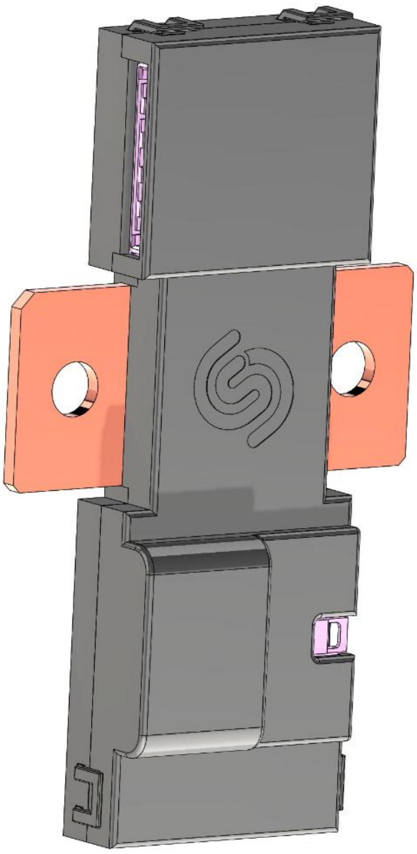
High Voltage Intelligent Battery Shunt Sensor Pro



FEATURES

- Current measurement
  - Low TCR shunt resistor (down to < ±10 ppm)
  - Low thermal EMF (as low as < 1.25 µV/°C)
  - Very low inductance (< 5 nH)
  - Easy to connect to a busbar.
  - Continuous current rating up to 1800 A
  - 5 s overload up to 9000 A
- 10 channel voltage measurement
  - Voltage measurement up to 1200 V
  - Precision to ± 0.5 % with low TCR tracking to 10 ppm/°C utilizing thick film technology.
- Insulation resistance measurement
- Analog frontend
  - 24-bit analog-digital converter
  - Up to 64 ksps output rate
- Hardware features
  - I/O isolation test voltage 3.5 kVDC
  - 9 V to 24 V power supply
  - CANFD interface (optional)
  - NTC temperature measurement
  - Functional safety level up to ASIL D

APPLICATIONS

- Automotive and industry
- Industrial and server computing
- Networking, telecom, and base station power supplies
- Battery management systems
- EV test environment
- Solar installations
- Home automation

DESCRIPTION

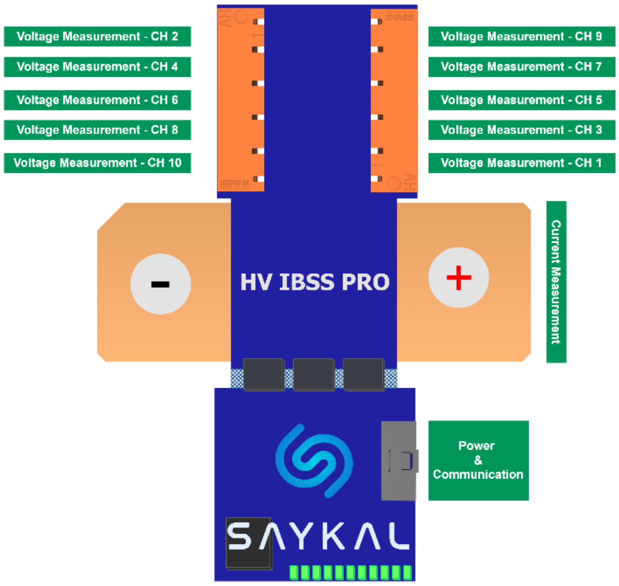
The Intelligent Battery Shunt Sensor (IBSS PRO) is based on Low TCR shunt resistor and high precision low tracing error voltage divider allowing high bandwidth, high accuracy current and voltage measurements over a wide range of temperatures without the need for temperature compensation.

The HV IBSS PRO is available with multiple shunt values to match the user's measurement ranges Table 1.

Order number	SSA009C06A	SSA009C05A	SSA009C04A	SSA009C03A	SSA009C02A	SSA009C01A
CURRENT MEASUREMENT						
Shunt resistance	100 µΩ	50 µΩ	30 µΩ	50 µΩ	25 µΩ	15 µΩ
Power rating (70 °C)	36 W	36 W	36 W	50 W	50 W	50 W
Continuous current	600 A	849 A	1095 A	1000 A	1414 A	1826 A
Short time overload (5x for 5 s)	3000 A	4245 A	5475 A	5000 A	7070 A	9130 A
Max. measurable current (ADC limit, gain 8)	1500 A	3000 A	5000 A	3000 A	6000 A	10000 A
Max. measurable current (ADC limit, gain 8)	3000 A	5000 A	5000 A	6000 A	6000 A	10000 A
Shunt resistance accuracy (%)	5%	5%	5%	5%	5%	5%
Shunt load life (resistance change over 1000 h)	1%	1%	1%	1%	1%	1%
Shunt TCR (max.)	± 10 ppm/K	± 10 ppm/K	± 10 ppm/K	± 10 ppm/K	± 10 ppm/K	± 10 ppm/K
Shunt thermal EMF (max.)	1.25 µV/K	1.25 µV/K	1.25 µV/K	1.25 µV/K	1.25 µV/K	1.25 µV/K
Shunt temperature operating range	-65 °C to +170 °C	-65 °C to +170 °C	-65 °C to +170 °C	-65 °C to +170 °C	-65 °C to +170 °C	-65 °C to +170 °C
VOLTAGE MEASUREMENT						
Resistor Range	8000 kΩ	8000 kΩ	8000 kΩ	8000 kΩ	8000 kΩ	8000 kΩ
Voltage divider ratio	0.001	0.001	0.001	0.001	0.001	0.001
Voltage divider accuracy	1%	1%	1%	1%	1%	1%
Voltage divider ratio accuracy	0.50%	0.50%	0.50%	0.50%	0.50%	0.50%
Voltage measurement range	1200	1200	1200	1200	1200	1200

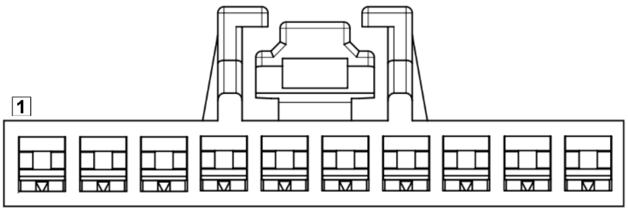
Table 1. Available Current and Voltage Ranges

1. PIN CONFIGURATION



1.1. Power Supply & Communication Pins

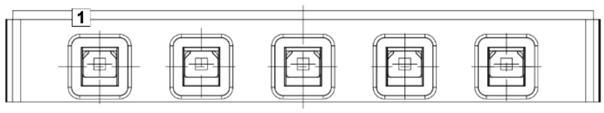
Pin	Name	Description
1	12V-24V	DC supply input / Vcc (+)
2	Ground	DC supply input / Vss (-)
3	CAN Bus 1 High	CAN Bus communication pin
4	CAN Bus 1 Low	CAN Bus communication pin
5	CAN Bus 1 High	CAN Bus communication pin
6	CAN Bus 1 Low	CAN Bus communication pin
7	LIN Bus 1	LIN Bus communication pin
8	LIN Bus 2	LIN Bus communication pin
9	Input 1	Digital input pin
10	Input 2	Digital input pin



Power Supply & Communication Connector (1511000010)

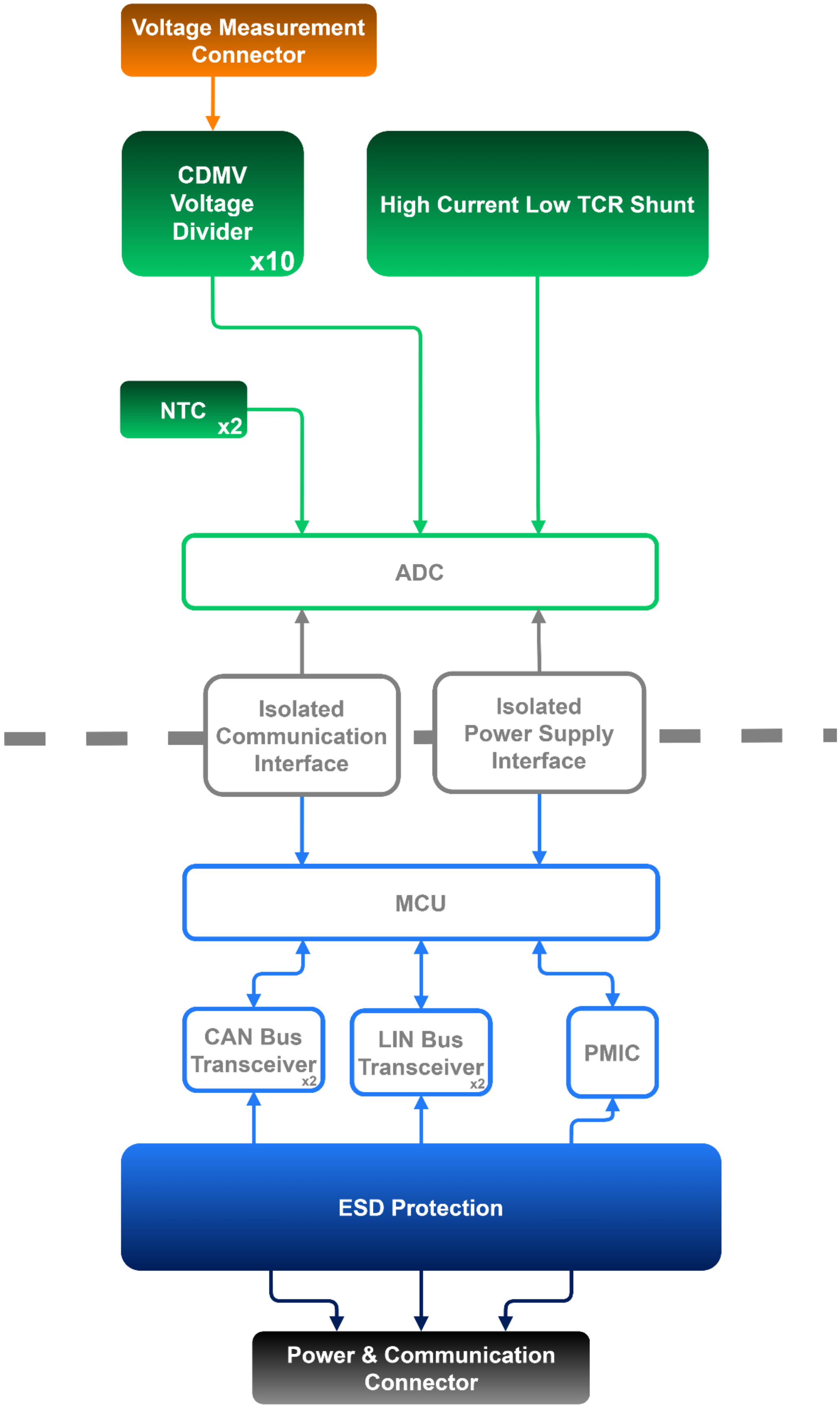
1.2. Voltage Measurement Pins

Pin	Name	Description
1	High Precision Differential Voltage Measurement Channel	CH-1 - CH-2 Voltage Sensing
2	Low Precision Redundant Voltage Measurement Channel	CH-3 – CH-4 Voltage Sensing
3	High Precision Voltage Measurement Channel	CH-5 – CH-6 Voltage Sensing
4	High Precision Voltage Measurement Channel	CH-7 – CH-8 Voltage Sensing
5	High Precision Voltage Measurement Channel	CH-9 – CH-10 Voltage Sensing



Voltage Measurement Connector (524198-E)

2. OVERALL BLOCK DIAGRAM



3. OPERATIONAL DESCRIPTION

3.1. Device Overview

The circuit is designed for precise voltage and current measurement with galvanic isolation between the high-voltage (HV) and low-voltage (LV) domains, ensuring the safe operation of low-voltage components while interfacing with the high-voltage measurement system.

Key components include a CDMV voltage divider (x10) and NTC thermistors for temperature compensation. A high current low TCR shunt is used for accurate current measurement, while an ADC digitizes the analog signals.

The circuit features an isolated communication interface and power supply. The isolated power supply provides 3.3V to the HV side and transmits CAN TX/RX signals to the microcontroller. The MCU handles data processing and system control, with communication via CAN and LIN bus transceivers. ESD protection is included to safeguard against electrostatic discharges, and a power and communication connector allows external interfacing.

This design minimizes isolation barriers to reduce costs while ensuring reliable operation in high-voltage environments. The isolated power supply and CAN bus interface facilitate safe and efficient system operation.

A DBC file describing the CAN protocol is available upon request. Please contact us directly to obtain the data sheet or additional documentation.

3.2. Current Measurement

When the current flows through the shunt, the shunt's resistive element produces a voltage drop. This voltage is filtered (RC filter) and digitized using a 24-bit ADC. The obtained digital value is transferred via SPI to the MCU and processed into data packages that are broadcasted on the CAN bus.

Due to the low thermal coefficient of resistance, the voltage drops over the shunt's resistive element is very stable with temperature (down to 10 ppm/K). Therefore, to reach industry standard deviations over the whole automotive temperature range and lifetime of the product temperature compensation is not required.

The WSBE series of shunts come with 5 % resistance accuracy. The accuracy of the final reading can be increased by calibration (two-point calibration since temperature compensation is not necessary) and hence is practically limited by the accuracy of the calibration standard used, the resolution and precision achieved by the ADC.

To keep offset errors to a minimum, the global chop mode of the ADCs is activated by default and should be kept active.

The sensor autonomously calibrates the ADC gain and samples at the maximum deviation rate permissible by the ADC corresponding to the relevant gain setting.

3.3. Voltage Measurement

For voltage measurement, the high-voltage (HV) source is connected to a CDMV voltage divider, which reduces the input voltage at a ratio of 1000:1, producing a voltage in a range suitable for the ADC to directly measure.

The accuracy of the voltage measurement is influenced by several factors, such as thermal drift between the upper and lower resistances in the divider, as well as gain and offset errors in the ADC. The unique construction of the CDMV voltage divider limits thermal drift to 10 ppm, and the ADC's offset errors are minimized through the global chop mode. However, the main contributors to measurement errors are non-compensable issues like thermal and temporal gain error drifts.

In addition to the main high-precision measurement path, the system includes several additional measurement paths for redundancy and lower precision measurements:

- 2 High Precision Differential Voltage Measurement Channels: These channels are designed for accurate voltage measurements in differential mode, ensuring precise measurement even in the presence of common-mode noise.
- 2 Low Precision Single-Ended Redundant Voltage Measurement Channels: These channels provide redundant, lower-precision single-ended voltage measurements, adding fault tolerance to the system by ensuring that critical voltage data can still be captured even if one path fails.
- 6 Low Precision Single-Ended Voltage Measurement Channels: These channels offer low-precision single-ended voltage measurements, which are useful for applications where high accuracy is not as critical, but broad monitoring capabilities are needed.

This combination of high-precision and low-precision measurement channels ensures both accuracy and flexibility, while allowing the system to capture a wide range of voltage values under various operational conditions.

3.4. Temperature Measurement

The HV intelligent battery shunt sensor (IBSS PRO) employs NTC thermistors to measure the temperature of the shunt resistor. These NTC sensors are placed near the shunt resistor to accurately capture its thermal state.

As the temperature increases, the resistance of the NTC thermistors decreases, which in turn generates a voltage signal. The microcontroller reads this voltage signal through an embedded ADC, which is then used to calculate the temperature.

The microcontroller reads this voltage via and embedded ADC and calculates the temperature, ensuring precise monitoring of the shunt temperature to prevent overheating and ensure system safety.

3.5. Insulation Monitoring

The insulation monitoring system continuously checks the integrity of the insulation in the system to ensure safe operation. This is particularly important in high-voltage (HV) systems where insulation failures can lead to hazardous conditions.
The system uses dedicated insulation monitoring components that measure the resistance between the HV domain and ground. If the resistance drops below a predefined threshold, indicating a potential insulation failure, the system immediately triggers an alert.

This insulation monitoring system enhances the overall safety of the high-voltage system by providing early detection of potential insulation issues, thus preventing equipment damage, system downtime, and safety hazards.

4. MECHANICAL