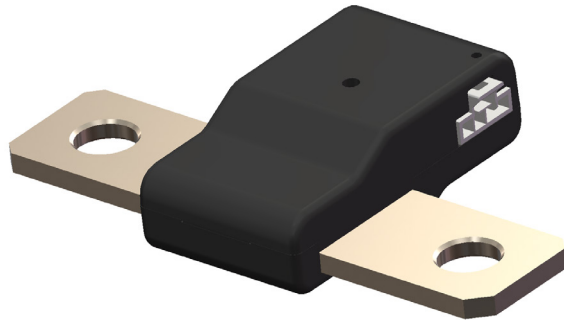


# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



- 100A to 1000A
- AC or DC Circuits
- 1500VDC Reinforced Isolation
- Amplified Differential Output,  $\pm 2.5V$  peak
- 0.1% Tolerance
- Typical Applications:
  - » Battery Systems
  - » UPS systems
  - » Motor Drives
  - » Frequency Inverters
  - » Fuel Cells

## SPECIFICATIONS

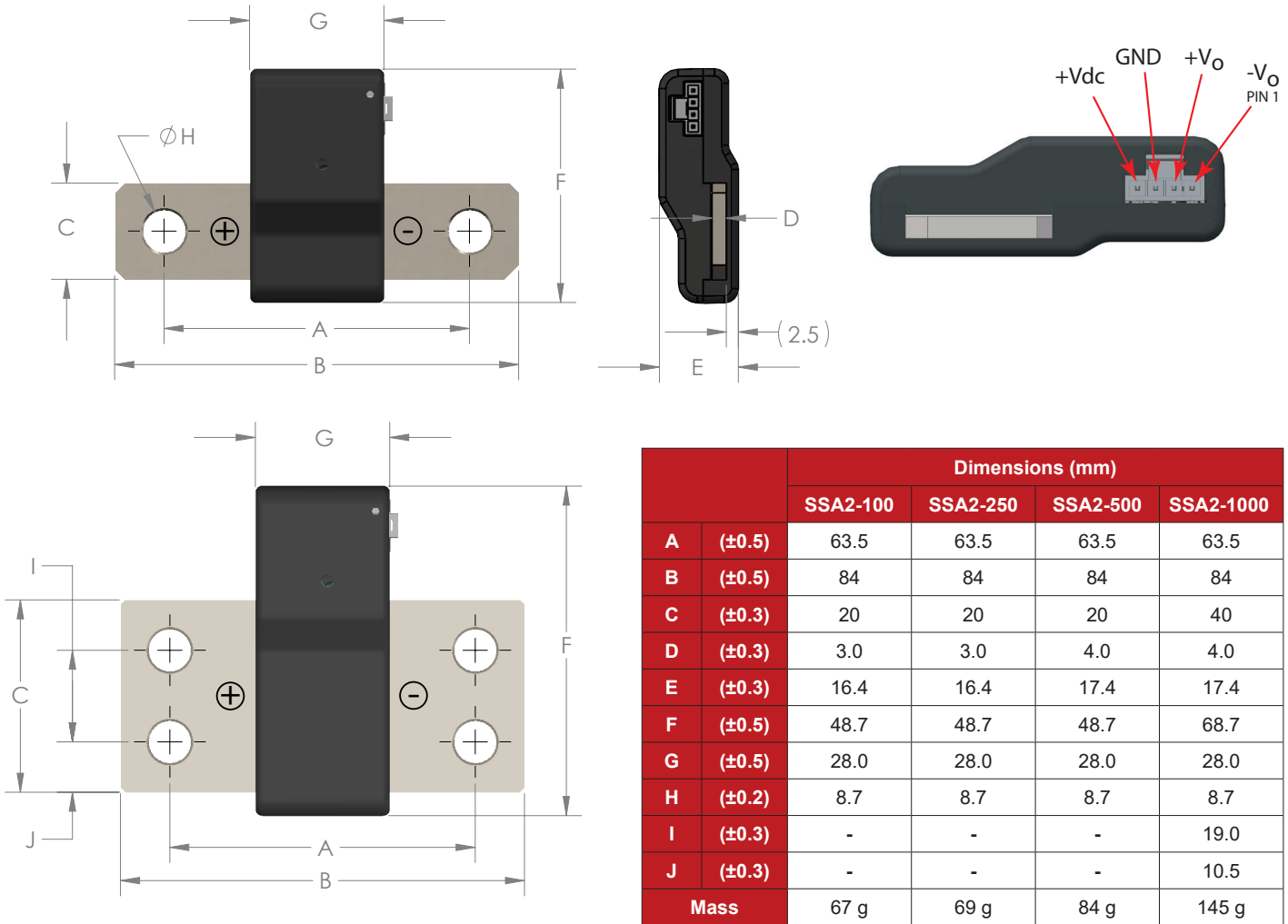
Nominal Current	100A	250A	500A	1000A
Differential Analog Output $\pm 2.6$ volts maximum unclipped	$\pm 12.5$ mV/A	$\pm 5$ mV/A	$\pm 2.5$ mV/A	$\pm 1.25$ mV/A
Power Dissipation Rated current at primary terminations	4 W	9 W	17 W	35 W
Maximum Current ( unclipped output )	200A	500A	1000A	2000A
Over Current ( 1s, clipped )	600A	1500A	3000A	6000A
Power Supply (3.0 to 5.5vdc) with high impedance load	@ 3.0V, 20mA typical		@ 5.5V, 40mA typical	
DC Offset ( @ 25°C )	$\leq \pm 0.4$ mV ( 10Hz LP filter )			
Initial Accuracy ( @ 25°C )	$\pm 0.1\%$ (Offset is zeroed prior to calibrating using DC current)			
Linearity over Current Range	$\pm 0.1\%$ of range			
Bandwidth (electronics)	300kHz			
Reaction Time (typical)	1.6 $\mu$ s (input step function, 50% rise on input to 50% rise on output)			
Common Mode Rejection Ratio	CMRR: -100dB @ DC, -98dB @ 10kHz			
Common Mode Transient Immunity	CMTI: 80kV/ $\mu$ S typical, 55kV/ $\mu$ S minimum			
Signal to Noise Ratio (SNR)	VIN = 100 mVPP, fIN = 1 kHz, BW = 10 kHz 80dB min 84dB typical VIN = 100 mVPP, fIN = 10 kHz, BW = 100 kHz 70dB typical			
Long term stability	< $\pm 0.2\%$ 1000 hours 45°C terminal temperature < $\pm 0.5\%$ 1000 hours 100°C terminal temperature			
Reinforced Isolation	1500V <sub>DC</sub> 1000V <sub>AC</sub> RMS (maximum continuous working voltage)			
Dielectric Strength	3500V <sub>AC RMS</sub> 1 minute			
Operating Temperature	- 40°C to +115°C ambient - 40°C to +125°C primary conductor ( see derating curve on page 4 )			
Storage Temperature	- 55°C to +125°C			
Materials (RoHS Compliant)	Resistance Element: Manganin Terminal Block: Nickel Plated Copper Suitable for Copper, Copper-Clad Aluminum or Aluminum conductors Electronics Housing: 94-V0 rated Potting Material: 94-V0 rated			

# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## Standard Configuration



### Mating Connector:

	<b>Molex PN</b>	
1pc	1053071204	4-Pin Female
4pc	1053002200*	20-22 AWG Female Crimp Terminals
1pc	1053251004	4-Pin TPA ( Optional )

\* Use gold plated terminals for +115C Temperature rating

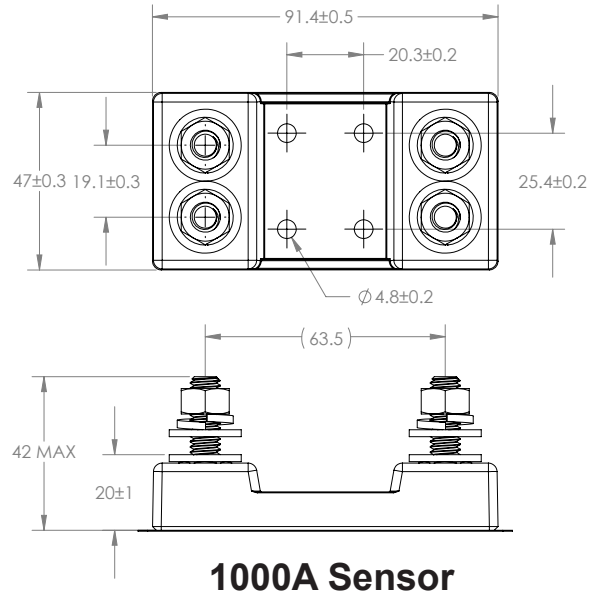
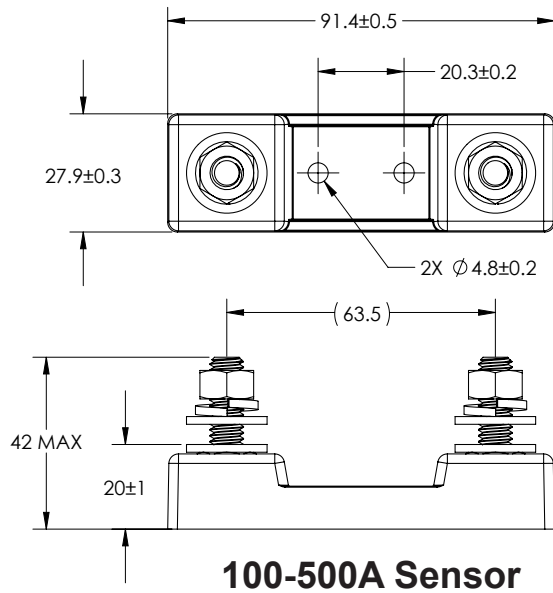
Product Safety notice - The SSA current sensor must be used in a manner specified by this datasheet, otherwise the protection provided by the equipment may be impaired. The SSA series should not be treated as a structural part of the installation and must be properly supported on both ends.

# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## BASE Mounting Fixtures (Optional)



Ordering Info: SSA-BASE

SSA-BASE-1K



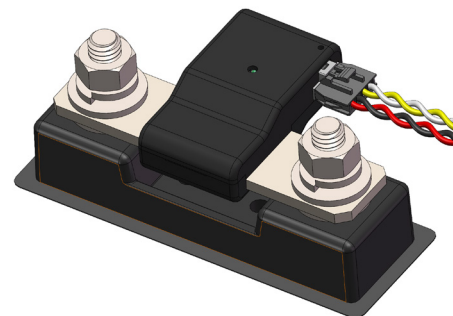
- Robust design
- 5/16-18 Stainless Steel Hardware
- Torque Nuts:  
11-13 ft-lb (15-17.6 N-m)
- UL 94-V0 rated materials

## SS-CABLE Power/Output Connection (Optional)



- For all SSA2 models
- Color coded 22ga wire
- Two twisted pairs
- 1 meter standard length

Differential Output		
White	Analog (-)	Pin 1
Yellow	Analog (+)	Pin 2
Black	Ground	Pin 3
Red	+3.0v to 5.5v	Pin 4



Ordering Info: SS-CABLE-1M

SSA shown with optional accessories

# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## Frequently Asked Questions

### Q: How does the Riedon SSA compare with hall effect technology?

A: When compared to hall effect technology, the SSA smart current sensor will offer:

- Immunity to stray magnetic fields
- Unlike closed loop hall sensors, the SSA has a unipolar power supply requirement
- No hysteresis
- Low-noise resolution and offset performance allows accurate low-current measurements
- Superior offset, gain and linearity performance over entire temperature range
- Low noise
- Higher bandwidth (300KHz vs 50KHz)
- Lighter weight
- Superior stability
- No sensitivity to conductor positioning
- No periodic calibration

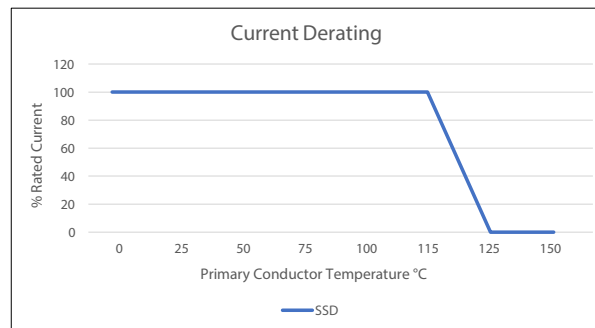
Here is a document published by Texas Instruments that discusses some of the technical aspects:  
<http://www.ti.com/lit/sbaa293>

### Q: Is the SSA suitable for AC measurements?

A: The wide bandwidth of the SSA makes it appropriate for measuring AC currents as well as DC

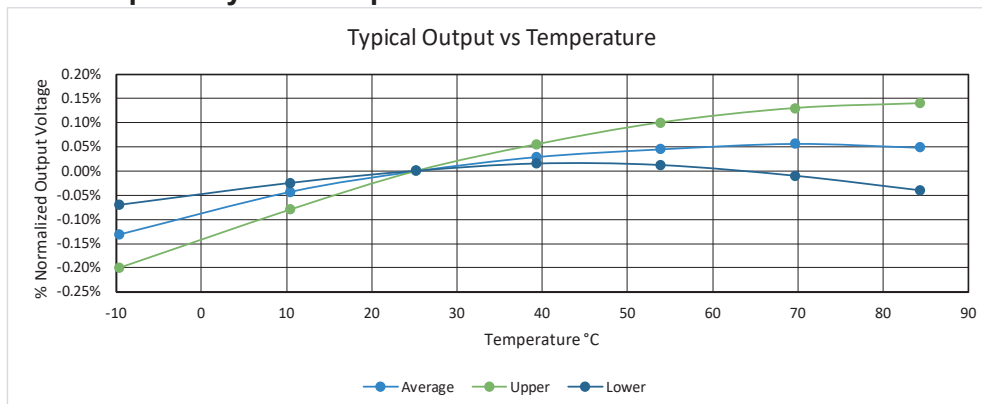
### Q: Is there a derating for temperature?

A:



### Q: How does the output vary with temperature?

A:



# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



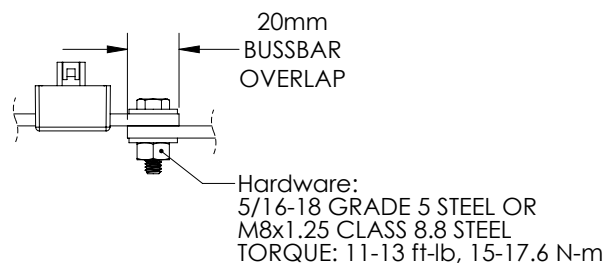
## Frequently Asked Questions

### Q: What are the overload capabilities of the SSA?

A: The output reading will saturate with an input current that exceeds the corresponding maximum unclipped voltage output of 2.62volts. Ultimately, the overload capabilities are thermally limited per the derating curve.

### Q: What is the best way to connect to the SSA's terminals?

A: Make sure connections are clean and well prepared. Bolts to be torqued to the hardware manufacturer's recommendations. There should be sufficient clamping force to ensure proper connection. Overlap shown below should be taken as a minimum. Suitable for Copper, Copper-Clad Aluminum or Aluminum conductors.



### Q: How much heat does the SSA smart current sensor create?

A: A majority of the heat generated by the SSA is dissipated through the primary conductors. Care should be taken to ensure that the primary conductors are sized appropriately given expected amperage and conductor length. We recommend a 70°C maximum conductor temperature. If there are thermal concerns, oversizing the conductors will help minimize the operating temperature of the smart current sensor.

### Q: What size wire is suitable for the SSA?

A:

Copper Conductor Ampacity Ratings (continuous)						
mm2	AWG	AMPS (75°C)		mm2	AWG	AMPS (75°C)
13.3	6	65		107	0000 (4/0)	230
21.2	4	85		127	250 MCM	255
33.6	2	115		152	300 MCM	285
42.4	1	130		203	400 MCM	335
54	0 (1/0)	150		253	500 MCM	380
67	00 (2/0)	175		380	750 MCM	475
85	000 (3/0)	200		887	1500 MCM	625

### Q: Is it necessary to install the SSA on the low side of the circuit?

A: The SSA series of smart current sensors is completely isolated, so it may be installed in either the low or high side of the circuit.

# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## Frequently Asked Questions

### Q: Thermal EMF?

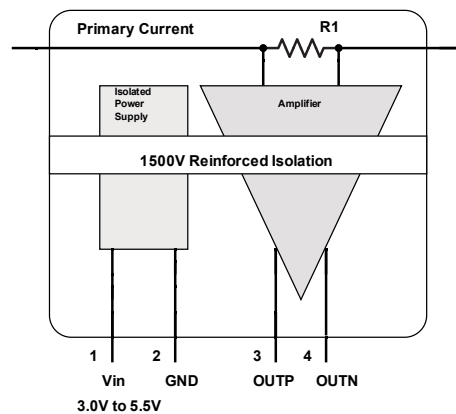
A: Thermal EMF happens when the two sensing terminals of the current sensor experience different temperatures. This phenomenon is essentially eliminated with the differential output of the SSA. It is still possible that the two current carrying terminals could experience a temperature differential, however. This offset would be 0.5mV/°C.

### Q: Is there a version with digital outputs?

A: Riedon plans to develop digital output versions in the very near future.

### Q: Is there a functional diagram of the general layout?

A:

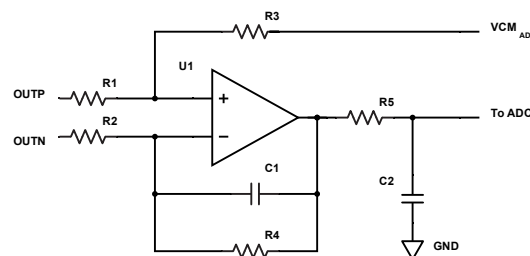


### Q: How do I improve the signal to noise ratio (SNR) of the smart current sensor?

A: Oversampling and averaging are two ways to increase SNR and resolution. See the following link for a full explanation: <https://www.cypress.com/file/236481/download>

### Q: Is there a way to convert the differential output to a single-ended output?

A: VCM will be the new zero current point and the output will be offset by this amount. R3, R4, R5 set the gain.



# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## Frequently Asked Questions

### Q: Is there another way to read the differential output with single ended ADCs?

**A:** The Riedon SSA outputs have a common mode voltage of about +1.44VDC referenced to ground. The difference between OUP+ and OUP- is the differential voltage. You can use two single-ended ADC channels to measure the OUP+ and OUP- voltages referenced to ground and then just subtract the two in software to find the differential voltage. Ideally you would do a simultaneous measurement if possible.

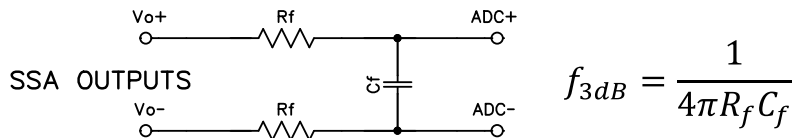
For example: If OUP+ measures 1.85V and OUP- measures 1.03V the differential voltage is 1.85-1.03=0.82V

### Q: I notice a high frequency noise on the output signal, why is this?

**A:** The Riedon SSA smart current sensor has an output chopper circuit at 625KHz. This is how we achieve the good DC-accuracy and low temperature drift of offset and gain. Chopping noise is the differential errors (mismatch, etc) that have been modulated to high frequency to remove them from the baseband. The chopping noise is far above the SSA bandwidth of 300KHz. Use an analog filter to attenuate if necessary, see below.

### Q: How do I improve the stability of precision DC current readings?

**A: Analog Filtering:** The Riedon SSA smart current sensor has no internal filtering to maximize its 300KHz bandwidth for high speed AC measurements. Most applications will operate at much lower frequencies and would benefit greatly from analog filtering, especially for DC signals. A low pass RC filter before the A/D converter will improve the signal. Pick the lowest practical filter frequency. Typically one would prioritize lower resistance values and higher capacitances to reduce Johnson noise and output impedance.



$$f_{3dB} = \frac{1}{4\pi R_f C_f}$$

**A: Digital Filtering:** The filtering can be done digitally by the CPU. Averaging multiple readings will stabilize the readings at the cost of CPU cycles.

# SSA2 - Smart Current Sensor

Amplified Analog Output and Reinforced Isolation



## Frequently Asked Questions

### Q: I'm getting overshoot on fast rising currents, why?

A: When using the SSA series in square wave or pulse applications without filtering, the output will have an excessive amplitude due to the skin effect of the shunt. This will be true with microsecond rise-time currents.

The output of the shunt is inversely proportional to its effective cross sectional area. For the first couple of microseconds the current is flowing on the surface of the resistance material and not evenly across the whole cross sectional area like with lower frequency currents. The higher the  $\Delta I/\Delta t$ , the lower the effective cross section which results in a higher resistance and a higher output voltage. In under 10 micro-seconds the current is flowing through the whole cross section and the output returns to normal.

The amplitude of the pulse is hard to quantify as it is highly dependent on the rest of the circuit's reactance. Filtering is the usual answer. This can either be placed on the output of the SSA shunt before the ADC or Riedon can add a filter internally on the sensing side of the electronics. Contact us if this is required.

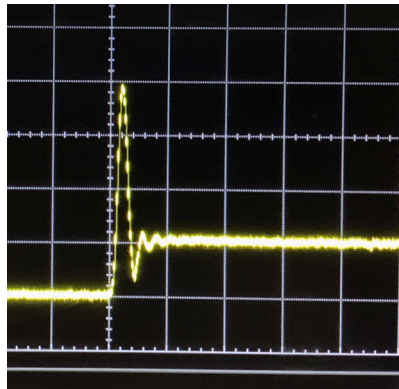
### SHUNT CROSS SECTION



Current Flowing Through Entire Cross Section



Current Flowing Only On Surface



Step response from Fluke 5220A amplifier at 20A square-wave current (no load), 20 $\mu$ s/div range