

GREEN MODE PWM CONTROLLER

AP384XG

General Description

The AP384XG is a Green Mode PWM controller. It is specially designed for off-line AC-DC adapter and battery charger applications where both needs for low standby power and high efficiency in normal operation are required. In a well designed product, the AP384XG is capable to allow the system consuming only 0.5W power in standby mode.

In normal operation, the AP384XG features adjustable frequency by using an external resistor and capacitor combination. When output power falls below a given level, the IC automatically switches to the skip mode, which works by skipping switching cycles. The AP384XG also features low start-up and low standby operating current for its special topology.

The AP384XG provides accurate protection against over-temperature, over-current and maximal output power.

The AP384XG is available in SOIC-8 and DIP-8 packages.

Features

- Green Mode PWM Controller to Support the "Blue Angel" Norm
- Adjustable Skip Cycle Mode Operation
- Low Start-up Current: 50µA (Typ.)
- Low Standby Operating Current: 6mA
- Internal Leading Edge Blanking
- Adjustable Oscillator Frequency up to 500KHz
- Totem Pole Output
- Under Voltage Lock Out (UVLO)
- Over-Temperature Protection
- Pin to Pin Replacement for AZ384XA

Applications

- Off-line Converter
- DC-DC Converter
- DVD/STB Power Supply
- Power Adapter
- CRT Monitor Power Supply

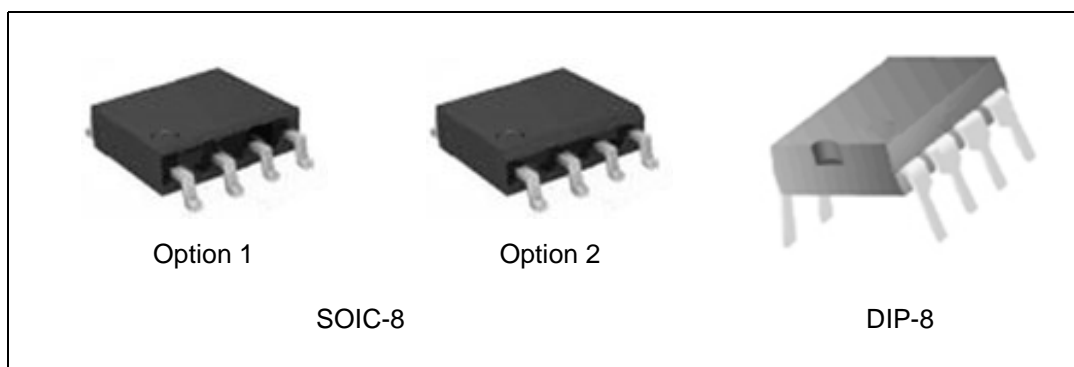


Figure 1. Package Types of AP384XG

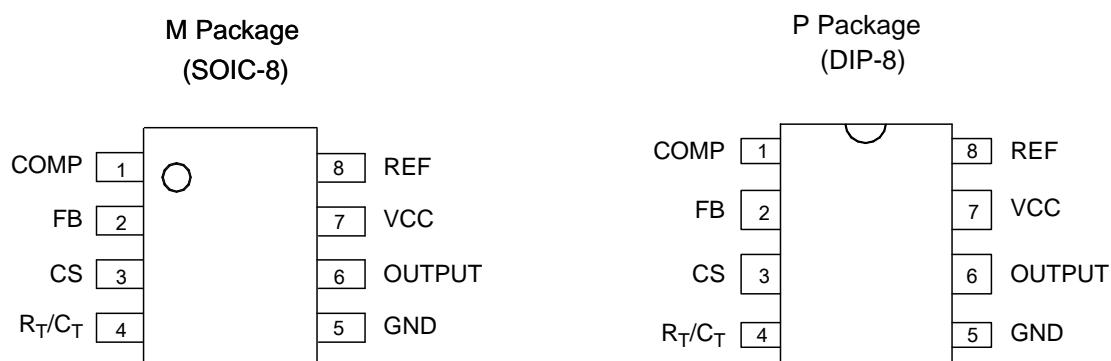
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Pin Configuration


Figure 2. Pin Configuration of AP384XG (Top View)

Pin Description

Pin Number	Pin Name	Function
1	COMP	This pin is the Error Amplifier output and is made available for loop compensation.
2	FB	The inverting input of the Error Amplifier. It is normally connected to the switching power supply output through an external resistor divider.
3	CS	It is used either for current sense (normal mode) or skip cycle level selection (standby mode).
4	R_T/C_T	The oscillator frequency and maximum output duty cycle are programmed by connecting resistor R_T to REF and capacitor C_T to ground.
5	GND	The ground pin.
6	OUTPUT	This output directly drives the gate of a power MOSFET. Peak currents up to 1.0 A are sourced and sunk by this pin.
7	VCC	The power supply pin.
8	REF	This is the reference output. It provides charging current for capacitor C_T through resistor R_T .

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Functional Block Diagram

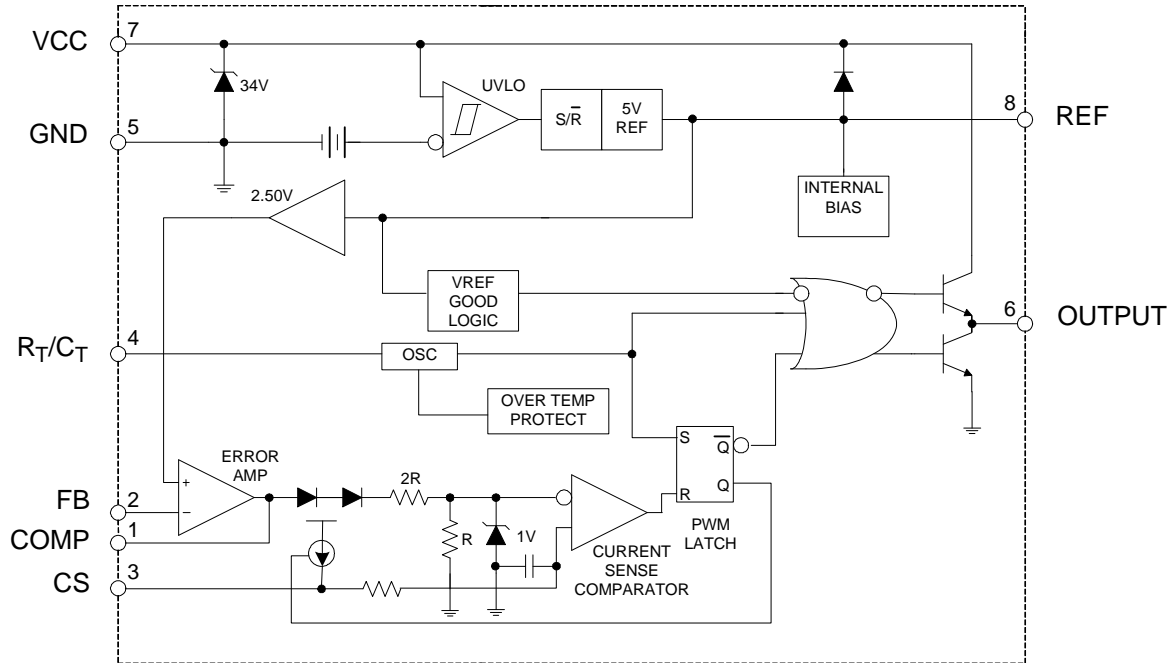
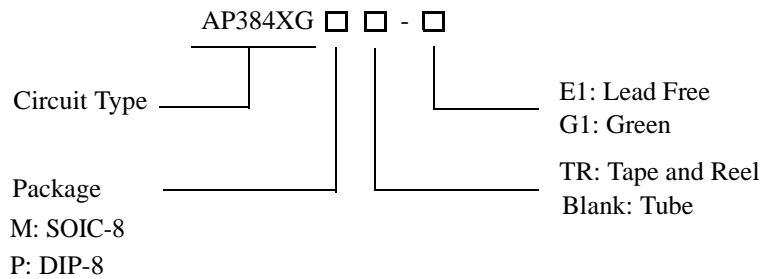


Figure 3. Functional Block Diagram of AP384XG

Ordering Information



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Lead Free	Green	Lead Free	Green	
SOIC-8	-40 to 85°C	AP3842/3/4/5GM-E1	AP3842/3/4/5GM-G1	3842/3/4/5GM-E1	3842/3/4/5GM-G1	Tube
		AP3842/3/4/5GMTR-E1	AP3842/3/4/5GMTR-G1	3842/3/4/5GM-E1	3842/3/4/5GM-G1	Tape & Reel
DIP-8	-40 to 85°C	AP3842/3/4/5GP-E1	AP3842/3/4/5GP-G1	AP3842/3/4/5GP-E1	AP3842/3/4/5GP-G1	Tube

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.

**GREEN MODE PWM CONTROLLER****AP384XG****Absolute Maximum Ratings (Note 1, 2)**

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	30	V
Gate Output Current	I_O	± 1	A
Analog Inputs (pin2, 3)	V(ANA)	-0.3 to 6.3	V
Error Amp Output Sink Current	$I_{SINK(E.A)}$	20	mA
Power Dissipation at $T_A < 25\text{ }^\circ\text{C}$ (DIP-8)	P_D (Note 3)	1000	mW
Power Dissipation at $T_A < 25\text{ }^\circ\text{C}$ (SOIC-8)	P_D (Note 3)	460	mW
Storage Temperature Range	T_{STG}	-65 to 150	$^\circ\text{C}$
Ambient Temperature	T_A	-40 to 85	$^\circ\text{C}$
Lead Temperature (Soldering, 10sec)	T_{LEAD}	+300	$^\circ\text{C}$
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.

Note 2: All voltages are with respect to pin GND and all currents are positive into specified terminal.

Note 3: Board thickness 1.6mm, board dimension 90mm X 90mm.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Oscillation Frequency	f		500	KHz
Ambient Temperature	T_A	-40	85	$^\circ\text{C}$



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Electrical Characteristics

($V_{CC}=15V$, $R_T=10k\Omega$ $C_T=3.3nF$, $T_A=25^\circ C$, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
REFERENCE SECTION						
Reference Output Voltage	V_{REF}	$T_A=25^\circ C$, $I_{REF}=1mA$	4.95	5.00	5.05	V
Total Output Variation		Line, Load, Temp.	4.9		5.10	V
Line Regulation	ΔV_{REF}	$12V \leq V_{CC} \leq 25V$		4	15	mV
Load Regulation	ΔV_{REF}	$1mA \leq I_{REF} \leq 20mA$		4	15	mV
Short Circuit Output Current	I_{SC}	$T_A=25^\circ C$		-100	-180	mA
Temperature Stability		(Note 6)		0.3		mV/ $^\circ C$
UNDER VOLTAGE LOCK OUT SECTION						
Start-up Threshold		AP3842G/AP3844G	15	16	17	V
		AP3843G/AP3845G	7.8	8.4	9.0	
Minimum Operating Voltage		AP3842G/AP3844G	8.5	10	11.5	V
		AP3843G/AP3845G	7.0	7.6	8.2	
TOTAL STANDBY CURRENT SECTION						
Start-up Current		AP3842G/AP3844G, $V_{CC}=14V$		50	80	μA
		AP3843G/AP3845G, $V_{CC}=6.5V$		50	80	
Operating Current		$V_{FB}=0$, $V_{CS}=0$, $C_L=1nF$		8		mA
Standby Operating Current		$V_{FB}=2.7V$, $V_{CS}=0.5V$		6		mA
Zener Voltage		$I_{CC}=25mA$	30	34		V
PWM SECTION						
Maximum Duty Cycle		AP3842G/AP3843G	94	96		%
		AP3844G/AP3845G	46	48	50	
Minimum Duty Cycle					0	%
OSCILLATOR SECTION						
Oscillation Frequency	f	$T_A=25^\circ C$	47	52	57	KHz
Oscillator Amplitude	V_{OSC}	Pin RT/CT, peak to peak		1.7		V
Temperature Stability				2		%
Voltage Stability		$12V \leq V_{CC} \leq 25V$		0.2	1	%
Discharge Current		$V_{RT/CT}=2V$ (Note 4)	8.5	9.5	10.5	mA

Note 4: This parameter is measured with $R_T=10k\Omega$ to V_{REF} , it contributes 0.3mA of current to the measured value. So the total current flowing into the CT pin will be 0.3mA higher than the measured value approximately.



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Electrical Characteristics (Continued)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
ERROR AMPLIFIER SECTION						
Input Voltage	V _I	V _{COMP} =2.5V	2.45	2.50	2.55	V
Output Sink Current	I _{SINK}	V _{COMP} =1.1V	6	10		mA
Output Source Current	I _{SOURCE}	V _{COMP} =5V	-0.5	-0.8		mA
High Output Voltage	V _{OH}	R _L =15kΩ to GND	5	7		V
Low Output Voltage	V _{OL}	R _L =15kΩ to pin REF		0.7	1.1	V
Voltage Gain		2V ≤ V _O ≤ 4V	65	90		dB
Power Supply Rejection Ratio	PSRR	12V ≤ V _{CC} ≤ 25V	60	70		dB
CURRENT SENSE SECTION						
Maximum Input Signal	V _I (MAX)	V _{COMP} =5V (Note 5)	0.9	1	1.1	V
Gain	GV	0V ≤ V _{CS} ≤ 4V (Note 5, 6)	2.85	3	3.15	V/V
Power Supply Rejection Ratio	PSRR	12V ≤ V _{CC} ≤ 25V (Note 5, 7)		70		dB
Delay to Output		V _{CS} = 0 to 2V (Note 7)		150	250	ns
Input Bias Current	I _{BIAS}	V _{OUTPUT} =High		-3	-10	μA
Leading Edge Blanking Duration	T _{LEB}			250		ns
OUTPUT SECTION						
Low Output Voltage	V _{OL}	I _{SINK} = 20mA		0.2	0.4	V
		I _{SINK} = 200mA		1.4	2.2	V
High Output Voltage	V _{OH}	I _{SOURCE} = 20mA	13	13.5		V
		I _{SOURCE} = 200mA	12	13		V
Rise Time	t _R	T _A =25°C, C _L =1nF		150	250	ns
Fall Time	t _F	T _A =25°C, C _L =1nF		50	150	ns
SKIP CYCLE MODE SECTION						
Source Current (@CS)		V _{OUTPUT} =Low, T _A =25°C	180	200	220	μA
OVER-TEMPERATURE PROTECT SECTION						
Shutdown Temperature	T _{SHUT}			155		°C
Temperature Hysteresis	T _{HYS}			25		°C
Thermal Resistance (Junction to Case)	θ _{JC}	SOIC-8		18		°C/W
		DIP-8		12		

Note 5: Parameters are tested at trip point of latch with V_{pin2} = 0.

Note 6: Here gain is defined as:

$$A = \frac{\Delta V_{Pin 1}}{\Delta V_{Pin 3}}, 0 \leq V_{pin3} \leq 0.8V$$

Note 7: These parameters, although guaranteed, are not 100% tested in production.

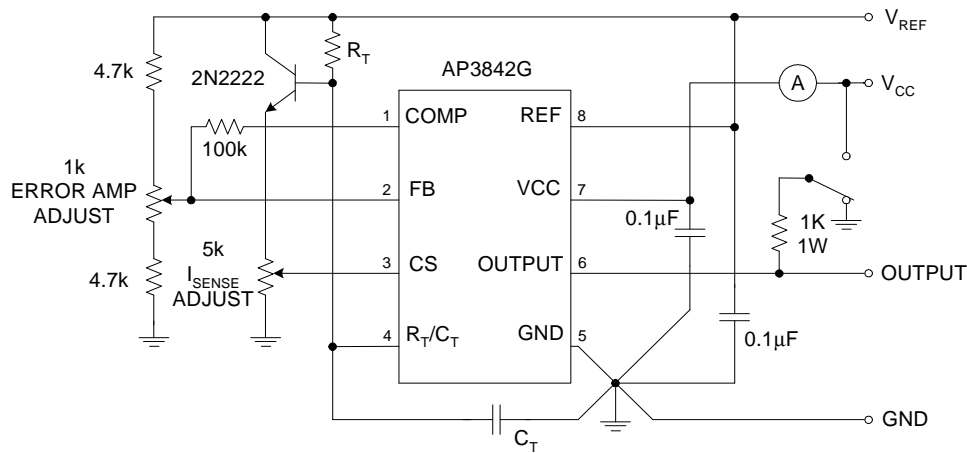
Electrical Characteristics (Continued)


Figure 4. Basic Test Circuit

Figure 4 is the basic test circuit for AP384XG. In testing, the high peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.



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Typical Performance Characteristics

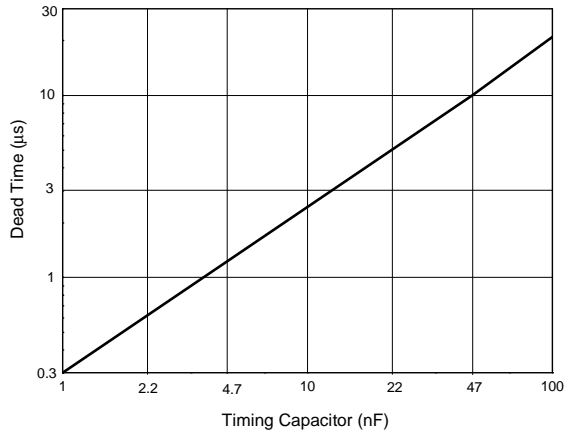


Figure 5. Oscillator Dead Time vs. Timing Capacitor

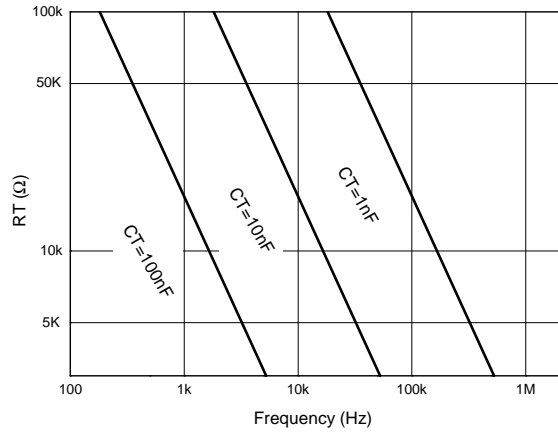


Figure 6. Timing Resistor vs. Frequency

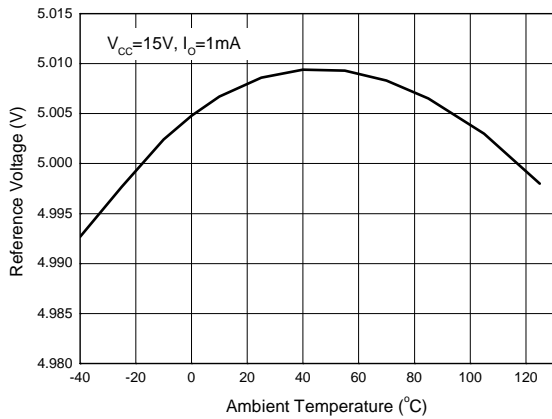


Figure 7. Reference Voltage vs. Ambient Temperature

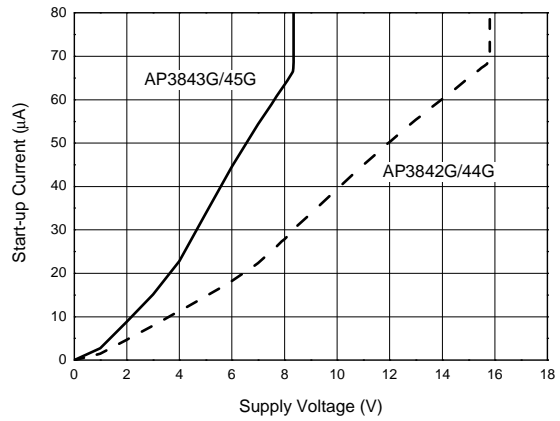


Figure 8. Start-up Current vs. Supply Voltage



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Typical Performance Characteristics (Continued)

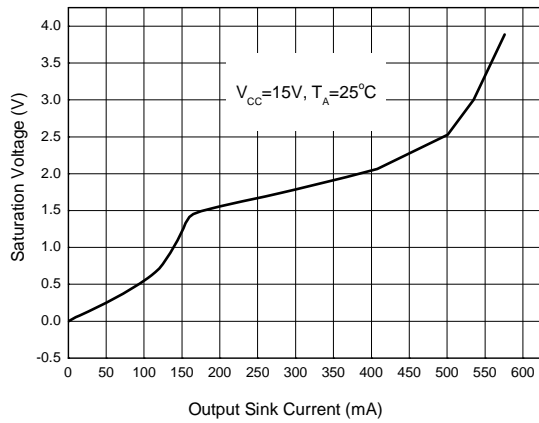


Figure 9. Output Saturation Characteristics

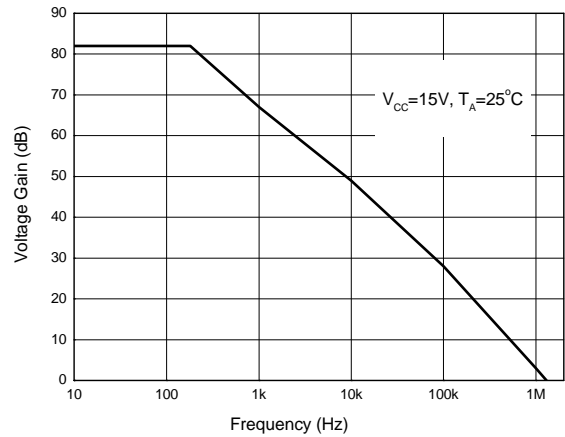


Figure 10. Error Amplifier Open-Loop Frequency Response

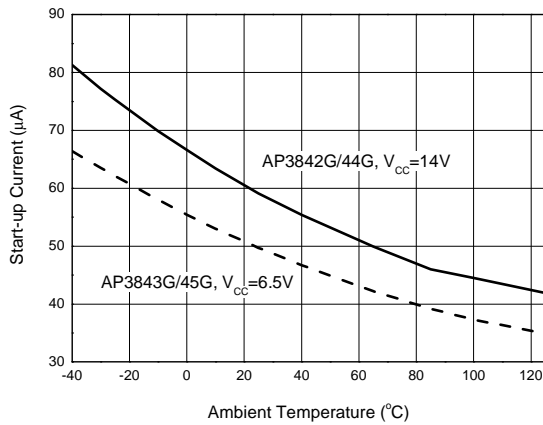


Figure 11. Start-up Current vs. Ambient Temperature

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Typical Application

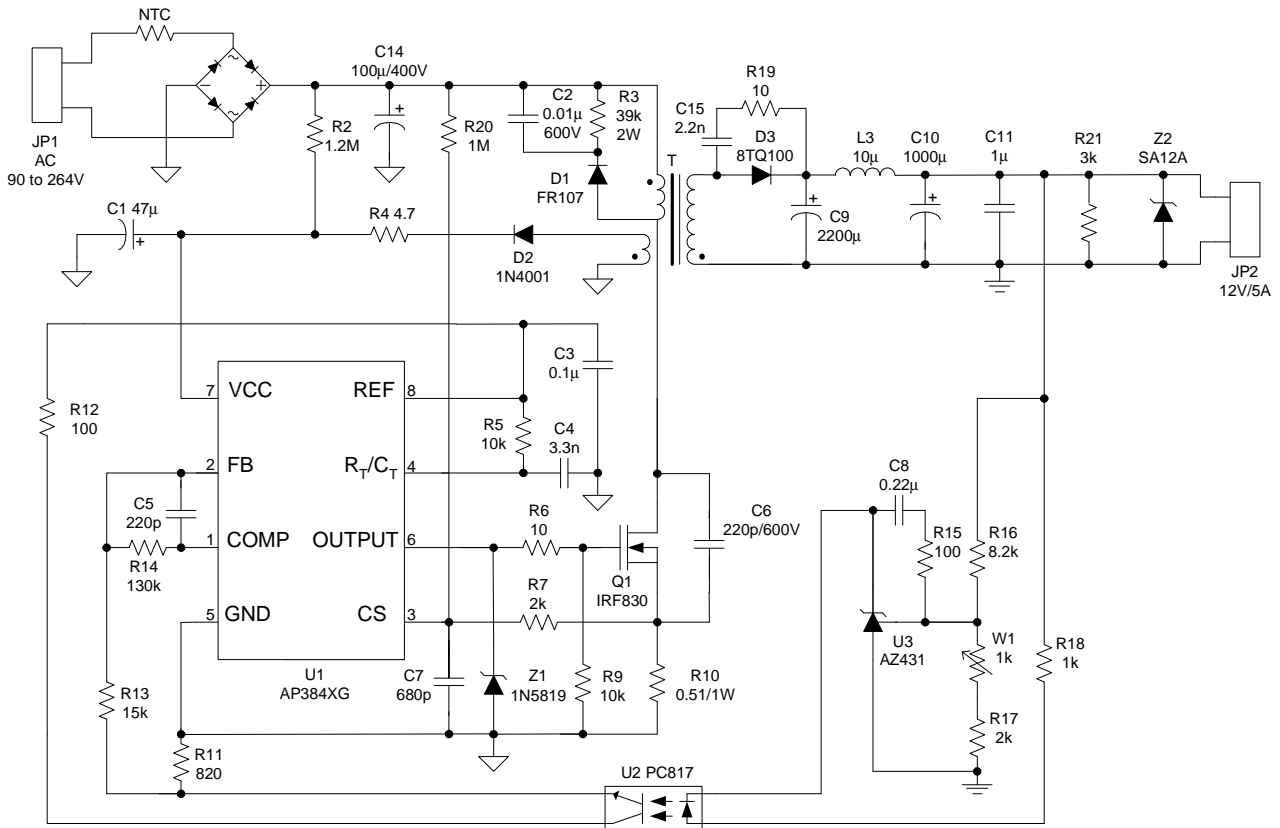


Figure 12. Typical Application of AP384XG in AC/DC Converter



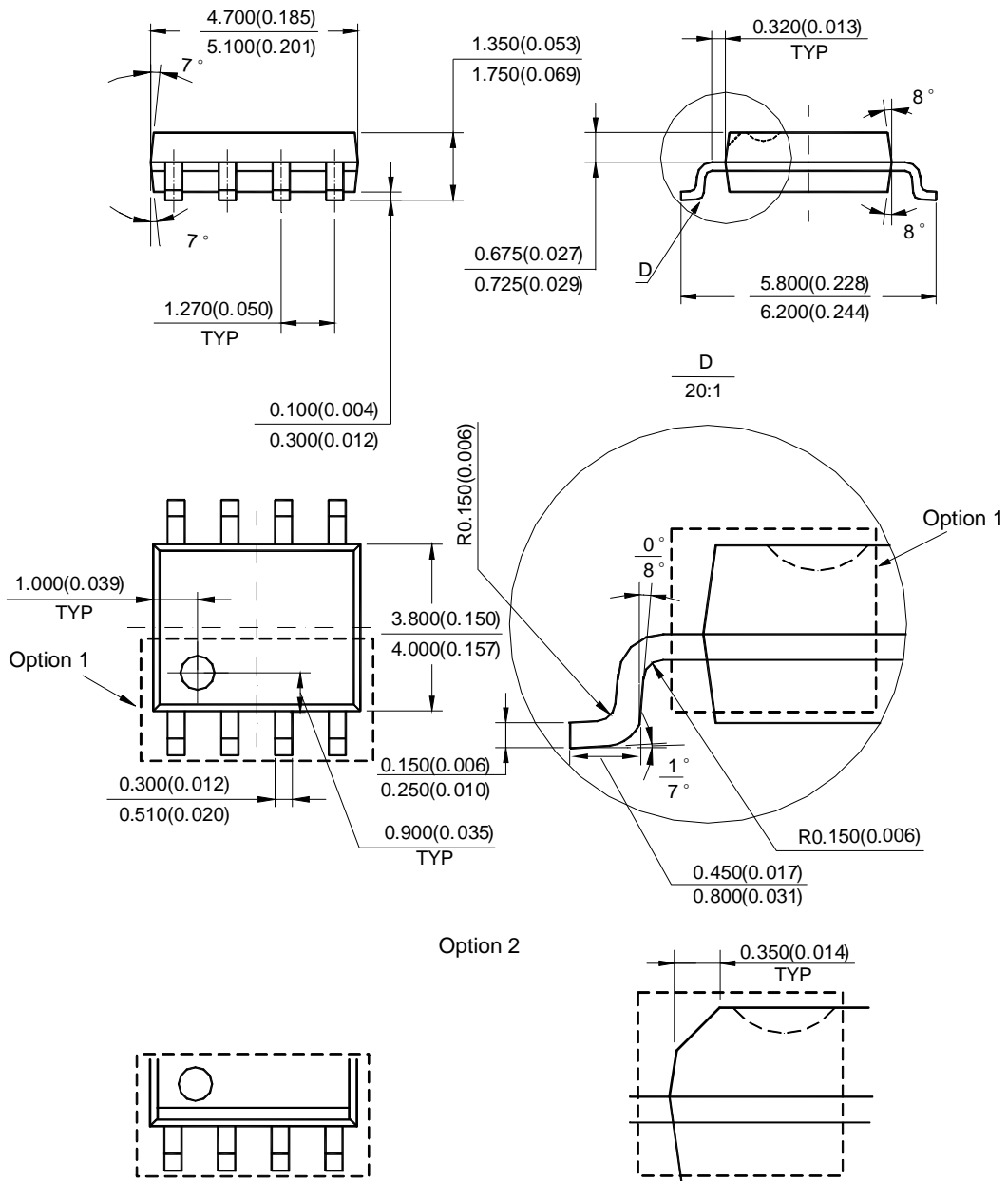
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Mechanical Dimensions

SOIC-8

Unit: mm(inch)



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



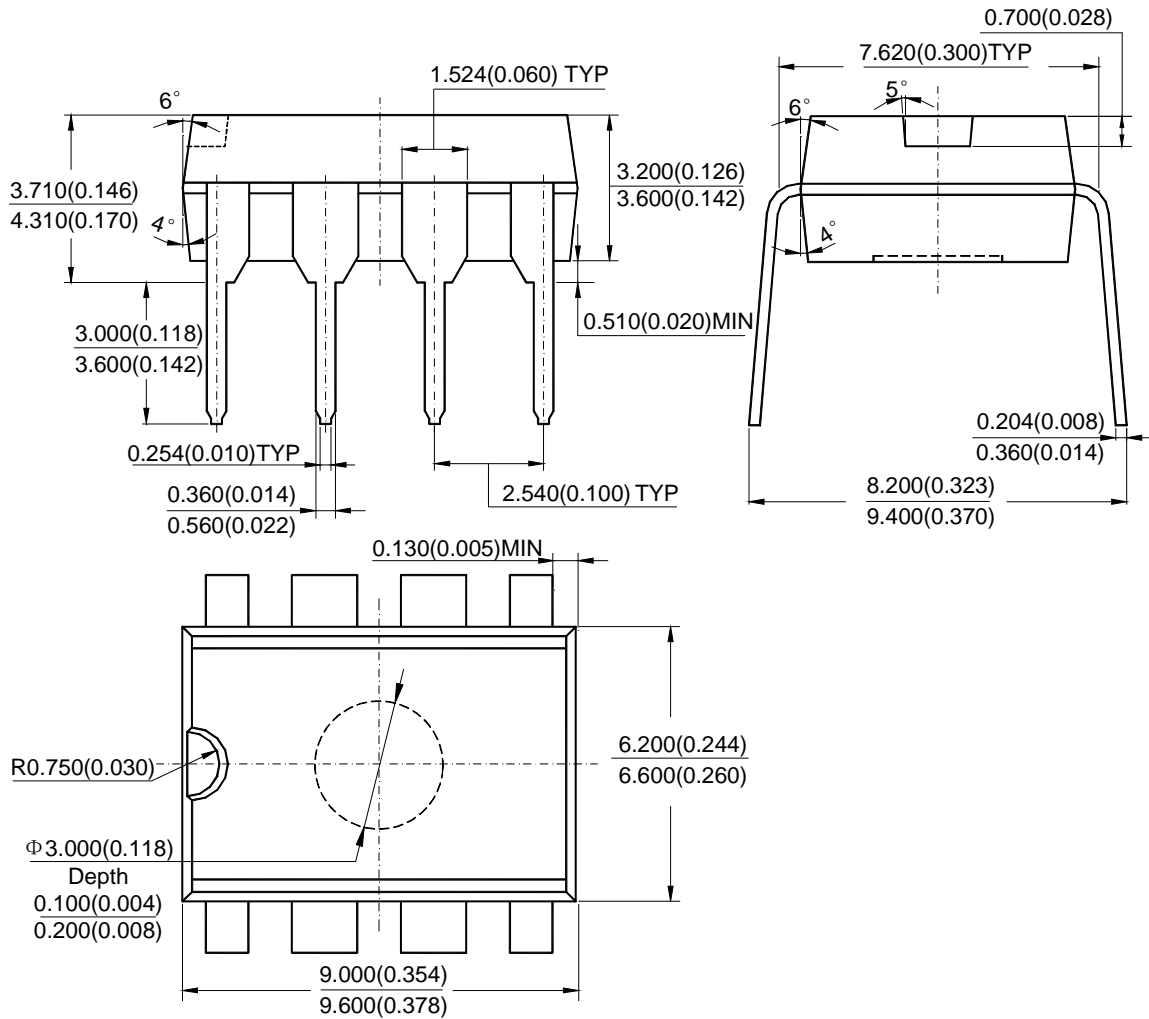
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Mechanical Dimensions (Continued)

DIP-8

Unit: mm(inch)

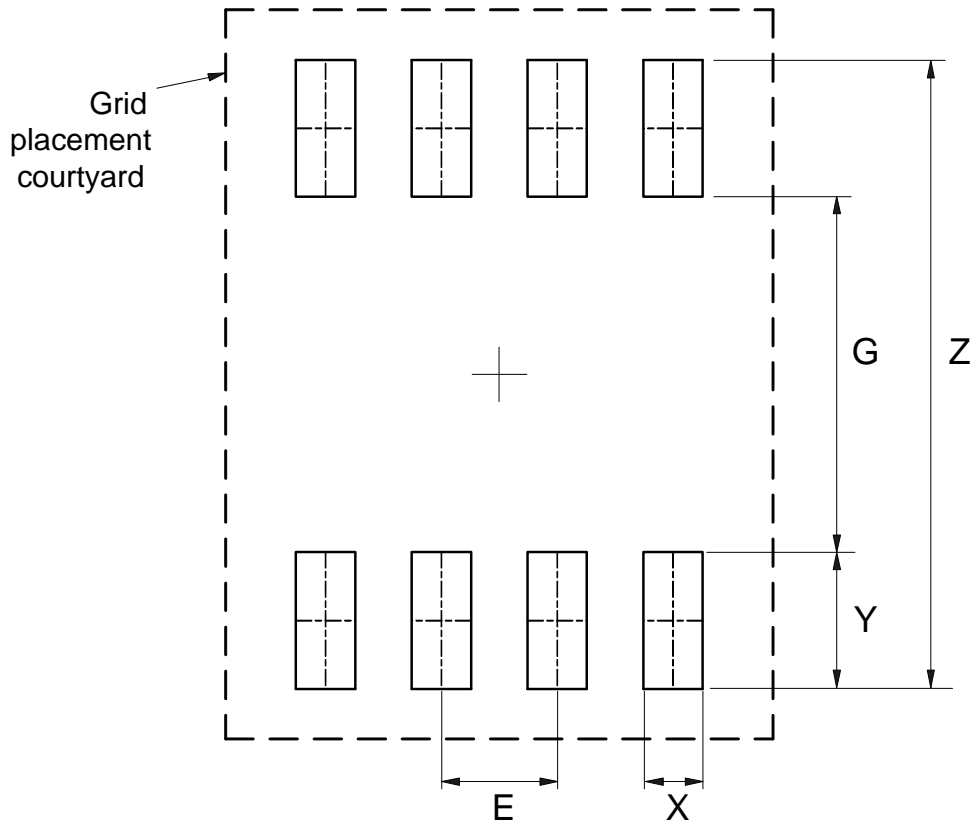


Note: Eject hole, oriented hole and mold mark is optional.

Mounting Pad Layout

SOIC-8

Unit: mm(inch)



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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