# Intelligent Battery Shunt Single (IBSS)
# Intelligent Battery Shunt Redundant (IBSR)

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## 1. CONSTRUCTION

### 1.1. THE INTELLIGENT BATTERY SHUNT SINGLE (IBSS)

The heart of any electric vehicle, the battery pack and its associated control electronics, is arguably one of the most critical sub-components in terms of the accuracy and performance required. Therefore, it is important to explore new technologies to improve the overall operation and efficiency of the battery management system. As electric vehicles are being tasked to perform in increasingly harsh environments, the battery pack must be designed to operate and survive over a wide range of temperatures.

In this white paper, Vishay demonstrates the capabilities of its new high voltage intelligent battery shunt single (HV-IBSS). Shunts are used to monitor charge / discharge currents in battery management applications by measuring the differential voltage across a given known resistance. The HV-IBSS features a solid nickel-chrome alloy resistive element, which results in a reduced temperature coefficient of resistance (TCR) that minimizes the variation of the resistance over the operating temperature range.

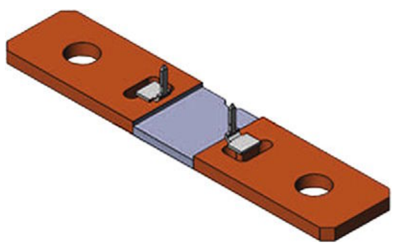

Fig. 1 - Vishay Intelligent Battery Shunt Single

Furthermore, this shunt features a unique mechanical design that incorporates strategically placed cutouts to minimize the effect of the pins (used to measure the differential voltage) on the electrical current field. This technology further reduces the variation in resistance with changes in temperature. Preliminary characterization suggests typical TCR values of less than 3 ppm/°C.

### 1.2. THE INTELLIGENT BATTERY SHUNT REDUNDANT (IBSR)

A redundant element intelligent battery shunt (HV-IBSR) was used to provide the test data in this white paper. The shunt has two resistive elements for independent current measurements. This type of construction increases the measurement accuracy and system reliability / redundancy, and supports today's ASIL-D safety regulations for automotive battery management systems.

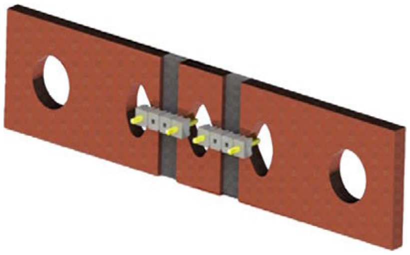

Fig. 2 - Vishay Intelligent Battery Shunt Redundant

Several integrated circuits used in conjunction with the current shunt are required to process the differential voltage measurements. Although degradation of the measurement accuracy is rarely a problem, the redundant elements allow the battery management system to continue functioning in the event of a failure in one of the measurement circuits. Both shunts have an operating temperature range of -65 °C to +170 °C. Available resistance values range from 100 μΩ to 1000 μΩ. The current shunt is rated for 36 W of power dissipation up to ambient temperatures of 70 °C, and then it must be derated for higher temperatures in accordance with the graph in the datasheet.





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## 2. TEST SETUP

The test setup consisted of the device under test (DUT) - the current shunt resistor. The differential voltage was amplified with a precision current amplifier, which has a maximum gain error of ± 0.3 %. A 22-bit ADC with an INL peak error of 0.006 % was used to process the shunt voltage measurement.

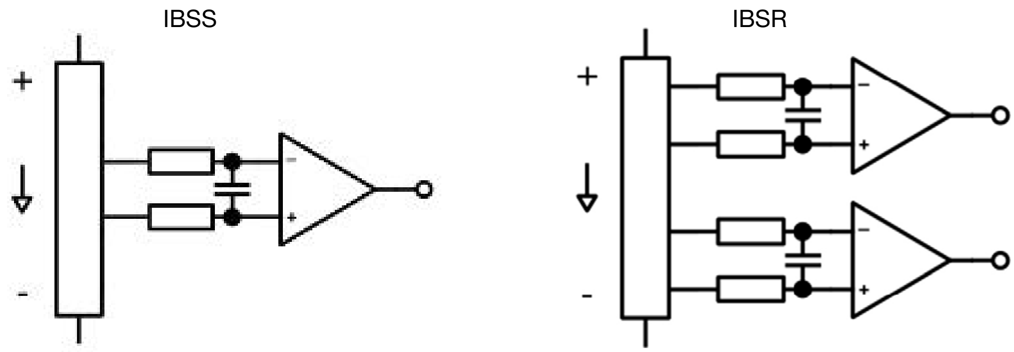


Fig. 3 - Test Setup With Resistor Under Test

The measurements were displayed using a Vishay MessWEB controller, which utilizes a 32-bit microcontroller, and were also written to an external storage device. The controller board also had a device for measurement of the temperature.

The DC current in the shunt was provided by an external voltage source and a resistive load.

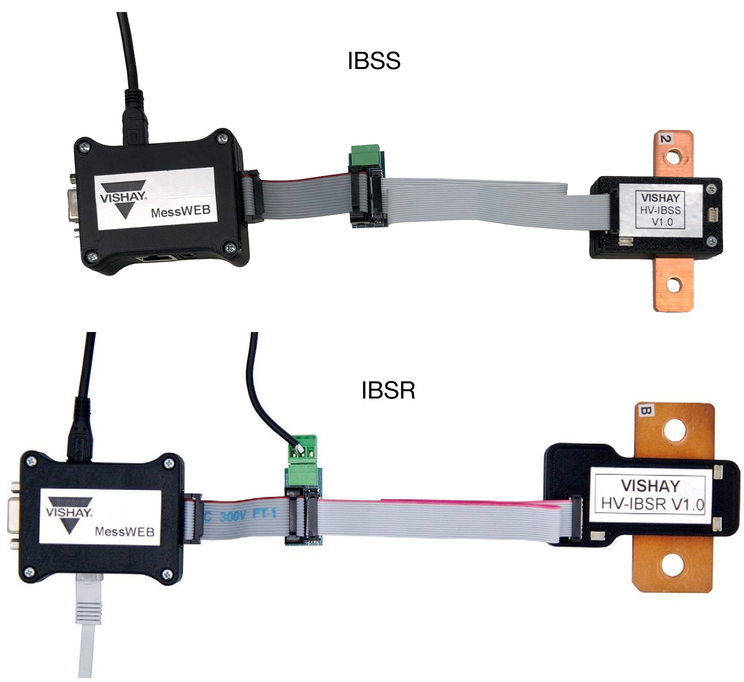


Fig. 4 - Test Setup Using the IBSS and IBSR and MessWEB

During the test, the ambient temperature was slowly increased using an external heat source. The temperature rise did not exceed 10 K/min, allowing for uniform heating of the DUT. While the current and voltage levels were kept constant, the current and temperature measurements were recorded at very short time intervals. The current for both elements of the redundant shunt were measured.





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## 3. TEST RESULTS

The test results for the intelligent battery shunt are shown below:

IBSS IBSR

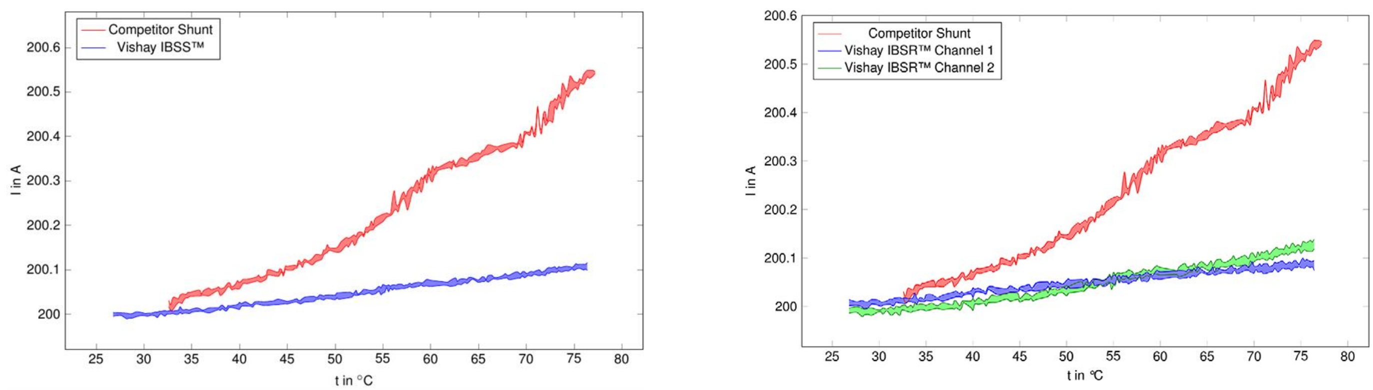


Fig. 5 - Accuracy Drift From Temperature Change

For all of the measurements recorded, the total drift averaged less than 11.2 ppm/°C.

The drift due to the measurement equipment itself was determined to be ~9 ppm/°C. Therefore, the resulting drift for the Vishay current shunt is ~2.2 ppm/°C, and the preliminary datasheet lists a typical accuracy of 3 ppm/°C.

## 4. MessWEB INTEGRATION

The MessWEB controller allows the IBSS / IBSR to be connected to a personal computer for real-time data monitoring and logging of data to the user's hard drive. When a redundant element shunt is connected, the MessWEB user interface can display data from both measurement channels.

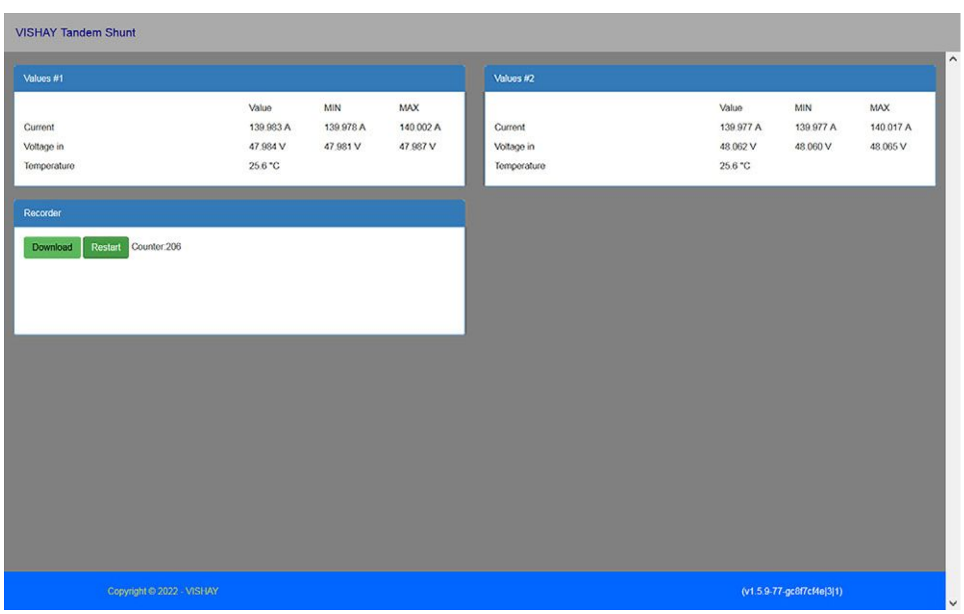


Fig. 6 - Overview of the MessWEB User Interface


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The user interface consists of three separate functional blocks. A block for each data acquisition channel displays the real-time current value as well as the minimum and maximum values. Both the HV-IBSS and HV-IBSR can also measure the high voltage and ambient temperature in addition to the current that is derived from the differential voltage measured across the shunt.

The third block contains functions for recording the data measurements. The data is continuously recorded internally every ~250 ms. The “restart” button can be used to delete the internal log. The “download” button can be used to download the current log to the user's hard drive.

To use the MessWEB controller it must first be connected to the IBSS / IBSR with the supplied serial cable, and powered via the three-pin connector on the adapter in the serial cable (refer to Fig. 4). The mechanical configuration of the connector prevents the power supply from being connected with the wrong polarity. A separate USB connection must be used for the isolated power supply of the MessWEB.

Finally, the MessWEB is connected to the user’s PC with a conventional ethernet cable. The user interface can be viewed by opening http://192.168.0.1 in a web browser.

## 5. CONCLUSION

A test system was designed to quantify the effects of temperature on a Vishay high voltage shunt used to measure current.

In automotive battery management systems where high temperature environments are common, the Vishay HV-IBSS and HV-IBSR exhibited an industry-leading low drift of less than 3 ppm/°C (which is an order of magnitude lower than currently available shunt devices), even at temperatures up to 80 °C.

The compact design lends itself well to high voltage and high power battery management applications where improved accuracy is required, and the dual redundant element configuration can be used to satisfy ASIL-D safety regulations.

And finally, the newly developed MessWEB controller provides an isolated interface for safely connecting the HV-IBSS or HV-IBSR to any computer to display real-time current measurements with a user-friendly interface.


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