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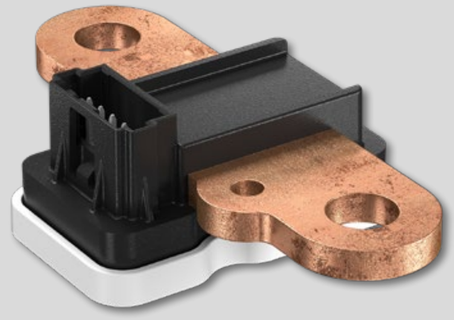
SWOBODA INTEGRATED CURRENT SENSOR FOR AUTOMOTIVE APPLICATIONS



The Swoboda integrated current sensor is suitable for inverter & battery applications.

INTRODUCTION

Current sensors are used in a wide variety of commercial, industrial and automotive applications..
The Swoboda Integrated Current Sensor is a galvanically isolated sensor that contains differential Hall sensing elements and an embedded copper busbar. It is optimized to measure high currents at high voltages (AC & DC), that are common in automotive inverter (AC phase currents & DC link) and high voltage battery applications. It is fully automotive qualified and complies with functional safety level up to ASIL-B.

ADVANTAGES

- Highly accurate measurement of AC & DC currents
- Significantly smaller footprint than conventional core-based current sensors
- Extremely low drift over temperature and lifetime
- High linearity due to coreless measurement principle
- Bandwidth of more than 60 kHz

FEATURES & BENEFITS

- Single-ended analog output
- Single supply voltage of 5 V
- Measurement of peak currents up to ±1500 A
- Also available with dedicated over current detection (OCD) output with a detection time of less than 1.7 µs
- Functional safety (ISO26262): ASIL-B
- Inherent immunity to external / stray magnetic fields due to differential measurement principle
- 30 % less weight compared to similar sensors
- High bandwidth / fast response time
- Built-in programming interface (via dedicated pin) for EOL calibration
- Fully automotive qualified

APPLICATION AREAS

- Automotive main inverter
- Battery management system
- Electric motor drives
- General current monitoring

Any questions about this product?
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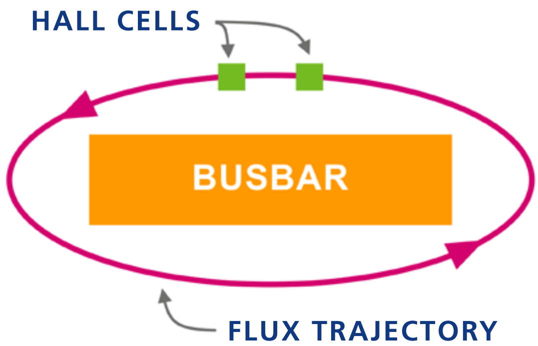
PRINCIPLE OF OPERATION

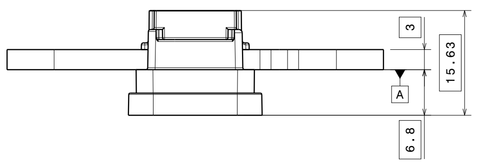
All current carrying conductors generate a magnetic field around them. Therefore, by measuring this flux density, the current flowing can be measured. The integrated current sensor consists of two hall cells separated by a gap of approximately 2.3 mm, as shown below. The difference between the flux densities measured by the two sensitive elements is filtered and amplified. Subsequently, an analog output voltage that is proportional to the measured flux density is given out. As this flux density is proportional to the current flowing, the chip measures the current flowing in the busbar. This system by inherent design offers the following advantages over traditional core based single ended sensors:

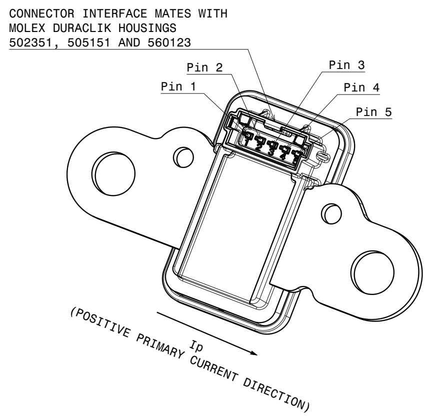
- Immunity to uniform stray magnetic flux densities because of the differential measurement principle.
- High linearity and negligible hysteresis due to the absence of a ferromagnetic core.



Hall cells in differential configuration, marked in green,along with thebusbar

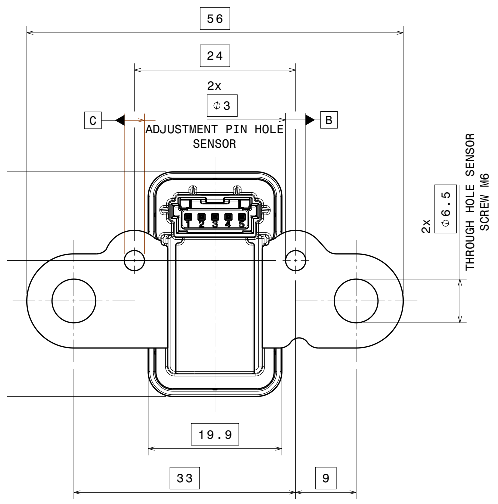
DRAWING

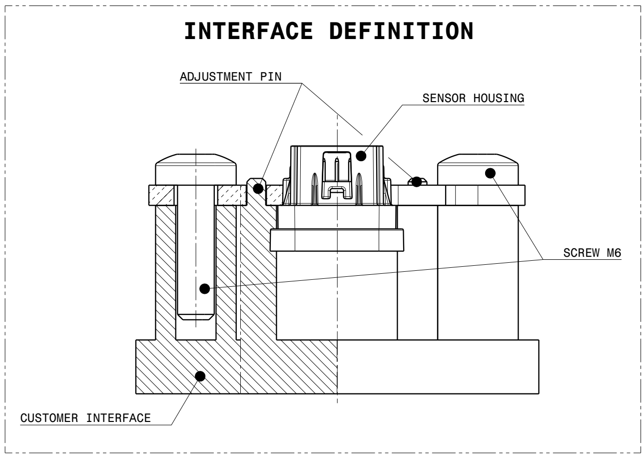




PIN	PIN ASSIGN	DESCRIPTION
1	V_{DD}	SUPPLY VOLTAGE
2	A_{out}	ANALOG SIGNAL OUTPUT
3	GND	GROUND
4	NC	NOT CONNECTED (PRODUCT TYPE WITHOUT OCD)
	OCD	OVER CURRENT DETECTION (PRODUCT TYPE WITH OCD)
5	DCDI	PROGRAMMING

PARTNAME	MATERIAL	PLATING
HOUSING	>PA66-GF30<	
COVER	>PA66-GF25<	
BUSBAR	>CU-ETP<	
PINS	>CuNi3Si1Mg<	Sn matte over Ni ductile





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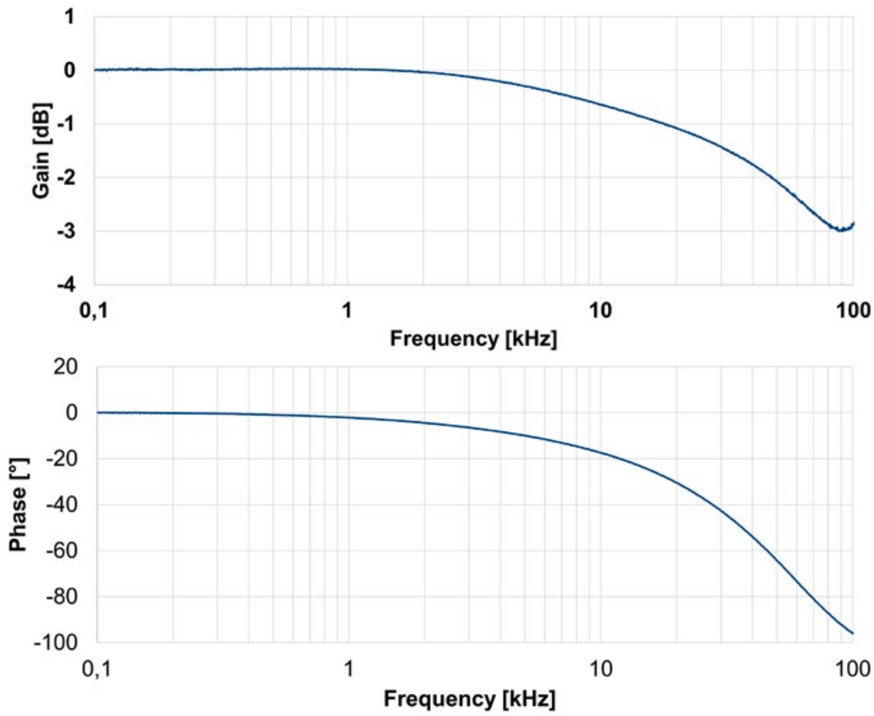
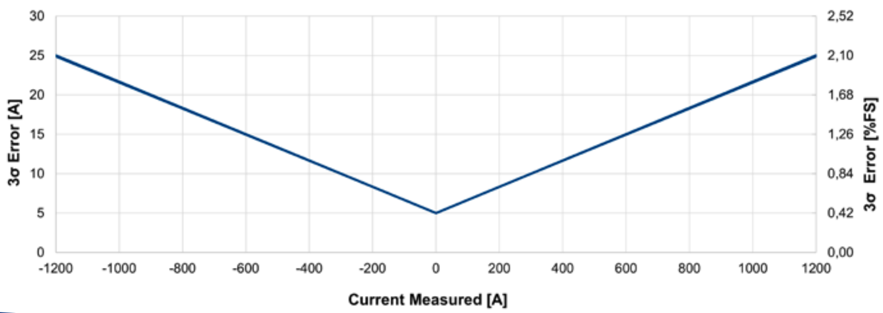
NOMINAL OPERATING CHARACTERISTICS

SIGNAL DESCRIPTION	UNITS	MIN.	NOM.	MAX.	REMARKS
Primary current, peak value	[A]	-1500	-	+1500	Lower range configurable. Max current is however limited by bus bar design and thermal conditions.
Ambient temperature	[°C]	-40	-	+125	
V_{DD}	[V]	4.5	5.0	5.5	Supply voltage
A_{OUT}	[V]	-0.3	-	V_{DD}	Analog signal output
OCD*	[V]	-0.3	-	V_{DD}	Overcurrent detection: open drain output
DCDI	[V]	-0.3	-	V_{DD}	DCDI communication interface: open drain I/O
I_{DD}	[mA]	-	21	25	Current consumption, I_{Aout} = 0 mA
Load current	[mA]	-6.5	-	6.5	DC current
Comparitive tracking index (CTI)	[V]	600	-	-	
Creepage	[mm]	-	15.2	-	
Clearance	[mm]	-	9.3	-	
Life time	[years]	15	-	-	
Weight	[g]	-	28	-	

*Valid only for product type with OCD



Measured frequency plots of the integrated current sensor.



Estimated 3σ error of the integrated current sensor after calibration, for a measurement range of ± 1200 A

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EMC PERFORMANCE

TEST	STANDARD	REMARKS
Conducted Emission (CE)	CISPR-25:2021	Voltage based
Radiated Emission (RE)	CISPR-25:2021	ALSE, Class 5, Upto 5925 MHz
Radiated Immunity (RI)	GMW3097:2015	ALSE, Level 2, 400 MHz to 2000 MHz
Bulk Current Injection (BCI)	GMW3097:2015	Level 2, CBCI and DBCI, Upto 400 MHz
ESD Handling (ESDH)	GMW3097:2015	±4 kV at pins, upto ±8 kV on housing and busbar

ELECTRICAL PERFORMANCE

TEST	STANDARD	REMARKS
Bode Plot		20 A_{peak}, 0 to 100 kHz
Noise*		0 to 1 MHz
dv/dt		11 kV/µs, 50 Hz
di/dt*		150 A/µs, 500 A_{peak}
RMS voltage for AC insulation	IEC 60664-1	2.5 kV_{ms} AC, 50 Hz, 60 s, I < 0.1 mA
Insulation test	ISO 16750-2 (2010)	500 V, $I_R \geq$ 100 MΩ

**Tests in planning*

ENVIRONMENTAL PERFORMANCE

TEST	STANDARD	REMARKS
High temperature, high humidity Electrical connection	JESD 22-A101 (03/2009)	+85 °C / 85 % RH, Duration: 1000 h U_c = 5 V, I = 0 A, monitoring
Thermal cycles	IEC 60068-2-14 test Nb	T_{min} = -40 °C, T_{max} = +125 °C, t_{cycle} = 480 min / 8 h, Number of cycles: 30, Duration total: 240 h
Thermal shocks	IEC 60068-2-14 test Na	T_{min} = -40 °C, T_{max} = +125 °C 30 min @-40 °C / 30 min @+125 °C Number of cycles: 500 U_c not connected, I = 0 A
High temperature storage	IEC 600068-2-2	Temperature: +125 °C, Duration: 1000 h U_c not connected, I = 0 A
Low temperature storage	IEC 600068-2-1	Temperature: -40 °C, Duration: 240 h U_c not connected, I = 0 A
Mechanical Shock test	IEC 60068-2-27	Acceleration: 500 m/s2, Duration: 6 ms Number of shocks: 10 per test direction U_c not connected, I = 0 A
Random Vibration test	IEC 60068-2-6	Frequency: 10 to 2000 Hz, Acceleration: 9.7 g Duration: 3 axes x 22 h/axis / 66 h in total U_c = 5 V, I = 100 A, monitoring