

CURRENT MODE PWM CONTROLLER

AP384XC

General Description

The AP3842C/3C/4C/5C are high performance fixed frequency current-mode PWM controller series.

These integrated circuits are optimized for off-line and DC-DC converter applications with minimum external components. They feature under-voltage lockout (UVLO) circuit with low start-up current, trimmed oscillator for precise duty cycle control, current sense comparator providing maximum current limiting and a totem pole output stage for increasing output current. In addition, these ICs also feature accurate protection against over-temperature, over-current and maximal output power.

The AP3842C and AP3844C have UVLO thresholds of 16V(on) and 10V(off); The corresponding thresholds for AP3843C and AP3845C are 8.4 V(on) and 7.6V(off).

The AP3842C and AP3843C can operate approaching 100% duty cycle; AP3844C and AP3845C can operate from zero to 50% duty cycle.

These ICs are available in SOIC-8 and DIP-8 packages.

Features

- Low Start-up Current: 50µA
- Robust V_{REF} Line/Load Regulation
Low Line Regulation : 4mV
Low Load Regulation : 4mV
- High Stability of Reference Voltage over a Full Temperature Range: 0.2mV/ °C
- Operating Frequency up to 500kHz
- High PWM Frequency Stability over a Full Temperature Range: 2.5%
- High PWM Frequency Stability under a Full Supply Voltage Range: 0.2%
- Accurate Over-temperature Protection with Hysteresis
- UVLO with Hysteresis

Applications

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

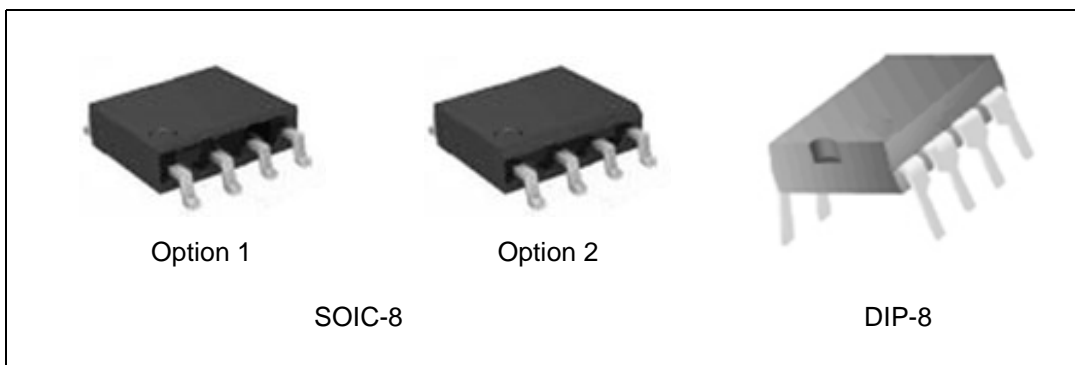


Figure 1. Package Types of AP3842C/3C/4C/5C

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Pin Configuration

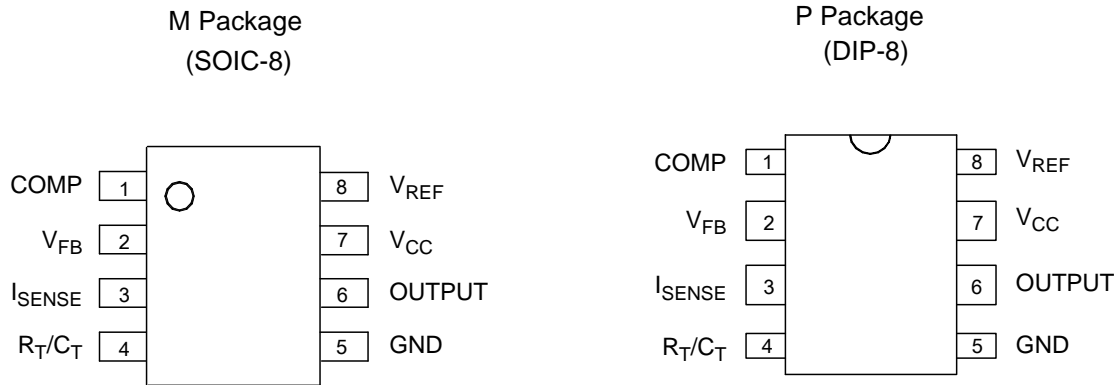


Figure 2. Pin Configuration of AP3842C/3C/4C/5C (Top View)

Pin Description

| Pin Number | Pin Name | Function |
|------------|--------------------------------|---|
| 1 | COMP | This pin is the Error Amplifier output and is made available for loop compensation. |
| 2 | V _{FB} | The inverting input of the Error Amplifier. It is normally connected to the switching power supply output through a resistor divider. |
| 3 | I _{SENSE} | A voltage proportional to inductor current is connected to this input. The PWM uses this information to terminate the output switch conduction. |
| 4 | R _T /C _T | The Oscillator frequency and maximum output duty cycle are programmed by connecting resistor R _T to V _{REF} and capacitor C _T to ground. Operation to 500 kHz is possible. |
| 5 | GND | The combined control circuitry and power ground. |
| 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 | V _{CC} | The positive supply of the control IC. |
| 8 | V _{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

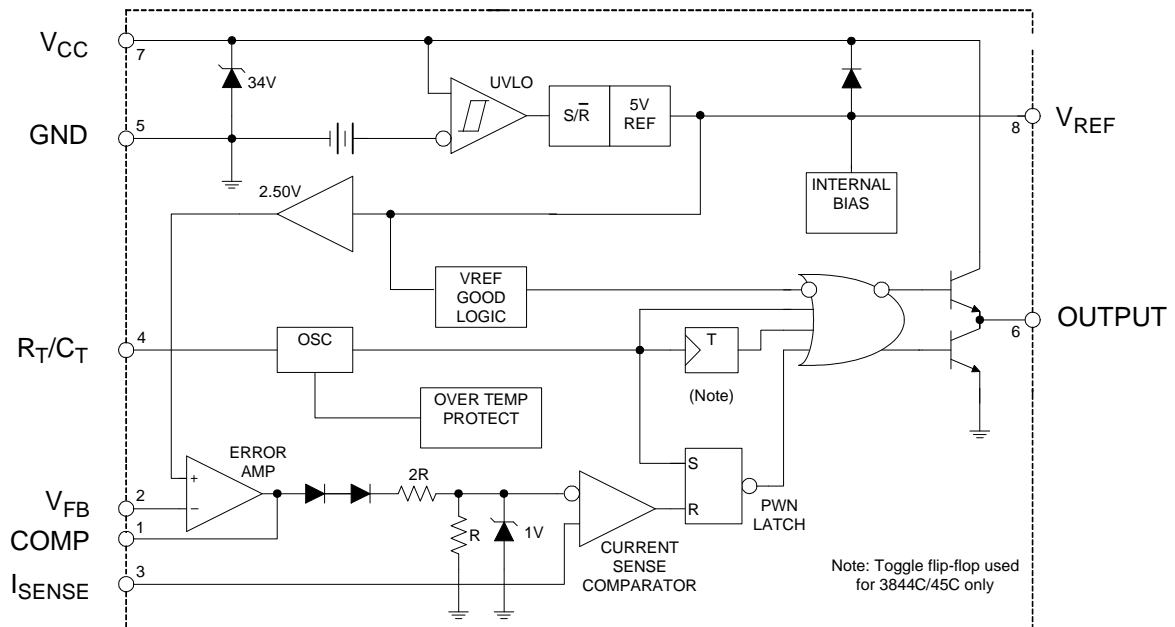


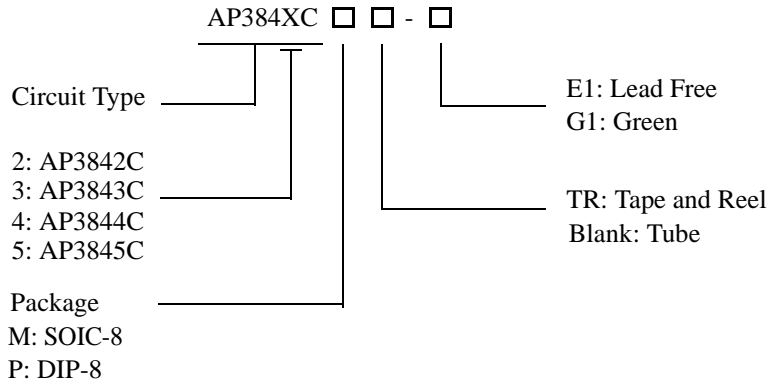
Figure 3. Functional Block Diagram of AP3842C/3C/4C/5C



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Ordering Information



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

**CURRENT MODE PWM CONTROLLER****AP384XC****Absolute Maximum Ratings (Note 1, 2)**

| Parameter | Symbol | Value | Unit | |
|--|-----------------|-------------|------------------|---------------------------|
| Supply Voltage | V_{CC} | 30 | V | |
| Output Current | I_O | ± 1 | A | |
| Analog Inputs | V(ANA) | -0.3 to 6.3 | V | |
| Error Amp Output Sink Current | $I_{SINK(E.A)}$ | 10 | 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 | |
| Junction Operating Temperature | T_J | -40 to 150 | $^\circ\text{C}$ | |
| Thermal Resistance (Junction to Ambient) | θ_{JA} | DIP-8 | 140 | $^\circ\text{C}/\text{W}$ |
| | | SOIC-8 | 160 | $^\circ\text{C}/\text{W}$ |
| Storage Temperature Range | T_{STG} | -65 to 150 | $^\circ\text{C}$ | |
| Lead Temperature (Soldering, 10sec) | T_{LEAD} | +300 | $^\circ\text{C}$ | |
| ESD (Machine Model) | | 250 | 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 5 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} | $T_A=25^\circ C$, $I_{REF}=1mA$ | 4.90 | 5.00 | 5.10 | V |
| Total Output Variation | | Line, Load, Temp. | 4.82 | | 5.18 | 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/ $^\circ C$ |
| OSCILLATOR SECTION | | | | | | |
| Oscillation Frequency | f | $T_A=25^\circ C$ | 47 | 52 | 57 | KHz |
| Oscillator Amplitude | V_{OSC} | Pin 4, peak to peak (Note 6) | | 1.7 | | V |
| Temperature Stability | | (Note 6) | | 2.5 | | % |
| Voltage Stability | | $12V \leq V_{CC} \leq 25V$ | | 0.2 | 1 | % |
| Discharge Current | | Vpin 4 = 2V (Note 7) | 8.5 | 9.5 | 10.5 | mA |
| ERROR AMPLIFIER SECTION | | | | | | |
| Input Voltage | V_I | Vpin 1=2.5V | 2.45 | 2.50 | 2.55 | V |
| Output Sink Current | I_{SINK} | Vpin1=1.1V | 5 | 8 | | mA |
| Output Source Current | I_{SOURCE} | Vpin1=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 8 | | 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 | $V_I(MAX)$ | Vpin1=5V (Note 4) | 0.9 | 1 | 1.1 | V |
| Gain | GV | (Note 4, 5) | 2.85 | 3 | 3.15 | V/V |
| Power Supply Rejection Ratio | PSRR | $12V \leq V_{CC} \leq 25V$ (Note 4, 6) | | 70 | | dB |
| Delay to Output | | Vpin3 = 0 to 2V (Note 6) | | 150 | 300 | ns |
| Input Bias Current | I_{BIAS} | | | -3 | -10 | μA |
| OUTPUT SECTION | | | | | | |
| Low Output Voltage | V_{OL} | $I_{SINK} = 20mA$ | | 0.1 | 0.4 | V |
| | | $I_{SINK} = 200mA$ | | 1.4 | 2.2 | V |
| High Output Voltage | V_{OH} | $I_{SOURCE} = 20mA$ | 13 | 14 | | V |
| | | $I_{SOURCE} = 200mA$ | 12 | 13 | | V |
| Rise Time | t_R | $T_A=25^\circ C$, $C_L=1nF$ (Note 6) | | 50 | 150 | ns |
| Fall Time | t_F | $T_A=25^\circ C$, $C_L=1nF$ (Note 6) | | 50 | 150 | ns |

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Electrical Characteristics (Continued)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---------------------|--------------------------------|-----|------|------|-------------|
| UNDER -VOLTAGE LOCKOUT SECTION | | | | | | |
| Start Threshold | $V_{TH(ST)}$ | AP3842C/AP3844C | 15 | 16 | 17 | V |
| | | AP3843C/AP3845C | 7.8 | 8.4 | 9.0 | V |
| Min. Operation Voltage (After Turn On) | V_{OPR} (Min.) | AP3842C/AP3844C | 8.5 | 10.0 | 11.5 | V |
| | | AP3843C/AP3845C | 7.0 | 7.6 | 8.2 | V |
| PWM SECTION | | | | | | |
| Max. Duty Cycle | D(Max.) | AP3842C/AP3843C | 95 | 97 | 100 | % |
| | D(Max.) | AP3844C/AP3845C | 46 | 48 | 50 | % |
| Min. Duty Cycle | D(Min.) | | | | 0 | % |
| TOTAL STANDBY CURRENT SECTION | | | | | | |
| Start-up Current | I_{ST} | AP3842C/AP3844C, $V_{CC}=14V$ | | 50 | 80 | μA |
| | | AP3843C/AP3845C, $V_{CC}=6.5V$ | | 50 | 80 | |
| Operating Supply Current | $I_{CC(OPR)}$ | $V_{pin3}=V_{pin2}=0V$ | | 8 | 12 | mA |
| Zener Voltage | V_Z | $I_{CC}=25mA$ | 30 | 34 | | V |
| OVER-TEMPERATURE PROTECT SECTION | | | | | | |
| Shutdown Temperature | T_{SHUT} | (Note 6) | | 155 | | $^{\circ}C$ |
| Temperature Hysteresis | T_{HYS} | (Note 6) | | 25 | | $^{\circ}C$ |

Note 4: Parameters are tested at trip point of latch with $V_{pin2} = 0$.

Note 5: Here gain is defined as:

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

Note 6: These parameters, although guaranteed, are not 100% tested in production.

Note 7: 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.

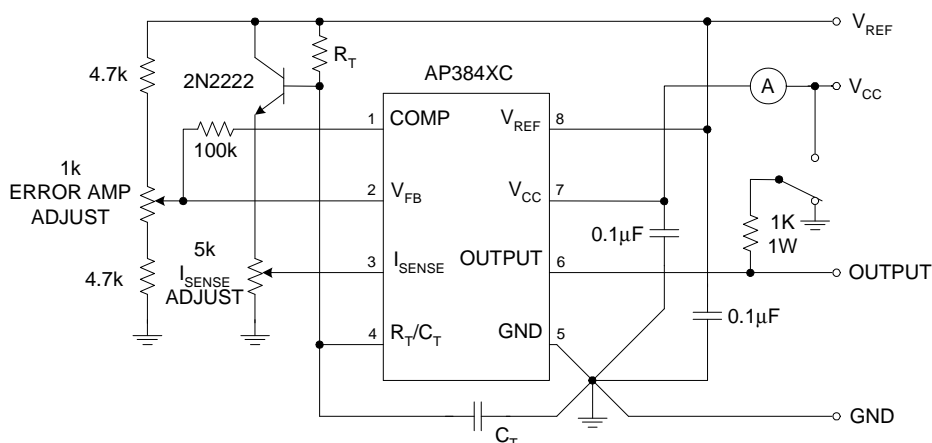


Figure 4. Basic Test Circuit



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Electrical Characteristics (Continued)

Figure 4 is the basic test circuit for AP384XC. 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.

Typical Performance Characteristics

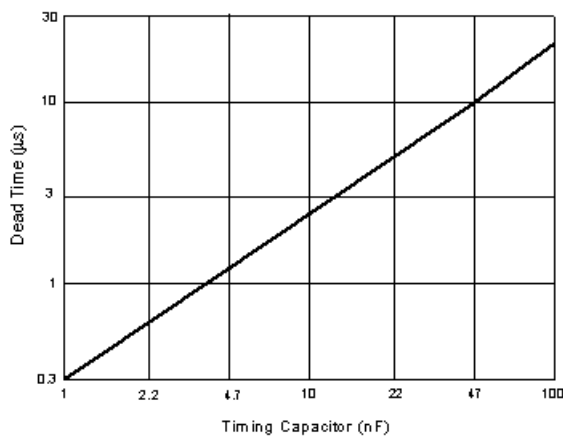


Figure 5. Oscillator Dead Time vs. Timing Capacitor

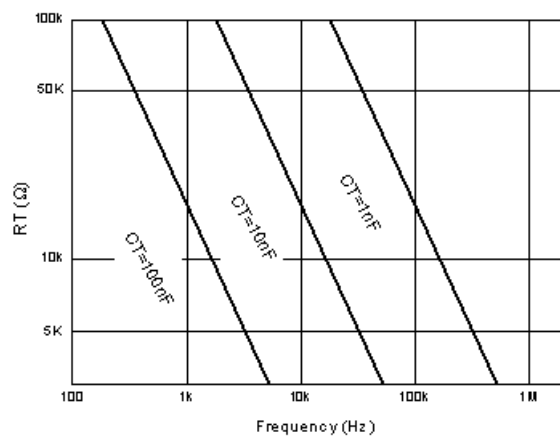


Figure 6. Timing Resistor vs. Frequency

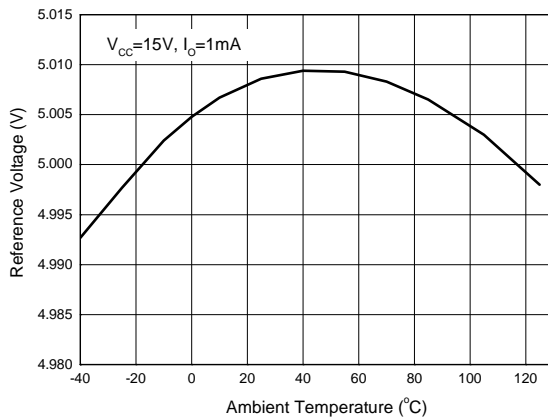


Figure 7. Reference Voltage vs. Ambient Temperature

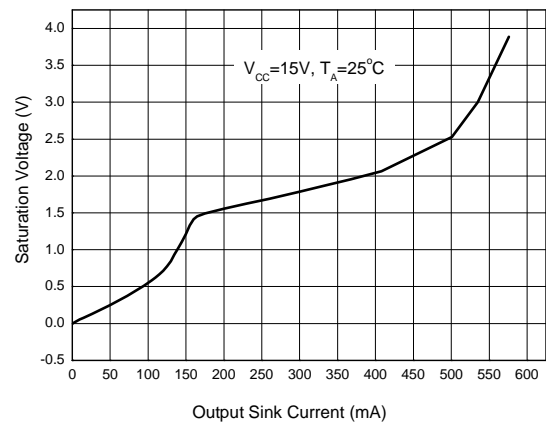


Figure 8. Output Saturation Characteristics



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Typical Performance Characteristics (Continued)

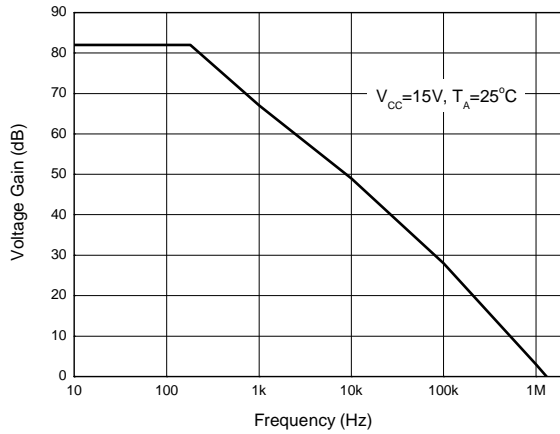


Figure 9. Error Amplifier Open-Loop Frequency Response

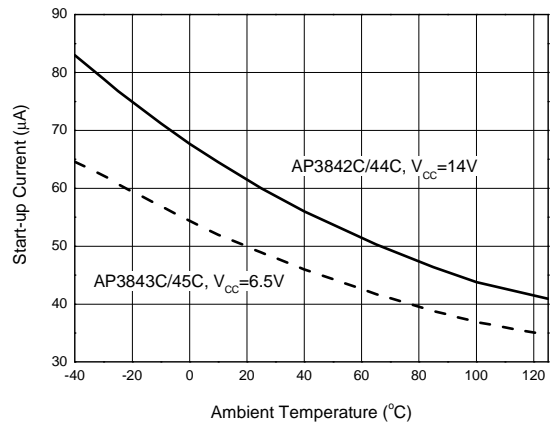


Figure 10. Start-up Current vs. Ambient Temperature

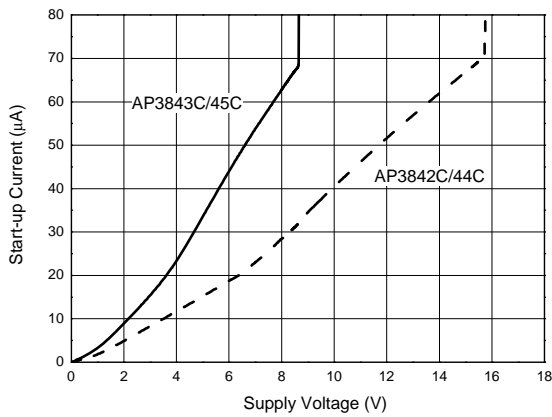


Figure 11. Start-up Current vs. Supply Voltage

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Typical Application

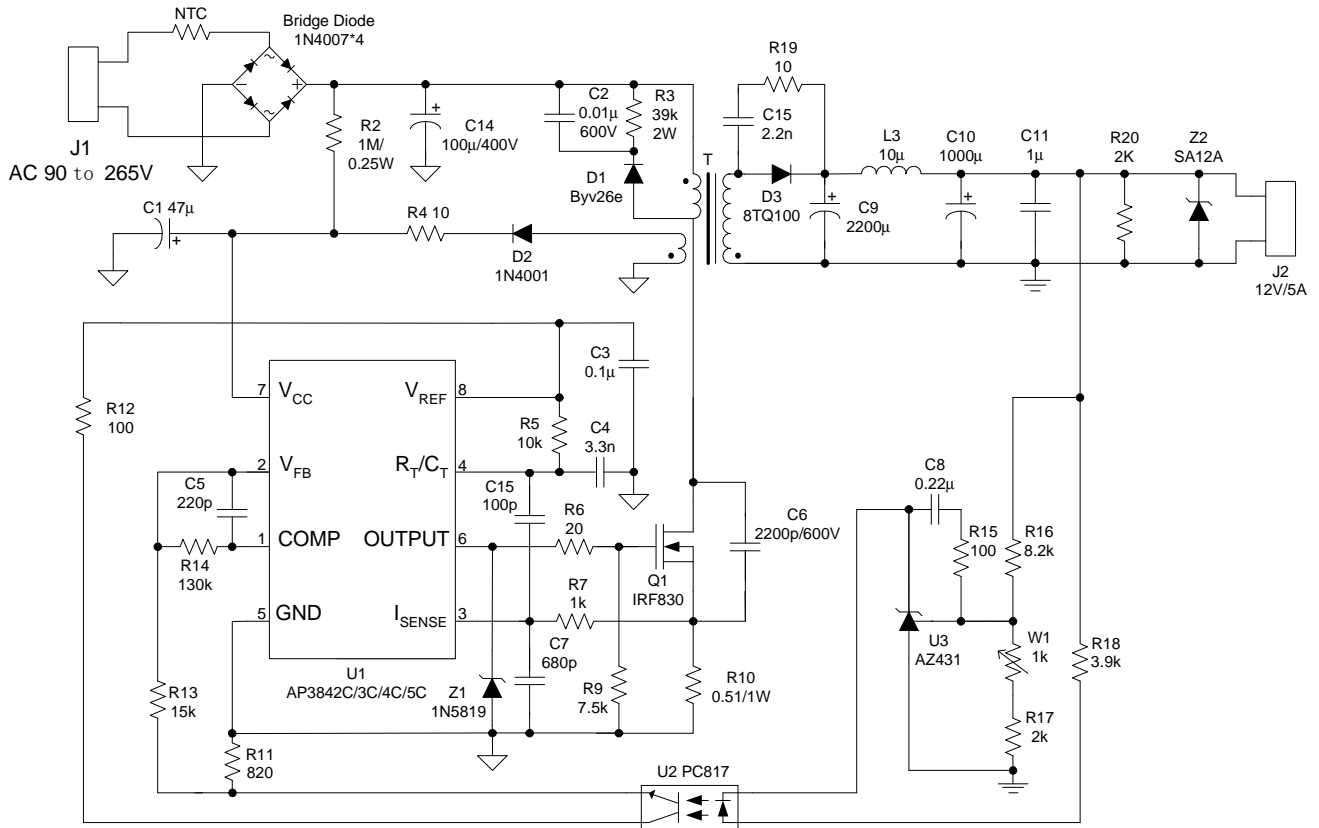


Figure 12. Typical Application of AP3842C/3C/4C/5C



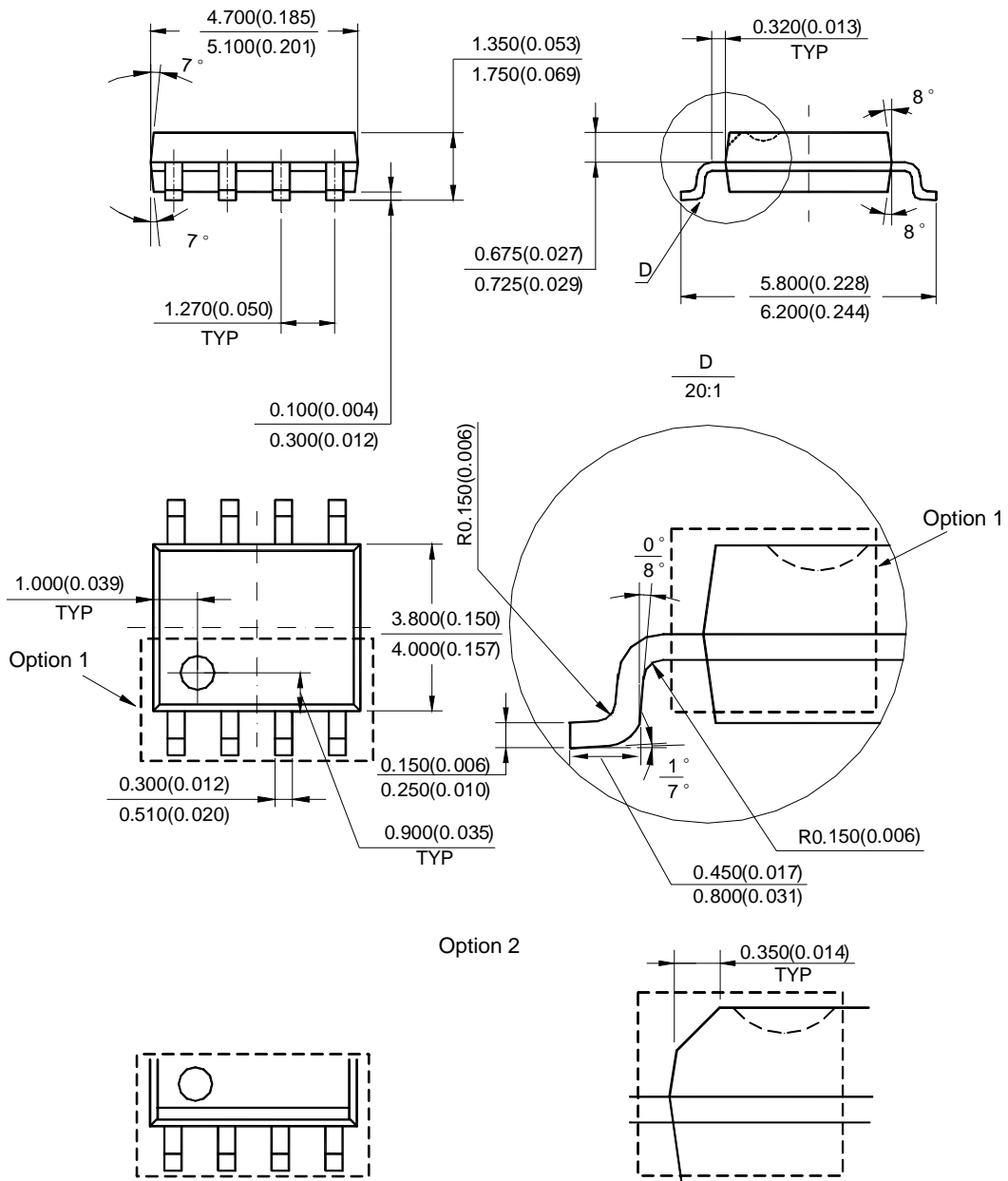
CURRENT MODE PWM CONTROLLER

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Mechanical Dimensions

SOIC-8

Unit: mm(inch)



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



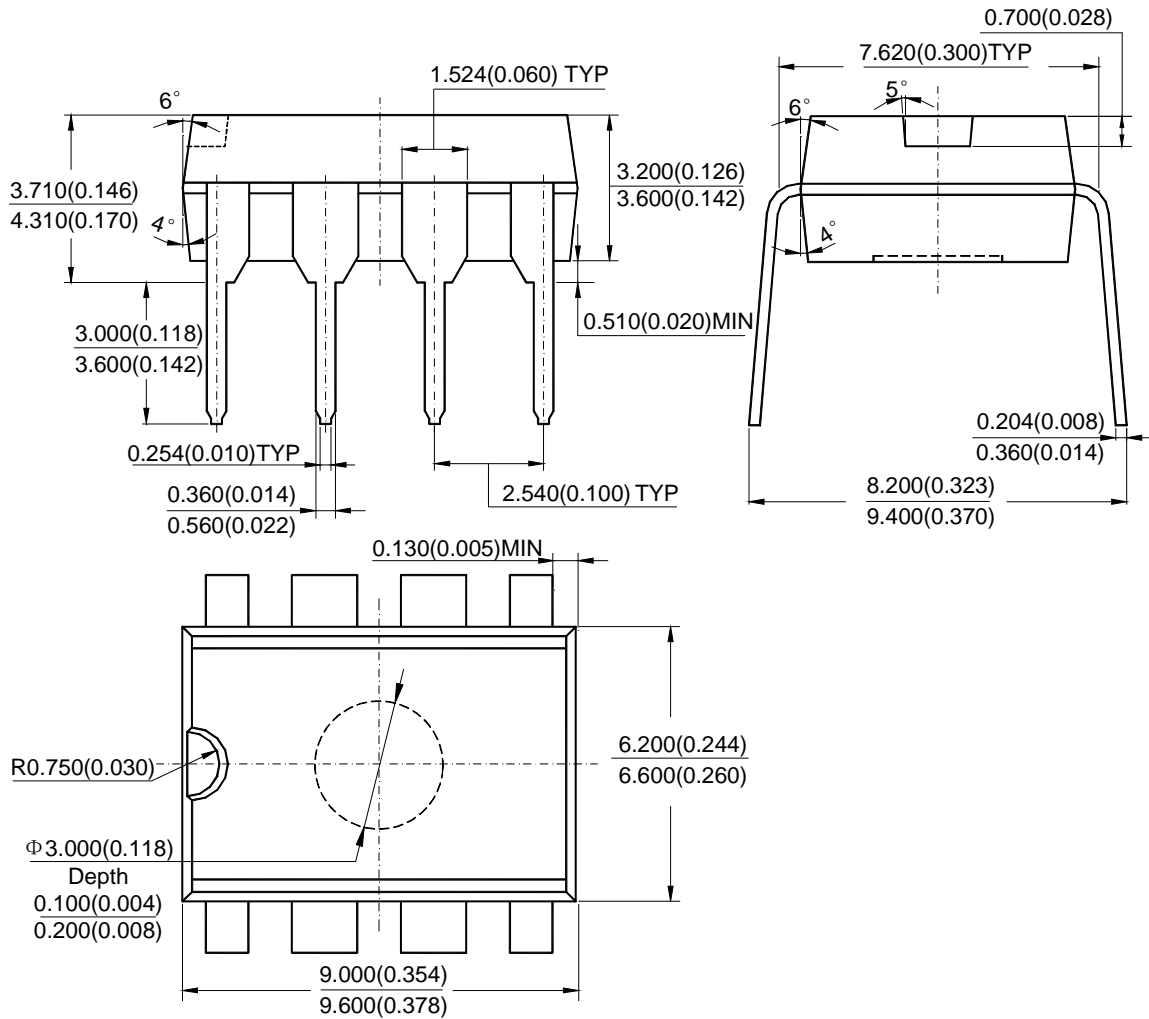
CURRENT MODE PWM CONTROLLER

AP384XC

Mechanical Dimensions (Continued)

DIP-8

Unit: mm(inch)

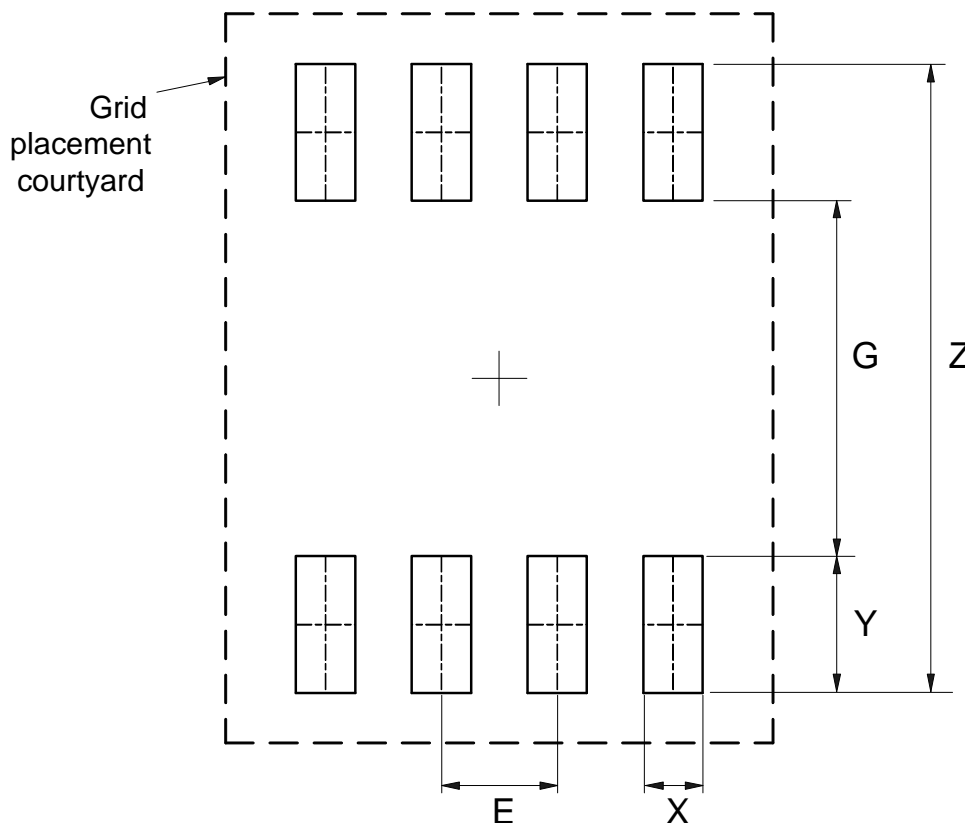


Note: Eject hole, oriented hole and mold mark is optional.

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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