NEW PRODUCT

AP1688

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

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.

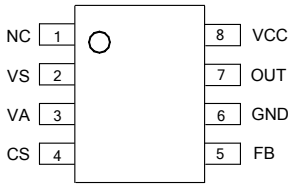
An open loop algorithm is adopted in the AP1688, which will make the system achieve excellent line and load regulations with high PF for universal mains input.

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

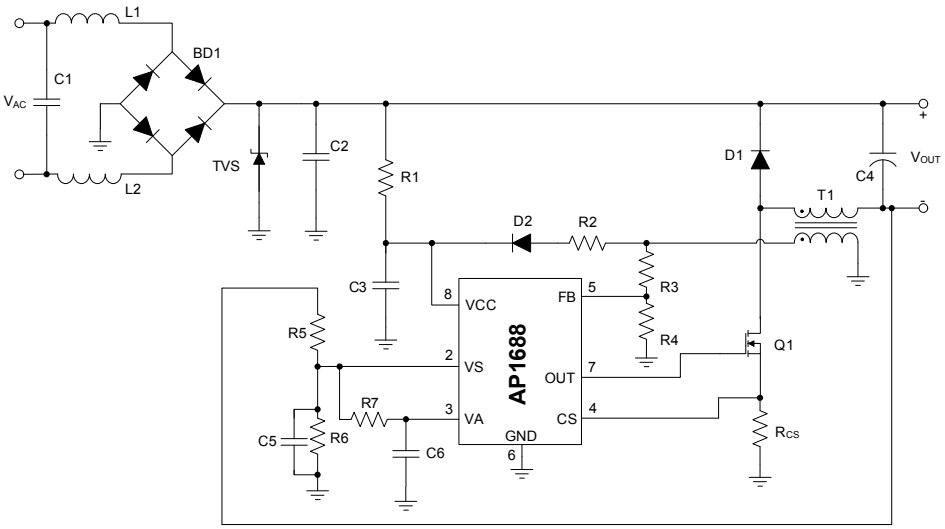
- Optimized for Buck Topology
- Boundary Conduction Mode (BCM) Operation to Achieve High Efficiency
- High Power Factor > 0.9
- High Efficiency > 90%
- System Current Accuracy: ±5%
- Good Line Regulation and Load Regulation
- Low Start-up Current
- Tight CC Regulation Performance for Universal Input 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

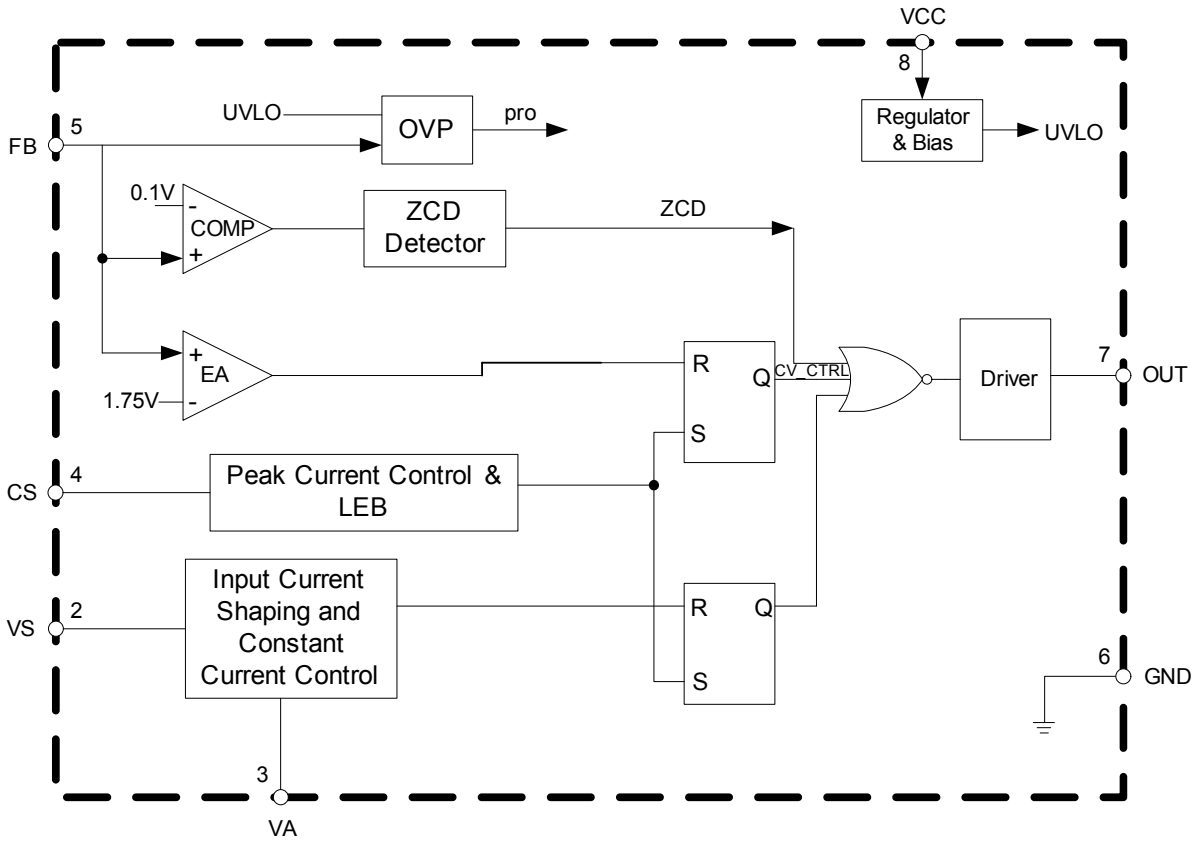


NEW PRODUCT

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



NEW PRODUCT

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

NEW PRODUCT

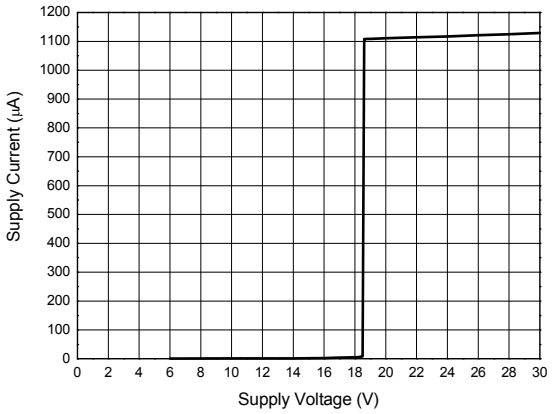
Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

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

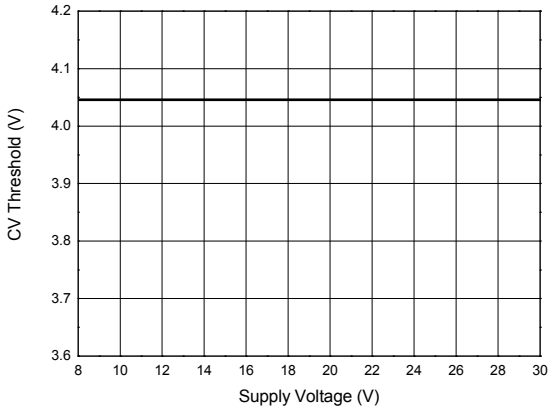
NEW PRODUCT

Performance Characteristics

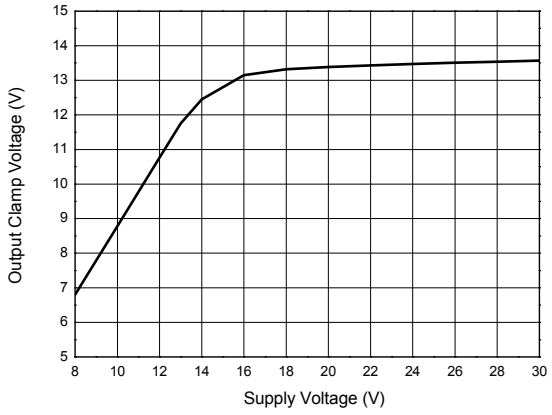
Supply Current vs. Supply Voltage



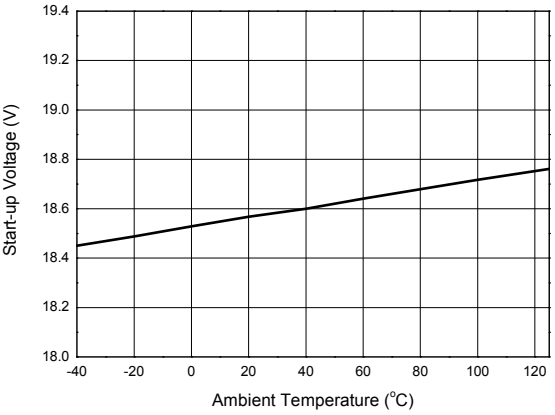
CV Threshold vs. Supply Voltage



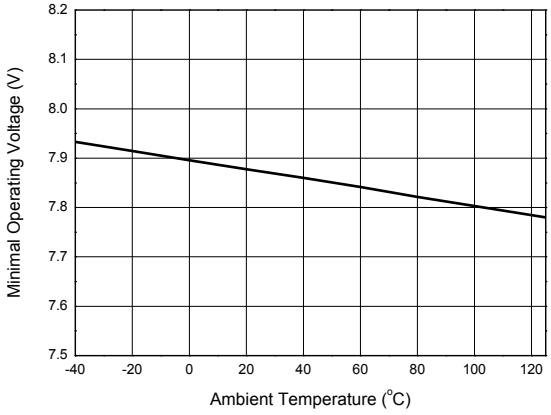
Output Clamp Voltage vs. Supply Voltage



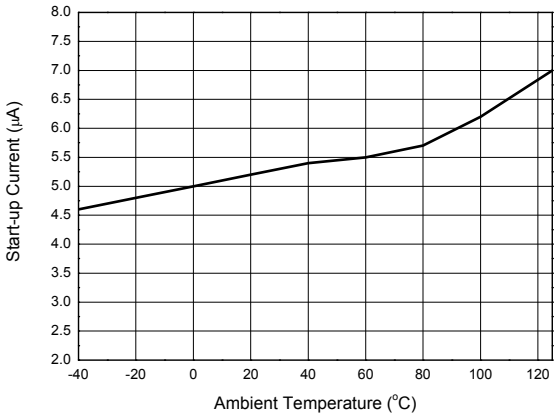
Start-up Voltage vs. Ambient Temperature



Minimal Operating Voltage vs. Ambient Temperature



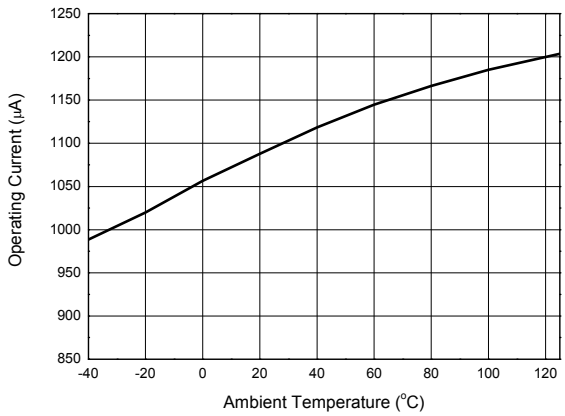
Start-up Current vs. Ambient Temperature



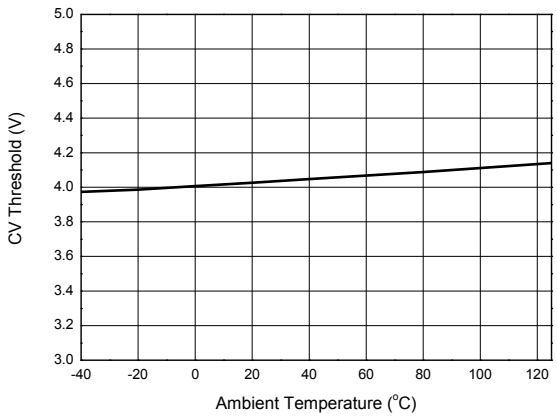
NEW PRODUCT

Performance Characteristics (Cont.)

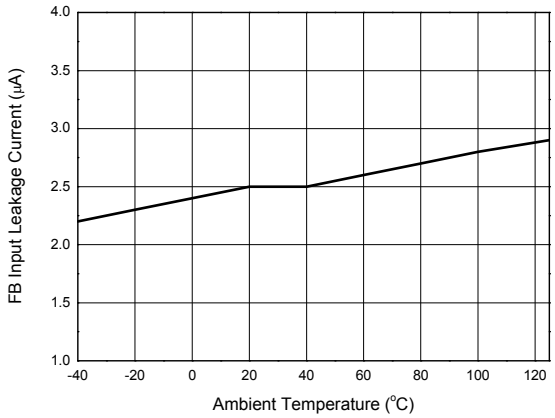
Operating Current vs. Ambient Temperature



CV Threshold vs. Ambient Temperature

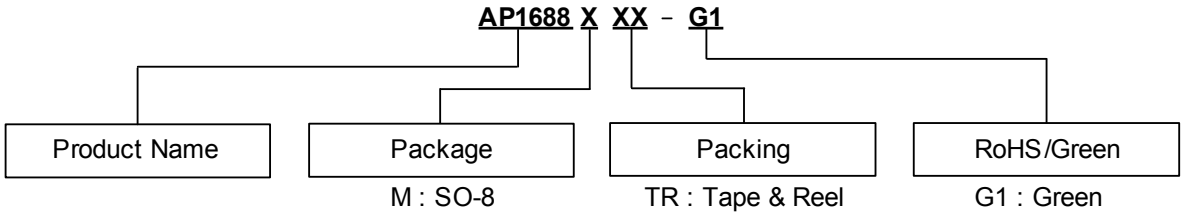


FB Leakage Current vs. Ambient Temperature



NEW PRODUCT

Ordering Information

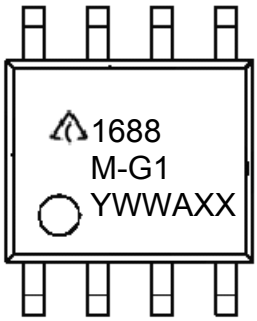


Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

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)

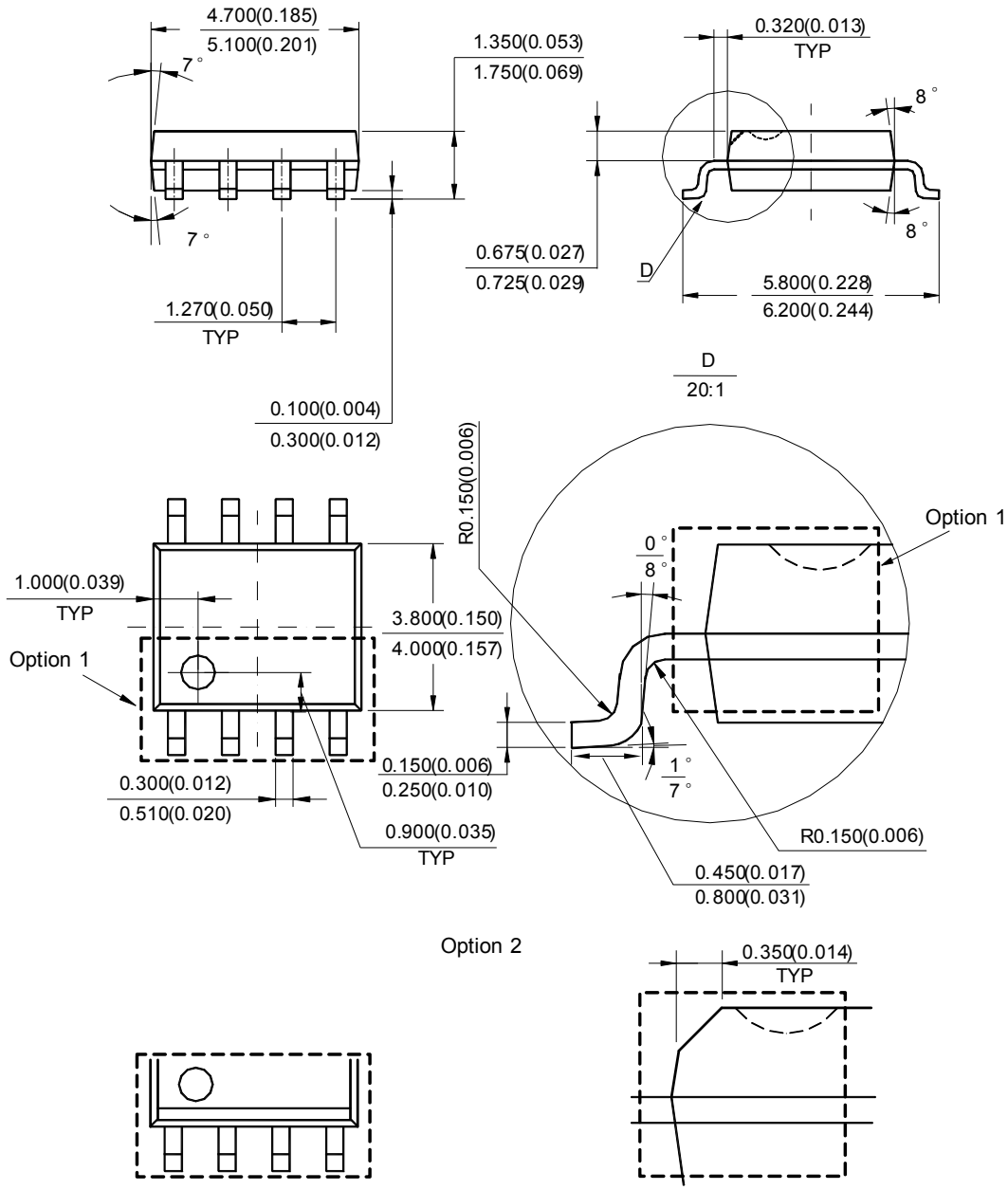


First and Second Lines: Logo and Marking ID
(See Ordering Information)
Third Line: Date Code
Y: Year
WW: Work Week of Molding
A: Assembly House Code
XX: 7th and8th Digits of Batch No

NEW PRODUCT

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

(1) Package Type: SO-8

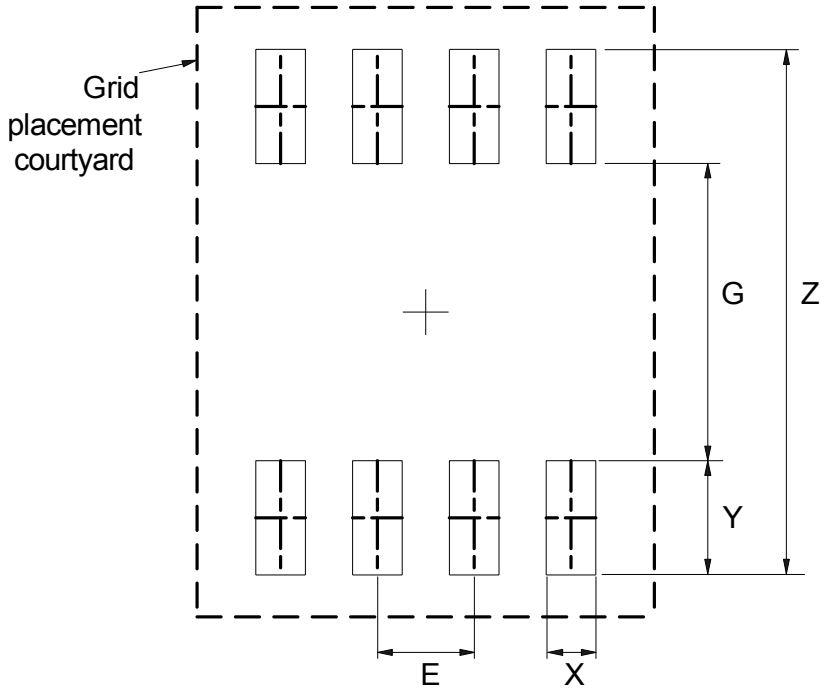


Note: Eject hole, oriented hole and mold mark is optional .

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

NEW PRODUCT

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel. Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

www.diodes.com