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/ ^{o}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

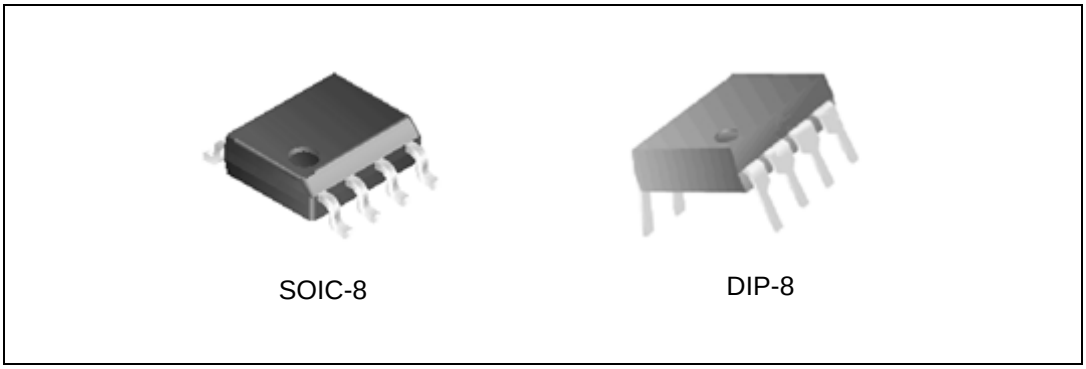


Figure 1. Package Types of AP3842C/3C/4C/5C

Pin Configuration

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

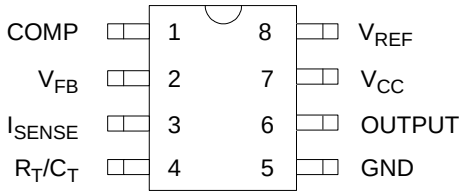


Figure 2. Pin Configuration of AP3842C/3C/4C/5C (Top View)

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.

Functional Block Diagram

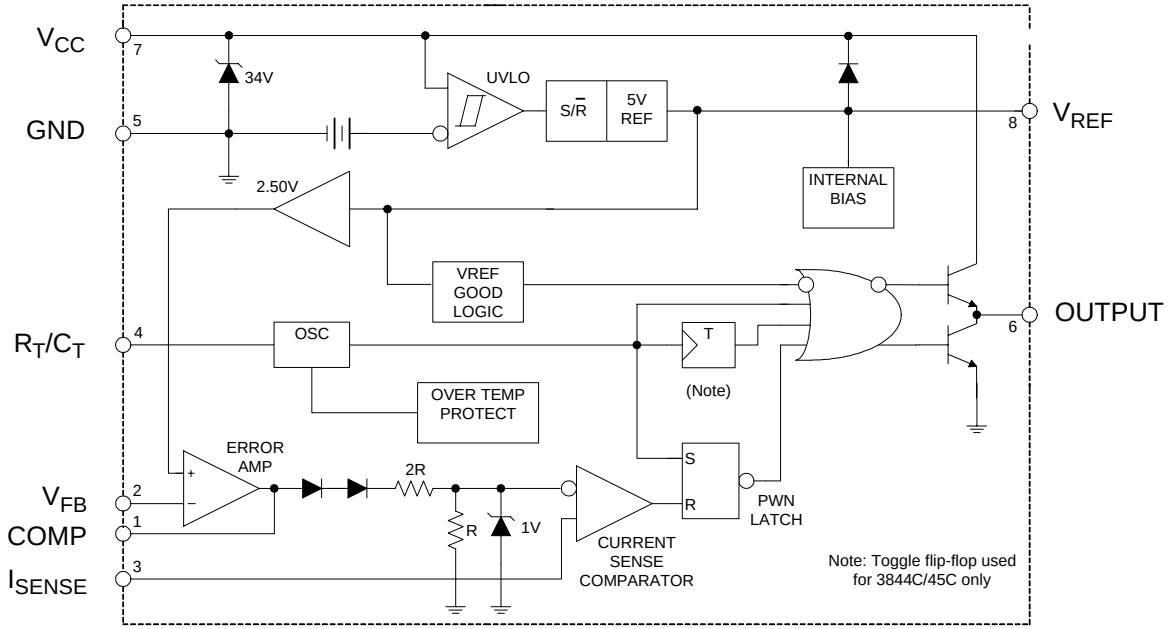
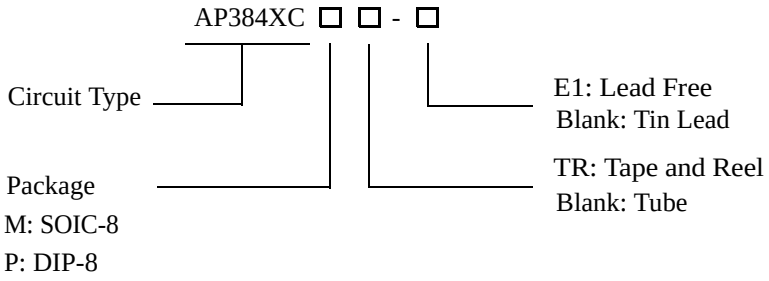


Figure 3. Functional Block Diagram of AP3842C/3C/4C/5C

Ordering Information



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

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

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 °C (DIP-8)		P_D (Note 3)	1000	mW
Power Dissipation at T_A<25 °C (SOIC-8)		P_D (Note 3)	460	mW
Junction Operating Temperature		T_J	-40 to 150	°C
Thermal Resistance (Junction to Ambient)	DIP-8	$R_{\theta JA}$	140	°C/W
	SOIC-8		160	°C/W
Storage Temperature Range		T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10sec)		T_{LEAD}	+300	°C
ESD (Machine Mode)			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	°C

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	4.90	5.00	5.10	V
Total Output Variation		Line, Load, Temp.	4.82		5.18	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
OSCILLATOR SECTION						
Oscillation Frequency	f	T_J=25°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 ⩽ V_{CC} ⩽ 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}	RL=15kΩ to GND	5	7		V
Low Output Voltage	V_{OL}	RL=15kΩ to pin 8		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)	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 ≤ V_{CC} ≤ 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_J=25°C, C_L=1nF (Note 6)		50	150	ns
Fall Time	t_F	T_J=25°C, C_L=1nF (Note 6)		50	150	ns

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}			50	80	μA
Operating Supply Current	I_{CC}(OPR)	Vpin3=Vpin2=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		°C
Temperature Hysteresis	T_{HYS}	(Note 6)		25		°C

Note 4: Parameters are tested at trip point of latch with Vpin2 = 0.
Note 5: Here gain is defined as:

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

Note 6: These parameters, although guaranteed, are not 100% tested in production.
Note 7: 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.

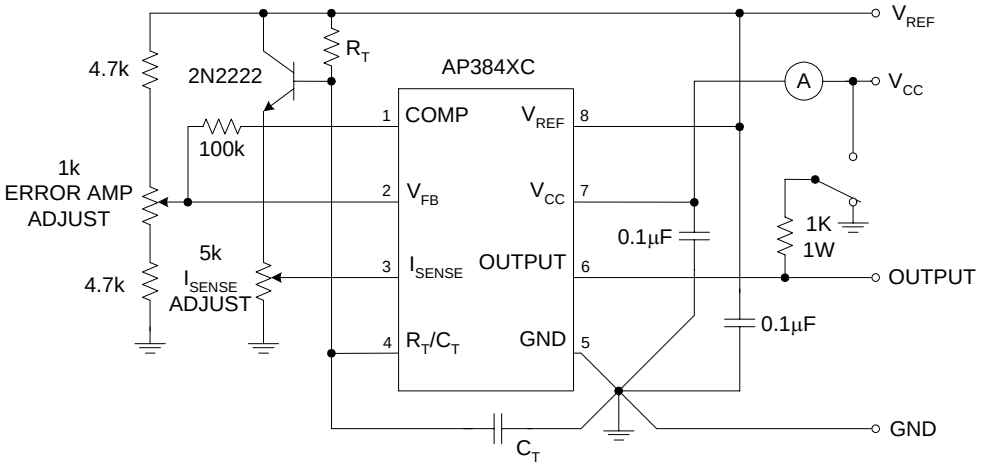


Figure 4. Basic Test Circuit

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

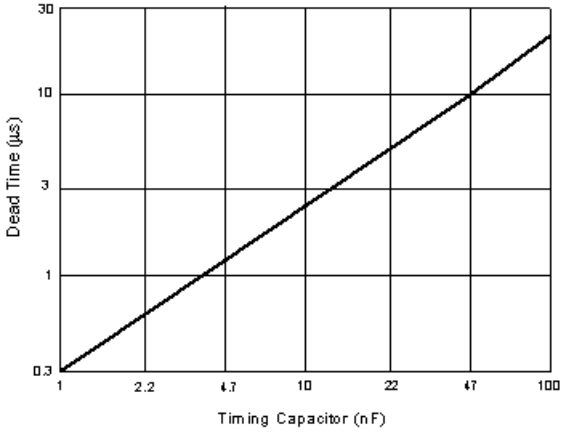


Figure 5. Oscillator Dead Time vs. Timing Capacitor

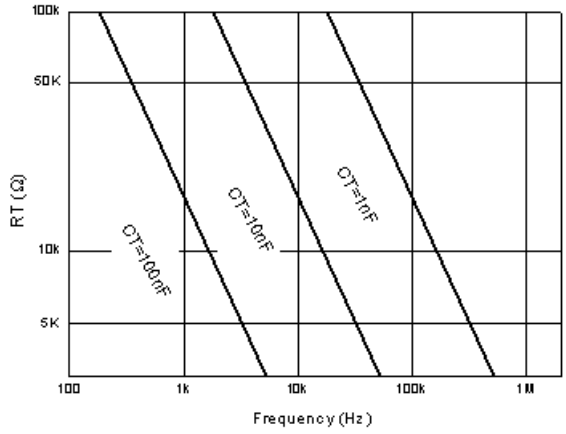


Figure 6. Timing Resistor vs. Frequency

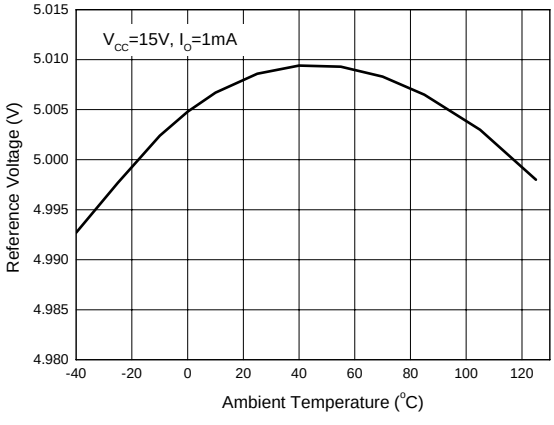


Figure 7. Reference Voltage vs. Ambient Temperature

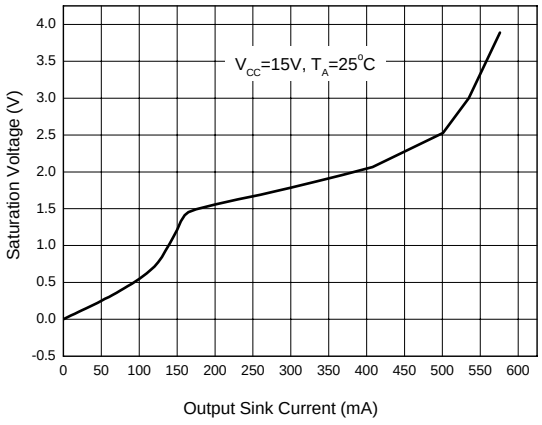


Figure 8. Output Saturation Characteristics

Typical Performance Characteristics (Continued)

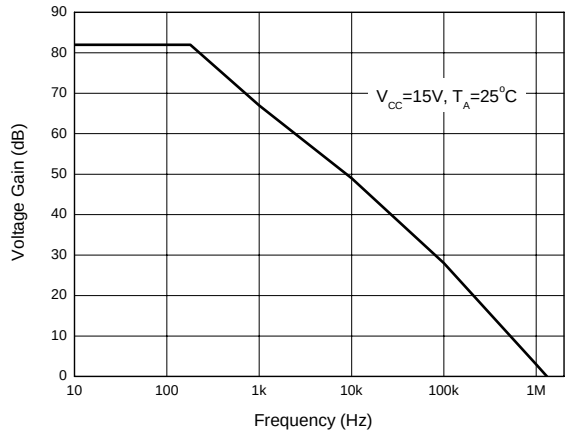


Figure 9. Error Amplifier Open-Loop Frequency Response

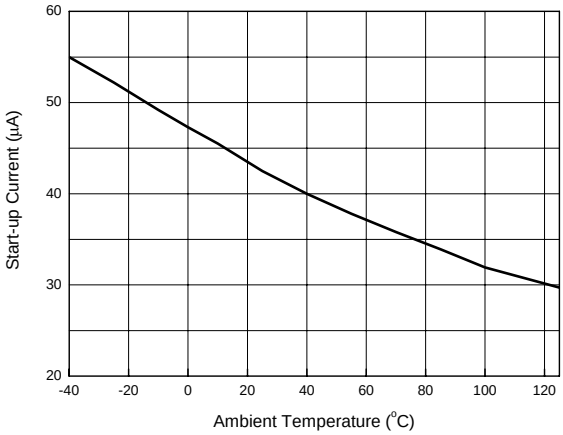


Figure 10. Start-up Current vs. Ambient Temperature

Typical Application

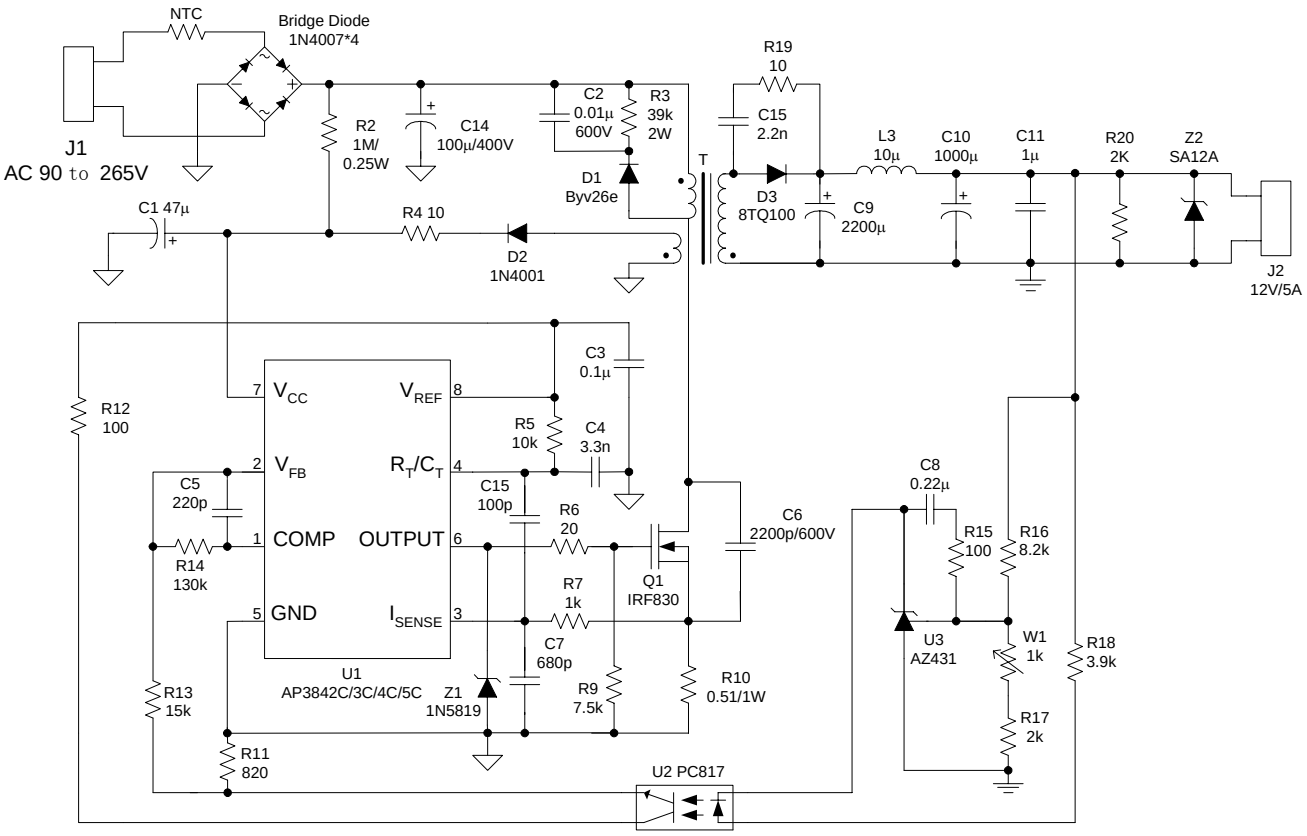
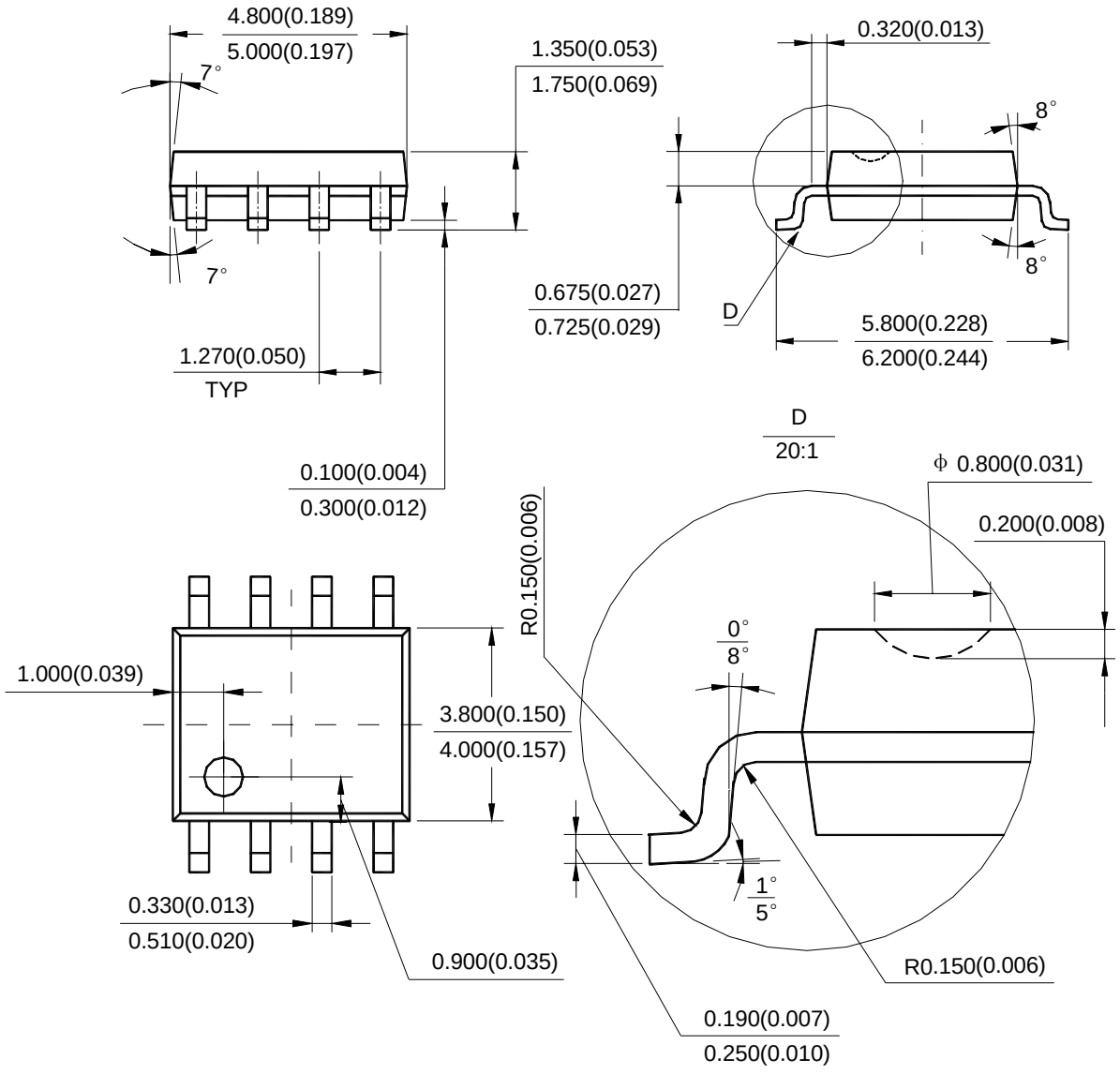


Figure 11. Typical Application of AP3842C/3C/4C/5C

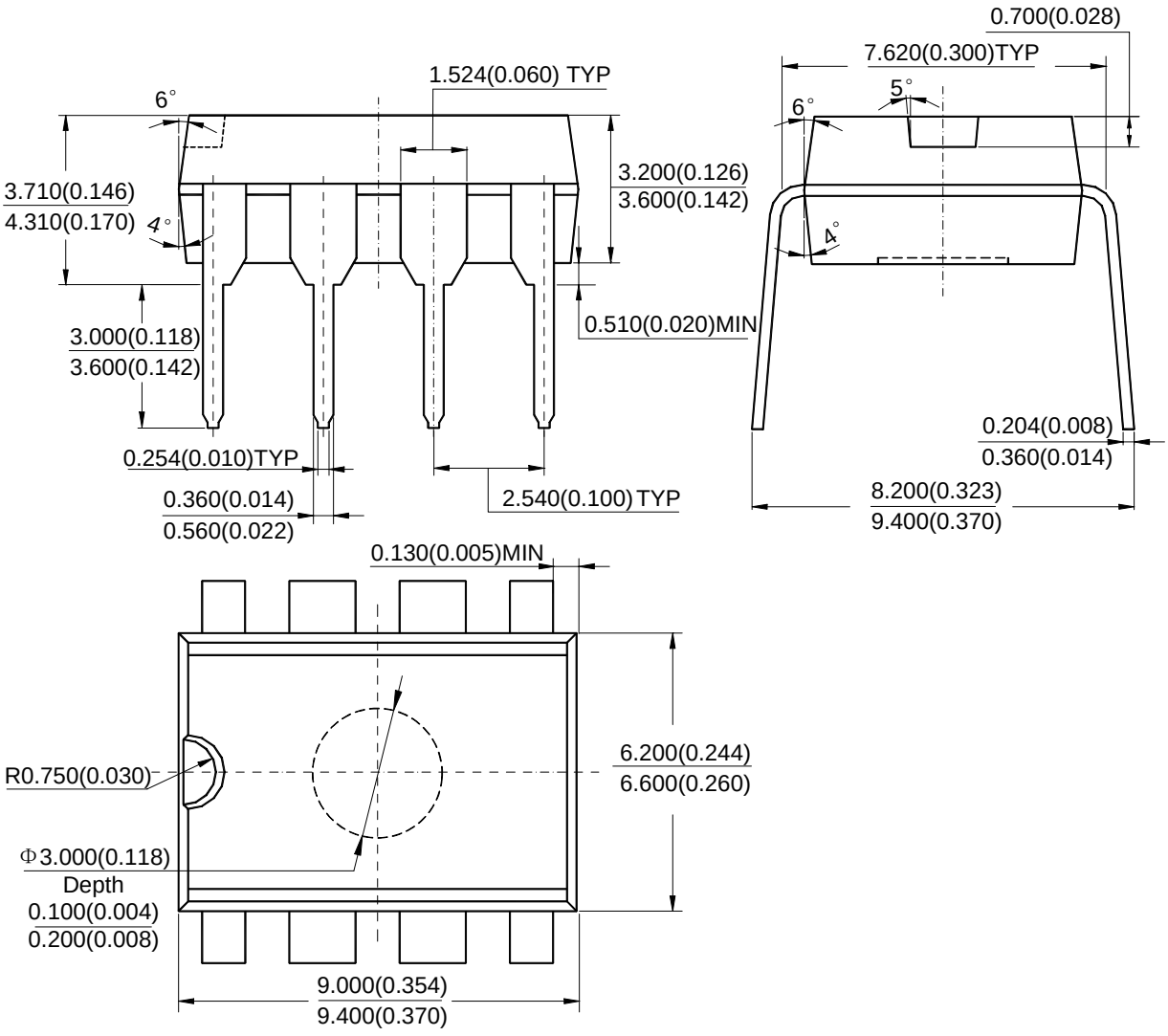
Mechanical Dimensions

SOIC-8 **Unit: mm(inch)**



Mechanical Dimensions (Continued)

DIP-8 **Unit: mm(inch)**





BCD Semiconductor Manufacturing Limited

http://www.bcdsemi.com

IMPORTANT NOTICE

BCD Semiconductor Manufacturing Limited reserves the right to make changes without further notice to any products or specifications herein. BCD Semiconductor Manufacturing Limited does not assume any responsibility for use of any its products for any particular purpose, nor does BCD Semiconductor Manufacturing Limited assume any liability arising out of the application or use of any its products or circuits. BCD Semiconductor Manufacturing Limited does not convey any license under its patent rights or other rights nor the rights of others.

MAIN SITE

BCD Semiconductor Manufacturing Limited
- Wafer Fab
Shanghai SIM-BCD Semiconductor Manufacturing Limited
800, Yi Shan Road, Shanghai 200233, China
Tel: +86-21-6485 1491, Fax: +86-21-5450 0008

BCD Semiconductor Manufacturing Limited
- IC Design Group
Advanced Analog Circuits (Shanghai) Corporation
8F, Zone B, 900, Yi Shan Road, Shanghai 200233, China
Tel: +86-21-6495 9539, Fax: +86-21-6485 9673

REGIONAL SALES OFFICE

Shenzhen Office
Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd. Shenzhen Office
Advanced Analog Circuits (Shanghai) Corporation Shenzhen Office
Room E, 5F, Noble Center, No.1006, 3rd Fuzhong Road, Futian District, Shenzhen 518026, China
Tel: +86-755-8826 7951, Fax: +86-755-8826 7865

Taiwan Office
BCD Semiconductor (Taiwan) Company Limited
4F, 298-1, Rui Guang Road, Nei-Hu District, Taipei, Taiwan
Tel: +886-2-2656 2808, Fax: +886-2-2656 2806

USA Office
BCD Semiconductor Corporation
3170 De La Cruz Blvd., Suite 105, Santa Clara,
CA 95054-2411, U.S.A