

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: 50 μ A (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

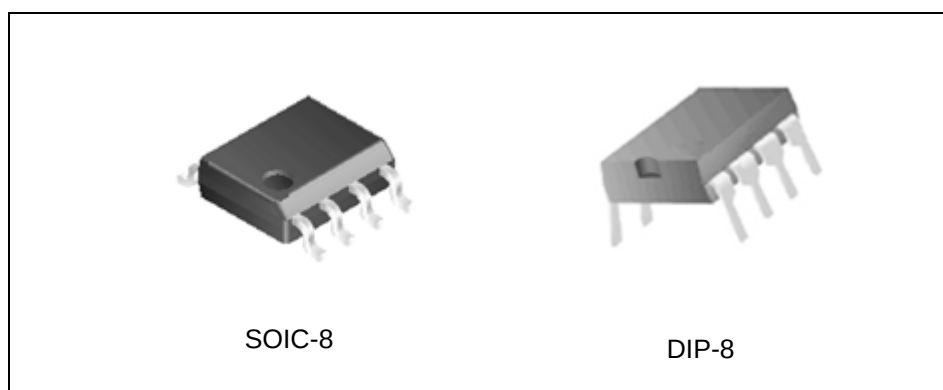


Figure 1. Package Types of AP384XG

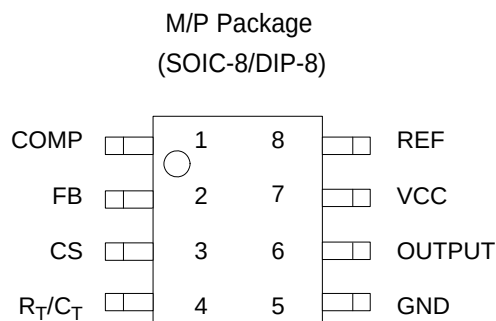
**GREEN MODE PWM CONTROLLER****AP384XG****Pin Configuration**

Figure 2. Pin Configuration of AP384XG

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

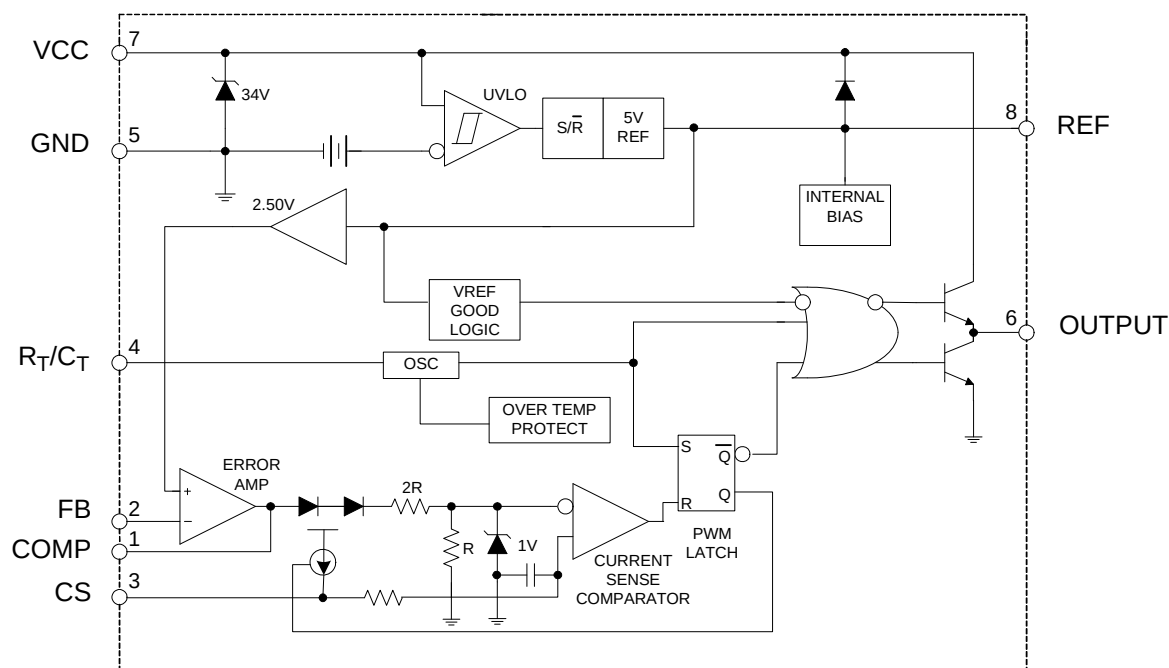


Figure 3. Functional Block Diagram of AP384XG

Ordering Information

AP384XG □ □ - □		
Circuit Type		E1: Lead Free Blank: Tin Lead
Package		TR: Tape and Reel Blank: Tube
M: SOIC-8		
P: DIP-8		

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

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

**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	$^{\circ}\text{C}$

**GREEN MODE PWM CONTROLLER****AP384XG****Electrical Characteristics**(V_{CC}=15V, R_T=10k Ω , C_T=3.3nF, T_A= -40 to 85°C, unless otherwise specified.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
REFERENCE SECTION						
Reference Output Voltage	V _{REF}	T _J =25°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 ≤ V _{CC} ≤25V		4	15	mV
Load Regulation	ΔV _{REF}	1mA ≤ I _{REF} ≤20mA		4	15	mV
Short Circuit Output Current	I _{SC}	T _A =25°C		-100	-180	mA
Temperature Stability				0.2	0.4	mV/°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		V _{CC} =14V		50	80	μA
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 _J =25°C	47	52	57	KHz
Oscillator Amplitude	V _{OSC}	Pin RT/CT, peak to peak		1.7		V
Temperature Stability				2		%
Voltage Stability		12V ≤ V _{CC} ≤ 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 RT=10k Ω 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.

**GREEN MODE PWM CONTROLLER****AP384XG****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}	$R_L=15k\Omega$ to GND	5	7		V
Low Output Voltage	V_{OL}	$R_L=15k\Omega$ to pin REF		0.7	1.1	V
Voltage Gain		$2V \leq V_O \leq 4V$	65	90		dB
Power Supply Rejection Ratio	PSRR	$12V \leq V_{CC} \leq 25V$	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	$0V \leq V_{CS} \leq 4V$ (Note 5, 6)	2.85	3	3.15	V/V
Power Supply Rejection Ratio	PSRR	$12V \leq V_{CC} \leq 25V$ (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	$T_J=25^\circ C, C_L=1nF$		150	250	ns
Fall Time	t_F	$T_J=25^\circ C, C_L=1nF$		50	150	ns
SKIP CYCLE MODE SECTION						
Source Current (@ CS)		$V_{OUTPUT}=Low, T_J=25^\circ C$	180	200	220	μA
OVER-TEMPERATURE PROTECT SECTION						
Shutdown Temperature	T_{SHUT}			155		$^\circ C$
Temperature Hysteresis	T_{HYS}			25		$^\circ C$

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.

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Electrical Characteristics (Continued)

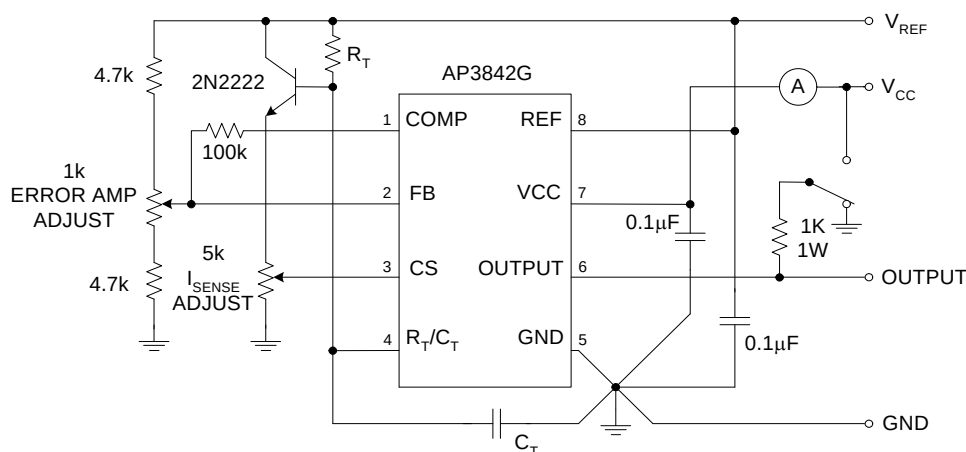


Figure 4. Basic Test Circuit

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.

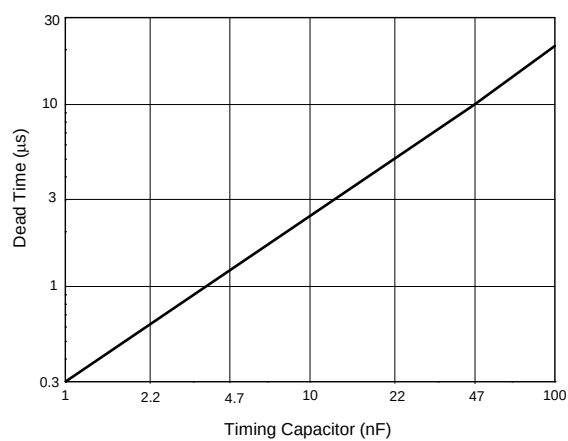
**GREEN MODE PWM CONTROLLER****AP384XG****Typical Performance Characteristics**

Figure 5. Oscillator Dead Time vs. Timing Capacitor

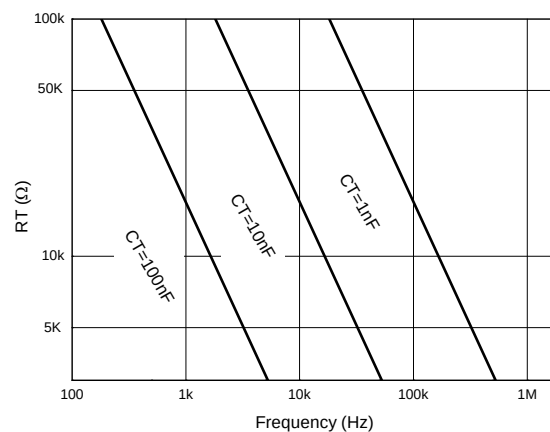


Figure 6. Timing Resistor vs. Frequency

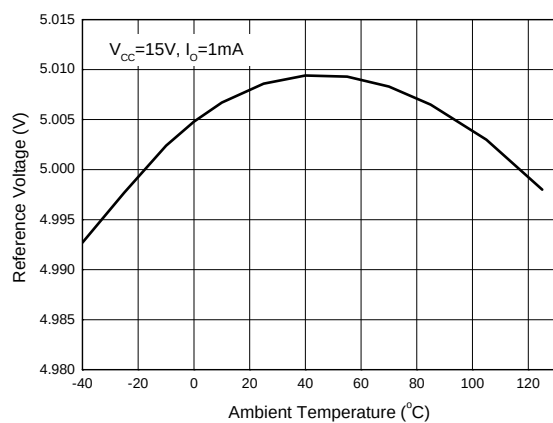


Figure 7. Reference Voltage vs. Ambient Temperature

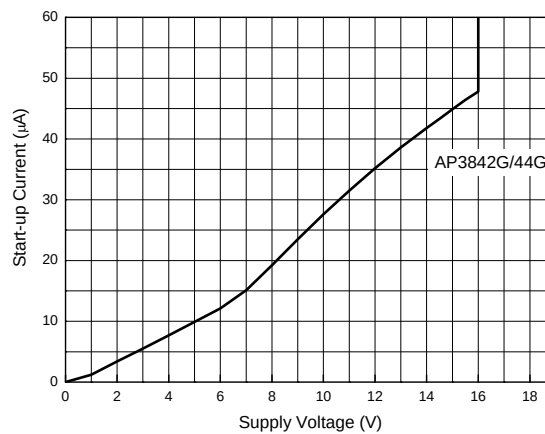


Figure 8. Start-up Current vs. Supply Voltage

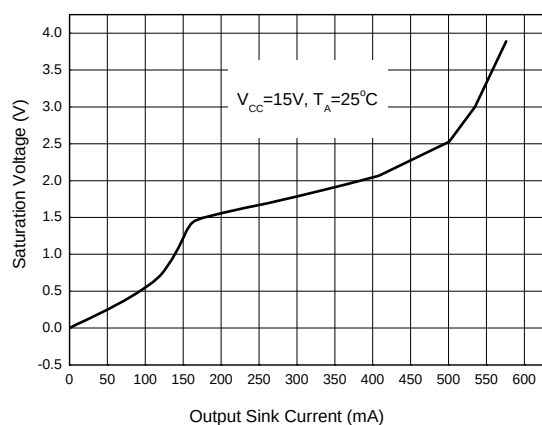
**GREEN MODE PWM CONTROLLER****AP384XG****Typical Performance Characteristics (Continued)**

Figure 9. Output Saturation Characteristics

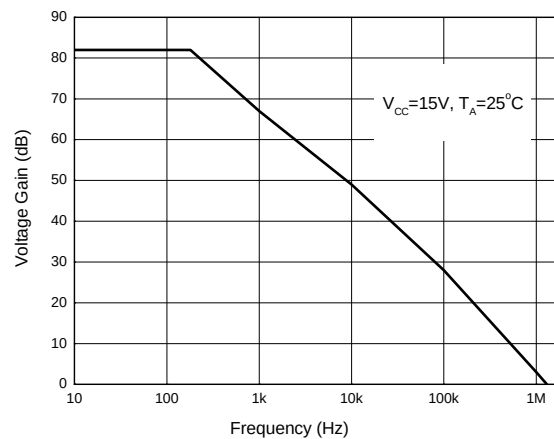


Figure 10. Error Amplifier Open-Loop Frequency Response

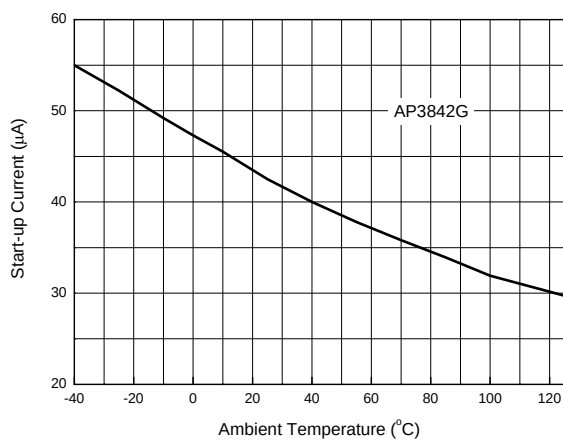


Figure 11. Start-up Current vs. Ambient Temperature

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Typical Application

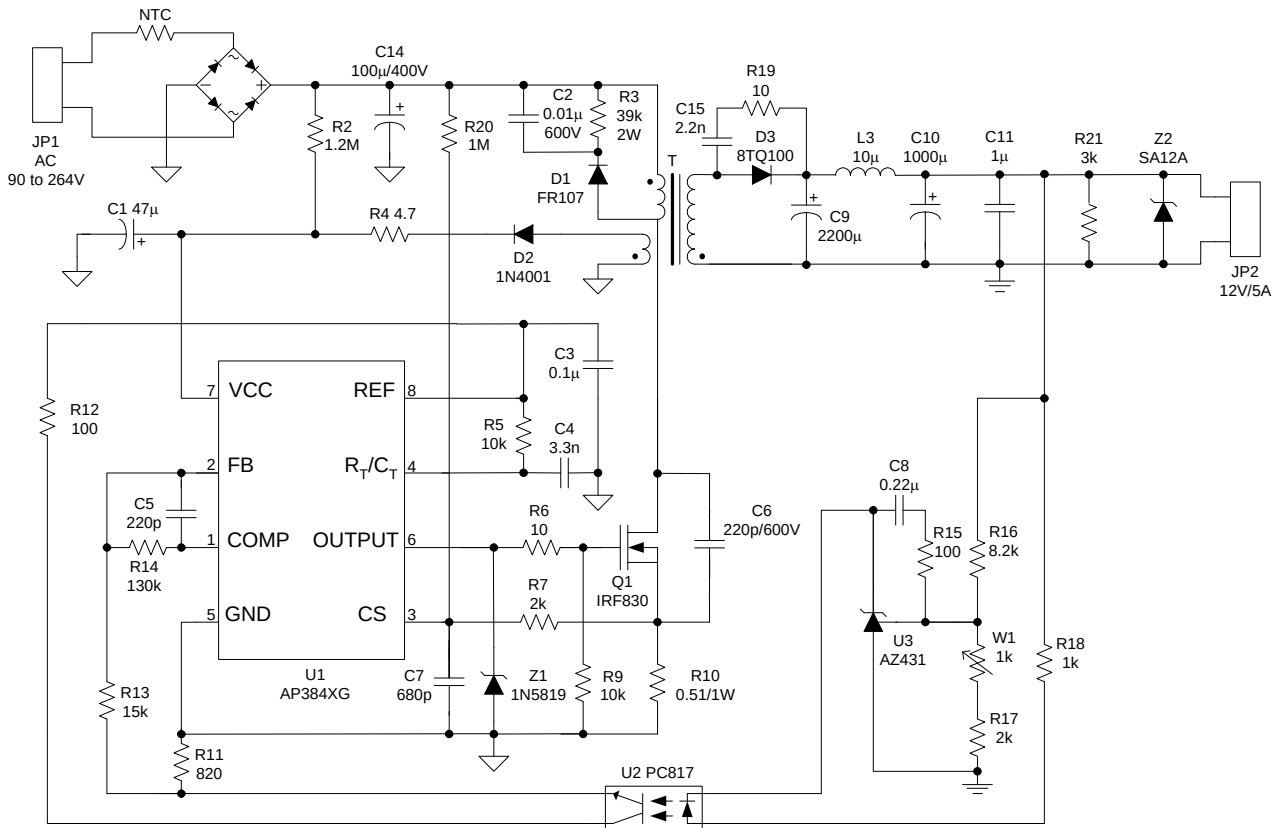
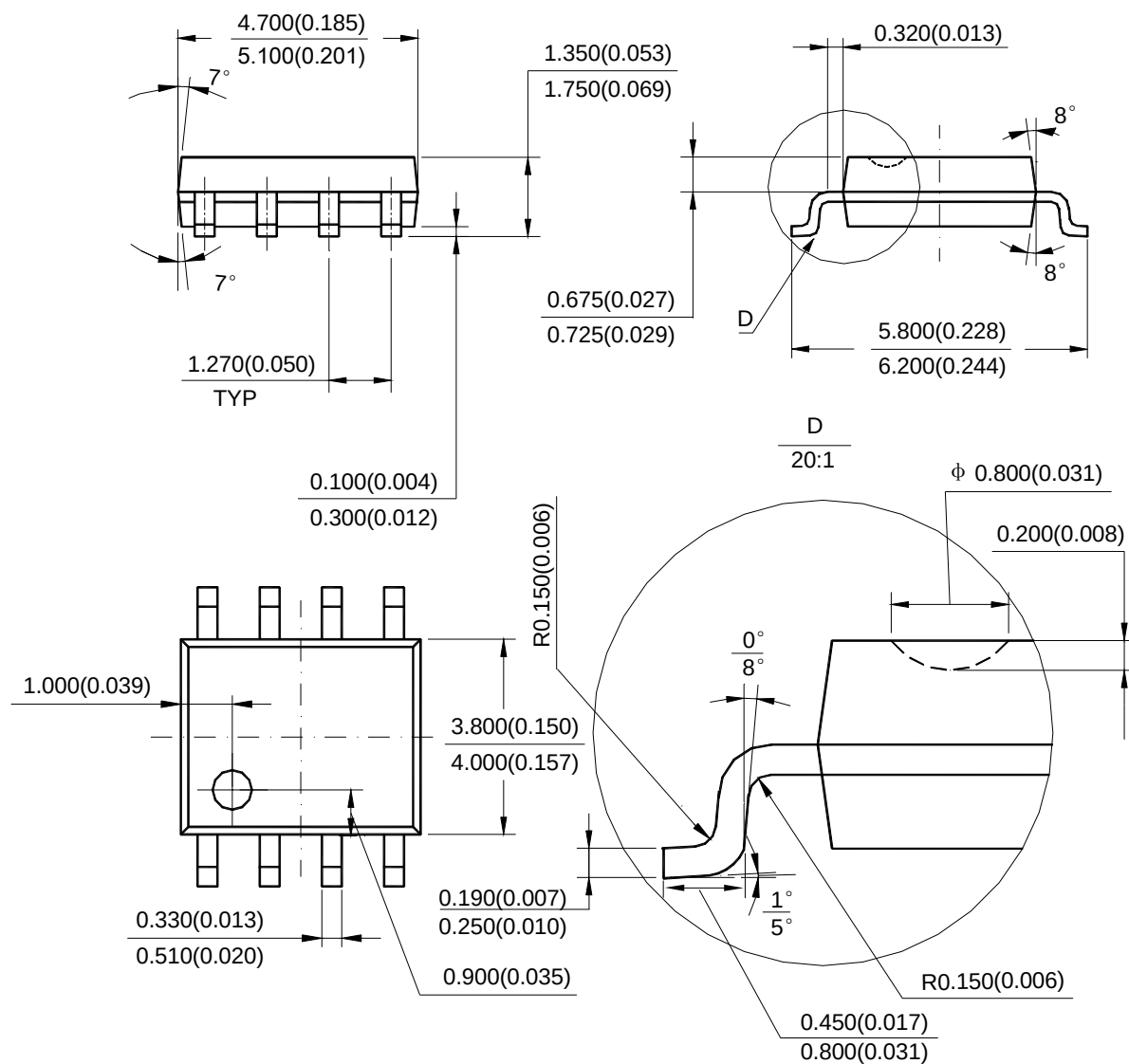
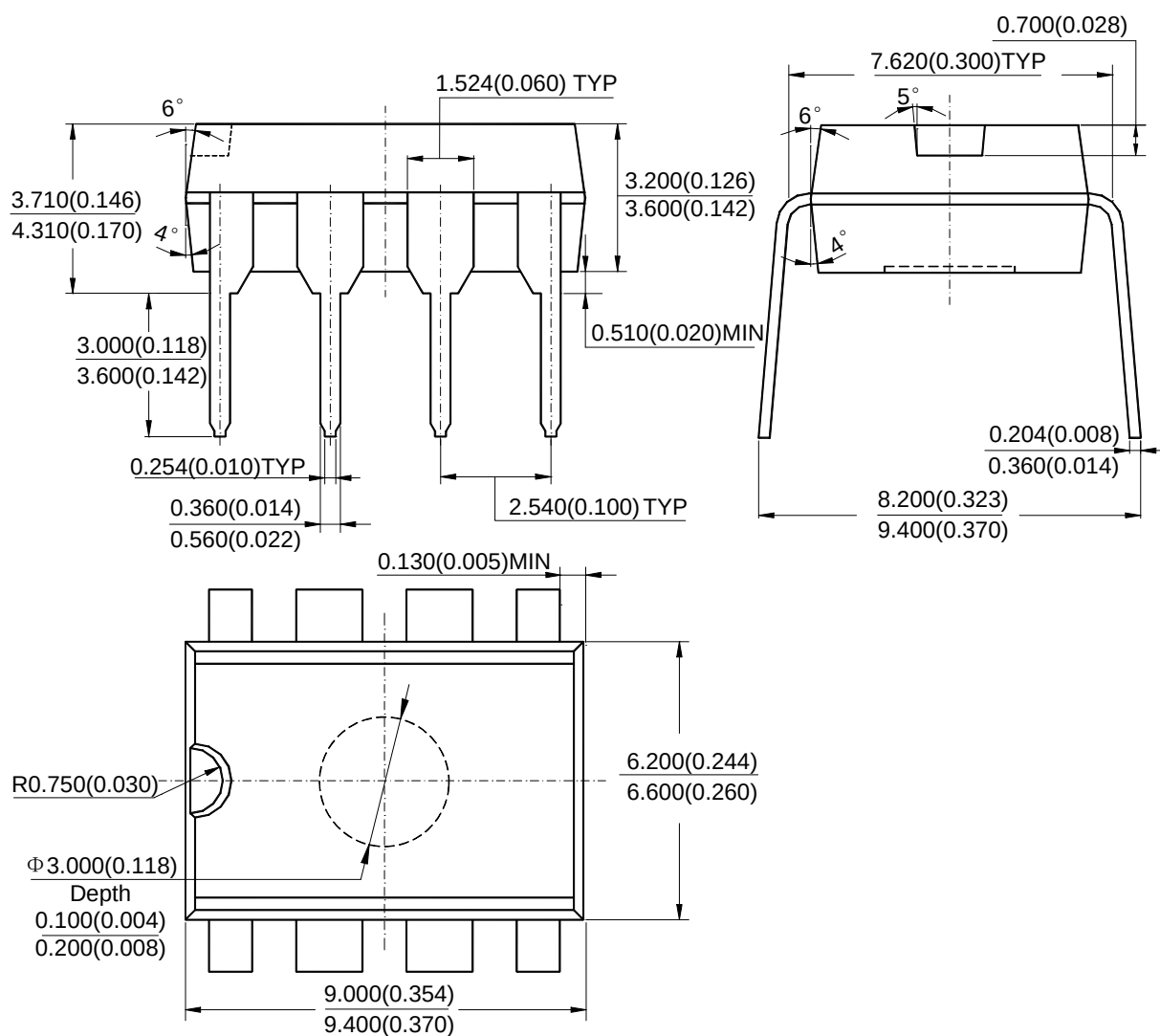


Figure 12. Typical Application of AP384XG in AC/DC Converter

**GREEN MODE PWM CONTROLLER****AP384XG****Mechanical Dimensions****SOIC-8****Unit: mm(inch)**

**GREEN MODE PWM CONTROLLER****AP384XG****Mechanical Dimensions (Continued)****DIP-8****Unit: mm(inch)**



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