

## 4-Bit DAC and Voltage Monitor

### FEATURES

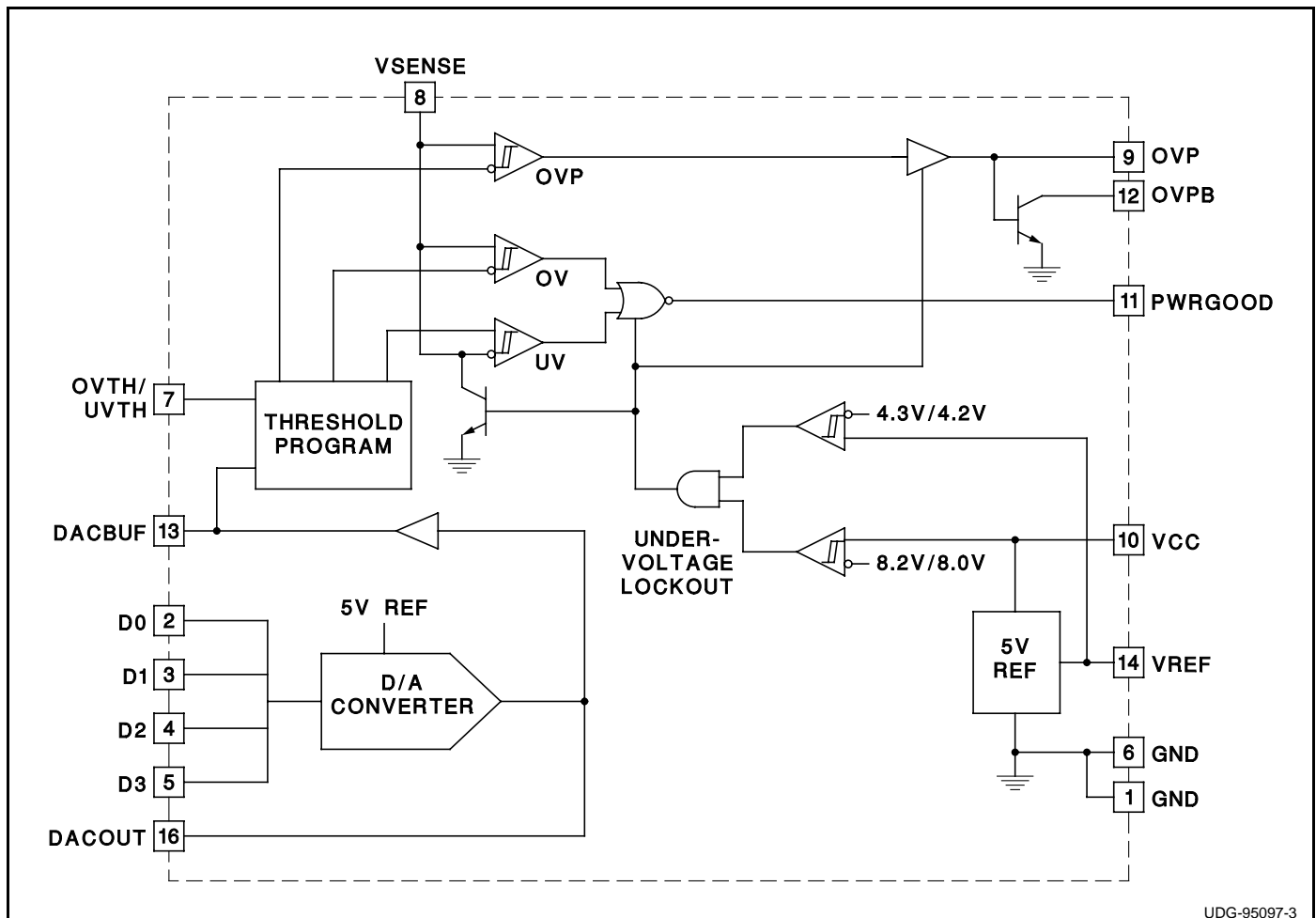
- Precision 5V Reference
- 4-Bit Digital-to-Analog (DAC) Converter
- 0.5% DAC/Reference Combined Error
- Programmable Undervoltage and Overvoltage Fault Windows
- Overvoltage Comparator with Complementary SCR Driver and Open Collector Outputs
- Undervoltage Lockout

### DESCRIPTION

The UC3910 is a complete precision reference and voltage monitor circuit for Intel Pentium® Pro and other high-end microprocessor power supplies. It is designed for use in conjunction with the UC3886 PWM. The UC3910 together with the UC3886 converts 5VDC to an adjustable output ranging from 2.0VDC to 3.5VDC in 100mV steps with 1% DC system accuracy.

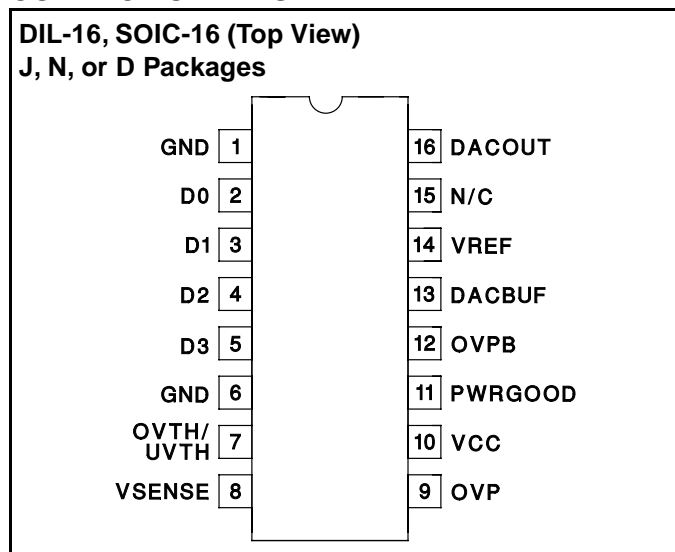
The UC3910 utilizes thin film resistors to ensure high accuracy and stability of its precision circuits. The chip includes a precision 5V voltage reference which is capable of sourcing 10mA to external circuitry. The output voltage of the DAC is derived from this reference, and the accuracy of the DAC/reference combination is 0.5%. Programmable window comparators monitor the supply voltage to indicate that it is within acceptable limits. The window is programmed as a percentage centered around the DAC output. An overvoltage protection comparator is set at a percentage 2 times larger than the programmed lower overvoltage level and drives an external SCR as well as provides an open collector output. Undervoltage lockout protection assures the correct logic states at the outputs during power-up and power-down.

### BLOCK DIAGRAM



UDG-95097-3

## CONNECTION DIAGRAM



**ELECTRICAL CHARACTERISTICS** Unless otherwise specified, VCC = 12V, VSENSE = 3.5V, VOVTH/UVTH = 1.26V, VD0 = VD1 = VD2 = VD3 = 0V, 0°C < TA < 70°C for the UC3910, -25°C < TA < 80°C for the UC2910, -55°C < TA < 125°C for the UC1910 TA = TJ.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Undervoltage Lockout</b>					
VIN UVLO Turn-on Threshold		7	8	9	V
UVLO Threshold Hysteresis		50	200	500	mV
<b>Supply Current</b>					
IIN Startup	VCC = 5V		2	3.5	mA
IIN	VCC = 12V		10	12	mA
<b>DAC/Reference</b>					
DACOUT Voltage Accuracy	Line, Load, 0°C < TA < 70°C (Note 1)	-0.9		0.9	%
	Line, Load, -55°C < TA < 125°C	-1.5		1.5	%
D0-D3 Voltage High	Dx Pin Floating	4.6	4.85		V
D0-D3 Input Bias Current	Dx Pin Tied to GND	-140	-105		μA
VREF Output Voltage	IVREF = 0mA, 0°C < TA < 70°C	4.97	5	5.03	V
VREF Total Variation	Line, Load, 0°C < TA < 70°C (Note 1)	4.96	5	5.04	V
	Line, Load, -55°C < TA < 125°C	4.925	5	5.075	V
VREF Sourcing Current	VREF = 0V	10			mA
<b>DAC Buffer</b>					
Input Offset Voltage	IDACBUF = -1mA, 0°C < TA < 70°C	-25		25	mV
Output Sourcing Current		-12		-1	mA
<b>Monitor Circuitry (Note 2)</b>					
VSENSE UV Threshold Voltage	Code 0, Ratio = 0.45 (Note 3)	3.174	3.237	3.3	V
	Code 0, Ratio = 0.9	2.87	2.975	3.08	V
	Code 15, Ratio = 0.45	1.816	1.85	1.884	V
	Code 15, Ratio = 0.9	1.635	1.7	1.765	V
VSENSE OV Threshold Voltage	Code 0, Ratio = 0.45	3.7	3.763	3.826	V
	Code 0, Ratio = 0.9	3.92	4.025	4.13	V
	Code 15, Ratio = 0.45	2.116	2.15	2.184	V
	Code 15, Ratio = 0.9	1.635	2.3	2.365	V

**ELECTRICAL CHARACTERISTICS (cont.)** Unless otherwise specified, VCC = 12V, VSENSE = 3.5V, VOVTH/UVTH = 1.26V, VD0 = VD1 = VD2 = VD3 = 0V, 0°C < TA < 70°C for the UC3910, -25°C < TA < 80°C for the UC2910, -55°C < TA < 125°C for the UC1910 TA = TJ.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
<b>Monitor Circuitry (Note 2) (cont.)</b>					
VSENSE OVP Threshold Voltage	Code 0, Ratio = 0.45	3.937	4.025	4.113	V
	Code 0, Ratio = 0.9	4.41	4.55	4.69	V
	Code 15, Ratio = 0.45	2.235	2.3	2.365	V
	Code 15, Ratio = 0.9	2.505	2.6	2.695	V
OV, UV Comparator Hysteresis	Code 0, Ratio = 0.9	70	88	120	mV
	Code 15, Ratio = 0.45	15	25	40	mV
OVP Comparator Hysteresis	Code 0, Ratio = 0.9	160	218	300	mV
	Code 15, Ratio = 0.45	40	62	85	mV
Input Common Mode Range	OV, UV, OVP Comparators	0		5	V
Propagation Delay	OV, UV Comparators			5	μs
	OVP Comparator			5	μs
<b>PWRGOOD, OVP, OVPB Outputs</b>					
PWRGOOD Voltage Low	IPWRGOOD = 10mA			0.4	V
OVP Sourcing Current	VOVP = 1.4V	65			mA
OVPB Voltage Low	IOVPB = 1mA			0.4	V

Note 1: "Line, Load" implies that the parameter is tested at all combinations of the conditions:  
10.8V < VCC < 13.2V, -2mA < IVREF < 0mA.

Note 2: These are the actual voltages on VSENSE which will cause the OVPB and PWRGOOD outputs to switch, assuming the DACOUT voltage is perfect. These limits apply for 0°C < TA < 70°C.

Note 3: "Code 0" means pins D0 - D4 are all low; "Code 15" means they are all floating or high (See Table 1). "Ratio" is the divider ratio of the resistor string between DACBUF and OVTH/UVTH (See Figure 1).

## PIN DESCRIPTIONS

**D0-D3 (DAC Digital Input Control Codes):** These are the DAC digital input control codes, with D0 representing the least significant bit (LSB) and D3, the most significant bit (MSB) (See Table 1). A bit is set low by being connected to GND; a bit is set high by floating it, or connecting it to a 3V to 5V voltage source. Each control pin is pulled up to approximately 4.8V by an internal 40μA current source.

**DACBUF (Buffered DACOUT Voltage):** This pin provides a buffered version of the DACOUT voltage to allow external programming of the OV/UV thresholds (see OVTH/UVTH below).

**DACOUT (Digital-to-Analog Converter Output Voltage):** This pin is the output of the 4-bit digital to analog (DAC) converter. Setting all input control codes low produces 3.5V at DACOUT; setting all codes high produces 2.0V at DACOUT. The LSB step size (i.e. resolution) is 100mV (See Table 1). The DACOUT source impedance is typically 3kΩ and must therefore drive a high impedance input. Bypass DACOUT at the driven input with a 0.01μF, low ESR, low ESL capacitor for best circuit noise immunity.

**GND (Signal Ground):** All voltages are measured with

Decimal Code	D3	D2	D1	D0	DACOUT Voltage
15	1	1	1	1	2.0
14	1	1	1	0	2.1
13	1	1	0	1	2.2
12	1	1	0	0	2.3
11	1	0	1	1	2.4
10	1	0	1	0	2.5
9	1	0	0	1	2.6
8	1	0	0	0	2.7
7	0	1	1	1	2.8
6	0	1	1	0	2.9
5	0	1	0	1	3.0
4	0	1	0	0	3.1
3	0	0	1	1	3.2
2	0	0	1	0	3.3
1	0	0	0	1	3.4
0	0	0	0	0	3.5

**Table 1. Programming the DACOUT Voltage**

respect to GND. The two GND pins are connected together internally but should also be connected externally using a short PC board trace. Bypass capacitors on the VCC and VREF pins should be connected directly to the ground plane near one of the signal ground

## PIN DESCRIPTIONS (cont.)

pins.

**OVP (Overvoltage Comparator Output):** This output pin drives an external SCR circuit with up to 65mA when the voltage on VSENSE rises above its nominal value by a percentage programmed by OVTH/UVTH pin (see below). The OVP comparator hysteresis is a function of both the DACBUF voltage and the OV/UV percentage programmed.

**OVPB (Overvoltage Comparator Complementary Output):** This output is a complement to the OVP output (see above) and provides an open collector capable of sinking 1mA when the voltage on VSENSE rises above its nominal value by a percentage set by the voltage on the OVTH/UVTH pin (see below).

**OVTH/UVTH (Undervoltage and Lower Overvoltage Threshold Input):** This pin is used to program the window thresholds for the OV and UV comparators. The OV-UV window is centered around the DACBUF voltage and can be programmed from  $\pm 5\%$  to  $\pm 15\%$  about DACBUF. Connect a resistor divider between DACBUF and GND to set the percentage. The threshold for the OVP comparator is internally set to a percentage 2 times larger than the programmed OV percentage; therefore, its range extends from 10% to 30% above DACBUF.

**PWRGOOD (Undervoltage/Lower Overvoltage Out-**

**put):** This pin is an open collector output which is driven low to reset the microprocessor when VSENSE rises above or falls below its nominal value by a percentage programmed by OVTH/UVTH. The OV and UV comparators' hysteresis is a function of the DACBUF voltage and the OV/UV programmed percentage.

**VCC (Positive Supply Voltage):** This pin supplies power to the chip. Connect VCC to a stable voltage source of at least 9V and capable of sourcing at least 15mA. The OVP and PWRGOOD outputs are held low, the OVPB output is in a high impedance state, and the VSENSE pin is pulled low until VCC exceeds the upper undervoltage lockout threshold. This pin should be bypassed directly to the GND pin with a 0.1 $\mu$ F low ESR, low ESL capacitor.

**VREF (Voltage Reference Output):** This pin provides an accurate 5V reference, capable of delivering up to 10mA to external circuitry, and is internally short circuit current limited. For best reference stability, bypass VREF directly to the GND pin with a 0.1 $\mu$ F, low ESR, low ESL capacitor.

**VSENSE (Output Voltage Sensing Input):** This pin is the input to the OVP and PWRGOOD comparators and is connected to the system output voltage through a lowpass filter. When choosing the resistor value for this filter, make sure that no more than 500 $\mu$ A will flow

## APPLICATION INFORMATION

The Overvoltage (OV), Undervoltage (UV) and Overvoltage Protection Voltage (OVP) threshold detection voltages are programmed as a percentage about the nominal DAC output voltage, DACOUT. Figure 1 illus-

trates how to program the UC3910 by setting a voltage divider, R<sub>DIV</sub>, at the OVTH/UVTH pin. The voltage divider ratio is defined as

$$R_{DIV} = \frac{RS1}{RS1 + RS2}$$

The UC3910 allows a ratio R<sub>DIV</sub> at the OVTH/UVTH pin from 0.3 to 0.9, which corresponds to overvoltage and undervoltage percentage thresholds from 5% to 15% and an OVP percentage threshold from 10% to 30%. These thresholds are shown in Figure 2.

The OV, UV and OVP percentage thresholds are given by

$$\begin{aligned} \%V_{OV} &= R_{DIV} \cdot 16.7 \\ \%V_{UV} &= -(R_{DIV} \cdot 16.7) \\ \%V_{OVP} &= \%V_{OV} \cdot 2.0 = R_{DIV} \cdot 33.4 \end{aligned}$$

An R-C filter is added to the VSENSE pin to filter noise and ripple at the comparator inputs. An R-C filter frequency of F<sub>SWITCH</sub>/10 is recommended. Choose the

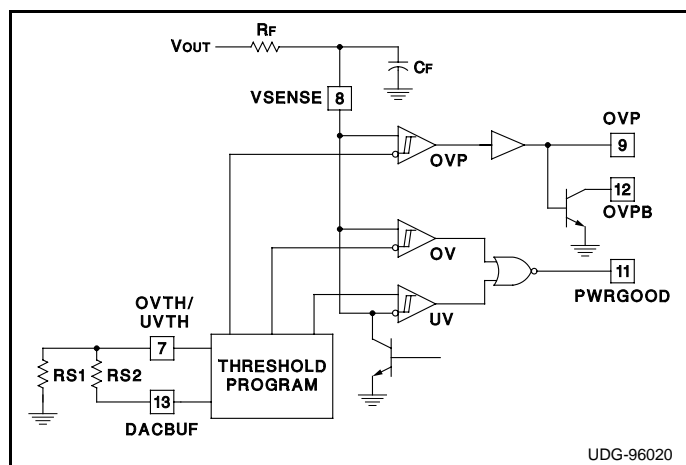


Figure 1. Setting the OV/UV/OVP Threshold Percentages

APPLICATION INFORMATION (cont.)

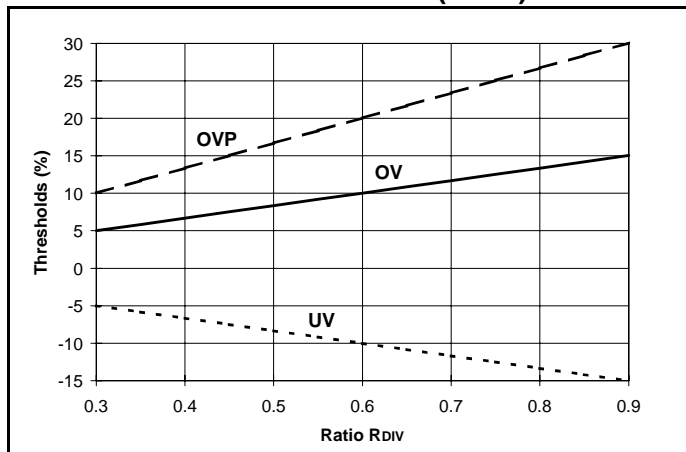


Figure 2. OV, UV and OVP Percentage Thresholds as a Function of the Divider Ratio RDIV

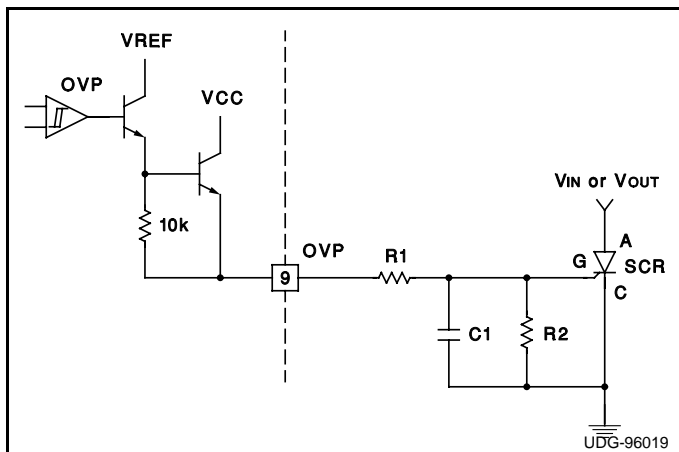


Figure 3. Driving and SCR Using the UC3910 OVP Signal

value of  $R_F$  such that it limits the current into  $V_{SENSE}$  to  $\leq 0.5mA$ .

$$R_F \cdot C_F = \frac{1}{2 \cdot \pi \cdot \left(\frac{F_{SWITCH}}{10}\right)}$$

$$R_F \geq \frac{V_{OUT}}{0.5mA}$$

The Overvoltage Protection output, OVP, can be used to directly drive a crowbaring SCR, as shown in Figure 3.

A typical application is shown in Figure 4 using the UC3910 together with the UC3886 Average Current Mode PWM Controller IC for a power supply to drive Intel's Pentium® Pro processor.

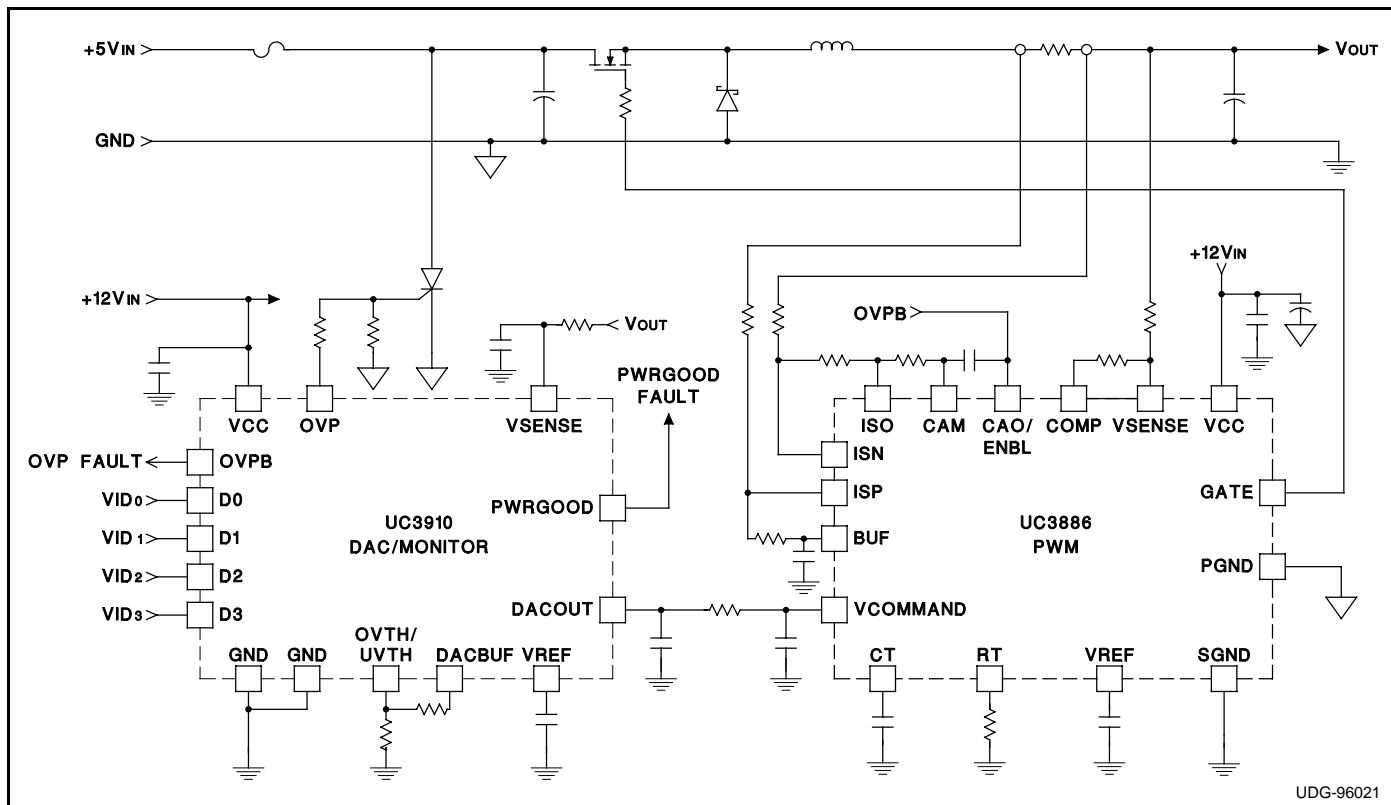


Figure 4. UC3910 Configured with the UC3886 for a Pentium® Pro DC/DC Converter

**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>
UC3910DTR	NRND	SOIC	D	16		TBD	Call TI	Call TI
UC3910DTRG4	NRND	SOIC	D	16		TBD	Call TI	Call TI
UC3910N	NRND	PDIP	N	16		TBD	Call TI	Call TI
UC3910NG4	NRND	PDIP	N	16		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.

## 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 TI 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. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

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

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</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 © 2008, Texas Instruments Incorporated