A-ISOMETER® IR155-3203 / IR155-3204
Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles
Insulation monitoring device (IMD) for ungrounded DC drive systems (IT systems) in electric vehicles

**A-ISOMETER® IR155-3203 / 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 (≤1 μF)
- Detection of ground faults and lost ground line
- Isolation monitoring of AC and DC insulation faults for ungrounded 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 (MHS / MLS 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 (Un = DC 0 V…1000 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 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 (OKHS output) and a measurement output (MHS / MLS 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 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 MHS resp. MLS. 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 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  Kl. 31b  Electronic 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  $M_{LS}$  Data Out, PWM (low side)
Pin 7  n.c.
Pin 8  OK$_{HS}$  Status Output (high side)

Typical application

[Diagram showing wiring connections and components such as IMD, energy storage, vehicle internal earthing structure, surface earth, etc.]
A-ISOMETER® iso-F1

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 \( I_I \)
150 mA

Max. current \( I_k \)
2 A

Power dissipation \( P_S \)
< 2 W

Line L+ / L- Voltage \( U_n \)
AC 0 V...1000 V peak;
DC 0 V...1000 V

Protective separation (reinforced insulation) between \((L+ / L-) – (Kl.31b, Kl.15, E, KE, MHS, MLS, OK)\)

Voltage test
AC 3500 V / 1 min

Under voltage detection
0 V...500 V; Default: 0 V (inactive)

System leakage capacity \( C_e \)
\( \leq 1 \mu F \)

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® technology

Factor averaging
\( F_{ave} \)
1...10 (default: 10; EOL Bender)

Relative error at SST \((\leq 2 s)\)
Good ≥ 2 * \( R_{an} \)
Bad < 0.5 * \( R_{an} \)

Relative error at DCP
100 kΩ...10 MΩ ≥ +/- 15 %
100 kΩ...1 MΩ ≥ +/- 7 %
1 MΩ...10 MΩ ≥ +/- 15 %

Absolute error (DCP)
0 Ω...85 kΩ ≥ +/- 20 kΩ

Switch-off time \( t_{ab} \) (OKHS; DCP)
(Changeover \( R_t; R_m/2; \) at \( C_e = 1 \mu F; U_n = 1000 V DC \))

Absolute error (DCP)
0 Ω...85 kΩ ≥ +/- 20 kΩ

Switch-off time \( t_{ab} \) (OKHS; DCP)
(Changeover \( R_t; R_m/2; \) at \( C_e = 1 \mu F; U_n = 1000 V DC \))

Relative error (SST)
“Good-Value” ≥ 2 * \( R_{an} \)
“Bad-Value” ≤ 0.5 * \( R_{an} \)

Relative error (DCP)
100 kΩ...1.2 MΩ ≥ +/- 15 % to +/- 7 %
1.2 MΩ...10 MΩ ≥ +/- 15 %

Relative error (DCP)
100 kΩ...1 MΩ ≥ +/- 20 kΩ

Response time \( t_{an} \) (OKHS; SST)
10 s (every 5 minutes; has to be added to \( t_{an} / t_{ab} \))

Response time \( t_{an} \) (OKHS; DCP)
Changeover \( R_F: 10 MΩ \) at \( C_e = 1 \mu F; U_n = 1000 V DC \)

Response time \( t_{an} \) (OKHS; DCP)
Changeover \( R_F; R_m/2; \) at \( C_e = 1 \mu F; U_n = 1000 V DC \)

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

Self test time
10 s

Response time \( t_{an} \) (OKHS; DCP)
Changeover \( R_F: 10 MΩ \) at \( C_e = 1 \mu F; U_n = 1000 V DC \)
During self test \( t_{an} + 10 s \)

Response time \( t_{an} \) (OKHS; DCP)
Changeover \( R_F: R_m/2; \) at \( C_e = 1 \mu F; U_n = 1000 V DC \)

Response time \( t_{an} \) (OKHS; DCP)
Changeover \( R_F: 10 MΩ \) at \( C_e = 1 \mu F; U_n = 1000 V DC \)
During self test \( t_{an} + 10 s \)
Measurement Output (M)

**M**₃₅ switches to **U**₂ - 2 V (3204)
(external load to ground necessary)

**M**₅₃ switches to Kl.31b – 2 V (3203)
(external load to **U**₃ necessary)

- **0 Hz**: Hi > short to **U**₂ and Kl.15; Low > IMD off or short to Kl.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; 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 %

**OK₅₅ Output**

- **OK₅₅** switches to **U**₂ - 2 V
(external load to ground necessary)

- **High**: No fault; **R**₁ > 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
  - \( R_1 = \frac{90\% \times 1200 \, \text{kΩ}}{d_{\text{meas}} - 5\%} - 1200 \, \text{kΩ} \)
  - \( d_{\text{meas}} = \) measured duty cycle (5 % - 95 %)

- Load current \( I_L \) 20 mA
- Turn-on time \( t_{\text{on}} \) to 90 % \( V_{\text{OUT}} \) Max. 125 μs
- Turn-off time \( t_{\text{off}} \) to 10 % \( V_{\text{OUT}} \) Max. 175 μs
- Slew rate on \( t_{\text{slew on}} \) to 30 % \( V_{\text{OUT}} \) Max. 6 V/μs
- Slew rate off \( t_{\text{slew off}} \) to 70 % \( V_{\text{OUT}} \) Max. 8 V/μs
- Timing 3204 (inverse of 3203)

**Connectors**

TYCO-MICRO MATE-N-LOK
1 x 2-1445088-8
(Kl.31b, Kl.15, E, KE, M₅₅, M₃₅, OK₅₅)
2 x 2-1445088-2 (L+, L-)

**Crimp contacts**

TYCO MICRO MATE-N-LOK Gold
14 x 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.

Tors, 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 (KL.31; vehicle mass).

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

Conformal coating Thick-Film-Laqueur

Weight 52 g +/- 2 g

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**Dimensions in mm**

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

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**Ordering information**

<table>
<thead>
<tr>
<th>Type</th>
<th>Art.No</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR155-3203</td>
<td>Fixed default parameters</td>
</tr>
<tr>
<td>$R_{\text{an}}$: 100 kΩ</td>
<td>$F_{\text{arb}}$: 10</td>
</tr>
<tr>
<td>Under voltage detection: 300 V</td>
<td>Measurement output low side</td>
</tr>
<tr>
<td>IR155-3203</td>
<td>Parameters can be customised</td>
</tr>
<tr>
<td>$R_{\text{an}}$: 100 kΩ...1 MΩ</td>
<td>$F_{\text{arb}}$: 1...10</td>
</tr>
<tr>
<td>Under voltage detection: 0 V...500 V</td>
<td>Measurement output low side</td>
</tr>
<tr>
<td>IR155-3204</td>
<td>Fixed default parameters</td>
</tr>
<tr>
<td>$R_{\text{an}}$: 100 kΩ</td>
<td>$F_{\text{arb}}$: 10</td>
</tr>
<tr>
<td>Under voltage detection: 0 V (inactive)</td>
<td>Measurement output high side</td>
</tr>
<tr>
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<td>Parameters can be customised</td>
</tr>
<tr>
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<td>Measurement output high side</td>
</tr>
</tbody>
</table>

**Example for ordering**

IR155-3204-100kΩ-0V + B 9106 8139

IR155-3204-200kΩ-100V + B 9106 8139C

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