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.

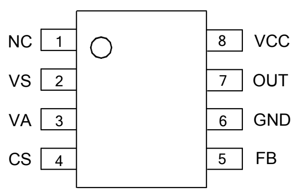
The AP1688 is available in SO-8 package.

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)**

Pin Assignments

(Top View)



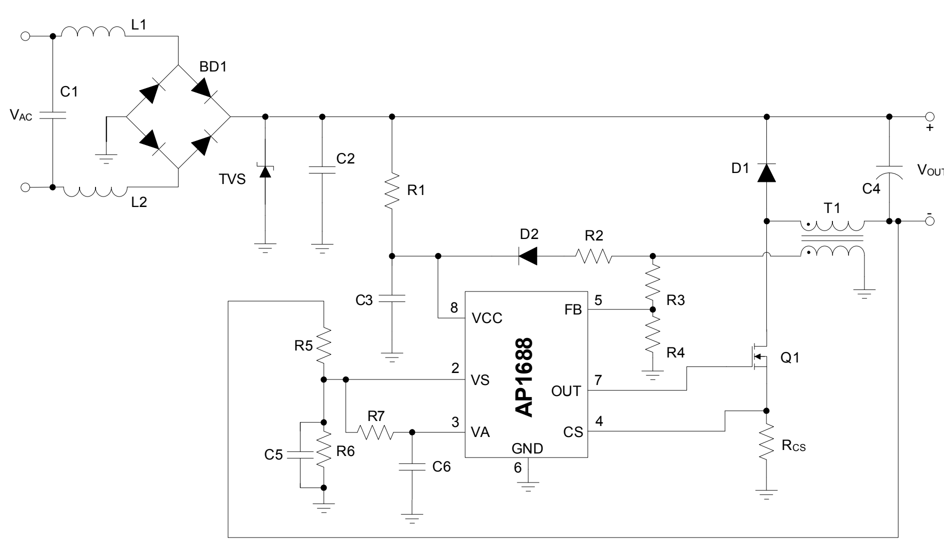
(SO-8/ M Package)

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.

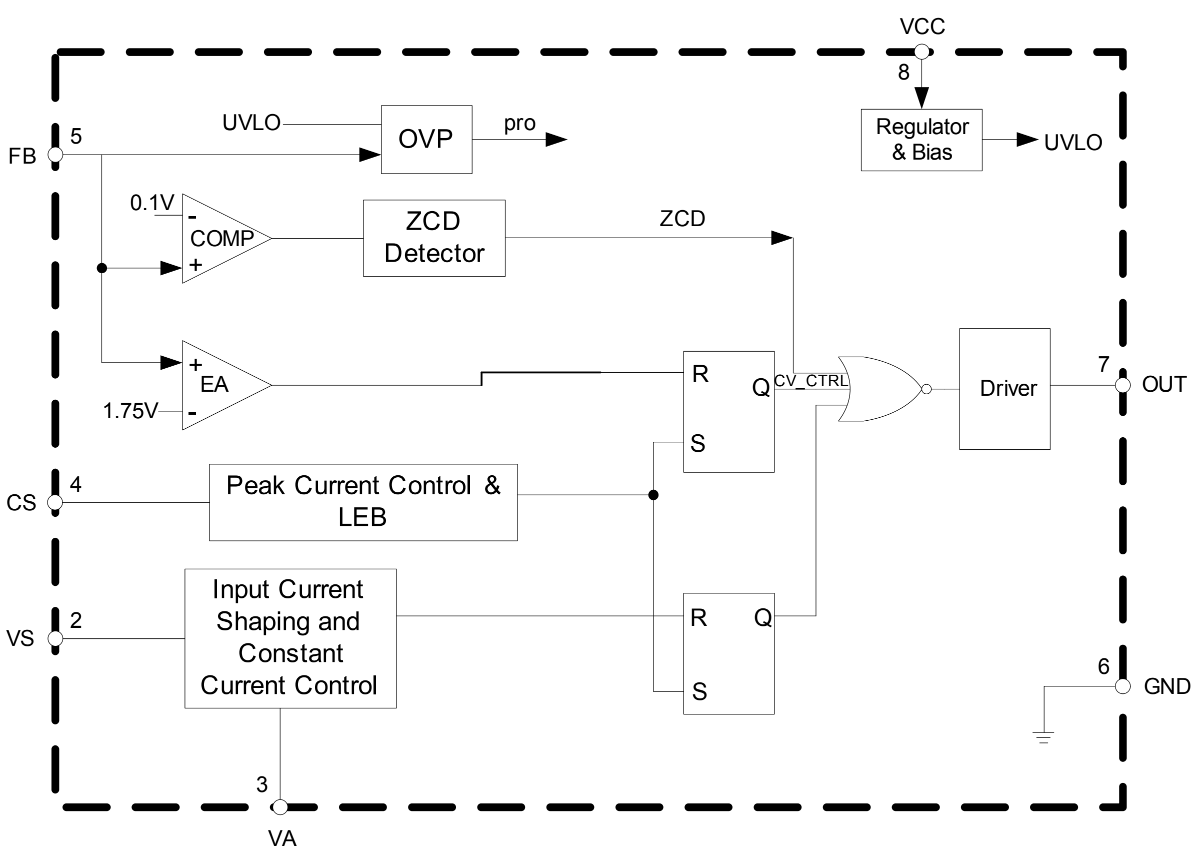
Typical Applications Circuit



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



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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

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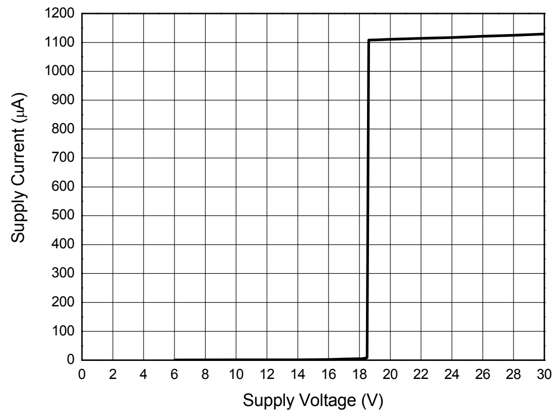
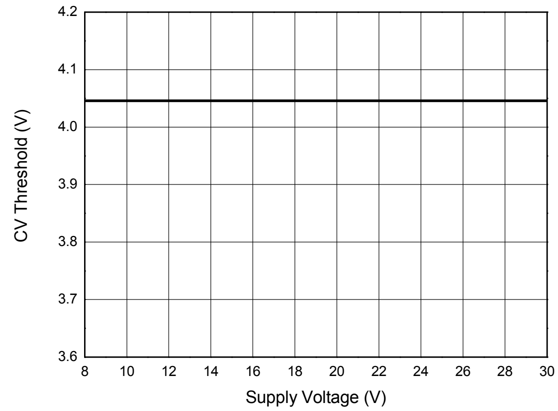
Performance Characteristics

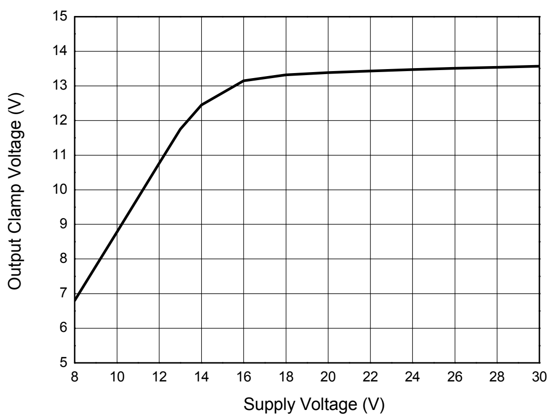
Supply Current vs. Supply Voltage



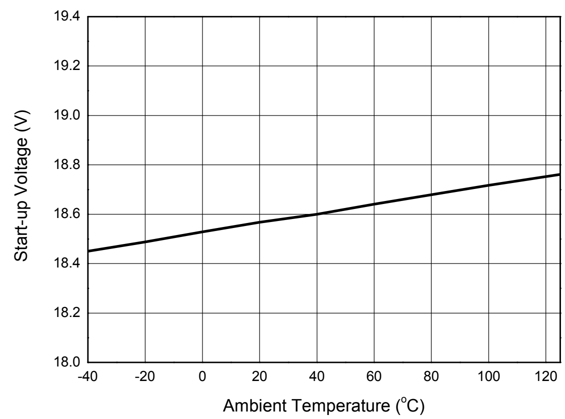
CV Threshold vs. Supply Voltage



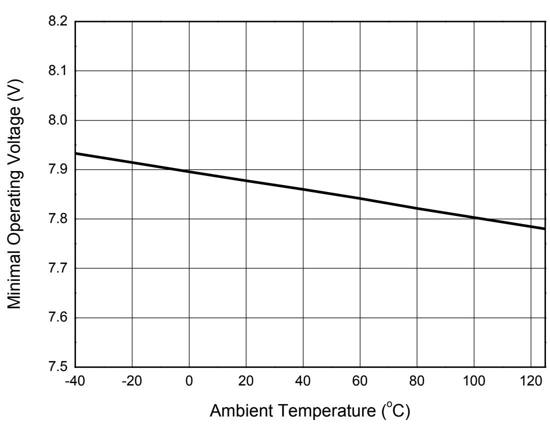
Output Clamp Voltage vs. Supply Voltage



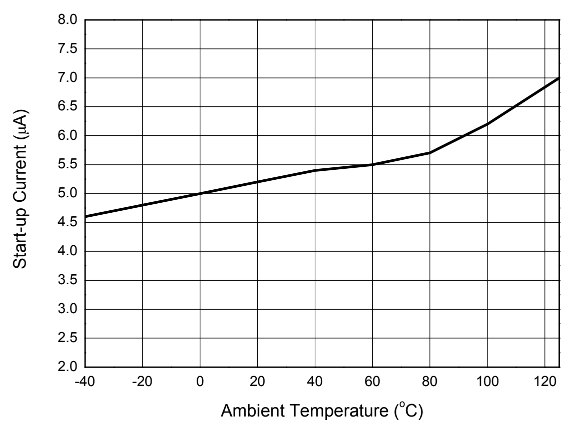
Start-up Voltage vs. Ambient Temperature



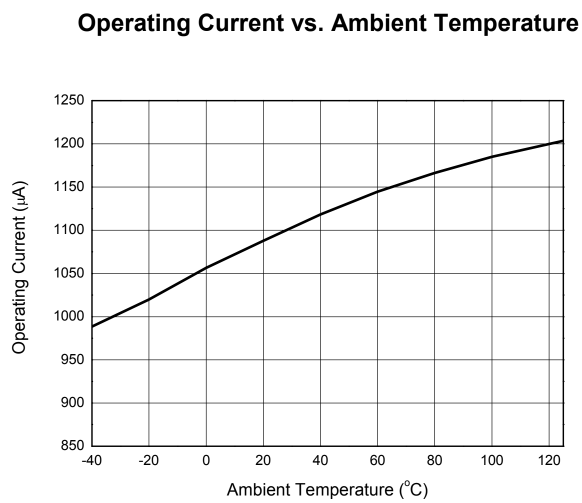
Minimal Operating Voltage vs. Ambient Temperature

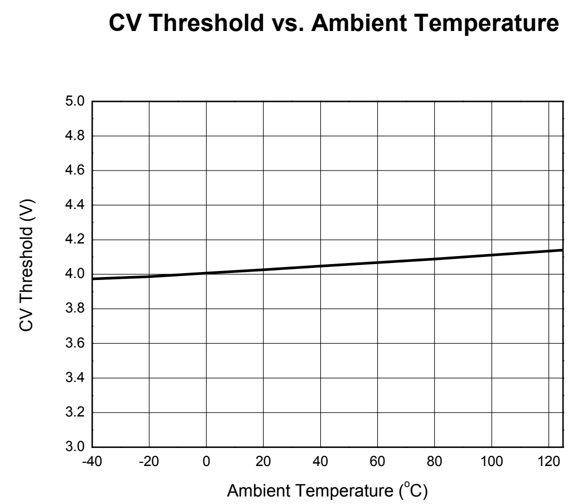


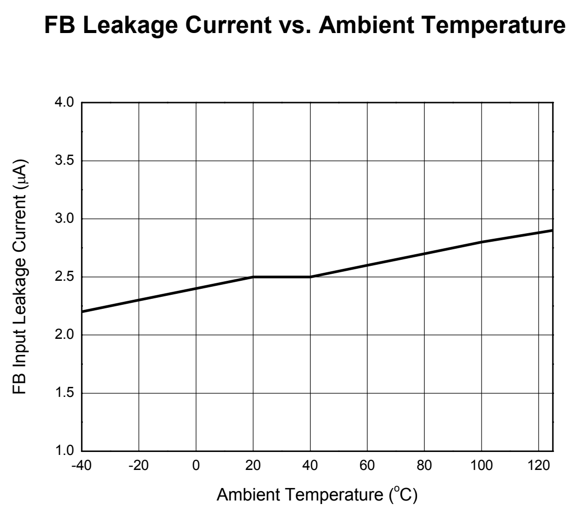
Start-up Current vs. Ambient Temperature



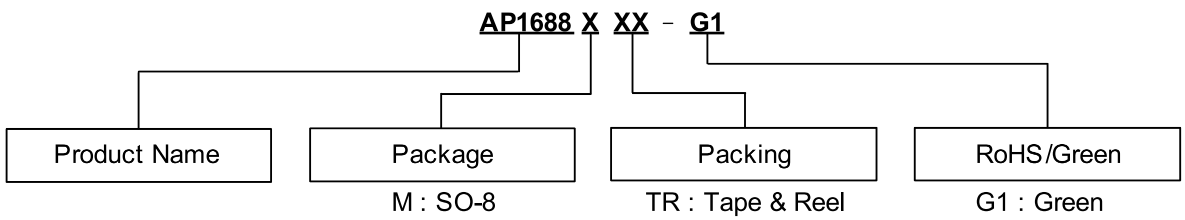
Performance Characteristics (Cont.)







Ordering Information

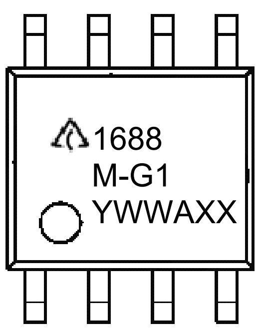


Diodes IC's Pb-free products with "G1" suffix in the part number, are RoHS compliant and green.

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

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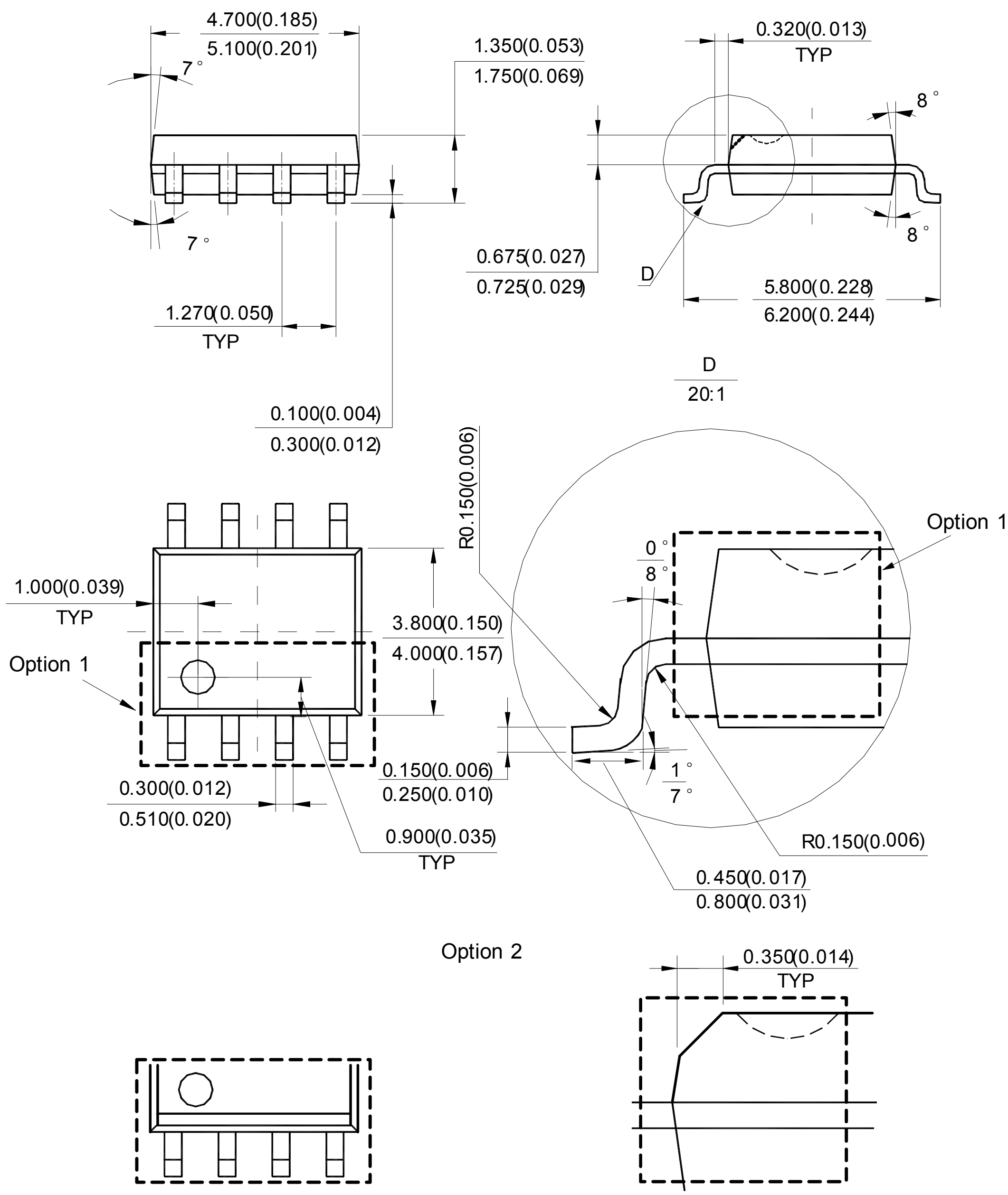
Package Outline Dimensions (All dimensions in mm(inch).)

(1) Package Type: SO-8



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

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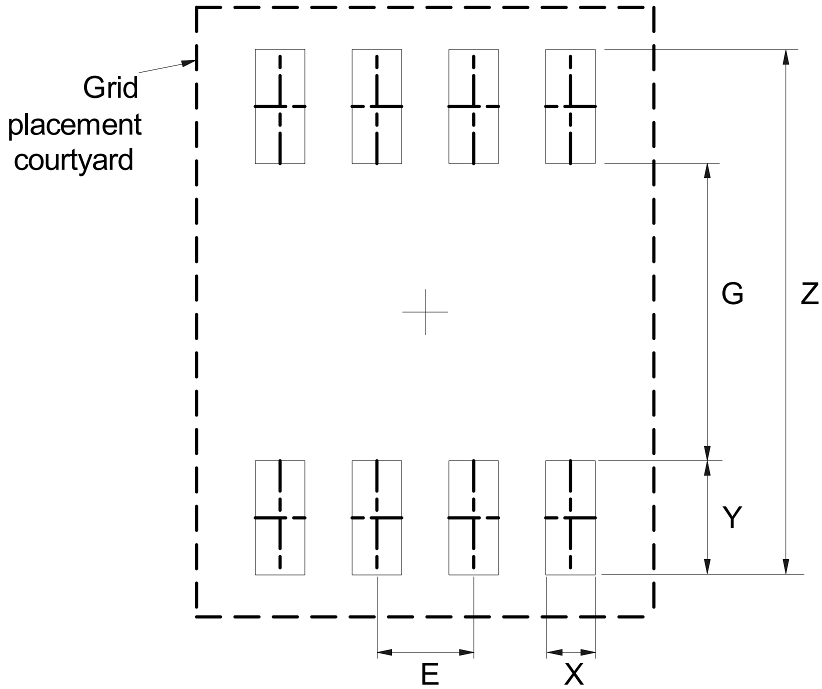
Suggested Pad Layout

(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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