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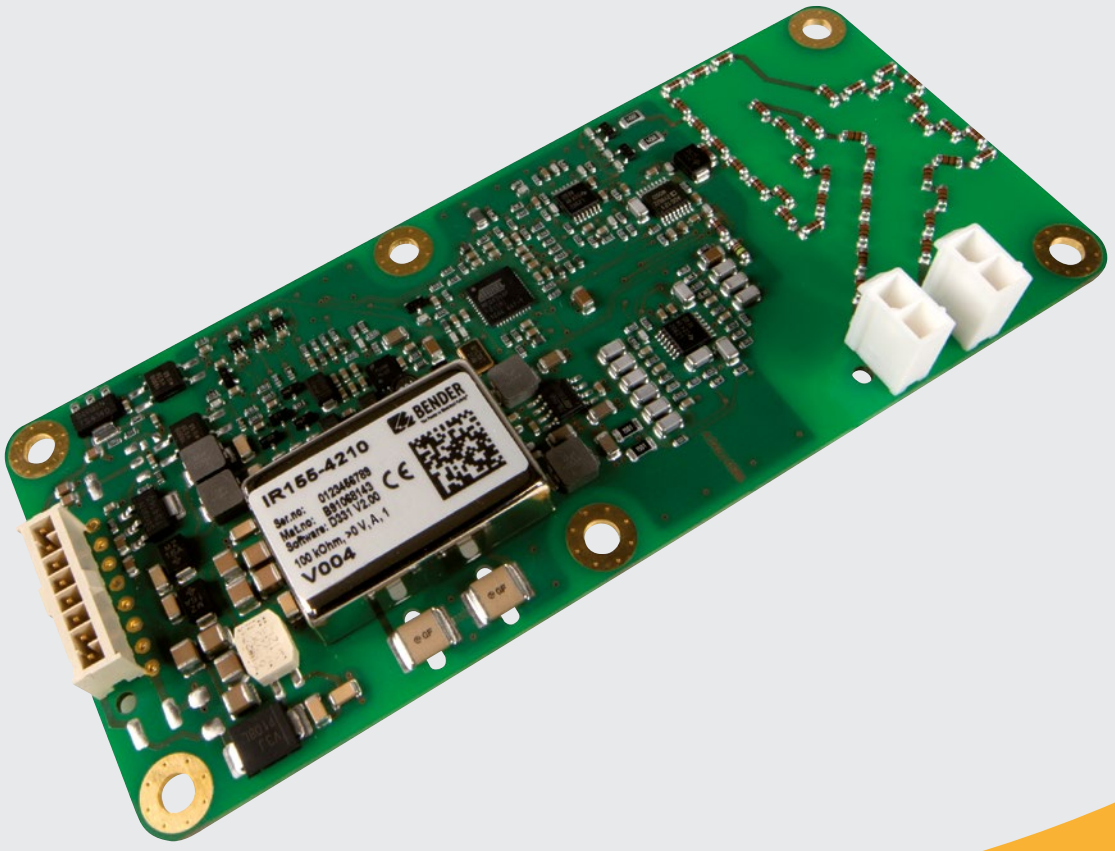
ISOMETER® IR155-4210

Insulation monitoring device (IMD) for unearthed charging systems (IT systems), for e.g. electric vehicles

Version V004



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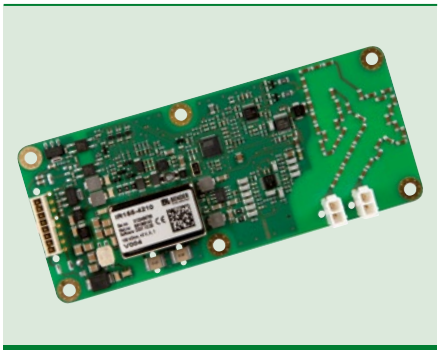


ISOMETER® IR155-4210

Device features

- Suitable for 12 V and 24 V systems
- Automatic device self test
- Continous measurement of insulation resistance 0…10 MΩ
  - Response time < 2 s after power on for first estimated insulation resistance (SST)
  - Response time < 10 s for measured insulation resistance (AMP)
- Automatic adaptation to the existing system leakage capacitance (≤1 µF)
- Detection of ground faults and lost ground line
- Isolation monitoring of AC and DC insulation faults for unearthed systems (IT systems) 0 V…800 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 side driver (M_{HS} output)
- Conformal coating (SL1301ECO-FLZ)
- UL 2231 compliant

Approvals

CE EAC

ATTENTION

Observe precautions for handling electrostatic sensitive devices.

Handle only at safe work stations.

ATTENTION

The device is monitoring HIGH VOLTAGE.

Be aware of HIGH VOLTAGE near to the device.

Product description

The ISOMETER® iso-F1 IR155-4210 monitors the insulation resistance between the insulated and active HV-conductors of an electrical drive/charger system (U_n = DC 0 V…800 V) and the reference earth (chassis ground ▸ Kl.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/charger system. Existing insulations faults will be signalised reliably even under high system interferences which can be caused by motor/charger control processes, etc.

Due to its space saving design and optimised measurement technology, the device is optimised for use in chargers for hybrid or fully electric vehicles. The device meets the increased automotive requirements in regard of 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-side driver). The interface consists of a status output (OK_{HS} output) and a measurement output (M_{HS} output). The status output signalises errors resp. the "good" condition. The measurement output signalises the actual insulation resistance. Furthermore it's possible to distinguish between different fault messages and device conditions, which are base frequency encoded.

Function

The ISOMETER® iso-F1 IR155-4210 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 terminal M_{HS}.
The connection between the terminals E/KE and the chassis ground (▸ Kl.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 AMP measurement (▸ continuous measurement method) starts subsequently. The AMP measurement provides the first successful value at 10 sec after power on. Faults in the connecting wires or functional faults will be automatically recognised and signalled.

Standards

Corresponding norms and regulations*

IEC 61557-8	2007-01
IEC 61010-1	2010-06
IEC 60664-1	2004-04
IEC 61326-2-4	2010-05
ISO 6469-3	2001-11
ISO 23273-3	2006-11
ISO 16750-1	2006-08
ISO 16750-2	2010-03
ISO 16750-4	2010-04
e1 acc. 72/245/EWG/EEC	2009/19/EG/EC
DIN EN 60068-2-38	Z/AD:2010
DIN EN 60068-2-30	Db:2006
DIN EN 60068-2-14	Nb:2010
DIN EN 60068-2-64	Fh:2009
DIN EN 60068-2-27	Ea:2010
UL2231-1	2002
UL2231-2	2002

*** Normative exclusion**

The device went through an automotive test procedure in combination of multi customer requirements reg. ISO16750-x.

The norm IEC61557-8 will be fulfilled by creating the function for LED warning and test button at the customer site if necessary.

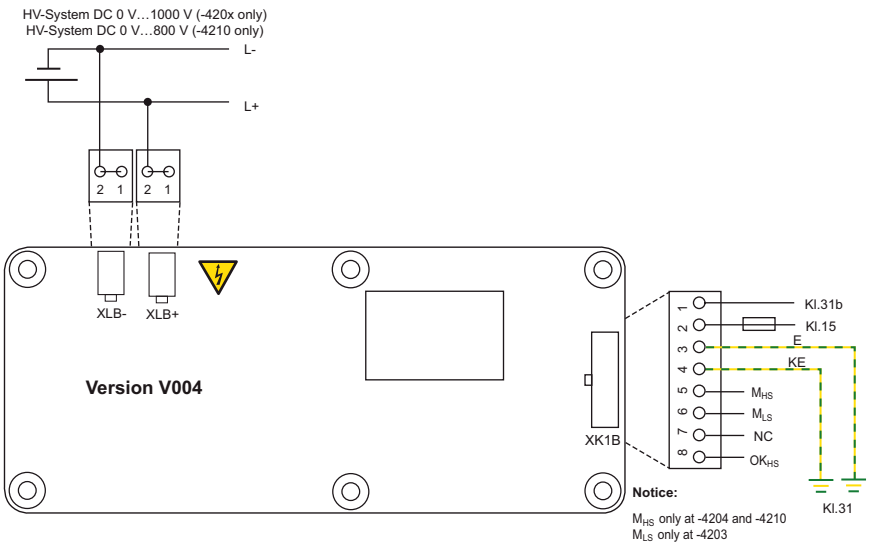
The device includes no surge and load dump protection above 40V. An additional central protection is necessary.

Abbreviations

AMP	Adaptive Measuring Pulse
SST	Speed Start Measuring

AC/DC

Wiring diagrams



Connector XLB+

Pin 1+2	L+	Line voltage

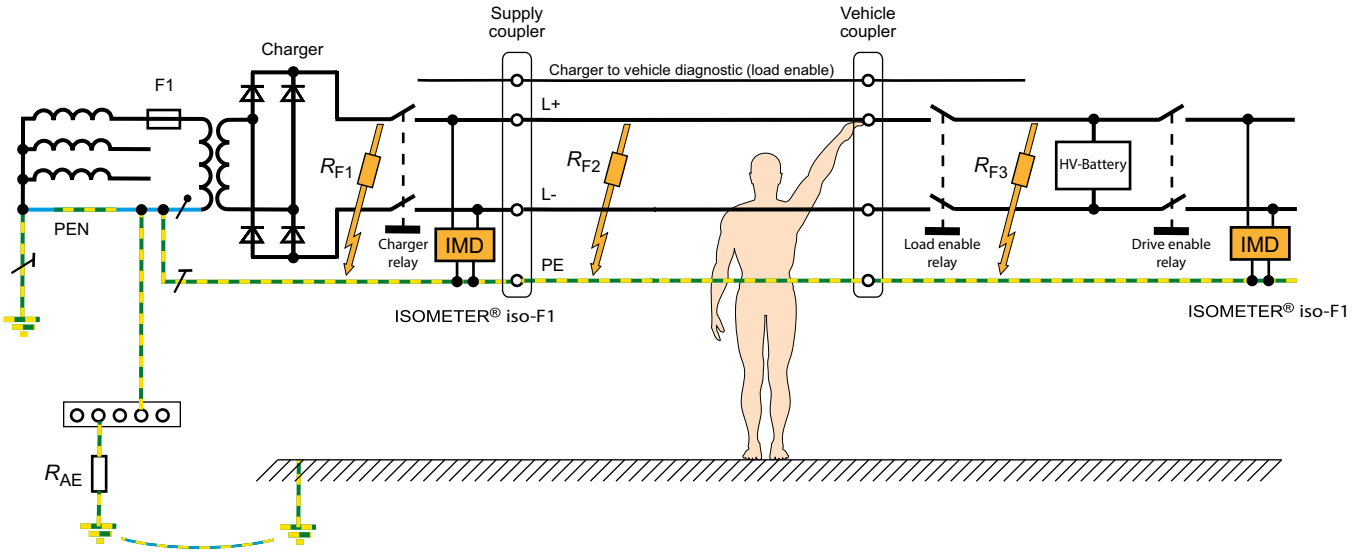
Connector XLB-

Pin 1+2	L-	Line voltage

Connector XK1B

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

Typical application



Notes for end products using an IR155-4210 acc. UL 2231

An end product employing a manual test feature shall be marked:

"Test Before Each Use"

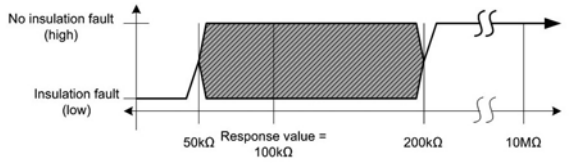
The instructions about performing the test (is the IMI working as specified? E.g. response time ≤ 10 s) and interpreting the results have to be included. These instructions are to state that a device that produces an unacceptable test result is not to be used.

Example:

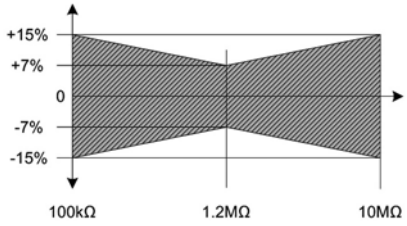
The device has to response within max. 10 s, if the insulation resistance of the monitored system is falling below the programmed response value of the IMI. This could be realised by switching a test resistor (R_{an}/2) into the system (between the HV conductors and ground) and a simultaneous measurement of the response time. The system shall not be used by a failed test. The test resistor has to be removed after the test.

Technical data

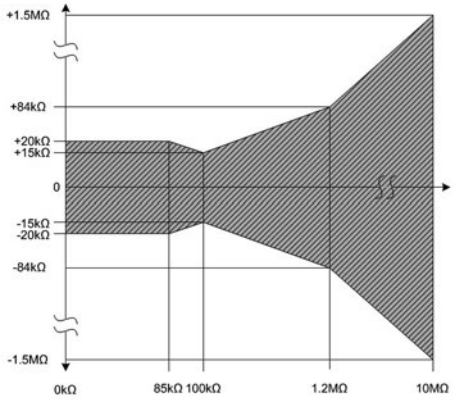
Supply voltage U_S	DC 10…36 V
Nominal supply voltage	DC 12 V / 24 V
Voltage range	10 V…36 V
Max. operational current I_S	150 mA
Max. current I_k	2 A 6 A / 2 ms Rush-In current
Power dissipation P_S	<2 W
Line L+ / L- Voltage U_n	AC 0 V…800 V peak; 0 V…560 V rms (10 Hz…1 kHz) DC 0 V…800 V
Protective separation (reinforced insulation) between	(L+ / L-) – (KI.31, KI.15, E, KE, M_{HS}, OK_{HS})
Voltage test	AC 3500 V / 1 min
Load dump protection	< 40 V
Under voltage detection	0 V…500 V; Default: 0 V (inactive)
System leakage capacity C_e	≤ 1 µF
Reduced measuring range and increased measuring time at C_e (E.g. max. range 1 MΩ @ 3 µF, t_{an} = 30 s @ change over R_F 1MΩ > R_{an}/2)	> 1µF
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 AMP Technologie
Relative error at SST (≤ 2 s)	Good > 2 * R_{an}; Bad < 0.5 * R_{an}
Relative error at AMP	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 ≥ 100 V ▸ +/-10 %; at U_n ≥ 300 V ▸ +/-5 %
Response value hysteresis (AMP)	25 %
Response value R_{an}	100 kΩ…200 kΩ ▸ higher tolerances at R_{an} < 85 kΩ; (Default: 100 kΩ)
Response time t_{an} (OK_{HS}; SST)	t_{an} ≤ 2 s (typ. < 1 s at U_n > 100 V)
Response time t_{an} (OK_{HS}; AMP)	t_{an} ≤ 10 s
Switch-off time t_{ab} (OK_{HS}; AMP)	t_{ab} ≤ 26 s
Self test time	10 s (only at power on)
Relative error (SST)	"Good-Value" ≥ 2 * R_{an} "Bad-Value" ≤ 0.5 * R_{an}



Relative error (AMP)	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 (AMP)	0 Ω…85 kΩ ▸ +/-20 kΩ



Measurement Output (M)

***M_{HS}* switches to U_S – 2V (4210)**

(external load to ground necessary ➞ 2.2 kΩ)

0 Hz ▸ Hi > short to U_b+ (KI.15); Low > IMD off or short to KI.31

10 Hz ▸ Normal Condition
Insulation measuring AMP; starts 10 s after Power-On; PWM active 5 %…95 %

20 Hz ▸ Under voltage condition
Insulation measuring AMP (correct measurement) starts 10 s after Power-On;
PWM active 5 %…95 %
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%

Status Output (OK_{HS})

***OK_{HS}* switches to U_S – 2 V**

(external load to ground necessary ➞ 2.2 kΩ)

High ▸ No fault; R_F > response value
Low ▸ Insulation resistance ≤ response value detected; IMD error; ground error, under voltage detected or IMD off (ext. pull-down resistor required)

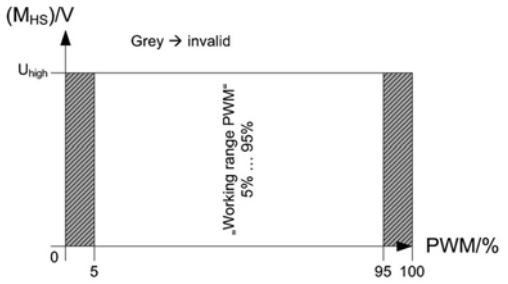
Operating principle PWM- driver

- Condition “Normal” and “Under voltage detected” (10Hz; 20Hz)

Duty cycle ▶ 5 % = >50 MΩ (∞)
Duty cycle ▶ 50 % = 1200 kΩ
Duty cycle ▶ 95 % = 0 kΩ

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

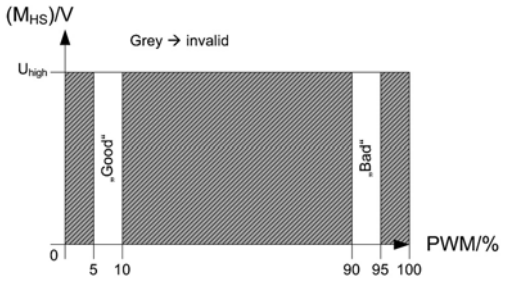
dc_{meas} = measured duty cycle (5 %…95 %)



Operating principle PWM- driver

- Condition “SST” (30Hz)

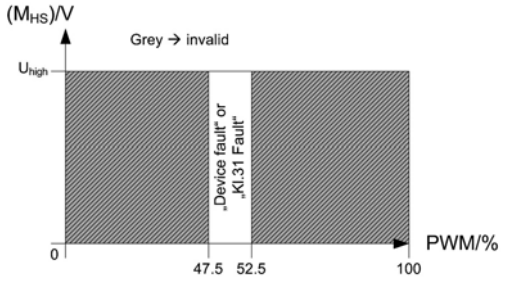
Duty cycle ▶ 5 %…10 % („Good“)
90 % … 95 % („Bad“)



Operating principle PWM- driver

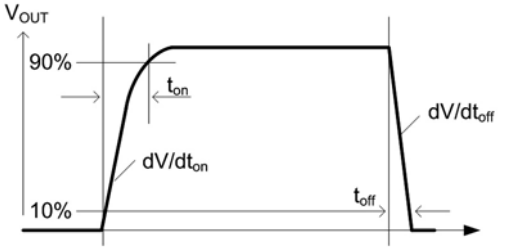
- Condition “Device error” and “KI.31 fault” (40Hz; 50Hz)

Duty cycle ▶ 47.5% … 52.5 %



Load current I_L	80 mA
Turn-on time ▶ to 90 % V_{OUT}	Max. 125 µs
Turn-off time ▶ to 10 % V_{OUT}	Max. 175 µs
Slew rate on ▶ 10 to 30 % V_{OUT}	Max. 6 V/µs
Slew rate off ▶ 70 to 40 % V_{OUT}	Max. 8 V/µs

Timing 4210



Connectors	Samtec Mini Mate Housing, IPD1-08-S-K (Kl. 31B, Kl.15, KE, E, M_{HS}, M_{LS}, OK_{HS}) Molex Mini Fit Jr. Housing, 39-01-2025, (L+, L-)
Crimp contacts	Samtec Mini Mate Gold, CC79R2024-01-L, AWG 20…24 Molex Mini Fit Jr. Gold, 39-00-0089, AWG 16
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.

Mounting and connector kits are not included in delivery, but are available as accessories. 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 (Kl.31; vehicle mass).

Deflection	max. 1 % of the length resp. width of the PCB
Conformal coating	Thick-Film-Lacquer
Weight	52 g +/-2 g

Ordering information

Parameters	Response value R_{an}	Undervoltage detection	Measured value output	Type	Art. No.
Continuously set value	100 kΩ	0 V (inactive)	high-side	**IR155-4210**	**B 9106 8143**
Customer-specific setting	100…200 kΩ	0 V…500 V	high-side	**IR155-4210**	**B 9106 8143C**

Accessories

Type designation	Art. No.
Fastening set	**B 9106 8500**
Connector set IR155-42xx	**B 9106 8502**

Example for ordering

IR155-4210-100kΩ-0V + B 9106 8143

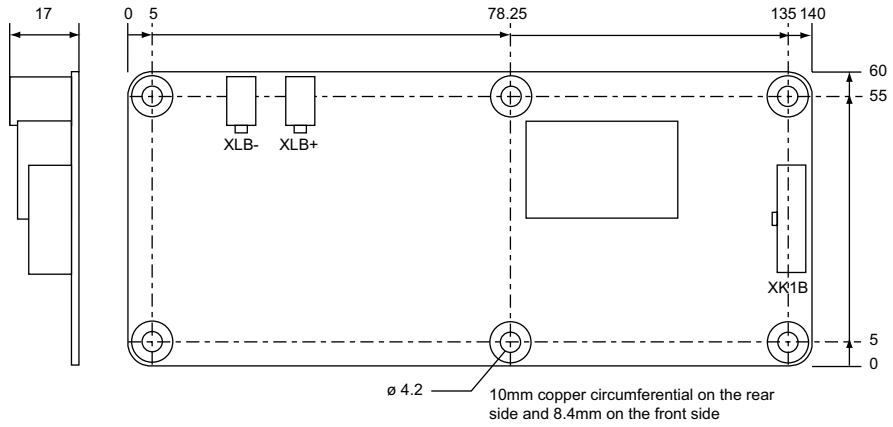
IR155-4210-200kΩ-100V + B 9106 8143C

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 17 mm



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