UNITRODE

application INFO available

UCC1926
UCC2926
UCC3926

±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

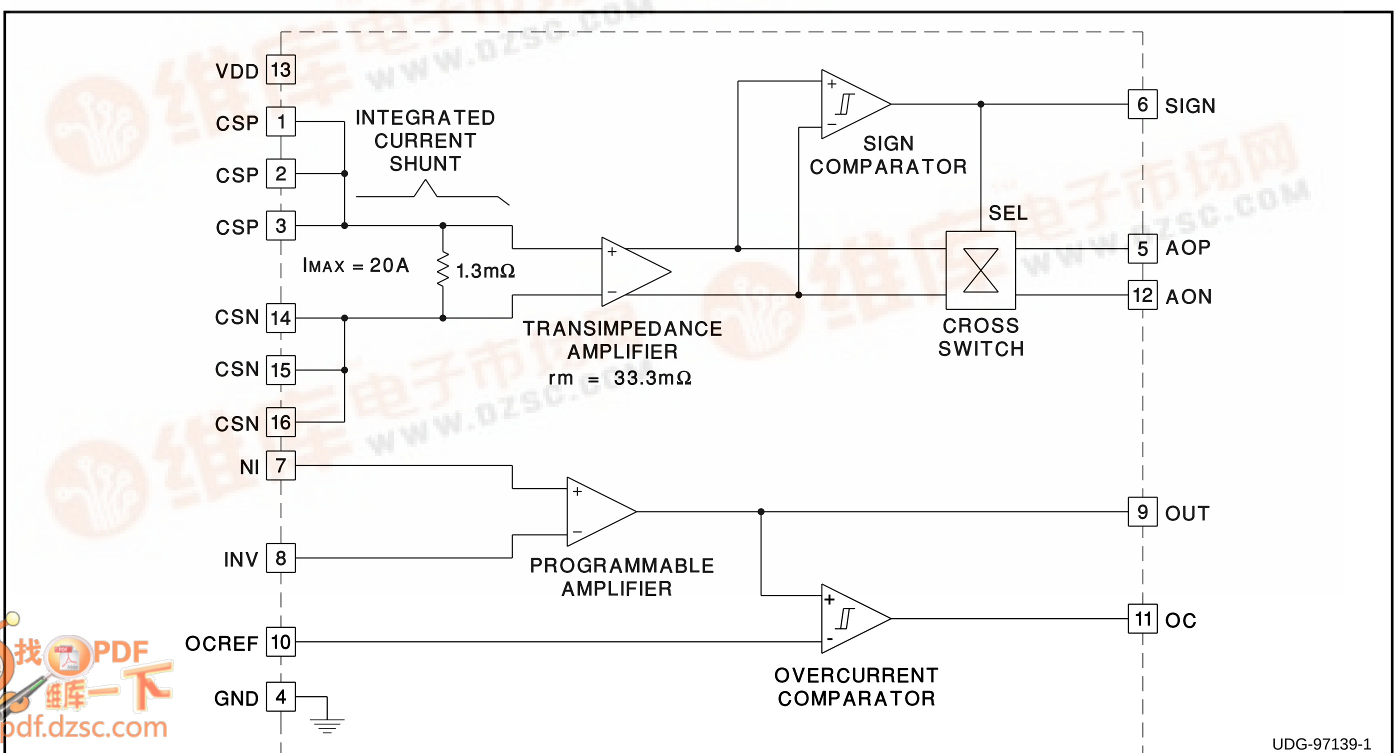
The UCC3926 Current Sensor IC contains a wideband, transimpedance amplifier for converting the current through an internal, non-inductive 1.3mΩ shunt resistor into a proportional voltage. The sense element operates in both high-side (V_{DD} referenced) and low-side (GND referenced) applications.

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



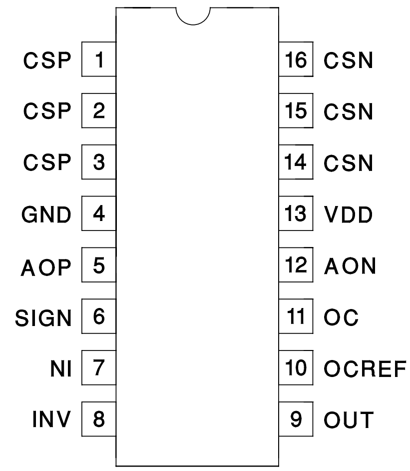
ABSOLUTE MAXIMUM RATINGS

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 V_{DD}) . . . . ± 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.

CONNECTION DIAGRAM

SOIC-16 (Top View)
DS Package



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

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
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 = 0µA		100	200	mV
	INV – NI = 20mV, IO = 200µA		150	300	mV
V_{OH}	NI – INV = 20mV, IO = –200µA, (VDD – OUT)		1.2	2	V
V_{OH}, Clamp	NI – INV = 20mV, VDD = 14V	6	7	8	V
I_{OL}	OUT = 1.5V	1	3.5		mA
I_{OH}	OUT = 1.5V	– 250	– 325		mA
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
VOL	(OCREF – OUT) = 100mV, IOC = 100µA		0.2	0.4	V
VOH, VDD – OC	(OUT – OCREF) = 100mV, IOC = –100µA		0.2	0.4	V
Propagation Delay	(OUT – OCREF) = ±100mV		90	175	ns

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

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 1.3mΩ. The current shunt has a nominal temperature coefficient of 3530 ppm/°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 VDD for high side sensing. CSP – CSN may vary from ±75mV from either GND or VDD. 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 1.3mW. The current shunt has a nominal temperature coefficient of 3530 ppm/°C. The temperature adjusted autozero gain should cancel this temp co. effect. CSP may be referenced to GND for low side sensing or to VDD for high side sensing. CSP – CSN may vary from ±75mV from either GND or VDD. Current into CSP is defined as positive.

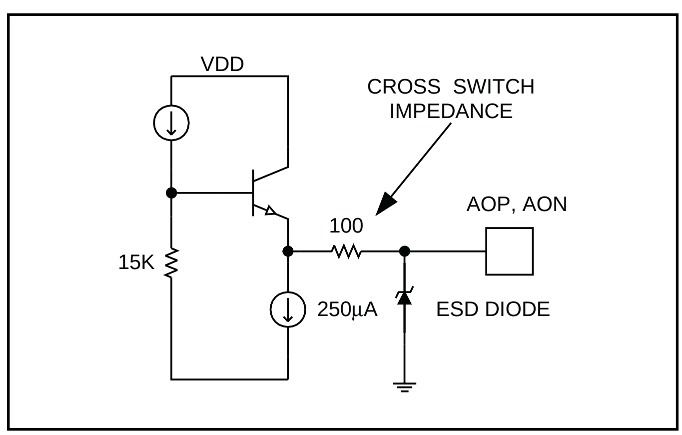


Figure 1. AOP and AON output stage.

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

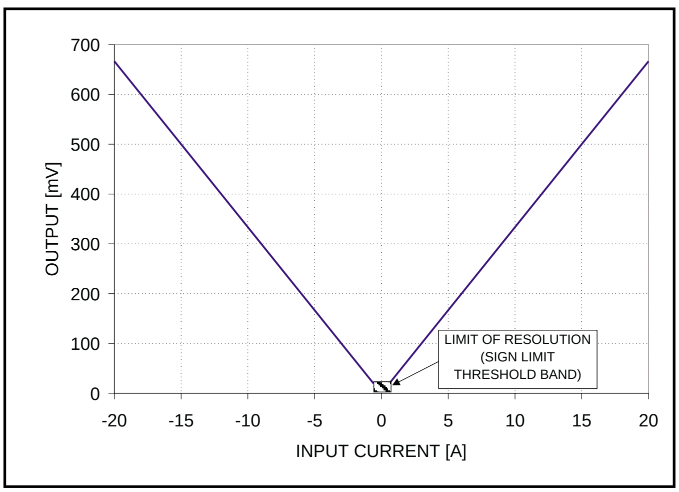


Figure 2. Differential output voltage (AOP-AON) vs. input current (I_{IN}).

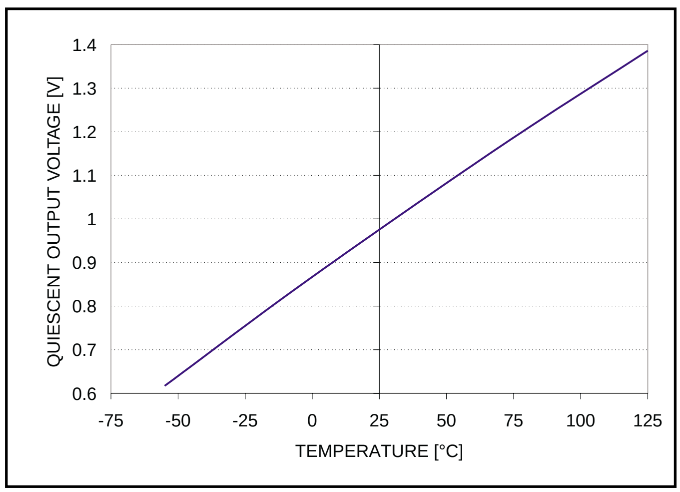


Figure 3. Quiescent AOP, AON output voltage vs. temperature.

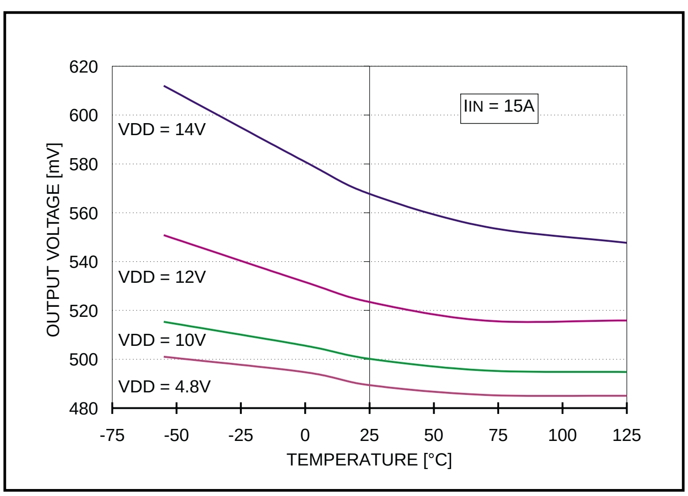


Figure 4. Differential output voltage (AOP - AON) vs. VDD and temperature.

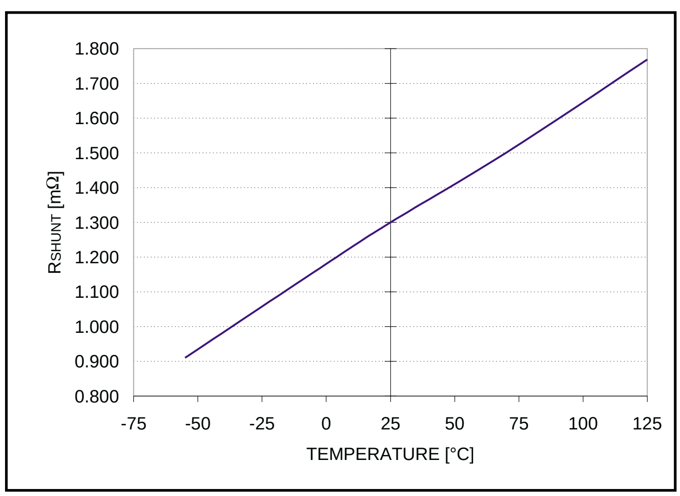
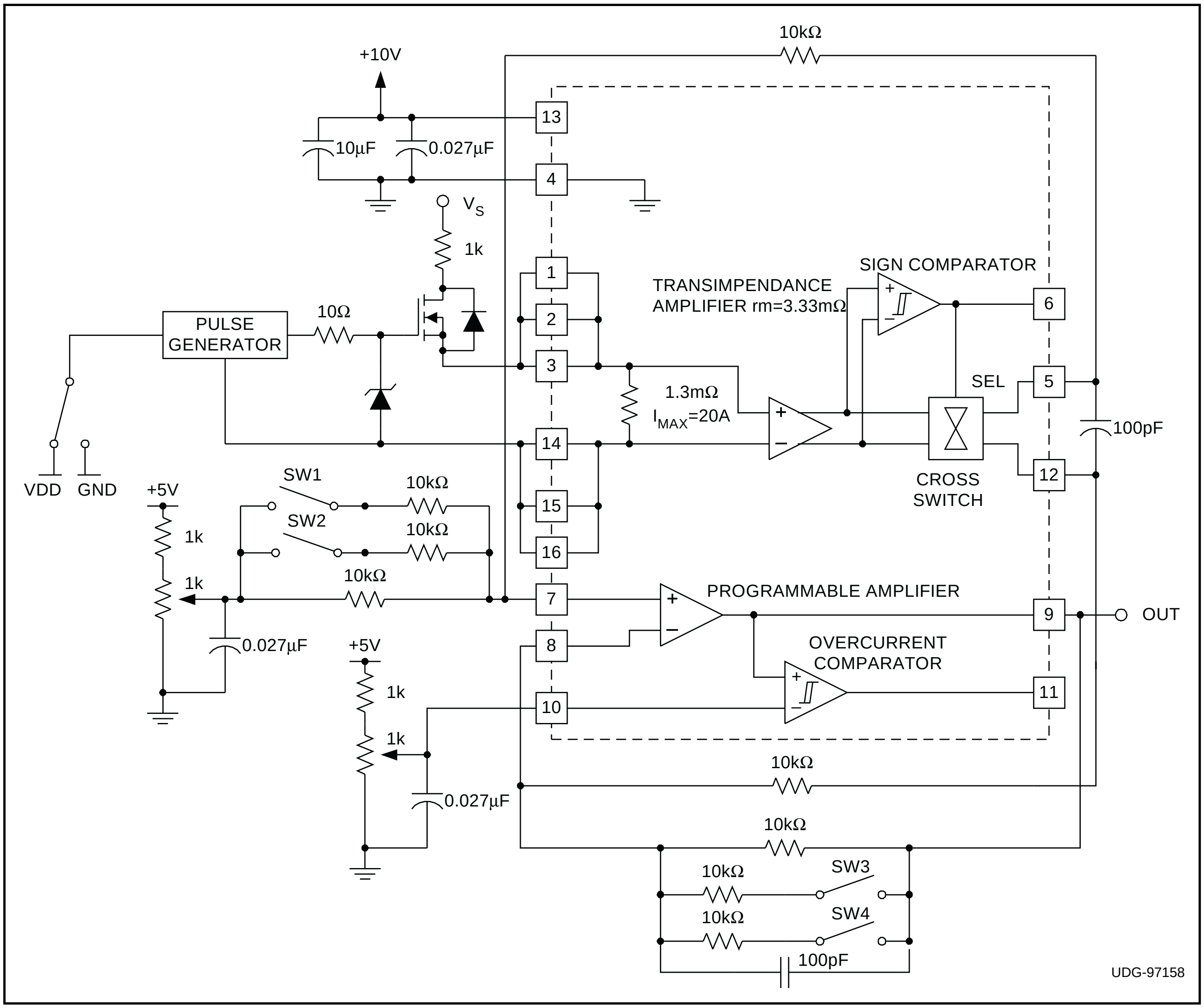


Figure 5. Typical shunt resistance vs. temperature.

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.



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