

**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 $\mu$ 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

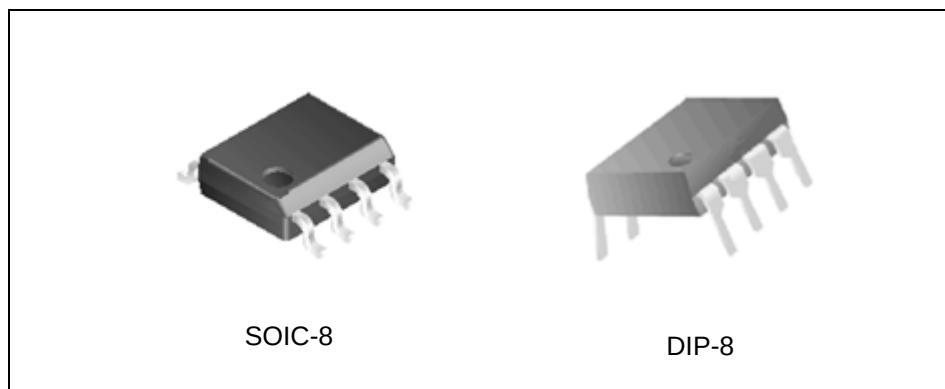


Figure 1. Package Types of AP384XG



## GREEN MODE PWM CONTROLLER

AP384XG

### Pin Configuration

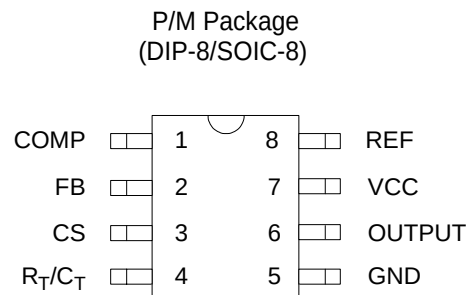


Figure 2. Pin Configuration of AP384XG

### 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 <sub>T</sub> /C <sub>T</sub> | The oscillator frequency and maximum output duty cycle are programmed by connecting resistor R <sub>T</sub> to REF and capacitor C <sub>T</sub> 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 <sub>T</sub> through resistor R <sub>T</sub> .                                  |



AP384XG □ □ - □

Circuit Type

Package

M: SOIC-8

P: DIP-8

E1: Lead Free  
Blank: Tin Lead

TR: Tape and Reel  
Blank: Tube

| Package | Tempera-<br>ture Range | Part Number      |                     | Marking ID     |                   | Packing<br>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            |

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Aug. 2005 Rev. 1.2

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

| Parameter                                                        | Symbol          | Value       | Unit               |
|------------------------------------------------------------------|-----------------|-------------|--------------------|
| Supply Voltage                                                   | $V_{CC}$        | 30          | V                  |
| Gate Output Current                                              | $I_O$           | $\pm 1$     | 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<sub>CC</sub>=15V, R<sub>T</sub>=10kΩ C<sub>T</sub>=3.3nF, T<sub>A</sub>= -40 to 85°C, unless otherwise specified.)

| Parameter                      | Symbol            | Conditions                                                  | Min  | Typ  | Max  | Unit  |
|--------------------------------|-------------------|-------------------------------------------------------------|------|------|------|-------|
| REFERENCE SECTION              |                   |                                                             |      |      |      |       |
| Reference Output Voltage       | V <sub>REF</sub>  | T <sub>J</sub> =25°C, I <sub>REF</sub> =1mA                 | 4.95 | 5.00 | 5.05 | V     |
| Total Output Variation         |                   | Line, Load, Temp.                                           | 4.9  |      | 5.10 | V     |
| Line Regulation                | ΔV <sub>REF</sub> | 12V ≤ V <sub>CC</sub> ≤25V                                  |      | 4    | 15   | mV    |
| Load Regulation                | ΔV <sub>REF</sub> | 1mA ≤ I <sub>REF</sub> ≤20mA                                |      | 4    | 15   | mV    |
| Short Circuit Output Current   | I <sub>SC</sub>   | T <sub>A</sub> =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 <sub>CC</sub> =14V                                        |      | 50   | 80   | μA    |
| Operating Current              |                   | V <sub>FB</sub> =0, V <sub>CS</sub> =0, C <sub>L</sub> =1nF |      | 8    |      | mA    |
| Standby Operating Current      |                   | V <sub>FB</sub> =2.7V, V <sub>CS</sub> =0.5V                |      | 6    |      | mA    |
| Zener Voltage                  |                   | I <sub>CC</sub> =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 <sub>J</sub> =25°C                                        | 47   | 52   | 57   | KHz   |
| Oscillator Amplitude           | V <sub>OSC</sub>  | Pin RT/CT, peak to peak                                     |      | 1.7  |      | V     |
| Temperature Stability          |                   |                                                             |      | 2    |      | %     |
| Voltage Stability              |                   | 12V ≤ V <sub>CC</sub> ≤ 25V                                 |      | 0.2  | 1    | %     |
| Discharge Current              |                   | V <sub>RT/CT</sub> = 2V (Note 4)                            | 8.5  | 9.5  | 10.5 | mA    |

Note 4: This parameter is measured with RT=10kΩ to V<sub>REF</sub>, 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       |
|-----------------------------------------|--------------|----------------------------------------|------|------|------|------------|
| <b>ERROR AMPLIFIER SECTION</b>          |              |                                        |      |      |      |            |
| 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         |
| <b>CURRENT SENSE SECTION</b>            |              |                                        |      |      |      |            |
| 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  | $\mu A$    |
| Leading Edge Blanking Duration          | $T_{LEB}$    |                                        |      | 250  |      | ns         |
| <b>OUTPUT SECTION</b>                   |              |                                        |      |      |      |            |
| 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         |
| <b>SKIP CYCLE MODE SECTION</b>          |              |                                        |      |      |      |            |
| Source Current (@ CS)                   |              | $V_{OUTPUT}=Low, T_J=25^\circ C$       | 180  | 200  | 220  | $\mu A$    |
| <b>OVER-TEMPERATURE PROTECT SECTION</b> |              |                                        |      |      |      |            |
| 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.

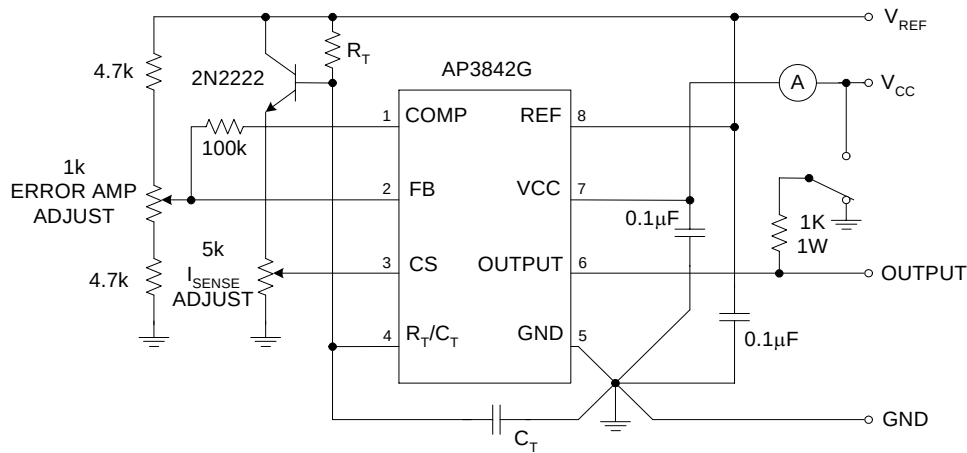
**GREEN MODE PWM CONTROLLER****AP384XG****Electrical Characteristics (Continued)**

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.

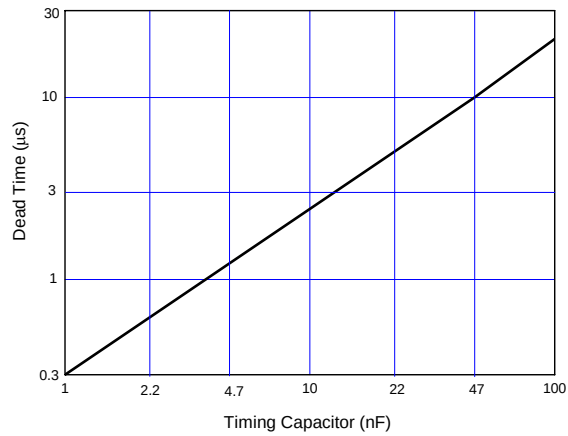
**GREEN MODE PWM CONTROLLER****AP384XG****Typical Performance Characteristics**

Figure 5. Oscillator Dead Time vs. Timing Capacitor

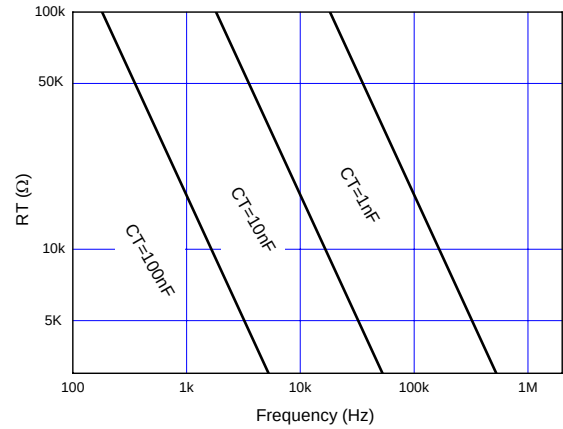


Figure 6. Timing Resistor vs. Frequency

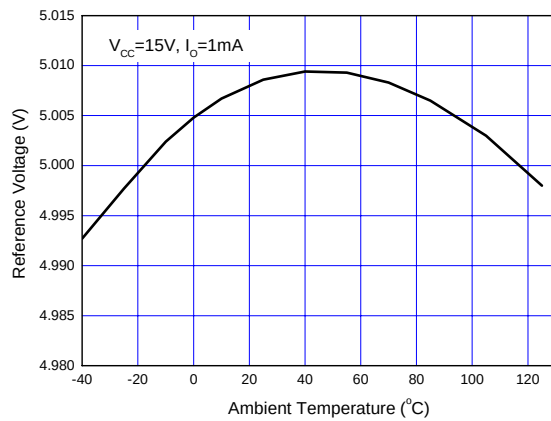


Figure 7. Reference Voltage vs. Ambient Temperature

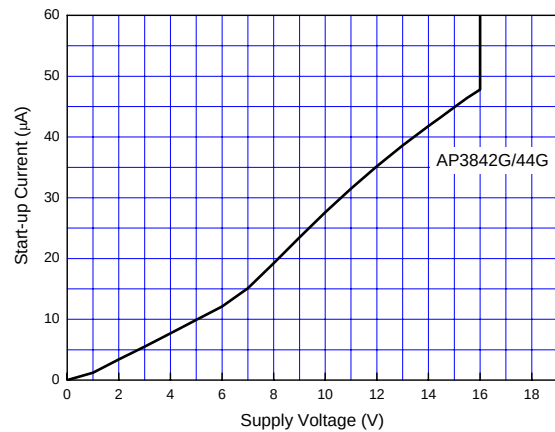


Figure 8. Start-up Current vs. Supply Voltage



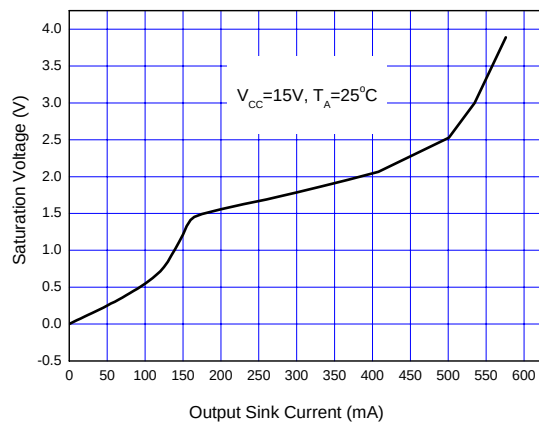
**GREEN MODE PWM CONTROLLER****AP384XG****Typical Performance Characteristics (Continued)**

Figure 9. Output Saturation Characteristics

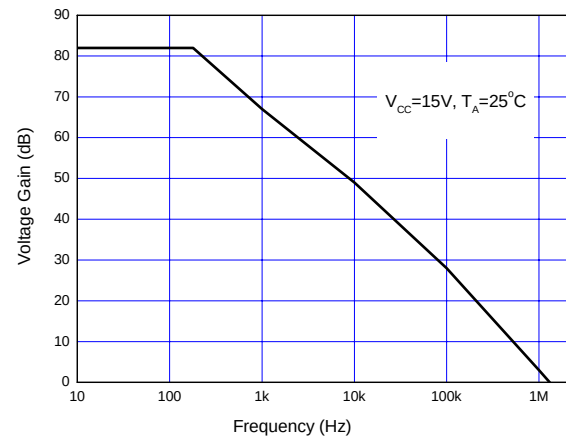


Figure 10. Error Amplifier Open-Loop Frequency Response

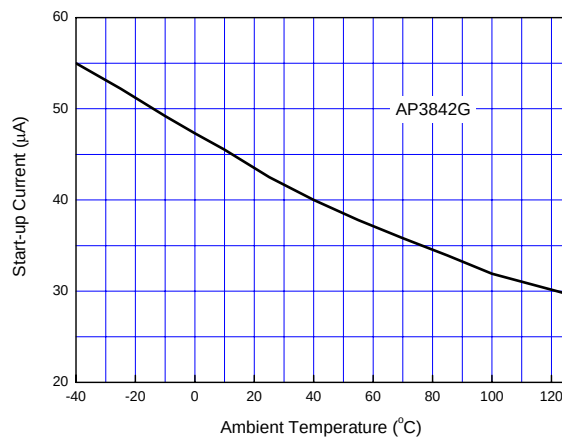


Figure 11. Start-up Current vs. Ambient Temperature



# GREEN MODE PWM CONTROLLER

AP384XG

## Typical Application

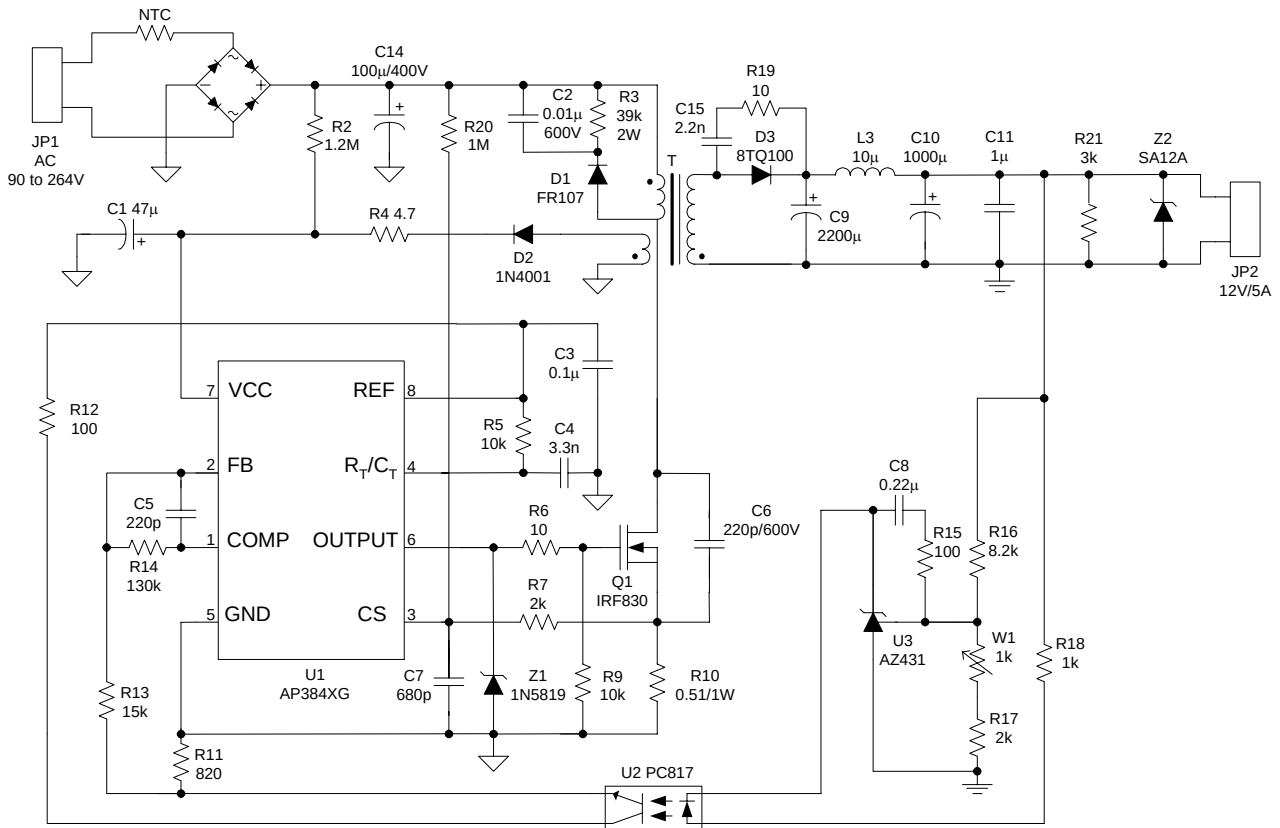
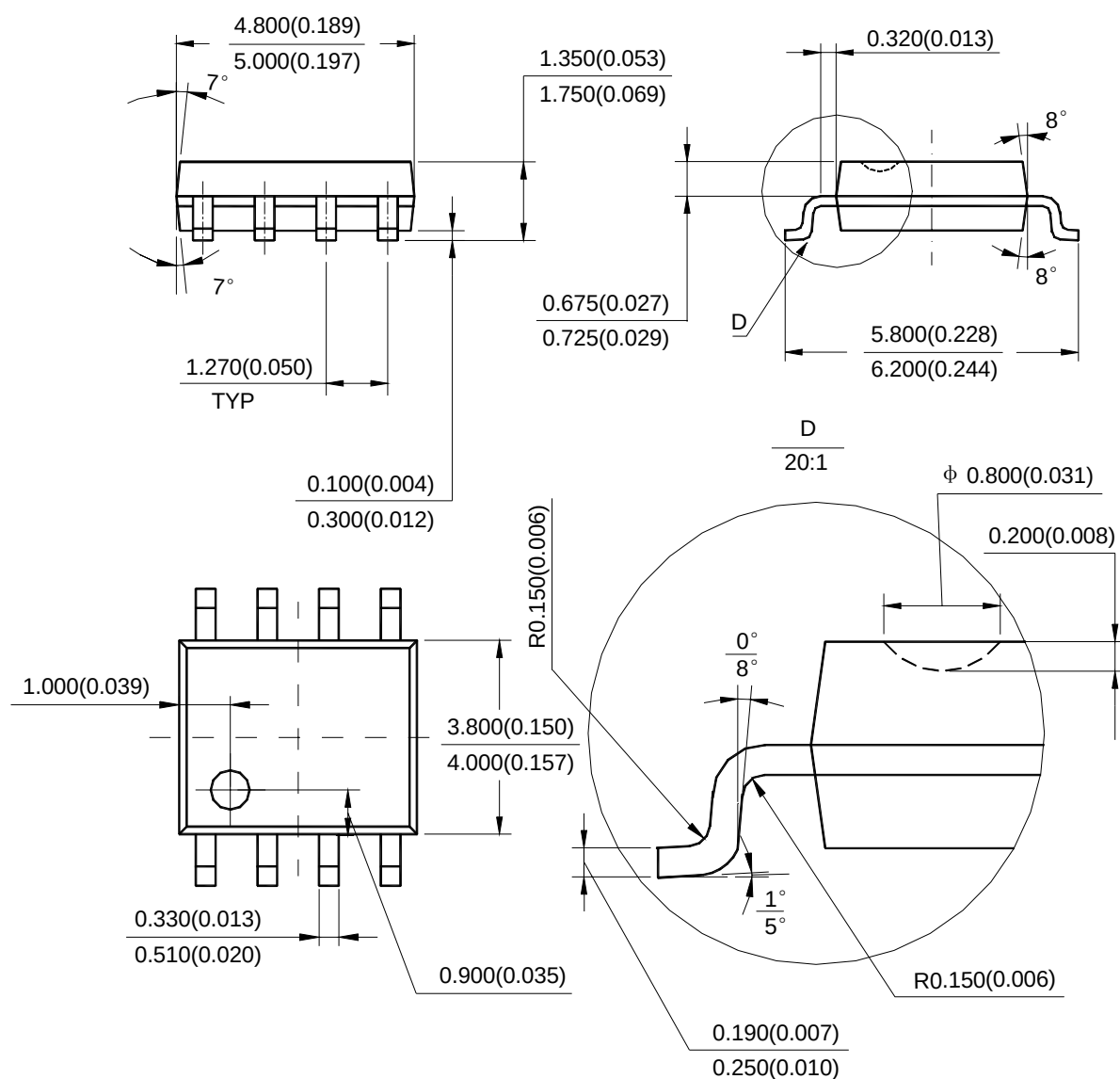
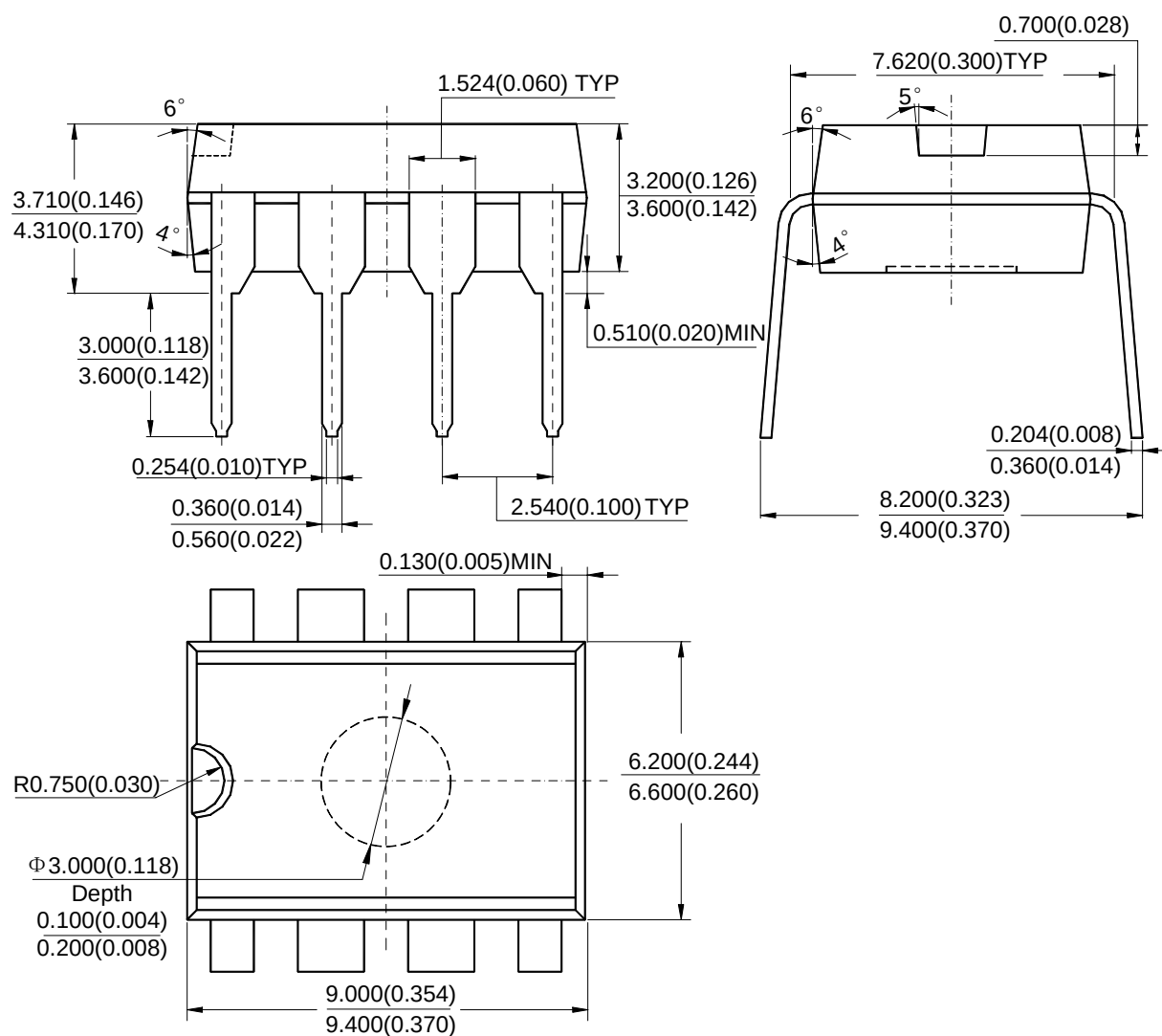


Figure 12. Typical Application of AP384XG in AC/DC Converter

**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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