

UC184xA-SP QML Class V、電流モード PWM コントローラ

1 特長

- QML Class V (QMLV)認定済み、SMD 5962-86704
- 放射線耐性: 30krad(Si) TID ⁽¹⁾ (2)
- オフラインおよびDC/DCコンバータ用に最適化
- 低いスタートアップ電流(0.5mA未満)
- トリムされた発振器放電電流
- 自動的なフィードフォワード補償
- パルス単位の電流制限
- 拡張された負荷応答特性
- ヒステリシス付きの低電圧誤動作防止(UVLO)
- ダブル・パルス抑制
- 大電流トータムポール出力
- 内部トリム付きのバンドギャップ参照
- 500kHzでの動作
- 低R_Oのエラー・アンプ

2 アプリケーション

- DC/DCコンバータ
- 各種のトポロジをサポート
 - フライバック、フォワード、降圧、昇圧
 - 外部インターフェイス回路付きのプッシュプル、ハーフブリッジ、フルブリッジ
- 軍用温度範囲(-55°C~125°C)で利用可能

3 概要

UC184xA-SPファミリのコントロールICは、UC184xファミリとピン互換の強化版です。このデバイスは、電流モード・スイッチング・モード電源のコントロールに必要な特性を提供し、機能が拡張されています。スタートアップ電流は0.5mA未満に規定され、発振器放電は8.3mAにトリムされています。UVLO時には、5V以上のV_{CC}について、出力ステージは1.2V未満で最低10mAをシンクします。

デバイス比較表には、このファミリのメンバ間の相違点が示されています。放射線強化版が利用可能かどうか、および注文方法については、各製品のデータシートを参照してください。

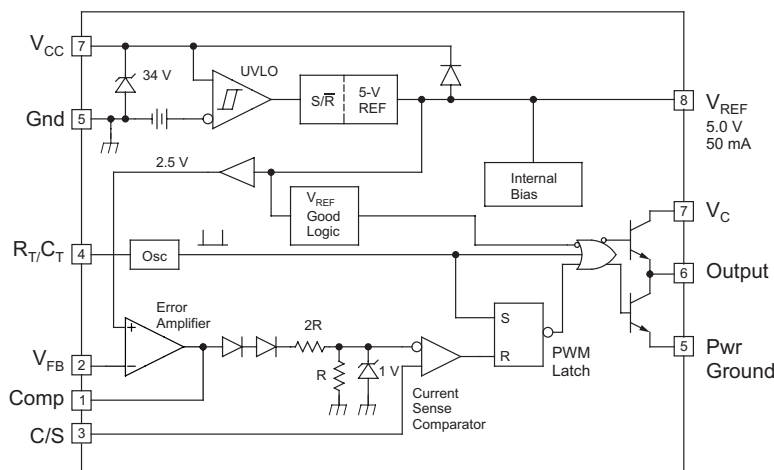
製品情報⁽¹⁾

型番	パッケージ	本体サイズ(公称)
UC1842A-SP	CDIP (8)	6.67mm×9.60mm
UC1844A-SP	LCCC (20)	8.89mm×8.89mm

- (1) LDRが強化されたダイはUC1843A-SPでのみ利用可能(5962-8670409VPAとして注文可能)です。UC1842A-SPおよびUC1844A-SPのLDR強化バージョンについては、工場へお問い合わせください。
- (2) 放射線耐性は、線量率 = 10 mrad(Si)/sの初期デバイス認定に基づく標準値です。放射線ロット受け入れテストも実施可能です。詳しくは工場にお問い合わせください。

- (1) 提供されているすべてのパッケージについては、巻末の注文情報を参照してください。

概略回路図



目次

1	特長	1	8.3	Feature Description	9
2	アプリケーション	1	8.4	Device Functional Modes	14
3	概要	1	9	Application and Implementation	15
4	改訂履歴	2	9.1	Application Information	15
5	Device Comparison Table	3	9.2	Typical Application	15
6	Pin Configuration and Functions	3	10	Power Supply Recommendations	23
7	Specifications	4	11	Layout	23
7.1	Absolute Maximum Ratings	4	11.1	Layout Guidelines	23
7.2	ESD Ratings	4	11.2	Layout Example	24
7.3	Recommended Operating Conditions	4	12	デバイスおよびドキュメントのサポート	25
7.4	Thermal Information	4	12.1	関連リンク	25
7.5	Electrical Characteristics	5	12.2	ドキュメントの更新通知を受け取る方法	25
7.6	Electrical Characteristics (Radiation-Improved Devices)	7	12.3	コミュニティ・リソース	25
7.7	Typical Characteristics	8	12.4	商標	25
8	Detailed Description	9	12.5	静電気放電に関する注意事項	25
8.1	Overview	9	12.6	Glossary	25
8.2	Functional Block Diagram	9	13	メカニカル、パッケージ、および注文情報	25

4 改訂履歴

Revision D (May 2015) から Revision E に変更		Page
•	データシートから UC1843A-SP 製品を削除	1
•	Changed the <i>Pin Configuration</i> images	3
•	Changed CT (pF) To: CT (μF) in Equation 1	17

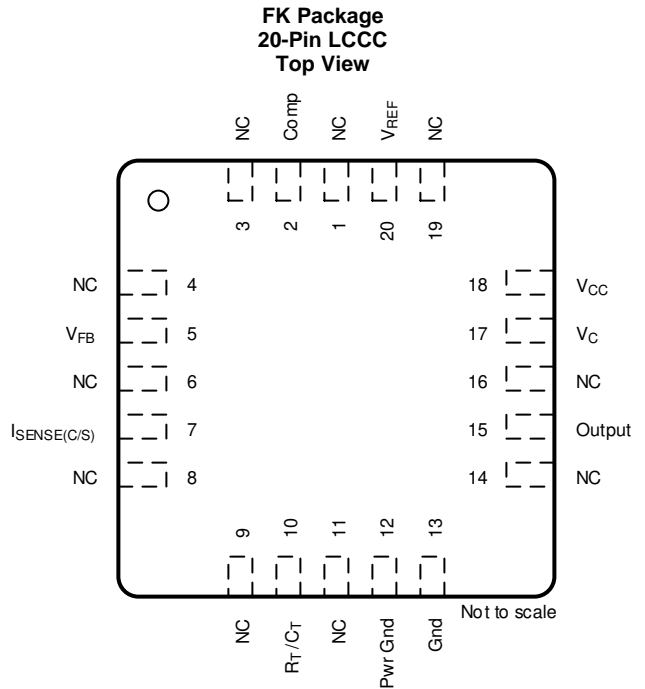
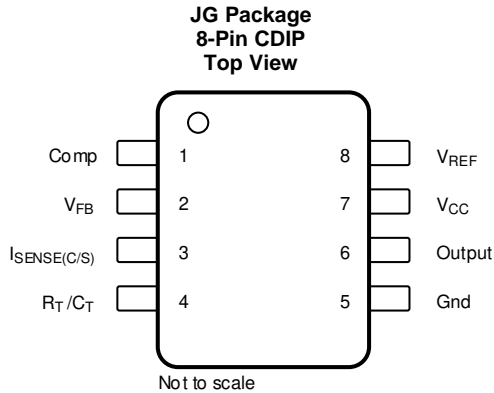
Revision C (March 2015) から Revision D に変更		Page
•	特長を更新し、放射線耐性の保証を削除	1
•	Updated table notes for Electrical Characteristics	5
•	Updated table note in Electrical Characteristics (Radiation-Improved Devices)	7
•	Corrected minimum discharge current in Electrical Characteristics (Radiation-Improved Devices)	7
•	Corrected input voltage unit to V and MIN and MAX values	7
•	Decreased set point variation over temperature from ±10% to ±2%	13

Revision B (October 2013) から Revision C に変更		Page
•	「ESD定格」表、「代表的特性」セクション、「詳細説明」セクション、「アプリケーションと実装」セクション、「電源に関する推奨事項」セクション、「レイアウト」セクション、「デバイスおよびドキュメントのサポート」セクション 追加	1
•	データシートから UC1845A-SP 製品を削除	1

5 Device Comparison Table

PART NO.	UVLO ON	UVLO OFF	MAXIMUM DUTY CYCLE
UC1842A	16 V	10 V	<100%
UC1843A	8.5 V	7.9 V	<100%
UC1844A	16 V	10 V	<50%

6 Pin Configuration and Functions



Pin Functions

NAME	PIN		I/O	DESCRIPTION
	CDIP	LCCC		
Comp	1	2	I	Error amplifier output.
V _{FB}	2	5	I	Voltage feedback input to error amplifier.
I _{SENSE(C/S)}	3	7	I	Current sense comparator input pin.
R _T /C _T	4	10	I	RC time constant input to oscillator.
NC	—	1, 3, 4, 6, 8, 9, 11, 14, 16, 19	—	No connect.
Pwr Gnd	—	12	—	Output section ground.
Gnd	5	13	—	Ground.
Output	6	15	O	Regulated output.
V _C	—	17	—	Output section supply voltage.
V _{CC}	7	18	—	Unregulated supply voltage.
V _{REF}	8	20	O	5-V internally generated reference.

7 Specifications

7.1 Absolute Maximum Ratings⁽¹⁾⁽²⁾

over operating free-air temperature (unless otherwise noted)

		MIN	MAX	UNIT
V _{CC}	Supply voltage, low-impedance source		30	V
V _I	Input voltage (V _{FB} , I _{SENSE})	-0.3	6.3	V
	Supply current	Self limiting		
I _O	Output current		±1	A
	Error amplifier output sink current		10	mA
	Output energy (capacitive load)		5	μJ
P _D	Power dissipation (T _A = 25°C)		1	W
T _{stg}	Storage temperature	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to ground. Currents are positive in, negative out of the specified terminal.

7.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±4000	V

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

over operating free-air temperature range (T_A = T_J = -55°C to 125°C), unless otherwise noted

		MIN	MAX	UNIT
V _{CC}	Supply voltage	12	25	V
	Sink/source output current (continuous or time average)	0	200	mA
	Reference load current	0	20	mA

7.4 Thermal Information

THERMAL METRIC ⁽¹⁾	UC184xA-SP		UNIT	
	JG (CDIP)	FK (LCCC)		
	8 PINS	20 PINS		
R _{θJA}	Junction-to-ambient thermal resistance	103	—	°C/W
R _{θJC(bot)}	Junction-to-case (bottom) thermal resistance	9.6	9.0	°C/W
R _{θJB}	Junction-to-board thermal resistance	69.2	—	°C/W
ψ _{JT}	Junction-to-top characterization parameter	13.9	—	°C/W
ψ _{JB}	Junction-to-board characterization parameter	73	—	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

7.5 Electrical Characteristics

 $V_{CC} = 15\text{ V}^{(1)}$, $R_T = 10\text{ k}\Omega$, $C_T = 3.3\text{ nF}$, $T_A = T_J = -55^\circ\text{C}$ to 125°C (unless otherwise noted) ⁽²⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT	
REFERENCE						
Output voltage	$T_J = 25^\circ\text{C}$, $I_O = 1\text{ mA}$	4.95	5	5.06	V	
Line regulation	$V_{IN} = 12\text{ to }25\text{ V}$		6	20	mV	
Load regulation	$I_O = 1\text{ to }20\text{ mA}$		6	25	mV	
Temperature stability ⁽³⁾⁽⁴⁾			0.2	0.4	mV/°C	
Total output variation ⁽³⁾	Over line, load, and temperature	4.9		5.1	V	
Output noise voltage	$10\text{ Hz} \leq f \leq 10\text{ kHz}$, $T_J = 25^\circ\text{C}$		50		μV	
Long-term stability	1000 hours, $T_A = 125^\circ\text{C}^{(3)}$		5	25	mV	
Short-circuit output current		-30	-100	-180	mA	
OSCILLATOR						
Initial accuracy	$T_J = 25^\circ\text{C}^{(5)}$	47	52	57	kHz	
Voltage stability	$V_{CC} = 12\text{ to }25\text{ V}$		0.2%	1%		
Temperature stability	$T_A = \text{MIN to MAX}^{(3)}$		5%			
Amplitude peak-to-peak	V pin 4 ⁽³⁾		1.7		V	
Discharge current	V pin 4 = 2 V ⁽⁶⁾	$T_J = 25^\circ\text{C}$	7.8	8.3	8.8	mA
		$T_J = \text{Full range}$	7.5		8.8	mA
ERROR AMPLIFIER						
Input voltage	$V_{Comp} = 2.5\text{ V}$	2.45	2.50	2.55	V	
Input bias current			-0.3	-1	μA	
Open-loop voltage gain	$V_O = 2\text{ to }4\text{ V}$	65	90		dB	
Unity-gain bandwidth	$T_J = 25^\circ\text{C}^{(3)}$	0.7	1		MHz	
PSRR	$V_{CC} = 12\text{ to }25\text{ V}$	60	70		dB	
Output sink current	$V_{FB} = 2.7\text{ V}$, $V_{Comp} = 1.1\text{ V}$	2	6		mA	
Output source current	$V_{FB} = 2.3\text{ V}$, $V_{Comp} = 5\text{ V}$	-0.5	-0.8		mA	
High-level output voltage	$V_{FB} = 2.3\text{ V}$, $R_L = 15\text{ k}\Omega$ to ground	5	6		V	
Low-level output voltage	$V_{FB} = 2.7\text{ V}$, $R_L = 15\text{ k}\Omega$ to V_{REF}		0.7	1.1	V	
CURRENT SENSE						
Gain ⁽⁷⁾⁽⁸⁾		2.85	3	3.15	V/V	
Maximum input signal	$V_{Comp} = 5\text{ V}^{(7)}$	0.9	1	1.1	V	
PSRR	$V_{CC} = 12\text{ to }25\text{ V}^{(7)}$		70		dB	
Input bias current			-2	-10	μA	
Delay to output	$V_{ISENSE} = 0\text{ to }2\text{ V}^{(3)}$		150	300	ns	

(1) Adjust V_{CC} above the start threshold before setting at 15 V.

(2) Electrical table applicable to 5962-8670405, 5962-8670406, and 5962-8670407 device types.

(3) Parameters ensured by design and/or characterization, if not production tested.

(4) Temperature stability, sometimes referred to as average temperature coefficient, is described by the equation:
Temperature Stability = $(V_{REF}(\text{max}) - V_{REF}(\text{min})) / (T_J(\text{max}) - T_J(\text{min}))$. $V_{REF}(\text{max})$ and $V_{REF}(\text{min})$ are the maximum and minimum reference voltage measured over the appropriate temperature range. Note that the extremes in voltage do not necessarily occur at the extremes in temperature.

(5) Output frequency equals oscillator frequency for the UC1842A-SP and UC1843A-SP. Output frequency is one-half oscillator frequency for UC1844A.

(6) This parameter is measured with $R_T = 10\text{ k}\Omega$ to V_{REF} . This contributes approximately 300 μA of current to the measurement. The total current flowing into the R_T or C_T pin will be approximately 300 μA higher than the measured value.

(7) Parameter measured at trip point of latch with $V_{FB} = 0\text{ V}$.

(8) Gain defined as: $G = \Delta V_{Comp} / \Delta V_{ISENSE}$; $V_{ISENSE} = 0\text{ to }0.8\text{ V}$.

Electrical Characteristics (continued)
 $V_{CC} = 15\text{ V}^{(1)}$, $R_T = 10\text{ k}\Omega$, $C_T = 3.3\text{ nF}$, $T_A = T_J = -55^\circ\text{C}$ to 125°C (unless otherwise noted) ⁽²⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
OUTPUT					
Output low-level voltage	$I_{SINK} = 20\text{ mA}$		0.1	0.4	V
	$I_{SINK} = 200\text{ mA}$		1.5	2.2	
Output high-level voltage	$I_{SOURCE} = -20\text{ mA}$	13	13.5		V
	$I_{SOURCE} = -200\text{ mA}$	12	13.5		
Rise time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}^{(3)}$		50	150	ns
Fall time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}^{(3)}$		50	150	ns
UVLO saturation	$V_{CC} = 5\text{ V}$, $I_{SINK} = 10\text{ mA}$		0.7	1.2	V
UNDERVOLTAGE LOCKOUT					
Start threshold	UC1842A, UC1844A	15	16	17	V
	UC1843A	7.8	8.4	9	
Minimum operation voltage after turnon	UC1842A, UC1844A	9	10	11	V
	UC1843A	7	7.6	8.2	
PWM					
Maximum duty cycle	UC1842A, UC1843A	94%	96%	100%	
	UC1844A	47%	48%	50%	
Minimum duty cycle				0%	
TOTAL STANDBY CURRENT					
Start-up current			0.3	0.5	mA
Operating supply current	$V_{FB} = V_{ISENSE} = 0\text{ V}$		11	17	mA
V_{CC} Zener voltage	$I_{CC} = 25\text{ mA}$	30	34		V

7.6 Electrical Characteristics (Radiation-Improved Devices)

 $V_{CC} = 15\text{ V}$, $R_T = 10\text{ k}\Omega$, $C_T = 3.3\text{ nF}$, $T_A = T_J = -55^\circ\text{C}$ to 125°C (unless otherwise noted) ⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
REFERENCE					
Output voltage	$T_J = 25^\circ\text{C}$, $I_O = 1\text{ mA}$	4.94	5	5.06	V
Line regulation	$V_{CC} = 12\text{ to }25\text{ V}$		6	20	mV
Load regulation	$I_L = 1\text{ to }20\text{ mA}$		6	25	mV
Total output variation	Over line, load, and temperature	4.9		5.1	V
Output noise voltage	$10\text{ Hz} \leq f \leq 10\text{ kHz}$, $T_J = 25^\circ\text{C}$		50		μV
Short-circuit output current		-30	-100	-180	mA
OSCILLATOR					
Initial accuracy	$T_J = 25^\circ\text{C}$	47	52	57	kHz
Voltage stability	$V_{CC} = 12\text{ to }25\text{ V}$		0.2%	1%	
Temperature stability	$T_J = -55^\circ\text{C}$ to 125°C		5%		
Amplitude	$V_{RT/CT}$ peak to peak		1.7		V
Discharge current ⁽²⁾	$T_J = 25^\circ\text{C}$, $V_{RT/CT} = 2\text{ V}$	7.8	8.3	8.8	mA
	$V_{RT/CT} = 2\text{ V}$	7.5		8.8	
ERROR AMPLIFIER					
Input voltage	$V_{Comp} = 2.5\text{ V}$	2.45	2.50	2.55	V
Input bias current			-0.3	-1	μA
Open-loop voltage gain	$V_O = 2\text{ to }4\text{ V}$	65	90		dB
Unity-gain bandwidth	$T_J = 25^\circ\text{C}$ ⁽³⁾	0.7	1		MHz
PSRR	$V_{CC} = 12\text{ to }25\text{ V}$	60	70		dB
Output sink current	$V_{FB} = 2.7\text{ V}$, $V_{Comp} = 1.1\text{ V}$	2	6		mA
Output source current	$V_{FB} = 2.3\text{ V}$, $V_{Comp} = 5\text{ V}$	-0.5	-0.8		mA
High-level output voltage	$V_{FB} = 2.3\text{ V}$, $R_L = 15\text{ k}\Omega$ to ground	5	6		V
Low-level output voltage	$V_{FB} = 2.7\text{ V}$, $R_L = 15\text{ k}\Omega$ to V_{REF}		0.7	1.1	V
CURRENT SENSE					
Gain ⁽⁴⁾ ⁽⁵⁾		2.85	3	3.15	V/V
Maximum input signal	$V_{Comp} = 5\text{ V}$ ⁽⁴⁾	0.9	1	1.1	V
PSRR	$V_{CC} = 12\text{ to }25\text{ V}$ ⁽⁴⁾		70		dB
Input bias current			-2	-10	μA
Delay to output	$V_{ISENSE} = 0\text{ to }2\text{ V}$ ⁽³⁾		150	300	ns
OUTPUT					
Output low-level voltage	$I_{SINK} = 20\text{ mA}$		0.1	0.4	V
	$I_{SINK} = 200\text{ mA}$		1.5	2.2	
Output high-level voltage	$I_{SOURCE} = 20\text{ mA}$	13	13.5		V
	$I_{SOURCE} = 200\text{ mA}$	12	13.0		
Rise time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}$ ⁽³⁾		50	150	ns
Fall time	$C_L = 1\text{ nF}$, $T_J = 25^\circ\text{C}$ ⁽³⁾		50	150	ns
UVLO saturation	$V_{CC} = 5\text{ V}$, $I_{SINK} = 10\text{ mA}$		0.7	1.2	V
UNDERVOLTAGE LOCKOUT					
Start threshold		7.8	8.4	9	V
Minimum operation voltage after turnon		7	7.6	8.2	V

(1) Electrical table applicable to radiation-improved 5962-8670409 device type

(2) This parameter is measured with $R_T = 10\text{ k}\Omega$ to V_{REF} . This contributes approximately 300 μA of current to the measurement. The total current flowing into the R_T or C_T pin will be approximately 300 μA higher than the measured value.

(3) Parameters ensured by design and/or characterization, if not production tested.

(4) Parameter measured at trip point of latch with $V_{FB} = 0\text{ V}$.

(5) Gain defined as: $G = \Delta V_{Comp} / \Delta V_{ISENSE}$; $V_{ISENSE} = 0\text{ to }0.8\text{ V}$.

Electrical Characteristics (Radiation-Improved Devices) (continued)

$V_{CC} = 15\text{ V}$, $R_T = 10\text{ k}\Omega$, $C_T = 3.3\text{ nF}$, $T_A = T_J = -55^\circ\text{C}$ to 125°C (unless otherwise noted) ⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
PWM					
Maximum duty cycle		94%	96%	100%	
Minimum duty cycle				0%	
TOTAL STANDBY CURRENT					
Start-up current			0.3	0.5	mA
Operating supply current	$V_{FB} = V_{ISENSE} = 0\text{ V}$		11	17	mA
V_{CC} Zener voltage	$I_{CC} = 25\text{ mA}$	30	34		V

7.7 Typical Characteristics

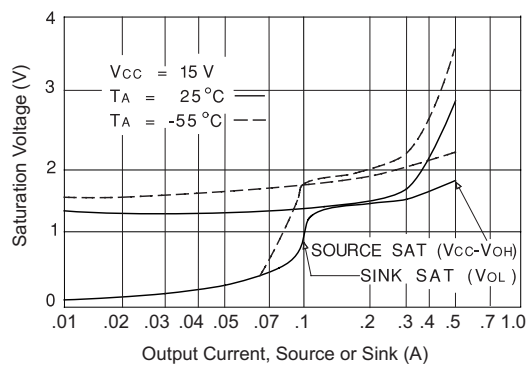


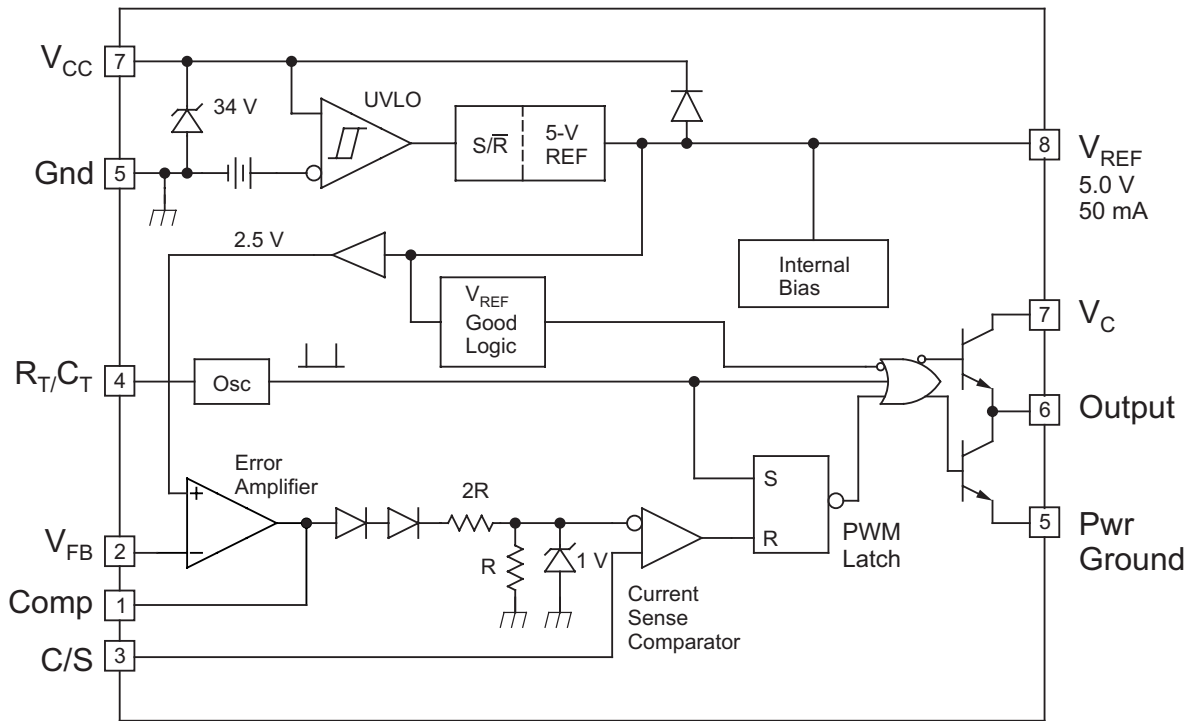
Figure 1. Output Saturation Characteristics

8 Detailed Description

8.1 Overview

The UC184xA-SP control IC is a pin-for-pin compatible improved version of the UC184x family. Providing the necessary characteristics to control current-mode switched-mode power supplies, this device has improved features. Start-up current is specified to be less than 0.5 mA and oscillator discharge is trimmed to 8.3 mA. During UVLO, the output stage can sink at least 10 mA at less than 1.2 V for V_{CC} over 5 V.

8.2 Functional Block Diagram



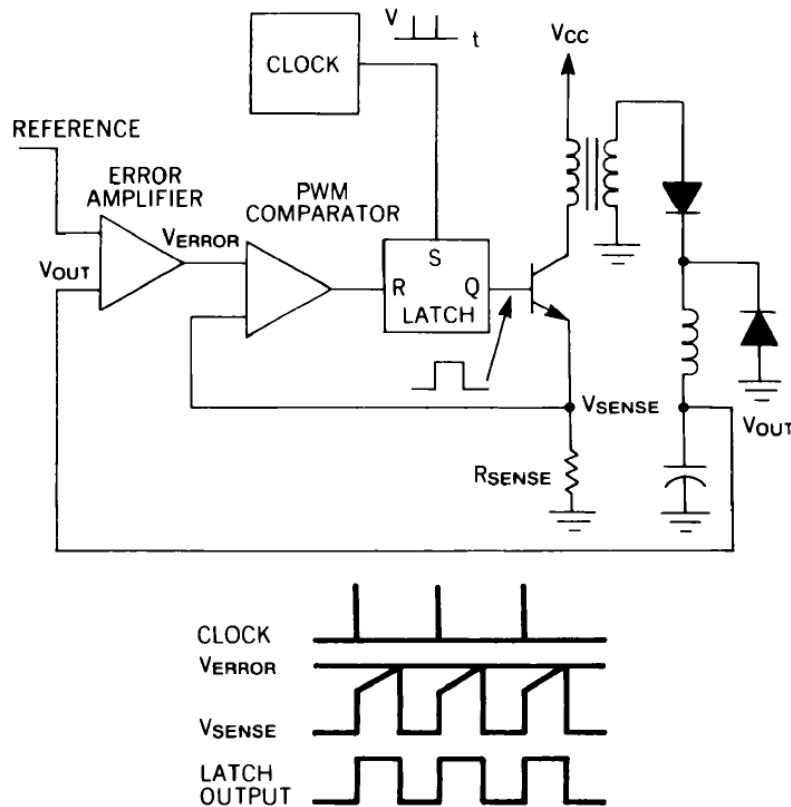
Copyright © 2016, Texas Instruments Incorporated

8.3 Feature Description

UC184xA-SP is a current mode controller, used to support various topologies such as forward, flyback, buck, boost and using an external interface circuit will also support half-bridge, full-bridge, and push-pull configurations.

Figure 2 shows the two-loop current-mode control system in a typical buck regulator application. A clock signal initiates power pulses at a fixed frequency. The termination of each pulse occurs when an analog of the inductor current reaches a threshold established by the error signal. In this way, the error signal actually controls peak inductor current. This contrasts with conventional schemes in which the error signal directly controls pulse width without regard to inductor current.

Several performance advantages result from the use of current-mode control. First, an input voltage feed-forward characteristic is achieved; that is, the control circuit instantaneously corrects for input voltage variations without using up any of the error amplifier's dynamic range. Therefore, line regulation is excellent and the error amplifier can be dedicated to correcting for load variations exclusively.

Feature Description (continued)


0019-1

Figure 2. Two-Loop Current-Mode Control System

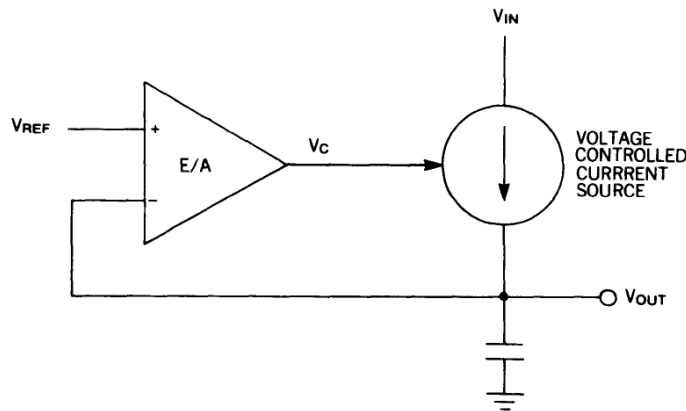
For converters in which inductor current is continuous, controlling peak current is nearly equivalent to controlling average current. Therefore, when such converters employ current-mode control, the inductor can be treated as an error-voltage-controlled-current-source for the purposes of small-signal analysis (see [Figure 3](#)). The two-pole control-to-output frequency response of these converters is reduced to a single-pole (filter capacitor in parallel with load) response. One result is that the error amplifier compensation can be designed to yield a stable closed-loop converter response with greater gain bandwidth than would be possible with pulse-width control, giving the supply improved small-signal dynamic response to changing loads. A second result is that the error amplifier compensation circuit becomes simpler, as shown in [Figure 4](#).

Capacitor C_i and resistor R_i , in [Figure 4\(A\)](#), add a low-frequency zero, which cancels one of the two control-to-output poles of non-current-mode converters. For large signal load changes, in which converter response is limited by inductor slew rate, the error amplifier saturates while the inductor is catching up with the load. During this time, C_i charges to an abnormal level. When the inductor current reaches its required level, the voltage on C_i causes a corresponding error in supply output voltage. The recovery time is $R_{iz}C_i$, which may be long. However, the compensation network of [Figure 4\(B\)](#) can be used where current-mode control has eliminated the inductor pole. Large-signal dynamic response is then greatly improved due to the absence of C_i .

Current limiting is greatly simplified with current-mode control. Pulse-by-pulse limiting is, of course, inherent in the control scheme. Furthermore, an upper limit on the peak current can be established by simply clamping the error voltage. Accurate current limiting allows optimization of magnetic and power semiconductor elements while ensuring reliable supply operation.

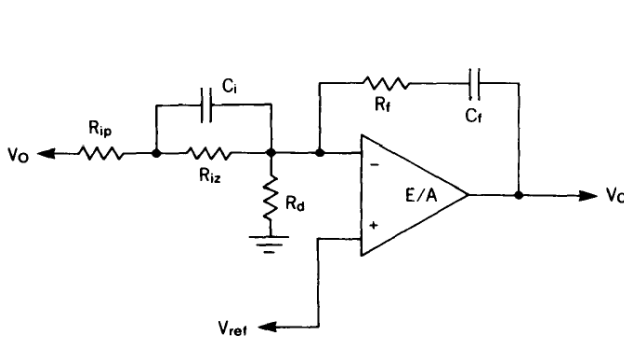
Finally, current-mode controlled power stages can be operated in parallel with equal current sharing. This opens the possibility of a modular approach to power supply design.

Feature Description (continued)



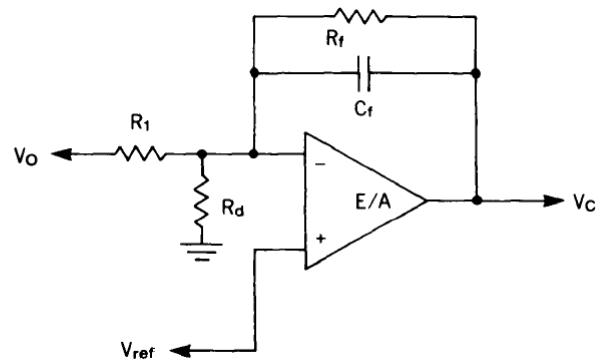
0019-2

Figure 3. Inductor Looks Like a Current Source to Small Signals



0019-3

A. Direct duty cycle control



0019-4

B. Current mode control

Figure 4. Required Error Amplifier Compensation for Continuous Inductor Current Designs

8.3.1 UVLO

The UVLO circuit ensures that V_{CC} is adequate to make the UC184xA-SP fully operational before enabling the output stage. Figure 5 shows that the UVLO turnon and turnoff thresholds are fixed internally at 16 V and 10 V, respectively. The 6-V hysteresis prevents V_{CC} oscillations during power sequencing.

Figure 6 shows supply current requirements. Start-up current is < 1 mA for efficient bootstrapping from the rectified input of an off-line converter, as shown in Figure 7. During normal circuit operation, V_{CC} is developed from auxiliary winding, $WAux$, with D_1 and C_{IN} . However, at start-up, C_{IN} must be charged to 16 V through R_{IN} . With a start-up current of 1 mA, R_{IN} can be as large as 100 k Ω and still charge C_{IN} when $V_{Ac} = 90$ -V RMS (low line). Power dissipation in R_{IN} would then be less than 350 mW even under high line ($V_{Ac} = 130$ -V RMS) conditions.

During UVLO, the output driver is in a low state. While it does not exhibit the same saturation characteristics as normal operation, it can easily sink 1 mA, enough to ensure the MOSFET is held off.

Feature Description (continued)

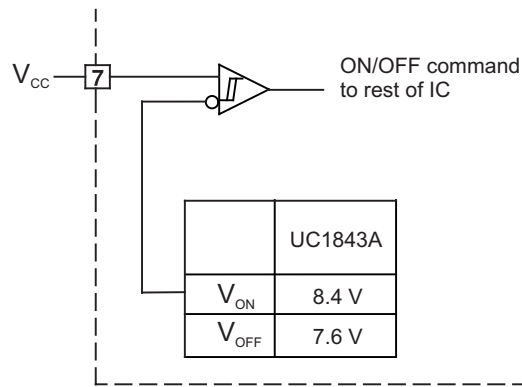
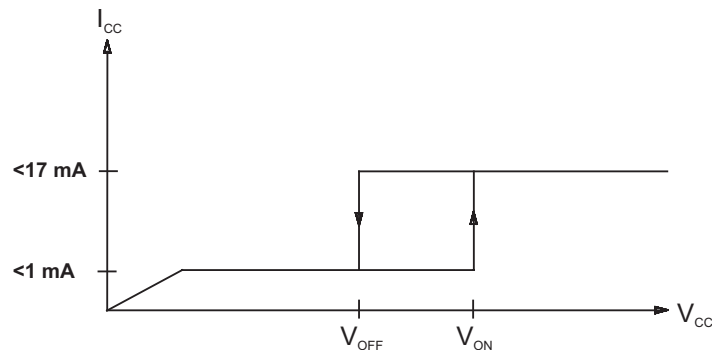
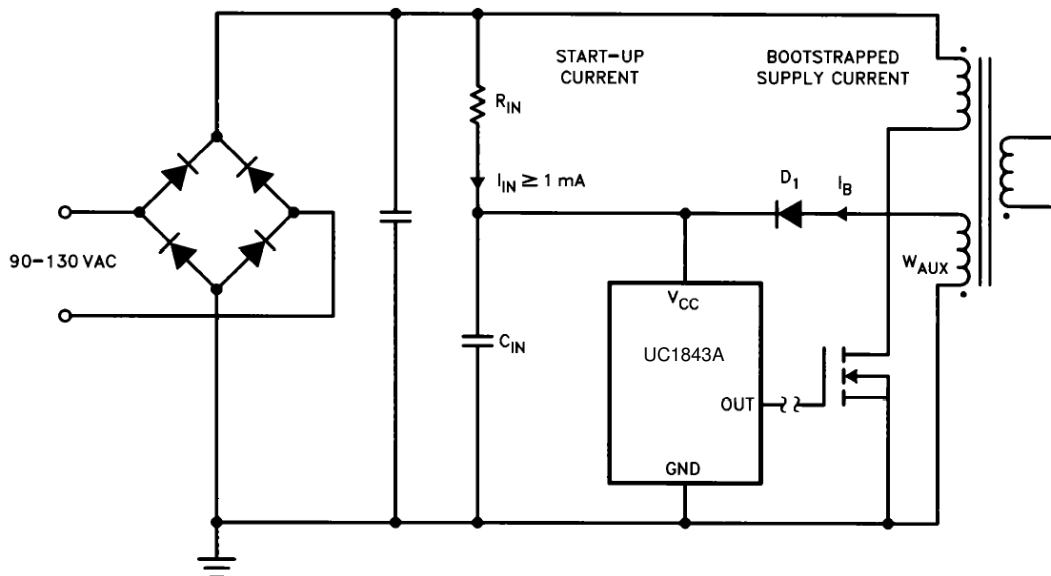


Figure 5. UVLO Turnon TurnOff Threshold



During UVLO, the output driver is biased to sink minor amounts of current.

Figure 6. Supply Current Requirements



0019-8

Figure 7. Providing Power to the UC184xA-SP

Feature Description (continued)

8.3.2 Reference

As highlighted in the [Functional Block Diagram](#), UC184xA-SP incorporates a 5-V internal reference regulator with $\pm 2\%$ set point variation over temperature.

8.3.3 Totem-Pole Output

The UC184xA-SP PWM has a single totem-pole output which can be operated to ± 1 -A peak for driving MOSFET gates, and a +200 mA average current for bipolar power U-100A transistors. Cross conduction between the output transistors is minimal, the average added power with $V_{IN} = 30$ V is only 80 mW at 200 kHz.

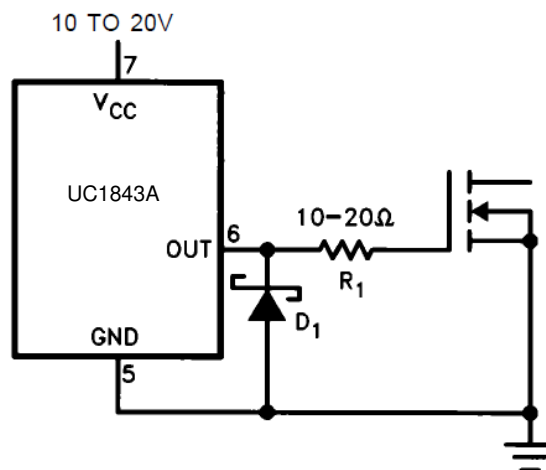
Limiting the peak current through the IC is accomplished by placing a resistor between the totem-pole output and the gate of the MOSFET. The value is determined by dividing the totem-pole collector voltage V_C by the peak current rating of the IC's totem-pole. Without this resistor, the peak current is limited only by the dV/dT rate of the totem-pole switching and the FET gate capacitance.

The use of a Schottky diode from the PWM output to ground prevents the output voltage from going excessively below ground, causing instabilities within the IC. To be effective, the diode selected should have a forward drop of less than 0.3 V at 200 mA. Most 1- to 3-A Schottky diodes exhibit these traits above room temperature. Placing the diode as physically close to the PWM as possible enhances circuit performance. Implementation of the complete drive scheme is shown in [Figure 8](#) through [Figure 10](#). Transformer-driven circuits also require the use of the Schottky diodes to prevent a similar set of circumstances from occurring on the PWM output. The ringing below ground is greatly enhanced by the transformer leakage inductance and parasitic capacitance, in addition to the magnetizing inductance and FET gate capacitance. Circuit implementation is similar to the previous example.

[Figure 8](#) through [Figure 10](#) show suggested circuits for driving MOSFETs and bipolar transistors with the UC184xA-SP output. The simple circuit of [Figure 8](#) can be used when the control IC is not electrically isolated from the MOSFET turnon and turnoff to ± 1 A. It also provides damping for a parasitic tank circuit formed by the FET input capacitance and series wiring inductance. Schottky diode, D_1 , prevents the output of the IC from going far below ground during turnoff.

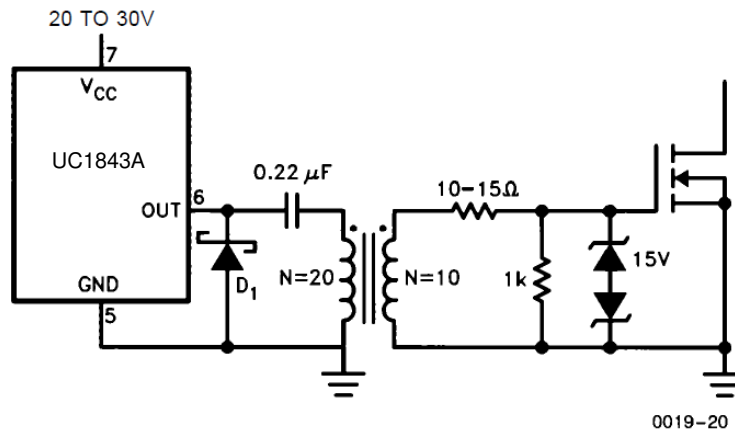
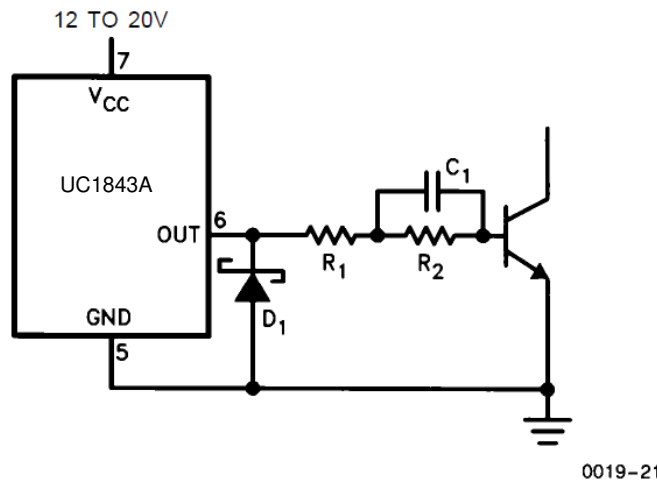
[Figure 9](#) shows an isolated MOSFET drive circuit which is appropriate when the drive signal must be level shifted or transmitted across an isolation boundary. Bipolar transistors can be driven efficiently with the circuit of [Figure 10](#). Resistors R_1 and R_2 fix the on-state base current while capacitor C_1 provides a negative base current pulse to remove stored charge at turnoff.

Because the UC184xA-SP series has only a single output, an interface circuit is needed to control push-pull, half-bridge, or full-bridge topologies. The UC1706 dual output driver with internal toggle flip-flop performs this function. [Typical Application](#) shows a typical application for these two ICs. Increased drive capability for driving numerous FETs in parallel, or other loads can be accomplished using one of the UC1705/6/7 driver ICs.



0019-19

Figure 8. Direct MOSFET Drive

Feature Description (continued)

Figure 9. Isolated MOSFET Drive

Figure 10. Bipolar Drive With Negative turnoff Bias
8.4 Device Functional Modes

The UC184xA-SP uses fixed frequency, peak current mode control. An internal oscillator initiates the turn on of the driver to high-side power switch. The external power switch current is sensed through an external resistor and is compared via internal comparator. The voltage generated at the COMP pin is stepped down via internal resistors (as shown in the functional block diagram). When the sensed current reaches the stepped down COMP voltage, the high-side power switch is turned off.

9 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

UC184xA-SP can be used as a controller to design various topologies such as buck, boost, flyback, and forward. Using an external interphase circuit can also support push-pull, half-bridge and full-bridge topologies.

9.2 Typical Application

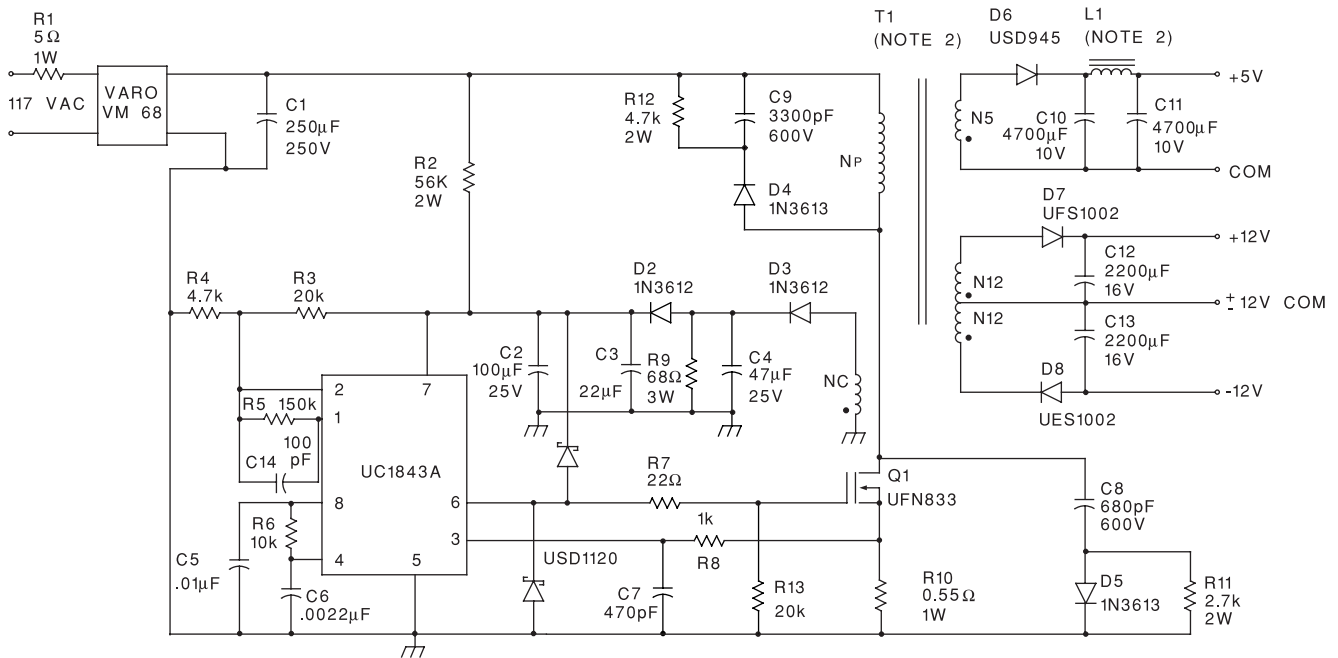


Figure 11. Typical Application Schematic

9.2.1 Design Requirements

See Table 1 for parameter values.

Table 1. Design Parameters⁽¹⁾

DESIGN PARAMETER	VALUE
Input voltage	95 VAC to 130 VAC
Line isolation	3750 V
Switching frequency	40 kHz
Efficiency (full load)	70%
Output voltage (A)	+5 V, ±5%; 1-A to 4-A load; Ripple voltage: 50-mV P-P max
Output voltage (B)	+12 V, ±3%; 0.1-A to 0.3-A load; Ripple voltage: 100-mV P-P max
Output voltage (C)	-12 V, ±3%; 0.1-A to 0.3-A load; Ripple voltage: 100-mV P-P max

(1) See Figure 11 for reference.

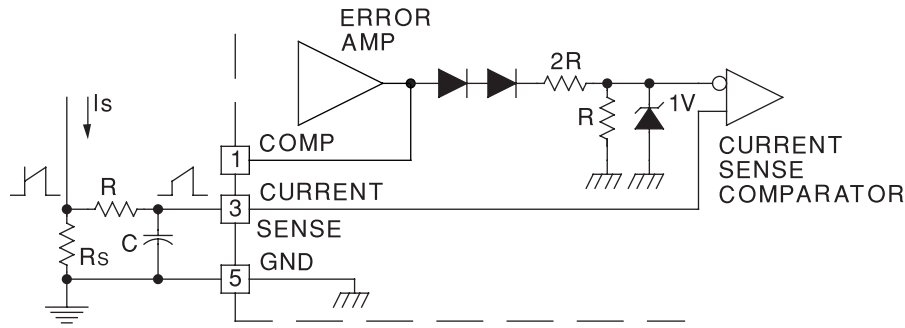
9.2.2 Detailed Design Procedure

See [Table 2](#) for component values.

Table 2. Components⁽¹⁾

COMPONENT	VALUE
R1	5 Ω , 1 W
R2	56 k Ω , 2 W
R3	20 k Ω
R4	4.7 k Ω
R5	150 k Ω
R6	10 k Ω
R7	22 Ω
R8	1 k Ω
R9	68 Ω
R10	0.55 Ω , 1 W
R11	2.7 k Ω , 2 W
R12	4.7 k Ω , 2 W
R13	20 k Ω
C1	250 μ F, 250 V
C2	100 μ F, 25 V
C3	22 μ F
C4	47 μ F, 25 V
C5	0.1 μ F
C6	0.0022 μ F
C7	470 pF
C8	680 pF, 600 V
C9	3300 pF, 600 V
C10	4700 μ F, 10 V
C11	4700 μ F, 10 V
C12	2200 μ F, 10 V
C13	2200 μ F, 10 V
C14	100 pF
D2	1N3612
D3	1N3612
D4	1N3613
D5	1N3613
D6	USD945
D7	UFS1002
D8	UES1002
Q1	UFN833

(1) See [Figure 11](#) for reference.

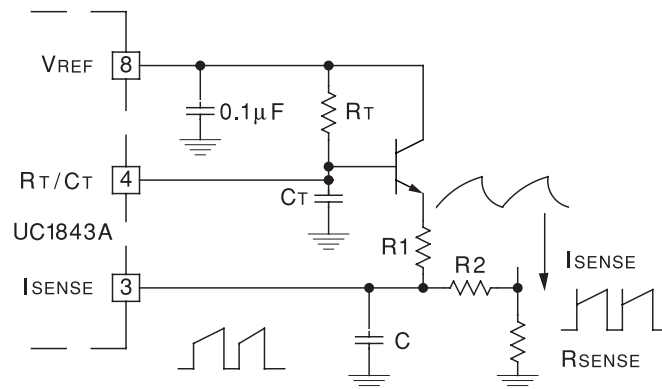


Peak Current (I_s) is determined by the formula:

$$I_{S\text{MAX}} = \frac{1.0 \text{ V}}{R_S}$$

A small RC filter may be required to suppress switch transients.

Figure 12. Current-Sense Circuit



NOTE: A fraction of the oscillator ramp can be resistively summed with the current sense signal to provide slope compensation for converters requiring duty cycles over 50%.

Capacitor, C, forms a filter with R2 to suppress the leading edge switch spikes.

Figure 13. Slope Compensation

9.2.2.1 Oscillator

The UC184xA-SP oscillator is programmed as shown in [Figure 15](#). Timing capacitor C_T is charged from V_{REF} (5 V) through the timing resistor R_T , and discharged by an internal current source. The first step in selecting the oscillator components is to determine the required circuit dead time. Once obtained, [Figure 16](#) is used to pinpoint the nearest standard value of C_T for a given dead time. Next, the appropriate R_T value is interpolated using the parameters for C_T and oscillator frequency. [Figure 17](#) shows the R_T/C_T combinations versus oscillator frequency. The timing resistor can be calculated from the following formula.

$$f_{\text{osc}} \text{ (kHz)} = \frac{1.72}{R_T \text{ (k}\Omega) \times C_T \text{ (}\mu\text{F)}} \quad (1)$$

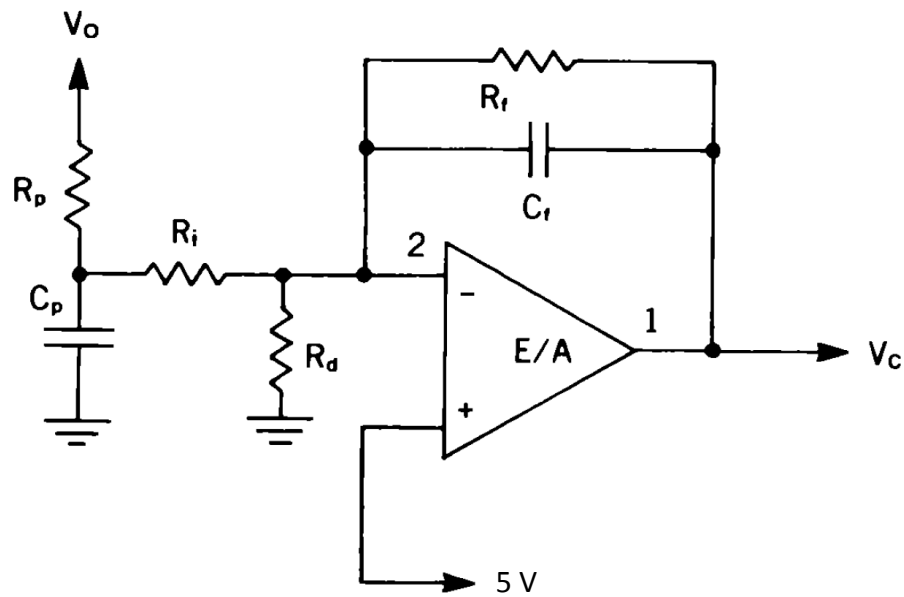
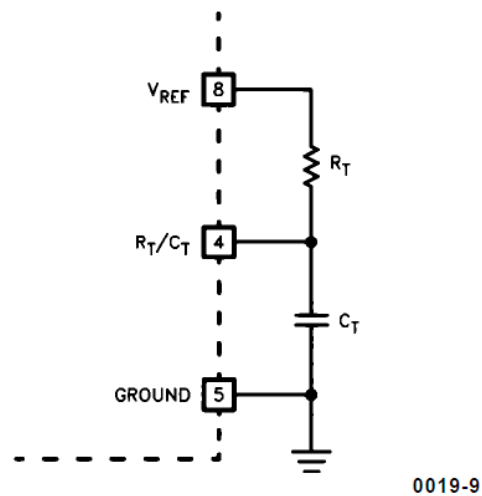


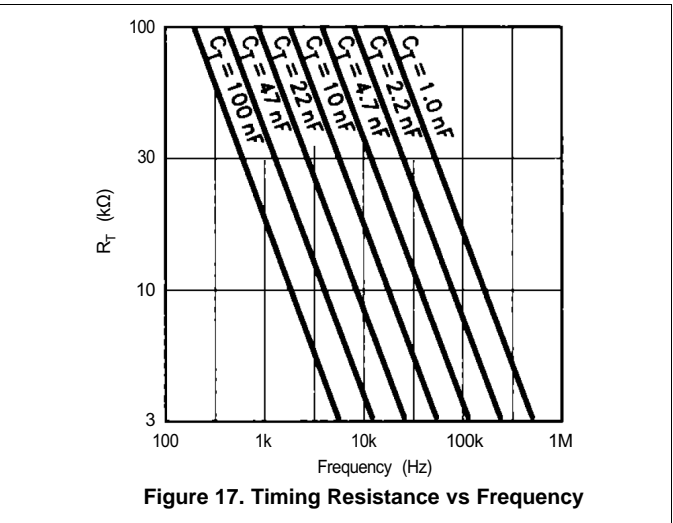
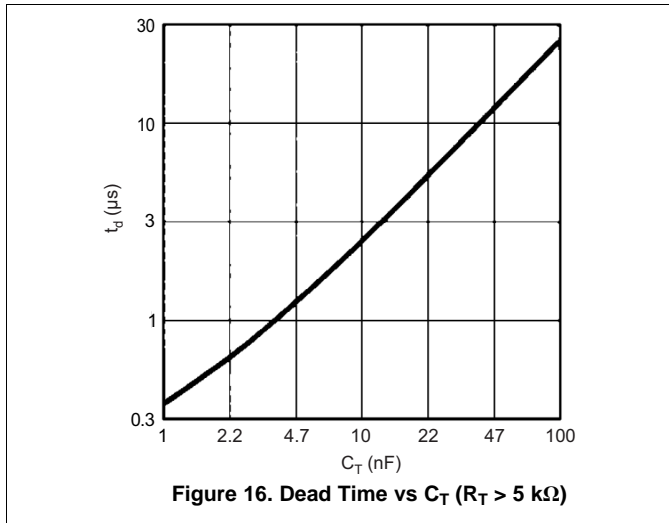
Figure 14. E/A Compensation Circuit for Continuous Boost and Flyback Topologies

The UC184xA-SP has an internal divide-by-two flip-flop driven by the oscillator for a 50% maximum duty cycle. Therefore, their oscillators must be set to run at twice the desired power supply switching frequency.



0019-9

Figure 15. Oscillator Programming



9.2.2.2 Current Sensing and Limiting

The UC184xA-SP current sense input is configured as shown in Figure 18. Current-to-voltage conversion is done externally with ground-referenced resistor R_S . Under normal operation, the peak voltage across R_S is controlled by the E/A according to the following relation:

$$I_p = \frac{V_C - 1.4 \text{ V}}{3 R_S}$$

where

- V_C = Control voltage = E/A output voltage (2)

R_S can be connected to the power circuit directly or through a current transformer, as Figure 18 shows. While a direct connection is simpler, a transformer can reduce power dissipation in R_S , reduce errors caused by the base current, and provide level shifting to eliminate the restraint of ground-referenced sensing. The relation between V_C and peak current in the power stage is given by:

$$i_{(pk)} = N \left(\frac{V_{R_S(pk)}}{R_S} \right) = \frac{N}{3 R_S} (V_C - 1.4 \text{ V})$$

where

- N = Current sense transformer turns ratio = 1 when transformer not used. (3)

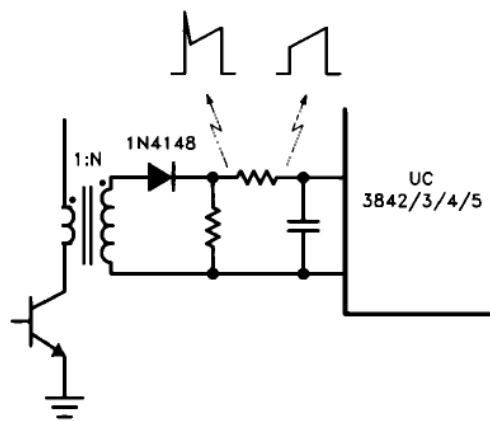
For purposes of small-signal analysis, the control-to-sensed-current gain is:

$$\frac{i_{(pk)}}{V_C} = \frac{N}{3 R_S} \quad (4)$$

When sensing current in series with the power transistor, as shown in Figure 18, the current waveform often has a large spike at its leading edge. This spike is due to rectifier recovery and/or inter-winding capacitance in the power transformer. If unattenuated, this transient can prematurely terminate the output pulse. As shown, a simple RC filter is usually adequate to suppress this spike. The RC time constant should be approximately equal to the current spike duration (usually a few hundred nanoseconds).

The inverting input to the UC184xA-SP current-sense comparator is internally clamped to 1 V (Figure 18). Current limiting occurs if the voltage at pin 3 reaches this threshold value, that is, the current limit is defined by:

$$i_{max} = \frac{N \times 1 \text{ V}}{R_S} \quad (5)$$



0019-13

Figure 18. Transformer-Coupled Current Sensing

9.2.2.3 Error Amplifier

The error amplifier (E/A) configuration is shown in Figure 19. The non-inverting input is not brought out to a pin, but is internally biased to 5 V \pm 2%. The E/A output is available at pin 1 for external compensation, allowing the user to control the converter's closed-loop frequency response.

Figure 20 shows an E/A compensation circuit suitable for stabilizing any current-mode controlled topology except for flyback and boost converters operating with inductor current. The feedback components add a pole to the loop transfer function at $f_p = \frac{1}{2} \pi R_F$. R_F and C_F are chosen so that this pole cancels the zero of the output filter capacitor ESR in the power circuit. R_1 and R_F fix the low-frequency gain. They are chosen to provide as much gain as possible while still allowing the pole formed by the output filter capacitor and load to roll off the loop gain to unity (0 dB) at $f \approx f_{\text{SWITCHING}} / 4$. This technique ensures converter stability while providing good dynamic response.

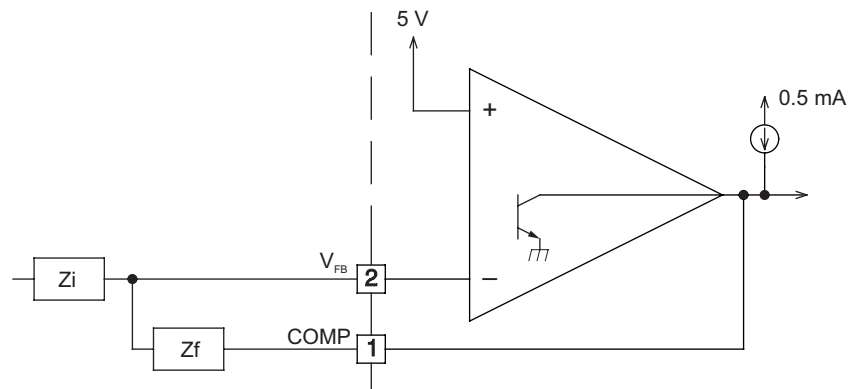
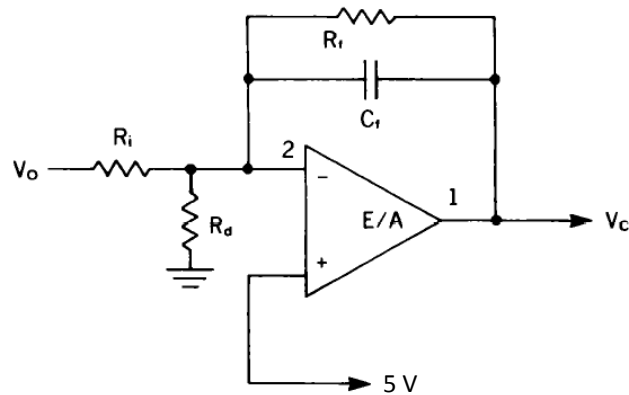


Figure 19. E/A Configuration



0019-15

Figure 20. Compensation

The E/A output sources 0.5 mA and sinks 2 mA. A lower limit for RF is given by:

$$R_{F(MIN)} \approx \frac{V_{EA\ OUT(MAX)} - 2.5\ V}{0.5\ mA} = \frac{6\ V - 2.5\ V}{0.5\ mA} = 7\ k\Omega \quad (6)$$

E/A input bias current (2- μ A max) flows through R_i , resulting in a DC error in output voltage (VO) given by:

$$\Delta V_{O(MAX)} = (2\ \mu A) R_i \quad (7)$$

Therefore, the designer should keep the value of R_i , as low as possible.

Figure 21 shows the open-loop frequency response of the UC184xA-SP E/A. The gain represents an upper limit on the gain of the compensated E/A. Phase lag increases rapidly as frequency exceeds 1 MHz due to second-order poles at about 10 MHz and above.

Continuous-inductor-current boost and flyback converters each have a right-half-plane zero in their transfer function. An additional compensation pole is needed to roll off loop gain at a frequency less than that of the RHP zero. R_P and C_P in the circuit of Figure 14 provide this pole.

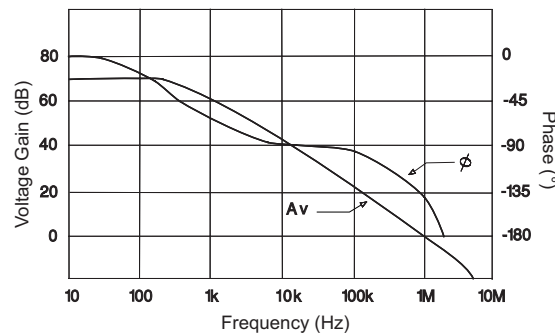


Figure 21. Error Amplifier Open-Loop Frequency Response

9.2.3 Application Curves

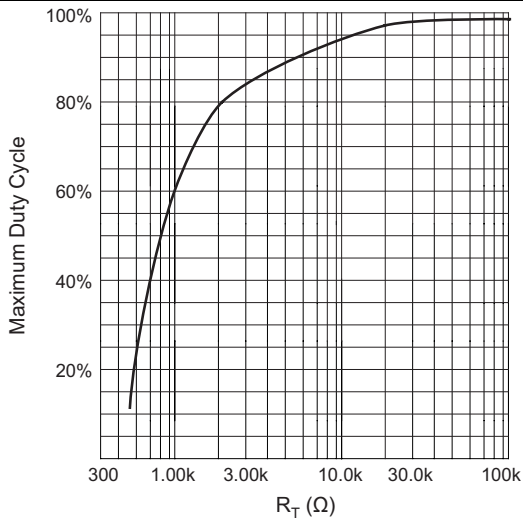


Figure 22. Oscillator Frequency vs Timing Resistance

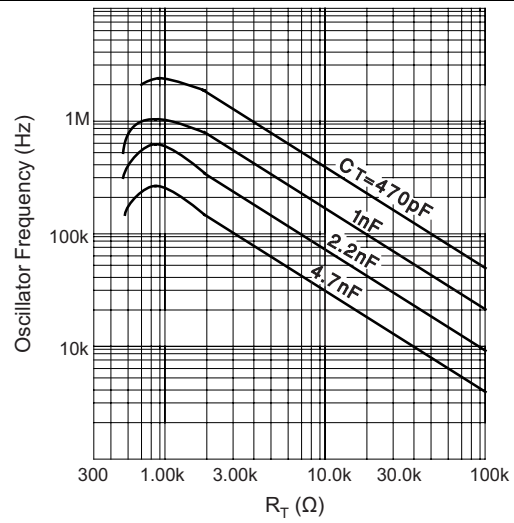
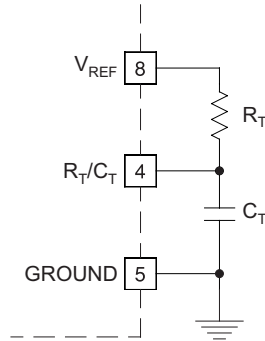


Figure 23. Maximum Duty Cycle vs Timing Resistor

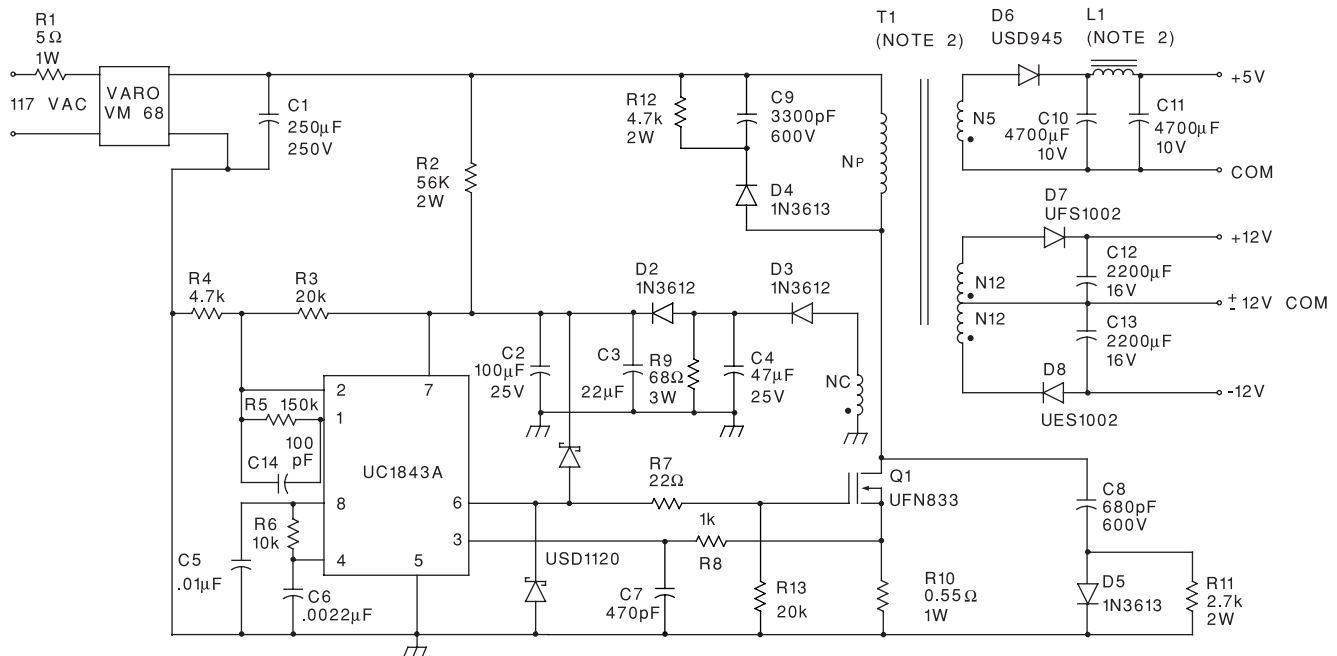


For $R_T > 5k$ $f \approx 1.72 / (R_T C_T)$

Figure 24. Oscillation Schematic

10 Power Supply Recommendations

The devices are designed to operate from an input voltage supply range between 8 V and 40 V. This input supply should be well regulated. If the input supply is located more than a few inches from the UC184xA-SP converter, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. A tantalum capacitor with a value of 47 μF is a typical choice; however, this may vary depending upon the output power being delivered.



Power supply specifications:

1. Input voltage: 95 VAC to 130 VAC (50 Hz/60 Hz)
2. Line isolation: 3750 V
3. Switching frequency: 40 kHz
4. Efficiency full load: 70%
5. Output voltage:
 - a. +5 V, $\pm 5\%$; 1- to 4-A load, ripple voltage: 50 mVP-P max
 - b. +12 V, $\pm 3\%$; 0.1- to 0.3-A load, ripple voltage: 100 mVP-P max
 - c. -12 V, $\pm 3\%$; 0.1- to 0.3-A load, ripple voltage: 100 mVP-P max

Figure 25. Offline Flyback Regulator

11 Layout

11.1 Layout Guidelines

Always try to use a low-EMI inductor with a ferrite-type closed core. Some examples would be toroid and encased E core inductors. Open core can be used if they have low-EMI characteristics and are located a farther away from the low-power traces and components. Make the poles perpendicular to the PCB as well if using an open core. Stick cores usually emit the most unwanted noise.

11.1.1 Feedback Traces

Try to run the feedback trace as far as possible from the inductor and noisy power traces. The designer should also make the feedback trace as direct as possible and somewhat thick. These two guidelines sometimes involve a trade-off, but keeping the trace away from inductor EMI and other noise sources is the more critical guideline. Run the feedback trace on the side of the PCB opposite of the inductor with a ground plane separating the two.

12 デバイスおよびドキュメントのサポート

12.1 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

表 3. 関連リンク

製品	プロダクト・フォルダ	サンプルとご購入	技術資料	ツールとソフトウェア	サポートとコミュニティ
UC1842A-SP	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
UC1844A-SP	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック

12.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

12.3 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.4 商標

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.5 静電気放電に関する注意事項



これらのデバイスは、限定的なESD(静電破壊)保護機能を内蔵しています。保存時または取り扱い時は、MOSゲートに対する静電破壊を防止するために、リード線同士をショートさせておくか、デバイスを導電フォームに入れる必要があります。

12.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-8670405VPA	ACTIVE	CDIP	JG	8	50	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	8670405VPA UC1842A	Samples
5962-8670407VPA	ACTIVE	CDIP	JG	8	50	Non-RoHS & Green	SNPB	N / A for Pkg Type	-55 to 125	8670407VPA UC1844A	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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.

OTHER QUALIFIED VERSIONS OF UC1842A-SP, UC1844A-SP :

- Catalog : [UC1842A](#), [UC1844A](#)
- Enhanced Product : [UC1842A-EP](#), [UC1844A-EP](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

PACKAGE OUTLINE

JG0008A

CDIP - 5.08 mm max height

CERAMIC DUAL IN-LINE PACKAGE



NOTES:

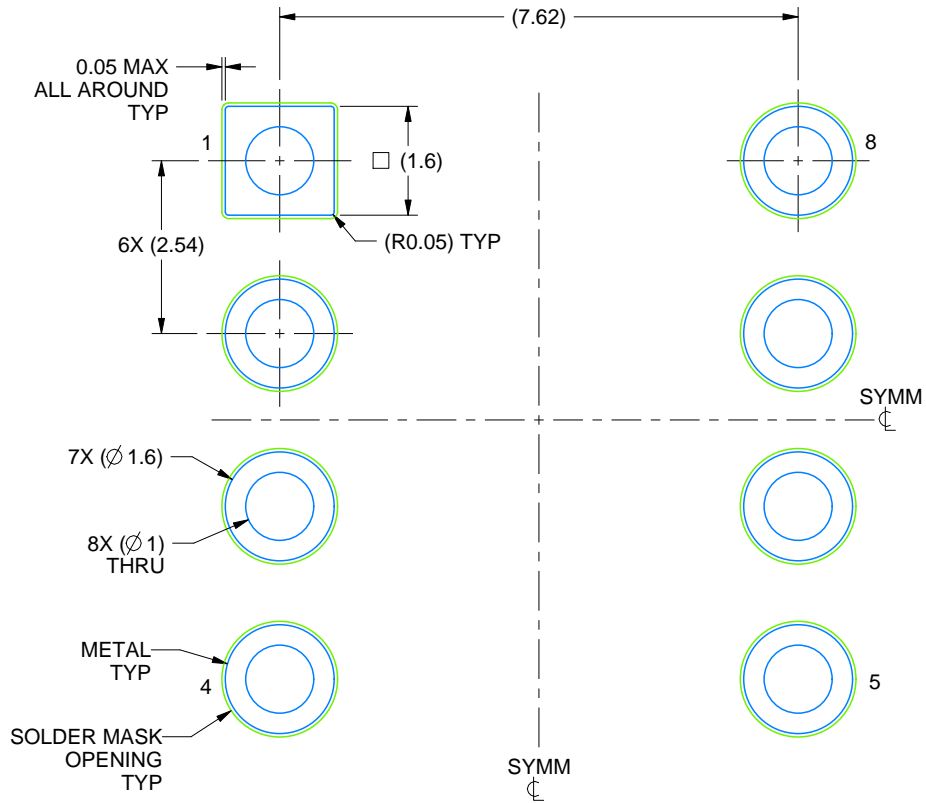
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package can be hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification.
5. Falls within MIL STD 1835 GDIP1-T8

EXAMPLE BOARD LAYOUT

JG0008A

CDIP - 5.08 mm max height

CERAMIC DUAL IN-LINE PACKAGE



LAND PATTERN EXAMPLE
NON SOLDER MASK DEFINED
SCALE: 9X

4230036/A 09/2023

重要なお知らせと免責事項

TI は、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス・デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、または [ti.com](#) やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所 : Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2024, Texas Instruments Incorporated