

## 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 that operates as a boundary conduction mode (BCM) to achieve high efficiency and easy EMI.

An open loop algorithm is adopted in the AP1688, which makes 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. The device also has rich protection features including overvoltage, short- and open-circuit, overcurrent, and overtemperature protection.

The AP1688 is available in SO-8 package.

## Features

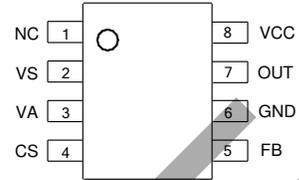
- Optimized for Buck Topology
- Boundary Conduction Mode (BCM) Operation to Achieve High Efficiency
- High Power Factor > 0.9
- High Efficiency > 90%
- System Current Accuracy:  $\pm 5\%$
- Good Line Regulation and Load Regulation
- Low Start-up Current
- Tight CC Regulation Performance for Universal Input Mains Voltage Range
- Eliminates Control Loop Compensation Circuitry
- Easy EMI
- Open-Load and Reload Detection
- Overtemperature Protection
- Overcurrent Protection
- Overvoltage and Short- and Open-Circuit Protection
- **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](https://www.diodes.com/quality/product-definitions/) 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)

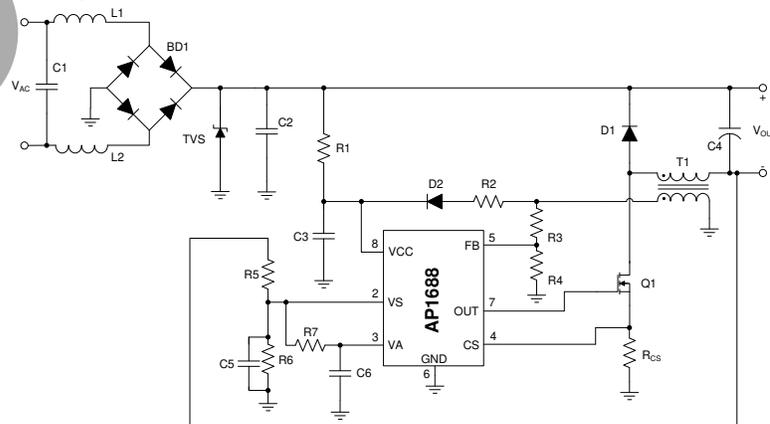


(SO-8/ M Package)

## Applications

- Universal Mains LED Lighting

## Typical Applications Circuit

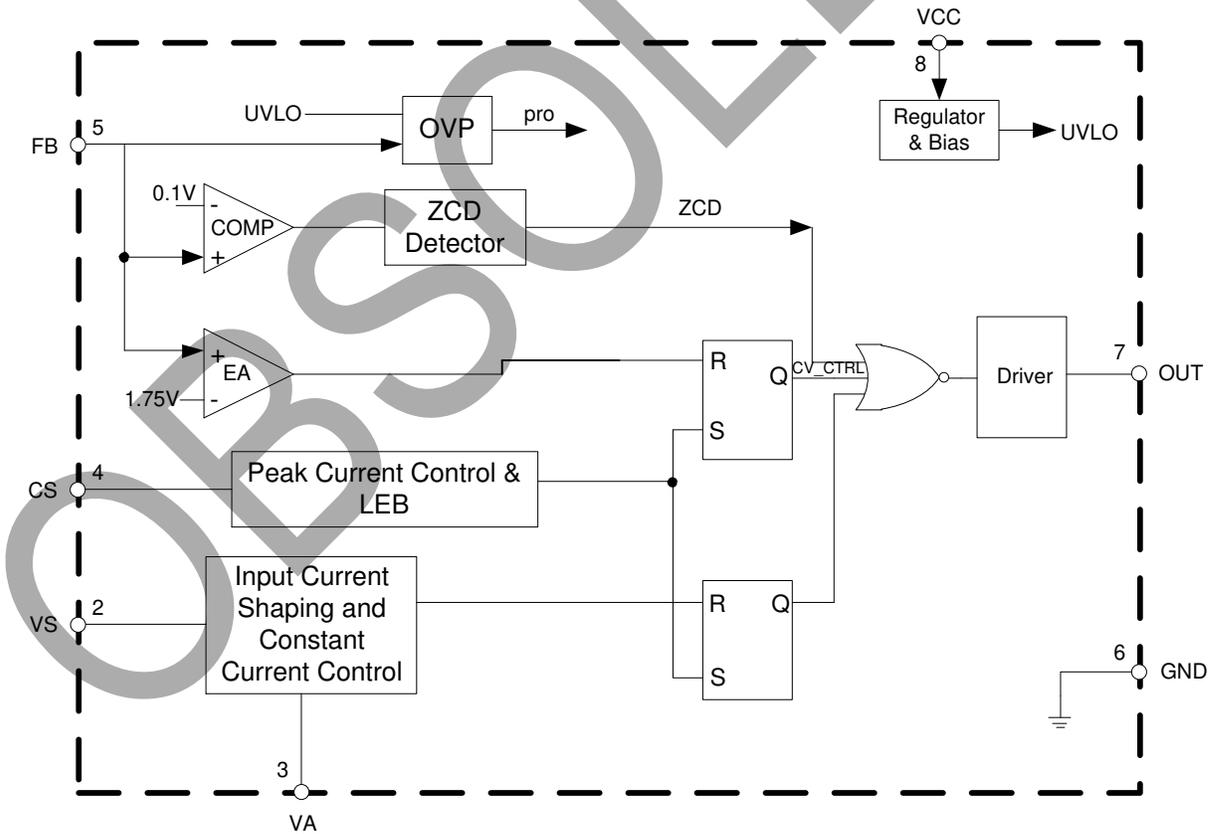


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**Pin Descriptions**

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<sub>A</sub> = +25°C, unless otherwise specified. Note 4)

Symbol	Parameter	Rating	Unit
V <sub>CC</sub>	Power Supply Voltage	-0.3 to 40	V
I <sub>OUT</sub>	Driver Output Current	300	mA
V <sub>VS</sub> , V <sub>VA</sub> , V <sub>CS</sub>	Voltage at VS, VA, CS to GND	-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, 10sec)	+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 (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 <sub>CC</sub>	Power Supply Voltage	12	21	V
T <sub>A</sub>	Ambient Temperature	-40	+105	°C

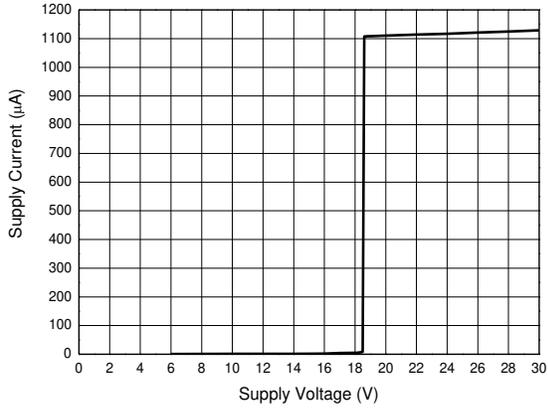
**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

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)	Minimum Operating Voltage	After turn on	7	8	9	V
V <sub>CC_OVP</sub>	VCC OVP Voltage	—	28	32	36	V
<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	—	—	20	μA
I <sub>CC</sub> (OPR)	Operating Current	Static	—	1000	1300	μA
<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
V <sub>UVLO</sub>	UVLO Saturation Voltage	V <sub>CC</sub> = 0 to V <sub>CC_ON</sub> I <sub>SINK</sub> = 10mA	—	—	1.1	V
<b>Current Sense Section</b>						
t <sub>ON</sub> (Min)	Minimum On Time	—	500	1000	1500	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> (CV)	CV Threshold	—	3.8	4.0	4.2	V
V <sub>FB</sub> (OVP)	Over Voltage Protection	—	4.5	6	7.5	V
<b>VS Input Section</b>						
V <sub>VS</sub> /V <sub>VA</sub> (Max)	Maximum Ratio	V <sub>VS</sub> = V <sub>VA</sub> = 3V	0.8	1	1.2	V
V <sub>VS</sub> /V <sub>VA</sub> (Min)	Minimum Ratio	V <sub>VS</sub> = 0V, V <sub>VA</sub> = 3V	—	—	0.2	V
<b>Overtemperature Protection Section</b>						
—	Shutdown Temperature	—	—	+170	—	°C
—	Temperature Hysteresis	—	—	+20	—	°C

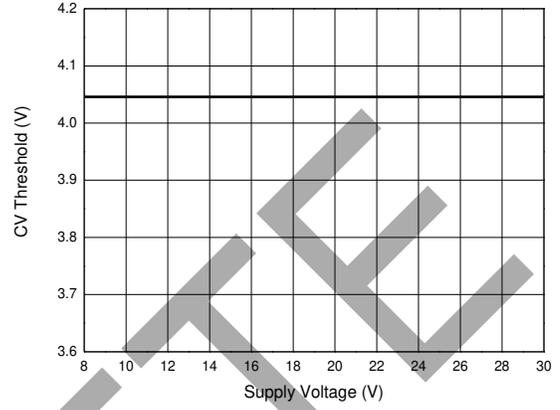
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**Performance Characteristics**

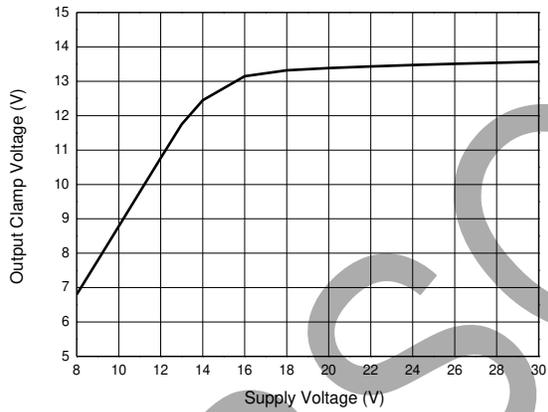
**Supply Current vs. Supply Voltage**



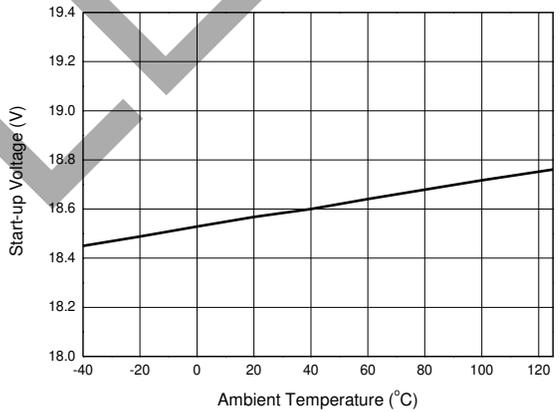
**CV Threshold vs. Supply Voltage**



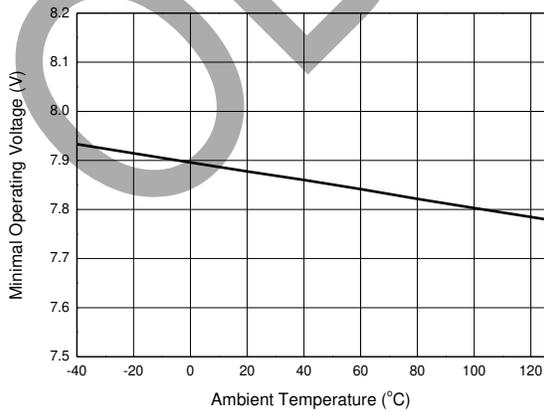
**Output Clamp Voltage vs. Supply Voltage**



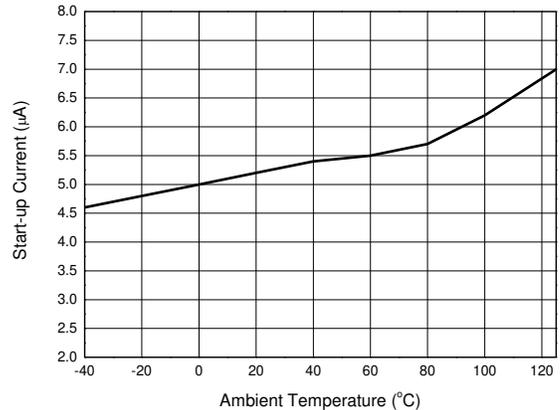
**Start-up Voltage vs. Ambient Temperature**



**Minimal Operating Voltage vs. Ambient Temperature**



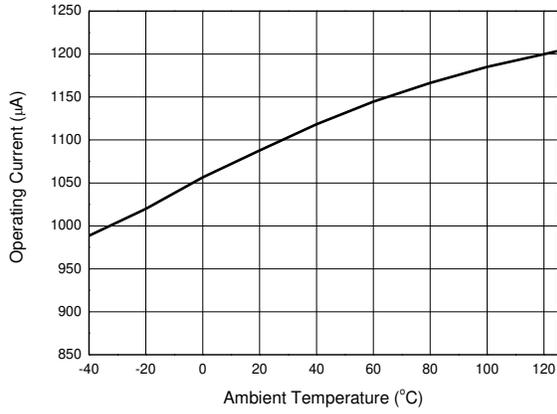
**Start-up Current vs. Ambient Temperature**



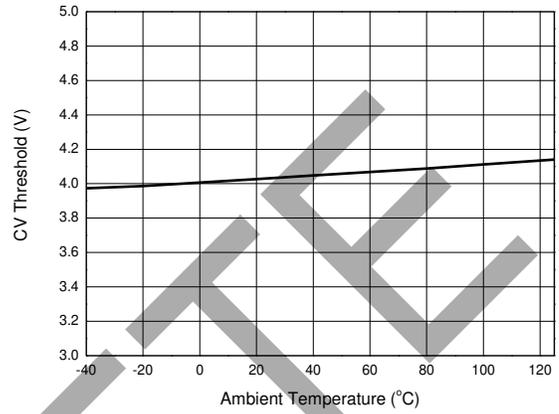
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**Performance Characteristics** (continued)

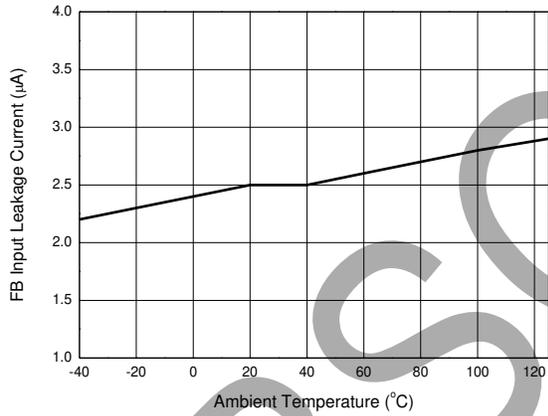
**Operating Current vs. Ambient Temperature**



**CV Threshold vs. Ambient Temperature**



**FB Leakage Current vs. Ambient Temperature**

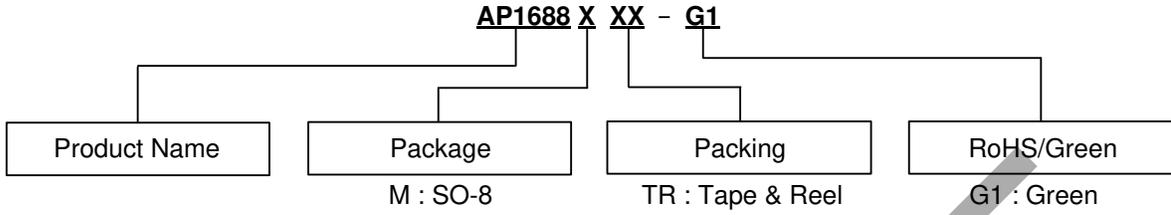


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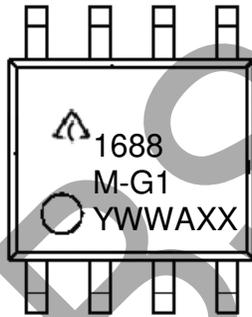
**Ordering Information**



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)

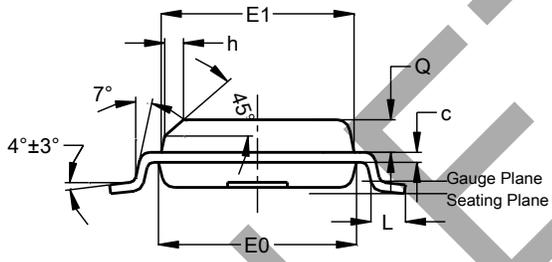
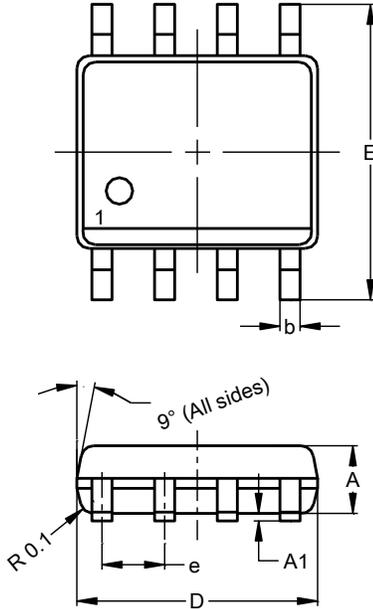


First and Second Lines: Logo and Marking ID  
(See Ordering Information)  
Third Line: Date Code  
Y: Year  
WW: Work Week of Molding  
A: Assembly House Code  
XX: 7<sup>th</sup> and 8<sup>th</sup> Digits of Batch No

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

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

SO-8



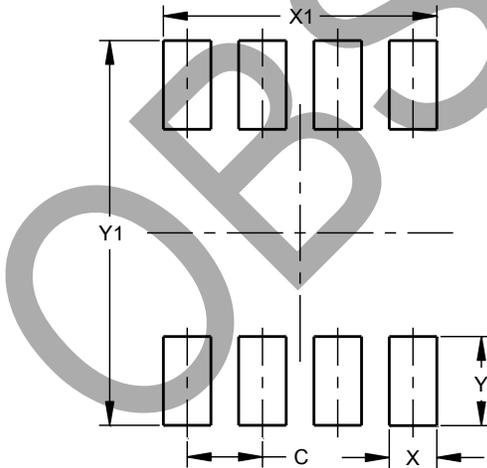
SO-8			
Dim	Min	Max	Typ
A	1.40	1.50	1.45
A1	0.10	0.20	0.15
b	0.30	0.50	0.40
c	0.15	0.25	0.20
D	4.85	4.95	4.90
E	5.90	6.10	6.00
E1	3.80	3.90	3.85
E0	3.85	3.95	3.90
e	--	--	1.27
h	-	--	0.35
L	0.62	0.82	0.72
Q	0.60	0.70	0.65
All Dimensions in mm			

OBSOLETE - PART DISCONTINUED

**Suggested Pad Layout**

Please see <http://www.diodes.com/package-outlines.html> for the latest version.

SO-8



Dimensions	Value (in mm)
C	1.27
X	0.802
X1	4.612
Y	1.505
Y1	6.50

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