

Current Mode PWM 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 Modular Power Systems
- Differential Current Sense Amplifier with Wide Common Mode Range
- Double Pulse Suppression
- 500mA (Peak) Totem-pole Outputs
- $\pm 1\%$ Bandgap Reference
- Under-voltage Lockout
- Soft Start Capability
- Shutdown Terminal
- 500kHz Operation

DESCRIPTION

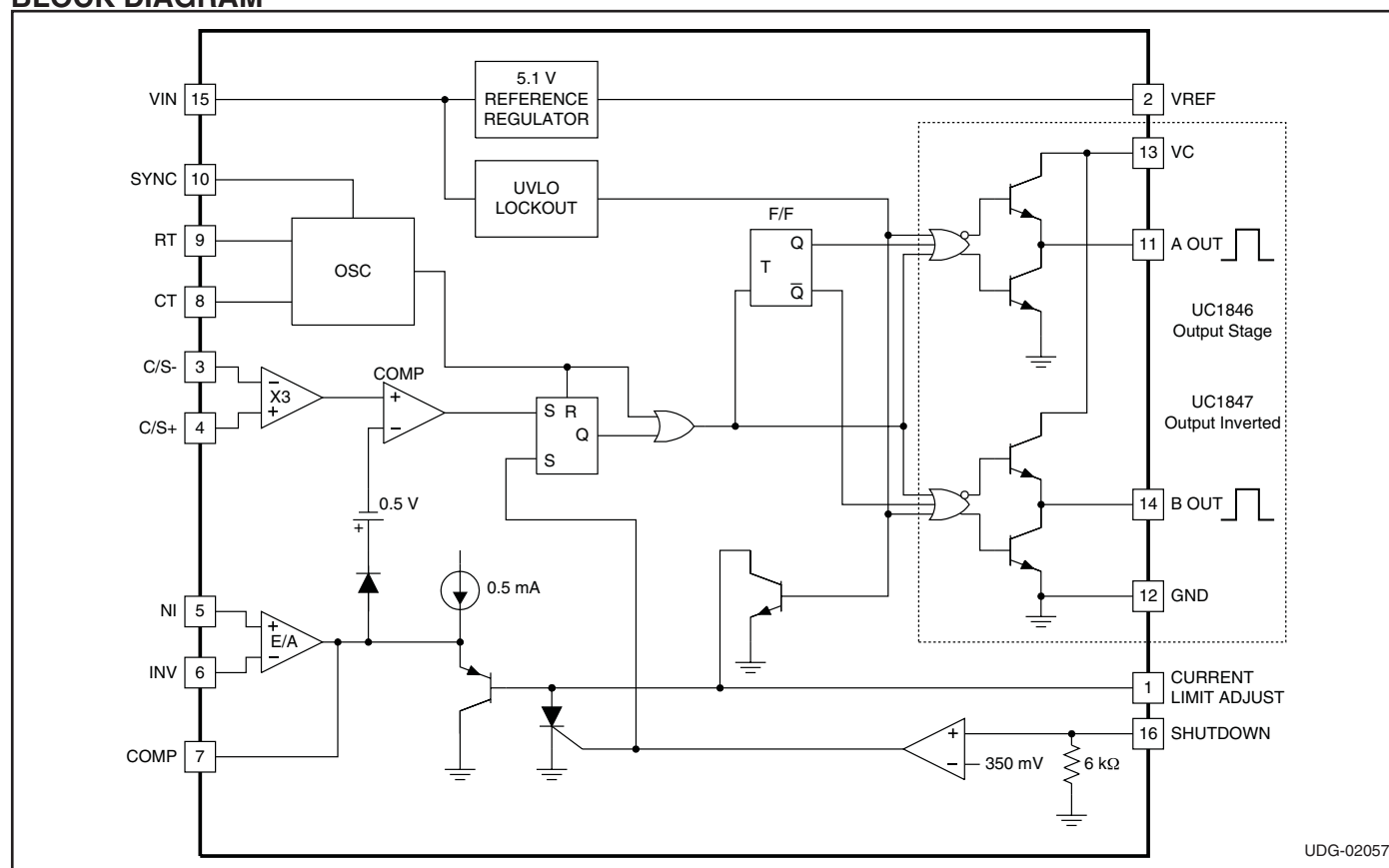
The UC1846/7 family of control ICs provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, 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 modules" 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, deadline adjust capability, and a $\pm 1\%$ trimmed bandgap reference.

The UC1846 features low outputs in the OFF state, while the UC1847 features high outputs in the OFF state.

BLOCK DIAGRAM



UDG-02057

ABSOLUTE MAXIMUM RATINGS (Note 1)

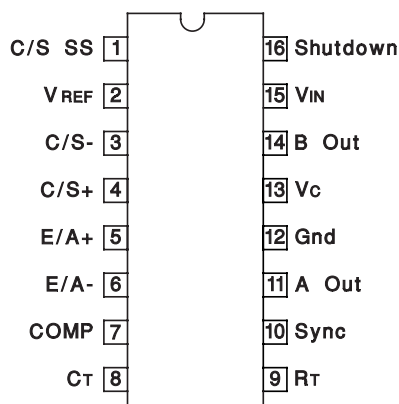
Supply Voltage (Pin 15)	+40V
Collector Supply Voltage (Pin 13)	+40V
Output Current, Source or Sink (Pins 11, 14)	500mA
Analog Inputs (Pins 3, 4, 5, 6, 16)	-0.3V to +V _{IN}
Reference Output Current (Pin 2)	-30mA
Sync Output Current (Pin 10)	-5mA
Error Amplifier Output Current (Pin 7)	-5mA
Soft Start Sink Current (Pin 1)	50mA
Oscillator Charging Current (Pin 9)	5mA
Power Dissipation at T _A =25°C	1000mW
Power Dissipation at T _C =25°C	2000mW
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10 seconds)	+300°C

Note 1. All voltages are with respect to Ground, Pin 13. Currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages. Pin numbers refer to DIL and SOIC packages only.

CONNECTION DIAGRAMS

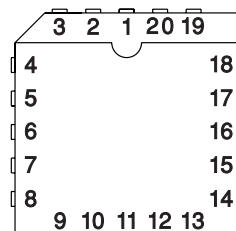
DIL-16, SOIC-16 (TOP VIEW)

J or N Package, DW Package



PLCC-20, LCC-20 (TOP VIEW)

Q, L Packages



PACKAGE PIN FUNCTION	
FUNCTION	PIN
N/C	1
C/L SS	2
V _{REF}	3
C/S-	4
C/S+	5
N/C	6
E/A+	7
E/A-	8
Comp	9
C _T	10
N/C	11
R _T	12
Sync	13
A Out	14
Gnd	15
N/C	16
V _C	17
B Out	18
V _{IN}	19
Shutdown	20

ELECTRICAL CHARACTERISTICS (Unless otherwise stated, these specifications apply for T_A=-55°C to +125°C for UC1846/7; -40°C to +85°C for the UC2846/7; and 0°C to +70°C for the UC3846/7; V_{IN}=15V, R_T=10k, C_T=4.7nF, T_A=T_J.)

PARAMETER	TEST CONDITIONS	UC1846/UC1847 UC2846/UC2847			UC3846/UC3847			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Reference Section								
Output Voltage	T _J =25°C, I _o =1mA	5.05	5.10	5.15	5.00	5.10	5.20	V
Line Regulation	V _{IN} =8V to 40V		5	20		5	20	mV
Load Regulation	I _L =1mA to 10mA		3	15		3	15	mV
Temperature Stability	Over Operating Range, (Note 2)		0.4			0.4		mV/°C
Total Output Variation	Line, Load, and Temperature (Note 2)	5.00		5.20	4.95		5.25	V
Output Noise Voltage	10Hz ≤ f ≤ 10kHz, T _J =25°C (Note 2)		100			100		μV
Long Term Stability	T _J =125°C, 1000 Hrs. (Note 2)		5			5		mV
Short Circuit Output Current	V _{REF} =0V	-10	-45		-10	-45		mA

ELECTRICAL CHARACTERISTICS (cont.) (Unless otherwise stated, these specifications apply for $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ for UC1846/7; -40°C to $+85^{\circ}\text{C}$ for the UC2846/7; and 0°C to $+70^{\circ}\text{C}$ for the UC3846/7; $V_{IN} = 15\text{V}$, $R_T = 10\text{k}$, $C_T = 4.7\text{nF}$, $T_A = T_J$.)

PARAMETER	TEST CONDITIONS	UC1846/UC1847 UC2846/UC2847			UC3846/UC3847			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Oscillator Section								
Initial Accuracy	TJ=25°C	39	43	47	39	43	47	kHz
Voltage Stability	VIN=8V to 40V		-1	2		-1	2	%
Temperature Stability	Over Operating Range (Note 2)		-1			-1		%
Sync Output High Level		3.9	4.35		3.9	4.35		V
Sync Output Low Level			2.3	2.5		2.3	2.5	V
Sync Input High Level	Pin 8=0V	3.9			3.9			V
Sync Input Low Level	Pin 8=0V			2.5			2.5	V
Sync Input Current	Sync Voltage=3.9V, Pin 8=0V		1.3	1.5		1.3	1.5	mA
Error Amp Section								
Input Offset Voltage			0.5	5		0.5	10	mV
Input Bias Current			-0.6	-1		-0.6	-2	µA
Input Offset Current			40	250		40	250	nA
Common Mode Range	VIN=8V to 40V	0		VIN-2V	0		VIN-2V	V
Open Loop Voltage Gain	ΔVo=1.2 to 3V, VCM=2V	80	105		80	105		dB
Unity Gain Bandwidth	TJ=25°C (Note 2)	0.7	1.0		0.7	1.0		MHz
CMRR	VCM=0V to 38V, VIN=40V	75	100		75	100		dB
PSRR	VIN=8V to 40V	80	105		80	105		dB
Output Sink Current	VID=-15mV to -5V, VPIN 7=1.2V	2	6		2	6		mA
Output Source Current	VID=15mV to 5V, VPIN 7=2.5V	-0.4	-0.5		-0.4	-0.5		mA
High Level Output Voltage	RL=(Pin 7) 15kΩ	4.3	4.6		4.3	4.6		V
Low Level Output Voltage			0.7	1		0.7	1	V
Current Sense Amplifier Section								
Amplifier Gain	VPIN 3=0V, Pin 1 Open (Notes 3 & 4)	2.5	2.75	3.0	2.5	2.75	3.0	V
Maximum Differential Input Signal (VPIN 4-VPIN 3)	Pin 1 Open (Note 3) RL (Pin 7)=15kW	1.1	1.2		1.1	1.2		V
Input Offset Voltage	VPIN 1=0.5V, Pin 7 Open (Note 3)		5	25		5	25	mV
CMRR	VCM=1V to 12V	60	83		60	83		dB
PSRR	VIN=8V to 40V	60	84		60	84		dB
Input Bias Current	VPIN 1=0.5V, Pin 7 Open (Note 3)		-2.5	-10		-2.5	-10	µA
Input Offset Current	VPIN 1=0.5V, Pin 7 Open (Note 3)		0.08	1		0.08	1	µA
Input Common Mode Range		0		VIN-3	0		VIN-3	V
Delay to Outputs	TJ=25°C, (Note 2)		200	500		200	500	ns
Current Limit Adjust Section								
Current Limit Offset	VPIN 3=0V, VPIN 4=0V, Pin 7 Open (Note 3)	0.45	0.5	0.55	0.45	0.5	0.55	V
Input Bias Current	VPIN 5=VREF, VPIN 6=0V		-10	-30		-10	-30	µA
Shutdown Terminal Section								
Threshold Voltage		250	350	400	250	350	400	mV
Input Voltage Range		0		VIN	0		VIN	V
Minimum Latching Current (IPIN 1)	(Note 6)	3.0	1.5		3.0	1.5		mA

ELECTRICAL CHARACTERISTICS (cont.)

(Unless otherwise stated, these specifications apply for $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ for UC1846/7; -40°C to $+85^\circ\text{C}$ for the UC2846/7; and 0°C to $+70^\circ\text{C}$ for the UC3846/7; $V_{IN} = 15\text{V}$, $R_T = 10\text{k}$, $C_T = 4.7\text{nF}$, $T_A = T_J$.)

PARAMETER	TEST CONDITIONS	UC1846/UC1847 UC2846/UC2847			UC3846/UC3847			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Shutdown Terminal Section (cont.)								
Maximum Non-Latching Current (IPIN 1)	(Note 7)		1.5	0.8		1.5	0.8	mA
Delay to Outputs	TJ=25°C (Note 2)		300	600		300	600	ns
Output Section								
Collector-Emitter Voltage		40			40			V
Collector Leakage Current	VC=40V (Note 5)			200			200	μA
Output Low Level	ISINK=20mA		0.1	0.4		0.1	0.4	V
	ISINK=100mA		0.4	2.1		0.4	2.1	V
Output High Level	ISOURCE=20mA	13	13.5		13	13.5		V
	ISOURCE=100mA	12	13.5		12	13.5		V
Rise Time	CL=1nF, TJ=25°C (Note 2)		50	300		50	300	ns
Fall Time	CL=1nF, TJ=25°C (Note 2)		50	300		50	300	ns
Under-Voltage Lockout Section								
Start-Up Threshold			7.7	8.0		7.7	8.0	V
Threshold Hysteresis			0.75			0.75		V
Total Standby Current								
Supply Current			17	21		17	21	mA

Note 2. These parameters, although guaranteed over the recommended operating conditions, are not 100% tested in production.

Note 3. Parameter measured at trip point of latch with $V_{PIN\ 5} = V_{REF}$, $V_{PIN\ 6} = 0\text{V}$.

Note 4. Amplifier gain defined as: $G = \frac{\Delta V_{PIN\ 7}}{\Delta V_{PIN\ 4}}$; $V_{PIN\ 4} = 0$ to 1.0V

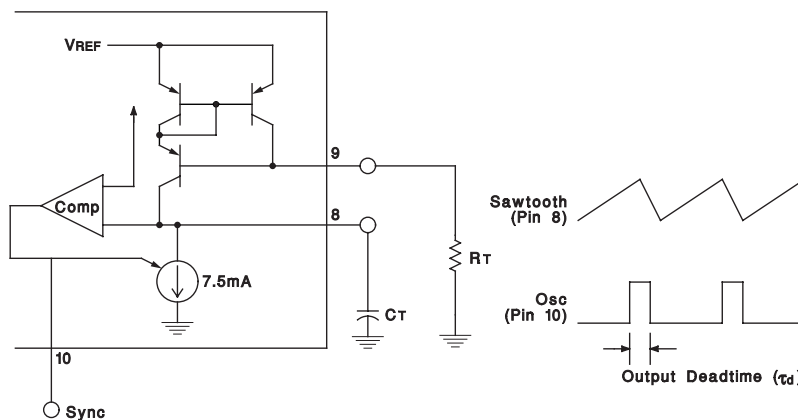
Note 5. Applies to UC1846/UC2846/UC3846 only due to polarity of outputs.

Note 6. Current into Pin 1 guaranteed to latch circuit in shutdown state.

Note 7. Current into Pin 1 guaranteed not to latch circuit in shutdown state.

APPLICATIONS DATA

Oscillator Circuit



Output deadtime is determined by the external capacitor, C_T , according to the formula: $\tau_d (\mu\text{s}) = 145 C_T (\mu\text{f}) \left(\frac{I_D}{I_D - \frac{3.6}{RT (k\Omega)}} \right)$.

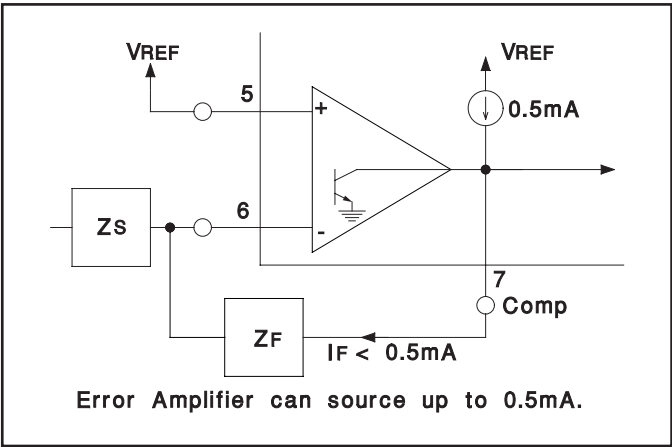
I_D = Oscillator discharge current at 25°C is typically 7.5.

For large values of RT : $\tau_d (\mu\text{s}) \approx 145 C_T (\mu\text{f})$.

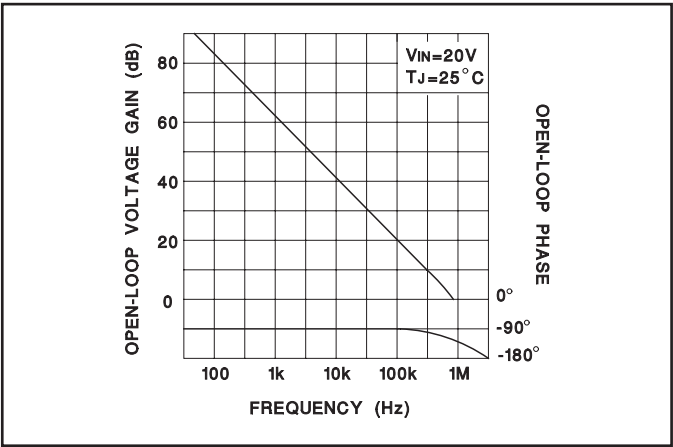
Oscillator frequency is approximated by the formula: $f_T (\text{kHz}) \approx \frac{2.2}{RT (k\Omega) \cdot C_T (\mu\text{f})}$.

APPLICATIONS DATA (cont.)

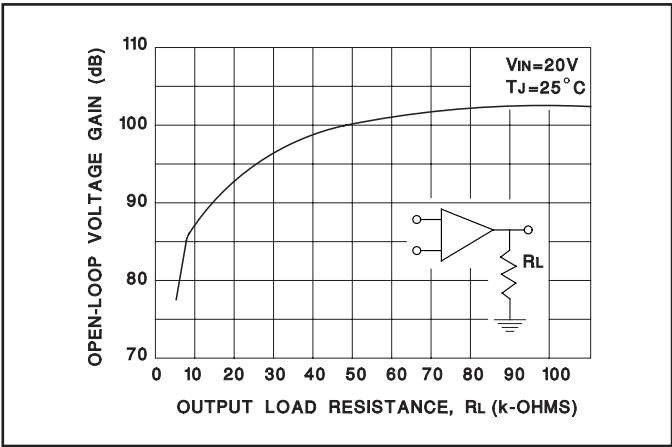
Error Amp Output Configuration



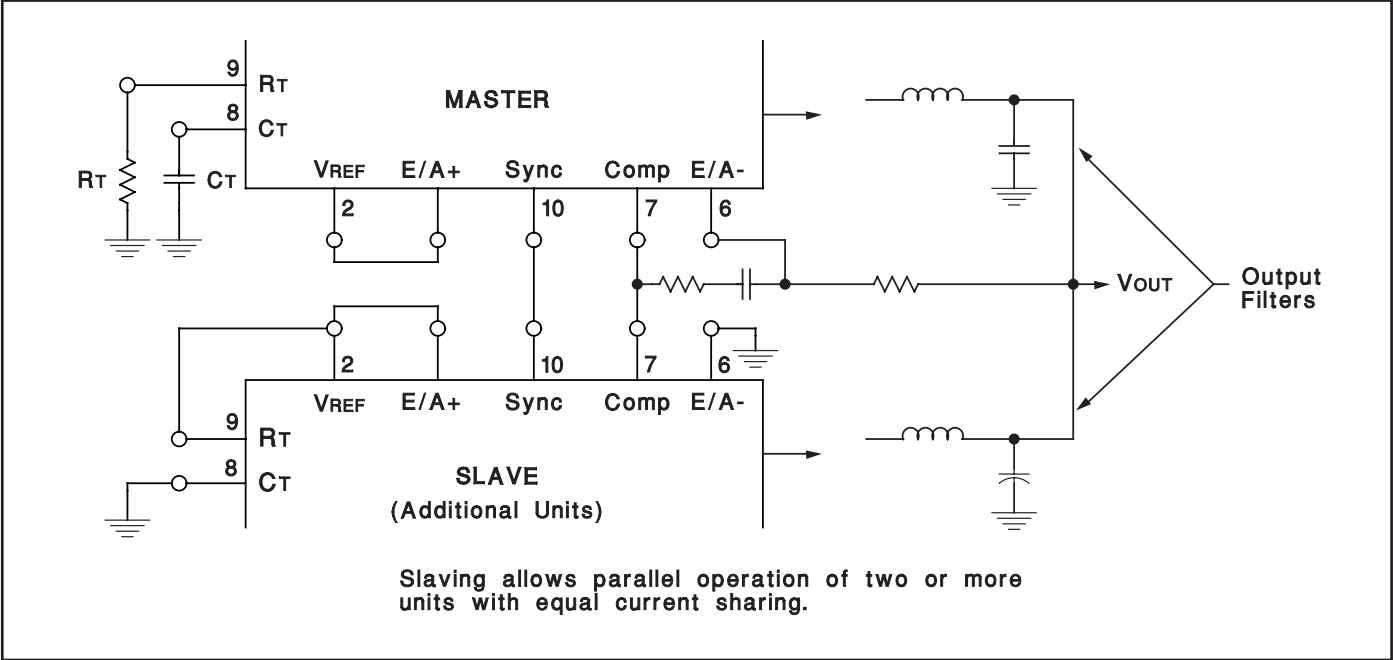
Error Amp Gain and Phase vs Frequency



Error Amp Open-Logic D.C. Gain vs Load Resistance

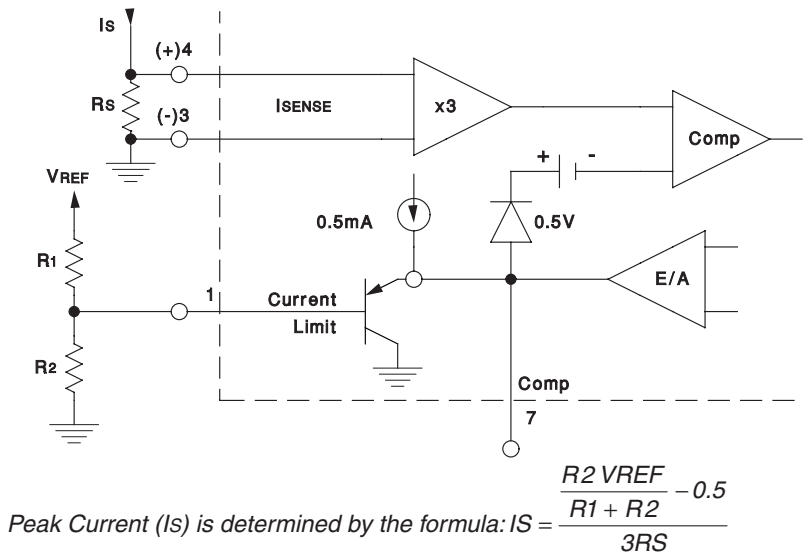


Parallel Operation

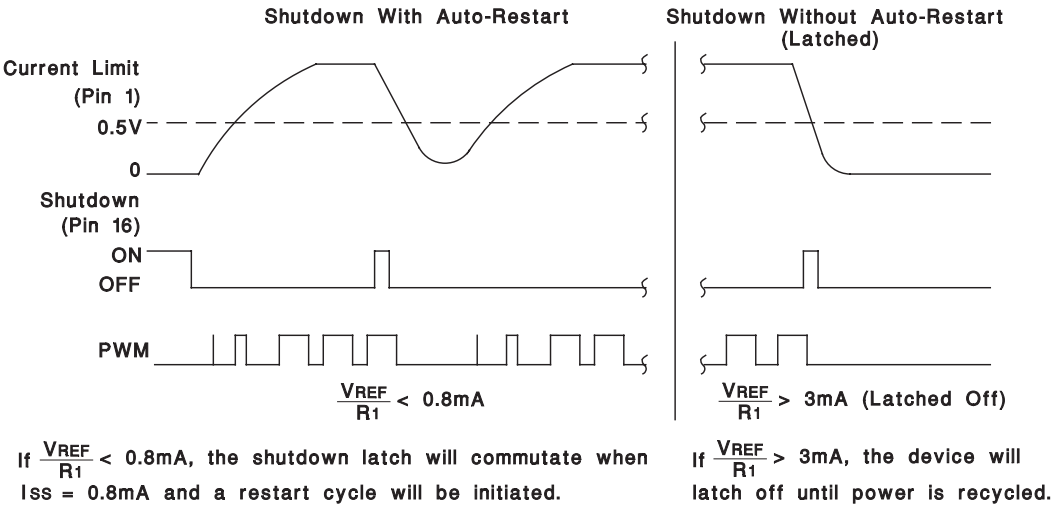
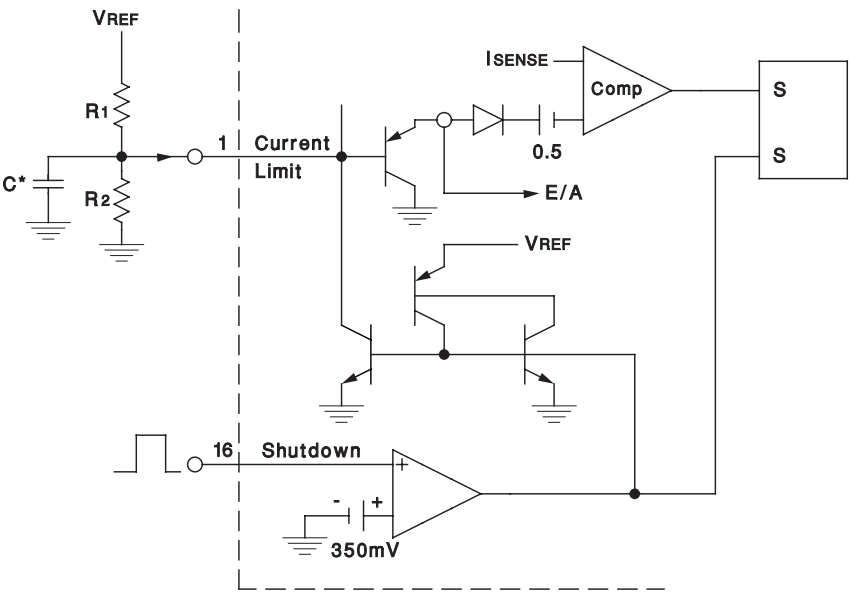


APPLICATIONS DATA (cont.)

Pulse by Pulse Current Limiting



Soft Start and Shutdown /Restart Functions



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

The diagram shows a UC1846 motor driver circuit with the following components and connections:

- Timing Resistor (RT):** A network of resistors (150k, 10k, 1.8k) connected to the Freq. Set & Max Duty Cycle RT pin (pin 9).
- Timing Capacitor (CT):** A network of capacitors (0.1μF, 1nF, 4.7nF) connected to the Timing Cap CT pin (pin 8).
- ISENSE Adjust:** A 1kΩ resistor connected to the I_{S+} pin (pin 4) and ground, with a note indicating an adjustment of approximately 1V peak.
- Duty Cycle Adjust:** A 1kΩ resistor connected to the Inv pin (pin 6) and ground, with a 5V supply and a 400Ω resistor in series.
- Current Limit Adjust:** A 10-turn potentiometer connected to the I_L Adj pin (pin 1) and ground, with a 1kΩ resistor in series.
- Shutdown:** A 0.1μF capacitor connected to the Shutdown pin (pin 16) and ground, with a 2kΩ resistor connected to the +5V supply.
- Outputs:** Out A and Out B pins (pins 14 and 11) are connected to the motor terminals through 150Ω resistors. The Gnd pin (pin 12) is connected to ground.
- Power Supply:** The +12V supply (VIN) is connected to pin 15, and the +5V supply (VREF) is connected to pin 2. Both are decoupled with 0.1μF capacitors.
- Other Pins:** The Comp pin (pin 7) is connected to the Inv pin (pin 6). The I_{S+} pin (pin 3) is connected to ground for normal operation.

- Bypass Caps Should Be Low ESR & ESL Type
- Short Pins 6 & 7 for Unity Gain Testing

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-86806012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
5962-8680601EA	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	Level-NC-NC-NC
5962-8680601V2A	ACTIVE	LCCC	FK	20	1	TBD	Call TI	Level-NC-NC-NC
5962-8680601VEA	ACTIVE	CDIP	J	16	1	TBD	Call TI	Level-NC-NC-NC
UC1846J	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	Level-NC-NC-NC
UC1846J/80257	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC1846J/80364	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC1846J/80619	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC1846J883B	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	Level-NC-NC-NC
UC1846JQMLV	ACTIVE	CDIP	J	16		TBD	Call TI	Call TI
UC1846L883B	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
UC1846LQMLV	ACTIVE	LCCC	FK	20		TBD	Call TI	Call TI
UC1847J	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC1847J883B	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC1847L	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI
UC1847L883B	OBSOLETE	LCCC	FK	20		TBD	Call TI	Call TI
UC2846DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2846DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2846J	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	Level-NC-NC-NC
UC2846N	ACTIVE	PDIP	N	16	25	TBD	CU NIPDAU	Level-NA-NA-NA
UC2846Q	ACTIVE	PLCC	FN	20	46	TBD	Call TI	Level-2-220C-1 YEAR
UC2846QTR	ACTIVE	PLCC	FN	20	1000	TBD	Call TI	Level-2-220C-1 YEAR
UC2847DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2847DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC2847N	ACTIVE	PDIP	N	16	25	TBD	CU NIPDAU	Level-NA-NA-NA
UC3846DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3846DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3846J	ACTIVE	CDIP	J	16	1	TBD	A42 SNPB	Level-NC-NC-NC
UC3846N	ACTIVE	PDIP	N	16	25	TBD	CU NIPDAU	Level-NA-NA-NA
UC3846Q	ACTIVE	PLCC	FN	20	46	TBD	Call TI	Level-2-220C-1 YEAR
UC3846QTR	ACTIVE	PLCC	FN	20	1000	TBD	Call TI	Level-2-220C-1 YEAR
UC3847DW	ACTIVE	SOIC	DW	16	40	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3847DWTR	ACTIVE	SOIC	DW	16	2000	TBD	CU NIPDAU	Level-2-220C-1 YEAR
UC3847J	OBSOLETE	CDIP	J	16		TBD	Call TI	Call TI
UC3847N	ACTIVE	PDIP	N	16	25	TBD	CU NIPDAU	Level-NA-NA-NA

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DSP	dsp.ti.com	Broadband	www.ti.com/broadband
Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
		Telephony	www.ti.com/telephony
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

Copyright © 2005, Texas Instruments Incorporated