# ISOMETER® IR155-3210

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

## Version V004

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for unearthed charging systems (IT systems),
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**ISOMETER® IR155-3210**

## 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 ($\leq 1$ 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



## 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 IR155-3210 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 IR155-3210 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.

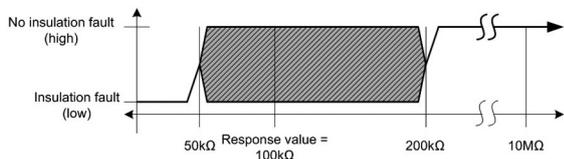The device includes no surge and load dump protection above 40V. An additional central protection is necessary.

## Abbreviations

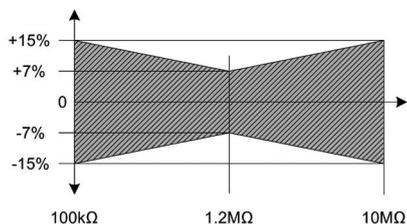| | |
|---|---|
| AMP | Adaptive Measuring Pulse |
| SST | Speed Start Measuring |

## Wiring diagrams

HV-System DC 0V…1000V (-320x only)
HV-System DC 0V…800V (-3210 only)

**Connector XLA+**
Pin 1+2    L+       Line voltage

**Connector XLA-**
Pin 1+2    L-       Line voltage

**Connector XK1A**
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)

Notice:
$M_{HS}$ only at -3204 and -3210
$M_{LS}$ only at -3203

## Typical application

## Notes for end products using an IR155-3210 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.

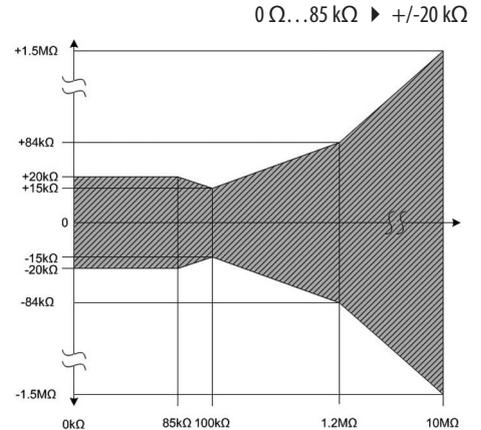## Technical data

| | |
|---|---|
| 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-) – (Kl.31, Kl.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 $C_e$ | > 1µF |
| (E.g. max. range 1 MΩ @ 3 µF, $t_{an} = 68$ s @ change over $R_F$ 1MΩ > $R_{an}/2$) | |
| 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 (3210)
(external load to ground necessary ➙ 2.2 kΩ)

**0 Hz** ▶ Hi > short to $U_b$+ (Kl.15); Low > IMD off or short to Kl.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 (Kl. 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 (∞)
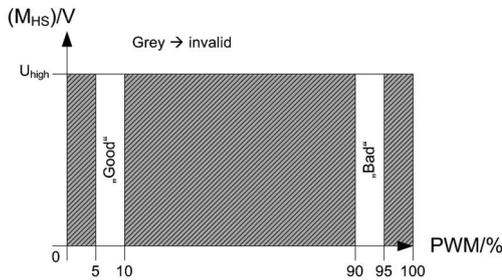
Duty cycle  ▶  50 % = 1200 kΩ

Duty cycle  ▶  95 % = 0 kΩ

$$R_F = \frac{90\% \times 1200\ k\Omega}{dc_{meas} - 5\%} - 1200\ k\Omega$$
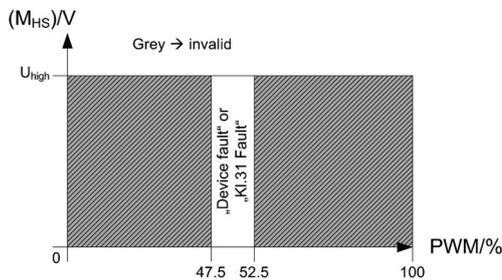
$dc_{meas}$ = measured duty cycle (5 %…95 %)
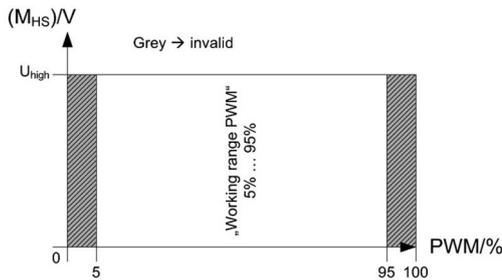
## Operating principle PWM- driver

- Condition "SST" (30Hz)

Duty cycle  ▶  5 %…10 % („Good")

90 % … 95 % („Bad")

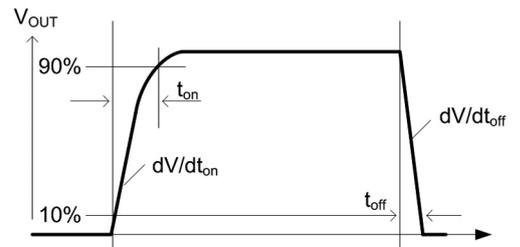## Operating principle PWM- driver

- Condition "Device error" and "Kl.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 3210

| | |
|---|---|
| Connectors | TYCO-MICRO MATE-N-LOK |
| | 1 x 2-1445088-8 |
| | (Kl.31, Kl.15, E, KE, $M_{HS}$, $OK_{HS}$) |
| | 2 x 2-1445088-2 (L+, L-) |
| Crimp contacts | TYCO MICRO MATE-N-LOK Gold |
| | 14x 1-794606-1 |
| | Wire size: AWG 20…24 |
| Necessary crimp tongs (TYCO) | 91501-1 |
| Operating mode / mounting | Continuous operation / any position |
| Temperature range | -40 ℃…+105 ℃ |
| 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

| Type | | Art.No |
|---|---|---|
| IR155-3210 | Fixed default parameters<br>$R_{an}$: 100 kΩ<br>Under voltage detection: 0 V (inactive)<br>Measurement output high side | B 9106 8140V4 |
| IR155-3210 | Parameters can be customised<br>$R_{an}$: 100 kΩ…200 kΩ<br>Under voltage detection: 0 V…500 V<br>Measurement output high side | B 9106 8140CV4 |

## Accessories

| | |
|---|---|
| Mounting kit | B 9106 8500 |
| Connecting kit IR155-32xx | B 9106 8501 |

## Example for ordering

IR155-3210-100kΩ-0V + B 9106 8140V4

IR155-3210-200kΩ-100V + B 9106 8140CV4

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

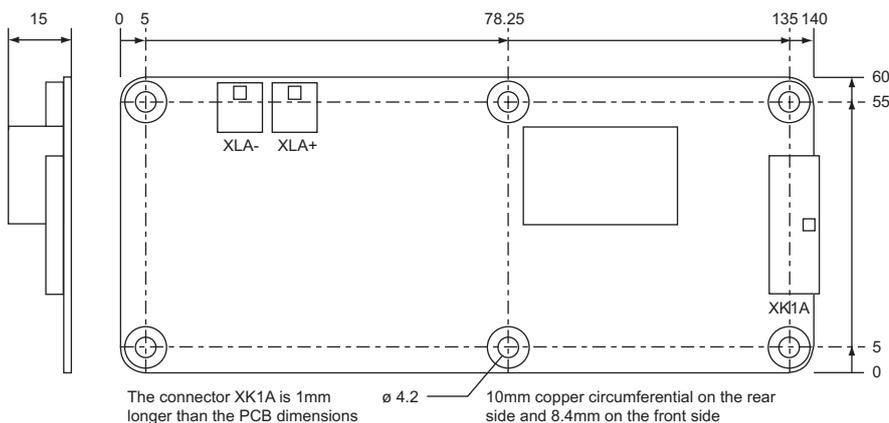## Dimension diagram

Dimensions in mm

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



The connector XK1A is 1mm longer than the PCB dimensions

ø 4.2

10mm copper circumferential on the rear side and 8.4mm on the front side

XLA-  XLA+

XK1A

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