

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

## Description

The AP1690 is a high performance AC/DC universal input Primary Side Regulation Power Factor Controller for dimmable LED driver applications.

The AP1690 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 AP1690 achieves excellent regulation and high efficiency, yet meets the requirement of IEC61000-3-2 harmonic standard.

The AP1690 features low start-up current, low operation current and high efficiency. It also has rich protection features including over voltage, short circuit, over current, over temperature protection etc. In order to regulate the output current of LED current with the phase of dimmer, pin 2 and pin 3 are used to set the peak current of transformer according to the voltage applied to these two pins.

The AP1690 is available in SO-8 package.

## Features

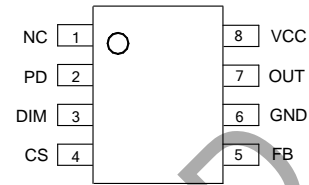
- Primary Side Control for Output Current Regulation Without Opto-coupler and Secondary CV/CC Control Circuitry
- Low Start-up Current
- Good Dimmer Compatibility
- Tight CC Regulation Performance for Universal Input Mains Voltage Range
- Eliminates Control Loop Compensation Circuitry
- Built-in Acceleration Start
- LED Open Protection
- LED Short Circuit Protection
- Over Temperature Protection
- Over Current Protection
- Cost Effective for Dimmable LED Driver Solution
- **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) & 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)

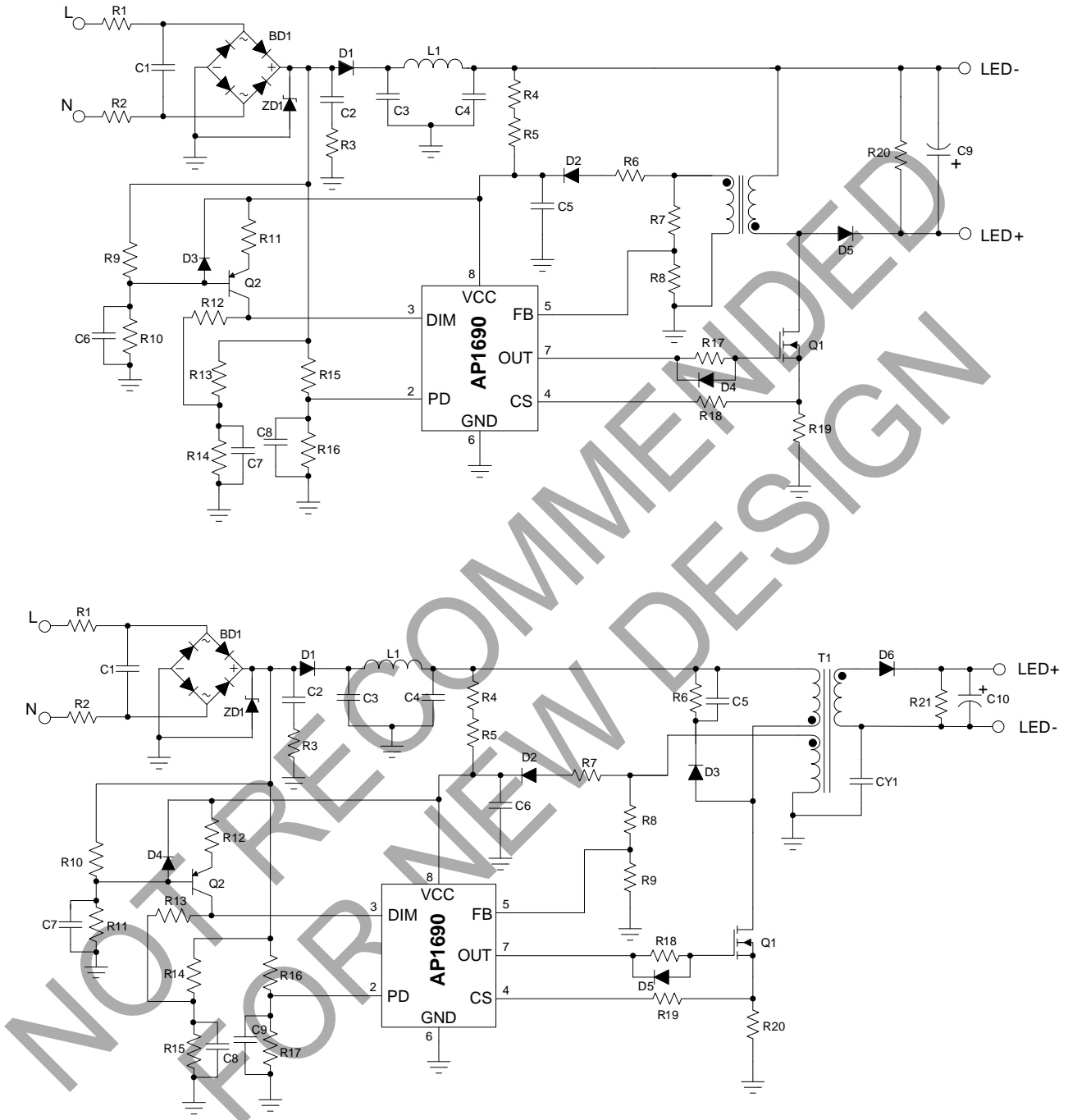


(SO-8)

## Applications

- Single Stage Power Factor Correction Power Supply for Dimmable LED Lighting

**Typical Applications Circuit**

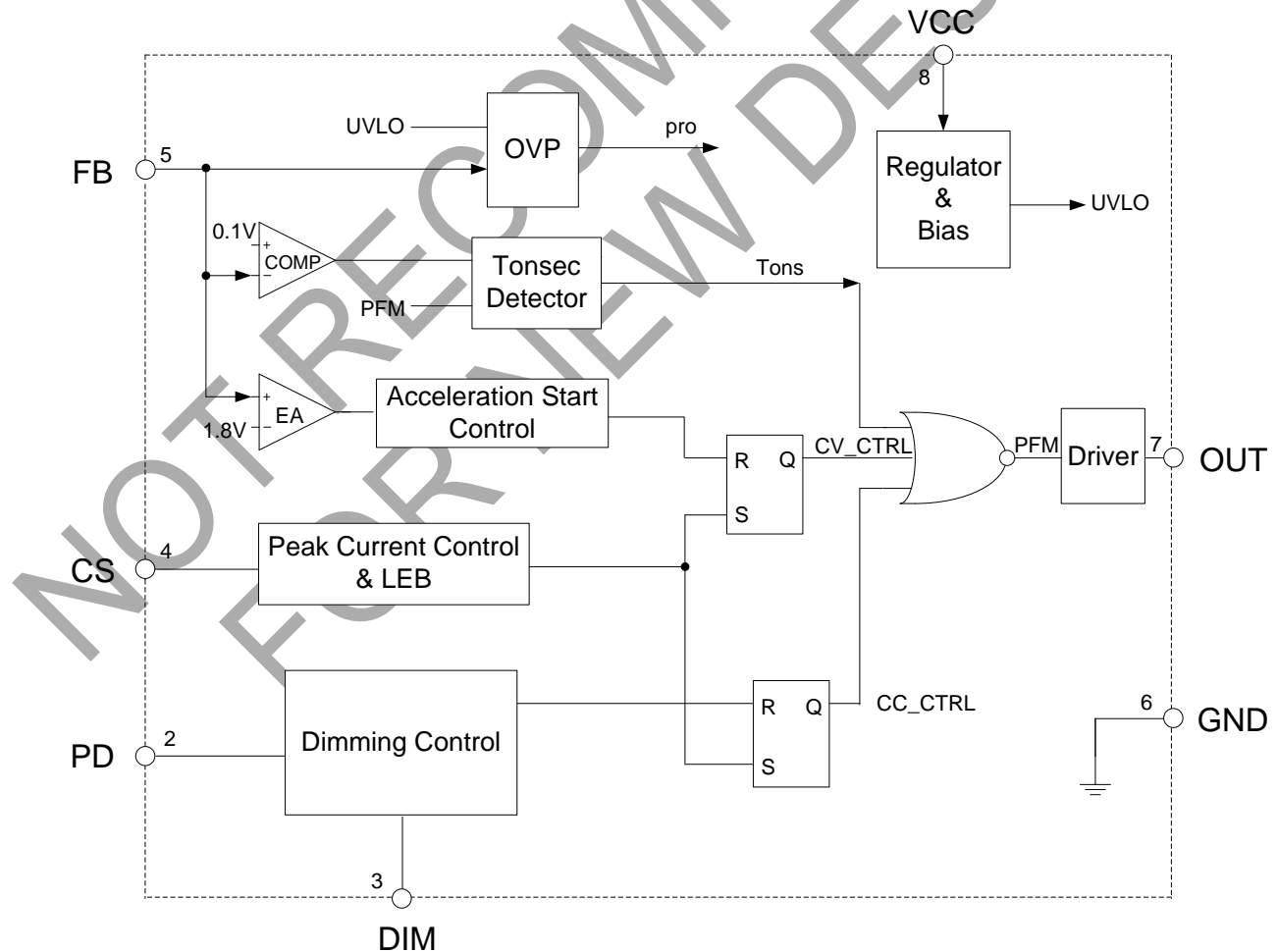


Isolated

**Pin Descriptions**

Pin Number	Pin Name	Function
1	NC	No connection
2	PD	The rectified input voltage sensing pin. The pin is detecting the phase of dimmer
3	DIM	The rectified input voltage sensing pin. The pin is detecting the average AC 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 30	V
I <sub>OUT</sub>	Driver Output Current	300	mA
V <sub>PD</sub> , V <sub>DIM</sub> , V <sub>CS</sub>	Voltage at PD, DIM, 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, 10 sec)	+300	°C
P <sub>D</sub>	Power Dissipation at 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” 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

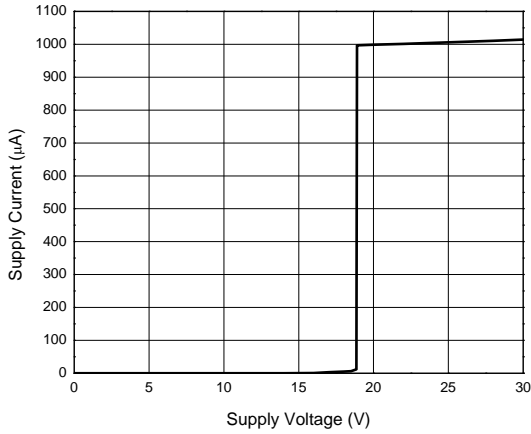
Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Power Supply Voltage	9	21	V
T <sub>A</sub>	Ambient Temperature	-40	+105	°C

**Electrical Characteristics** (@V<sub>CC</sub> = 15V, T<sub>A</sub> = +25°C, unless otherwise specified.)

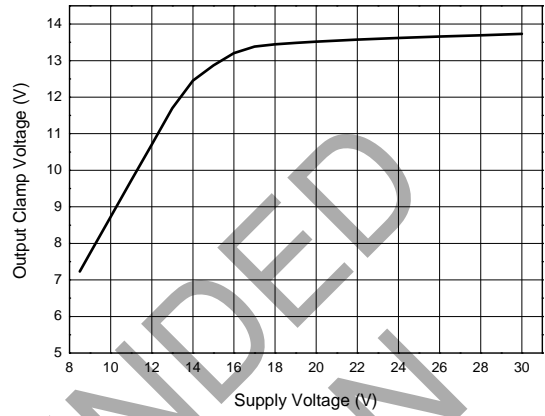
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>UVLO Section</b>						
V <sub>TH</sub> (ST)	Start-up Threshold	–	18	19	20	V
V <sub>OPR</sub> (Min)	Minimal Operating Voltage	After turn on	7	8	9	
V <sub>CC_OVP</sub>	VCC OVP Voltage	–	28	32	36	
<b>Standby Current Section</b>						
I <sub>ST</sub>	Start-up Current	V <sub>CC</sub> = V <sub>TH</sub> (ST)-0.5V, Before start up	–	–	100	μA
I <sub>CC</sub> (Max)	Maximum Operating Current	V <sub>PD</sub> = V <sub>DIM</sub> = 3V	–	1500	2000	
<b>Drive Output Section</b>						
V <sub>OH</sub>	Output High Level Voltage	I <sub>GD-SOURCE</sub> = 20mA V <sub>CC</sub> = 12V	10	–	–	V
V <sub>OL</sub>	Output Low Level Voltage	I <sub>GD-SINK</sub> = 20mA V <sub>CC</sub> = 12V	–	–	1	V
t <sub>R</sub>	Output Voltage Rise Time	C <sub>L</sub> = 1nF	100	140	190	ns
t <sub>F</sub>	Output Voltage Fall Time	C <sub>L</sub> = 1nF	30	60	90	ns
V <sub>O-CLAMP</sub>	Output Clamp Voltage	I <sub>GD-SOURCE</sub> = 5mA V <sub>CC</sub> = 20V	12	13.5	15	V
<b>Current Sense Section</b>						
t <sub>ON</sub> (Min)	Minimum On Time	–	500	750	1000	ns
V <sub>SOCP</sub>	Short Circuit Protection Voltage	–	3	4	–	V
<b>Feedback Input Section</b>						
I <sub>FB</sub>	FB Pin Input Leakage Current	V <sub>FB</sub> = 4V	–	2	8	μA
V <sub>FB</sub> (ACC)	Acceleration Start Threshold	–	1.4	1.8	2.2	V
V <sub>FB</sub> (OVP)	Over Voltage Protection	–	4.5	6	7.5	V
<b>Dimming Section</b>						
V <sub>IN</sub>	PD Pin and DIM Pin Input Voltage Range	–	–	3	6	V

**Performance Characteristics**

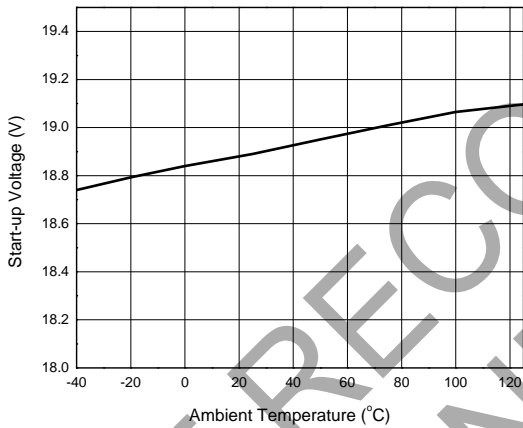
**Supply Current vs. Supply Voltage**



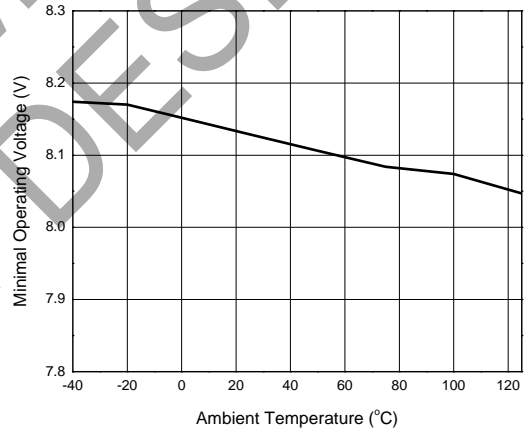
**Output Clamp Voltage vs. Supply Voltage**



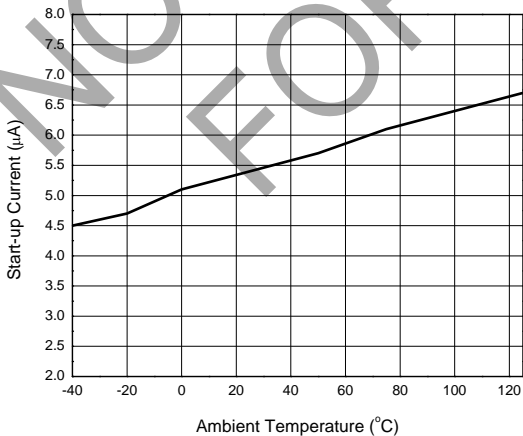
**Start-up Voltage vs. Ambient Temperature**



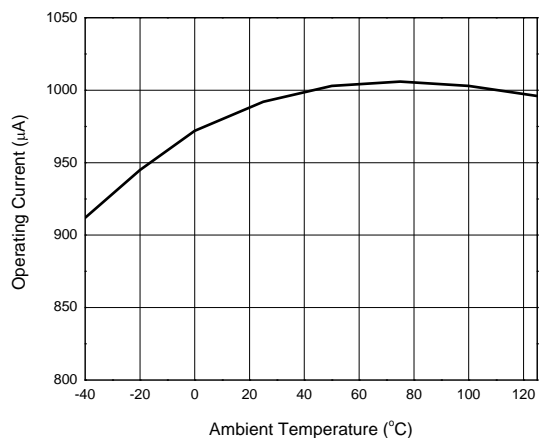
**Minimal Operating Voltage vs. Ambient Temperature**



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

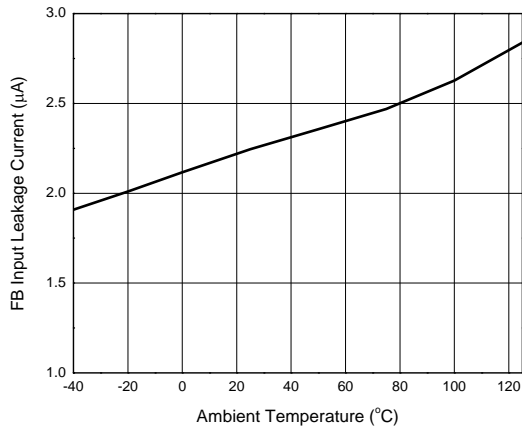


**Operating Current vs. Ambient Temperature**

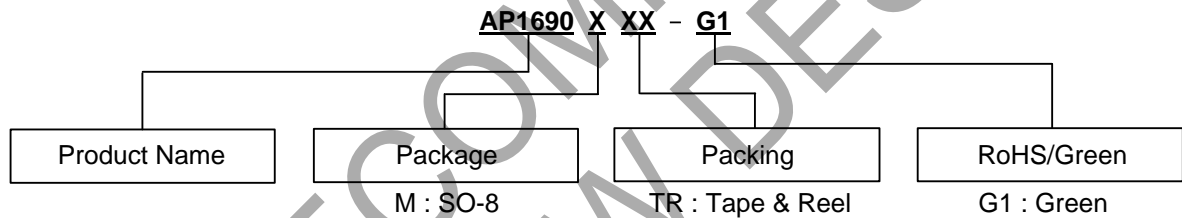


**Performance Characteristics** (Cont.)

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

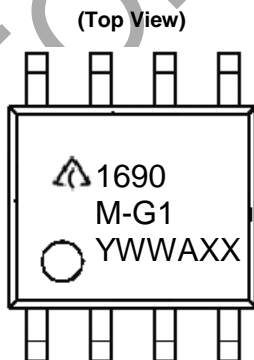


**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing
SO-8	-40 to +105°C	AP1690MTR-G1	1690M-G1	4000/13" Tape & Reel

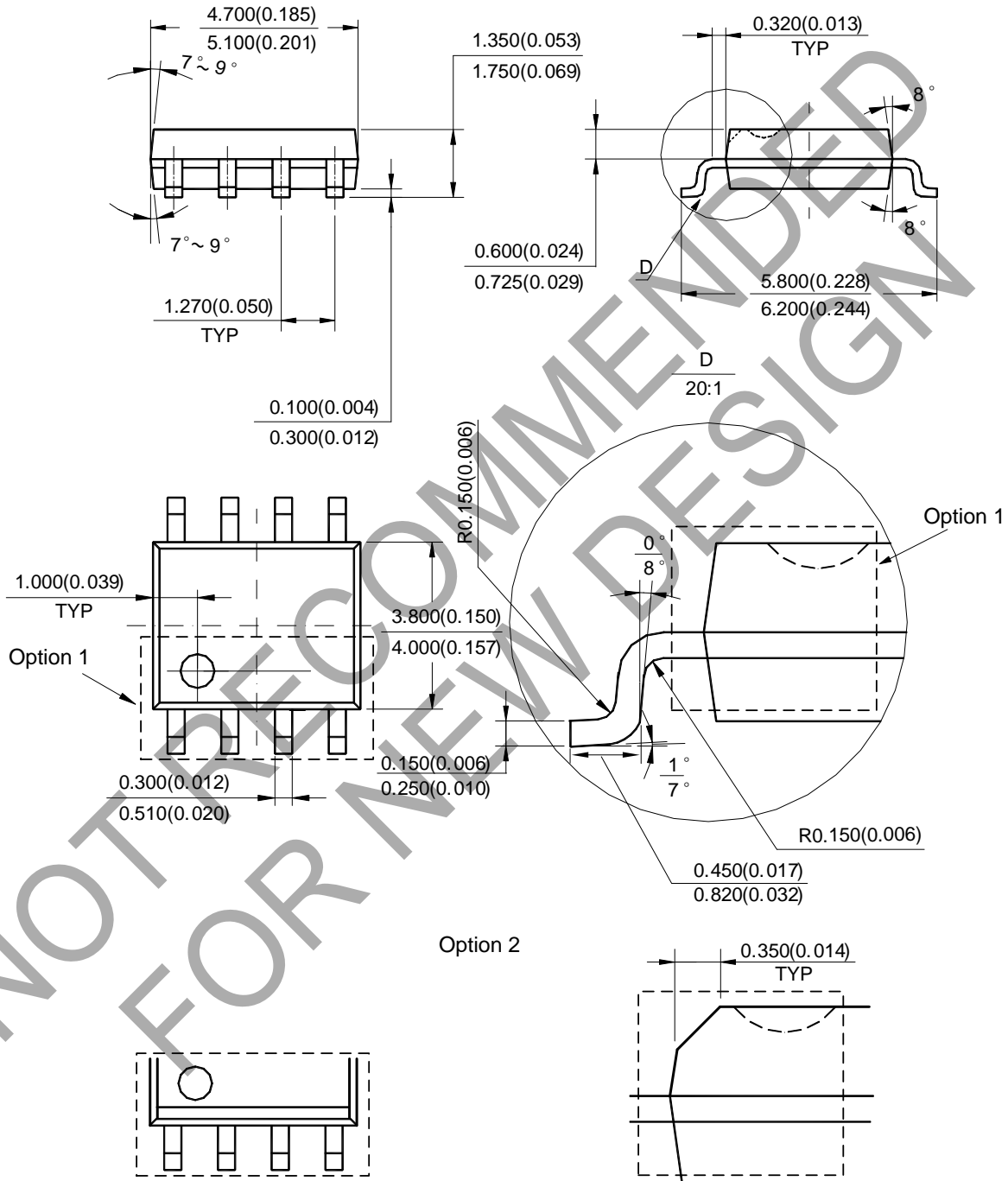
**Marking Information**



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: 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

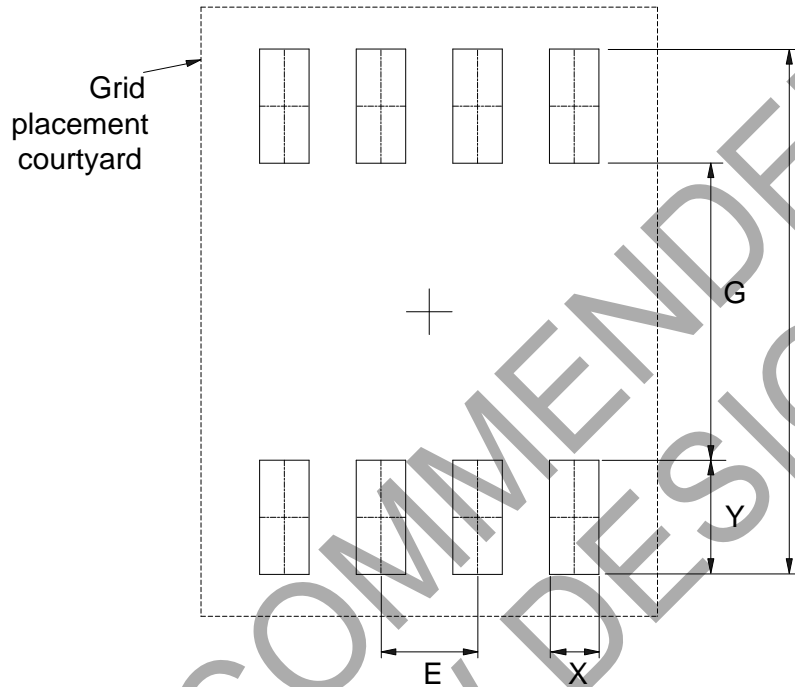


Note: Eject hole, oriented hole and mold mark is optional.



**Suggested Pad Layout**

(1) Package Type: SO-8



Dimensions	Z (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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