Current Sense Amplifier – SiSA4080

76V High-Side Unidirectional Current Sense Amplifier in bare die form

Rev 1.0
14/10/20

Description

SiSA4080 is a 76V capable current sense amplifier produced using SOI (Silicon-On-Insulator) technology. A wide power supply range of 4.5V - 76V applies to both input common-mode and supply voltages for simplified high-voltage current monitoring. The device can be powered by the same voltage being monitored and requires no intermediate supply voltage routed to the point of load. High-side current monitoring avoids ground path interference with the measured load and is functionally suited for high-voltage precision applications.

SiSA4080 is a fixed 60V/V gain device and is specified for operation over a wide -40°C to +125° temperature range. A user selectable external sense resistor sets the full-scale current reading and its proportional output voltage.

Optimized design + fab process deliver an industry smallest die with exceptional stability. This device suits applications requiring very high integration and reliability over temperature.

Features:

- Industry smallest form factor
- Power supply range: 4.5V to 76V
- Input common-mode range: 4.5V to 76V
- Unidirectional I_{SENSE}
- Fixed Gain: 60 V/V
- Gain accuracy: 0.1%
- Offset Voltage: 100μV
- Input Bias Current: 5μA
- Bandwidth: 270 kHz minimum
- Quiescent Current: 75μA
- PSRR (DC): 122 dB
- CMRR (DC): 124 dB
- Wide automotive temperature range.

Ordering Information

The following part suffixes apply:

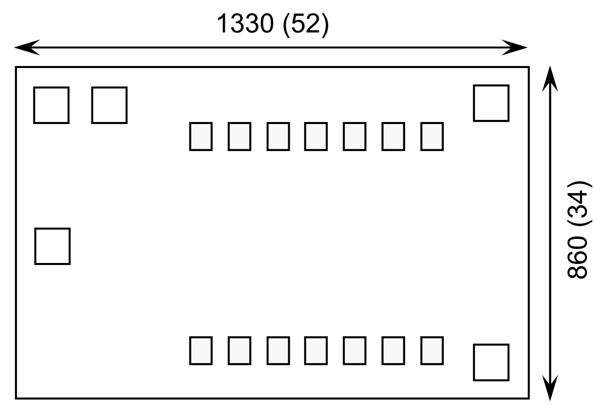
- No suffix - MIL-STD-883 /2010B Visual Inspection
- "**H**" - MIL-STD-883 /2010B Visual Inspection
  + MIL-PRF-38534 Class H LAT
- "**K**" - MIL-STD-883 /2010A Visual Inspection (Space)
  + MIL-PRF-38534 Class K LAT

LAT = Lot Acceptance Test.

For further information on LAT process flows see below.

www.siliconsupplies.com\quality\bare-die-lot-qualification

Die Dimensions in µm (mils)



Supply Formats:

- Default – Die in Waffle Pack (400 per tray capacity)
- Sawn Wafer on Tape – On request
- Unsawn Wafer – On request
- Die Thickness <> 380µm(15 Mils) – On request
- Assembled into in VSSOP package – On request

Mechanical Specification

Die Size (Un-sawn)	1330 x 860 52 x 34	µm mils
Minimum Bond Pad Size	85 x 85 3.35 x 3.35	µm mils
Die Thickness	380 (±20) 14.96 (±0.79)	µm mils
Top Metal Composition	Al	
Back Metal Composition	N/A – Bare Si	

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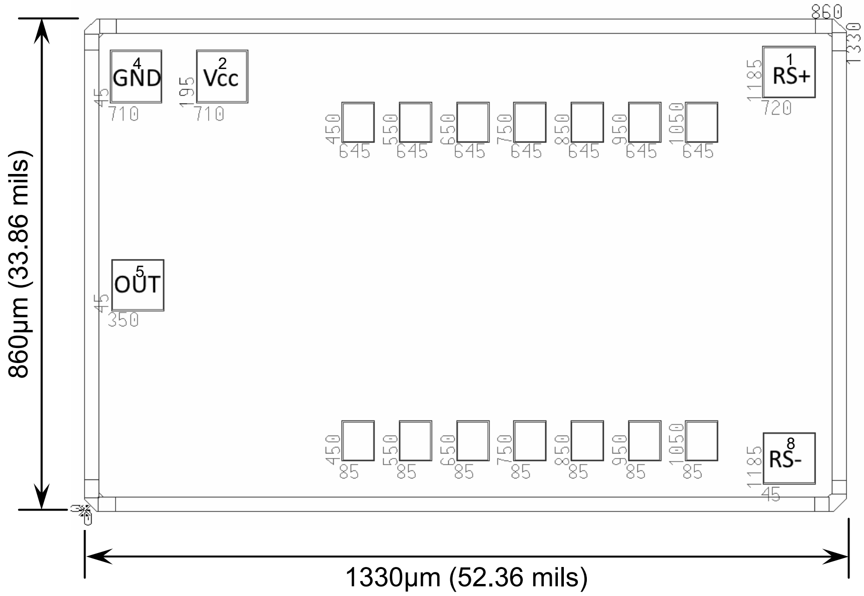
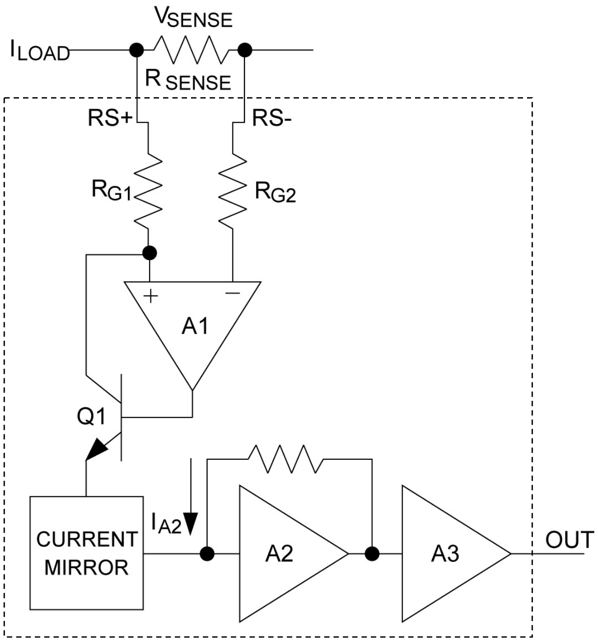
Pad Layout and Functions

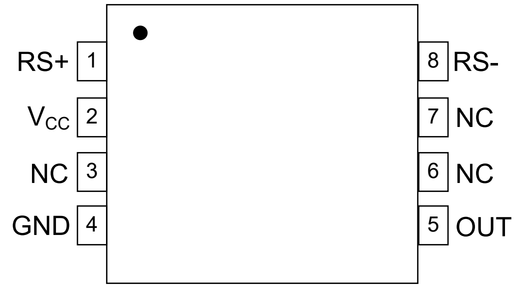


PAD	FUNCTION	COORDINATES (μm)	
		X	Y
1	RS +	1185	720
2	V_{CC}	195	710
3	NC	-	-
4	GND	45	710
5	OUT	45	350
6	NC	-	-
7	NC	-	-
8	RS -	1185	45
ISOLATE CHIP BACKSIDE			

Functional Diagram



Pinout (Assembled in VSSOP)



Absolute Maximum Ratings[1] (Voltages referenced to GND unless otherwise stated)

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	V_{CC}	-0.3 to +80	V
RS+ or RS-	V_{IN}	-0.3 to +80	V
Output Voltage	V_{OUT}	-0.3 to the lesser of +18 or (V_{CC} + 0.3)	V
Differential Input Voltage	$V_{RS+} - V_{RS-}$	±80	V
Current into any pin	I_{IN}	±20	mA
Storage Temperature	T_{STG}	-65 to +150	°C
Operating Junction Temperature	T_J	-40 to 125	°C

1. Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability.

Recommended Operating Conditions (Voltages referenced to GND unless otherwise stated)

PARAMETER	SYMBOL	MIN	MAX	UNIT
Operating Temperature	T_A	-40	+125	°C
DC Supply Voltage	V_{CC}	4.5	76	V
Common Mode Voltage	V_{CM}	4.5	76	V

DC Electrical Characteristics

$V_{CC} = V_{RS+}$ = 4.5V to 76V, $V_{SENSE} = (V_{RS+} - V_{RS-})$ = 0V, R_{LOAD} = 100kΩ, T_A = -40 to +125°C unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS		LIMITS			UNITS
				MIN	TYP	MAX	
Input Offset Voltage	V_{OS}	$V_{CC}=V_{RS+}$=48V	25°C	-	±0.1	±0.6	mV
			-40 to +85°C	-	-	±1	
			-40 to +125°C	-	-	±1.2	
Input Bias Current	I_{RS+} , I_{RS-}	$V_{CC} = V_{RS+}$ = 76V		-	5	12	µA
Input Leakage Current		V_{CC} = 0, V_{RS+} = 76V		-	0.01	2	
Full-Scale Sense Voltage	V_{SENSE}	-		-	±100	-	mV
Gain	A_V	-		-	60	-	V/V
Gain Error	ΔA_V	$V_{CC}=V_{RS+}$=48V V_{SENSE} = 10mV to 100mV	25°C	-	±0.1	±0.6	%
			-40 to +85°C	-	-	±1	
			-40 to +125°C	-	-	±1.2	
Power-Supply Rejection Ratio	PSRR	V_{RS+} = 48V, V_{CC} = 4.5V to 76V, V_{SENSE} = 50mV		100	122	-	dB
Common-Mode Rejection Ratio	CMRR	V_{CC} = 48V, V_{RS+} = 4.5V to 76V, V_{SENSE} = 50mV		100	124	-	
Input Common-Mode Voltage Range[2]	CMVR	CMRR > 100 dB		4.5	-	76	V

2. The common-mode range at the low end of 4.5V applies to the most positive potential at RS+ or RS-. Depending on the polarity of V_{SENSE} and the device's gain, either RS+ or RS- can extend below 4.5V by the device's typical full-scale value of V_{SENSE}

DC Electrical Characteristics continued

$V_{CC} = V_{RS+} = 4.5V$ to $76V$, $V_{SENSE} = (V_{RS+} - V_{RS-}) = 0V$, $R_{LOAD} = 100k\Omega$, $T_A = -40$ to $+125°C$ unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	LIMITS			UNITS
			MIN	TYP	MAX	
Output Resistance	R_{OUT}	$V_{SENSE} = 100mV$	-	0.1	-	Ω
Output Voltage Headroom[3]	$V_{CC} - V_{OUT}$	$V_{CC} = 4.5V$, $V_{RS+} = 48V$, I_{OUT} (sourcing) = +500µA, $V_{SENSE} = 100mV$	-	0.15	0.27	V
Supply Current	I_{CC}	$V_{CC} = V_{RS+} = 76V$, no load	-	75	190	µA

3. Output voltage is internally clamped not to exceed 18V

AC Electrical Characteristics[4]

$V_{CC} = V_{RS+} = 4.5V$ to $76V$, $V_{SENSE} = (V_{RS+} - V_{RS-}) = 0V$, $R_{LOAD} = 100k\Omega$, $C_{LOAD} = 20pF$, $T_A = -40$ to $+125°C$ unless otherwise noted.

PARAMETER	SYMBOL	CONDITIONS	LIMITS			UNITS
			MIN	TYP	MAX	
Bandwidth	BW	$V_{CC} = V_{RS+} = 48V$, $V_{OUT} = 2.5V$	270	-	-	kHz
Output Settling Time to 1% of final value	t_{SETTLE}	$V_{SENSE} = 10mV$ to $100mV$	-	20	-	µs
Power-Up Time	t_{PU}	$V_{CC} = V_{RS+} = 48V$, $V_{SENSE} = 100mV$, Output to 1% of final value	-	50	-	µs
Saturation Recovery Time	$t_{RECOVERY}$	Output settles to 1% of final value, device does not experience phase reversal when overdriven	-	50	-	µs
Output Capacitance Load	C_{LOAD}	No sustained oscillations	-	500	-	pF

4. Not production tested in die form, characterized by chip design.

Typical Component Values

FULL-SCALE LOAD CURRENT, I_{LOAD} (A)	CURRENT-SENSE RESISTOR (mΩ)	FULL-SCALE, V_{SENSE} (mV)	FULL-SCALE OUTPUT VOLTAGE (V)
0.100	1000	100	6.0
1.000	100	100	6.0
10.000	10	100	6.0

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Application Notes

Formulae

Output Voltage:

$V_{OUT} = V_{SENSE}$ 5 A_V

Where:

- V_{SENSE} is the full-scale sense voltage
- A_V is the gain of the device.

The Full-Scale Output Voltage is:

$V_{OUT} = R_{SENSE} \times I_{LOAD\ (MAX)} \times A_V$

$V_{SENSE(MAX)}$ = 100mV for 60V/V gain

Power-Supply Bypassing and Grounding

For most applications, bypass V_{CC} to GND with a 0.1µF ceramic capacitor. In many applications, V_{CC} can be connected to one of the current monitor terminals (RS+ or RS-). Because V_{CC} is independent of the monitored voltage, V_{CC} can be connected to a separate regulated supply. If V_{CC} will be subject to fast-line transients, a series resistor can be added to the power-supply line to minimize output disturbance. This resistance and the decoupling capacitor reduce the rise time of the transient. For most applications, 1kΩ in conjunction with a 0.1µF bypass capacitor works well. In bare die form the backside of the die should be isolated, in package form the device requires no special considerations with respect to layout or grounding. Consideration should be given to minimizing errors due to the large charge and discharge currents in the system.

Sense Resistor Selection

Select R_{SENSE} based on the following criteria:

- *Voltage Loss* - A high R_{SENSE} value causes the power-source voltage to degrade through IR loss. For minimal voltage loss, use the lowest R_{SENSE} value.
- *Accuracy* - A high R_{SENSE} value allows lower currents to be measured more accurately. This is due to offsets becoming less significant when the sense voltage is larger. For best performance, select R_{SENSE} to provide approximately 100mV of sense voltage for the full-scale current in each application.
- *Efficiency and Power Dissipation* - At high current levels, the I2R losses in R_{SENSE} can be significant. Take this into consideration when choosing the resistor value and its power dissipation (wattage) rating. Also, the sense resistor's value might drift if it is allowed to heat up excessively.
- *Inductance* - Keep inductance low if I_{SENSE} has a large high-frequency component. Wire-wound resistors have the highest inductance, while metal film is somewhat better. Low-inductance, metal-film resistors are also available. Instead of being spiral- wrapped around a core, as in metal-film or wire-wound resistors, they are a straight band of metal and are available in values under 1Ω. Because of the high currents that flow through R_{SENSE}, take care to eliminate parasitic trace resistance from causing errors in the sense voltage. Either use a four-terminal current-sense resistor or use Kelvin (force and sense) PC board layout techniques.