

**HIGH PERFORMANCE POWER FACTOR CORRECTOR****AP1661A****General Description**

The AP1661A is an active power factor control IC which is designed mainly for use as pre-converter in electronic ballast, AC-DC adapters and off-line SMPS applications.

The AP1661A includes an internal start-up timer for stand-alone applications, a one-quadrant multiplier to realize near unity power factor and a zero current detector to ensure DCM boundary conduction operation. The totem pole output stage is capable of driving power MOSFET with 600mA source current and 800mA sink current.

Designed with advanced BiCMOS process, the AP1661A features low start-up current, low operation current and low power dissipation. The AP1661A also has rich protection features including over-voltage protection, input under-voltage lockout with hysteresis and multiplier output clamp to limit maximum peak current.

The AP1661A meets IEC61000-3-2 standard even at one-quadrant load and its THD is lower than 10% at high-end line voltage and full load.

This IC is available in SOIC-8 and DIP-8 packages.

**Features**

- Comply with IEC61000-3-2 Standard
- Proprietary Design for Minimum THD
- Zero Current Detection Control for DCM Boundary Conduction Mode
- Adjustable Output Voltage with Precise Over-Voltage Protection
- Ultra-low Startup Current: 30 $\mu$ A Typical
- Low Quiescent Current: 2.5mA Typical
- Precision Internal Reference Voltage: 1%
- Internal Startup Timer
- Disable Function for Reduced Current Consumption
- Totem Pole Output with 600mA Source Current and 800mA Sink Current Capability
- Under-voltage Lockout with 2.5V of Hysteresis

**Applications**

- AC-DC Adapter
- Off-line SMPS
- Electronic Ballast

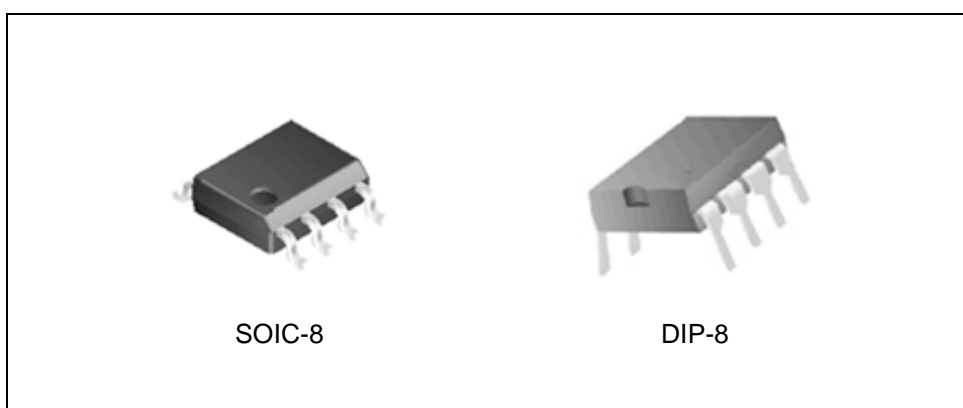


Figure 1. Package Types of AP1661A

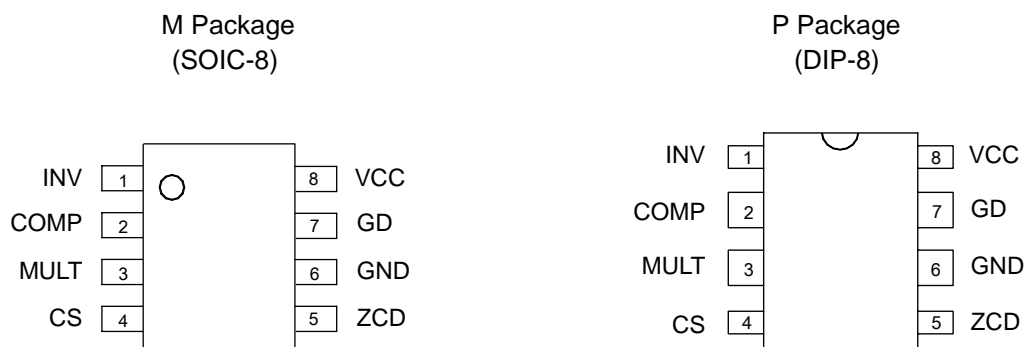
**HIGH PERFORMANCE POWER FACTOR CORRECTOR**
**AP1661A**
**Pin Configuration**


Figure 2. Pin Configuration of AP1661A (Top View)

**Pin Description**

Pin Number	Pin Name	Function
1	INV	Inverting input of the error amplifier
2	COMP	Output of the error amplifier
3	MULT	Input of the multiplier
4	CS	Input of the current control loop comparator
5	ZCD	Zero current detection input. If it is connected to GND, the device is disabled
6	GND	Ground. Current return for gate driver and control circuits of the IC
7	GD	Gate driver output
8	VCC	Supply voltage of gate driver and control circuits of the IC



**HIGH PERFORMANCE POWER FACTOR CORRECTOR**

**AP1661A**

**Functional Block Diagram**

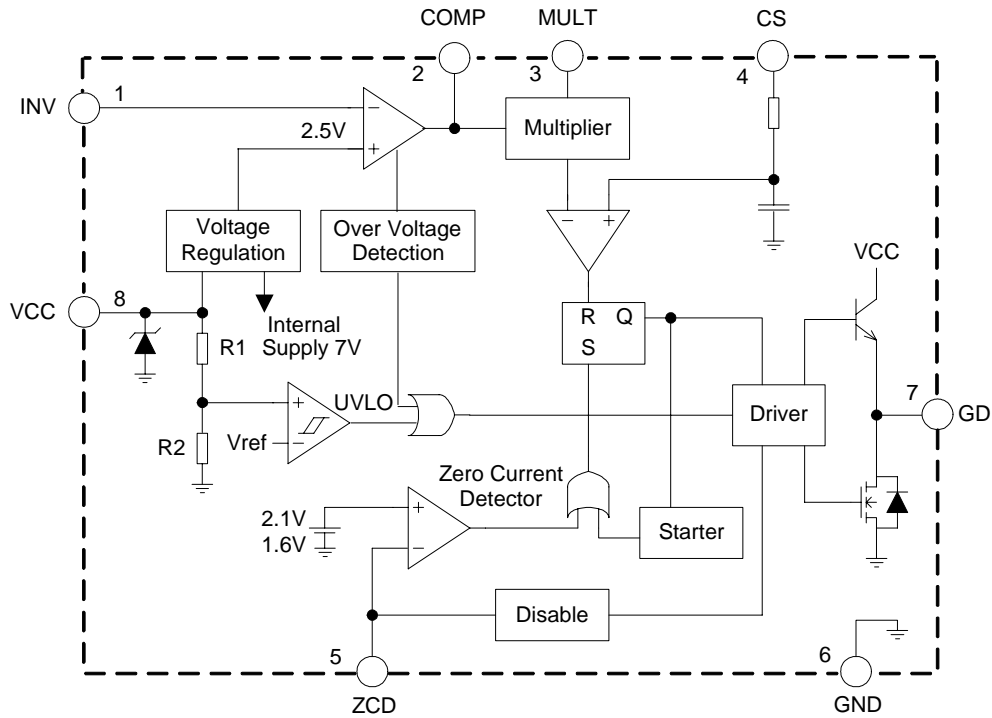
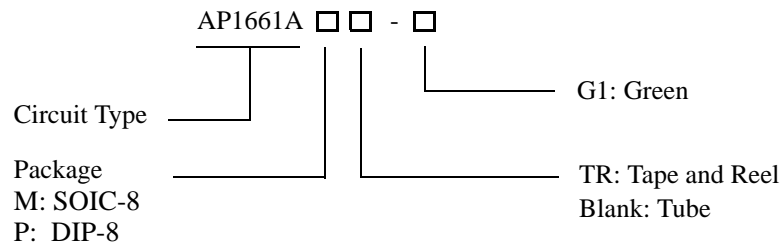


Figure 3. Functional Block Diagram of AP1661A

**Ordering Information**



Package	Temperature Range	Part Number	Marking ID	Packing Type
SOIC-8	-40 to 85°C	AP1661AM-G1	1661AM-G1	Tube
		AP1661AMTR-G1	1661AM-G1	Tape & Reel
DIP-8	-40 to 85°C	AP1661AP-G1	AP1661AP-G1	Tube

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

**HIGH PERFORMANCE POWER FACTOR CORRECTOR****AP1661A****Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit	
Power Supply Voltage	$V_{CC}$	20	V	
Operating Supply Current	$I_{CC}$	30	mA	
Driver Output Current	$I_{OUT}$	$\pm 800$	mA	
Input/Output of Error Amplifier, Input of Multiplier	$V_{INV}$ , $V_{COMP}$ $V_{MULT}$	-0.3 to 7	V	
Current Sense Input	$V_{CS}$	-0.3 to 7	V	
Zero Current Detector Input	$I_{ZCD}$	Source	-50	mA
		Sink	10	
Thermal Resistance Junction-Ambient	$R_{\theta JA}$	DIP-8	100	$^{\circ}C/W$
		SOIC-8	150	
Power Dissipation and Thermal Characteristics @ $T_A=50^{\circ}C$	$P_{TOT}$	DIP-8	1	W
		SOIC-8	0.65	
Operating Junction Temperature	$T_J$	-40 to 150	$^{\circ}C$	
Storage Temperature Range	$T_{STG}$	-65 to 150	$^{\circ}C$	
Lead Temperature (Soldering, 10 Seconds)	$T_{LEAD}$	260	$^{\circ}C$	
ESD (Human Body Model)		3000	V	
ESD (Machine Model)		300	V	

Note 1: 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.



**HIGH PERFORMANCE POWER FACTOR CORRECTOR**

**AP1661A**

**Electrical Characteristics**

$V_{CC}=14.5V$ ,  $T_A=-25^{\circ}C$  to  $125^{\circ}C$ , unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Under Voltage Lockout Section</b>						
Turn-on Threshold	$V_{CC-ON}$	$V_{CC}$ rising	11.7	12.5	13.3	V
Turn-off Threshold	$V_{CC-OFF}$	$V_{CC}$ falling	9.5	10	10.5	V
Hysteresis	$V_{CC-HYS}$		2.2	2.5	2.8	V
$V_{CC}$ Operating Range	$V_{CC}$	After turn-on	10.5		20	V
<b>Total Supply Section</b>						
Start-up Current	$I_{START-UP}$	$V_{CC}=11.7V$ before turn-on		30	60	$\mu A$
Operating Supply Current	$I_{CC}$	$C_L=1nF$ @frequency=70kHz		3.5	5	mA
		In OVP condition $V_{pin1}=2.7V$		1.4	2.1	
Quiescent Current	$I_Q$			2.5	3.75	mA
Quiescent Current	$I_Q$	$V_{pin5} \leq 150mV$ , $V_{CC} > V_{CC-OFF}$		1.4	2.1	mA
		$V_{pin5} \leq 150mV$ , $V_{CC} < V_{CC-OFF}$	20	50	90	
$V_{CC}$ Zener Voltage	$V_Z$	$I_{CC}=20mA$	20	22	24	V
<b>Error Amplifier Section</b>						
Voltage Feedback Input Threshold	$V_{INV}$	$T_A=25^{\circ}C$	2.465	2.5	2.535	V
		$10.3V < V_{CC} < 20V$	2.44		2.56	
Line Regulation		$V_{CC}=10.3V$ to $20V$		2	5	mV
Input Bias Current	$I_{INV}$	$V_{INV}=0V$		-0.1	-1	$\mu A$
Voltage Gain	$G_V$	Open Loop	60	80		dB
Gain Bandwidth	GB			1		MHz
Output Voltage	Upper Clamp Voltage	$V_{COMP-H}$	$I_{SOURCE}=0.5mA$		5.8	V
	Lower Clamp Voltage	$V_{COMP-L}$	$I_{SINK}=0.5mA$		2.25	
Output Current	Source Current	$I_{COMP-H}$	$V_{COMP}=4V$ , $V_{INV}=2.4V$	-2	-4	mA
	Sink Current	$I_{COMP-L}$	$V_{COMP}=4V$ , $V_{INV}=2.6V$	2.5	4.5	
Enable Threshold	$V_{INV-TH}$		400	500	600	mV
<b>Multiplier Section</b>						
Linear Input Voltage Range	$V_{MULT}$		0 to 3	0 to 3.5		V
Output Maximum Slope	$\frac{\Delta V_{CS}}{\Delta V_{MULT}}$	$V_{MULT}$ : 0 to 0.5V, $V_{COMP}$ =Upper Clamp Voltage		1.7		
Gain	k	$V_{MULT}=1V$ , $V_{COMP}=4V$	0.45	0.6	0.75	1/V



**HIGH PERFORMANCE POWER FACTOR CORRECTOR**

**AP1661A**

**Electrical Characteristics (Continued)**

V<sub>CC</sub>=14.5V, T<sub>A</sub>=-25°C to 125°C, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Current Sense Section</b>						
Input Bias Current	I <sub>CS</sub>	V <sub>CS</sub> =0V		-0.05	-1.0	μA
Current Sense Offset Voltage	V <sub>CS-OFFSET</sub>	V <sub>MULT</sub> =0V		30		mV
		V <sub>MULT</sub> =2.5V		5		
Current Sense Reference Clamp	V <sub>CS-CLAMP</sub>	V <sub>COMP</sub> =Upper Clamp Voltage, V <sub>MULT</sub> =2.5V	1.5	1.6	1.7	V
Delay to Output	t <sub>d(H-L)</sub>			175		ns
<b>Zero Current Detection Section</b>						
Input Threshold Voltage, V <sub>ZCD</sub> Rising Edge	V <sub>ZCD-R</sub>	(Note 2)		2.1		V
Hysteresis Voltage	V <sub>ZCD-RTH</sub>	(Note 2)	0.3	0.5	0.7	V
Upper Clamp Voltage	V <sub>ZCD-H</sub>	I <sub>ZCD</sub> =20μA	4.5	5.1	5.9	V
		I <sub>ZCD</sub> =3mA	4.7	5.2	6.1	
Lower Clamp Voltage	V <sub>ZCD-L</sub>	I <sub>ZCD</sub> =-3mA	0.3	0.65	1	V
Source Current Capability	I <sub>ZCD-SR</sub>		-3		-10	mA
Sink Current Capability	I <sub>ZCD-SN</sub>		3		10	mA
Sink Bias Current	I <sub>ZCD-B</sub>	1V≤V <sub>ZCD</sub> ≤4.5 V		2		μA
Disable Threshold	V <sub>ZCD-DIS</sub>		150	200	250	mV
Disable Hysteresis	V <sub>ZCD-HYS</sub>			100		mV
Restart Current After Disable	I <sub>ZCD-RES</sub>	V <sub>ZCD</sub> <V <sub>DIS</sub> ; V <sub>CC</sub> >V <sub>CC-OFF</sub>	-100	-200	-300	μA
<b>Drive Output Section</b>						
Dropout Voltage	V <sub>OH</sub>	I <sub>GD-SOURCE</sub> =200mA, V <sub>CC</sub> =12V		2.5	3	V
		I <sub>GD-SOURCE</sub> =20mA, V <sub>CC</sub> =12V		2	2.6	
	V <sub>OL</sub>	I <sub>GD-SINK</sub> =200mA, V <sub>CC</sub> =12V		0.9	1.9	V
Output Voltage Rise Time	t <sub>R</sub>	C <sub>L</sub> =1nF		40	100	ns
Output Voltage Fall Time	t <sub>F</sub>	C <sub>L</sub> =1nF		40	100	ns
Output Clamp Voltage	V <sub>O-CLAMP</sub>	I <sub>GD-SOURCE</sub> =5mA, V <sub>CC</sub> =20V	10	13	15	V
UVLO Saturation	V <sub>OS</sub>	V <sub>CC</sub> =0 to V <sub>CC-ON</sub> , I <sub>SINK</sub> =10mA			1.1	V
<b>Output Over Voltage Section</b>						
OVP Triggering Current	I <sub>OVP</sub>		35	40	45	μA
Static OVP Threshold	V <sub>OVP_TH</sub>		2.1	2.25	2.4	V
<b>Restart Timer</b>						
Restart Timer	t <sub>START</sub>		70	150	400	μs

Note 2: Limits over the full temperature are guaranteed by design, but not tested in production.



**Typical Performance Characteristics**

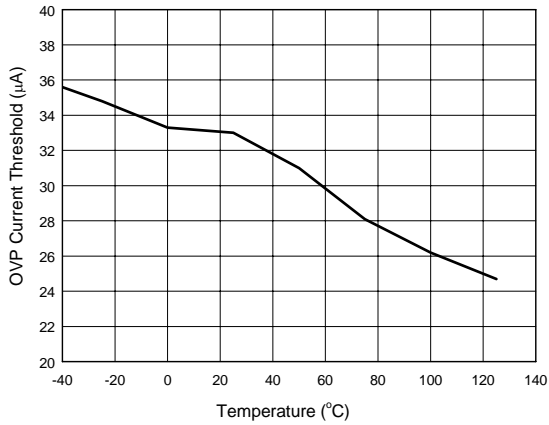


Figure 4. OVP Current Threshold vs. Temperature

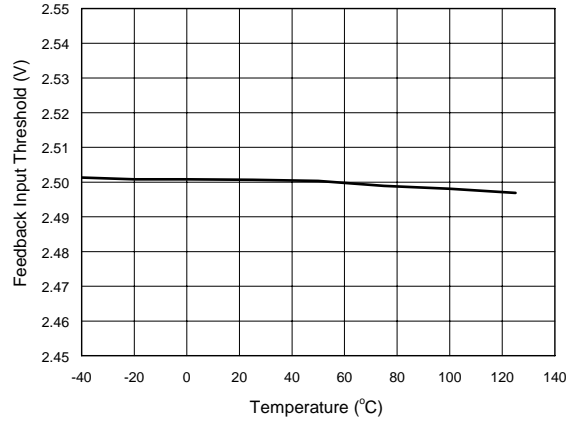


Figure 5. Feedback Input Threshold vs. Temperature

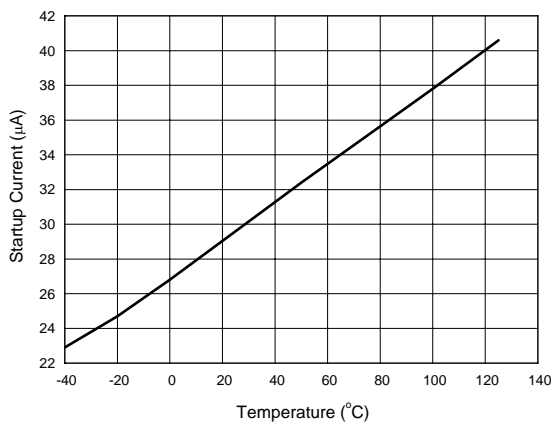


Figure 6. Startup Current vs. Temperature

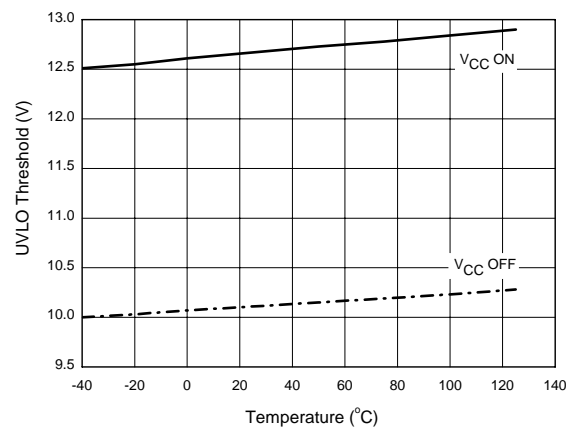


Figure 7. Under Voltage Lockout Threshold vs. Temperature



**HIGH PERFORMANCE POWER FACTOR CORRECTOR**

**AP1661A**

**Typical Performance Characteristics (Continued)**

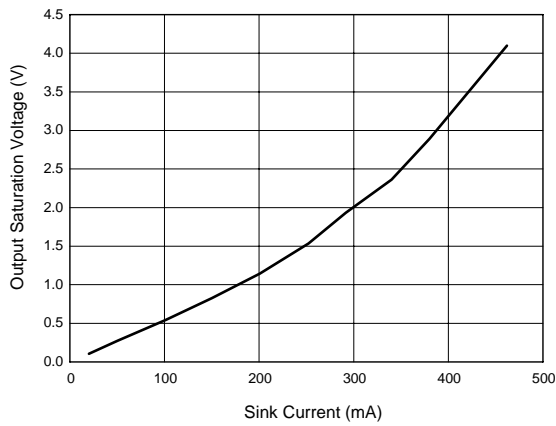


Figure 8. Output Saturation Voltage vs. Sink Current

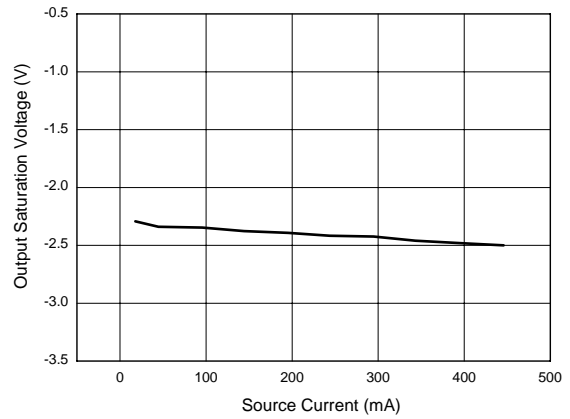


Figure 9. Output Saturation Voltage vs. Source Current

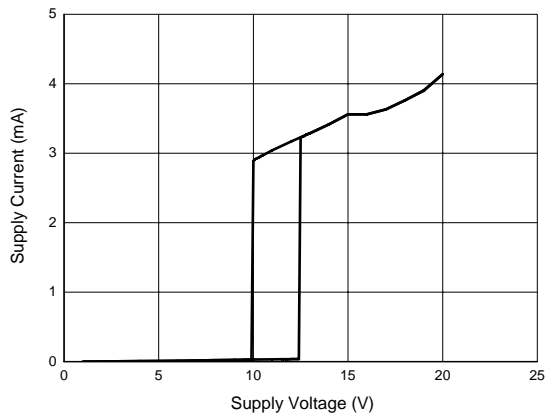


Figure 10. Supply Current vs. Supply Voltage

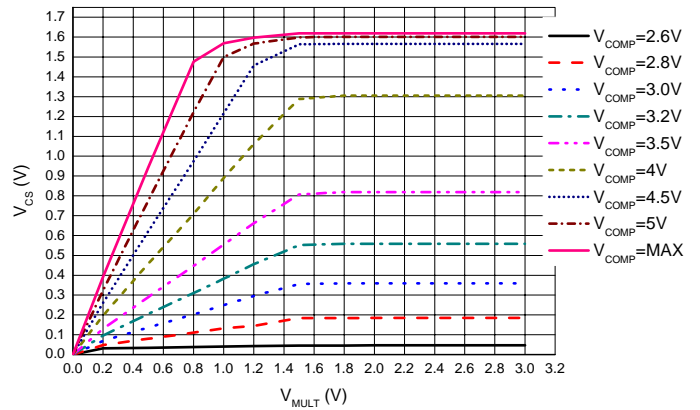


Figure 11. Multiplier Characteristics Family







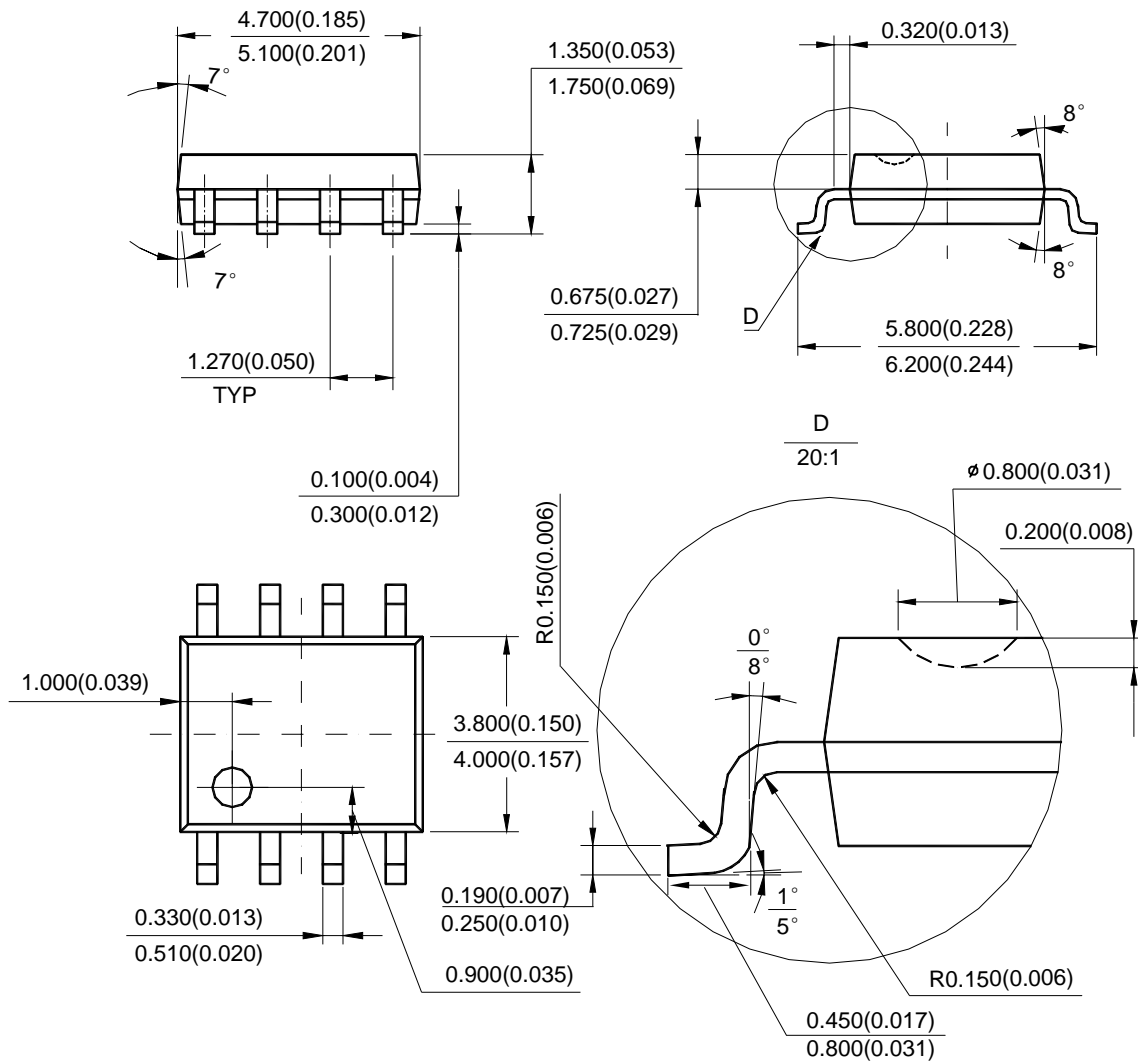
**HIGH PERFORMANCE POWER FACTOR CORRECTOR**

**AP1661A**

**Mechanical Dimensions (Continued)**

**SOIC-8**

**Unit: mm(inch)**



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



## BCD Semiconductor Manufacturing Limited

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