CS-3845B

Current Mode PWM Control Circuit with 50% Max Duty Cycle

Description

The CS-3845B provides all the necessary features to implement off-line fixed frequency current-mode control with a minimum number of external components.

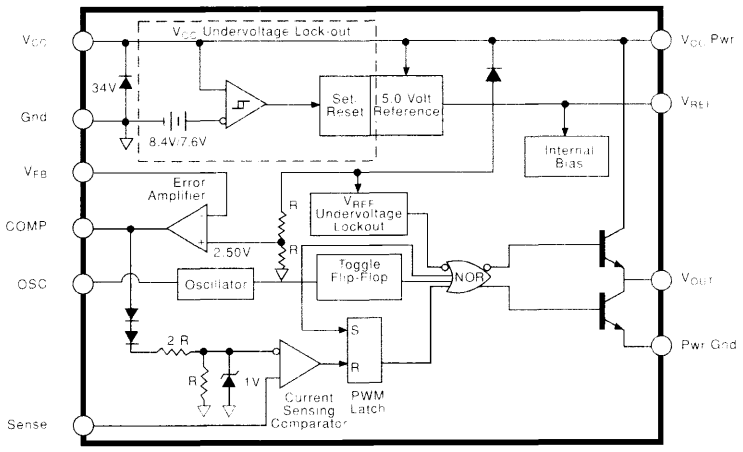
The CS-3845B incorporates a precision temperature-controlled oscillator to minimize variations in frequency. An internal toggle flip-flop, which blanks the output off every other clock cycle, ensures that the duty-cycle never exceeds 50%. The undervoltage lock-out feature ensures that V_{REF} is stabilized within specification before the output stage is enabled. **The CS-3845B has been optimized for lower start up current (500µA max).**

Other features include 1% trimmed band gap reference, pulse-by-pulse current limiting, and a high-current totem pole output for driving capacitive loads.

Absolute Maximum Ratings

Supply Voltage (I_{CC}<30mA) ..... Self Limiting
Supply Voltage (Low Impedance Source) 30V
Output Current ..... ±1A
Output Energy (Capacitive Load) 5µJ
Analog Inputs (V_{FB}, V_{SENSE}) ..... -0.3V to 5.5V
Error Amp Output Sink Current 10mA
Lead Temperature Soldering
Wave Solder (through hole styles only) ..... 10 sec. max, 260°C peak
Reflow (SMD styles only) ..... 60 sec. max above 183°C, 230°C peak

Block Diagram

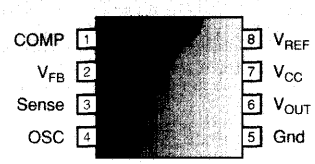


Features

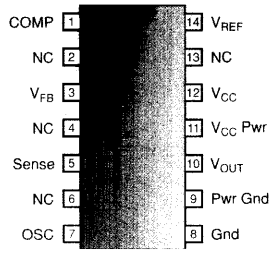
- Optimized for Off-line Use
- Temperature Compensated Oscillator
- 50% Maximum Duty-cycle Clamp
- Low Start-up Current (500µA max)
- Pulse-by-pulse Current Limiting
- Undervoltage Active Pull Down
- Double Pulse Suppression
- 1% Trimmed Bandgap Reference
- High Current Totem Pole Output

Package Options

8 Lead PDIP & SO



14 Lead SO Narrow



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PARAMETER	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
■ Reference Section					
Output Voltage	T_J=25°C, I_{REF}=1mA	4.90	5.00	5.10	V
Line Regulation	12≤V_{CC}≤25V		6	20	mV
Load Regulation	1≤I_{REF}≤20mA		6	25	mV
Temperature Stability	(Note 1)		0.2	0.4	mV/°C
Total Output Variation	Line, Load, Temp. (Note 1)	4.82		5.18	V
Output Noise Voltage	10Hz≤f≤10kHz, T_J=25°C (Note 1)		50		µV
Long Term Stability	T_A=125°C, 1000 Hrs. (Note 1)		5	25	mV
Output Short Circuit	T_A=25°C	-30	-100	-180	mA
■ Oscillator Section					
Initial Accuracy	Sawtooth Mode, T_J=25°C	47	52	57	kHz
Voltage Stability	12≤V_{CC}≤25V		0.2	1.0	%
Temperature Stability	Sawtooth Mode T_{MIN}≤T_A≤T_{MAX} (Note 1)		5		%
Amplitude	V_{OSC} (peak to peak)(Note 1)		1.7		V
Discharge	T_J=25°C; (Note 1)	7.5	8.3	9.3	mA
	T_{MIN}≤T_A≤T_{MAX} (Note 1)	7.2		9.5	mA
■ Error Amp Section					
Input Voltage	V_{COMP}=2.5V	2.42	2.50	2.58	V
Input Bias Current	V_{FB}=0V		-0.3	-2.0	µA
AVOL	2≤V_{OUT}≤4V	65	90		dB
Unity Gain Bandwidth	(Note 1)	0.7	1.0		MHz
PSRR	12≤V_{CC}≤25V	60	70		dB
Output Sink Current	V_{FB}=2.7V, V_{COMP}=1.1V	2.5	6		mA
Output Source Current	V_{FB}=2.3V, V_{COMP}=5V	-0.5	-0.8		mA
V_{OUT} HIGH	V_{FB}=2.3V, R_L=15kΩ to Gnd	5	6		V
V_{OUT} LOW	V_{FB}=2.7V, R_L=15kΩ to V_{REF}		0.7	1.1	V
■ Current Sense Section					
Gain	(Notes 2&3)	2.85	3.00	3.15	V/V
Maximum Input Signal	V_{COMP}=5V (Note 2)	0.9	1.0	1.1	V
PSRR	12≤V_{CC}≤25V (Note 2)		70		dB
Input Bias Current	V_{Sense}=0V		-2	-10	µA
Delay to Output	T_J=25°C (Note 1)		150	300	ns
■ Output Section					
Output Low Level	I_{SINK}=20mA		0.1	0.4	V
	I_{SINK}=200mA		1.5	2.2	V
Output High Level	I_{SOURCE}=20mA	13.0	13.5		V
	I_{SOURCE}=200mA	12.0	13.5		V
Rise Time	T_J=25°C, C_L=1nF (Note 1)		50	150	ns
Fall Time	T_J=25°C, C_L=1nF (Note 1)		50	150	ns

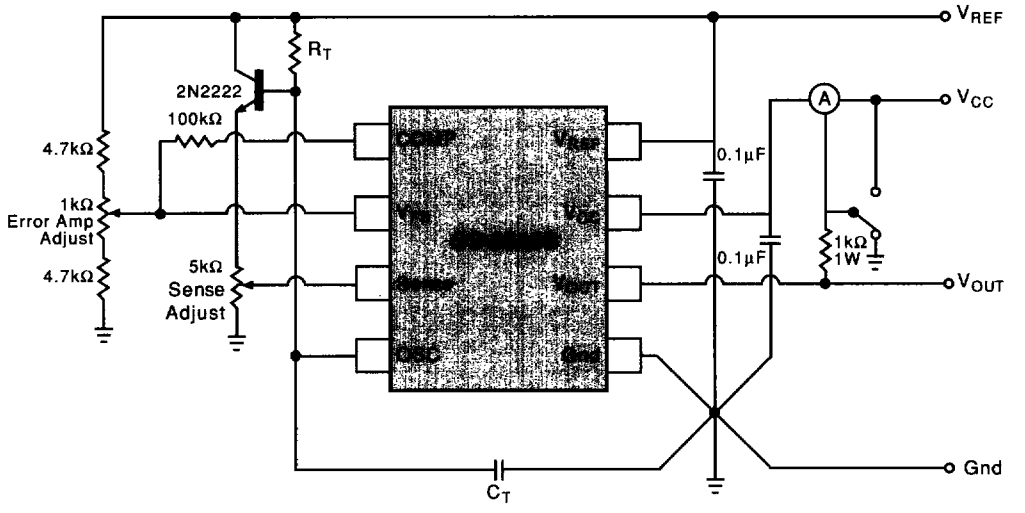
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
■ Total Standby Current					
Start-Up Current			300	500	µA
Operating Supply Current	V_{FB}=V_{Sense}=0V R_T=10kΩ, C_T=3.3nF		11	17	mA
V_{CC} Zener Voltage	I_{CC}=25mA		34		V
■ PWM Section					
Maximum Duty Cycle		46	48	50	%
Minimum Duty Cycle				0	%
■ Under-Voltage Lockout Section					
Start Threshold		7.8	8.4	9.0	V
Min. Operating Voltage	After Turn On	7.0	7.6	8.2	V

Notes: 1. These parameters, although guaranteed, are not 100% tested in production.

2. Parameter measured at trip point of latch with V_{FB}=0

3. Gain defined as: $A = \frac{\Delta V_{COMP}}{\Delta V_{Sense}}$; $0 \le V_{Sense} \le 0.8V$.

PIN NUMBER		PIN SYMBOL	PIN FUNCTION
8L PDIP & SO	14L SO		
1	1	COMP	Error amp output, used to compensate error amplifier
2	3	V_{FB}	Error amp inverting input
3	5	Sense	Noninverting input in Current Sense Comparator
4	7	OSC	Oscillator timing network with Capacitor to Gnd, resistor to V_{REF}
5	8	Gnd	Ground
6	10	V_{OUT}	Output drive pin
7	12	V_{CC}	Positive power supply
8	14	V_{REF}	Output of 5V internal reference
	9	Pwr Gnd	Output driver Gnd
	11	V_{CC} Pwr	Output driver positive supply
	2, 4, 6, 13	NC	No Connection



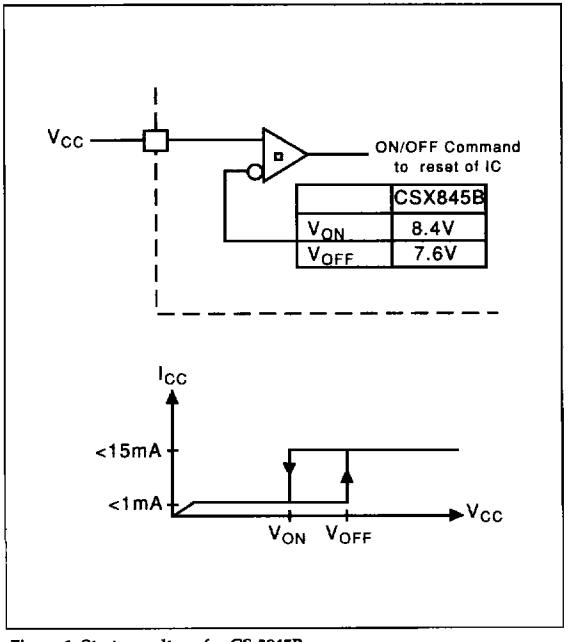


Figure 1: Startup voltage for CS-3845B.

Undervoltage Lockout

During Undervoltage Lockout (Figure 1), the output driver is biased to sink minor amounts of current. The output should be shunted to ground with a resistor to prevent activating the power switch with extraneous leakage currents.

PWM Waveform

To generate the PWM waveform, the control voltage from the error amplifier is compared to a current sense signal which represents the peak output inductor current (Figure 2). An increase in V_{CC} causes the inductor current slope to increase, thus reducing the duty cycle. This is an inherent feed-forward characteristic of current mode control, since the control voltage does not have to change during changes of input supply voltage.

When the power supply sees a sudden large output current increase, the control voltage will increase allowing the duty cycle to momentarily increase. Since the duty cycle tends to exceed the maximum allowed to prevent transformer saturation in some power supplies, the internal oscillator waveform provides the maximum duty cycle clamp as programmed by the selection of OSC components.

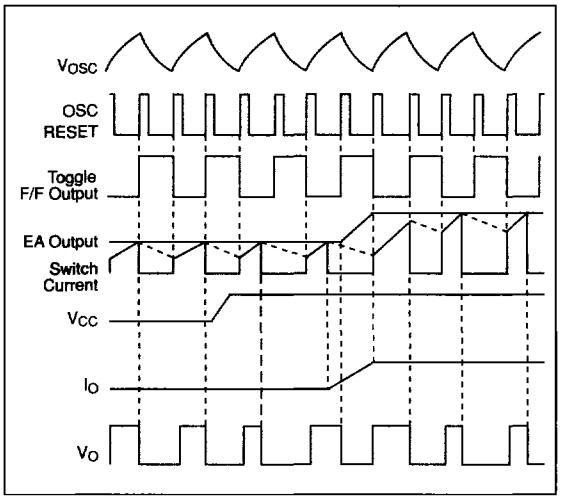


Figure 2: Timing Diagram

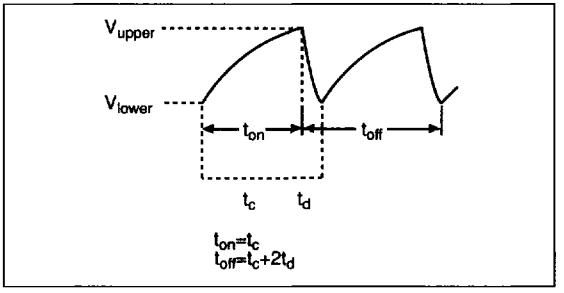


Figure 3: Timing Parameters.

Setting the Oscillator

The parameters T_c and T_d can be determined as follows:

$$t_c = R_T C_T \ln\left(\frac{V_{REF} - V_{lower}}{V_{REF} - V_{upper}}\right)$$

$$t_d = R_T C_T \ln\left(\frac{V_{REF} - I_d R_T - V_{lower}}{V_{REF} - I_d R_T - V_{upper}}\right)$$

Substituting in typical values for the parameters in the above formulas:

$V_{REF} = 5.0V$, $V_{upper} = 2.7V$, $V_{lower} = 1.0V$, $I_d = 8.3A$,

then

$$t_c \approx 0.5534 R_T C_T$$

$$t_d = R_T C_T \ln\left(\frac{2.3 - 0.0083\ R_T}{4.0 - 0.0083\ R_T}\right)$$

For better accuracy R_T should be $\geq 10k\Omega$.

Grounding

High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to Gnd in a single point ground.

The transistor and 5kΩ potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to Sense.

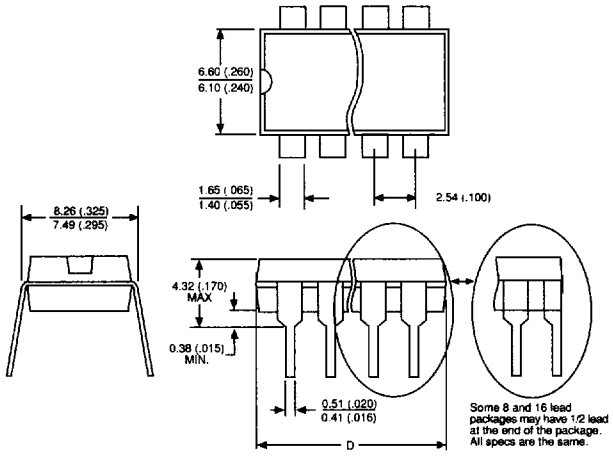
PACKAGE DIMENSIONS (in mm) (INCHES)

Lead Count	D Metric Max	D Metric Min	D English Max	D English Min
8 Lead PDIP	9.40	9.14	.370	.360
8 Lead SO Narrow	5.00	4.80	.197	.188
14 Lead SO Narrow	8.74	8.53	.344	.336

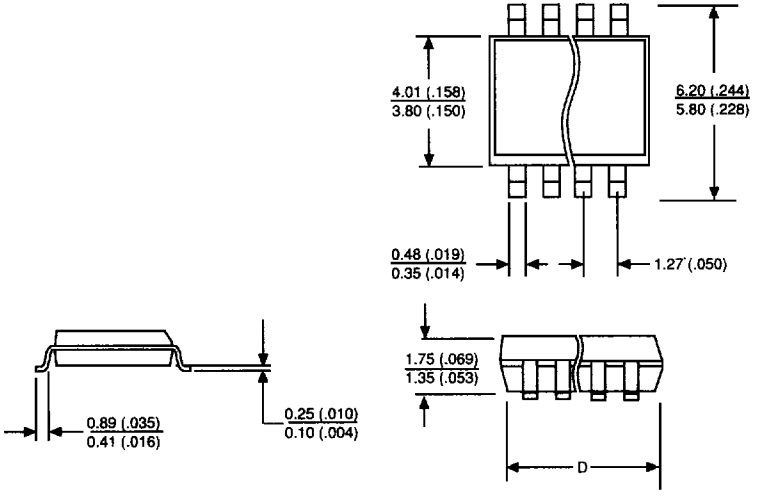
PACKAGE THERMAL DATA

Thermal Data		8 L PDIP	8L SO	14 L SO	
$R_{\theta JC}$	typ	52	45	30	°C/W
$R_{\theta JA}$	typ	100	165	125	°C/W

PDIP 300 mil wide



SO Narrow 150 mil wide



Ordering Information

Part Number	0°C to 70°C	Description
CS-3845BN8	•	8L PDIP
CS-3845BD8	•	8L SO
CS-3845BD14	•	14L SO