Advanced Analog Circuits

Preliminary Datasheet

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: 40µA (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
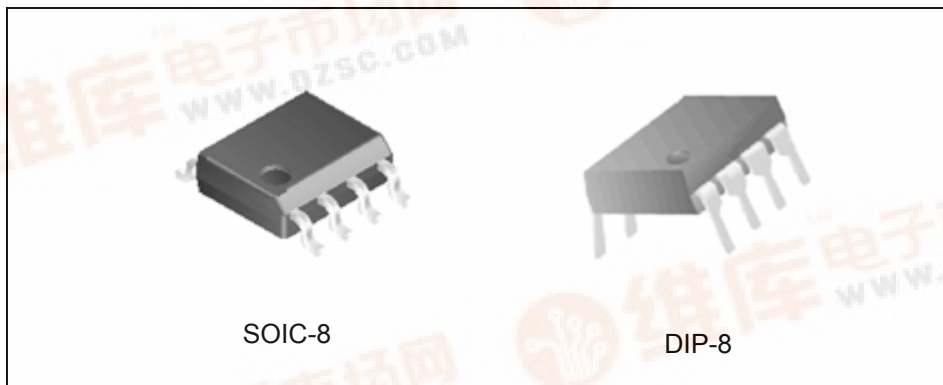- Power Adapter
- CRT Monitor Power Supply
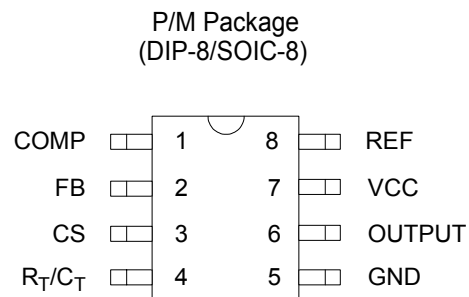

SOIC-8

DIP-8

Figure 1. Package Types of AP384XG

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GREEN MODE PWM CONTROLLER   **AP384XG**

Pin Configuration

P/M Package
(DIP-8/SOIC-8)

COMP	1	8	REF
FB	2	7	VCC
CS	3	6	OUTPUT
R_T/C_T	4	5	GND

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.

GREEN MODE PWM CONTROLLER   **AP384XG**
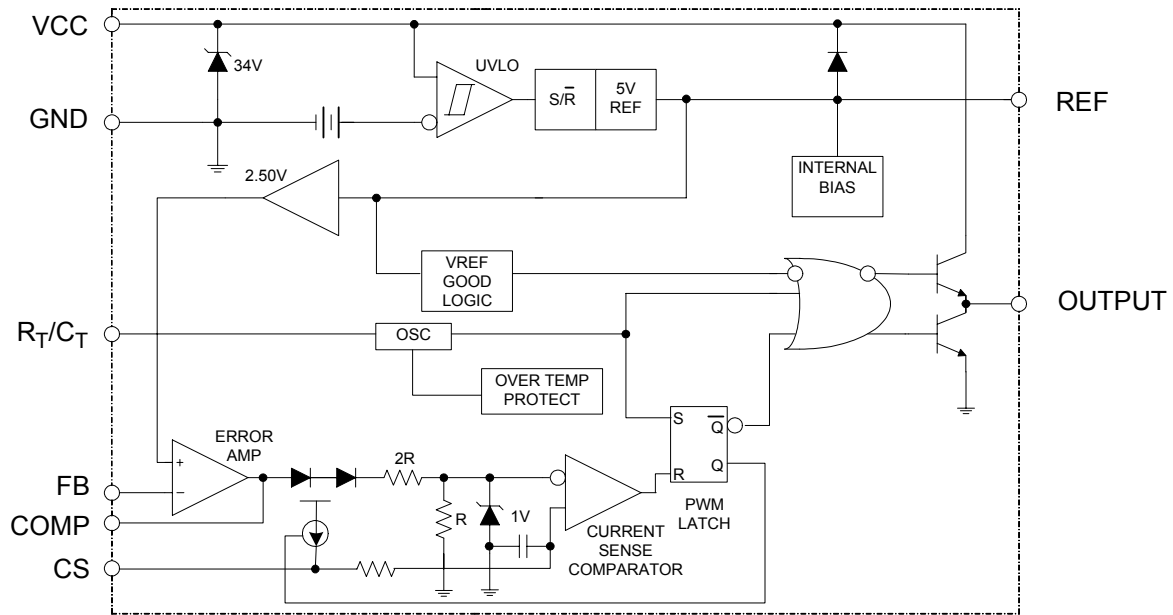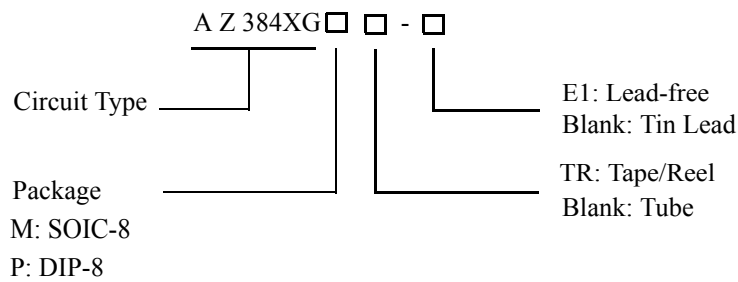
Functional Block Diagram

Figure 3. Functional Block Diagram of AP384XG

Ordering Information

Circuit Type

Package
M: SOIC-8
P: DIP-8

E1: Lead-free
Blank: Tin Lead

TR: Tape/Reel
Blank: Tube

Package	Tempera-ture Range	Part Number		Marking ID		Packing Type
		Tin Lead	**LeadFree**	**Tin Lead**	**LeadFree**	
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

The listed part numbers are used during the transition to lead-free products. After the transition completed, lead-free products will be considered as the"standard" and we will resume the original part numbers.

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GREEN MODE PWM CONTROLLER **AP384XG**

Absolute Maximum Ratings (Note 1, 2)

Parameter	Symbol	Value	Unit
Supply Voltage	Vcc	30	V
Gate Output Current	Io	± 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 ºC (DIP-8)	P_D (Note 3)	1000	mW
Power Dissipation at T_A<25 ºC (SOIC-8)	P_D (Note 3)	460	mW
Storage Temperature Range	T_{STG}	-65 to 150	ºC
Ambient Temperature	T_A	-40 to 85	ºC
Lead Temperature (Soldering, 10sec)	T_{LEAD}	+300	ºC
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	ºC

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Electrical Characteristics

(V_{CC}=15V, R_T=10kΩ 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/^{o}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		40	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=10kΩ 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=15kΩ to GND	5	7		V
Low Output Voltage	V_{OL}	R_L=15kΩ to pin REF		0.7	1.1	V
Voltage Gain		$2V \le V_O \le 4V$	65	90		dB
Power Supply Rejection Ratio	PSRR	$12V \le V_{CC} \le 25V$	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	$0V \le V_{CS} \le 4V$ (Note 5, 6)	2.85	3	3.15	V/V
Power Supply Rejection Ratio	PSRR	$12V \le V_{CC} \le 25V$ (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=25ºC, C_L=1nF		150	250	ns
Fall Time	t_F	T_J=25ºC, C_L=1nF		50	150	ns
SKIP CYCLE MODE SECTION						
Source Current (@ CS)		V_{OUTPUT}=Low, T_J=25ºC	180	200	220	µA
OVER-TEMPERATURE PROTECT SECTION						
Shutdown Temperature	T_{SHUT}			155		ºC
Temperature Hysteresis	T_{HYS}			25		ºC

Note 5: Parameters are tested at trip point of latch with Vpin2 = 0.

Note 6: Here gain is defined as:

$$A=\frac{\Delta VPin\ 1}{\Delta VPin\ 3}, \quad 0 \le Vpin3 \le 0.8V$$

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

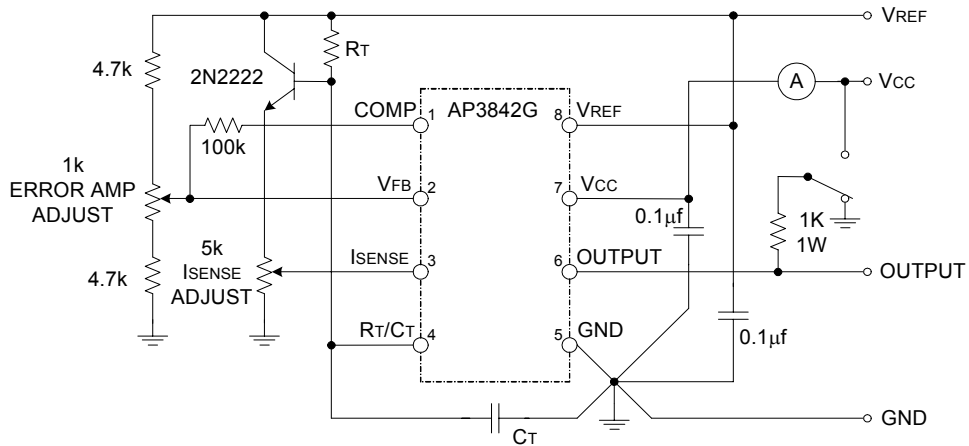## Electrical Characteristics (Continued)

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.

GREEN MODE PWM CONTROLLER | **AP384XG**

Typical Performance Characteristics
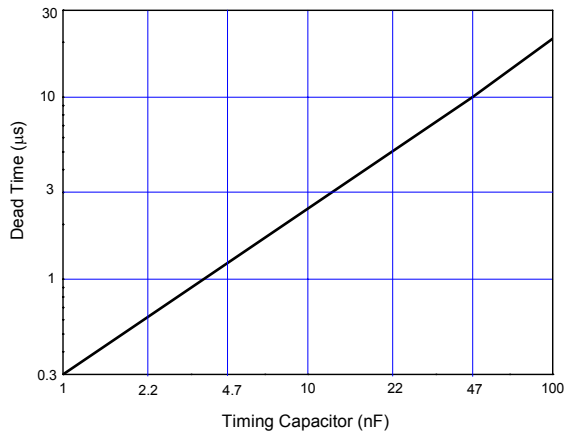
Figure 5. Oscillator Dead Time vs. Timing Capacitor
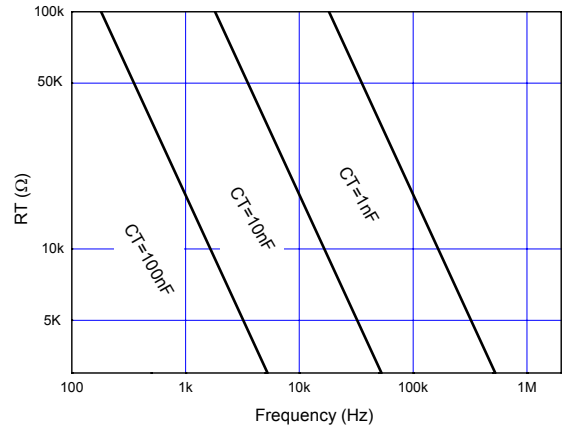
Figure 6. Timing Resistor vs. Frequency
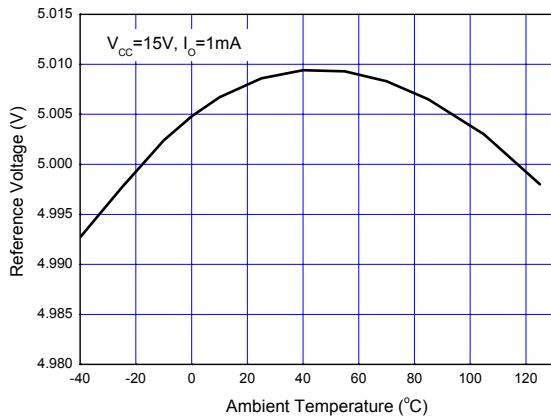
Figure 7. Reference Voltage vs. Ambient Temperature
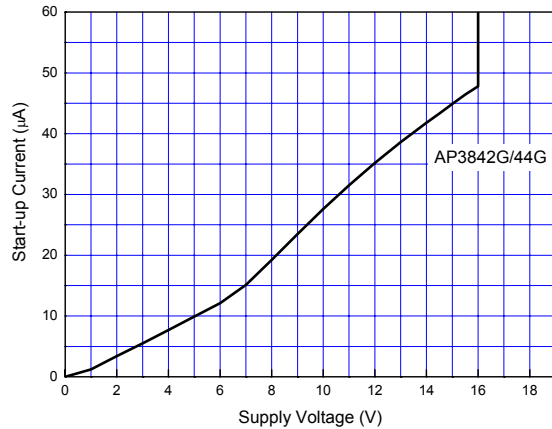
Figure 8. Start-up Current vs. Supply Voltage
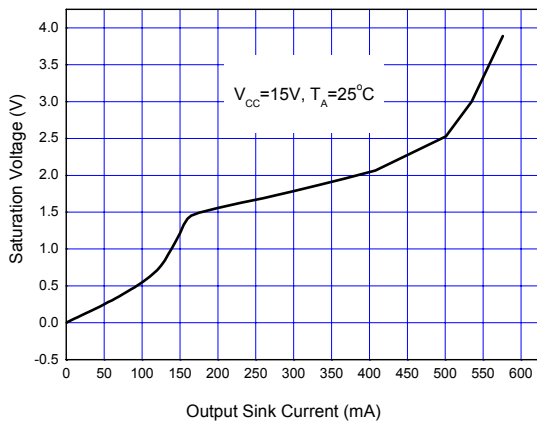
Typical Performance Characteristics (Continued)

Figure 9. Output Saturation Characteristics
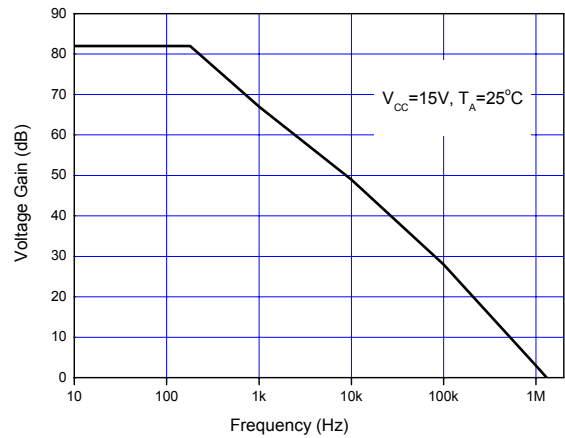

Figure 10. Error Amplifier Open-Loop Frequency Response
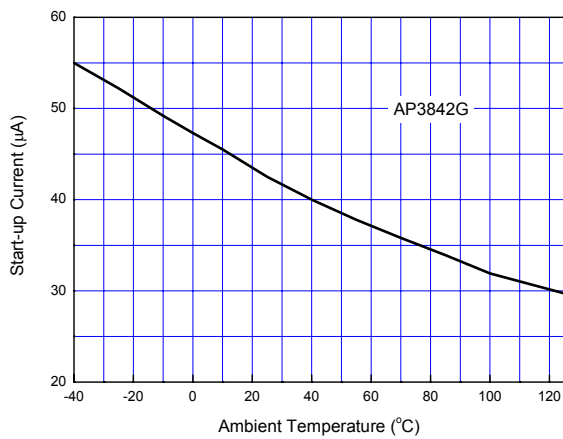

Figure 11. Start-up Current vs. Ambient Temperature

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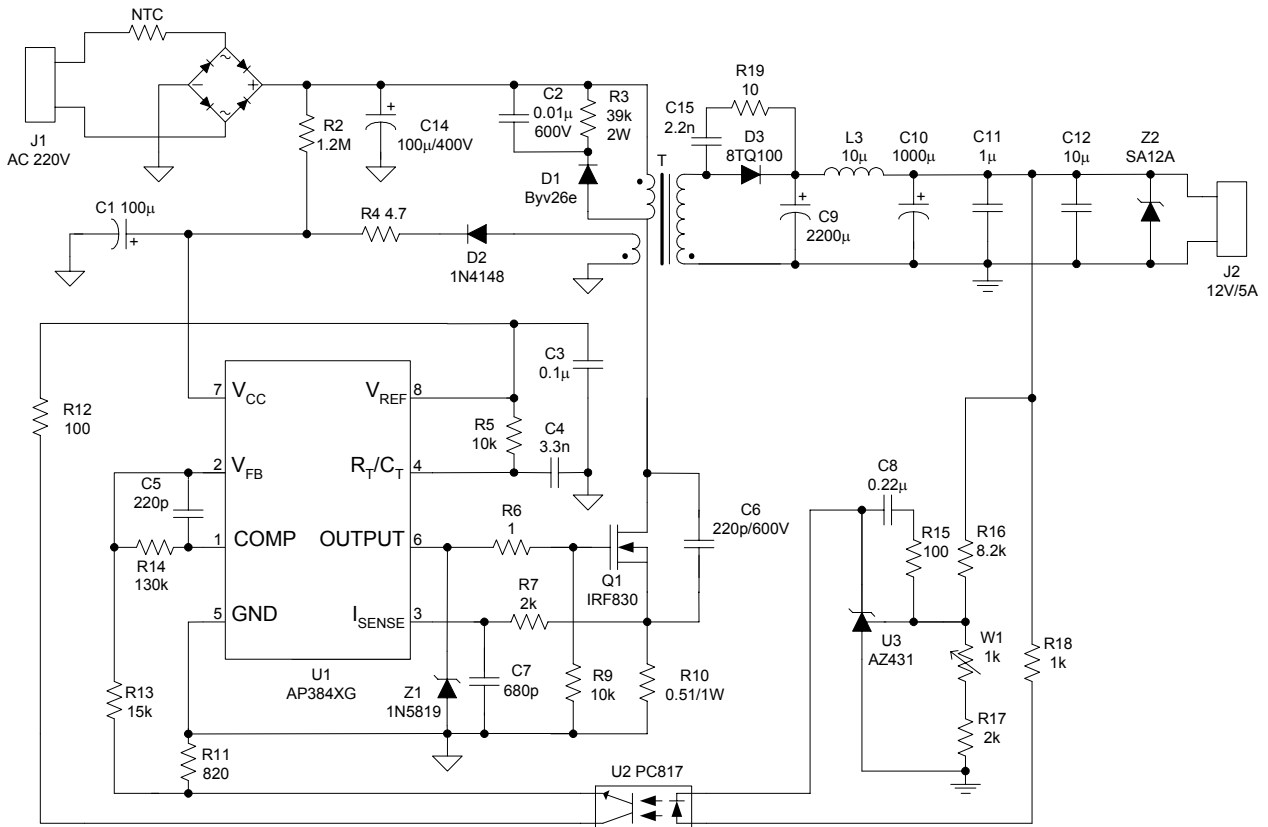
Typical Application

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