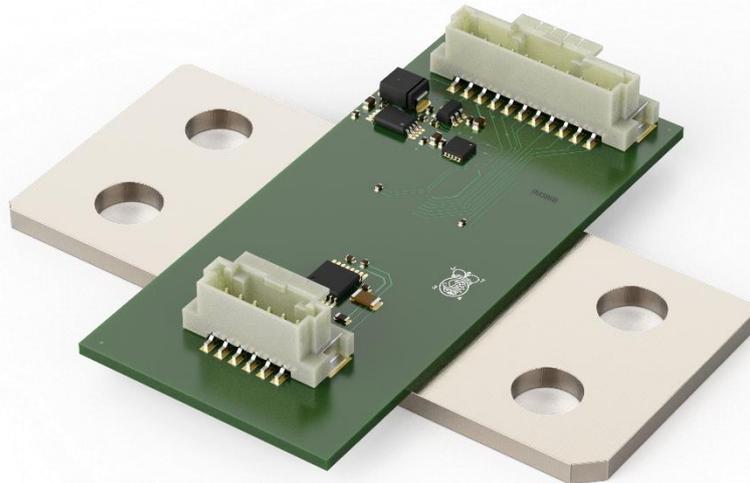




IAS





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1. Introduction

The IAS is a cutting-edge current sensor including shunt and tunnel magneto-resistance (TMR) current measurement to meet the highest standards of functional safety and availability. Engineered for redundant sensing with configurable overcurrent detection (OCD), this innovative product ensures enhanced precision and reliability in current sensing applications. Especially with regard to increased functional safety requirements. The IAS can be tailored to meet specific customer requirements. Whether you need different combinations of functionality or market specific adaptations, we offer flexible customization options to ensure the product perfectly fits your needs.

If you are interested in learning more about our offerings or have any questions, please do not hesitate to get in contact with us over the following address: CS-SL@isabellenhuette.com

2. Application

The sensor is designed for DC current measurement applications, like e.g.:

- Power Distribution Units
- Battery Disconnect Units
- Energy Storage Systems

3. Functional Description

3.1 Overview

The IAS contains the following measurement functions, all with analog outputs:

- a. Shunt current measurement
- b. Magneto resistive current measurement
- c. Overcurrent detection

Possible configurations:

Variant	Shunt + TMR + OCD	Shunt + TMR	Shunt + OCD
Redundant shunt taps	X	X	X
Temperature sensors	X	X	X
Overcurrent detection	X		X
TMR isolated sensing	X	X	

Table 1: Configuration overview

3.2 Safety

Isabellenhütte will provide the following results of an FMEDA as the base failure rates without consideration and evaluation of any safety mechanisms to reduce the failure rates:

- Total Failure Rate, λ (in FIT)

To reduce the failure rates, safety mechanisms must be considered on system level from customers. Isabellenhütte recommends considering the following mechanisms which can be specified in detail in case of a joint development:

1. Shunt current measurement channel:
 - a. To measure the main sense voltage lines and in addition the redundant sense voltage lines to perform an accuracy supervision by compare these measurements with each other
 - b. To perform a shunt break detection
 2. Magneto resistive current measurement: to evaluate and consider the possible safety mechanisms recommended by Supplier-Safety-Manual from TMR chip manufacturer.
- For more details, please contact the support team of Isabellenhütte.

3.3 Data Matrix Code (DMC)

Name	Format	Explanation	Start pos.	Number of digits ¹	Meaning (example)	Code (example)
Article number	PPPPPP	ERP-system part number	1	6	167583	167583
Product description	xxx-x-xx-xxx-xx-x-x	Product description	7	19	IAS-A-1K-0U0-OT-A-5	IAS-A-1K-0U0-OT-A-5
manufacturing plant code	XXX	Manufacturing plant code	26	3	Dillenburg	000 ²
Serial Number	YYMDxxxxxxx	Day of manufacturing (Gregorian calendar)	29	11	2025-05-16 Sequence Number 0000007	25EG0000007
Production Batch Number	vvvvvvvvv	Production batch number	40	10	1000907226	0000000000 ²
SHUNT_C_MAIN_x0	RRRRRR1	Shunt resistance value 1 in nano ohms @0°C	50	6	24.452 µOhm	024452
SHUNT_C_RED1_x0	RRRRRR2	Shunt resistance value 2 in nano ohms @0°C	56	6	24.452 µOhm	024452
SHUNT_C_RED2_x0	RRRRRR3	Shunt resistance value 3 in nano ohms @0°C	62	6	24.452 µOhm	024452
SHUNT_C_MAIN_x1	±c',ccc'E-'cc	Linear polynom coefficient 1 sign (+/-) ³	68	7	+5.471e-10	1547110
SHUNT_C_RED1_x1	±c',ccc'E-'cc	Linear polynom coefficient 2 sign (+/-) ³	75	7	+5.471e-10	1547110
SHUNT_C_RED2_x1	±c',ccc'E-'cc	Linear polynom coefficient 3 sign (+/-) ³	82	7	+5.471e-10	1547110
SHUNT_C_x2	±a',bbb'E-'bb	Quadratic polynom coefficient sign (+/-) ³	89	7	-2.898e-12	0289812
SHUNT_C_x3	±a',aaa'E-'aa	Cubic polynom coefficient sign ³	96	7	Placeholder	0000000 ²
TMR_CO_x0	±dddd',dddd	Constant polynom coefficient sign - offset temperature dependency ³	103	9	-3508.1355	-35081355
TMR_CO_x1	±c',ccc'E-'cc	Linear polynom coefficient sign - offset temperature dependency ³	112	7	1.47E-02	0000000 ²
TMR_CO_x2	±b',bbb'E-'bb	Quadratic polynom coefficient sign - offset temperature dependency ³	119	7	3.85E-04	0000000 ²
TMR_CG_x0	±dddd',dddd	Constant polynom coefficient sign - gain temperature dependency ³	126	9	1404.2336	+14042336
TMR_CG_x1	±c',ccc'E-'cc	Linear polynom coefficient sign – gain temperature dependency ³	135	7	1.00E-03	0000000 ²
TMR_CG_x2	±b',bbb'E-'bb	Quadratic polynom coefficient sign - gain temperature dependency ³	142	7	-2.98E-05	0000000 ²

Table 2: Description of content DMC
¹ No delimiter used, values can be identified by start position and length (number of digits)

² Not applicable or unused digits will have only zeros at their digit numbers

³ Prefix "+" = "1"; Prefix "-" = "0"

4. Measurement

4.1 Primary Measurement – Shunt Channels

The IAS provides multiple shunt channels for DC and AC measurements. The shunt measurement consists of three redundant and compensated sense lines to measure the voltage drop which is caused by the load current through the shunt. All sense lines are unamplified and tapped at the connector.

4.2 Secondary Measurement – TMR (Tunnel Magneto Resistance) Channel

The TMR is a contactless magnetic field current sensor for isolated measurement of direct and alternating current. Offset, gain and temperature are compensated. The output signal is an analog voltage. This analog signal has a nominal voltage range about 0.3 V - 4.7 V with a midpoint at $V_{CC}/2$ in the absence of an external magnetic field.

The sensor has internal diagnostics that monitor its function. If an error is detected, the analog output signal is pulled to ground or 5V or the output is set to high impedance.

4.3 OCD (Overcurrent Detection)

The default value for OCD is 2500 A. The threshold can be configured on customer request. The switching threshold of the overcurrent detection is designed symmetrically. With a desired switching threshold of 2500 A, it is triggered both at -2500 A and +2500 A.

4.4 Temperature Measurement

The IAS contains two NTCs for temperature measurement and compensation of TCR. The NTCs are used to monitor the temperature on each side of the resistance strip. The coefficients for current measurement compensation can be found within the DMC description in chapter 3.3.

5. Technical Data

5.1 Maximum Ratings

Description	min	max	Unit	
Transportation / storage temperature	-40	+125	°C	
Load current through shunt for continuous / pulse operation⁴	continuous	-1100	+1100	A
	10 s	-1300	+1300	A
	1 s	-2500	+2500	A
	100 ms	-5200	+5200	A
TMR supply voltage	-18	+18	V	
OCD supply voltage	+4.5	+6	V	
Ambient temperature	-40	+105	°C	

Table 3: Data overview

NOTE: Based on a shunt reference temperature of 20 °C at test start. After an extended load has occurred, the shunt must be cooled down so that operation conditions are reached again. 125 °C may never be exceeded in the middle of the shunt.

Please also consider the conditions mentioned in chapter 6.2.

⁴ Only for stand-alone shunt current measurement. If sensor also contains TMR current measurement, maximum current range is limited to ± 2950 A

5.2 Current Measurement

Shunt

Description	Value			Unit
	min	nominal	max	
Shunt resistance value		23.25		$\mu\Omega$
Output signal (analog)		± 23.25		mV/kA
Resistance tolerance (manufactured)		± 10		%
Current measurement tolerance with considered correction polynomial values from DMC		± 0.3		%
Tolerance over temperature (TCR)		± 35		ppm/K
Shunt measurement range ⁵	-4000		+4000	A
Temperature range	-40		+125	$^{\circ}\text{C}$
Functional safety	ASIL D ready ⁶			

Table 4: Shunt measurement data

Temperature Measurement

Description	Value			Unit
	min	nominal	max	
NTC resistance value (25 $^{\circ}\text{C}$)	+9.9	+10	+10.1	k Ω
NTC beta value (25 $^{\circ}\text{C}/100^{\circ}\text{C}$)		3455		K
NTC voltage			+5	V
Operating temperature range	-55		+150	$^{\circ}\text{C}$

Table 5: Temperature measurement data

TMR

Description	Value			Unit
	min	nominal	max	
Nominal voltage		± 500 ⁷		V
Output signal (analog, ratiometric)		$V_{cc}/2 \pm 0.142 V_{cc}/kA \cdot I$		V
Initial accuracy (manufactured)		$\pm(0.5 \text{ rdg.} + 0.1 \text{ rng})$		%
Accuracy ($R_t=23^{\circ}\text{C}$)		$\pm(1.5 \text{ rdg.} + 0.4 \text{ rng})$		%
Accuracy over temperature		$\pm(1.5 \text{ rdg.} + 0.8 \text{ rng})$		%
Variation of positioning (x, y, z < 30 $^{\circ}$)		$\pm 1.1 \text{ rng}$		%
TMR measurement range	-2800		+2800	A
TMR continuous output current	-1.2		+1.2	mA
Temperature range	-40		+125	$^{\circ}\text{C}$
Functional safety	ASIL B ready ⁸			
TMR supply voltage V_{cc}	+4.5	+5	+5.5	V
TMR supply current consumption			+37	mA

Table 6: TMR measurement data

OCD

Description	Value			Unit
	min	nominal	max	
OCD measurement range ⁵	-4000		+4000	A
OCD output signal		low active		
OCD pull-up resistance		+10		k Ω
OCD output current		up to +100		mA
OCD time (internal signal propagation time)		<5		μsec
OCD supply voltage	+4.5	+5	+5.5	V
OCD accuracy level		<10		%
Temperature range	-40		+125	$^{\circ}\text{C}$

Table 7: OCD measurement data

⁵ Only for stand-alone shunt current measurement. If sensor also contains TMR current measurement, measurement range is limited to ± 2950 A

⁶ ASIL D on customer system level

⁷ 1000 V with coating on request

⁸ ASIL B on customer system level

5.3 Connectors

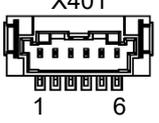
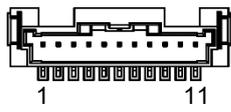
Illustration	Pin	Signal	Description	Connector
 <p>X401</p>	1	GND	TMR channel	Molex DuraClik TPA 5051510601
	2	5V		
	3	TMR_OUTPUT		
	4	Not connected		
	5	Not connected		
	6	Not connected		
 <p>X400</p>	1	OCD_out	Shunt taps Temperature sensor Overcurrent detection	Molex DuraClik TPA 5051511101
	2	GND_HV		
	3	5V_HV		
	4	NTC2		
	5	NTC1		
	6	Shunt_High_1		
	7	Shunt_Low_1		
	8	Shunt_High_2		
	9	Shunt_Low_2		
	10	Shunt_High_3		
	11	Shunt_Low_3		

Table 8: Connectors overview

5.4 Galvanic Insulation

General information TMR:

The TMR circuit is galvanically isolated from the shunt respectively the busbar. To keep and ensure the galvanic isolation between the shunt and TMR, supply voltages must be separated and isolated from each other.

Insulation voltage according to DIN EN IEC 60664-1:2008-01

Declarations are valid under the following condition:
5000 m above sea level

Nominal voltage	500 V ⁹
Overvoltage category	CAT II
High withstand voltage	4300 V (for 60 s)
Partial Discharge Test	5 pC (2 kV for 5 s)
Creepage distance	8.14 mm
Clearance distance	8.14 mm
Material Group	II
Pollution Degree	III

Table 9: Galvanic insulation characteristics

General information OCD & Shunt:

The OCD circuit is not galvanically isolated from the shunt, but it's isolated from the TMR. It is mandatory to use an independent V_{CC} supply voltage for OCD circuit separated from TMR's V_{CC}.

NOTE: In case of usage in systems that shall operate galvanically isolated from the shunt voltage level, the signals must be isolated by the customer.

⁹ 1000 V with coating on request

6. Mechanical Data

6.1 Dimensions

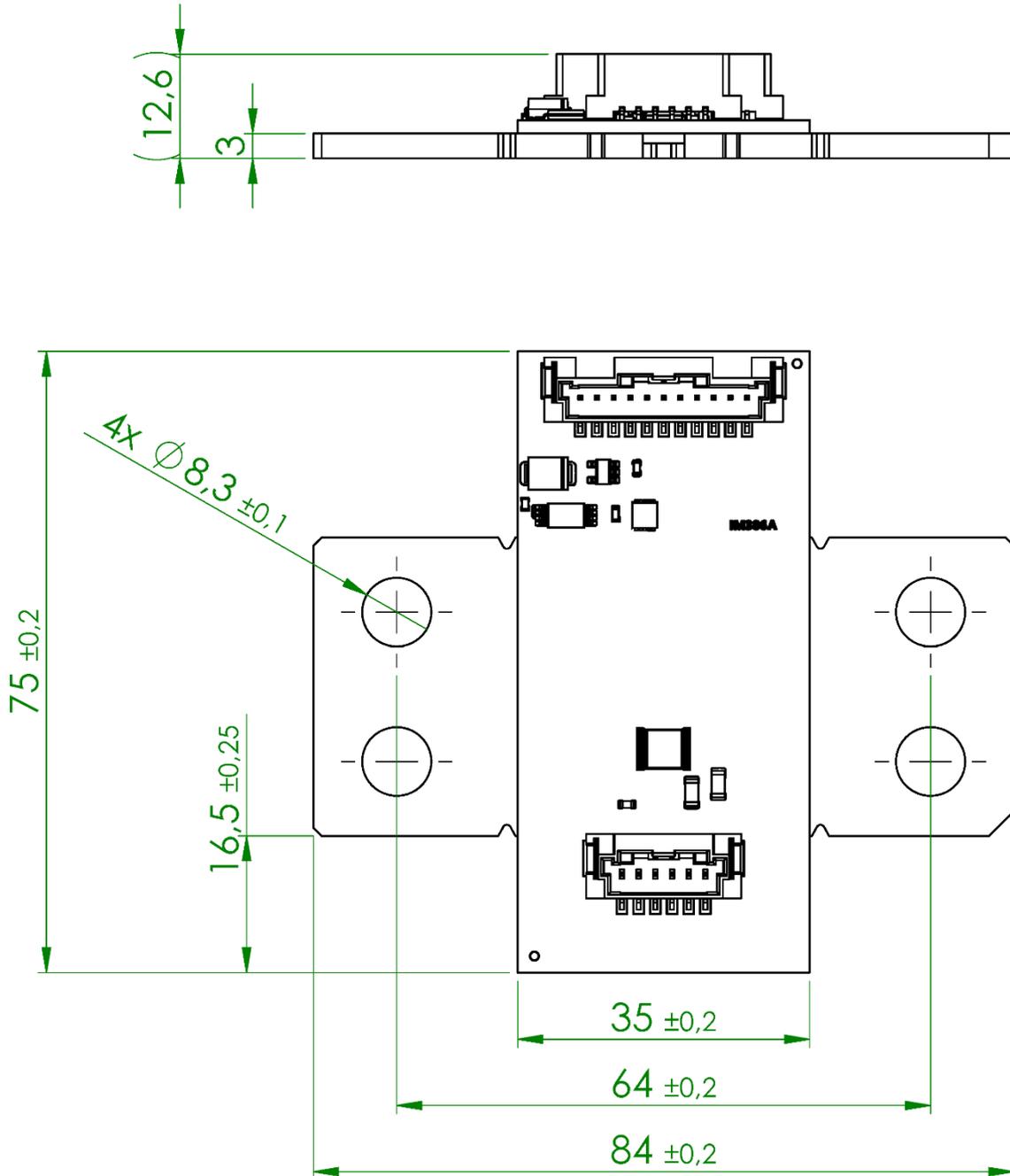


Figure 1: Drawing IAS

6.2 Busbar Connection

Parameter	Description
Shunt resistance (at 25°C ± 3°C)	23.25 μΩ ±10%
Shunt size	84x36x3 mm
Shunt mounting	Prepared for bolted connection only

Table 10: Basic characteristics shunt

The accuracy and repeatability of current measurement depends on the quality of the connection between customer's busbar and the shunt busbar. Please consider the following instructions:

- It is required to mount the IAS directly on a busbar (instead of mounting a cable onto the shunt).
- The busbar must run about 120 mm in the direction of the shunt on both sides.
- The shunt and the busbar must have an overlap of minimum 20 mm on both sides.
- To screw the IAS on a busbar, all mounting holes have to be used. Never use less than the available number of holes for screwing.
- It is recommended to use screws with an outer diameter of 8 mm (M8).
- Never use flat washers between the busbar and the shunt.
- All screws used for mounting must be tightened with a torque of 15 – 20 Nm.
- Shunt and busbar must be clean and free of grease before mounting. Cleaning before mounting might be necessary.
- The thermal situation within the application has to be considered to guarantee durability and reliability during the lifetime of the sensor.

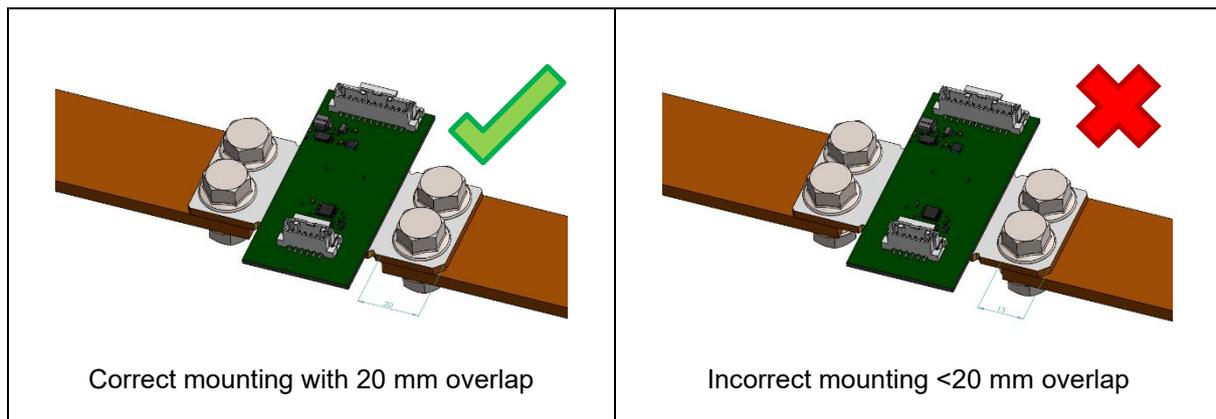


Table 11: Mounting examples

6.3 Dismounting

Before dismounting, take care that the IAS is disconnected from power supply. Prior to working on voltage lines, disconnect from power supply and secure against unwanted reconnection. Act accordingly to DIN VDE 0105-100 VDE 0105-100:2015-10. Isabellenhütte is not liable for any damage resulting from improper handling. Please use proper gloves while handling and appropriate packaging in case of shipping.



TOUCHING LIVE PARTS CAN BE FATAL!

Never touch the shunt or its mountings while current flows respectively voltage is attached.

7. Part Description

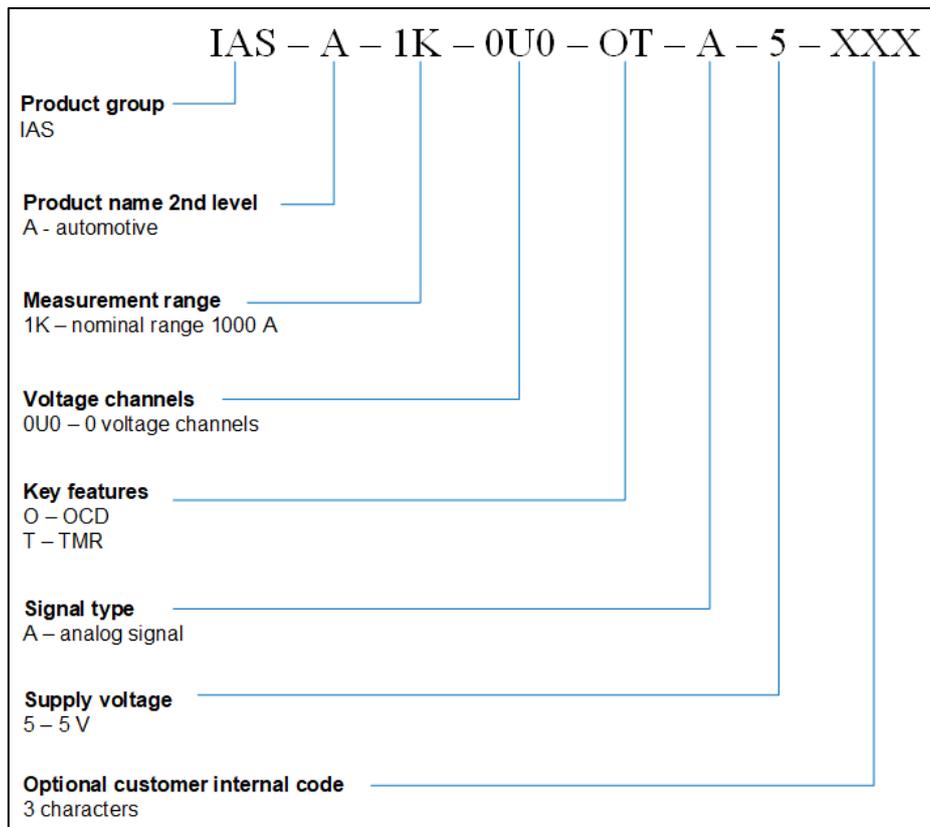


Figure 2: Details of part description

8. Qualification

Standard	Description
DIN EN 60664	Rated impulse voltage 2500 V Overvoltage category II Pollution degree III
DIN EN 60068-2-2	Environmental testing, Test B - Dry heat
ISO 16750-3:2023-07	Vibration Test IV Mechanical Shock II Free fall
ISO 16750-4:2023-07	Temperature cycle with specified change rate Rapid change of temperature with specified transition duration
ISO 11452-2:2019-01	Radiated immunity from 100 V/m up to 2 GHz with functional status I
ISO 11452-4:2020-04	Conducted immunity (BCI) from 50 mA between 100 kHz and 400 MHz with functional status I
ISO 11452-5:2002-04	Conducted immunity (strip line) from 100 V/m between 100 kHz and 400 MHz with functional status I
ISO 11452-8:2015-06	Magnetic immunity from 100 A/m at 50 Hz with functional status I
ISO 10605:2023-06	Direct contact discharge of 6kV with functional status I
DIN EN IEC 55025:2023-11	Radiated emissions with class III Conducted voltage emissions with class III

Table 12: Qualifications overview

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Table of abbreviations

Abbreviation	Meaning
DC	Direct Current
OCD	Overcurrent Detection
TMR	Tunnel Megneto-Resistance
ADC	Analog-Digital-Converter
AFE	Analog-Front-End

Table 13: Table of abbreviations

**Change History**

Version	Date	Author	Description
0.1	2025-04-16	M. Müller	Creation
0.2	2025-04-30	M. Müller	Updated information – proposal for review
0.3	2025-05-13	M. Müller	Update over findings
0.4	2025-05-28	M. Müller	Implemented changings Improved chapter 4
1.0	2025-06-18	M. Müller	Document release
1.1	2025-07-21	M. Müller	Chapter 3.3: Optimized layout table 2 Chapter 5.2: Changed table 6 Chapter 5.4: Changed sequence order; added the word “distance” in line “clearance” in table 9 Chapter 6.2: Updated graphics in table 11 Optimized layout
1.2	2025-09-09	T. Wagner	Table 5: NTC beta value added Table 6: Output signal, accuracy, measurement range changed