

**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 μ 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

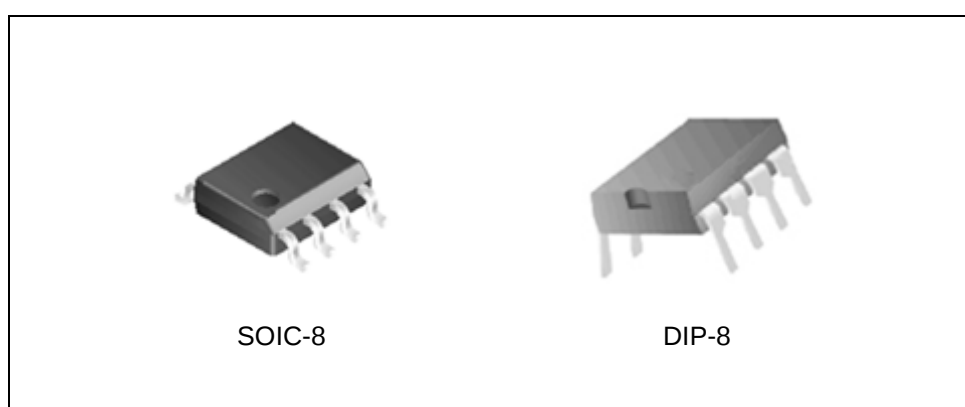


Figure 1. Package Types of AP1661A

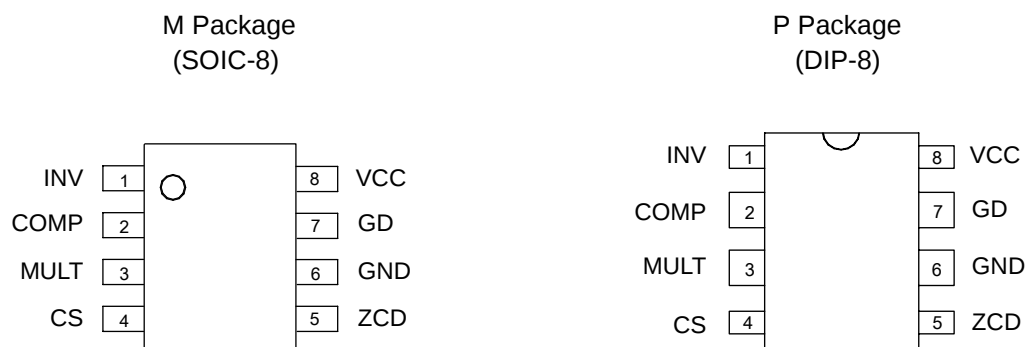
**HIGH PERFORMANCE POWER FACTOR CORRECTOR****AP1661A****Pin Configuration**

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

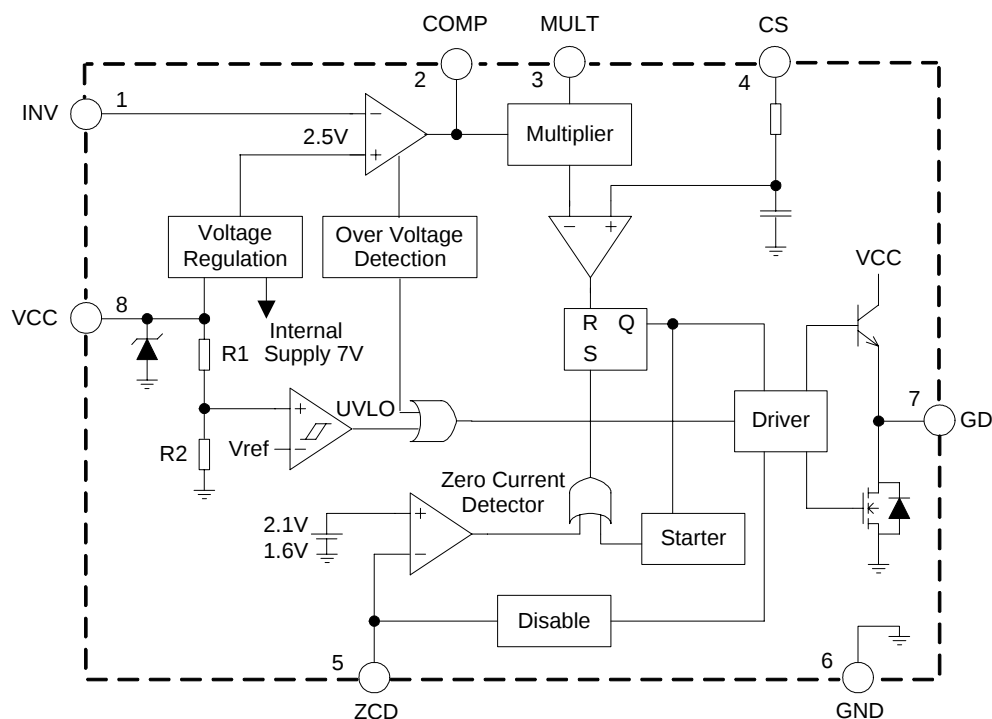
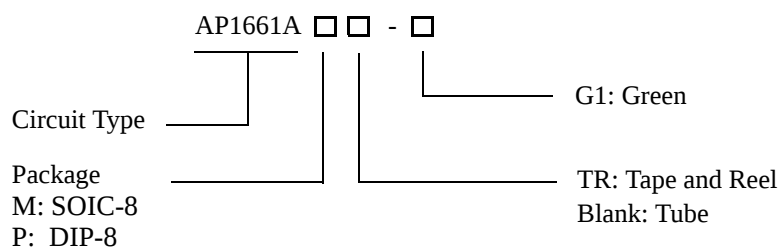


Figure 3. Functional Block Diagram of AP1661A

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}	± 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	$^{\circ}\text{C}/\text{W}$
		SOIC-8	150	
Power Dissipation and Thermal Characteristics @ $T_A=50^{\circ}\text{C}$	P_{TOT}	DIP-8	1	W
		SOIC-8	0.65	
Operating Junction Temperature	T_J	-40 to 150		$^{\circ}\text{C}$
Storage Temperature Range	T_{STG}	-65 to 150		$^{\circ}\text{C}$
Lead Temperature (Soldering, 10 Seconds)	T_{LEAD}	260		$^{\circ}\text{C}$
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

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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
Under Voltage Lockout Section						
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
Total Supply Section						
Start-up Current	$I_{START-UP}$	$V_{CC}=11.7V$ before turn-on		30	60	μA
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	μA
V_{CC} Zener Voltage	V_Z	$I_{CC}=20mA$	20	22	24	V
Error Amplifier Section						
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	μA
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
Multiplier Section						
Linear Input Voltage Range	V_{MULT}		0 to 3	0 to 3.5		V
Output Maximum Slope	$\Delta V_{CS}/\Delta V_{MULT}$	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)

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

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

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

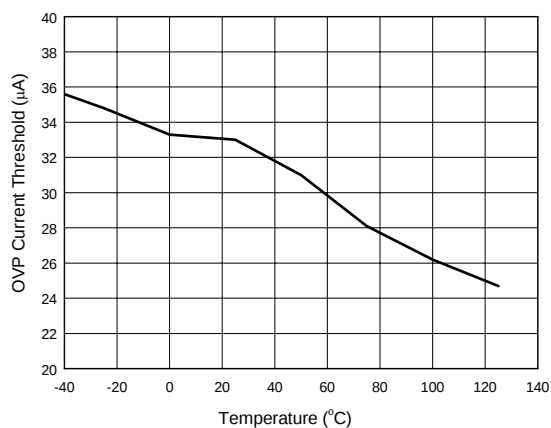
**Typical Performance Characteristics**

Figure 4. OVP Current Threshold vs. Temperature

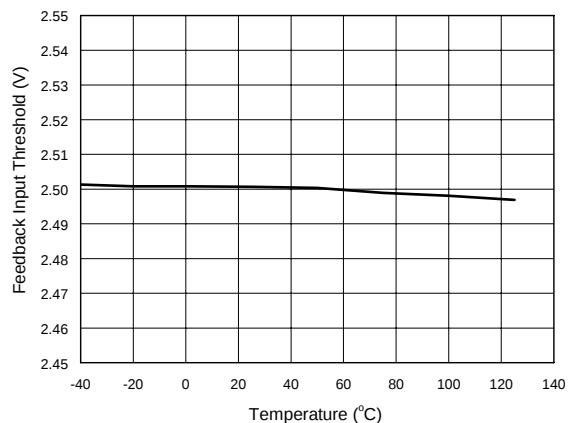


Figure 5. Feedback Input Threshold vs. Temperature

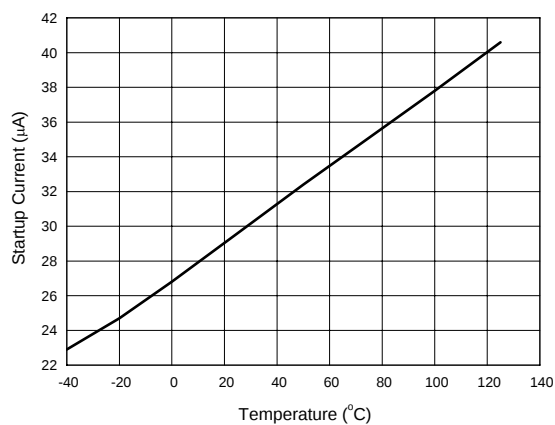


Figure 6. Startup Current vs. Temperature

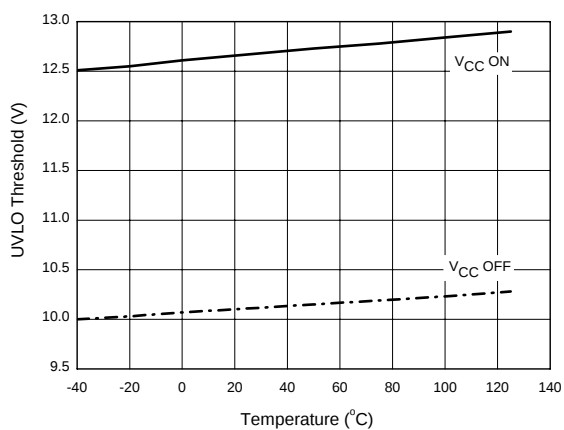


Figure 7. Under Voltage Lockout Threshold vs. Temperature

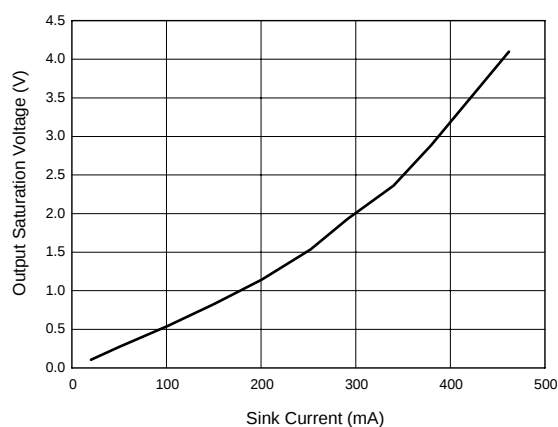
**Typical Performance Characteristics (Continued)**

Figure 8. Output Saturation Voltage vs. Sink Current

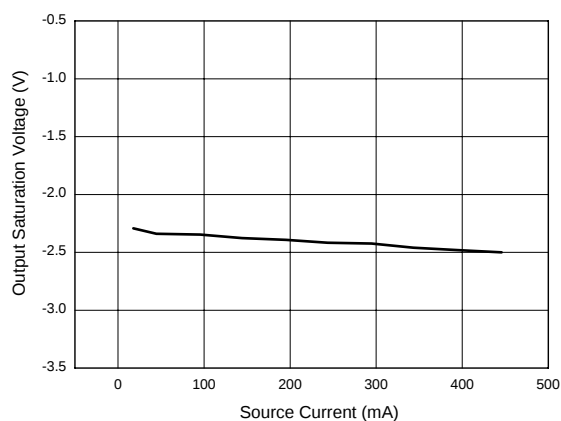


Figure 9. Output Saturation Voltage vs. Source Current

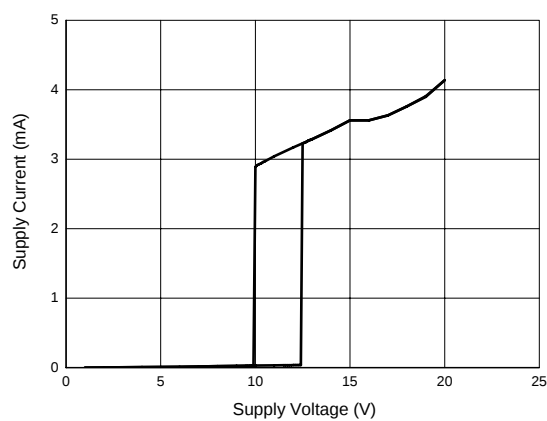


Figure 10. Supply Current vs. Supply Voltage

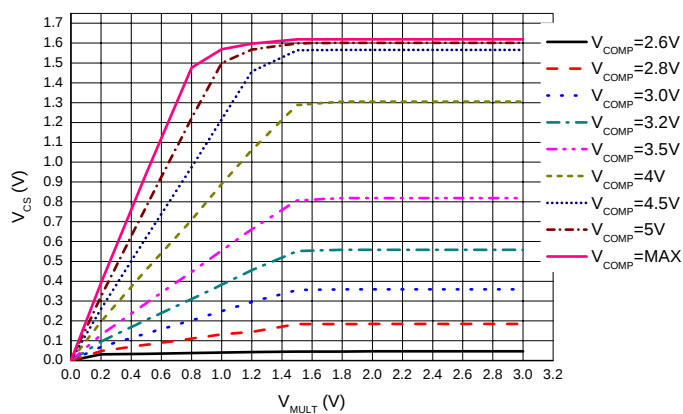
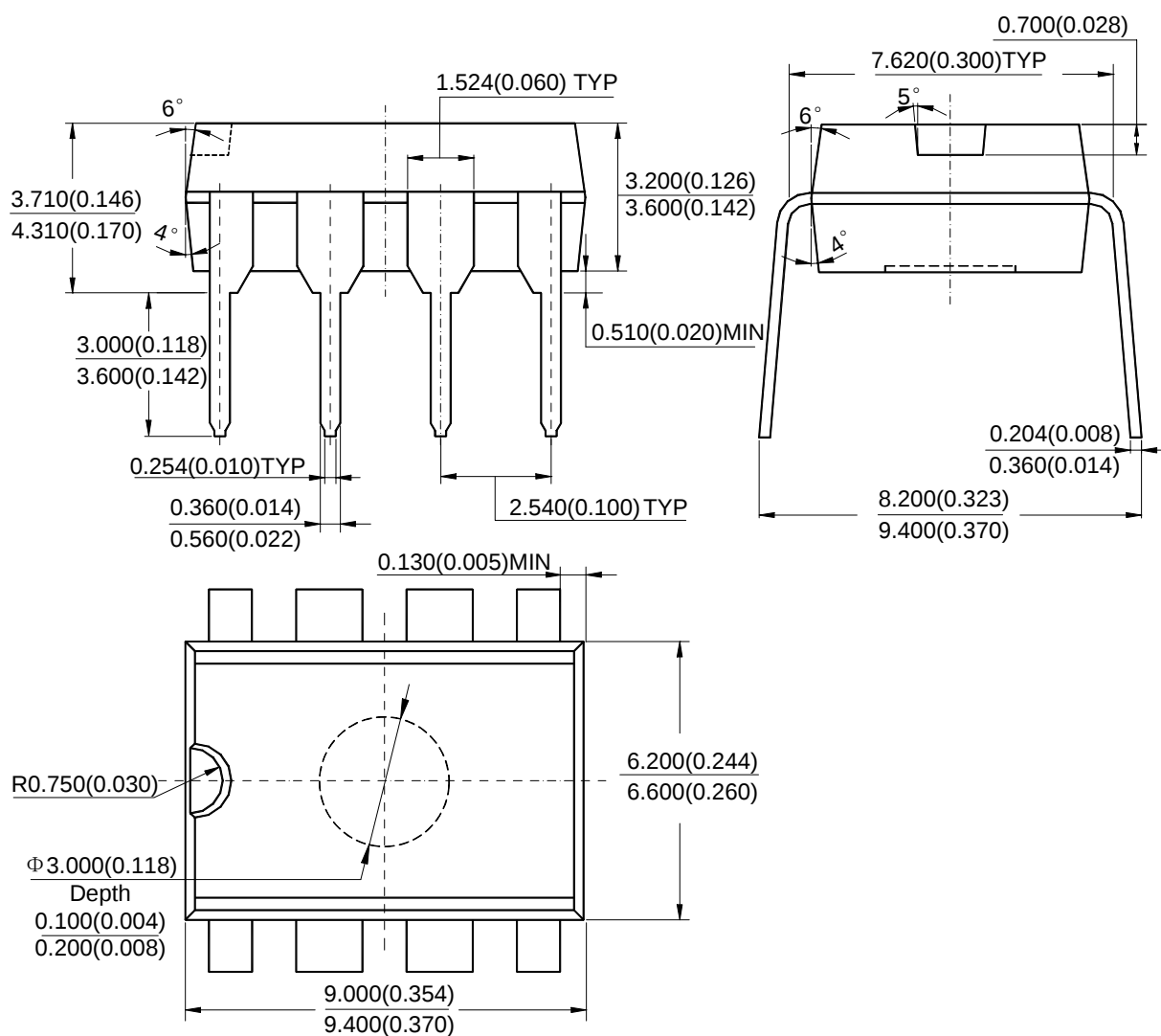
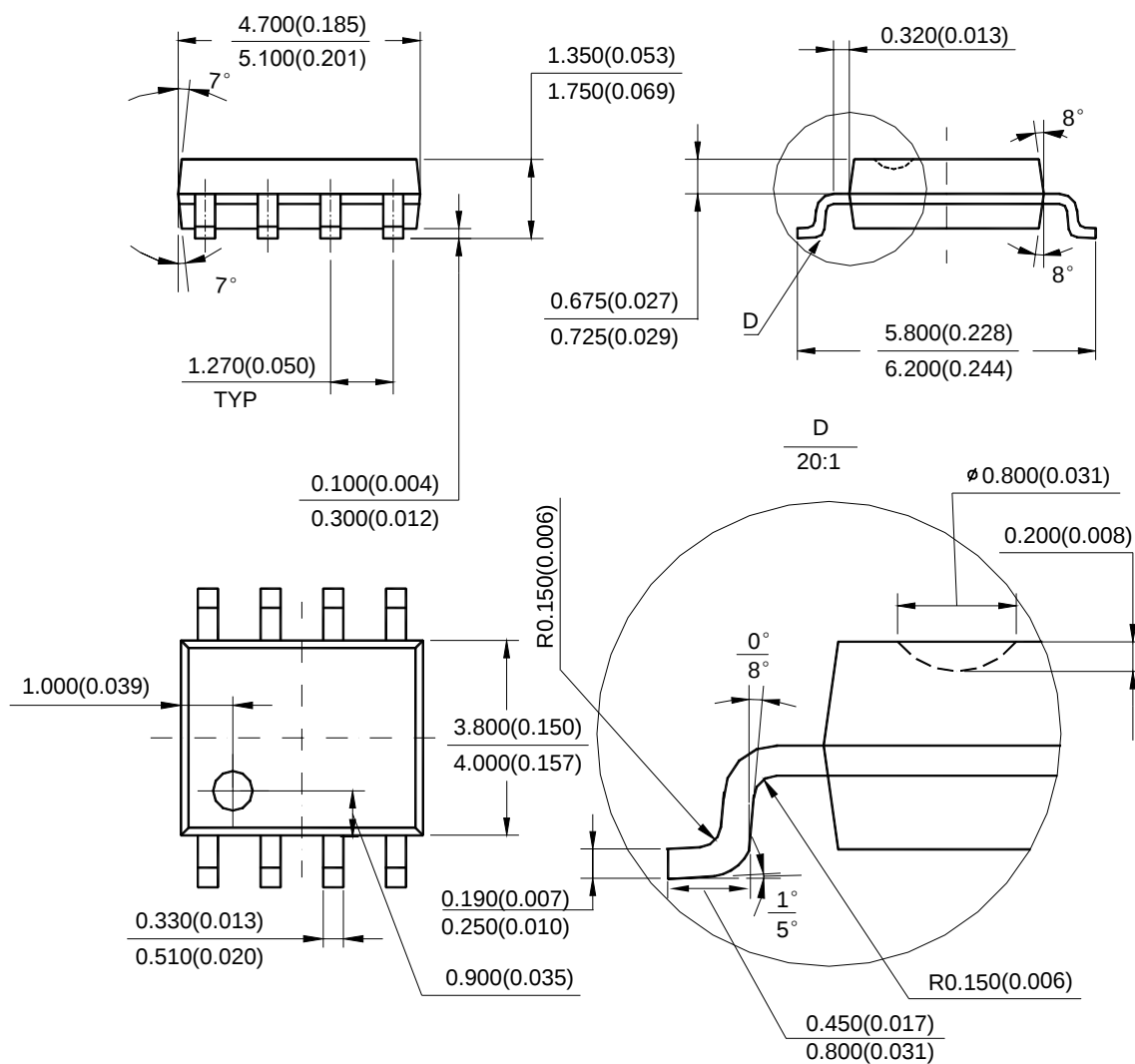


Figure 11. Multiplier Characteristics Family

**HIGH PERFORMANCE POWER FACTOR CORRECTOR****AP1661A****Mechanical Dimensions****DIP-8****Unit: mm(inch)**

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

**HIGH PERFORMANCE POWER FACTOR CORRECTOR****AP1661A****Mechanical Dimensions (Continued)****SOIC-8****Unit: mm(inch)**

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



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