ISB Series Current Sense Transducer
Application Information

1 Scope

This application note provides background information on the ISB current sensors and information on how to use the low cost current sensor in busbar applications. The ISB series features high creepage, high isolation, low cost, fast response and high bandwidth. The technology is easy to install in challenging mechanical applications with tight dimensions.

2 Introduction

The ISB current sensors are custom ASIC based hall effect devices designed to operate without the need for the core and winding commonly used in current sensors. The current sensors can be applied in a wide range of busbar applications with currents ranging from 75A up to over 670A. The devices feature low insertion loss, high isolation, fast response, wide bandwidth, small size and easy assembly to a bubar. Factory programmable features include output type and customizable current range.

The simplified design consists of a PCB assembly, shield and a mechanical package to integrate the component parts. Thus enabling a lower cost than traditional current sensors while offering performance between typical open loop and closed loop designs.

3 Bus Bar Sizing

The ISB is designed to fit a busbar with a maximum thickness of ¼" and can be used to measure currents up to 670 A. The thickness of the busbars is variable with a maximum thickness of ¼ inch for each with no loss in accuracy. There are limits on the minimum width of the busbar for each size. As a general rule of thumb, a minimum width of ½" is recommended. Customers are advised to provide the actual busbar dimensions for the calibration process. Please ask an ICE engineer for more details.

4 Shield

ICE accomplishes two objectives by adding a U-shaped shield to the design. First, the magnetic flux density is concentrated within the shield. Due to the smaller magnetic resistance,

(μr from air is smaller than the μr of the shielding material) a higher magnetic flux density is generated in the gap of the shield. Simulations show that the magnetic flux density is increased with the shield when the same current is applied. This helps the current sensors to measure low current levels when compared to the overall current range of the sensors. Secondly, the shield helps protect the sensor from stray EMI fields. Our tests show that by maintaining a distance of 12.7mm from adjacent high current paths the specified accuracy can be maintained.

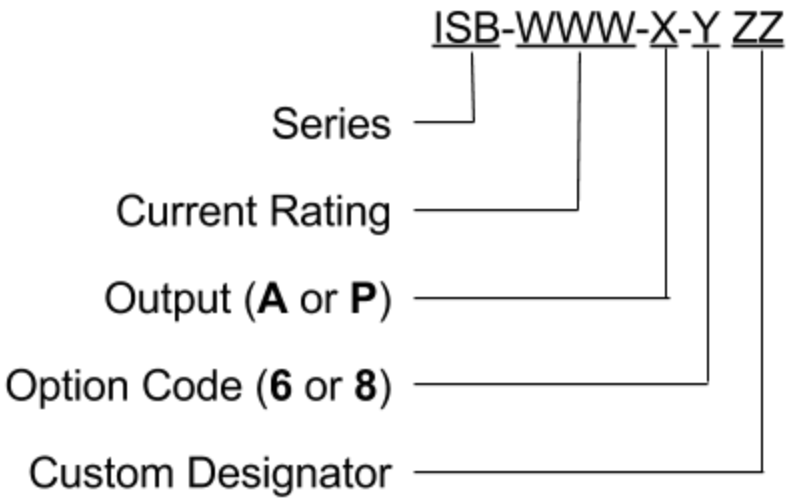
5 Connection

The ISB series has two options for connection to the circuit. The first option is by a 1.00mm pitch shrouded header connector; JST #BM04B-SRSS-TB, which requires JST #SHR-04V-S-B and #SSH-003T-P0.2 (Contact) x4 mating connector. The creepage distance using the connector is 8.5mm. The second option uses stranded #22 AWG UL3239 rated lead wires with a voltage rating of 3kV. The standard length of the lead wire is 150mm providing a much higher creepage distance of 158.5mm. Custom lead wire length can be provided as a custom part number.

6 Linear and Extended Ranges

The current sensors are specified with two current ranges; I_P and I_{PE}. I_P or linear current range is the range in which the current sensor measurements are within the specified linearity and accuracy. In many applications there is a nominal current to be measured more accurately and a higher current to be measured in startup or in failure situations. I_{PE} extends the current range when accuracy is not as important but some resolution at higher currents is needed.

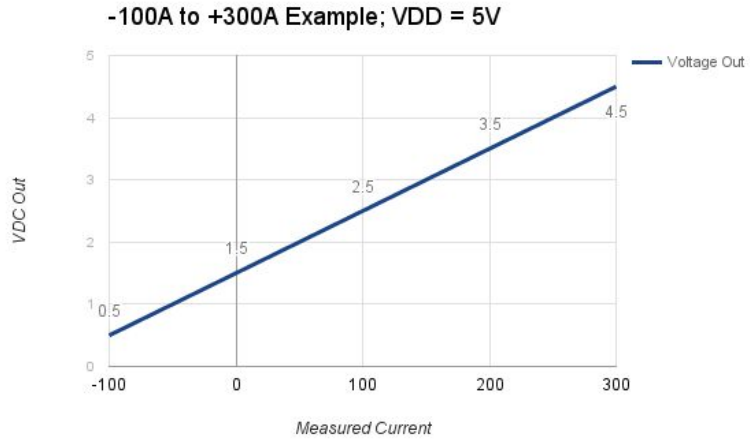
7 Part Number



Current Rating - W

The ISB comes in six (6) standard current ratings. The current ranges from positive to the negative value of the rated current. As an example, the ISB-425-A-600's current ranges from +425A to -425A.

The ISB series can be factory programmed for a custom current range. Any symmetrical or nonsymmetrical current range between +670A and -670A can be factory programmed as long as zero current is equal to or greater than 10% of V_{dd}. An example shown below is -100A to + 300A where -100A equals 10% of V_{dd} and +300A equals +90% of V_{dd}.



Output - X

The ISB series has two output options; **Analog (A)** or **PWM (P)**.

The analog output (A) is ratiometric with a full scale range from 10% to 90% of V_{dd}. An example is the ISB-425-A-600 with a precise 5VDC V_{dd}. The analog output will be 0.5V at -425A and 4.5V at +425A.

The PWM output (P) is a ratiometric PMW signal with a full scale range from 10% duty cycle to 90% of duty cycle. An example is the ISB-425-P-600. The duty cycle will be 10% at -425A and 90% at +425A. The PWM has a 125 Hz output frequency and a 1us tick time.

Any of the ISB current sensors with option code 6 can be programmed for the standard analog output or the optional PWM output.

For ISB current sensors with option code 8, only the analog output is available.

Option Code - Y

Two option codes are available; **6** or **8**.

Option code **6** features an 8 uSec response time, a temperature output and more robust absolute maximum ratings in a few key areas. More information about the temperature output is in section 9.

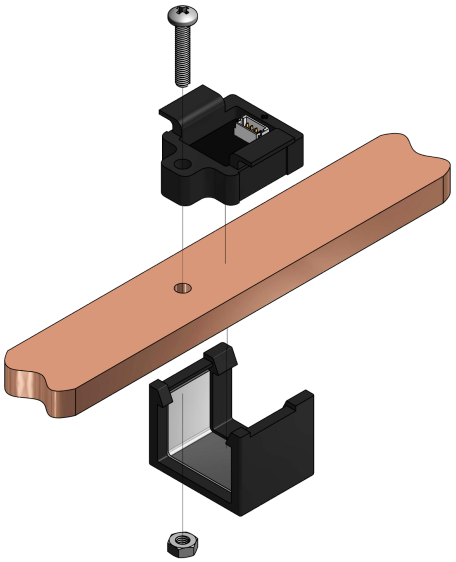
Option code **8** features a 3 uSec response time and better thermal stability.

Custom Code - Z

A custom code is assigned for any custom programming different from the standard part numbers. Examples include custom current ranges or custom lead lengths.

8 Busbar Attachment

As shown in the illustration below, the upper half of the ISB current sensor is attached to the busbar using standard hardware. The lower half of the housing is then clipped to the upper half for a secure connection. The lower housing also serves as protection for the shield.



9 Temperature Output

The option code 6 versions of ISB current sensor are equipped with a temperature output to monitor the temperature of the current sensor environment. The temperature sensor is located above the busbar within the potting material at the top of the sensor. This temperature could be used in an external algorithm to calibrate the sensor output accuracy over the application temperature range.

The temperature output voltage ranges from 367 mV to 2930 mV for temperatures ranging from -40 to 150°C. The accuracy is better than 5°C. The pin shall be able to sustain a low impedance connection to maximum 14V. The output is not ratiometric.

Offset:	1.38V at 35°C
Slope:	13.5mV/°C
Accuracy:	+/- 5°C
Output Current:	+/- 0.1 mA

10 Reference Output

The ISB series is available with an optional reference output that simplifies the driving of an op-amp circuit. The reference output is ratiometric to V_{dd} and provides a voltage that is 50% of V_{dd}.

11 High Current Application Example

In order to measure high currents without the need for a very wide shield, another option is to split the busbar so that only a fraction of the total current is measured by the sensor (exhibit 1). With this configuration, the shield can be made much smaller and lower cost.

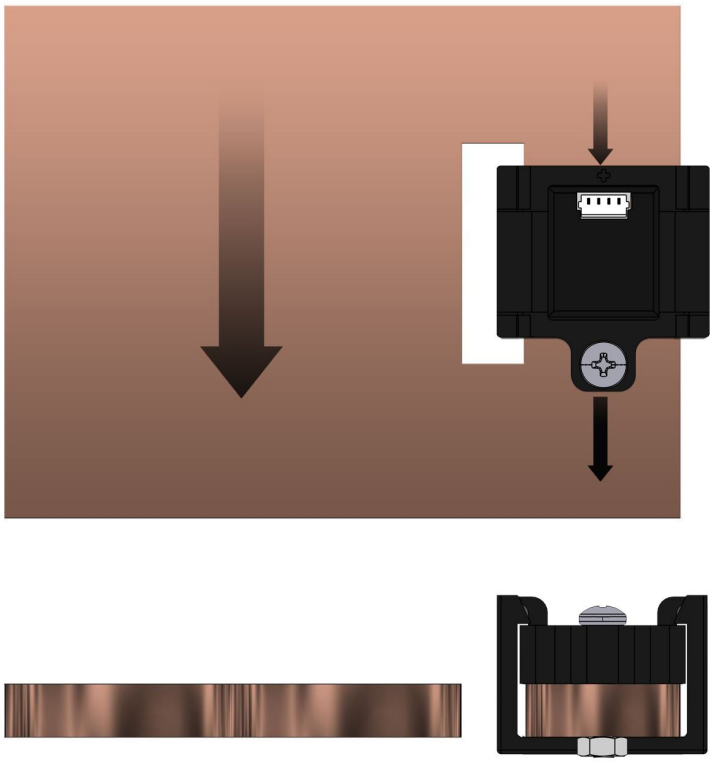


Exhibit 1

Considering an application with a current of 1,600A flowing in a busbar of 88mm (width). A straightforward solution would be to add a current sensor around the entire busbar resulting in a larger current sensor. Another approach is to divide a portion of the busbar into two by adding a

slot and then measure the current passing through the smaller section. The total current can be determined based on the ratio of the cross-sectional area of the measured section to the total cross-sectional area of the two sections. As illustrated below, a solution can be achieved by adding an 8mm slot that is 20mm from one side of the busbar (exhibit 2). The resulting current in the 20mm section is only 400A (¼ of the total busbar cross section). The ISB current sensor can be applied to the 20mm section of the busbar and can be scaled to measure the 1,600A flowing in the busbar.

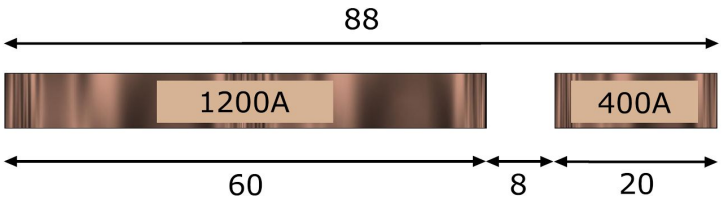


Exhibit 2