ISOMETER® IR155-3203/IR155-3204
Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles
Version V004
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Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles

Product description

The ISOMETER® IR155-3203/-3204 monitors the insulation resistance between the insulated and active HV-conductors of an electrical drive system ($U_n = DC 0 V...1000 V$) 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- or 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 or that the system is error free, i.e. the "good" condition as shown by the "Operating principle PWM driver" diagram on page 5. The measurement output signals the actual insulation resistance. Furthermore, it is possible to distinguish between different fault messages and device conditions, which are base frequency encoded.

Function

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

Connection monitoring of the earth terminals $E/KE$ is specified for $R_e \leq 4 \, \text{M} \Omega$ if the ISOMETER® is connected as shown in the application diagram on page 3.

Once power is switched on, the device performs an initialisation and starts the system state (SST) measurement. The ISOMETER® provides the first estimated insulation resistance during a maximum time of 2 seconds. The DCP measurement ($ightarrow$ 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.

Connection monitoring of the earth terminals $E/KE$ may not work as intended when $R_e > 4 \, \text{M} \Omega$ if the supply terminals (Kl.15/Kl.31) are not galvanically isolated from the chassis earth (Kl.31).

Standards

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E1 (ECE regulation No. 10 revision 5)
acc. 72/245/EG/ECC
DIN EN 60068-2-38
DIN EN 60068-2-30
DIN EN 60068-2-14
DIN EN 60068-2-64
DIN EN 60068-2-27

* Normative exclusion
The device went through an automotive test procedure in combination with multi customer requirements reg. ISO16750-x.

The standard 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 60 V. An additional central protection is necessary.

Abbreviations

| DCP | Direct Current Pulse |
| SST | Speed Start Measuring |
**Wiring diagrams**

1. **Connector XLA+**
   - Pin 1+2: L+ Line Voltage
2. **Connector XLA-**
   - Pin 1+2: L- Line Voltage
3. **Connector XK1A**
   - Pin 1: Kl. 31 Chassis ground/electronic ground
   - Pin 2: Kl. 15 Supply voltage
   - Pin 3: Kl. 31 Chassis ground (separate line)
   - Pin 4: Kl. 31 Chassis ground
   - 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 the wiring setup including the ISOMETER® iso-F1, Energy Storage, IMD, Drive 1 and 2, Generator, Brake, Air compressor, Power steering, Air Condition, DC 24 V Onboard, and surface earth connections.]
Technical data

Insulation coordination acc. to IEC 60664-1

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

Voltage test
AC 3500 V/1 min

Supply/IT system being monitored

Supply voltage
U_{S} DC 10…36 V

Max. operating current
I_{S} 150 mA

Max. current
I_{K} 2 A

6 A/2 ms inrush current

HV voltage range (L+/L-)
U_{n AC} 0…1000 V (peak value)
0…660 V r.m.s. (10 Hz…1 kHz)
DC 0…1000 V

Power consumption
< 2 W

Response values

Response value hysteresis (DCP)
25 %

Response value R_{an} 100 kΩ…1 MΩ

Undervoltage detection
0…500 V

Measuring range

Measuring range
0…10 MΩ

Undervoltage detection
0…500 V default setting: 0 V (inactive)

Relative uncertainty

SST (≤ 2 s)
good > 2 * R_{an} bad < 0.5 * R_{an}

Relative uncertainty DCP
0…85 kΩ ±20 kΩ

Relative uncertainty output M (fundamental frequency)
±5 % at each frequency
(10 Hz; 20 Hz; 30 Hz; 40 Hz; 50 Hz)

Relative uncertainty undervoltage detection
U_{n} ≥ 100 V 
“Good condition” ≥ 2 * R_{an}
“Bad condition” ≤ 0.5 * R_{an}

Relative uncertainty DCP

100 kΩ…10 MΩ ±15 %

100 kΩ…1.2 MΩ ±15 % to ±2 %
1.2…10 MΩ ±2 % to ±15 %
10 MΩ ±15 %

Switch-off time t_{ab} (OK CC; DCP)

(when changing over from R_{F} = 10 MΩ to R_{an}/2; at C_{e} = 1 µF; U_{S} = DC 1000 V)
t_{ab} ≤ 40 s (at F_{ave} = 10)
t_{ab} ≤ 33 s (at F_{ave} = 8)
t_{ab} ≤ 26 s (at F_{ave} = 6)
t_{ab} ≤ 26 s (at F_{ave} = 4)
t_{ab} ≤ 20 s (at F_{ave} = 2)
t_{ab} ≤ 20 s (at F_{ave} = 1)
during a self test t_{ab} + 10 s

Duration of the self test
10 s
during a self test t_{ab} + 10 s

Switch-off time t_{ab} (OK CC; DCP)

(when changing over from R_{an}/2 to R_{F} = 10 MΩ; at C_{e} = 1 µF; U_{S} = DC 1000 V)
t_{ab} ≤ 40 s (at F_{ave} = 10)
t_{ab} ≤ 33 s (at F_{ave} = 8)
t_{ab} ≤ 26 s (at F_{ave} = 6)
t_{ab} ≤ 26 s (at F_{ave} = 4)
t_{ab} ≤ 20 s (at F_{ave} = 2)
t_{ab} ≤ 20 s (at F_{ave} = 1)
during a self test t_{ab} + 10 s

Measuring voltage
U_{M} ±40 V

Measuring current I_{M}
at R_{F} = 0 ±33 µA
Impedance Z_{i} at 50 Hz ≥ 12 MΩ
Internal DC resistance R_{i} ≥ 1.2 MΩ

* F_{ave} = 10 is recommended for electric and hybrid vehicles
### Output

**Measurement output (M)**
- HS switches to $U_h$ – 2 V (3204)
  - (external pull-down resistor to Kl. 31 necessary 2.2 kΩ)
- LS switches to Kl. 31 + 2 V (3203)
  - (external pull-up resistor to Kl. 15 required 2.2 kΩ)

**Operation**
- Hi > short-circuit to $U_u$ (Kl. 15); Low > IMD off or short-circuit to Kl. 31
- Normal condition
  - Insulation measurement DCP; starts two seconds after power on;
  - First successful insulation measurement at ≤ 17.5 s
  - PWM active 5…95 %
- Undervoltage condition
  - Insulation measurement DCP (continuous measurement);
  - starts two seconds after power on;
  - First successful insulation measurement at ≤ 17.5 s

**Status output (OK) HS, LS**
- HS switches to $U_h$ – 2 V (3204)
  - (external pull-down resistor to Kl. 31 required 2.2 kΩ)
- LS switches to Kl. 31 + 2 V (3203)
  - (external pull-up resistor to Kl. 15 required 2.2 kΩ)

**Operating principle PWM driver**
- Condition “Normal” and “Undervoltage detected” (10 Hz; 20 Hz)
  - Duty cycle 5 % = > 50 MΩ ($\infty$)
  - Duty cycle 50 % = 1200 kΩ
  - Duty cycle 95 % = 0 kΩ
  - $R_t = \frac{90 \times 1200 \text{ kΩ}}{d_{\text{meas}} - 5\%} - 1200 \text{ kΩ}$
  - $d_{\text{meas}} = \text{measured duty cycle (5 %…95 %)}$

**Load current $I_L$**
- 80 mA

**Contact discharge**
- ≤ 10 kV

**Air discharge**
- ≤ 6 kV

**Conductor cross section**
- AWG 20…24

**Enclosure for crimp contacts**
- TYCO-MICRO MATE-N-LOK receptor HSG single R -1445022-8
  - TYCO-MICRO MATE-N-LOK receptor HSG single R -1445022-2

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**Graphs and Diagrams**

- PWM/%
- Voltage levels and duty cycles
- Timing diagrams for PWM outputs
- Graphs for load dump protection and factor averaging
- ESD protection levels
- Connection options
- Crimp contacts details

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**Technical Parameters**

- **Load dump protection:** < 60 V
- **Measurement method:** Bender-DCP technology
- **Factor averaging:** $F_{\text{ave}}$ (output M) 1…10 (factory set: 10)
- **ESD protection**
  - Contact discharge – directly to terminals: ≤ 10 kV
  - Contact discharge – indirectly to environment: ≤ 25 kV
  - Air discharge – handling of the PCB: ≤ 6 kV

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**Connection**

- **On-board connectors**
  - TYCO-MICRO MATE-N-LOK
    - 1 x 2-1445088-8 (Kl. 31, Kl.15, E, KE, HS, LS, OK)
    - 2 x 2-1445088-2 (L+, L-); The connection between the respective connecting pins at L+ or L- may only be used as redundancy. Cannot be used for looping through!
  - Crimp contacts
    - TYCO-MICRO MATE-N-LOK Gold
      - 14 x 1-794606-1
      - Conductor cross section: AWG 20…24
**General data**

- **Necessary crimp tongs (TYCO):** 91501-1
- **Operating mode/mounting:** Continuous operation/any position
- **Temperature range:** -40...+105 °C
- **Voltage failure:** ≤ 2 ms
- **Flammability class acc. to:** UL 94 V-0

**Mounting**

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

Mounting and connector kits are not included in delivery, but are available as accessories. The maximum diameter of the mounting points is 10 mm.

Before mounting the device, ensure sufficient insulation between the device and the vehicle or the mounting points (min. 11.4 mm to other parts). If the device is mounted on a metal or conductive subsurface, this subsurface has to be at earth potential (KL11; vehicle mass).

Deflection: max. 1% of the length or width of the PCB

Coating: thick-film lacquer

Weight: 52 g ±2 g

**Dimension diagram**

Dimensions in mm

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

**Example for ordering**

- IR155-3204-100kΩ-0V + B 9106 8139V4
- IR155-3204-200kΩ-100V + B 9106 8139CV4

The parameters, i.e. the response value and undervoltage protection value must be included in the order.