

# KA3846

## SMPS Controller

### Features

- Automatic Feed Forward Compensation
- Programmable Pulse by Pulse Current Limiting
- Automatic Symmetry Correction in Push-Pull Configuration
- Enhanced Load Response Characteristics
- Parallel Operation Capability for Modulator Power Systems
- Differential Current Sense Amplifier with Common Mode Range
- Double Pulse Suppression
- 200mA Totem-Pole Outputs
- $\pm 2\%$  Band gap Reference
- Under-Voltage Lockout
- Soft-Start Capability
- Shutdown Terminal
- 500KHz Operation

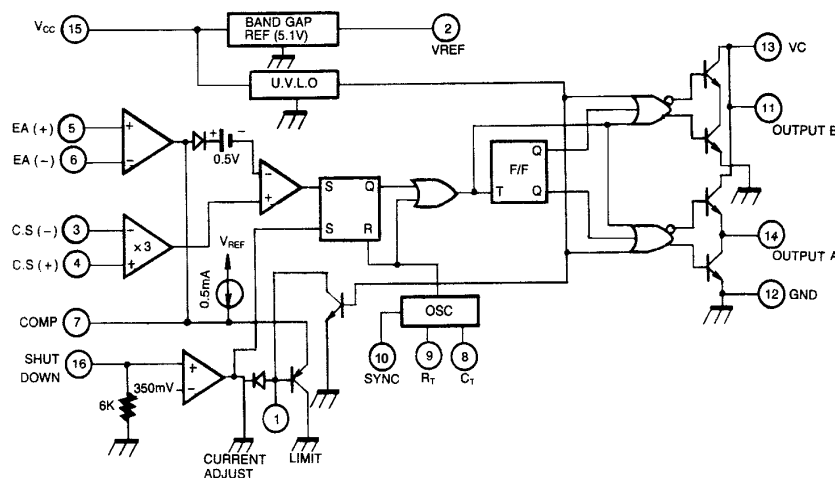
### Description

The KA3846 control IC provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to parallel "power module" while maintaining equal current sharing. Protection circuitry includes built-in-under-voltage lockout and programmable current limit in addition to soft-start capability. A shutdown function is also available which can initiate either a complete shutdown with automatic restart or latch the supply off. Other features include fully latched operation, double pulse suppression, deadtime adjust capability, and  $\pm 2\%$  trimmed bandgap reference. The KA3846 features low outputs in the OFF state.

16-DIP



### Internal Block Diagram



## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply Voltage	V <sub>CC</sub>	40	V
Collector Supply Voltage	V <sub>C</sub>	40	V
Output Current, Sink or Source (Peak)	I <sub>O</sub>	500	mA
Reference Output Current	I <sub>REF</sub>	30	mA
Soft Start Sink Current	I <sub>SINK(S.S)</sub>	50	mA
Sync Output Current	I <sub>SYNC</sub>	5	mA
Error Amplifier Output Current	I <sub>O(E.A)</sub>	5	mA
Oscillator Charging Current	I <sub>CHG(OSC)</sub>	5	mA
Power Dissipation (T <sub>A</sub> = 25°C)	P <sub>D</sub>	1000	mW
Operating Temperature	T <sub>OPR</sub>	0 ~ +70	°C
Storage Temperature	T <sub>STG</sub>	-65 ~ +150	°C
Lead Temperature (Soldering, 10sec)	T <sub>LEAD</sub>	+300	°C

## Electrical Characteristics

(V<sub>CC</sub>=15V, T<sub>A</sub>=0°C to +70°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>REFERENCE SECTION</b>						
Reference Output Voltage	V <sub>REF</sub>	T <sub>J</sub> = 25°C, I <sub>REF</sub> = 1mA	5.00	5.10	5.20	V
Line Regulation	ΔV <sub>REF</sub>	V <sub>CC</sub> = 8 to 40V	-	5	20	mV
Load Regulation	ΔV <sub>REF</sub>	I <sub>REF</sub> 1 to 10mA	-	3	15	mV
Temperature Stability(Note 6)	ST <sub>T</sub>	-	-	0.4	1.0	mV/°C
Output Voltage Range (Note 6)	V <sub>REF</sub>	Line, Load, Temp	4.95	-	5.25	V
Short Circuit Output Current	I <sub>SC</sub>	V <sub>REF</sub> = 0V	-10	-45	-	mA
Output Noise Voltage(Note 6)	V <sub>NO</sub>	f = 10Hz to 10KHz, T <sub>J</sub> = 25°C	-	100	-	μV
Long-Term Stability(Note 6)	ST	T <sub>J</sub> = 125°C, 1KHz	2	5	8	mV

## Electrical Characteristics

(VCC= 15V, TA=0°C to +70°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>OSCILLATOR SECTION (Note 2)</b>						
Initial Accuracy	ACCUR	T <sub>J</sub> = 25°C	39	43	47	KHz
Frequency Change with Voltage	$\Delta f/\Delta V_{CC}$	VCC = 8 to 40V	-	1	2	%
Frequency Change with Temperature (Note 6)	$\Delta f/\Delta T$	-	-	1	-	%
Sync Output High Level	V <sub>OH</sub> (SYNC)	-	3.9	4.35	-	V
Sync Output Low Level	V <sub>OL</sub> (SYNC)	-	-	2.3	2.5	V
Sync Input High Level	V <sub>IH</sub> (SYNC)	V <sub>8</sub> = 0V	3.9	-	-	V
Sync Input Low Level	V <sub>IL</sub> (SYNC)	V <sub>8</sub> = 0V	-	-	2.5	V
Sync Input Current	I <sub>I</sub> (SYNC)	Sync Voltage = 3.9V, V <sub>8</sub> = 0V	-	1.3	1.5	mA
<b>ERROR AMPLIFIER SECTION</b>						
Input Offset Voltage	V <sub>IO</sub>	-	-	0.5	5	mV
Input Bias Current	I <sub>BIAS</sub>	-	-	-0.6	-1	uA
Input Offset Current	I <sub>IO</sub>	-	-	40	250	uA
Common-Mode Range	V <sub>CM</sub>	VCC = 8 to 40V	0	-	VCC2	V
Open Loop Voltage Gain	G <sub>VO</sub>	V <sub>O</sub> = 1.2 to 3V, V <sub>CM</sub> = 2V	80	105	-	dB
Unity Gain Bandwidth(Note 6)	BW	T <sub>J</sub> = 25°C	0.7	1.0	-	MHz
Common Mode Rejection Ratio	CMRR	V <sub>CM</sub> = 0 to 38V, VCC = 40V	75	100	-	dB
Power Supply Rejection Ratio	PSRR	VCC = 8 to 40V	80	105	-	dB
Output Sink Current	I <sub>SINK</sub>	V <sub>IO</sub> = -15mV to 5V, V <sub>7</sub> = 2.5V	2	6	-	mA
Output Source Current	I <sub>SOURCE</sub>	R <sub>L</sub> = 15K $\Omega$	-0.4	-0.5	-	mA
High Output Voltage	V <sub>OH</sub>	R <sub>L</sub> = 15K $\Omega$	4.3	4.6	-	V
Low Output Voltage	V <sub>OL</sub>	-	-	0.7	1	V
<b>CURRENT SENSE AMPLIFIER SECTION</b>						
Amplifier Gain (Note 1, 3)	G <sub>V</sub>	V <sub>3</sub> = 0V, Pin 1 open	2.5	2.75	3.0	V
Maximum Differential Input Signal (V <sub>4</sub> - V <sub>3</sub> ) (Note 1)	V <sub>I</sub> (DIFF,MAX)	R <sub>L</sub> = 15K $\Omega$ , Pin 1 open	1.1	1.2	-	V
Input Offset Voltage (Note 1)	V <sub>IO</sub>	V <sub>1</sub> = 0.5V, Pin 1 open	-	5	25	mV
Common Mode Rejection Ratio	CMRR	V <sub>CM</sub> = 1 to 12V	60	83	-	dB
Power Supply Rejection Ratio	PSRR	VCC = 8 to 40V	60	84	-	dB
Input Bias Current (Note 1)	I <sub>BIAS</sub>	V <sub>1</sub> = 0.5V, Pin 7 open	-	-2.5	-10	uA
Input Offset Current (Note 1)	I <sub>IO</sub>	V <sub>1</sub> = 0.5V, Pin 7 open	-	0.08	1	uA
Delay to Outputs (Note 6)	t <sub>D</sub>	T <sub>J</sub> = 25°C	-	200	500	ns

## Electrical Characteristics

(V<sub>CC</sub>=15V, T<sub>A</sub>=0°C to + 70°C, unless otherwise specified)

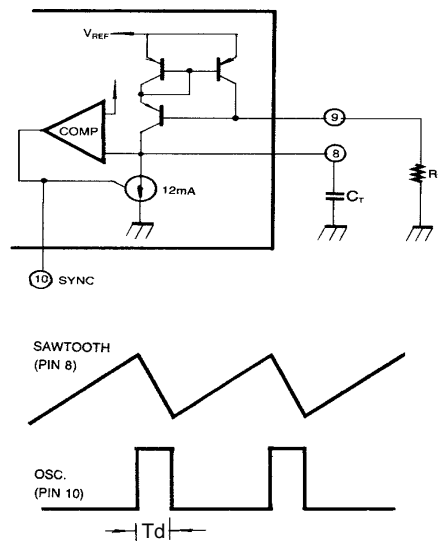
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
<b>CURRENT LIMIT ADJUST SECTION</b>						
Current Limit Offset Voltage (Note 1)	V <sub>IO(C.L)</sub>	V <sub>3</sub> = 0V V <sub>4</sub> = 0V, Pin 7 open	0.45	0.5	0.55	V
Input Bias Current	I <sub>BIAS</sub>	V <sub>5</sub> = V <sub>REF</sub> , V <sub>6</sub> = 0V	-	- 10	- 30	uA
<b>SHUTDOWN TERMINAL SECTION</b>						
Threshold Voltage	V <sub>TH</sub>	-	250	350	400	mV
Input Voltage Range	V <sub>I</sub>	-	0	-	V <sub>CC</sub>	V
Minimum Latching Current (Note 4)	I <sub>(LATCH,MIN)</sub>	-	3.0	1.5	-	mA
Maximum Non-Latching Current (Note 5)	I <sub>(NONLATCH,MAX)</sub>	-	-	1.5	0.8	mA
<b>UNDER-VOLTAGE LOCKOUT SECTION</b>						
Start Threshold	V <sub>TH(ST)</sub>	-	7	7.7	8.4	V
Threshold Hysteresis	V <sub>HYS</sub>	-	0.45	0.75	1.05	V
<b>OUTPUT SECTION</b>						
Collector-Emitter Voltage	V <sub>CEO</sub>	-	40	-	-	V
Collector Leakage Current	I <sub>LEAK</sub>	V <sub>C</sub> = 40V	-	-	200	uA
Low Output Voltage 1	V <sub>OL 1</sub>	I <sub>SINK</sub> = 20mA	-	0.1	0.4	V
Low Output Voltage 2	V <sub>OL 2</sub>	I <sub>SINK</sub> = 100mA	-	0.4	2.1	V
High Output Voltage 1	V <sub>OH 1</sub>	I <sub>SOURCE</sub> = 20mA	13	13.5	-	V
High Output Voltage 2	V <sub>OH 2</sub>	I <sub>SOURCE</sub> = 100mA	12	13.5	-	V
Rise Time (Note 6)	t <sub>R</sub>	C <sub>L</sub> = 1nF, T <sub>J</sub> = 25°C	-	50	300	us
Fall Time (Note 6)	t <sub>F</sub>	C <sub>L</sub> = 1nF, T <sub>J</sub> = 25°C	-	50	300	us
<b>TOTAL STANDBY CURRENT</b>						
Supply Current	I <sub>CC</sub>	-	-	17	21	mA

### Notes :

- Parameter measured at trip point at latch with V<sub>5</sub> = V<sub>REF</sub>, V<sub>6</sub> = 0V
- R<sub>T</sub> = 10KΩ, C<sub>T</sub> = 4.7nF
- Amplifier gain define as:

$$G = \frac{\Delta V_7}{\Delta V_4}; \Delta V_4 = 0 \text{ to } 1.0V$$

- Current into Pin 1 guaranteed to latch circuit in shutdown state.
- Current into Pin 1 guaranteed not to latch circuit in shutdown state.
- These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.



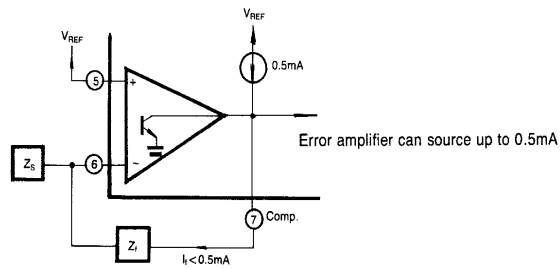
OUTPUT DEADTIME(T<sub>d</sub>)

**Figure 1. KA3846 Oscillator Circuit**

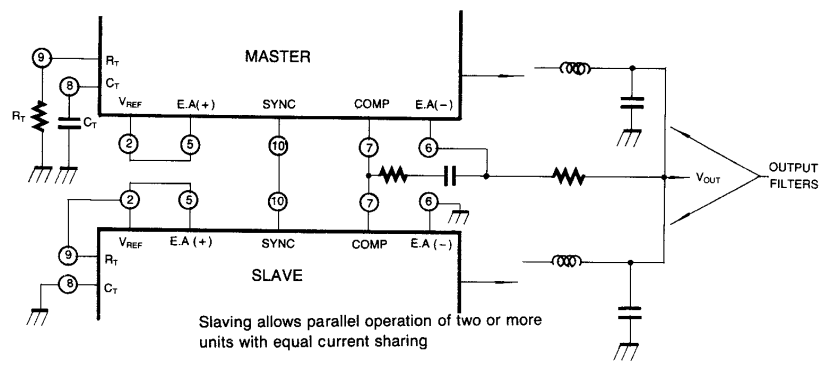
Output deadtime is determined by the external capacitor, C<sub>T</sub>, according to the formula:  $T_d(\mu s) = 145 C_T(\mu F) \left( \frac{12}{12 - \frac{3.6}{R_T(K\Omega)}} \right)$

For large values of R<sub>T</sub>:  $T_d(\mu s) = 145 C_T(\mu F)$  Oscillator frequency is approximately

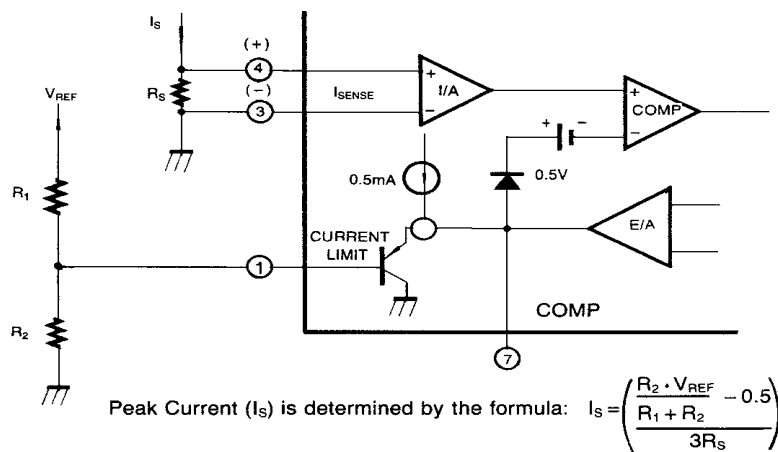
by the formula:  $f_T(KHz) = \frac{2.2}{R_T(K\Omega) C_T(\mu F)}$



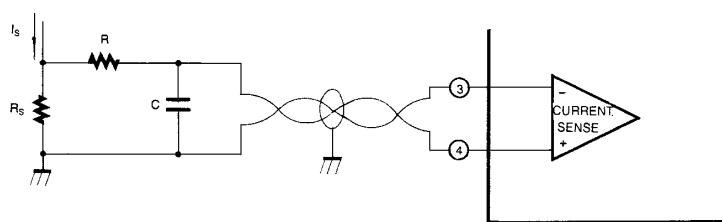
**Figure 2. Error Amplifier Output Configuration**



### Figure 3. Parallel Operation



#### Figure 4. Pulse By Pulse Current Limiting



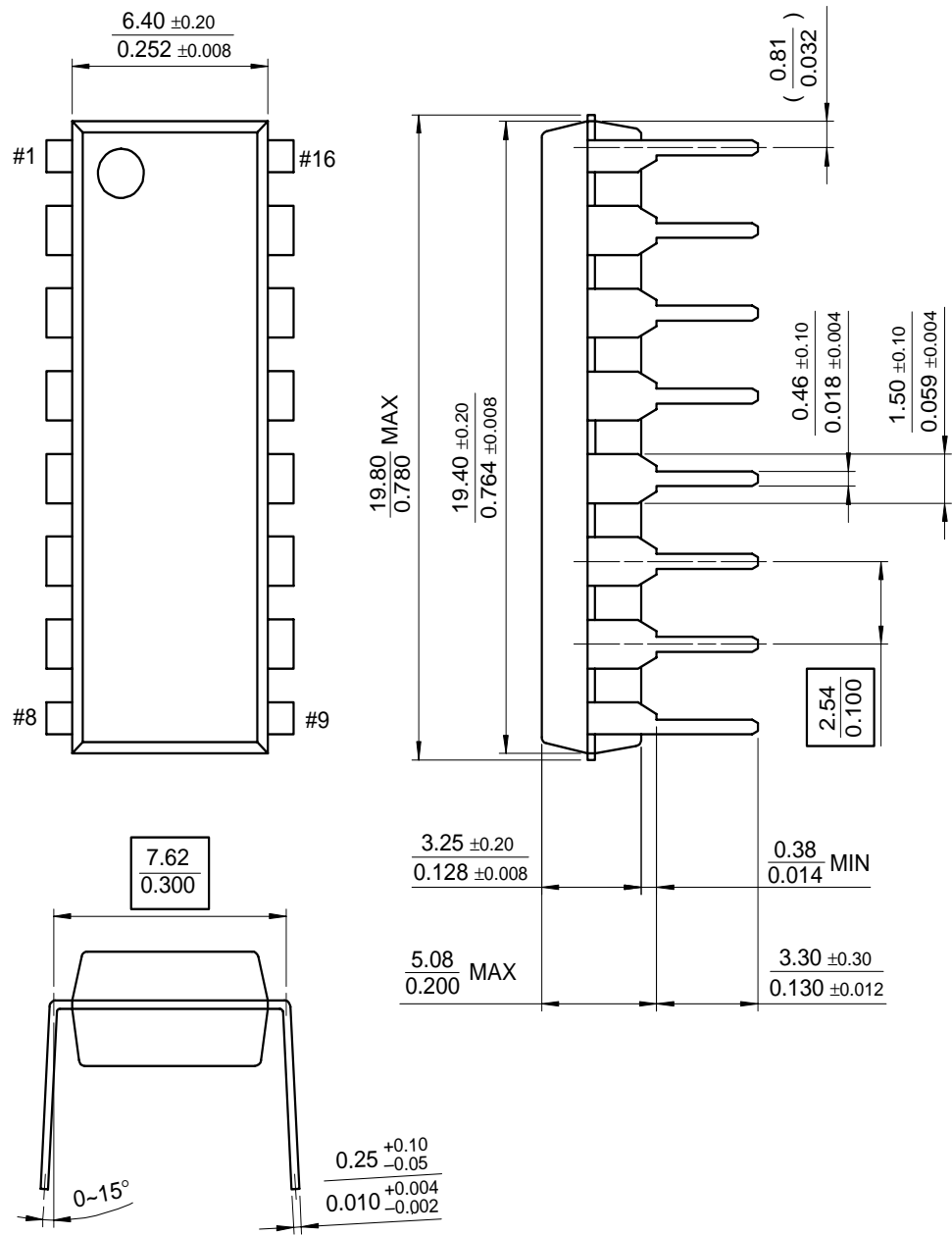
### Figure 5. Current Sense Amp Connections

A small PC filter may be required in some applications to reduce switch transients  
Differential input allows remote, noise free sensing.

Mechanical Dimensions

Package

16-DIP



## Ordering Information

Product Number	Package	Operating Temperature
KA3846	16 DIP	0 ~ + 70°C





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