



Improved Current Mode PWM Controller

FEATURES

- Pin-for-Pin Compatible With the UC3846
- 65ns Typical Delay From Shutdown to Outputs, and 50ns Typical Delay From Sync to Outputs
- Improved Current Sense Amplifier With Reduced Noise Sensitivity
- Differential Current Sense with 3V Common Mode Range
- Trimmed Oscillator Discharge Current for Accurate Deadband Control
- Accurate 1V Shutdown Threshold
- High Current Dual Totem Pole Outputs (1.5A peak)
- TTL Compatible Oscillator SYNC Pin Thresholds
- 4kV ESD Protection

DESCRIPTION

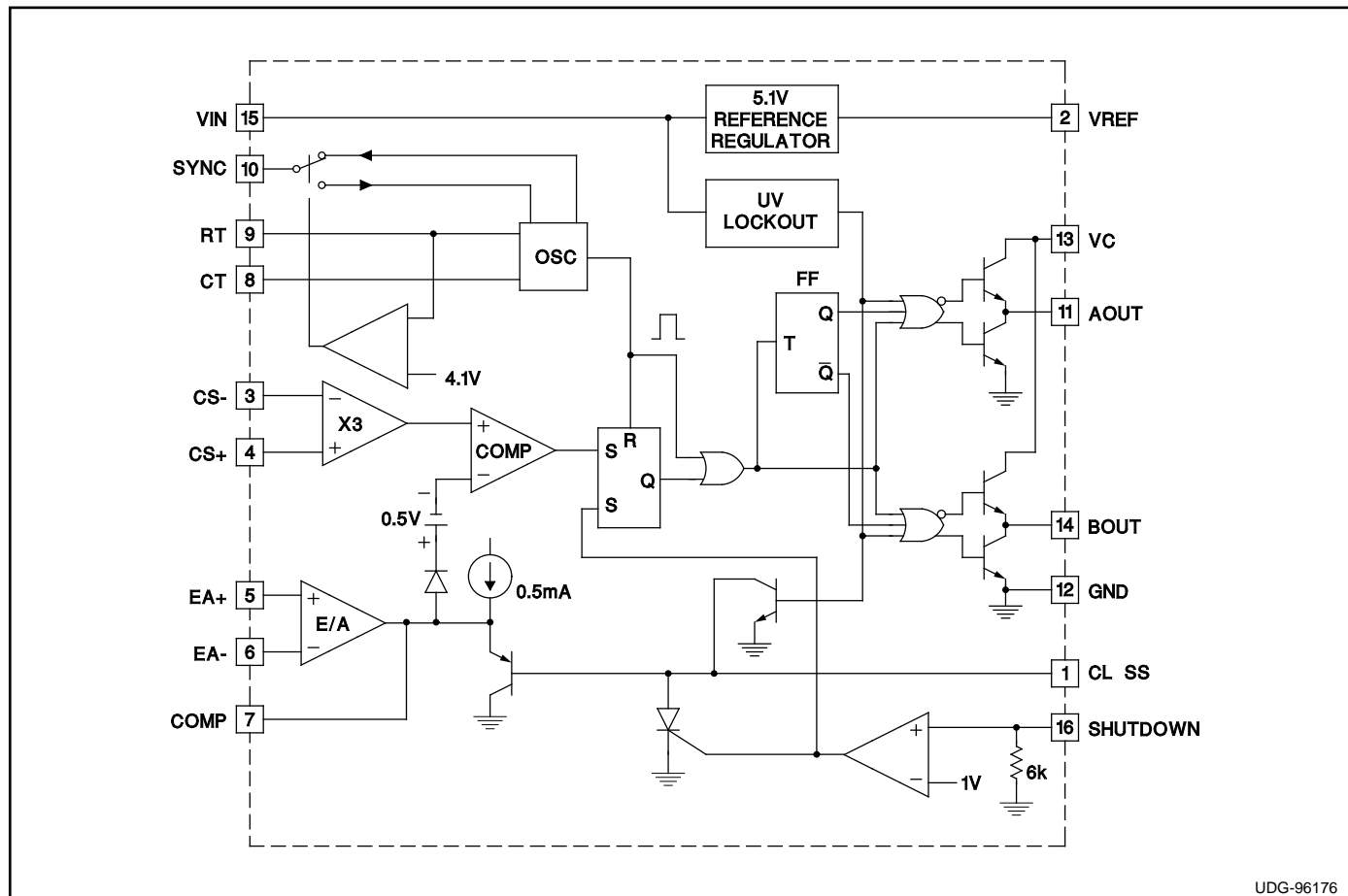
The UC3856 is a high performance version of the popular UC3846 series of current mode controllers, and is intended for both design upgrades and new applications where speed and accuracy are important. All input to output delays have been minimized, and the current sense output is slew rate limited to reduce noise sensitivity. Fast 1.5A peak output stages have been added to allow rapid switching of power FETs.

A low impedance TTL compatible sync output has been implemented with a tri-state function when used as a sync input.

Internal chip grounding has been improved to minimize internal "noise" caused when driving large capacitive loads. This, in conjunction with the improved differential current sense amplifier results in enhanced noise immunity.

Other features include a trimmed oscillator current (8%) for accurate frequency and dead time control; a 1V, 5% shutdown threshold; and 4kV minimum ESD protection on all pins.

BLOCK DIAGRAM



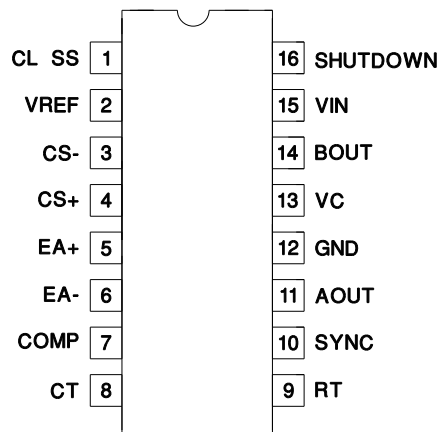
ABSOLUTE MAXIMUM RATINGS

Supply Voltage	+40V
Collector Supply Voltage	+40V
Output Current, Source or Sink	
DC	0.5A
Pulse (0.5μs)	2.0A
Error Amp Inputs	−0.3V to +V _{IN}
Shutdown Input	−0.3V to +10V
Current Sense Inputs	−0.3V to +3V
SYNC Output Current	±10mA
Error Amplifier Output Current	−5mA
Soft Start Sink Current	50mA
Oscillator Charging Current	5mA
Power Dissipation at T _A = 25°C (Note 2)	1000mW
Power Dissipation at T _C = 25°C (Note 2)	2000mW
Junction Temperature	−55°C to +150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	+300°C

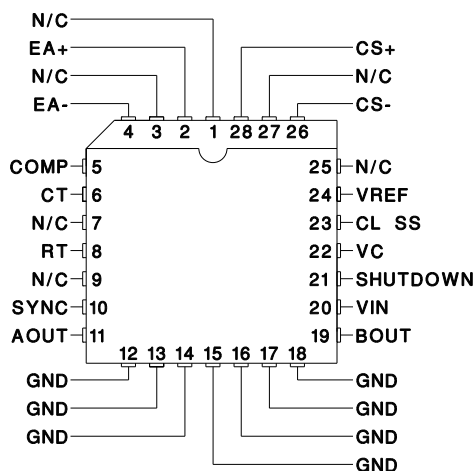
All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Consult packaging section of databook for thermal limitations and considerations of package.

CONNECTION DIAGRAMS

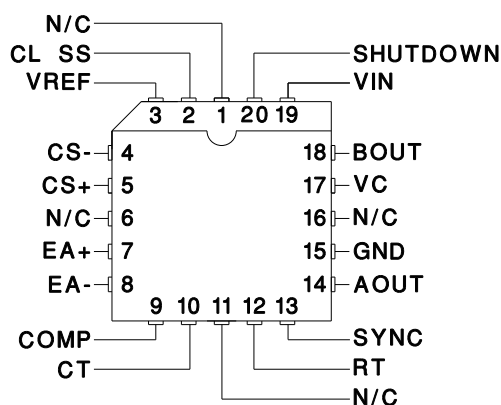
DIL-16, SOIC-16 (Top View)
J or N, DW PACKAGE



PLCC-28 (Top View)
QP PACKAGE



PLCC-20 (Top View)
Q PACKAGE



ELECTRICAL CHARACTERISTICS Unless otherwise stated, these specifications apply for T_A = −55°C to +125°C for UC1856; −40°C to +85°C for the UC2856; and 0°C to +70°C for the UC3856, V_{IN} = 15V, R_T = 10k, C_T = 1nF, T_A = T_J.

PARAMETER	TEST CONDITIONS	UC1856/UC2856			UC3856			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			20			20	mV
Load Regulation	I _o = −1mA to −10mA			15			15	mV
Total Output Variation	Line, Load, and Temperature	5.00		5.20	4.95		5.25	V
Output Noise Voltage	10Hz < f < 10kHz, T _J = 25°C		50			50		μV
Long Term Stability	T _J = 125°C, 1000 Hrs (Note 2)		5	25		5	25	mV
Short Circuit Current	V _{REF} = 0V	−25	−45	−65	−25	−45	−65	mA
Oscillator Section								
Initial Accuracy	T _J = 25°C	180	200	220	180	200	220	kHz
	Over Operating Range	170		230	170		230	kHz

ELECTRICAL CHARACTERISTICS (cont.) Unless otherwise stated, these specifications apply for $T_A = -55^{\circ}\text{C}$ to $+125^{\circ}\text{C}$ for UC1856; -40°C to $+85^{\circ}\text{C}$ for the UC2856; and 0°C to $+70^{\circ}\text{C}$ for the UC3856, $V_{IN} = 15\text{V}$, $R_T = 10\text{k}$, $C_T = 1\text{nF}$, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1856/UC2856			UC3856			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Oscillator Section (cont.)								
Voltage Stability	VIN = 8V to 40V			2			2	%
Discharge Current	TJ = 25°C, VCT = 2V	7.5	8.0	8.8	7.5	8.0	8.8	mA
	VCT = 2V	6.7	8.0	8.8	6.7	8.0	8.8	mA
Sync Output High Level	Io = −1mA	2.4	3.6		2.4	3.6		V
Sync Output Low Level	Io = +1mA		0.2	0.4		0.2	0.4	V
Sync Input High Level	CT = 0V, RT = VREF	2.0	1.5		2.0	1.5		V
Sync Input Low Level	CT = 0V, RT = VREF		1.5	0.8		1.5	0.8	V
Sync Input Current	CT = 0V, RT = VREF VSYNC = 5V		1	10		1	10	μA
Sync Delay to Outputs	CT = 0V, RT = VREF VSYNC = 0.8V to 2V		50	100		50	100	ns
Error Amplifier Section								
Input Offset Voltage	VCM = 2V			5			10	mV
Input Bias Current				−1			−1	μA
Input Offset Current				500			500	nA
Common Mode Range	VIN = 8V to 40V	0		VIN − 2	0		VIN − 2	V
Open Loop Gain	Vo = 1.2V to 3V	80	100		80	100		dB
Unity Gain Bandwidth	TJ = 25°C	1	1.5		1	1.5		MHz
CMRR	VCM = 0V to 38V, VIN = 40V	75	100		75	100		dB
PSRR	VIN = 8V to 40V	80	100		80	100		dB
Output Sink Current	VID = −15mV, VCOMP = 1.2V	5	10		5	10		mA
Output Source Current	VID = 15mV, VCOMP = 2.5V	−0.4	−0.5		−0.4	−0.5		mA
Output High Level	VID = 50mV, RL (COMP) = 15k	4.3	4.6	4.9	4.3	4.6	4.9	V
Output Low Level	VID = −50mV, RL (COMP) = 15k		0.7	1		0.7	1	V
Current Sense Amplifier Section								
Amplifier Gain	VCS− = 0V, CL SS Open (Notes 3,4)	2.5	2.75	3.0	2.5	2.75	3.0	V/V
Maximum Differential Input Signal (Vcs+ − Vcs-)	CL SS Open (Note 3) RL (COMP) = 15k	1.1	1.2		1.1	1.2		V
Input Offset Voltage	VCL SS = 0.5V COMP Open (Note 3)		5	35		5	35	mV
CMRR	VCM = 0V to 3V	60			60			dB
PSRR	VIN = 8V to 40V	60			60			dB
Input Bias Current	VCL SS = 0.5V, COMP Open (Note 3)			−1	−3	−1	−3	μA
Input Offset Current	VCL SS = 0.5V, COMP Open (Note 3)			1			1	mA
Input Common Mode Range		0		3	0		3	V
Delay to Outputs	VEA+ = VREF, EA− = 0V CS+ − CS− = 0V to 1.5V		120	250		120	250	ns
Current Limit Adjust Section								
Current Limit Offset	VCS− = 0V VCS+ = 0V, COMP = Open (Note 3)	0.43	0.5	0.57	0.43	0.5	0.57	V
Input Bias Current	VEA+ = VREF, VEA− = 0V		−10	−30		−10	−30	μA
Shutdown Terminal Section								
Threshold Voltage		0.95	1.00	1.05	0.95	1.00	1.05	V
Input Voltage Range		0		5	0		5	V

ELECTRICAL CHARACTERISTICS (cont.) Unless otherwise stated, these specifications apply for $T_A = -55^\circ\text{C}$ to $+125^\circ\text{C}$ for UC1856; -40°C to $+85^\circ\text{C}$ for the UC2856; and 0°C to $+70^\circ\text{C}$ for the UC3856, $V_{IN} = 15\text{V}$, $R_T = 10\text{k}$, $C_T = 1\text{nF}$, $T_A = T_J$.

PARAMETER	TEST CONDITIONS	UC1856/UC2856			UC3856			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
Shutdown Terminal Section (cont.)								
Minimum Latching Current (I _{CL SS})	(Note 5)	3	1.5		3	1.5		mA
Maximum Non-Latching Current (I _{CL SS})	(Note 6)		1.5	0.8		1.5	0.8	mA
Delay to Outputs	V _{SHUTDOWN} = 0 to 1.3V		65	110		65	110	ns
Output Section								
Collector-Emitter Voltage		40			40			V
Off-State Bias Current	V _C = 40V			250			250	μA
Output Low Level	I _{OUT} = 20mA		0.1	0.5		0.1	0.5	V
	I _{OUT} = 200mA		0.5	2.6		0.5	2.6	V
Output High Level	I _{OUT} = −20mA	12.5	13.2		12.5	13.2		V
	I _{OUT} = −200mA	12	13.1		12	13.1		V
Rise Time	C ₁ = 1nF		40	80		40	80	ns
Fall Time	C ₁ = 1nF		40	80		40	80	ns
UVLO Low Saturation	V _{IN} = 0V, I _{OUT} = 20mA		0.8	1.5		0.8	1.5	V
PWM Section								
Maximum Duty Cycle		45	47	50	45	47	50	%
Minimum Duty Cycle				0			0	%
Undervoltage Lockout Section								
Startup Threshold			7.7	8.0		7.7	8.0	V
Threshold Hysteresis			0.7			0.7		V
Total Standby Current								
Supply Current			18	23		18	23	mA

Note 1: All voltages are with respect to GND. Currents are positive into, negative out of the specified terminal.

Note 2: This parameter, although guaranteed over the recommended operating conditions is not 100% tested in production.

Note 3: Parameter measured at trip point of latch with $V_{EA+} = V_{REF}$, $V_{EA-} = 0\text{V}$.

Note 4: Amplifier gain defined as:

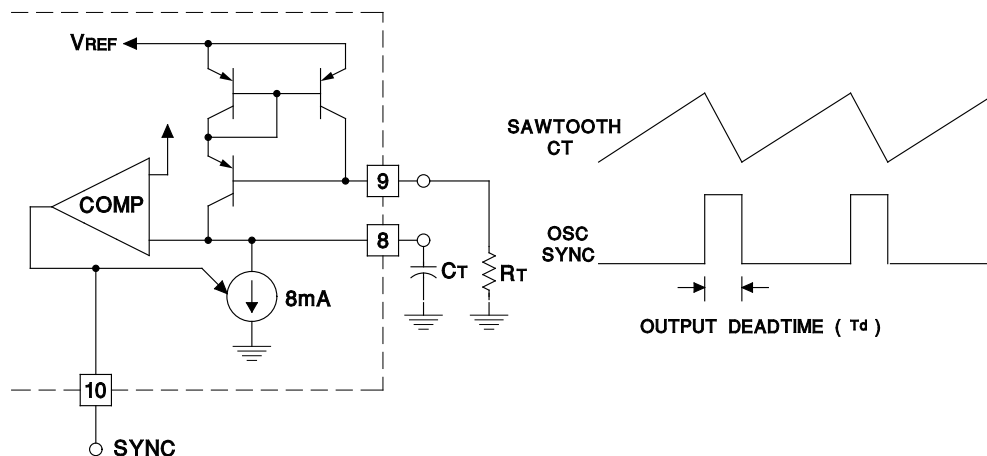
$$G = \frac{\Delta V_{COMP}}{\Delta V_{CS+}}; \quad \Delta V_{CS-} = 0\text{V to } 1.0\text{V}$$

Note 5: Current into CL SS guaranteed to latch circuit into shutdown state.

Note 6: Current into CL SS guaranteed not to latch circuit into shutdown state.

APPLICATIONS INFORMATION

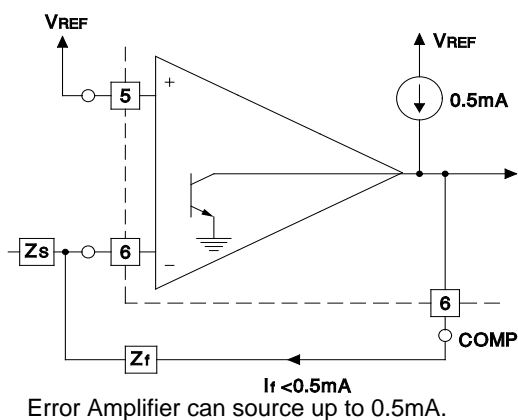
Oscillator Circuit



Output deadtime is determined by size of the external capacitor, C_T , according to the formula: $T_d = \frac{2C_T}{8mA - \frac{3.6}{R_T}}$
 For large values of R_T : $T_d = 250C_T$
 Oscillator frequency is approximated by the formula: $f_T = \frac{2}{R_T C_T}$

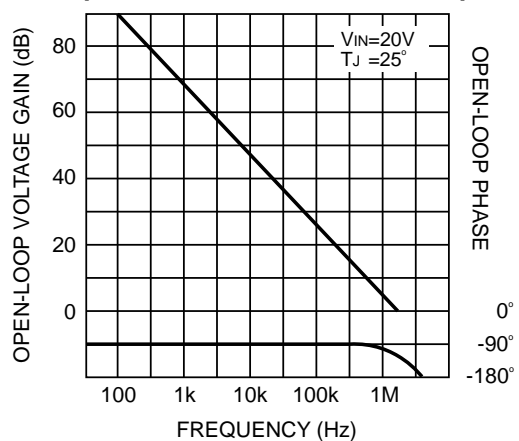
UDG-96177

Error Amplifier Output Configuration



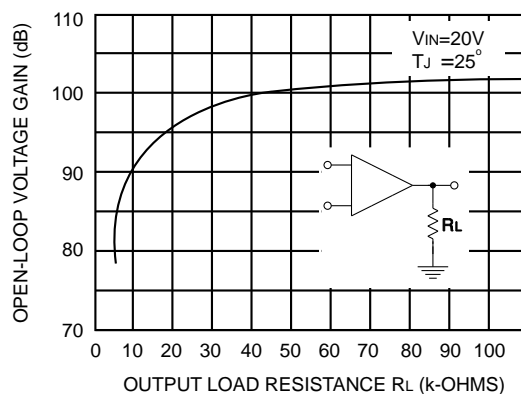
UDG-96178

Error Amplifier Gain and Phase vs Frequency



UDG-96179

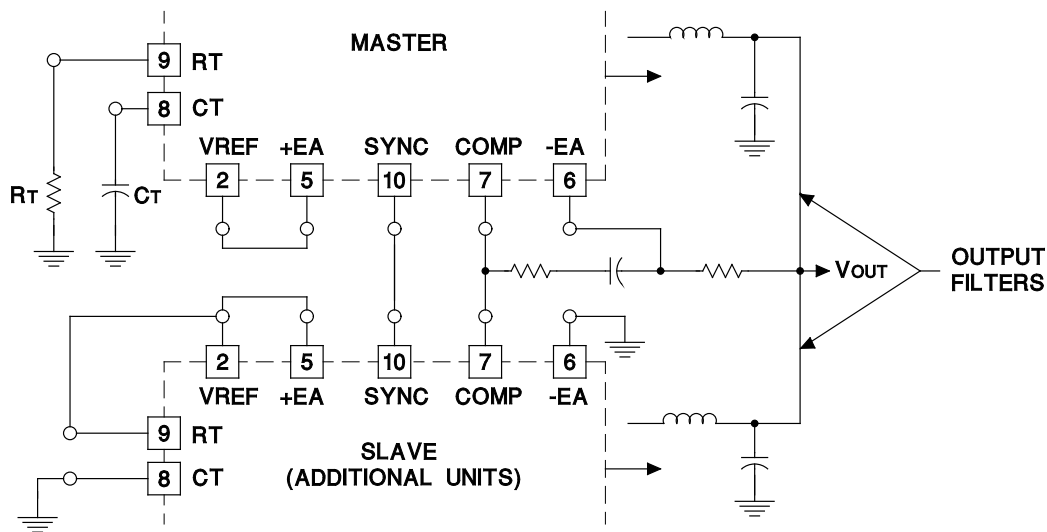
Error Amplifier Open-Loop D.C. Gain vs Load Resistance



UDG-96180

APPLICATIONS INFORMATION (cont.)

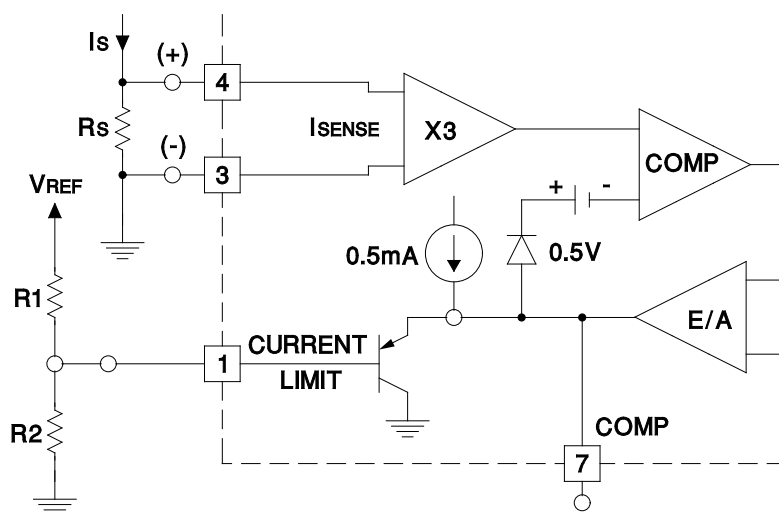
Parallel Operation



Slaving allows parallel operation of two or more units with equal current sharing.

UDG-96181

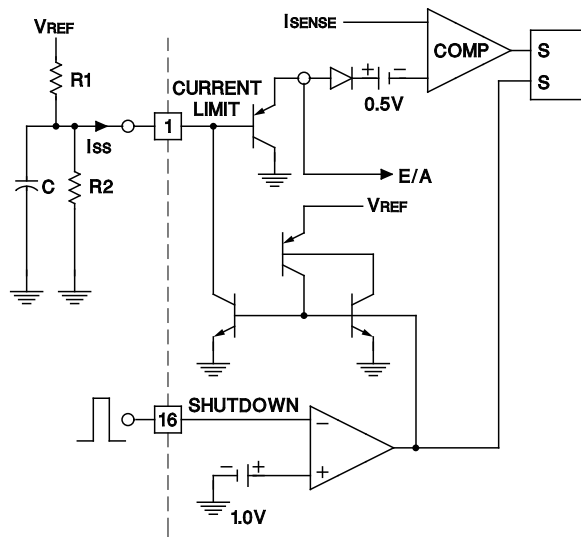
Pulse by Pulse Current Limiting



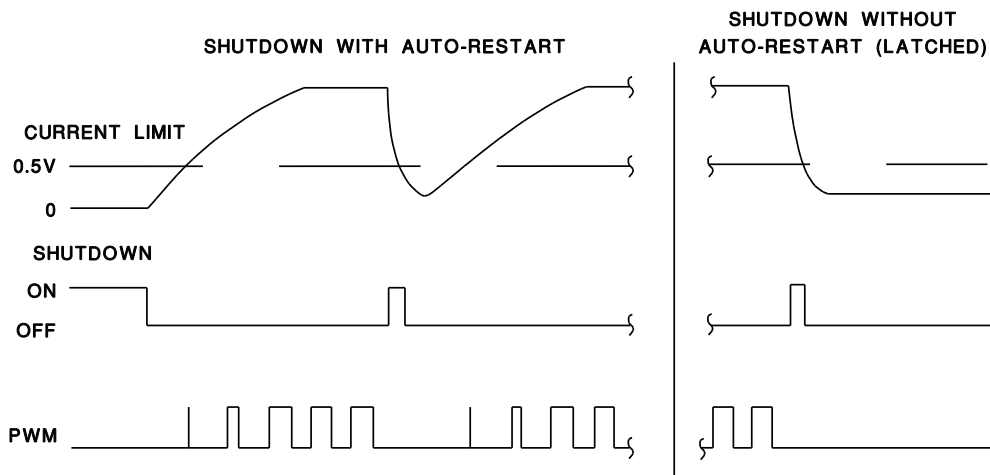
Peak current (I_s) is determined by the formula:
$$I_s = \frac{\left(\frac{R_2 V_{REF}}{R_1 + R_2} \right) - 0.5}{3R_s}$$

UDG-96182

APPLICATIONS DATA (cont.)



UDG-96183

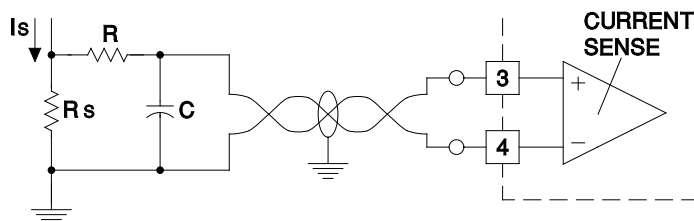


UDG-96184

If $\frac{V_{REF}}{R1} < 0.8\text{mA}$, the shutdown latch will commutate when $I_{SS} = 0.8\text{mA}$ and a restart cycle will be initiated.

If $\frac{V_{REF}}{R1} < 3\text{mA}$, the device will latch off until power is recycled.

Current Sense Amplifier Connections

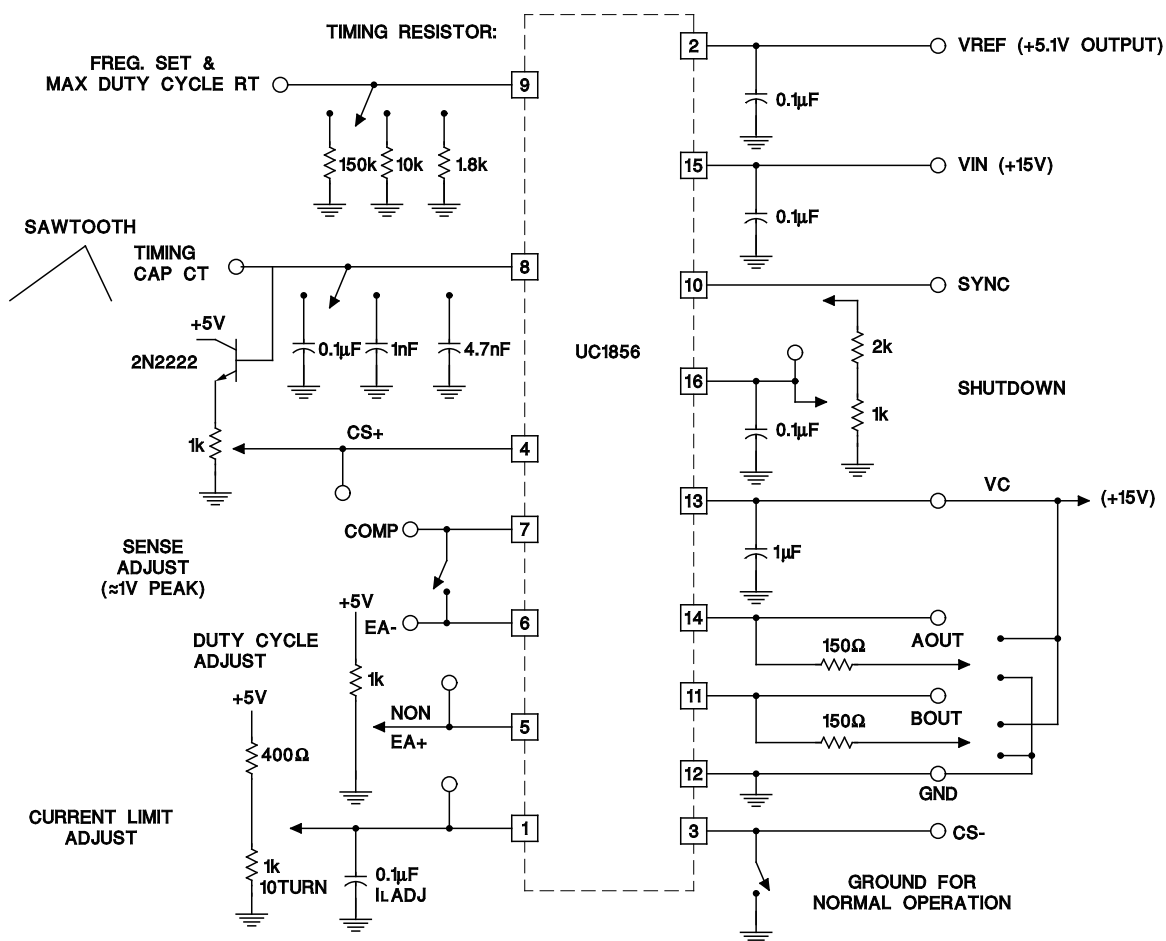


A small RC filter may be required in some applications to reduce switch transients. Differential input allows remote, noise sensing.

UDG-96185

APPLICATIONS INFORMATION (cont.)

UC1856 Open Loop Test Circuit



- BYPASS CAPS SHOULD BE LOW ESR & ESL TYPE
- SHORT E/A- & COMP FOR UNITY GAIN TESTING

THE USE OF A GROUND PLANE IS HIGHLY RECOMMENDED

UDG-96186

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

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

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.