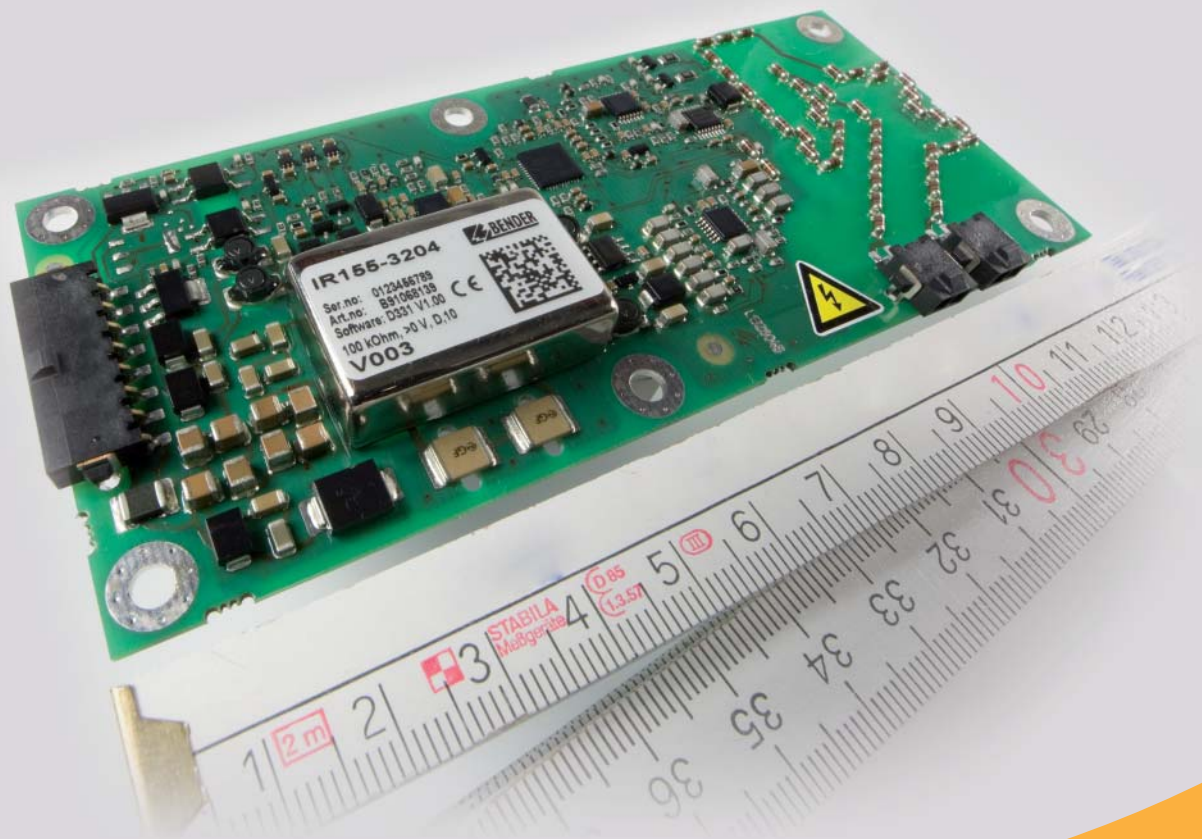


# A-ISOMETER® IR155-3203 / IR155-3204

Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles

Preliminary data sheet





A-ISOMETER® IR155-3204

### Device features

- Suitable for 12 V and 24 V systems
- Automatic device self test
- Continuous measurement of insulation resistance 0...10 MΩ
  - Response time < 2 s after power on for first estimated insulation resistance (SST)
  - Response time < 20 s for measured insulation resistance (DCP)
- Automatic adaptation to the existing system leakage capacitance ( $\leq 1 \mu\text{F}$ )
- Detection of ground faults and lost ground line
- Isolation monitoring of AC and DC insulation faults for unearthed systems (IT systems) 0 V...1000 V peak
- Low voltage detection for voltages below 500 V (value configurable EOL Bender)
- Short protected outputs for:
  - Fault detection (high side output)
  - Measurement value (PWM 5 % ... 95 %) & status (f = 10 Hz...50 Hz) at high or inverted low side driver ( $M_{HS} / M_{LS}$  output)
- Conformal coating (SL1301ECO-FLZ)

### Product description

The A-ISOMETER® iso-F1 IR155-3203/-3204 monitors the insulation resistance between the insulated and active HV-conductors of an electrical drive system ( $U_n = \text{DC } 0 \text{ V} \dots 1000 \text{ V}$ ) and the reference earth (chassis ground ▶ KI.31). The patented measurement technology is used to monitor the condition of the insulation on the DC side as well as on the AC motor side of the electrical drive system. Existing insulation faults will be signalled reliably even under high system interferences which can be caused by motor control processes, accelerating, energy recovering etc.

Due to its space saving design and optimised measurement technology, the device is optimised for use in hybrid or fully electric vehicles. The device meets the increased automotive requirements with regard to the environmental conditions (e.g. temperatures and vibration, EMC...).

The fault messages (insulation fault at the HV-system, connection or device error of the IMD) will be provided at the integrated and galvanic isolated interface (high- resp. low-side driver). The interface consists of a status output ( $OK_{HS}$  output) and a measurement output ( $M_{HS} / M_{LS}$  output). The status output signals errors resp. the "good" condition. The measurement output signals the actual insulation resistance. Furthermore it's possible to distinguish between different fault messages and device conditions, which are base frequency encoded.

### Function

The A-ISOMETER® iso-F1 IR155-3203/-3204 generates a pulsed measuring voltage, which is superimposed on the IT system by the terminals L+/L- and E/KE. The currently measured insulation condition is available as a pulse-width-modulated signal at the terminals  $M_{HS}$  resp.  $M_{LS}$ . The connection between the terminals E/KE and the chassis ground (▶ KI.31) is continuously monitored. Therefore it's necessary to install two separated conductors from the terminals E resp. KE to chassis ground.

Once power is switched on, the device performs an initialisation and starts the SST measurement. The device provides the first estimated insulation resistance during a maximum time of 2 sec. The DCP measurement (▶ continuous measurement method) starts subsequently. Faults in the connecting wires or functional faults will be automatically recognised and signalled.

During operation, a self test is carried out automatically every five minutes. The interfaces will not be influenced by these self tests.

### Standards

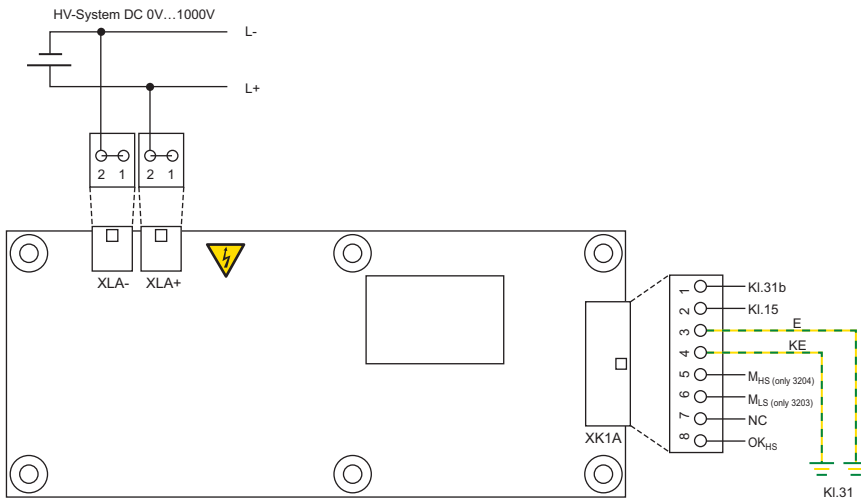
#### Corresponding norms and regulations

IEC 61557-1	2007-01
IEC 61557-8	2007-01
ISO 6469-3	2001-11
ISO 23273-3	2006-11
ISO 16750	2006 (E)
IEC 61010-1	2001-02
IEC 60664-1	2007-04
IEC 61326-2-4	2010
e1 acc. 72/245/EWG/EEC	

### Abbreviations

DCP	Direct Current Pulse
SST	Speed Start Measuring

**Wiring diagrams**



**Connector XLA+**

Pin 1+2 L+ Line voltage

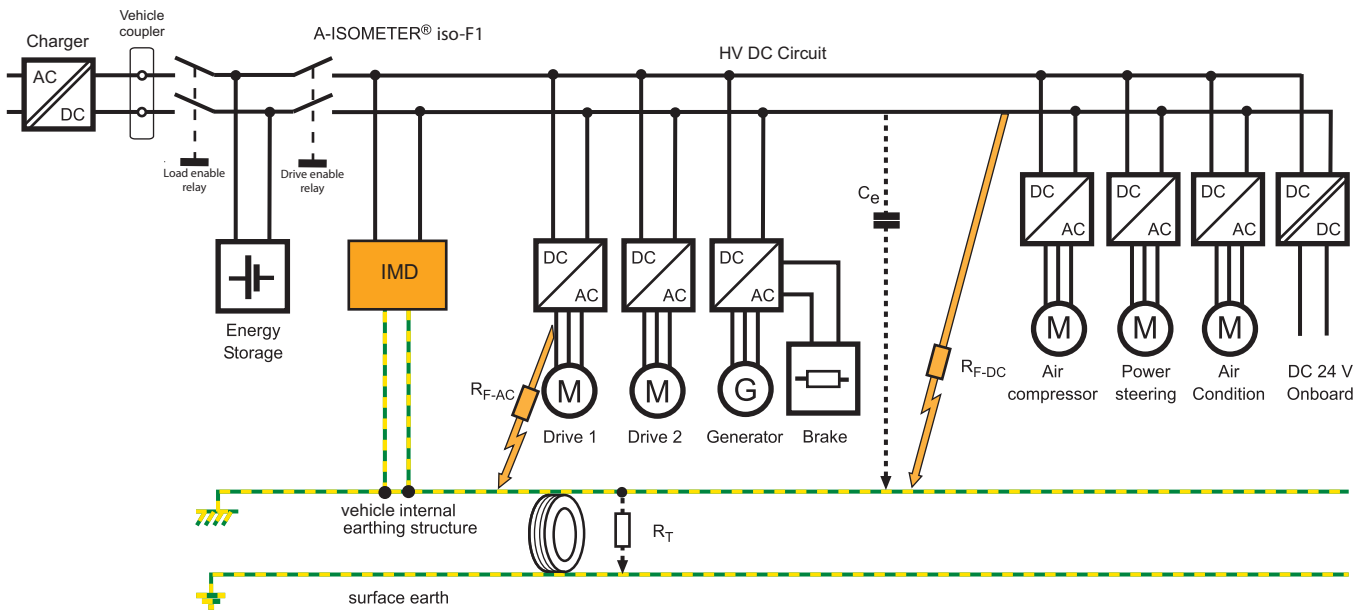
**Connector XLA-**

Pin 1+2 L- Line voltage

**Connector XK1A**

- Pin 1 KI. 31b Electronic ground
- Pin 2 KI. 15 Supply voltage
- Pin 3 KI. 31 Chassis ground
- Pin 4 KI. 31 Chassis ground (sep. line)
- Pin 5  $M_{HS}$  Data Out, PWM (high side)
- Pin 6  $M_{LS}$  Data Out, PWM (low side)
- Pin 7 n.c.
- Pin 8  $OK_{HS}$  Status Output (high side)

**Typical application**



**Technical data**

Supply voltage $U_S$	DC 10 ... 36 V
Nominal supply voltage	DC 12 V / 24 V
Voltage range	10 V ... 36 V
Max. operational current $I_S$	150 mA
Max. current $I_k$	2 A
	6 A / 2 ms Rush-In current
Power dissipation $P_S$	< 2 W
Line L+ / L- Voltage $U_n$	AC 0 V ... 1000 V peak; 0 V ... 660 V rms (10 Hz ... 1 kHz) DC 0 V ... 1000 V
Protective separation (reinforced insulation) between (L+ / L-) – (KI.31b, KI.15, E, KE, $M_{HS}$ , $M_{LS}$ , $OK_{HS}$ )	
Voltage test	AC 3500 V / 1 min
Under voltage detection	0 V ... 500 V; Default: 0 V (inactive)
System leakage capacity $C_e$	≤ 1 μF
Measuring voltage $U_m$	+/- 40 V
Measuring current $I_m$ at $R_F = 0$	+/- 33 μA
Impedance $Z_i$ at 50 Hz	≥ 1.2 MΩ
Internal resistance $R_i$	≥ 1.2 MΩ
Measurement range	0 ... 10 MΩ
Measurement method	Bender DCP technologie
Factor averaging	
$F_{ave}$ (Output M)	1 ... 10 (default: 10; EOL Bender)
Relative error at SST (≤ 2s)	Good > 2 * $R_{an}$ ; Bad < 0.5 * $R_{an}$
Relative error at DCP	0 ... 85 kΩ ▶ +/-20 kΩ 100 kΩ ... 10 MΩ ▶ +/-15 %
Relative error Output – M (base frequencies)	+/- 5 % at each frequency (10 Hz; 20 Hz; 30 Hz; 40 Hz; 50 Hz)
Relative error under voltage detection	$U_n \geq 100$ V ▶ +/-10 %; at $U_n \geq 300$ V ▶ +/-5 %
Response value hysteresis (DCP)	25 %
Response value $R_{an}$	100 kΩ ... 1 MΩ ▶ higher tolerances at $R_{an} < 85$ kΩ; (Default: 100 kΩ)
Response time $t_{an}$ ( $OK_{HS}$ ; SST)	$t_{an} \leq 2$ s (typ. < 1 s at $U_n > 100$ V)
Response time $t_{an}$ ( $OK_{HS}$ ; DCP)	
(Changeover $R_F$ : 10 MΩ ▶ $R_{an}/2$ ; at $C_e = 1$ μF; $U_n = 1000$ V DC)	
	$t_{an} \leq 20$ s (at $F_{ave} = 10^*$ ) $t_{an} \leq 17.5$ s (at $F_{ave} = 9$ ) $t_{an} \leq 17.5$ s (at $F_{ave} = 8$ ) $t_{an} \leq 15$ s (at $F_{ave} = 7$ ) $t_{an} \leq 12.5$ s (at $F_{ave} = 6$ ) $t_{an} \leq 12.5$ s (at $F_{ave} = 5$ ) $t_{an} \leq 10$ s (at $F_{ave} = 4$ ) $t_{an} \leq 7.5$ s (at $F_{ave} = 3$ ) $t_{an} \leq 7.5$ s (at $F_{ave} = 2$ ) $t_{an} \leq 5$ s (at $F_{ave} = 1$ ) during self test ▶ $t_{an} + 10$ s

\*  $F_{ave} = 10$  is recommended for electric vehicles

Switch-off time  $t_{ab}$  ( $OK_{HS}$ ; DCP)

(Changeover  $R_F$ :  $R_{an}/2$  ▶ 10 MΩ; at  $C_e = 1$  μF;  $U_n = 1000$  V DC)

- $t_{ab} \leq 40$  s (at  $F_{ave} = 10$ )
- $t_{ab} \leq 40$  s (at  $F_{ave} = 9$ )
- $t_{ab} \leq 33$  s (at  $F_{ave} = 8$ )
- $t_{ab} \leq 33$  s (at  $F_{ave} = 7$ )
- $t_{ab} \leq 33$  s (at  $F_{ave} = 6$ )
- $t_{ab} \leq 26$  s (at  $F_{ave} = 5$ )
- $t_{ab} \leq 26$  s (at  $F_{ave} = 4$ )
- $t_{ab} \leq 26$  s (at  $F_{ave} = 3$ )
- $t_{ab} \leq 20$  s (at  $F_{ave} = 2$ )
- $t_{ab} \leq 20$  s (at  $F_{ave} = 1$ )

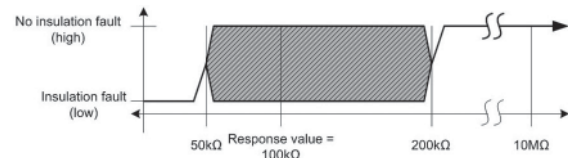
during self test ▶  $t_{ab} + 10$  s

Self test time

(every 5 minutes; has to be added to  $t_{an} / t_{ab}$ )

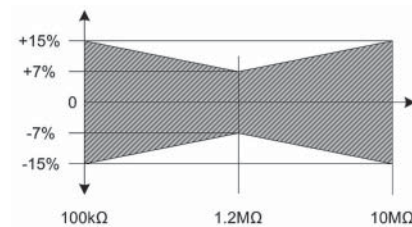
Relative error (SST)

“Good-Value” ≥ 2 \*  $R_{an}$   
“Bad-Value” ≤ 0.5 \*  $R_{an}$



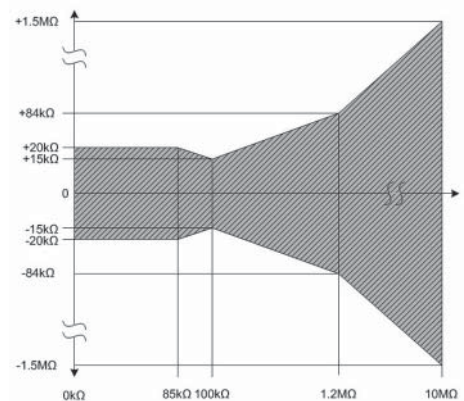
Relative error (DCP)

- 100 kΩ ▶ +/-15 %
- 100 kΩ ... 1.2 MΩ ▶ +/-15 % to +/-7 %
- 1.2 MΩ ▶ +/-7 %
- 1.2 MΩ ... 10 MΩ ▶ +/-7 % to +/-15 %
- 10 MΩ ▶ +/-15 %



Absolute error (DCP)

0 Ω ... 85 kΩ ▶ +/-20 kΩ



**Measurement Output (M)**

**M<sub>HS</sub> switches to U<sub>S</sub> – 2 V (3204)**  
(external load to ground necessary)

**M<sub>LS</sub> switches to KI.31b +2 V (3203)**  
(external load to U<sub>b</sub> necessary)

**0 Hz** ▶ Hi > short to U<sub>b</sub>+ (KI.15); Low > IMD off or short to KI.31

**10 Hz** ▶ Normal Condition  
Insulation measuring DCP;  
starts 2 s after Power-On;  
first successful insulation measurement at ≤ 17.5 s  
PWM active 5 % ... 95 %

**20 Hz** ▶ Under voltage condition  
Insulation measuring DCP (correct measurement);  
starts 2 s after Power-On;  
PWM active 5 % ... 95 %  
first successful insulation measurement at ≤ 17.5 s  
Under voltage detection 0 V ... 500 V  
(EOL Bender configurable).

**30 Hz** ▶ Speed Start  
Insulation measuring (only good/bad estimation);  
Starts directly after Power-On; response time ≤ 2 s;  
PWM 5 % ... 10 % (good) and 90 % ... 95 % (bad)

**40 Hz** ▶ IMD Error  
IMD error detected; PWM 47.5% ... 52.5%

**50 Hz** ▶ Ground error  
Error on measurement ground line (KI. 31) detected  
PWM 47.5% ... 52.5%

**OK<sub>HS</sub> Output**

OK<sub>HS</sub> switches to U<sub>S</sub> – 2V  
(external load to ground necessary)

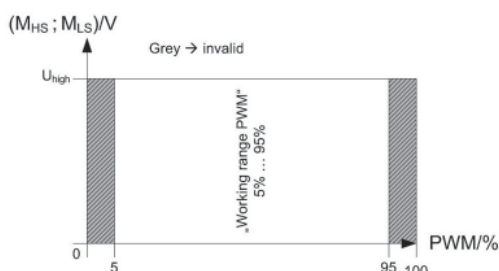
High ▶ No fault; R<sub>F</sub> > response value  
Low ▶ Insulation resistance ≤ response value  
detected; IMD error; ground error,  
under voltage detected or IMD off  
(ext. pull-down resistor required)

**Operating principle PWM- driver**

- Condition "Normal" and "Under voltage detected" (10Hz; 20Hz)  
Duty cycle ▶ 5 % => 50 MΩ (∞)  
Duty cycle ▶ 50 % = 1200 kΩ  
Duty cycle ▶ 95 % = 0 kΩ

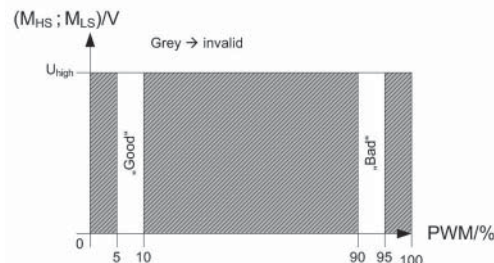
$$R_F = \frac{90\% \times 1200 \text{ k}\Omega}{dC_{\text{meas}} - 5\%} - 1200 \text{ k}\Omega$$

dC<sub>meas</sub> = measured duty cycle (5 % ... 95 %)



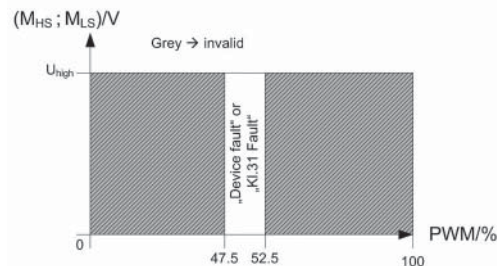
**Operating principle PWM- driver**

- Condition "SST" (30Hz)  
Duty cycle ▶ 5 % ... 10 % ("Good")  
90 % ... 95 % ("Bad")

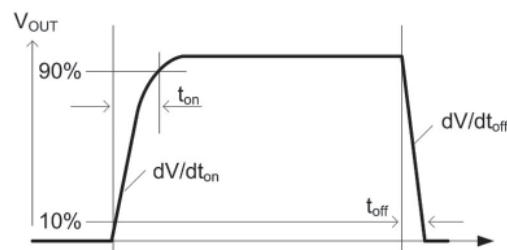


**Operating principle PWM- driver**

- Condition "Device error" and "KI.31 fault" (40Hz; 50Hz)  
Duty cycle ▶ 47.5 % ... 52.5 %



Load current I <sub>L</sub>	20 mA
Turn-on time ▶ to 90 % V <sub>OUT</sub>	Max. 125 μs
Turn-off time ▶ to 10 % V <sub>OUT</sub>	Max. 175 μs
Slew rate on ▶ 10 to 30 % V <sub>OUT</sub>	Max. 6 V/μs
Slew rate off ▶ 70 to 40 % V <sub>OUT</sub>	Max. 8 V/μs
Timing 3204 (inverse of 3203)	



Connectors	TYCO-MICRO MATE-N-LOK 1 x 2-1445088-8 (KI.31b, KI.15, E, KE, M <sub>HS</sub> , M <sub>LS</sub> , OK <sub>HS</sub> ) 2 x 2-1445088-2 (L+, L-)
Crimp contacts	TYCO MICRO MATE-N-LOK Gold 14x 1-794606-1
Necessary crimp tongs (TYCO)	91501-1
Operating mode / mounting	Continuous operation / any position
Temperature range	-40 °C ... +105 °C
Voltage dropout	≤ 2 ms
Fire protection class acc. UL94	V 0

**ESD protection**

Contact discharge – directly to terminals	≤ 10 kV
Contact discharge – indirectly to environment	≤ 25 kV
Air discharge – handling of the PCB	≤ 6 kV

## Mounting

Screw mounting: M4 metal screws with locking washers between screw head and PCB.  
Torx, T20 with a max. tightening torque of 4 Nm for the screws. Furthermore max. 10 Nm pressure to the PCB at the mounting points.

Screw and washer kit attached. The max. diameter of the mounting points is 10 mm.  
Before mounting the device, ensure sufficient insulation between the device and the vehicle resp. the mounting points (min. 11.4 mm to other parts). If the IMD is mounted on a metal or conductive subsurface, this subsurface has to get ground potential (KI.31; vehicle mass).

Deflection max. 1 % of the length resp. width of the PCB

Conformal coating Thick-Film-Laequer

Weight 52 g +/- 2 g

## Ordering information

Type		Art.No
IR155-3203	Fixed default parameters $R_{an}$ : 100 k $\Omega$ Under voltage detection: 300 V $F_{ave}$ : 10 Measurement output low side	B 9106 8138
IR155-3203	Parameters can be customised $R_{an}$ : 100 k $\Omega$ ... 1 M $\Omega$ Under voltage detection: 0 V... 500 V $F_{ave}$ : 1... 10 Measurement output low side	B 9106 8138C
IR155-3204	Fixed default parameters $R_{an}$ : 100 k $\Omega$ Under voltage detection: 0 V (inactive) $F_{ave}$ : 10 Measurement output high side	B 9106 8139
IR155-3204	Parameters can be customised $R_{an}$ : 100 k $\Omega$ ... 1 M $\Omega$ Under voltage detection: 0 V... 500 V $F_{ave}$ : 1... 10 Measurement output high side	B 9106 8139C

## Example for ordering

IR155-3204-100k $\Omega$ -0V + B 9106 8139

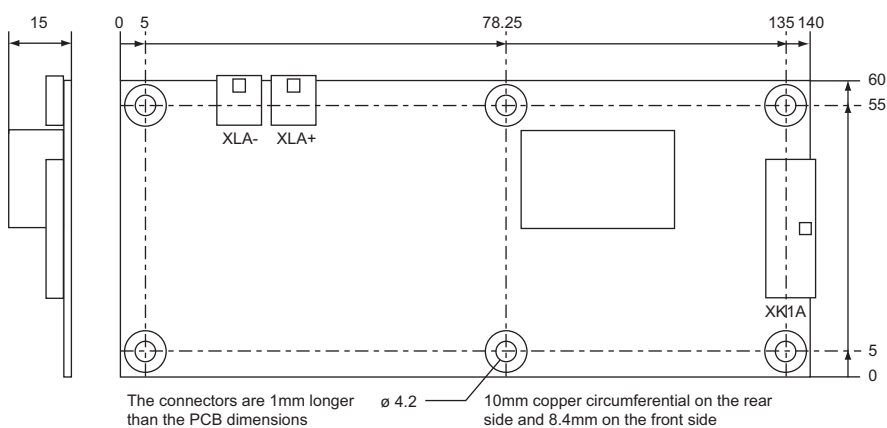
IR155-3204-200k $\Omega$ -100V + B 9106 8139C

The parameters acc. response value and under voltage protection have always to be added or included to an order.

## Dimension diagram

Dimensions in mm

PCB dimensions (L x W x H) 140 mm x 60 mm x 15 mm



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