

# Current-Mode PWM Controller

## FEATURES

- Low Start-Up Current (300µA Typical)
- Internal Precision Reference.
- 500KHz Current-Mode Operation.
- Pulse-by-Pulse Current Limiting.
- Automatic Feed-Forward Compensation.
- Optimized for Off-Line and DC/DC Converters.
- Undervoltage Lockout with Hysteresis.
- Double Pulse Suppression.
- High Current Totem-Pole Output.

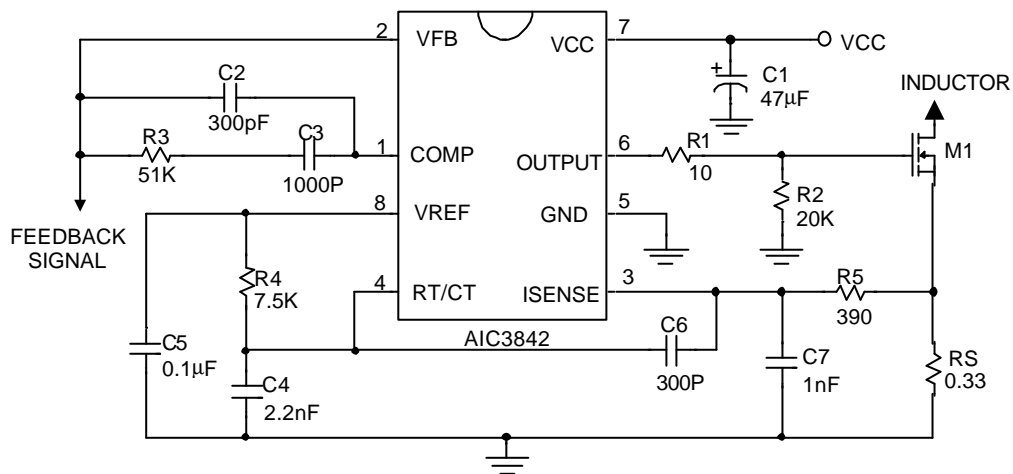
## APPLICATIONS

- Off-Line Converter.
- DC/DC Converter.

## DESCRIPTION

The AIC3842 control IC provides the features that are necessary to implement off-line or DC/DC Converter fixed-frequency current-mode schemes with a minimum number of external components. This integrated circuits features an undervoltage lockout (UVLO) with approximately 300µA start-up current, a precision reference trimmed for accuracy at the error amplifier input, high gain error amplifier, current sensing comparator, logic to insure latched operation, and a totem-pole output stage designed to source or sink high peak current. The output stage, suitable for driving N channel MOSFETs, is low in the off state.

## TYPICAL APPLICATION CIRCUIT

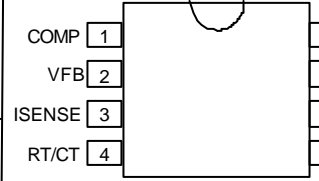
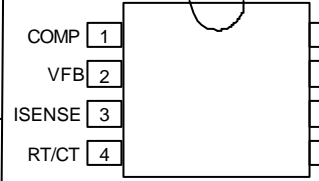


Current Mode PWM Control Circuit

## ORDERING INFORMATION

AIC3842CX

PACKAGE TYPE  
N: PLASTIC DIP  
S: SMALL OUTLINE

ORDER NUMBER	PIN CONFIGURATION
AIC3842CN (PLASTIC DIP)	
AIC3842CS (PLASTIC SO)	

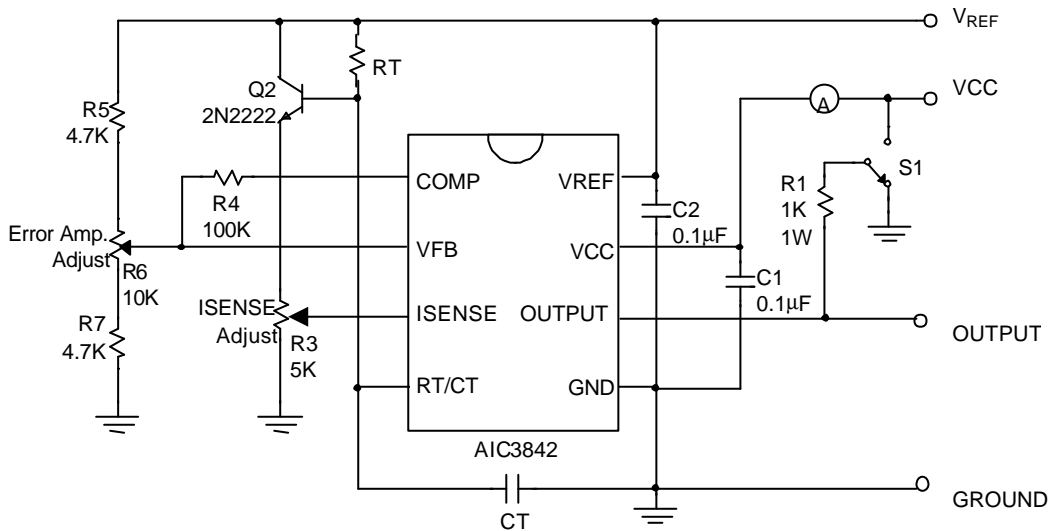
## ■ ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Low Impedance Source)	.....	30V
Supply Voltage ( $I_{CC} < 300\text{mA}$ )	.....	Self Limiting
Output Current	.....	$\pm 1\text{A}$
Output Energy (Capacitive Load)	.....	$5\mu\text{J}$
Analog Inputs (Pins 2, 3)	.....	-0.3V to +6.3V
Error Amp Output Sink Current	.....	10mA
Operation Temperature Range	.....	-40°C~85°C
Power Dissipation at $T_A \leq 25^\circ\text{C}$	DIP Package .....	1W
	SOIC Package .....	725mW
Storage Temperature Range	.....	-65°C to +150°C
Lead Temperature (Soldering, 10 seconds)	.....	300°C

Note 1: All voltages are with respect to Pin 5.

All currents are positive into the specified terminal.

## ■ TEST CIRCUIT



**ELECTRICAL CHARACTERISTICS** { $V_{CC}=15V$  (see Note 2),  $T_A=25^\circ C$ , unless otherwise specified.}

PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Reference Section</b>					
Output Voltage	$I_o=1mA$	4.9	5	5.1	V
Line Regulation	$V_{CC}=12V$ to $25V$		5	20	mV
Load Regulation	$I_o=1mA$ to $20mA$		5	25	mV
Temperature Coefficient of Output Voltage			0.2		mV/ $^\circ C$
Output Noise Voltage	$f=10Hz$ to $10KHz$		50		$\mu V$
Output Voltage Long-Term Drift	After 1000H at $T_A=25^\circ C$		5		mV
Short-Circuit Output Current			85		mA
<b>Oscillator Section</b>					
Oscillator Frequency (see Note 3)		47	52	57	KHz
Frequency Change with Supply Voltage	$V_{CC}=12V$ to $25V$		0.2		%
Frequency Change with Temperature	$T_A=T_{LOW}$ to $T_{HIGH}$		5		%
Peak-to-Peak Amplitude at RT/CT			1.7		V
<b>Error Amplifier Section</b>					
Feedback Input Voltage	COMP at $2.5V$	2.42	2.50	2.58	V
Input Bias Current			-0.3		$\mu A$
Open-Loop Voltage Amplification	$V_o=2V$ to $4V$		90		dB
Gain-Bandwidth Product			1		MHz
Supply Voltage Rejection Ratio	$V_{CC}=12V$ to $25V$		70		dB
Output Sink Current	$V_{FB}$ at $2.7V$ , COMP at $1.1V$		10		mA
Output Source Current	$V_{FB}$ at $2.3V$ , COMP at $5V$		1		mA
High-Level Output Voltage	$V_{FB}$ at $2.3V$ , $R_1=15K\Omega$ to GND		6.2		V
Low-Level Output Voltage	$V_{FB}$ at $2.7V$ , $R_1=15\Omega$ to VREF		0.8		V

**ELECTRICAL CHARACTERISTICS (Continued)**

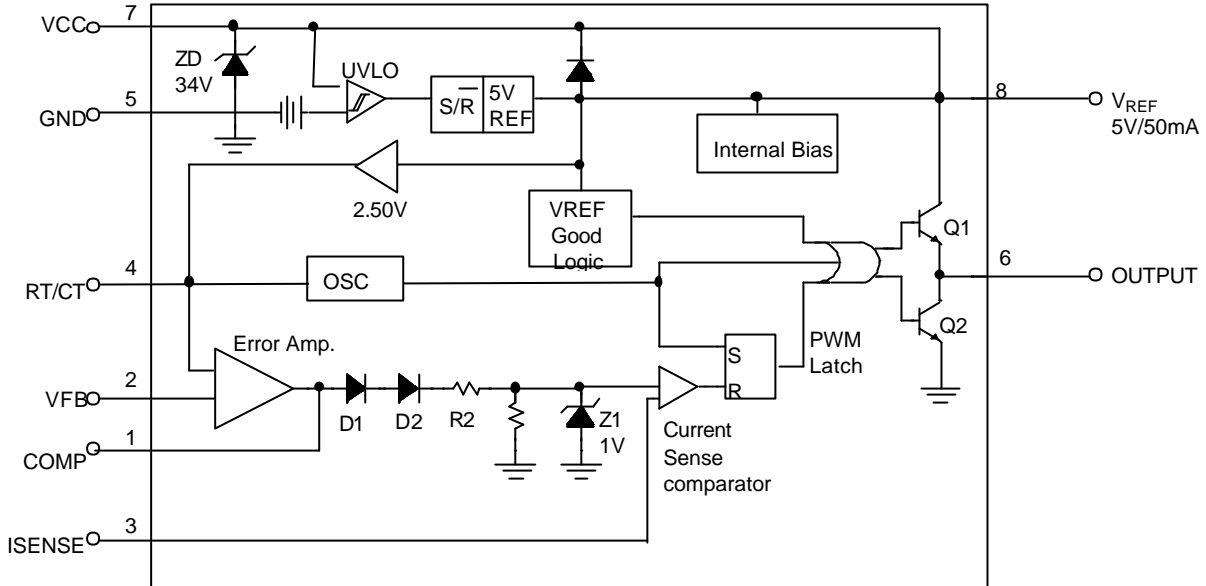
PARAMETERS	CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Current Sense Section</b>					
Voltage Amplification	See Note 3 and 4		3		V/V
Current Sense Comparator Threshold	COMP at 5V, See Note 3		1		V
Supply Voltage Rejection Ratio	V <sub>CC</sub> =12V to 25V, See Note 3		70		dB
Input Bias Current			-2		μA
Delay Time to Output			150		nS
<b>Output Section</b>					
High-Level Output Voltage	I <sub>SOURCE</sub> =20mA		13.5		V
	I <sub>SOURCE</sub> =200mA		13.4		V
Low-Level Output Voltage	I <sub>SINK</sub> =20mA		0.1		V
	I <sub>SINK</sub> =200mA		1.5		V
Rise Time	C <sub>L</sub> =1nF		50		nS
Fall Time	C <sub>L</sub> =1nF		50		nS
<b>Undervoltage Lockout Section</b>					
Start Threshold Voltage		14.5	16	17.5	V
Minimum Operating Voltage after Start-Up		8.5	10	11.5	V
<b>Pulse-Width-Modulator Section</b>					
Maximum Duty Cycle			96		%
Minimum Duty Cycle				0	%
<b>Supply Voltage</b>					
Start-Up Current			0.3	0.5	mA
Operating Supply Current	V <sub>FB</sub> and I <sub>SENSE</sub> at 0V		12	17	mA
Limiting Voltage	I <sub>CC</sub> =25mA		34		V

Note: 2: Adjust VCC above the start threshold before setting it to 15V.

3. These parameters are measured at the trip point of the latch with VFB at 0V.

4. Voltage amplification is measured between ISENSE and COMP with the input changing from 0V to 0.8V.

## ■ BLOCK DIAGRAM



## ■ PIN DESCRIPTIONS

- |   |   |
|---|---|
| <p><b>PIN 1: COMP</b> - This pin is the error amplifier output and is made available for loop compensation.</p>   | <p><b>PIN 5: GND-</b> This pin is the combined control circuitry and power ground.</p>  |
| <p><b>PIN 2: VFB</b> - This is the inverting input of the error amplifier. It is normally connected to the switching power supply output through a resistor divider.</p>  | <p><b>PIN 6: OUTPUT-</b> This output directly drives the gate of a power MOSFET. Peak currents up to 1A are sourced and sunk by this pin.</p> |
| <p><b>PIN 3: ISENSE</b> - A voltage proportional to inductor current is connected to this input. The PWM uses this information to terminate the output switch conduction.</p>   | <p><b>PIN 7: VCC -</b> This pin is the positive supply of the control IC.</p>   |
| <p><b>PIN 4: RT/CT</b> - The oscillator frequency and maximum output duty cycle are programmed by connecting resistor <math>R_T</math> to <math>V_{REF}</math> and capacitor <math>C_T</math> to ground. Operation to 500KHz is feasible.</p> | <p><b>PIN 8: VREF -</b> This is the reference output. It provides charging current for capacitor CT through resistor RT.</p>                  |

## ■ APPLICATION INFORMATIONS

### ● Undervoltage Lockout

There are two separate undervoltage lockout comparators incorporated to make sure that the IC is fully functional before the output stage is enabled. One is for power supply voltage (VCC) and the other is for reference output voltage (VREF). Each has a built in hysteresis to prevent erratic output behavior when their respective thresholds are crossed. For VCC comparator the upper and lower thresholds are 16V and 10V, respectively. For VREF compactor the upper and lower threshold are 3.6V and 3.4V, respectively. The large hysteresis and low start up current (0.3mA) of the AIC3842 make it ideally suited in off-line converter applications where efficient bootstrap startup techniques are required. A 34V zener is connected as a shunt regulator from VCC to ground. Its purpose is to protect the IC from excessive voltage that can occur during system start-up.

### Reference Output

The 5.0V reference output is trimmed to  $\pm 2.0\%$  tolerance at  $T_A=25^\circ\text{C}$ . It supplies charging current to the oscillator timing capacitor and is capable of providing current in excess of 20mA for powering additional control system circuitry. In case of overload, the reference is short-circuit protected at about 85mA.

### Error Amplifier

A fully compensated error amplifier is provided with inverting input and output externally accessible. The noninverting input is internally biased at 2.5V. The converter output voltage is usually divided down and connected to the inverting input.

The output of the error amplifier is accessible for external loop compensation, with an offset at two diode drops ( $\approx 1.4\text{V}$ ) and divided by three, before connected to the inverting input of the current sense comparator. This guarantees that no drive pulse appears at the output (pin 6).

### Oscillator

The oscillator frequency can be programmed through the setting of timing components  $R_T$  and  $C_T$ . Capacitor  $C_T$  is charged from the 5.0V reference output through  $R_T$  to about 2.8V and discharged to about 1.2V by the internal discharge current. When  $C_T$  is discharged the output (pin 6) must be in the low state, thus producing a controlled amount of output deadtime. Note that many values of  $R_T$  and  $C_T$  can produce the same frequency but only one combination will yield a specific output deadtime at a given frequency.

### Current Sense Comparator and PWM Latch

The output switch of AIC3842 is initiated by the oscillator and terminated when the peak inductor current reaches the threshold level established by the error amplifier output (pin 1). The AIC3842 is operated at a current mode since the inductor current is monitored cycle-by-cycle and decides the duty cycle.

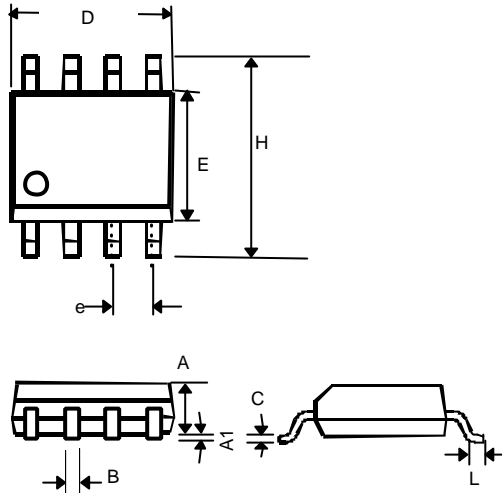
The inductor current is converted to a voltage by inserting the ground referenced sense resistor  $R_S$  in series with the source of output switch M1. This voltage is monitored by the current sense input (pin 3) and is compared to a level derived from the error amplifier output. In the normal operating conditions the peak inductor current is controlled by the voltage at pin 1 where

$$I_{PK} = \frac{V(\text{pin } 1) - 1.4\text{V}}{3R_S}$$

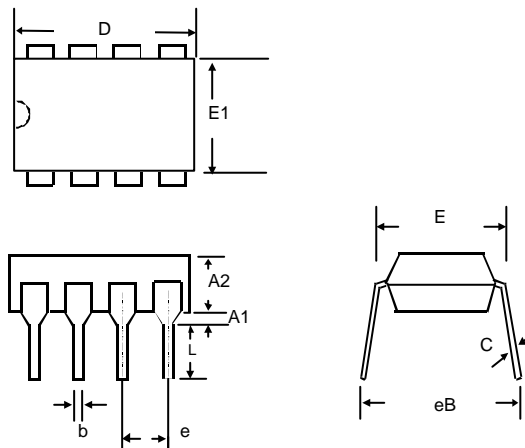
PWM Latch is used to ensure that only a single pulse appears at the output during any given oscillator cycle. However, a narrow spike on the leading edge of the current waveform can usually be observed and may cause the power supply to exhibit an instability when the output is tightly loaded.

### Output Switch

The AIC3842 contains a single totem-pole output stage that was specifically designed for direct drive of power MOSFET. If any undervoltage lockout is detected, internal circuitry will keep the output switch in a sinking current mode, no external pull down resistor is needed.

**PHYSICAL DIMENSIONS**
**● 8 LEAD PLASTIC SO (unit: mm)**


SYMBOL	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.33	0.51
C	0.19	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27(TYP)	
H	5.80	6.20
L	0.40	1.27

**● 8 LEAD PLASTIC DIP (unit: mm)**


SYMBOL	MIN	MAX
A1	0.381	—
A2	2.92	4.96
b	0.35	0.56
C	0.20	0.36
D	9.01	10.16
E	7.62	8.26
E1	6.09	7.12
e	2.54 (TYP)	
eB	—	10.92
L	2.92	3.81