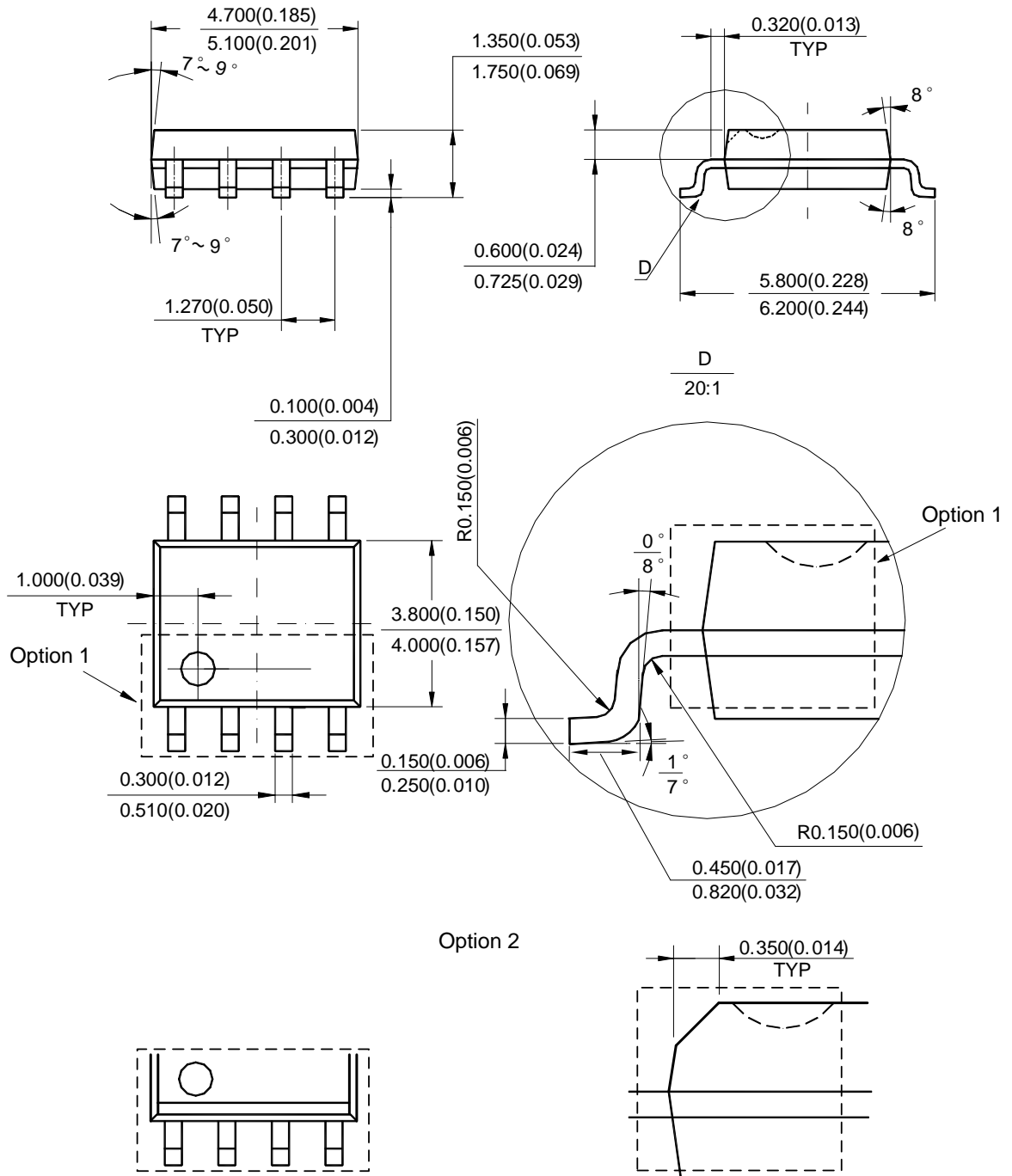


First and Second Lines: Logo and Marking ID
 Third Line: Date Code
 Y: Year (ex: 4 = 2024)
 WW: Work Week of Molding (01 to 53)
 A: Assembly House Code
 XX: 7th and 8th Digits of Batch No.

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

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

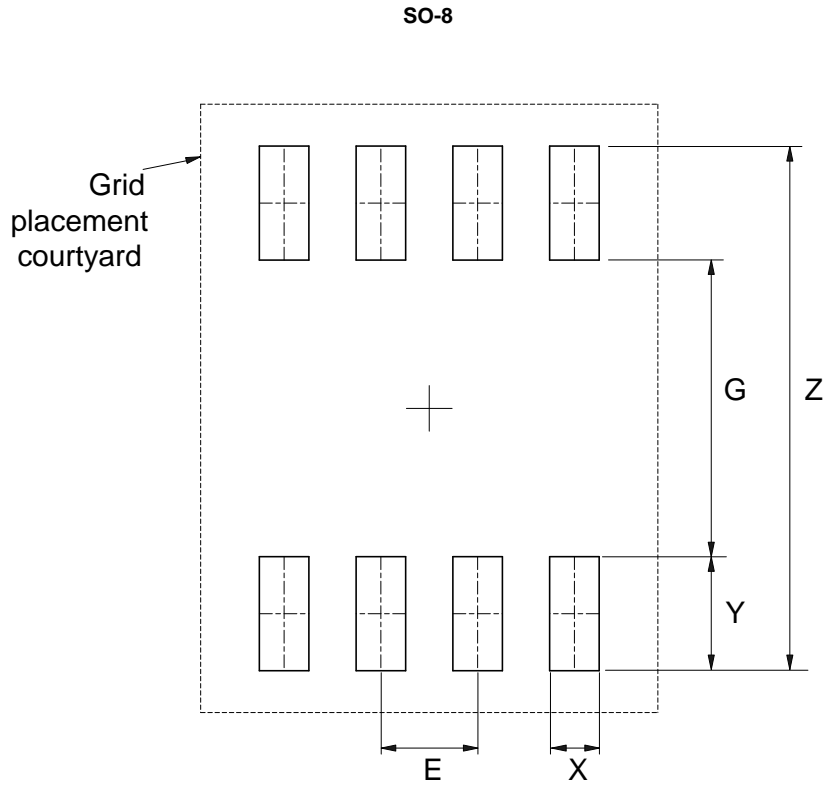
SO-8



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

Suggested Pad Layout

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



Dimensions	Z (mm)/(inch)	G (mm)/(inch)	X (mm)/(inch)	Y (mm)/(inch)	E (mm)/(inch)
Value	6.900/0.272	3.900/0.154	0.650/0.026	1.500/0.059	1.270/0.050

Mechanical Data

- Moisture Sensitivity: Level 1 per JESD22-A113
- Terminal Finish—Matte Tin Plated Leads; Solderable per JESD22-B102 (e3)
- Weight: 0.079 grams (Approximate)

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