

# Programmable Maximum Duty Cycle PWM Controller

## FEATURES

- User Programmable Maximum PWM Duty Cycle
- 100 A Startup Current
- Operation to 1MHz
- Internal Full Cycle Soft Start
- Internal Leading Edge Blanking of Current Sense Signal
- 1A Totem Pole Output

## DESCRIPTION

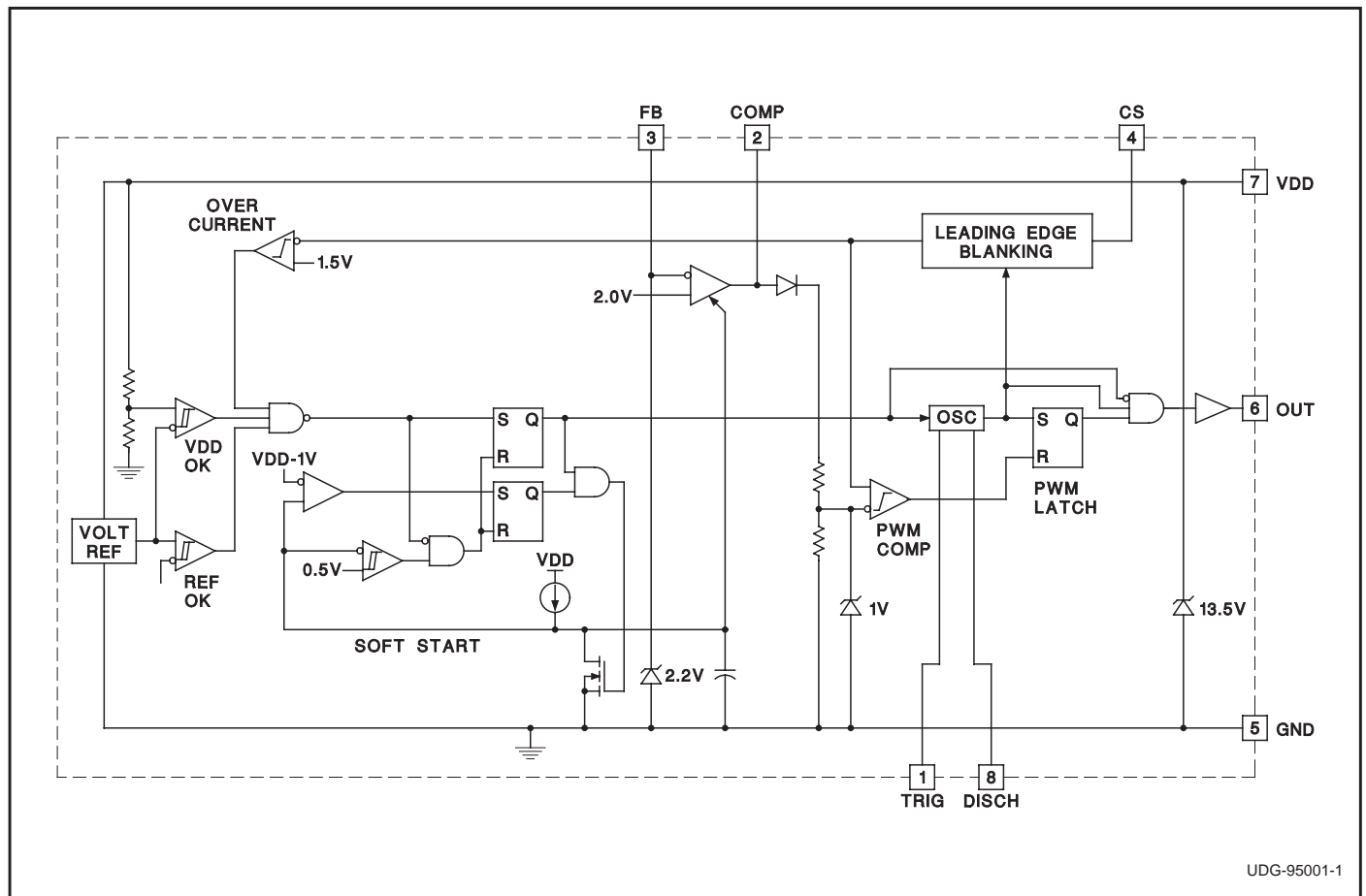
The UCC3807 family of high speed, low power integrated circuits contains all of the control and drive circuitry required for off-line and DC-to-DC fixed frequency current mode switching power supplies with minimal external parts count.

These devices are similar to the UCC3800 family, but with the added feature of a user programmable maximum duty cycle. Oscillator frequency and maximum duty cycle are programmed with two resistors and a capacitor. The UCC3807 family also features internal full cycle soft start and internal leading edge blanking of the current sense input.

The UCC3807 family offers a variety of package options, temperature range options, and choice of critical voltage levels. The family has UVLO thresholds and hysteresis levels for off-line and battery powered systems. Thresholds are shown in the table below.

Part Number	Turn-on Threshold	Turn-off Threshold	Packages
UCCx807-1	7.2V	6.9V	J
UCCx807-2	12.5V	8.3V	N, D
UCCx807-3	4.3V	4.1V	N, D, PW

## BLOCK DIAGRAM

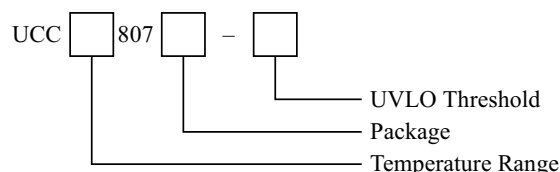


## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ( $I_{DD} = 10\text{mA}$ )	13.5V
Supply Current	30mA
OUT Current	$\pm 1\text{A}$
Analog Inputs (FB, CS)	$-0.3\text{V}$ to $(\text{VDD} + 0.3\text{V})$
Power Dissipation at $T_A + 25^\circ\text{C}$ (N or J packages)	1W
Power Dissipation at $T_A + 25^\circ\text{C}$ (D package)	0.65W
Storage Temperature	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Junction Temperature	$-65^\circ\text{C}$ to $+150^\circ\text{C}$
Lead Temperature (Soldering, 10 sec.)	$+300^\circ\text{C}$

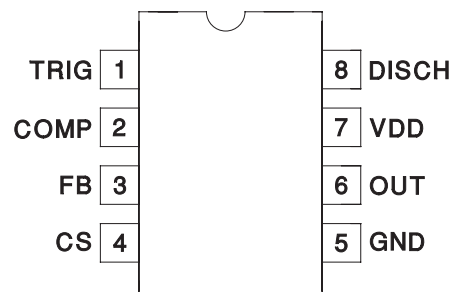
All currents are positive into, negative out of the specified terminal. Consult Packaging Section of Databook for thermal limitations and considerations of packages.

## ORDERING INFORMATION



## CONNECTION DIAGRAMS

DIL-8, SOIC-8, TSSOP-8 (Top View)  
J, N, D or PW Packages



**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated these specifications apply for  $T_A = -55^\circ\text{C}$  to  $+125^\circ\text{C}$  for UCC1807-1/-2/-3;  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  for UCC2807-1/-2/-3; and  $0^\circ\text{C}$  to  $+70^\circ\text{C}$  for UCC3807-1/-2/-3;  $\text{VDD} = 10\text{V}$  (Note 6),  $R_A = 12\text{k}\Omega$ ,  $R_B = 4.7\text{k}\Omega$ ,  $C_T = 330\text{pF}$ ,  $1.0\text{ }\mu\text{F}$  capacitor from  $\text{VDD}$  to  $\text{GND}$ ,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Oscillator Section</b>					
Frequency		175	202	228	kHz
Temperature Stability	(Note 5)		2.5		%
Amplitude	(Note 1)		1/3VDD		V
<b>Error Amplifier Section</b>					
Input Voltage	COMP = 2.0V	1.95	2.00	2.05	V
Input Bias Current		-1		1	A
Open Loop Voltage Gain		60	80		dB
COMP Sink Current	FB = 2.2V, COMP = 1.0V	0.3	2.5		mA
COMP Source Current	FB = 1.3V, COMP = 4.0V	-0.2	-0.5		mA
<b>PWM Section</b>					
Maximum Duty Cycle		75	78	81	%
Minimum Duty Cycle	COMP = 0V			0	%
<b>Current Sense Section</b>					
Gain	(Note 2)	1.1	1.65	1.8	V/V
Maximum Input Signal	COMP = 5.0V (Note 3)	0.9	1.0	1.1	V
Input Bias Current		-200		200	nA
CS Blank Time		50	100	150	ns
Overcurrent Threshold		1.4	1.5	1.6	V
COMP to CS Offset	CS = 0V	0.55	1.1	1.65	V
<b>Output Section</b>					
OUT Low Level	I = 100mA		0.4	1	V
OUT High Level	I = -100mA, VDD - OUT		0.4	1	V
Rise/Fall Time	CL = 1nF (Note 5)		20	100	ns
<b>Undervoltage Lockout Section</b>					

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated these specifications apply for  $T_A = -55^\circ\text{C}$  to  $+125^\circ\text{C}$  for UCC1807-1/-2/-3;  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  for UCC2807-1/-2/-3; and  $0^\circ\text{C}$  to  $+70^\circ\text{C}$  for UCC3807-1/-2/-3;  $V_{DD} = 10\text{V}$  (Note 6),  $R_A = 12\text{k}\Omega$ ,  $R_B = 4.7\text{k}\Omega$ ,  $C_T = 330\text{pF}$ ,  $1.0\text{ }\mu\text{F}$  capacitor from  $V_{DD}$  to  $\text{GND}$ ,  $T_A = T_J$ .

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Start Threshold	UCCx807-1 (Note 4)	6.6	7.2	7.8	V
	UCCx807-2	11.5	12.5	13.5	V
	UCCx807-3	4.1	4.3	4.5	V
Minimum Operating Voltage After Start	UCCx807-1 (Note 4)	6.3	6.9	7.5	V
	UCCx807-2	7.6	8.3	9.0	V
	UCCx807-3	3.9	4.1	4.3	V
Hysteresis	UCCx807-1	0.1	0.3	0.5	V
	UCCx807-2	3.5	4.2	5.1	V
	UCCx807-3	0.1	0.2	0.3	V
<b>Soft Start Section</b>					
COMP Rise Time	FB = 1.8V, From 0.5V to 4.0V		4		ms
<b>Overall Section</b>					
Startup Current	$V_{DD} < \text{Start Threshold (UCCx807-1,-3)}$		0.1	0.2	mA
	$V_{DD} < \text{Start Threshold (UCCx807-2)}$		0.15	0.25	mA
Operating Supply Current	FB = 0V, CS = 0V, No Load (Note 7)		1.3	2.1	mA
VDD Zener Shunt Voltage	$I_{DD} = 10\text{mA}$	12.0	13.5	15.0	V
Shunt to Start Difference		0.5	1.0		V

Note 1: Measured at TRIG; signal minimum =  $1/3 V_{DD}$ , maximum =  $2/3 V_{DD}$ .

Note 2: Gain is defined by:  $A = \frac{V_{COMP}}{V_{CS}}$ ,  $0 < V_{CS} < 0.8\text{V}$

Note 3: Parameter measured at trip point of latch with FB at 0V.

Note 4: Start Threshold and Zener Shunt thresholds track one another.

Note 5: Ensured by design. Not 100% tested in production.

Note 6: Adjust VDD above the start threshold before setting at 10V for UCC3807-2.

Note 7: Does not include current in external timing RC network.

## PIN DESCRIPTIONS

**COMP:** COMP is the output of the error amplifier and the input of the PWM comparator. The error amplifier in the UCC3807 is a low output impedance, 2MHz operational amplifier. COMP can both source and sink current. The error amplifier is internally current limited, which allows zero duty cycle by externally forcing COMP to GND.

The UCC3807 family features built-in full cycle soft start. Soft start is implemented as a clamp on the maximum COMP voltage.

**CS:** Current sense input. There are two current sense comparators on the chip, the PWM comparator and an overcurrent comparator.

The UCC3807 also contains a leading edge blanking circuit, which disconnects the external CS signal from the current sense comparator during the 100ns interval immediately following the rising edge of the signal at the OUT pin. In most applications, no analog filtering is required on CS. Compared to an external RC filtering technique, leading edge blanking provides a smaller effective CS to OUT propagation delay. Note, however, that the minimum non-zero on-time of the OUT signal is directly

affected by the leading edge blanking and the CS to OUT propagation delay.

The overcurrent comparator is only intended for fault sensing. Exceeding the overcurrent threshold causes a soft start cycle.

**FB:** The inverting input to the error amplifier. For best stability, keep connections to FB as short as possible and stray capacitance as small as possible.

**GND:** Reference ground and power ground for all functions of the part.

**OUT:** The output of a high current power driver capable of driving the gate of a power MOSFET with peak currents exceeding 1A. OUT is actively held low when VDD is below the UVLO threshold.

The high current power driver consists of MOSFET output devices in a totem pole configuration. This allows the output to switch from VDD to GND. The output stage also provides a very low impedance which minimizes overshoot and undershoot. In most cases, external Schottky clamp diodes are not required.

## PIN DESCRIPTIONS (cont.)

**TRIG/DISCH:** Oscillator control pins. Trig is the oscillator timing input, which has an RC-type charge/discharge signal controlling the chip's internal oscillator. DISCH is the pin which provides the low impedance discharge path for the external RC network during normal operation. Oscillator frequency and maximum duty cycle are computed as follows:

$$\text{frequency} = \frac{1.4}{R_A + 2R_B + C_T}$$

$$\text{duty cycle} = \frac{R_A + R_B}{R_A + 2R_B}$$

as shown in Figure 1.

For best performance, keep the lead from  $C_T$  to GND as short as possible. A separate ground connection for  $C_T$  is desirable. The minimum value of  $R_A$  is 10k $\Omega$ , the minimum value of  $R_B$  is 2.2k $\Omega$ , and the minimum value of  $C_T$  is 47pF.

**VDD:** The power input connection for this device. Total VDD current is the sum of quiescent current and the average OUT current. Knowing the operating frequency and the MOSFET gate charge (Qg), average OUT current can be calculated from

$$I_{OUT} = Q_g \cdot F, \text{ where } F \text{ is frequency.}$$

To prevent noise problems, bypass VDD to GND with a ceramic capacitor as close to the chip as possible in parallel with an electrolytic capacitor.

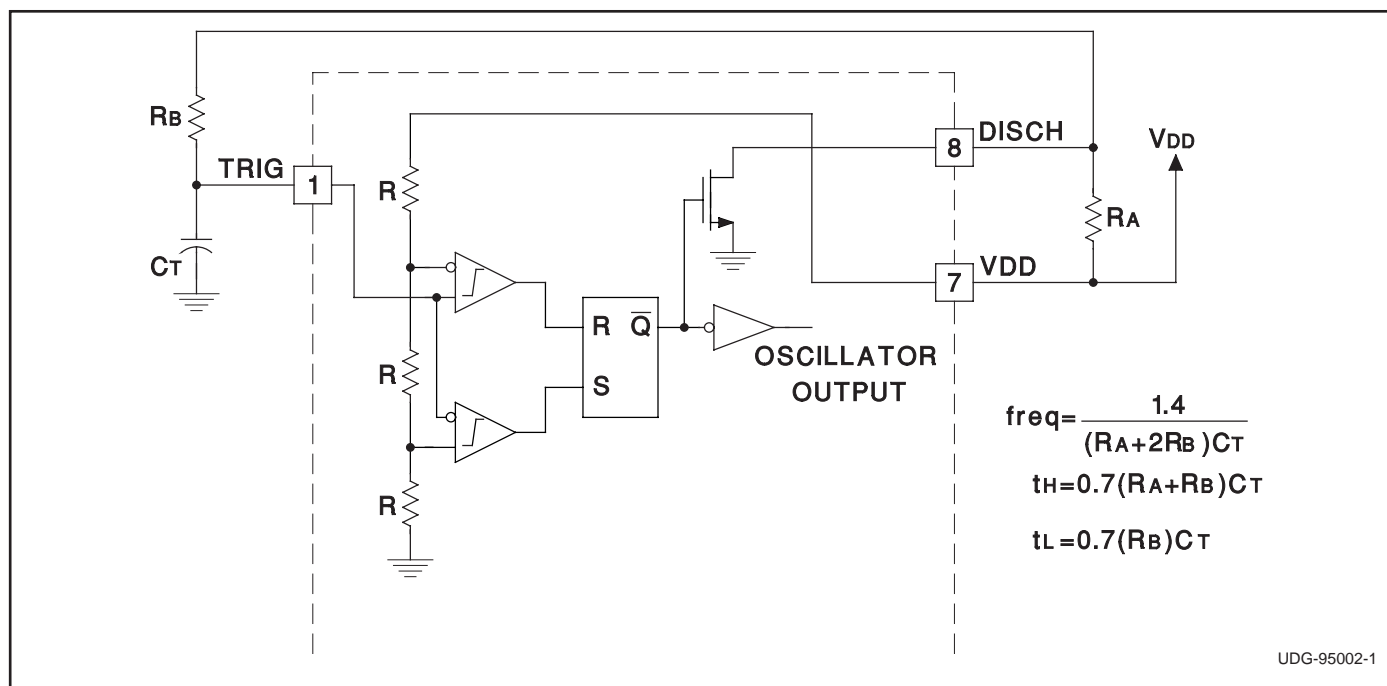


Figure 1. Oscillator Block Diagram

## APPLICATIONS INFORMATION

The circuit shown in Fig. 2 illustrates the use of the UCC3807 in a typical off-line application. The 100W, 200kHz, universal input forward converter produces a regulated 12VDC at 8 Amps. The programmable maximum duty cycle of the UCC3807 allows operation down to 80VRMS and up to 265VRMS with a simple RCD clamp to limit the MOSFET voltage and provide core reset. In this application the maximum duty cycle is set to about 65%. Another feature of the design is the use of a flyback winding on the output filter choke for both bootstrapping and voltage regulation. This method of loop closure eliminates the optocoupler and secondary side regulator, common to most off-line designs, while providing good line and load regulation.

<b>T1:</b>	
Core	Magnetics Inc. #P-42625-UG (ungapped)
Primary:	28 turns of 2x #26AWG
Secondary:	6 turns of 50x0.2mm Litz wire
<b>L1:</b>	
Core:	Magnetics Inc. #P-42625-SG-37 (0.020" gap)
Main Winding:	13 turns of 2x #18AWG
Second Winding:	11 turns of #26AWG
<b>Magnetics Inc.</b>	
900 E. Butler Road	
P.O. Box 391	
Butler, PA 16003	
Tel: (412) 282-8282	
Fax: (412) 282-6955	

# APPLICATIONS INFORMATION (cont.)

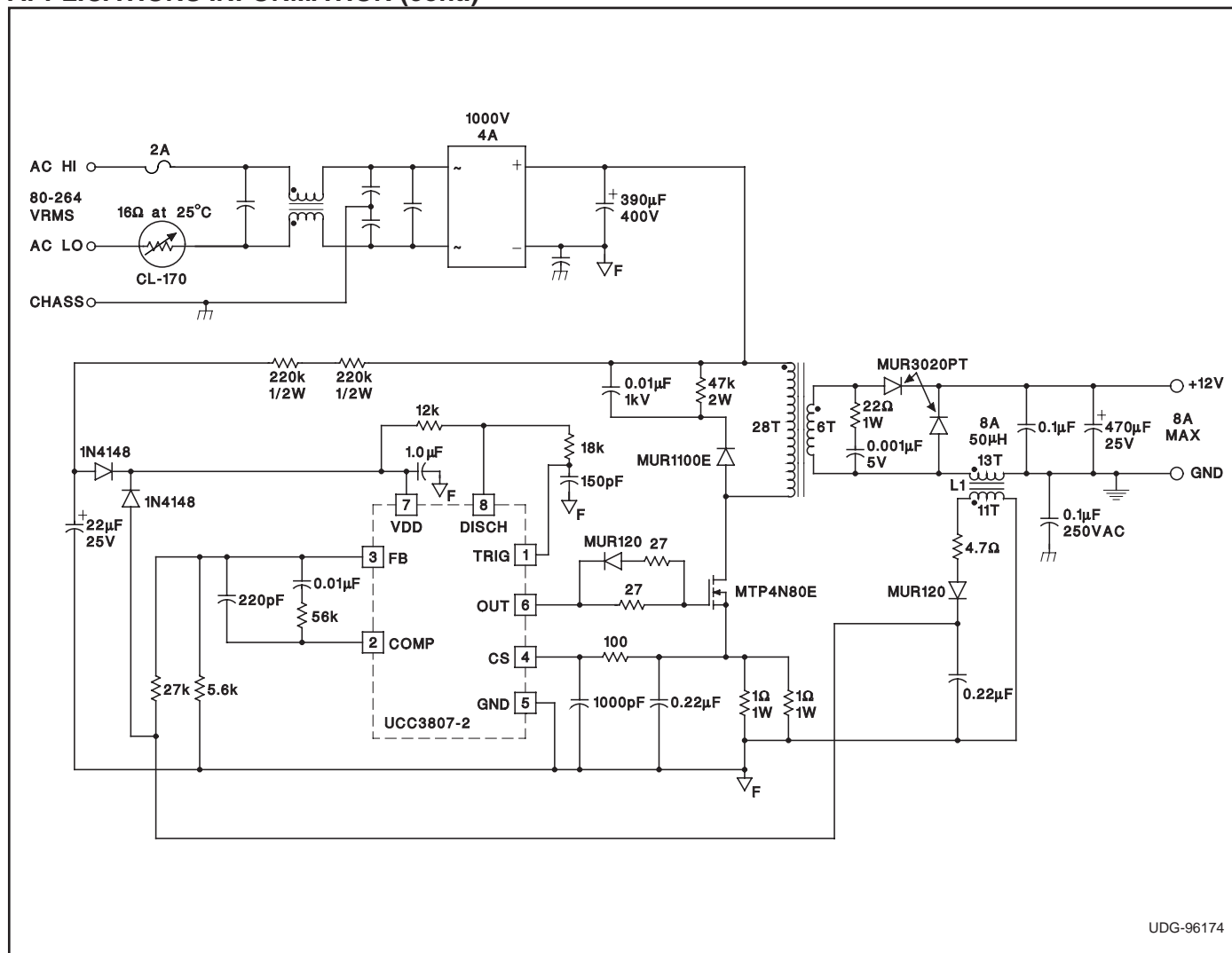


Figure 2. Typical Off-line Application Using UCC3807-2

UDG-96174

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
UCC2807D-1	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807D-1G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807D-2	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807D-2G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807D-3	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807D-3G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-1	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-1G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-2	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-2G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-3	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807DTR-3G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807N-1	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC2807N-2	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC2807N-2G4	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC2807PW-3	ACTIVE	TSSOP	PW	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807PW-3G4	ACTIVE	TSSOP	PW	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807PWTR-3	ACTIVE	TSSOP	PW	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC2807PWTR-3G4	ACTIVE	TSSOP	PW	14		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807D-1	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807D-1G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807D-2	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807D-2G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807D-3	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807DTR-1	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
UCC3807DTR-2	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807DTR-2G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807DTR-3	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807DTR-3G4	ACTIVE	SOIC	D	8		Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR
UCC3807N-1	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC3807N-2	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC3807N-3	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC3807N-3G4	ACTIVE	PDIP	P	8		Green (RoHS & no Sb/Br)	CU NIPDAU	N / A for Pkg Type
UCC3807PWTR-3	PREVIEW	TSSOP	PW	14		TBD	Call TI	Call TI

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), 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.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**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)

<sup>(3)</sup> 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.

## P (R-PDIP-T8)

## PLASTIC DUAL-IN-LINE



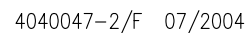
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)



POST OFFICE BOX 655303 • DALLAS, TEXAS 75265





A. All linear dimensions are in inches (millimeters).  
B. This drawing is subject to change without notice.  
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
D. Falls within JEDEC MS-012 variation AA.

## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

## 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:

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

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

Copyright © 2006, Texas Instruments Incorporated