

**SINGLE STAGE PRIMARY SIDE REGULATION PFC CONTROLLER FOR LED DRIVER**

## Description

The AP1682E is a high performance AC/DC universal input Primary Side Regulation Power Factor Controller for LED driver applications. The device uses Pulse Frequency Modulation (PFM) technology to regulate output current while achieving high power factor and low THD.

The AP1682E provides accurate constant current (CC) regulation while removing the opto-coupler and secondary control circuitry. It also eliminates the need of loop compensation circuitry while maintaining stability. The AP1682E achieves excellent regulation and high efficiency, yet meets the requirement of IEC61000-3-2 harmonic standard.

The AP1682E features low start-up current, low operation current and high efficiency. It also has rich protection features including over voltage, short circuit, over current protection etc.

The AP1682E is available in SO-8 package.

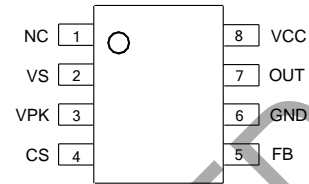
## Features

- Primary Side Control for Output Current Regulation Without Opto-coupler and Secondary CV/CC Control Circuitry
- Low Start-up Current
- High Power Factor and Low THD for Universal Input Range
- Tight CC Regulation Performance for Universal Input Mains Voltage Range
- Eliminates Control Loop Compensation Circuitry
- Built-in Acceleration Start
- Open-load and Reload Detection
- Over Voltage and Short Circuit Protection
- Over Current Protection
- Cost Effective Total PFC LED Driver Solution
- **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/>**

- 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)

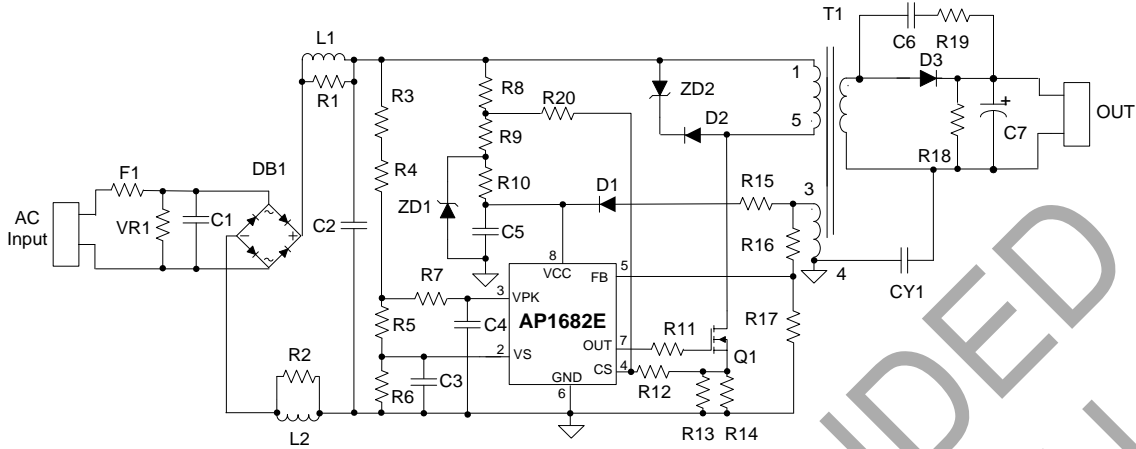


SO-8

## Applications

- Single Stage Power Factor Correction Power Supply for LED Lighting

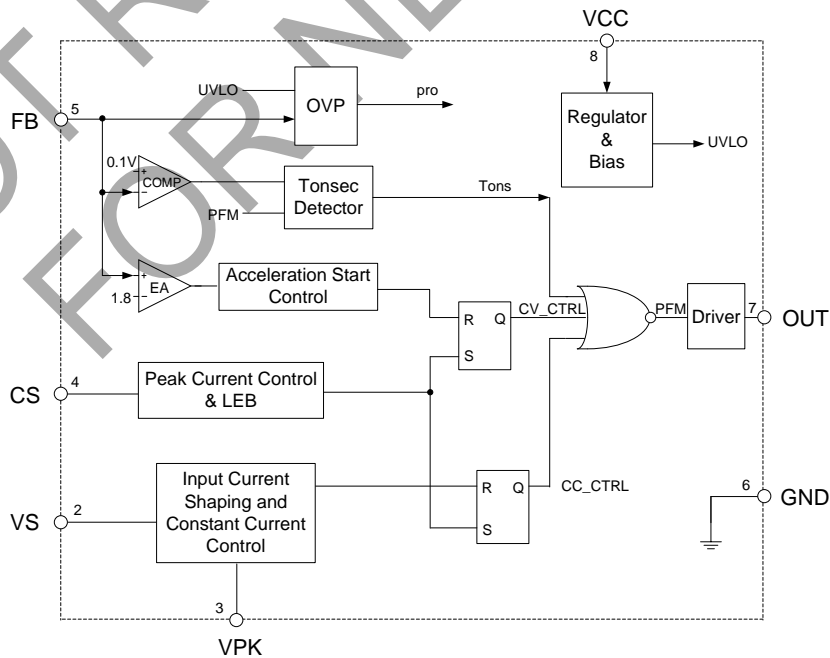
**Typical Applications Circuit**



**Pin Descriptions**

| Pin Number | Pin Name | Function  |
|------------|----------|---|
| 1          | NC       | No connection   |
| 2          | VS       | The rectified input voltage sensing pin. The pin is detecting the instantaneous rectified sine waveform of input voltage  |
| 3          | VPK      | The rectified input voltage peak value sensing pin. The pin is detecting the rectified sine waveform peak value of input voltage  |
| 4          | CS       | Primary current sensing   |
| 5          | FB       | This pin captures the feedback voltage from the auxiliary winding. FB voltage is used to control no load output voltage and determine acceleration stop point at start-up phase |
| 6          | GND      | Ground. Current return for gate driver and control circuits of the IC   |
| 7          | OUT      | Gate driver output  |
| 8          | VCC      | Supply voltage of gate driver and control circuits of the IC  |

**Functional Block Diagram**



### Absolute Maximum Ratings (Note 4)

| Symbol  | Parameter                                  | Rating      | Unit |
|---|--|-------------|------|
| V <sub>CC</sub>                                     | Power Supply Voltage                       | -0.3 to +35 | V    |
| I <sub>OUT</sub>                                    | Driver Output Current                      | 300         | mA   |
| V <sub>VS</sub> , V <sub>PK</sub> , V <sub>CS</sub> | Voltage at VS, VPK, CS                     | -0.3 to 7   | V    |
| V <sub>FB</sub>                                     | FB Input Voltage                           | -40 to 10   | V    |
| T <sub>J</sub>                                      | Operating Junction Temperature             | +150        | °C   |
| T <sub>STG</sub>                                    | Storage Temperature                        | -65 to +150 | °C   |
| T <sub>LEAD</sub>                                   | Lead Temperature (Soldering, 10s)          | +300        | °C   |
| P <sub>D</sub>                                      | Power Dissipation (T <sub>A</sub> = +50°C) | 0.65        | W    |
| θ <sub>JA</sub>                                     | Thermal Resistance (Junction to Ambient)   | 190         | °C/W |
| —   | ESD (Machine Model)                        | 200         | V    |
| —   | ESD (Human Body Model)                     | 3000        | 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

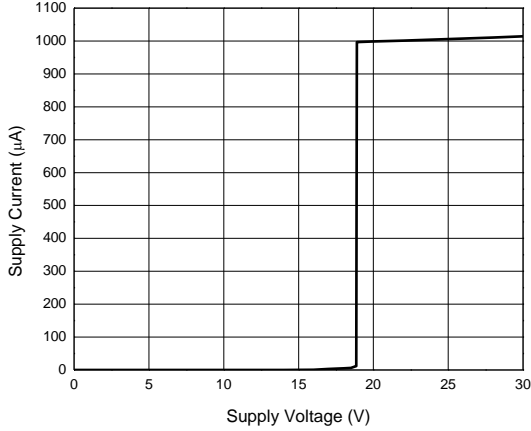
| Symbol          | Parameter            | Min | Max  | Unit |
|-----------------|----------------------|-----|------|------|
| V <sub>CC</sub> | Power Supply Voltage | 9   | 21   | V    |
| T <sub>A</sub>  | Ambient Temperature  | -40 | +105 | °C   |

**Electrical Characteristics** (@  $V_{CC} = 15V$ ,  $T_A = +25^{\circ}C$ , unless otherwise specified.)

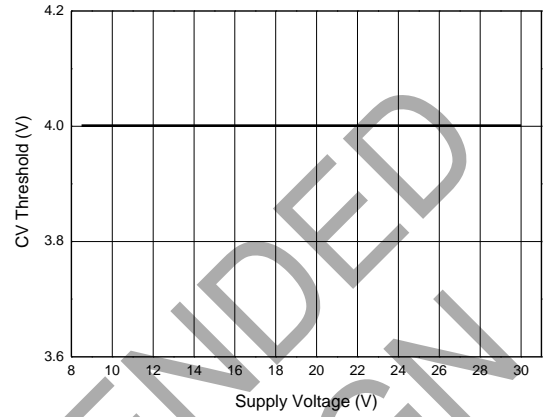
| Symbol                                     | Parameter                        | Conditions  | Min | Typ  | Max  | Unit        |
|--|----------------------------------|---|-----|------|------|-------------|
| <b>UVLO Section</b>                        |                                  |   |     |      |      |             |
| $V_{TH}$ (ST)                              | Start-up Threshold               | —   | 18  | 19   | 20   | V           |
| $V_{OPR}$ (Min)                            | Minimal Operating Voltage        | After turn on                                     | 7.5 | 8    | 8.5  | V           |
| $V_{CC\_OVP}$                              | VCC OVP Voltage                  | —   | 28  | 32   | 34   | V           |
| <b>Standby Current Section</b>             |                                  |   |     |      |      |             |
| $I_{ST}$                                   | Start-up Current                 | $V_{CC} = V_{TH}$ (ST)-0.5V,<br>Before start up   | —   | —    | 20   | $\mu A$     |
| $I_{CC}$ (Max)                             | Maximum Operating Current        | $V_{VS} = V_{PK} = 3V$                            | —   | 1000 | 1300 | $\mu A$     |
| <b>Drive Output Section</b>                |                                  |   |     |      |      |             |
| $V_{OH}$                                   | Output High Level Voltage        | $I_{GD\_SOURCE} = 20mA$<br>$V_{CC} = 12V$         | 10  | —    | —    | V           |
| $V_{OL}$                                   | Output Low Level Voltage         | $I_{GD\_SINK} = 20mA$<br>$V_{CC} = 12V$           | —   | —    | 1    | V           |
| $t_R$                                      | Output Voltage Rise Time         | $C_L = 1nF$                                       | 100 | 140  | 190  | ns          |
| $t_F$                                      | Output Voltage Fall Time         | $C_L = 1nF$                                       | 30  | 60   | 90   | ns          |
| $V_{O\_CLAMP}$                             | Output Clamp Voltage             | $I_{GD\_SOURCE} = 5mA$<br>$V_{CC} = 20V$          | 12  | 13.5 | 15   | V           |
| $V_{UVLO}$                                 | UVLO Saturation Voltage          | $V_{CC} = 0$ to $V_{CC\_ON}$<br>$I_{SINK} = 10mA$ | —   | —    | 1.1  | V           |
| <b>VS Input Section</b>                    |                                  |   |     |      |      |             |
| $V_{VS}/V_{PK}$ (Max)                      | Maximum Ratio                    | $V_{VS} = V_{PK} = 3V$                            | 0.8 | 1    | 1.2  | V           |
| $V_{VS}/V_{PK}$ (Min)                      | Minimum Ratio                    | $V_{VS} = 0V$ , $V_{PK} = 3V$                     | —   | —    | 0.2  | V           |
| <b>Current Sense Section</b>               |                                  |   |     |      |      |             |
| $t_{ON}$ (Min)                             | Minimum On Time                  | —   | 500 | 750  | 1000 | ns          |
| $V_{SOCP}$                                 | Short Circuit Protection Voltage | —   | 3   | 4    | —    | V           |
| <b>Feedback Input Section</b>              |                                  |   |     |      |      |             |
| $I_{FB}$                                   | FB Pin Input Leakage Current     | $V_{FB} = 4V$                                     | —   | 2    | 8    | $\mu A$     |
| $V_{FB}$ (ACC)                             | Acceleration Start Threshold     | —   | 1.4 | 1.8  | 2.2  | V           |
| $V_{FB}$ (CV)                              | CV Threshold                     | —   | 3.8 | 4.1  | 4.4  | V           |
| $V_{FB}$ (OVP)                             | Over Voltage Protection          | —   | 5.6 | 6.25 | 6.9  | V           |
| <b>Over Temperature Protection Section</b> |                                  |   |     |      |      |             |
| —  | Shutdown Temperature             | —   | —   | +140 | —    | $^{\circ}C$ |
| —  | Temperature Hysteresis           | —   | —   | +20  | —    | $^{\circ}C$ |

**Performance Characteristics**

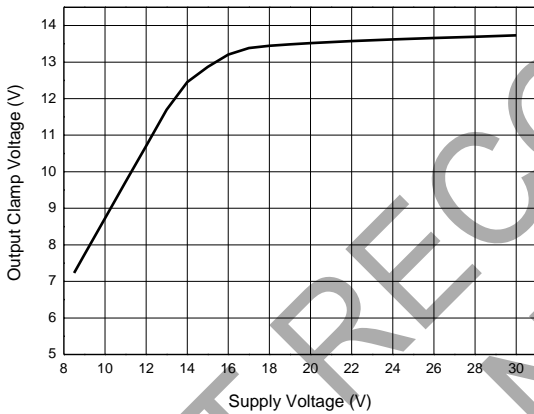
**Supply Current vs. Supply Voltage**



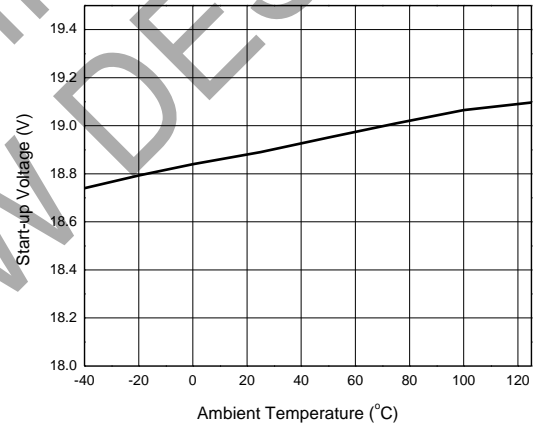
**CV Threshold vs. Supply Voltage**



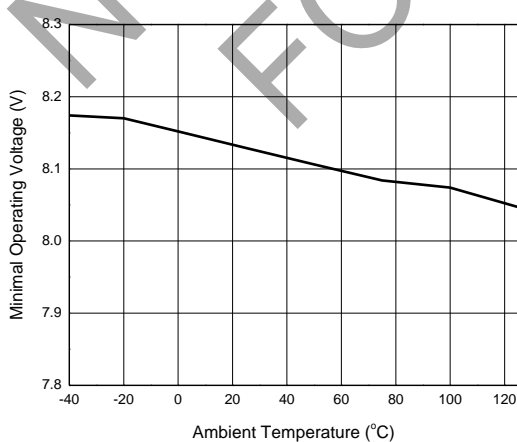
**Output Clamp Voltage vs. Supply Voltage**



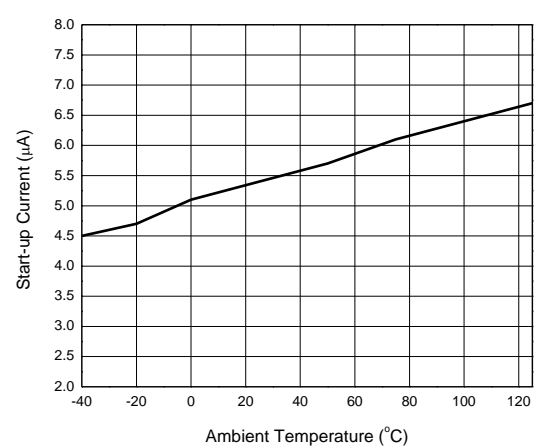
**Start-up Voltage vs. Ambient Temperature**



**Minimal Operating Voltage vs. Ambient Temperature**

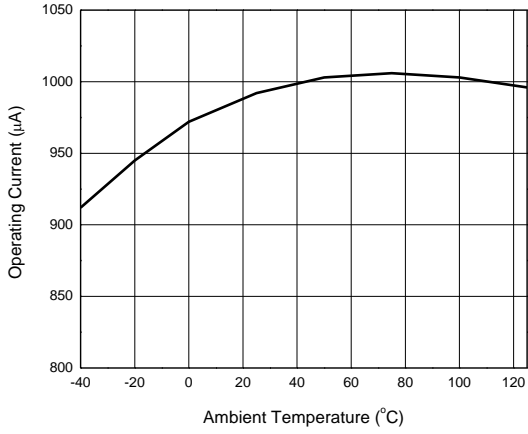


**Start-up Current vs. Ambient Temperature**

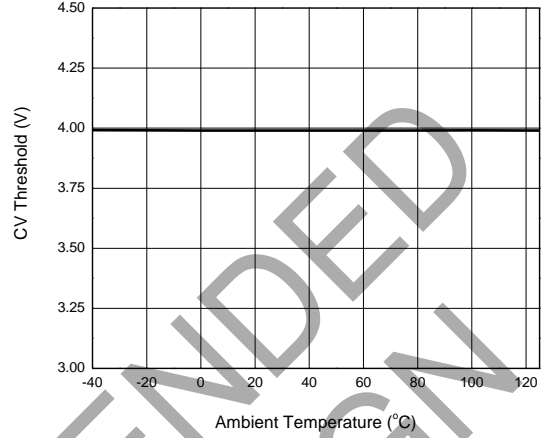


**Performance Characteristics** (continued)

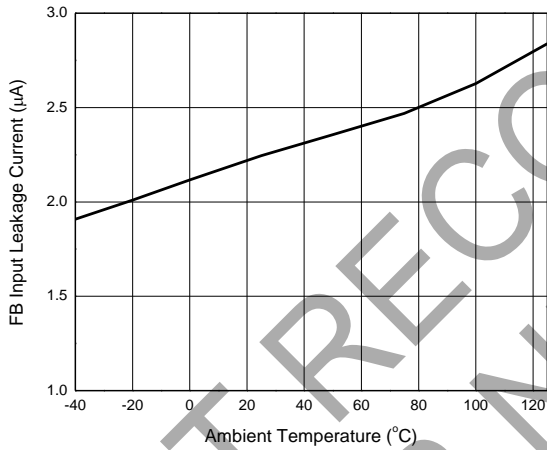
**Operating Current vs. Ambient Temperature**



**CV Threshold vs. Ambient Temperature**

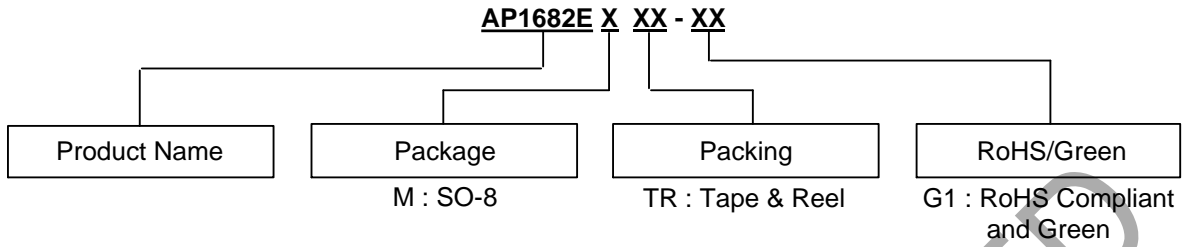


**FB Input Leakage Current vs. Ambient Temperature**



NOT RECOMMENDED FOR NEW DESIGN

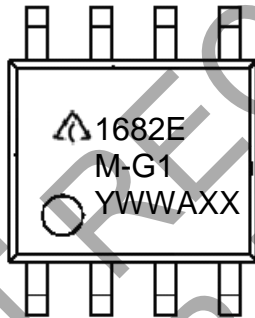
**Ordering Information**



| Package | Temperature Range | Part Number   | Marking ID | Packing              |
|---------|-------------------|---------------|------------|----------------------|
| SO-8    | -40°C to +105°C   | AP1682EMTR-G1 | 1682EM-G1  | 4000/13" Tape & Reel |

**Marking Information**

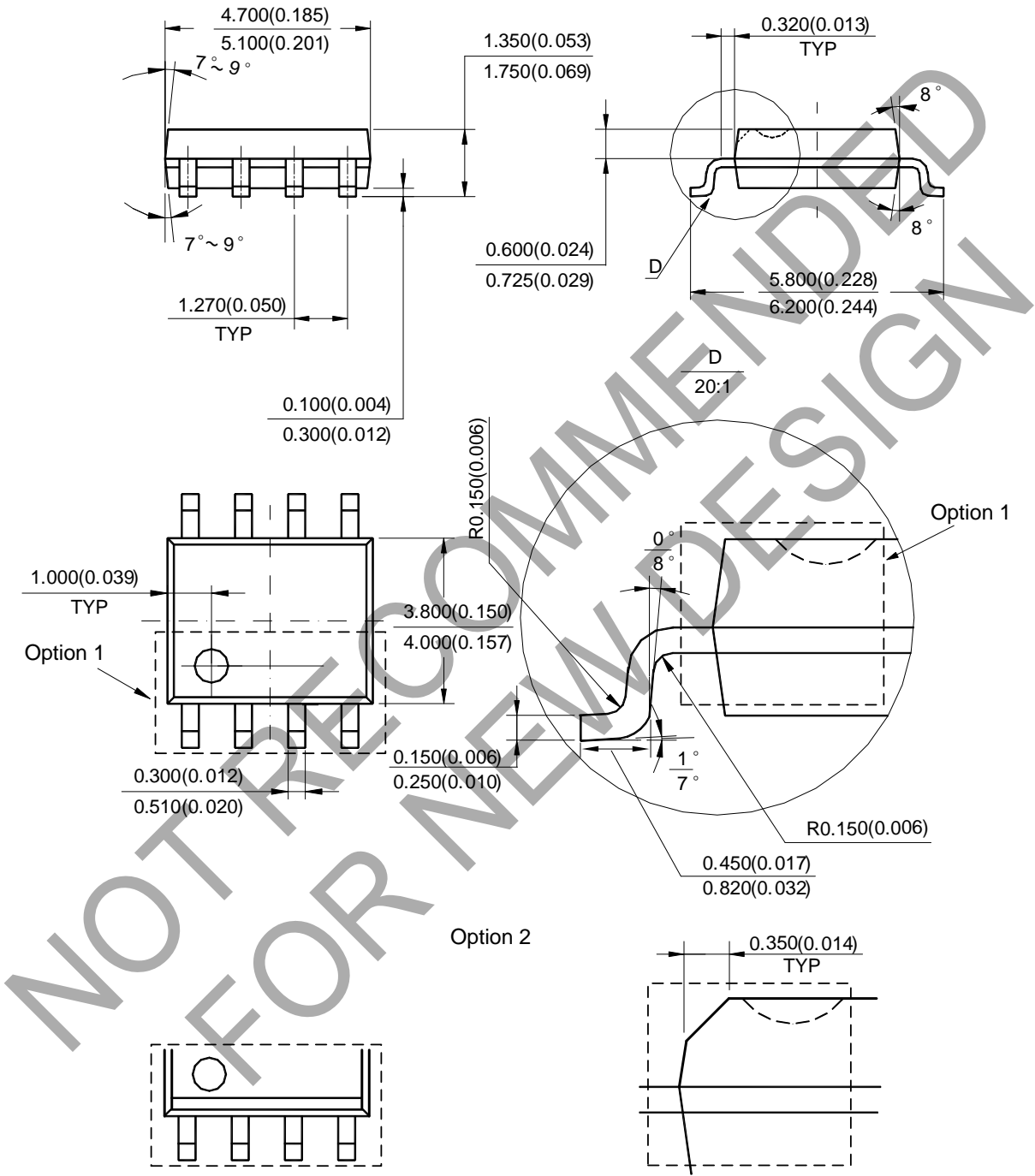
(Top View)



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 Number

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

(1) Package Type: SO-8

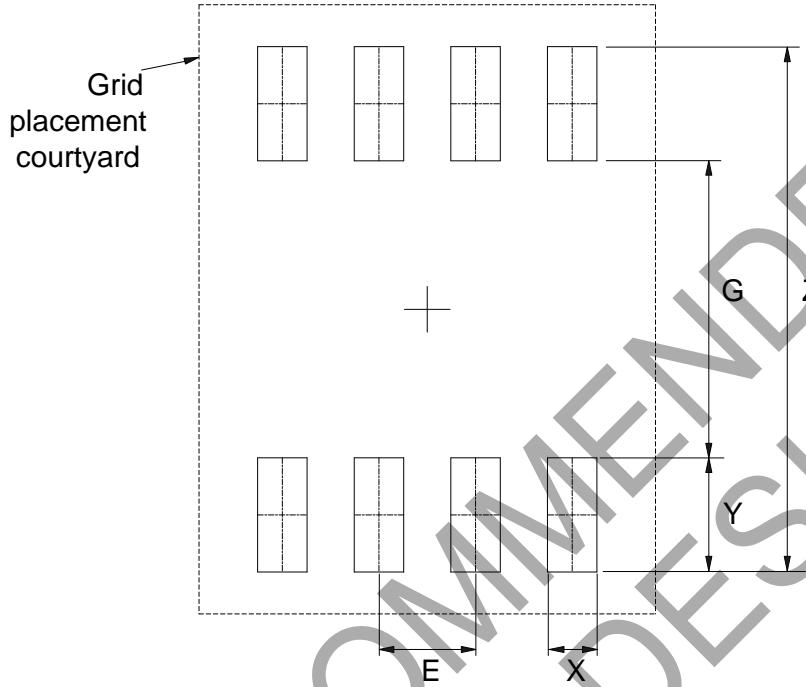


Note: Eject hole, oriented hole and mold mark is optional.



**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      |

NOT RECOMMENDED FOR NEW DESIGN

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