

AC/DC, HIGH PF, HIGH EFFICIENCY, UNIVERSAL MAINS LED DRIVER CONTROLLER

NEW PRODUCT

Description

The AP1688 is a high performance AC/DC PFC and constant current controller for universal mains LED driver applications. The device is a buck controller which operates as a boundary conduction mode (BCM) to achieve high efficiency and easy EMI.

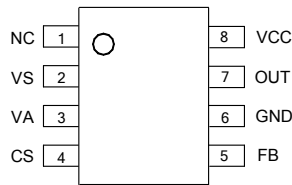
An open loop algorithm is adopted in the AP1688, which will make the system achieve excellent line and load regulations with high PF for universal mains input.

The AP1688 features fast start-up, low start-up current, low operation current and high efficiency. It also has rich protection features including over voltage, short and open circuit, over current, over temperature protection.

The AP1688 is available in SO-8 package.

Pin Assignments

(Top View)



(SO-8/ M Package)

Features

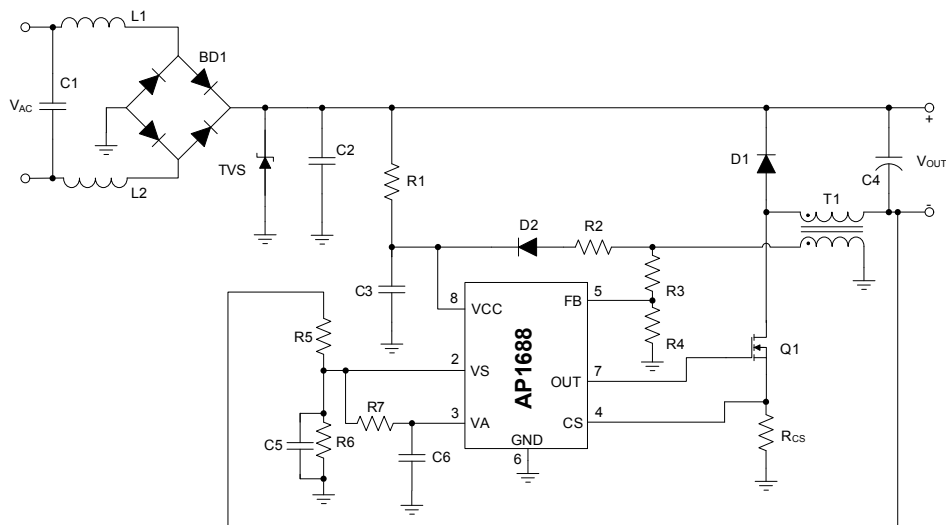
- Optimized for Buck Topology
- Boundary Conduction Mode (BCM) Operation to Achieve High Efficiency
- High Power Factor > 0.9
- High Efficiency > 90%
- System Current Accuracy: $\pm 5\%$
- Good Line Regulation and Load Regulation
- Low Start-up Current
- Tight CC Regulation Performance for Universal Input Mains Voltage Range
- Eliminates Control Loop Compensation Circuitry
- Easy EMI
- Open-load and Reload Detection
- Over Temperature Protection
- Over Current Protection
- Over Voltage and Short and Open Circuit Protection
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Applications

- Universal Mains LED lighting

- 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 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.

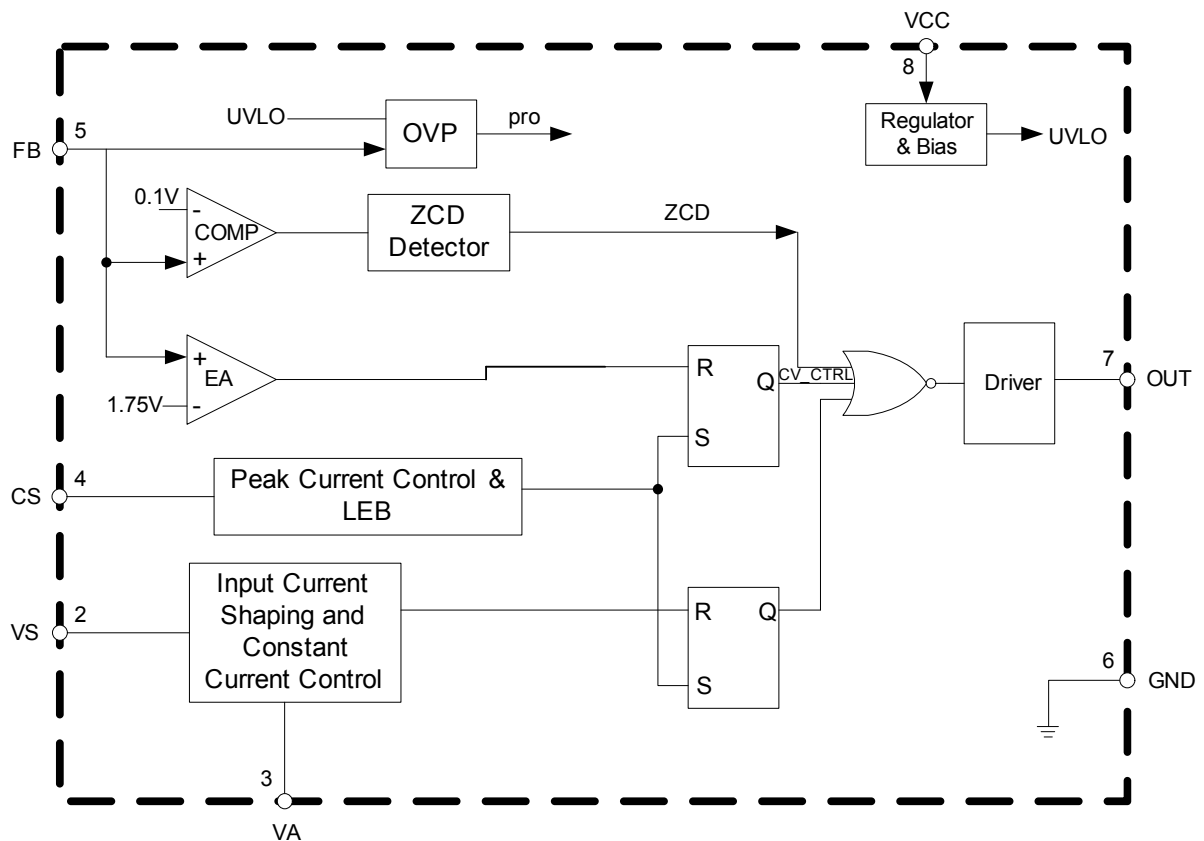
Typical Applications Circuit



Pin Descriptions

| Pin Number | Pin Name | Function |
|------------|----------|-----------------------------------------------------------------------|
| 1 | NC | No connection |
| 2 | VS | Detects the negative terminal voltage of output. |
| 3 | VA | Detects the average value of the negative terminal voltage of output. |
| 4 | CS | Primary current sensing |
| 5 | FB | The feedback voltage sensing from the auxiliary winding |
| 6 | GND | Ground |
| 7 | OUT | Gate driver output |
| 8 | VCC | Supply voltage of gate driver and control circuits of the IC |

Functional Block Diagram



Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified. Note 4)

| Symbol | Parameter | Rating | Unit |
|-----------------------------------------------------|--------------------------------------------|-------------|------|
| V _{CC} | Power Supply Voltage | -0.3 to 40 | V |
| I _{OUT} | Driver Output Current | 300 | mA |
| V _{VS} , V _{VA} , V _{CS} | Voltage at VS, VA, CS to GND | -0.3 to 7 | V |
| V _{FB} | FB Input Voltage | -40 to 10 | V |
| T _J | Operating Junction Temperature | +150 | °C |
| T _{STG} | Storage Temperature | -65 to +150 | °C |
| T _{LEAD} | Lead Temperature (Soldering, 10 sec) | +300 | °C |
| P _D | Power Dissipation (T _A = +50°C) | 0.65 | W |
| θ _{JA} | Thermal Resistance (Junction to Ambient) | 190 | °C/W |
| – | ESD (Human Body Model) | 3000 | V |
| – | ESD (Machine Model) | 200 | 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

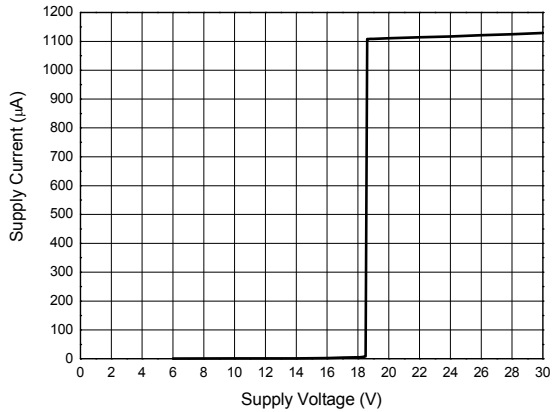
| Symbol | Parameter | Min | Max | Unit |
|-----------------|----------------------|-----|------|------|
| V _{CC} | Power Supply Voltage | 12 | 21 | V |
| T _A | Ambient Temperature | -40 | +105 | °C |

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

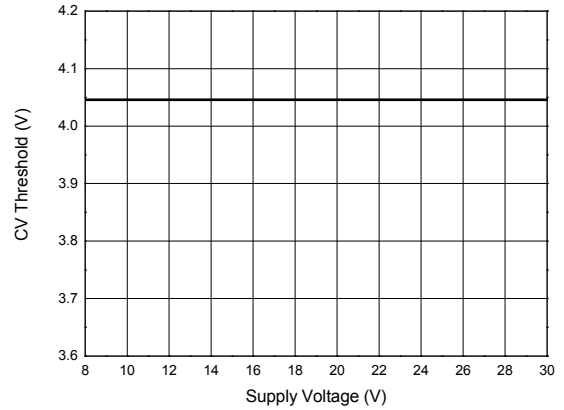
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|--------------------------------------------|----------------------------------|-----------------------------------------------------------------------|-----|------|------|------|
| UVLO Section | | | | | | |
| V _{TH} (ST) | Start-up Threshold | – | 18 | 19 | 20 | V |
| V _{OPR} (Min) | Minimum Operating Voltage | After turn on | 7 | 8 | 9 | V |
| V _{CC_OVP} | VCC OVP Voltage | – | 28 | 32 | 36 | V |
| Standby Current Section | | | | | | |
| I _{ST} | Start-up Current | V _{CC} = V _{TH} (ST)-0.5V, Before start up | – | – | 20 | μA |
| I _{CC} (OPR) | Operating Current | Static | – | 1000 | 1300 | μA |
| Drive Output Section | | | | | | |
| V _{OH} | Output High Level Voltage | I _{GD_SOURCE} = 20mA V _{CC} = 12V | 10 | – | – | V |
| V _{OL} | Output Low Level Voltage | I _{GD_SINK} = 20mA 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 V _{CC} = 20V | 12 | 13.5 | 15 | V |
| V _{UVLO} | UVLO Saturation Voltage | V _{CC} = 0 to V _{CC_ON} I _{SINK} = 10mA | – | – | 1.1 | V |
| Current Sense Section | | | | | | |
| t _{ON} (Min) | Minimum On Time | – | 500 | 1000 | 1500 | ns |
| V _{SOCP} | Short Circuit Protection Voltage | – | 3 | 4 | – | V |
| Feedback Input Section | | | | | | |
| I _{FB} | FB Pin Input Leakage Current | V _{FB} = 4V | – | 2 | 8 | μA |
| V _{FB} (CV) | CV Threshold | – | 3.8 | 4.0 | 4.2 | V |
| V _{FB} (OVP) | Over Voltage Protection | – | 4.5 | 6 | 7.5 | V |
| VS Input Section | | | | | | |
| V _{VS} /V _{VA} (Max) | Maximum Ratio | V _{VS} = V _{VA} = 3V | 0.8 | 1 | 1.2 | V |
| V _{VS} /V _{VA} (Min) | Minimum Ratio | V _{VS} = 0V, V _{VA} = 3V | – | – | 0.2 | V |
| Over Temperature Protection Section | | | | | | |
| – | Shutdown Temperature | – | – | +170 | – | °C |
| – | Temperature Hysteresis | – | – | +20 | – | °C |

Performance Characteristics

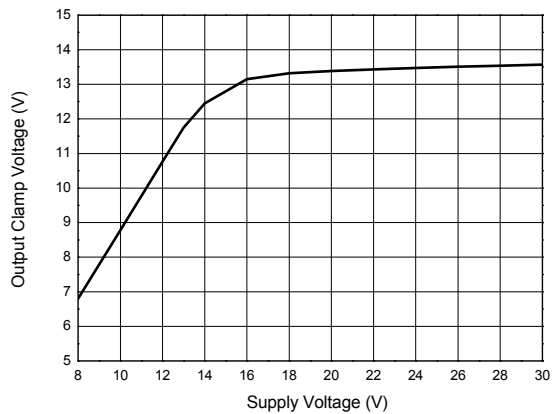
Supply Current vs. Supply Voltage



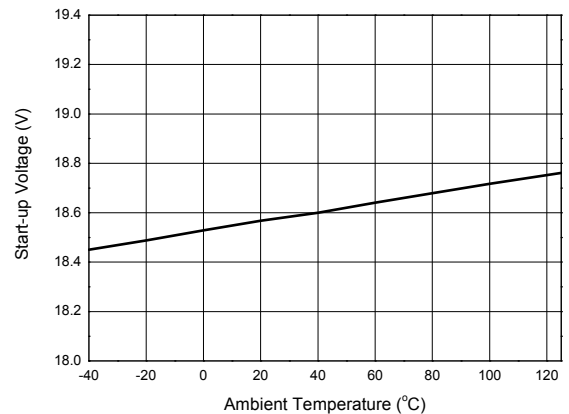
CV Threshold vs. Supply Voltage



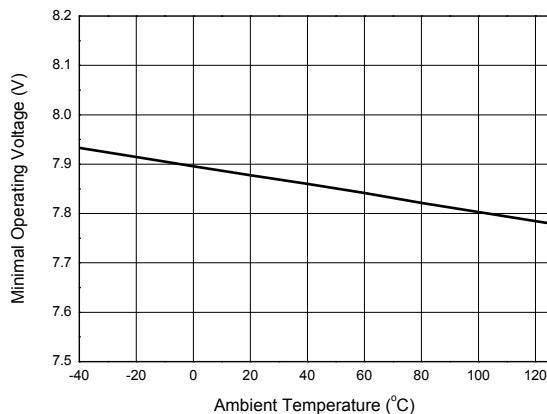
Output Clamp Voltage vs. Supply Voltage



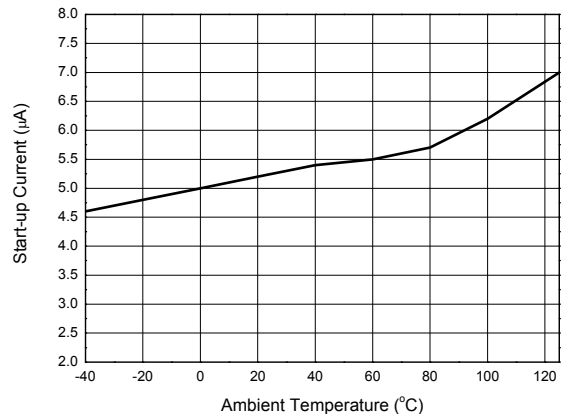
Start-up Voltage vs. Ambient Temperature



Minimal Operating Voltage vs. Ambient Temperature

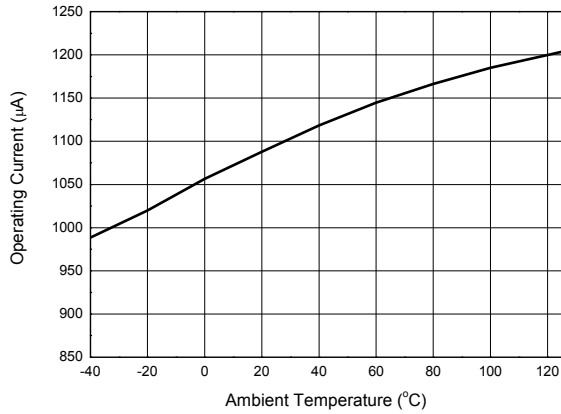


Start-up Current vs. Ambient Temperature

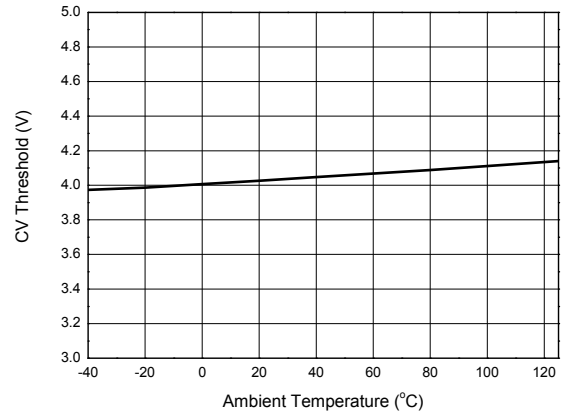


Performance Characteristics (Cont.)

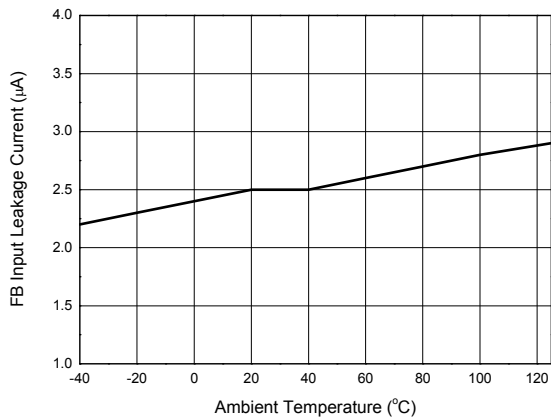
Operating Current vs. Ambient Temperature



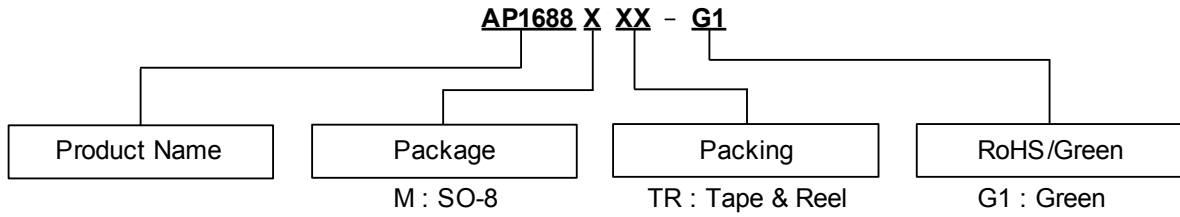
CV Threshold vs. Ambient Temperature



FB Leakage Current vs. Ambient Temperature



Ordering Information

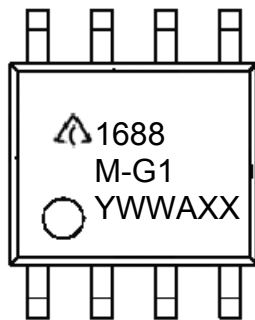


Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

| Package | Temperature Range | Part Number | Marking ID | Packing |
|---------|-------------------|--------------|------------|----------------------|
| SO-8 | -40 to +105°C | AP1688MTR-G1 | 1688M-G1 | 4000/13" Tape & Reel |

Marking Information

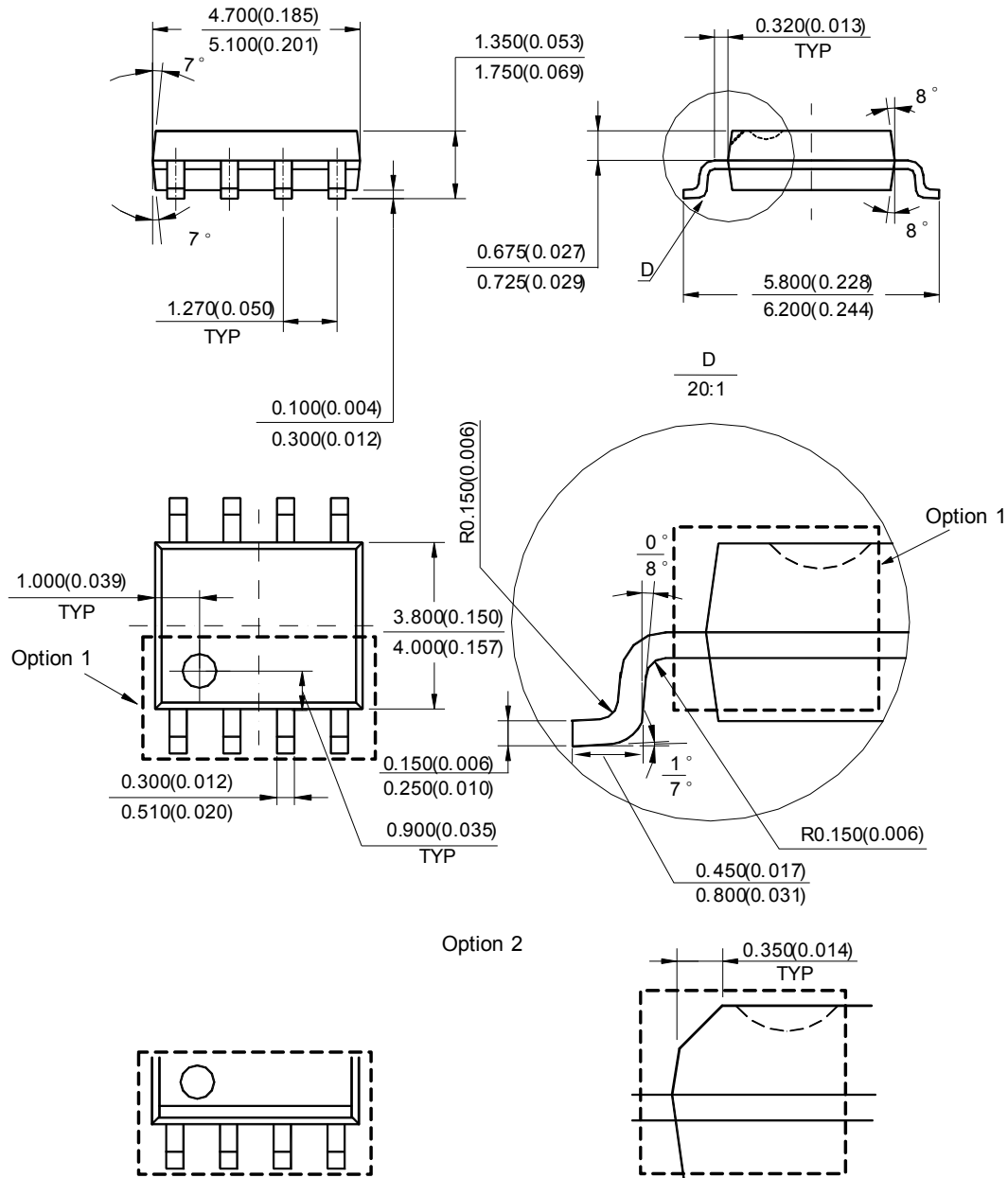
(Top View)



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 No

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

(1) Package Type: SO-8

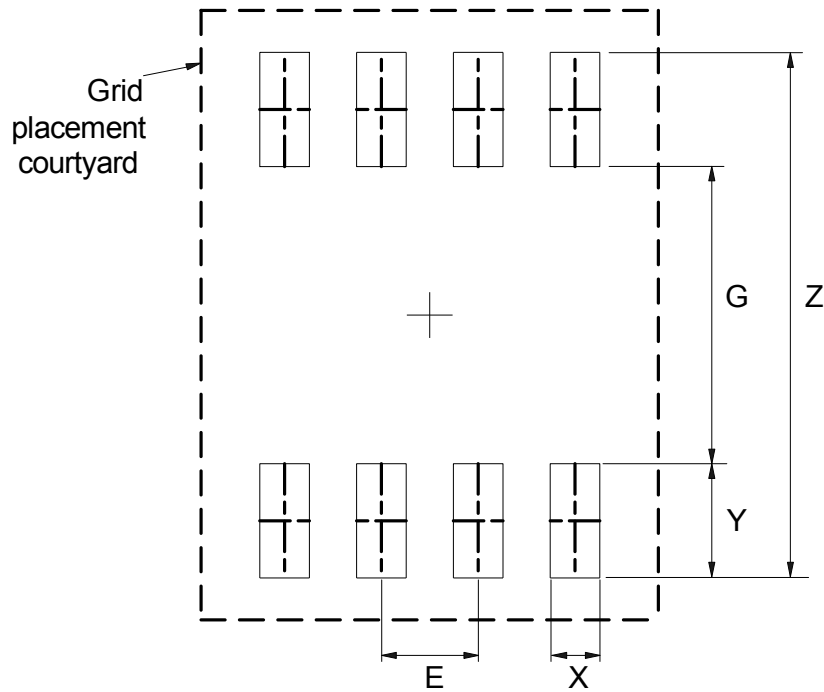


Note: Eject hole, oriented hole and mold mark is optional .

NEW PRODUCT

Suggested Pad Layout

(1) Package Type: SO-8



| 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 |

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