

±20A Integrated Current Sensor

FEATURES

- Integral Non-inductive Current Sense Element with Internal Kelvin Connections
- 20A Current Rating
- Bi-directional, High Side or Low Side Sensing
- Internal Temperature Nulling Circuitry for Current Sense Element and Amplifier
- Logic Compatible Current Direction Status Output
- Low Offset, Chopper Stabilized Current Sense Amplifier
- Uncommitted Amplifier with User Programmable Gain
- Overcurrent Indication with User Programmable Threshold

DESCRIPTION

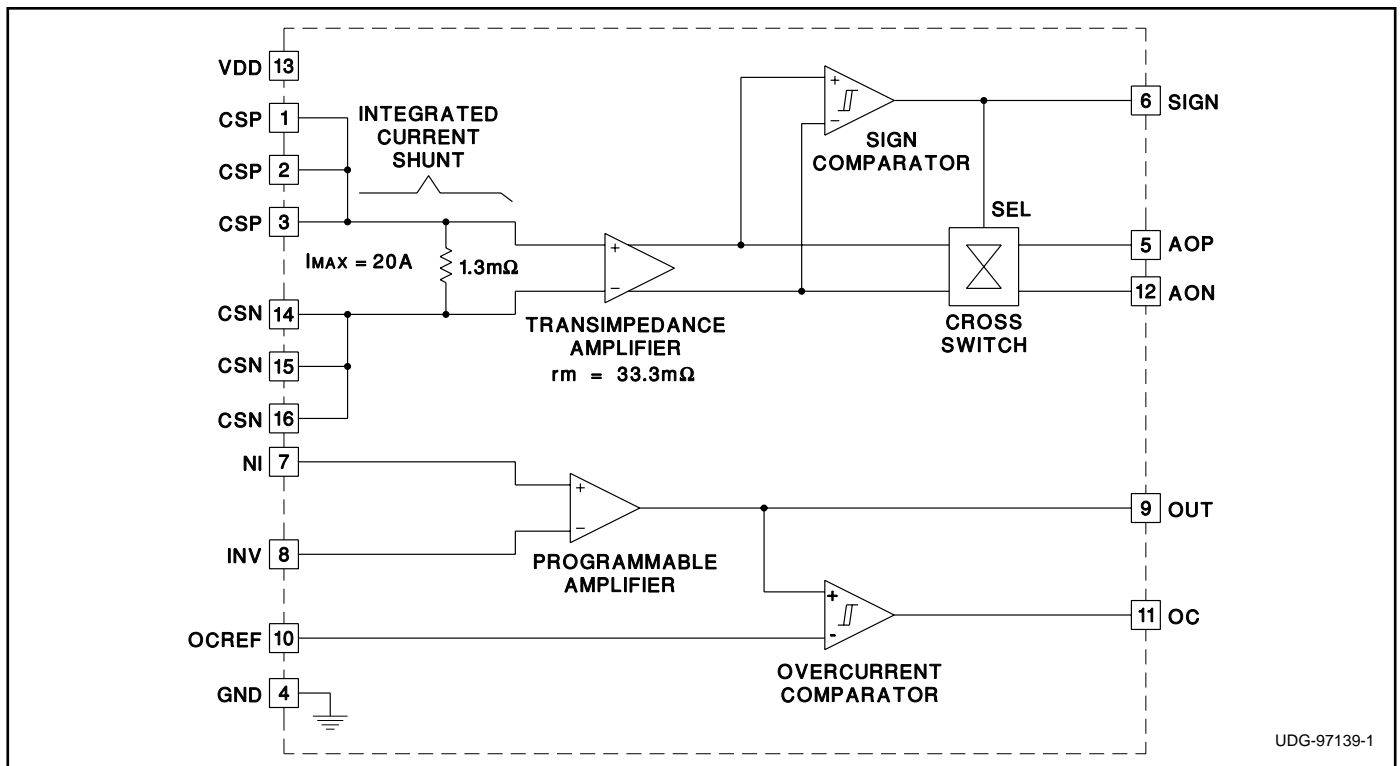
The UCC3926 Current Sensor IC contains a wideband, transimpedance amplifier for converting the current through an internal, non-inductive 1.3mΩ shunt resistor into a proportional voltage. The sense element operates in both high-side (V_{DD} referenced) and low-side (GND referenced) applications.

The UCC3926 can measure currents up to ±20A. This transimpedance amplifier gain is precisely trimmed to 33.3mΩ to convert a 15A input into a 500mV output signal. It has a very low input offset voltage from chopper-stabilization. A cross-switching block rectifies the input signal by forcing the differential output, AOP positive with respect to the other differential output, AON. SIGN indicates the polarity of the current.

The UCC3926 programmable amplifier provides three functions. It converts the differential transimpedance output signal into a single-ended signal. It has a user-controlled gain stage that sets the maximum current level to the desired voltage and it level shifts the zero current point to the desired level as well. A comparator then compares the output of the instrumentation amplifier to a user-set reference voltage on OCREF, which provides an overcurrent status bit OC.

The UCC3926 is available in the 16 pin SOIC package.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

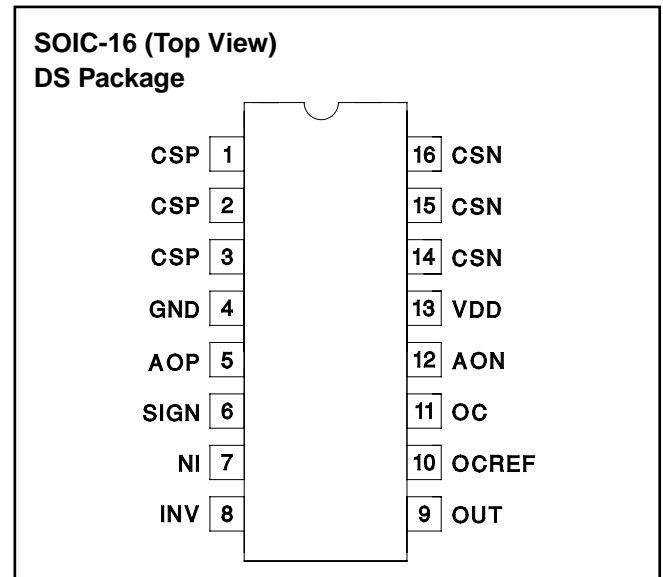
Input Sense Current (I _{IN})	± 20A
Supply Voltage, VDD	14.5V
Inrush Current, 50µs	±100A
Input Voltage Range (CSP, CSN)	-0.2V to 14.5V
CSP, CSN, Common Mode Range (referenced to GND)	± 200mV
CSP, CSN, Common Mode Range (referenced to VDD)	± 200mV
Shunt Resistance	2.25mΩ
Storage Temperature	-65°C to 150°C
Junction Temperature	-55°C to 150°C
Lead Temperature (Soldering, 10sec.)	300°C

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

ORDERING INFORMATION

	TEMPERATURE RANGE	PACKAGES
UCC1926	- 55°C to +125°C	DS
UCC2926	- 40°C to +85°C	DS
UCC3926	0°C to +70°C	DS

CONNECTION DIAGRAM



ELECTRICAL CHARACTERISTICS: Unless otherwise stated, these specifications apply for VDD = 4.8V; all temperature ranges and TA = TJ.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Supply Section					
VDD		4.8		14	V
I _{VDD}			3.8	6	mA
Transimpedance Amplifier Section					
AOP – AON	I _{IN} = 15A, VDD = 10V, 25°C	490	500	510	mV
	I _{IN} = 15A, VDD = 10V, 0°C to +70°C	480	500	520	mV
	I _{IN} = 15A, VDD = 10V, -40°C to +85°C	460	500	540	mV
	I _{IN} = 15A, VDD = 10V, -55°C to +125°C	410	500	590	mV
Quiescent Output Voltage (AOP, AON)	I _{IN} = 0		1.0		V
Quiescent Differential Voltage (AOP – AON)	I _{IN} = 0, Measure AC Peak to Peak		0	30	mV
Bandwidth	(Note 1)	20	40		MHz
Output Impedance			350	500	Ω
Shunt Resistance	CSP to CSN		1.3		mΩ
PSRR	VDD = 4.8V to 10V	45			dB
	VDD = 10V to 14V	25			dB
Temperature Coefficient	(Note 1)	-200		200	ppm/°C
Sign Comparator Section					
V _{OH} , VDD – SIGN	CSP = 1A, I _{SIGN} = -100µA, CSN = 0V		0.2	0.4	V
V _{OL} , SIGN	CSP = -1A, I _{SIGN} = 100µA, CSN = 0V		0.2	0.4	V
I _{IH} Threshold	Ramp CSP, CSN = 0V		400	700	mA
I _{IL} Threshold	Ramp CSP, CSN = 0V		-400	-700	mA
Programmable Amplifier Section					
A _{VOL}		60	70		dB
GBW	At 200kHz	6	13		MHz
V _{IO}	V _{IN} = 0.5V, 1.5V, 2.5V	-9		9	mV

ELECTRICAL CHARACTERISTICS: Unless otherwise stated, these specifications apply for $V_{DD} = 4.8V$; all temperature ranges and $T_A = T_J$.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Programmable Amplifier Section (cont.)					
PSRR	$V_{DD} = 4.8V$ to $10V$	60			dB
	$V_{DD} = 10V$ to $14V$	60			dB
Common Mode Input Range		0.5		2.5	V
I_{IB} , Input Bias Current (NI, INV)			-100	-350	nA
I_{IO} , Input Offset Current			20	350	nA
V_{OL}	INV – NI = 20mV, IO = 0 μ A		100	200	mV
	INV – NI = 20mV, IO = 200 μ A		150	300	mV
V_{OH}	NI – INV = 20mV, IO = -200 μ A, (V_{DD} – OUT)		1.2	2	V
V_{OH} , Clamp	NI – INV = 20mV, $V_{DD} = 14V$	6	7	8	V
I_{OL}	OUT = 1.5V	1	3.5		mA
I_{OH}	OUT = 1.5V	- 250	- 325		μ A
Overcurrent Comparator Section					
OC Comp Threshold	OCREF = 2V	2.00		2.05	V
Common Mode Range	(Note 1)	0.1		$V_{DD} - 2$	V
Hysteresis		20	40	60	mV
V_{OL}	(OCREF – OUT) = 100mV, IOC = 100 μ A		0.2	0.4	V
V_{OH} , $V_{DD} - OC$	(OUT – OCREF) = 100mV, IOC = -100 μ A		0.2	0.4	V
Propagation Delay	(OUT – OCREF) = $\pm 100mV$		90	175	ns

Note 1: Guaranteed by design. Not 100% tested in production.

PIN DESCRIPTIONS

AOP: Positive output of the converted current signal. Voltage from AOP to AON is the absolute value of the transimpedance amplifier output. AOP may show some “chopping” noise. The differential to single-ended conversion removes the common-mode noise between AOP and AON. Some high frequency filtering of AOP to GND can reduce the fast transient spikes. The output stage of AOP is shown in Figure 1.

AON: Negative output of the converted current signal. Voltage from AOP to AON is the absolute value of the transimpedance amplifier output. AON may show some “chopping” noise. The differential to single-ended conversion removes the common-mode noise between AOP and AON. Some high frequency filtering of AON to GND can reduce the fast transient spikes. Note that AON is above GND voltage. The output stage of AON is shown in Figure 1.

CSN: Input connection to one end of the internal current sense shunt resistor. Nominal resistance from CSP to CSN is 1.3m Ω . The current shunt has a nominal temperature coefficient of 3530 ppm/ $^{\circ}$ C. The temperature adjusted autozero gain is designed to cancel this temp co. effect. CSN may be referenced to GND for low side

sensing or to V_{DD} for high side sensing. CSP – CSN may vary from $\pm 75mV$ from either GND or V_{DD} . Current into CSN is defined as negative.

CSP: Input connection to the other end of the internal current sense shunt resistor. Nominal resistance from CSP to CSN is 1.3m Ω . The current shunt has a nominal temperature coefficient of 3530 ppm/ $^{\circ}$ C. The temperature adjusted autozero gain should cancel this temp co. effect. CSP may be referenced to GND for low side sensing or to V_{DD} for high side sensing. CSP – CSN may vary from $\pm 75mV$ from either GND or V_{DD} . Current into CSP is defined as positive.

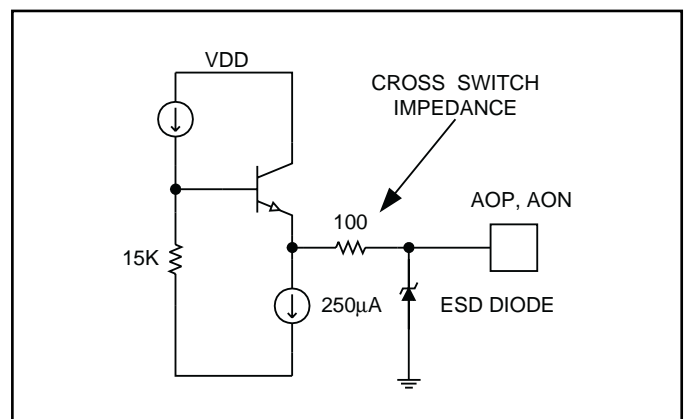


Figure 1. AOP and AON output stage.

PIN DESCRIPTIONS (cont.)

GND: This pin is the return point for all device currents.

INV: Negative input to the programmable amplifier to provide differential to single-ended signal conversion.

NI: Positive input to the programmable amplifier to provide differential to single-ended signal conversion.

OC: Overcurrent comparator output. When OUT is greater than OCREF, OC switches high. The OC comparator has a typical hysteresis of 25mV.

OCREF: The reference pin of overcurrent comparator for setting overcurrent threshold voltage.

OUT: Output of the programmable amplifier intended to provide differential to single-ended signal conversion of the transimpedance amplifier's outputs.

Use this opamp to establish overall gain and nominal zero current reference voltage. This amplifier may be configured with a gain of one or more. Any non-common mode “chopping” noise between AOP and AON will show up at OUT. Some filtering of OUT may improve the application’s performance.

SIGN: Sign comparator output. SIGN also controls the analog switches in the cross-switching block to keep AOP greater than AON. At currents near zero amps, the sign comparator may switch from “chopping” noise from the transimpedance amplifier.

VDD: VDD is the power input connection for this device. Its input range is from 4.8V to 14V. Bypass to GND using good quality ceramic capacitors.

TYPICAL CHARACTERISTICS CURVES

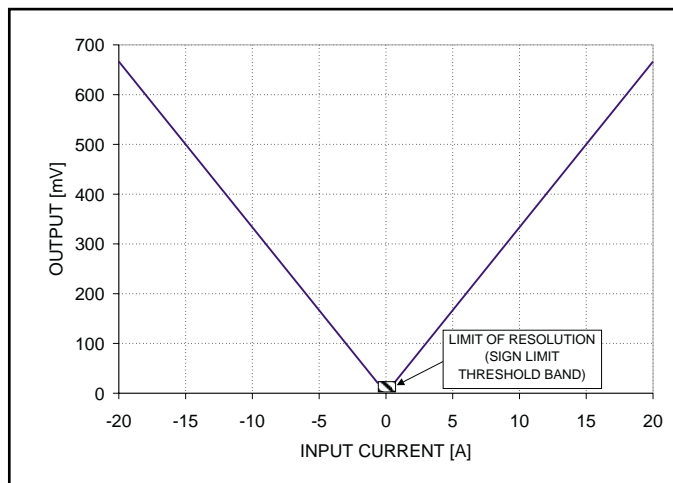


Figure 2. Differential output voltage (AOP-AON) vs. input current (I_{IN}).

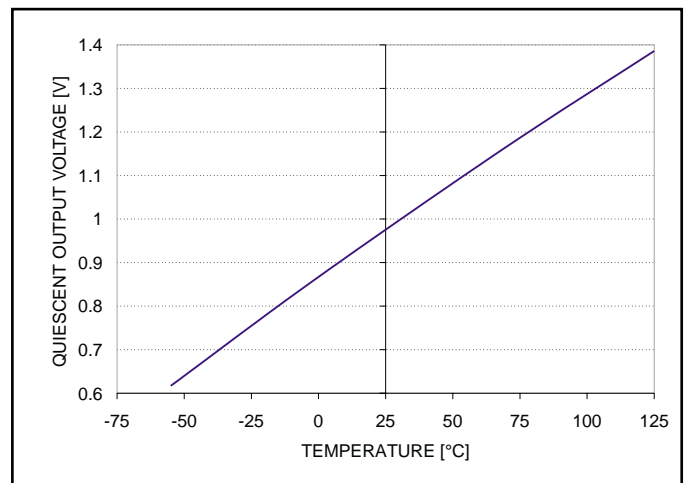


Figure 3. Quiescent AOP, AON output voltage vs. temperature.

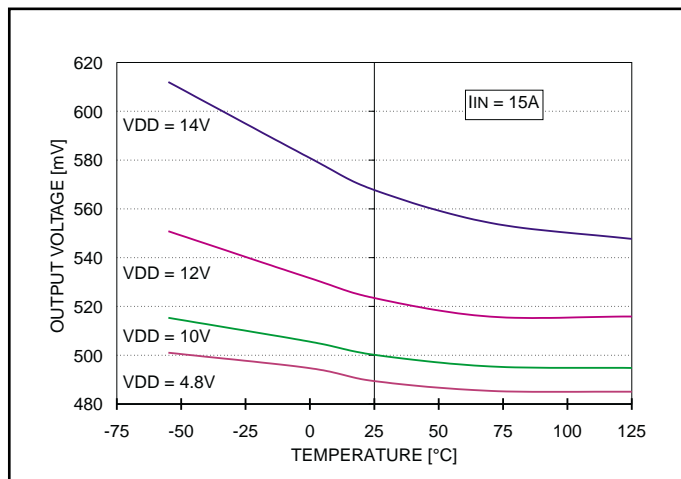


Figure 4. Differential output voltage (AOP - AON) vs. VDD and temperature.

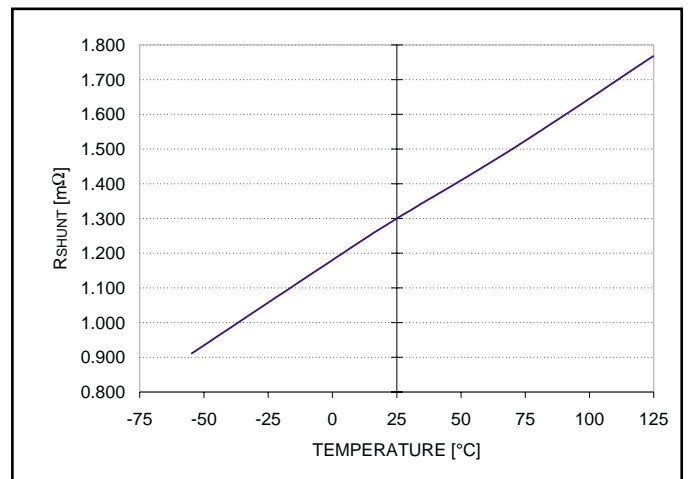
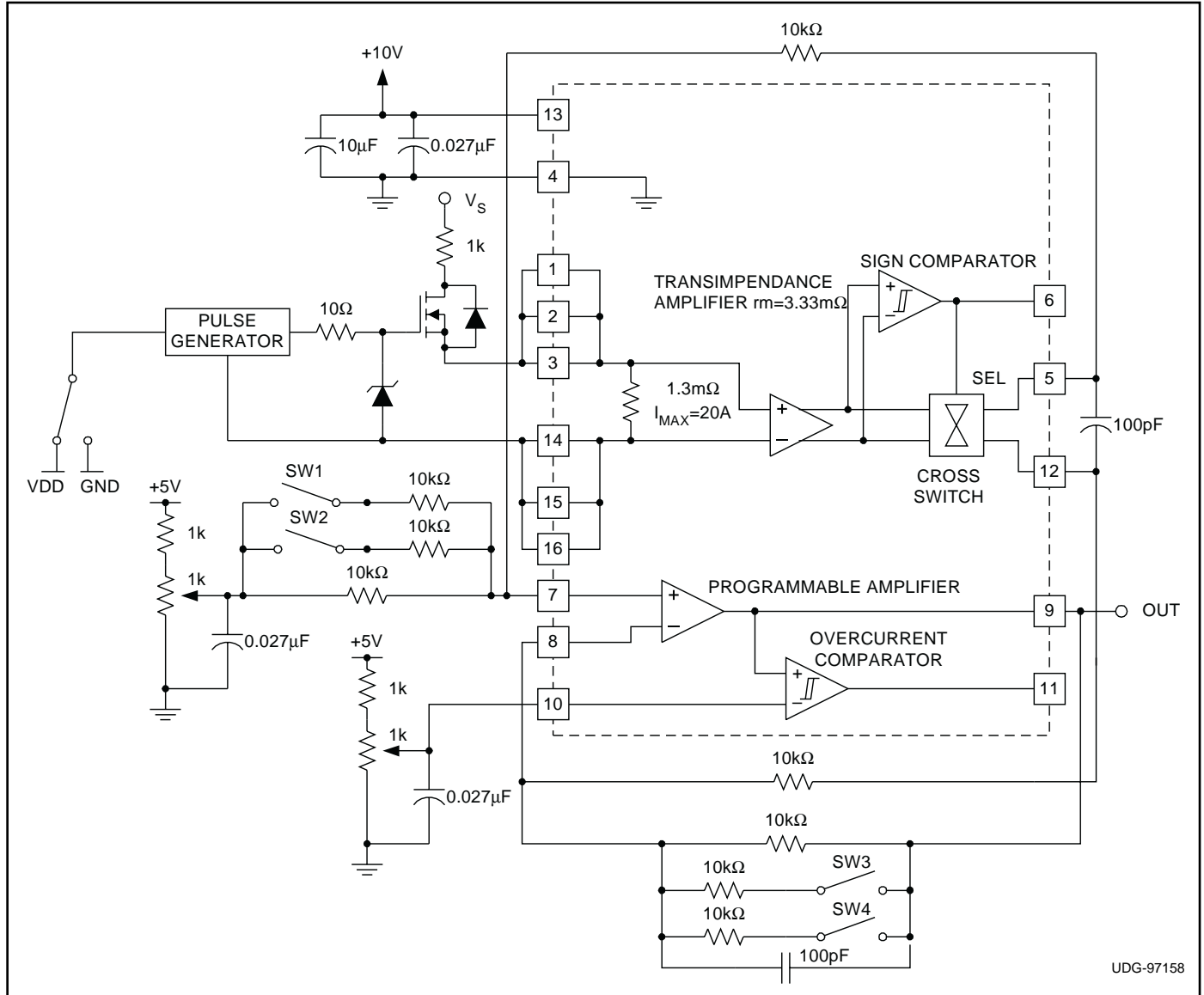


Figure 5. Typical shunt resistance vs. temperature.

LAB EVALUATION CIRCUIT

The circuit shown uses a pulse generator to switch currents while observing the analog voltage of the sensed current. A four position switch can be used to experiment

with different gain settings for the programmable amplifier. The OCREF voltage and the NI DC bias voltage can be adjusted with 1kΩ potentiometers to offset the amplifier output and set the overcurrent comparator threshold.



UDG-97158

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
UCC2926DS	OBSOLETE	SOIC	DW	16		TBD	Call TI	Call TI
UCC2926DSTR	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI
UCC3926DS	OBSOLETE	SOIC	DW	16		TBD	Call TI	Call TI
UCC3926DSTR	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI

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

ACTIVE: Product device recommended for new designs.

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

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

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

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), 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)

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

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

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

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
 - E. Reference JEDEC MS-012 variation AC.

DW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - 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-013 variation AA.

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

Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
RF/IF and ZigBee® Solutions	www.ti.com/lprf

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video
Wireless	www.ti.com/wireless-apps

TI E2E Community Home Page

e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2011, Texas Instruments Incorporated