

**AP4310A**

**DUAL OP AMP AND VOLTAGE REFERENCE**

**Description**

The AP4310A 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 AP4310A is available in SO-8 package.

**Features**

**OP Amp**

- Input Offset Voltage: 0.5mV
- Supply Current: 75µA 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

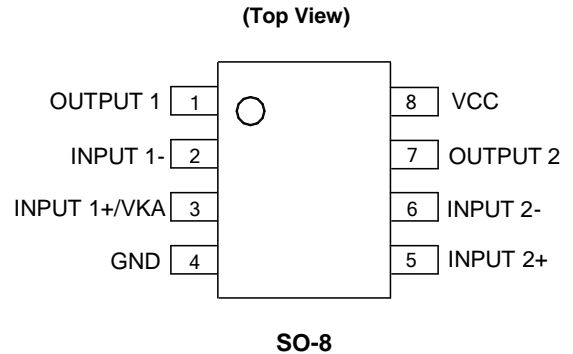
**Voltage Reference**

- Fixed Output Voltage Reference: 2.5V
- Reference Voltage Tolerance :±0.4%
- Sink Current Capability: 0.05 to 80mA
- Typical Output Impedance: 0.2Ω

- **Totally Lead-free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.  
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) 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.

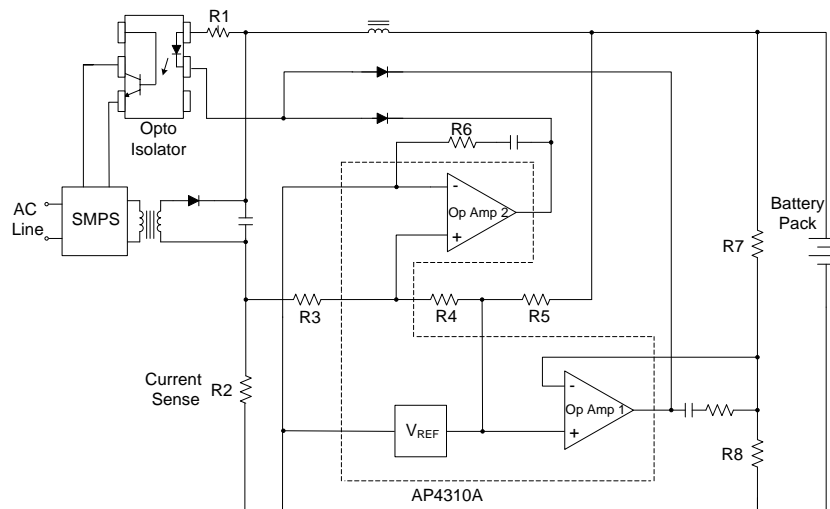
**Pin Assignments**



**Applications**

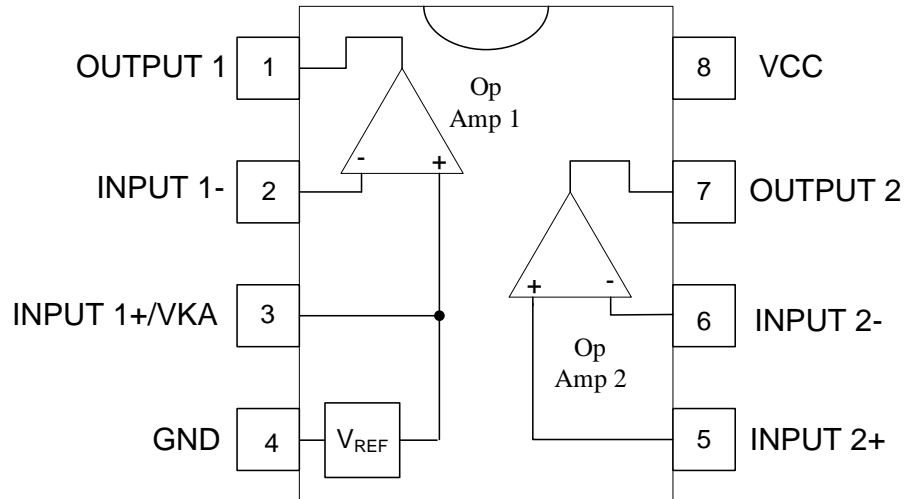
- Battery Charger
- Switching Power Supply

**Typical Applications Circuit**



Application of AP4310A 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 (VCC 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 ( $T_A = +25^{\circ}C$ )       | 500                  | mW          |
| $T_J$      | Operating Junction Temperature                   | +150                 | $^{\circ}C$ |
| $T_{STG}$  | Storage Temperature Range                        | -65 to +150          | $^{\circ}C$ |
| $T_{LEAD}$ | Lead Temperature (Soldering 10sec)               | +260                 | $^{\circ}C$ |
| ESD        | ESD (Human Body Model)                           | $\geq 2000$          | V           |

Note 4: Stresses greater than those listed under "Absolute Maximum Ratings" may 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 may affect device reliability.

**Recommended Operating Conditions**

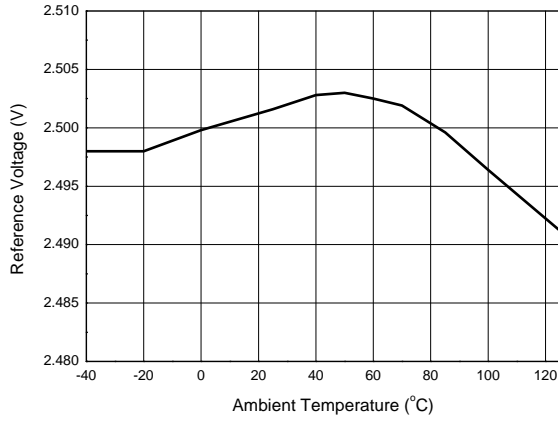
| Parameter           | Min | Max  | Unit        |
|---------------------|-----|------|-------------|
| Supply Voltage      | 3   | 36   | V           |
| Ambient Temperature | -40 | +105 | $^{\circ}C$ |

**Electrical Characteristics** (@ $V_{CC}=5V$ ,  $T_A=+25^{\circ}C$ , unless otherwise specified.)

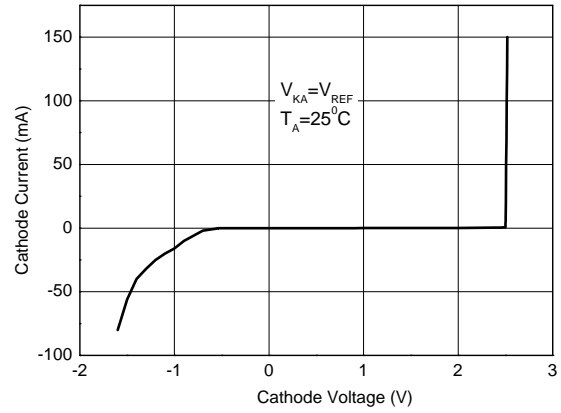
| Parameters   |        | Conditions  | Min  | Typ  | Max          | Unit              |   |
|--|--------|---|--|------|--------------|-------------------|---|
| Total Supply Current, excluding Current in Voltage Reference   |        | $V_{CC}=5V$ , no load, $-40^{\circ}C \leq T_A \leq +105^{\circ}C$                       | -  | 0.15 | 0.25         | mA                |   |
|  |        | $V_{CC}=30V$ , no load, $-40^{\circ}C \leq T_A \leq +105^{\circ}C$                      | -  | 0.20 | 0.30         |                   |   |
| <b>Voltage Reference Section</b>   |        |   |  |      |              |                   |   |
| Reference Voltage  |        | $I_K=10mA$  | $T_A = +25^{\circ}C$                       | 2.49 | 2.50         | 2.51              | V |
|  |        |   | $-40^{\circ}C \leq T_A \leq +105^{\circ}C$ | 2.48 | 2.50         | 2.52              |   |
| Reference Voltage Deviation over Full Temperature Range  |        | $I_K=10mA$ , $T_A = -40^{\circ}C$ to $+105^{\circ}C$                                    | -  | 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          | $\Omega$          |   |
| <b>Op Amp 1 Section</b> ( $V_{CC} = 5V$ , $V_O = 1.4V$ , $T_A = +25^{\circ}C$ , unless otherwise noted.) |        |   |  |      |              |                   |   |
| Input Offset Voltage   |        | $T_A = +25^{\circ}C$  | -  | 0.5  | 3            | mV                |   |
|  |        | $T_A = -40^{\circ}C$ to $+105^{\circ}C$   | -  | -    | 5            |                   |   |
| Input Offset Voltage Temperature Drift   |        | $T_A = -40^{\circ}C$ to $+105^{\circ}C$   | -  | 7    | -            | $\mu V/^{\circ}C$ |   |
| Input Bias Current (Inverting Input Only)  |        | $T_A = +25^{\circ}C$  | -  | 20   | 150          | nA                |   |
| Large Signal Voltage Gain  |        | $V_{CC} = 15V$ , $R_L = 2k\Omega$ , $V_O = 1.4V$ 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   | $V_{CC} = 15V$ , $V_{ID} = -1V$ , $V_O = 2V$  | 5  | 20   | -            |                   |   |
| Output Voltage Swing (High)  |        | $V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = 1V$                                      | 27   | 28   | -            | V                 |   |
| Output Voltage Swing (Low)   |        | $V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = -1V$                                     | -  | 17   | 100          | mV                |   |
| Slew Rate  |        | $V_{CC} = 18V$ , $R_L = 2k\Omega$ , $A_V = 1$ , $V_{IN} = 0.5V$ to $2V$ , $C_L = 100pF$ | 0.2  | 0.5  | -            | $V/\mu s$         |   |
| Unity Gain Bandwidth   |        | $V_{CC} = 30V$ , $R_L = 2k\Omega$ , $C_L = 100pF$                                       | 0.7  | 1.0  | -            | MHz               |   |
| <b>Op Amp 2 Section</b> ( $V_{CC} = 5V$ , $V_O = 1.4V$ , $T_A = +25^{\circ}C$ , unless otherwise noted.) |        |   |  |      |              |                   |   |
| Input Offset Voltage   |        | $T_A = +25^{\circ}C$  | -  | 0.5  | 3            | mV                |   |
|  |        | $T_A = -40^{\circ}C$ to $+105^{\circ}C$   | -  | -    | 5            |                   |   |
| Input Offset Voltage Temperature Drift   |        | $T_A = -40^{\circ}C$ to $+105^{\circ}C$   | -  | 7    | -            | $\mu V/^{\circ}C$ |   |
| Input Offset Current   |        | $T_A = +25^{\circ}C$  | -  | 2    | 30           | nA                |   |
| Input Bias Current   |        | $T_A = +25^{\circ}C$  | -  | 20   | 150          | nA                |   |
| Input Voltage Range  |        | $V_{CC} = 0$ to $36V$   | 0  | -    | $V_{CC}-1.5$ | V                 |   |
| Common Mode Rejection Ratio  |        | $T_A = +25^{\circ}C$ , $V_{CM} = 0$ to $3.5V$   | 70   | 85   | -            | dB                |   |
| Large Signal Voltage Gain  |        | $V_{CC} = 15V$ , $R_L = 2k\Omega$ , $V_O = 1.4V$ 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   | $V_{CC} = 15V$ , $V_{ID} = -1V$ , $V_O = 2V$  | 5  | 20   | -            |                   |   |
| Output Voltage Swing (High)  |        | $V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = 1V$                                      | 27   | 28   | -            | V                 |   |
| Output Voltage Swing (Low)   |        | $V_{CC} = 30V$ , $R_L = 10k\Omega$ , $V_{ID} = -1V$                                     | -  | 17   | 100          | mV                |   |
| Slew Rate  |        | $V_{CC} = 18V$ , $R_L = 2k\Omega$ , $A_V = 1$ , $V_{IN} = 0.5V$ to $2V$ , $C_L = 100pF$ | 0.2  | 0.5  | -            | $V/\mu s$         |   |
| Unity Gain Bandwidth   |        | $V_{CC} = 30V$ , $R_L = 2k\Omega$ , $C_L = 100pF$                                       | 0.7  | 1.0  | -            | MHz               |   |

**Performance Characteristics**

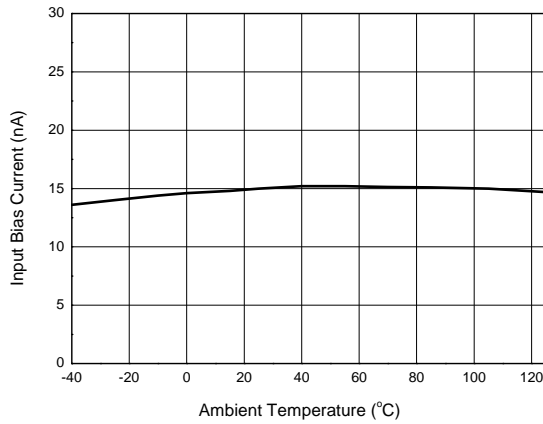
**Reference Voltage vs. Ambient Temperature**



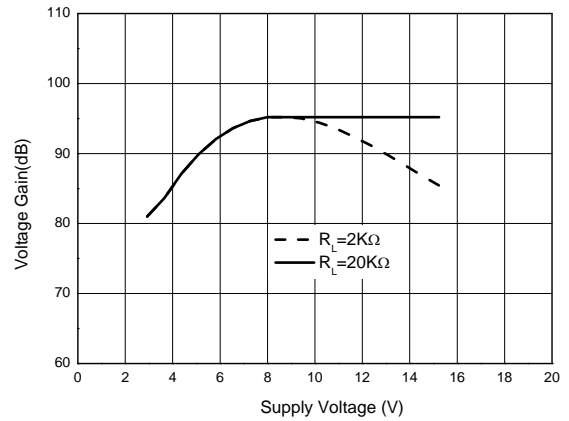
**Cathode Current vs. Cathode Voltage**



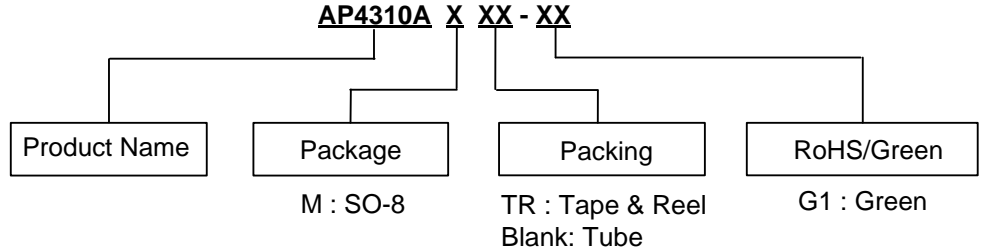
**Input Bias Current vs. Ambient Temperature**



**Op Amp Voltage Gain**



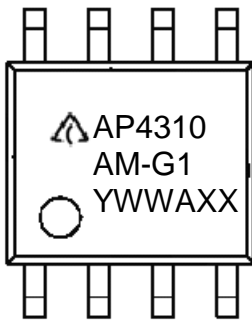
**Ordering Information**



| Package | Temperature Range | Reference Voltage | Voltage Tolerance | Part Number   | Marking ID  | Packing          |
|---------|-------------------|-------------------|-------------------|---------------|-------------|------------------|
| SO-8    | -40 to +105°C     | 2.5V              | ±0.4%             | AP4310AM-G1   | AP4310AM-G1 | 100/Tube         |
|         |                   |                   |                   | AP4310AMTR-G1 | AP4310AM-G1 | 4000/Tape & Reel |

**Marking Information**

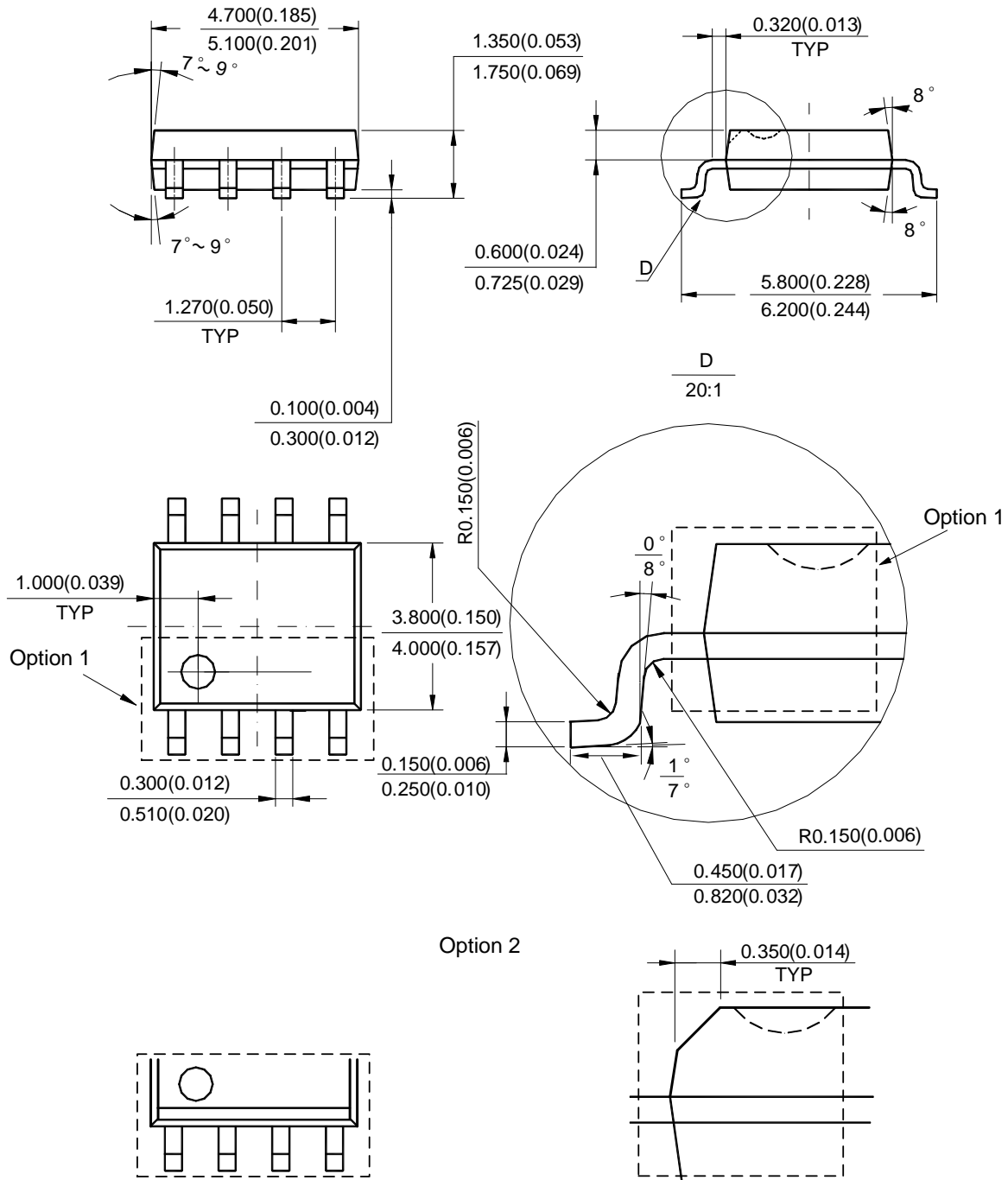
(Top View)



First and Second Lines: Logo and Marking ID  
 Third Line: Date Code  
 Y: Year  
 WW: Work Week of Molding  
 A: Assembly House Code  
 XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch No.

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

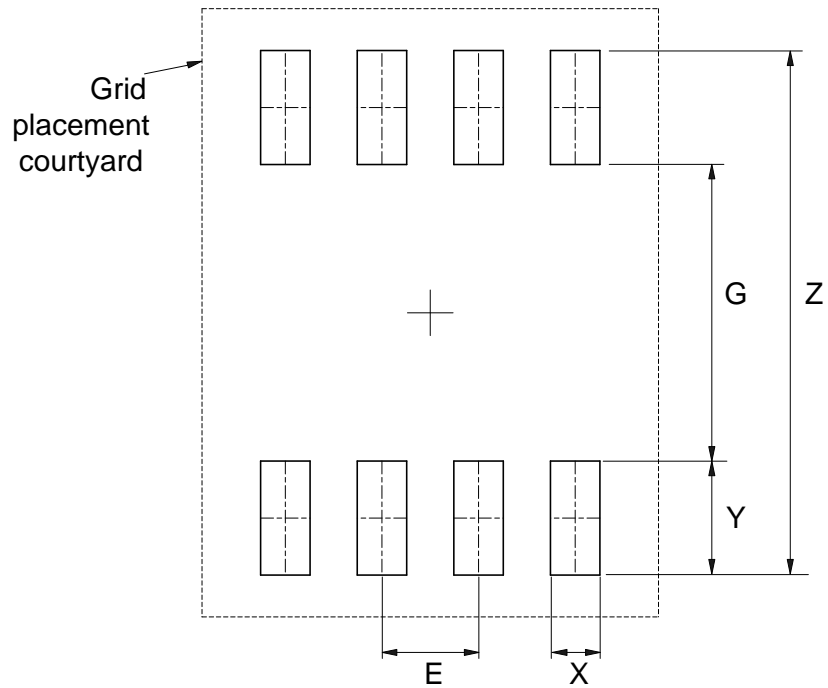
(1) Package Type: SO-8



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

**Suggested Pad Layout**

(1) Package Type: SO-8



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

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