# ISOMETER® iso175

Insulation monitoring device for unearthed drive systems (IT systems) in road vehicles
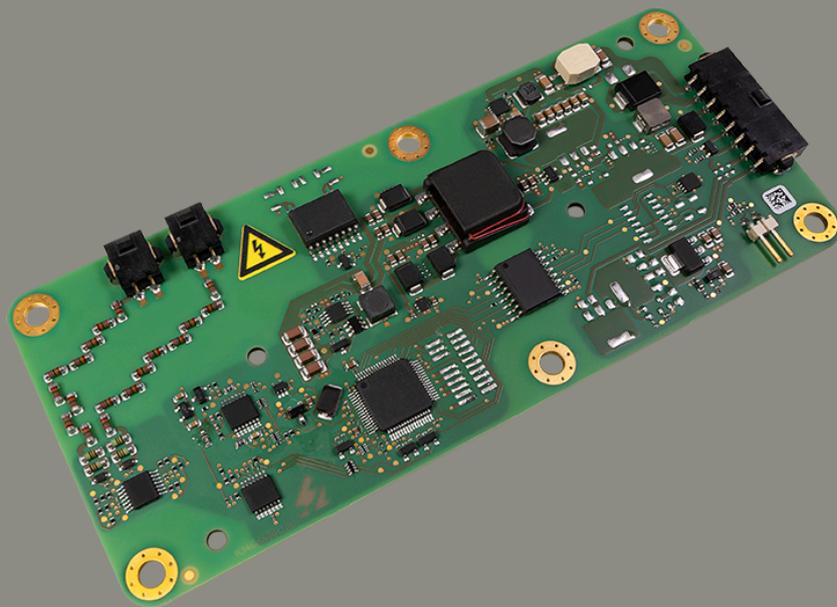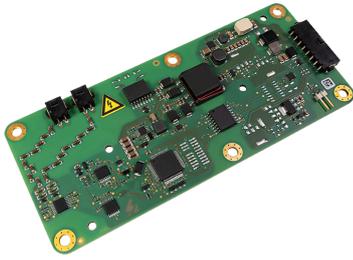
**BENDER**

# ISOMETER® iso175

**Insulation monitoring device for unearthed drive systems (IT systems) in road vehicles**



## Device features

- Suitable for 12 V and 24 V DC systems (supply voltage)
- Insulation monitoring of DC insulation faults for unearthed systems (IT systems)
- Insulation monitoring of AC insulation faults for unearthed systems (IT systems) (from firmware version D720V1.01)
- Continuous insulation resistance measurement R_iso_corrected and R_iso_original
- Response time ≤ 30 s for insulation resistances ≤ 500 Ω/Volt and system leakage capacitances ≤ 2µF
- Insulation measurement of larger leakage capacities possible through parameterisation (Profile High Capacity)
- Insulation measurement also when the vehicle's HV electric system is not energised
- integrated self diagnosis (online self test)
- HV connection monitoring (offline self test)
- Continuous monitoring of the earth connection
- Undervoltage detection
- Earth connection can be disconnected (Earthlift)
- Interfaces:
  - Digital output for device error message (OK_{HS})
    - HS-CAN interface with the following protocols
      - Bender-Standard
      - CAN-SAE J1939
  - All outputs short-circuit proof
- Load-dump protection

## Intended use

The ISOMETER® iso175 product line, called ISOMETER® in the following, is designed for installation in correspondingly marked HV-components of road vehicles. There it continuously monitors the insulation resistance of the HV system. Depending on the variant, the device communicates with a higher-level location using different CAN protocols (Bender standard, SAE J1939).

ℹ️ *Other installation locations in the vehicle or in industry sectors such as e. g. the shipping, railroad or aerospace industries are considered non-compliant with the intended use.*

## Function
### Insulation resistance measurement

The overall insulation resistance measurement of an HV system is based on a patented active measuring principle. This method uses a measuring voltage source internal to the device that injects a current into the monitored system, and the resulting voltage drop is measured. This is carried out independently of the voltage of the system to be monitored so that the insulation measurement can also be carried out when the HV system is deenergised.

⚠️ **ADVICE**

*For a correct insulation resistance measurement, a low-resistance connection between HV+ and HV- is required.*

The measuring duration for an individual measurement generally depends on the following factors and it can take up to 60 seconds:

- Overall insulation resistance of the HV system
- System leakage capacitance (Y capacitance)
- Measuring profile used (device parameter)

The present duration of an individual insulation measurement is output by the measured value Isolation: *Time_elapsed_since_last_measurement*. At the beginning of each new insulation measurement this value is automatically reset to 0 s.

Due to the then following internal statistical filtering and averaging of the individual measured values, the insulation resistance measured value is only available at the device interface with a delay (after up to 12 individual measurements).
When the fast start measurement is activated (Power-On profile "Standard with fast startup" or "High Capacity with fast startup"), the insulation resistance measured values (*R_iso_original, R_iso_corrected* and *R_iso_neg, R_iso_pos*) satisfy the specified tolerance as soon as the status signals *R_iso_status = 0xFE*.

When the fast start measurement is deactivated (Power-On profile *"Standard", "High Capacity", "Disturbed", "Service"*), the specified tolerance is met only after 12 individual measured values have been obtained in the status *R_iso_status = 0xFE*.

An insulation resistance *R_iso_corrected* is made available at the interface, and from which the currently valid "tolerance value" (set tolerance percentage times measured value) is subtracted. This ensures that this measured value never exceeds the actually present insulation resistance. The following example serves to illustrate this device function:

Rf = 1 MΩ, *R_iso_original* (measured) = e. g. 1.05 MΩ → tolerance ±12 %

*R_iso_corrected* = 1.05 MΩ – 1.05 MΩ * 0.12 = 924 kΩ

## Wiring diagram
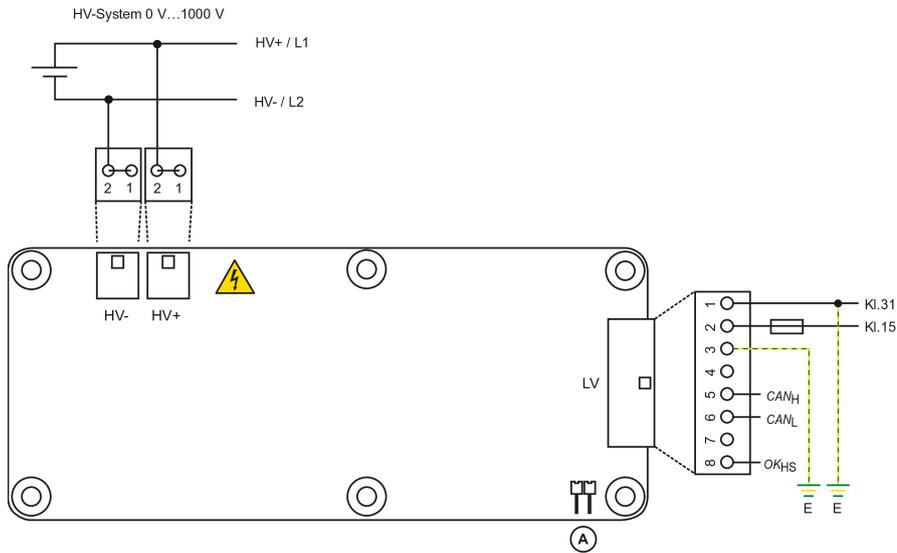


| Connector* | Pin no. | Description |
|---|---|---|
| HV+ | 1 | Mains voltage (HV+ / L1) |
| | 2 | |
| HV- | 1 | Mains voltage (HV- / L2) |
| | 2 | |
| LV | 1 | Supply voltage - (terminal 31) |
| | 2 | Supply voltage + (terminal 15) |
| | 3 | Earth connection (E)[1] |
| | 4 | n.c. |
| | 5 | CAN-High |
| | 6 | CAN-Low |
| | 7 | n.c. |
| | 8 | Status output (high side) $(OK_{HS})$[2] |
| A | | Jumper CAN terminating resistor 120 Ω[3] |

[1]  Pins 1 and 3 must be on the same potential for fault-free operation.

[2]  The electrical design of the status output is an open-collector topology, which requires a pull-down resistor against terminal 31 for a defined output signal. Here a 2k2 resistor with a power rating of at least 1 W is recommended.

[3]  The ISOMETER® furnished with an onboard CAN-bus termination with 120 Ω, which can be activated by plugging a jumper (for a recommendation see chapter "Technical data") to plug connector A.
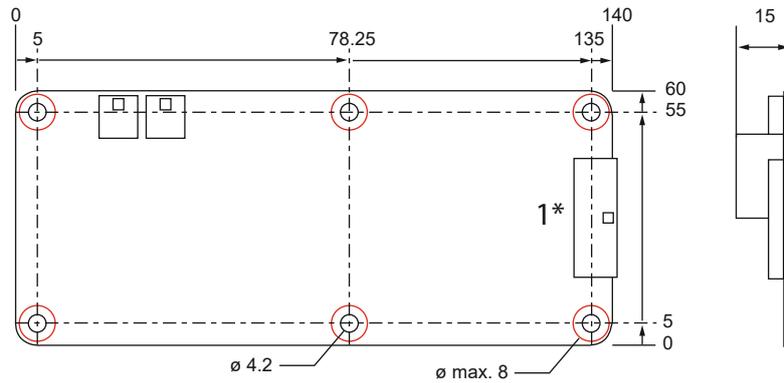
*  For details on the connectors required to connect to the HV system as well as to the supply voltage refer to  "Ordering information".

For a functioning connection detection of LV pin 3 to chassis ground, the connection of LV pin 1 must also be connected to chassis ground.

## Wiring example
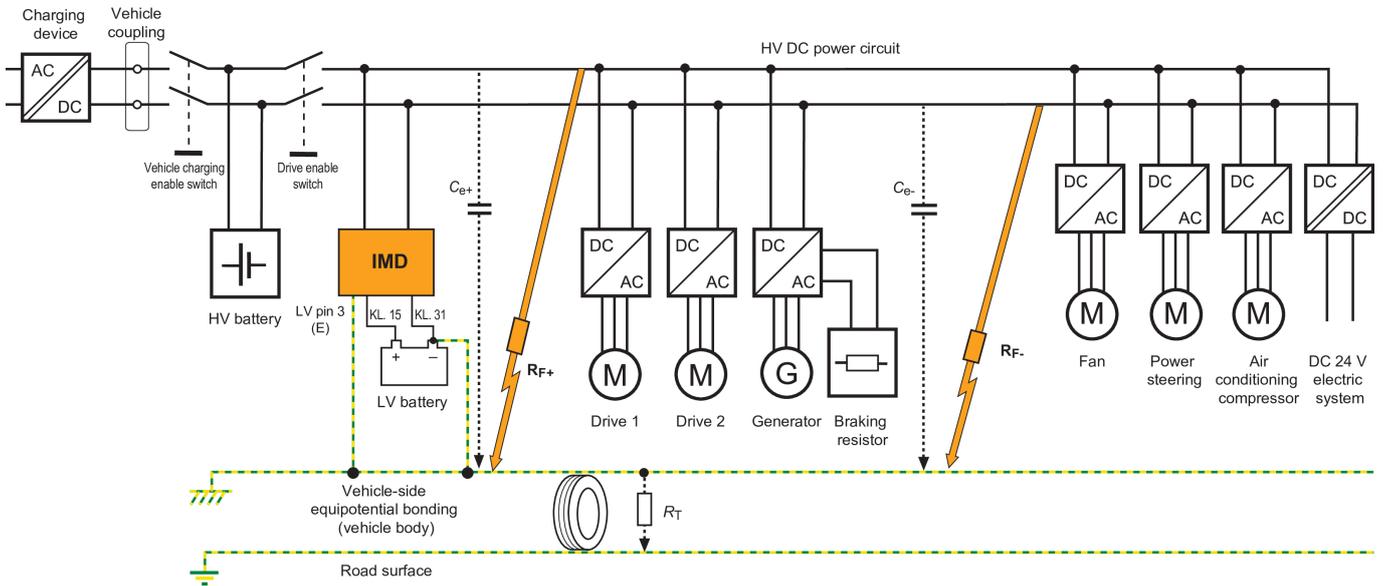


## Dimension diagram



Dimensions in mm (L x W x H) 140 x 60 x 15 mm

1*      LV: protrudes 1 mm from the printed circuit board edge

ℹ️   *Red markings: fastening positions*

## Technical data

### Insulation coordination acc. to IEC 60664-1

| | |
|---|---|
| Protective separation (reinforced insulation) | between (L1/L2) – (terminal 31, terminal 15, $E$, $CAN_H$, $CAN_L$, $OK_{HS}$) |
| Rated impulse voltage | 6000 V |
| Overvoltage category | II |
| Voltage test | DC 4200 V/ 1 min |
| Pollution degree | 2 |

### Supply / monitored IT system

| | |
|---|---|
| Supply voltage $U_s$ | DC 12…24 V |
| Tolerance Supply voltage $U_s$ | -17…+50 % |
| Self consumption, no load at output | ≤0.55 W |
| Max. operating current $I_s$ | 300 mA |
| HV voltage range (L1/L2) $U_n$ | DC 0…1000 V |
| | AC 0…480 $V_{RMS}$ (f=50/60Hz) |
| Tolerance $U_n$ | +10 % |
| Recommended back-up-fuse | M 630 mA |

### Response values

| | |
|---|---|
| Response value $R_{an}$ | 30 k…2 MΩ |
| Response value hysteresis (DCP) | 25 % |
| Undervoltage detection | DC 0…1000 V |
| | Default setting: 0 V (inactive) |
| Undervoltage detection hysteresis | 5 % |

### Measuring range

| | |
|---|---|
| R_iso_corrected | 0…40.5 MΩ |
| R_iso_original | 0…50 MΩ |
| Insulation: R_iso_neg* | 0…50 MΩ |
| Insulation: R_iso_pos* | 0…50 MΩ |
| Voltage: HV system voltage measurement | DC 0…1000 V AC 0…480 $V_{RMS}$ |
| Tolerance Voltage: HV system voltage measurement | ±5 % ± 2 V |
| Capacity $C_e$: Measured_Value | 0…10 µF |
| Unbalance $U_n$ (Prerequisite: DC ≥ 100 V, R_iso ≤ 5 MΩ) | 0…100 % |
| Tolerance Unbalance | ±5 % |
| Relative uncertainty of the estimated measured values of the fast start measurement: R_iso_status = 0xFC) | 0…-100 % |

| Tolerance "R_iso_corrected" (R_iso_status = 0xFD) | Measuring range | Abs. fault |
|---|---|---|
| | 0…50 kΩ | 0…-50 kΩ |
| | | Rel. fault |
| | 50 kΩ…1.2 MΩ | 0…-120 % to 0…-48 % |
| | 1.2…5 MΩ | 0…-48 % to 0…-76 % |
| | 5…10 MΩ | 0…-76 % |
| | > 10 MΩ | not specified |
| Tolerance "R_iso_corrected" (R_iso_status = 0xFE) | Measuring range | Abs. fault |
| | 0…50 kΩ | 0…-50 kΩ |
| | | Rel. fault |
| | 50 kΩ…1.2 MΩ | 0…-60 % to 0…-24 % |
| | 1.2…5 MΩ | 0…-24 % to 0…-38 % |
| | 5…10 MΩ | 0…-38 % |
| | > 10 MΩ | not specified |

\* Available from an HV voltage > 100 V

### Time response

| | |
|---|---|
| Enabling time $t_{start}$ ($OK_{HS}$; fast start measurement) | ≤ 5 s ($C_e$ ≤ 2 µF) |
| Response time $t_{an}$ ($OK_{HS}$) as per LV 123 (100…500 Ω/V, 2 µF (profiles: Standard/ Standard with fast startup) | ≤ 30 s |
| Switch-off time $t_{ab}$ ($OK_{HS}$; DCP)/ insulation fault (100… 500 Ω/V) until R_iso ≥ 10 MΩ, $C_e$ ≤ 1 µF | Profil standard ≤ 55 s Profil high capacity ≤ 60 s Profil distrubed ≤ 115 s Profil service ≤ 36 s |
| Online self test | ≤ 1 s |
| Offline self test with output test ($OK_{HS}$) | ≤ 5 s |

## Measuring circuit

| | | |
|---|---|---|
| System leakage capacitance $C_e$ max. | Standard profile | ≤ 5 µF |
| | High capacity (capacitance) profile | ≤ 10 µF |
| | Disturbed profile | ≤ 10 µF |
| Measuring voltage $U_M$ | | ±35 V ±2 V |
| Measuring current $I_M$ at $R_F = 0$ kΩ | | ≤ ±30 µA |
| DC internal resistance $R_i$ | | 1.2 MΩ ± 2 % |

## Status output OK$_{HS}$

| | |
|---|---|
| OK$_{HS}$ (High-Side driver) high $U_s$* | ≥ $U_s$ -2 V |
| OK$_{HS}$ (High-Side driver) low $U_s$* | ≤ 0,2 V |
| Permissible output current max. | 80 mA |

\* With correctly connected pull-down resistor (2k2 Ω)

## CAN interface

| | |
|---|---|
| Data transmission rate | 125, 250, 500, 666, 800, 1000 kBaud |
| Terminating resistor | 120 Ω* |

\* via jumper: Recommended: Weitronic W+P Products Jumper series 165. Manufacturer ordering no.: 165-101-10-00

## EMC

| | |
|---|---|
| Load-dump protection | ≤ 58 V |

## ESD protection

| | |
|---|---|
| Contact discharge – directly at the terminals | ≤ 4 kV |
| Contact discharge – indirectly via the environment | ≤ 4 kV |
| Air discharge – handling of printed circuit board | ≤ 8 kV |

## HV connection

| | |
|---|---|
| Cable length, max. | 2 m |
| Cable cross section | AWG 20…24 |
| Validated cable type | AlphaWire 5875 |

## Environment

| | |
|---|---|
| Operating temperature | -40…+105 ℃ |
| Temperature cycle (ISO 16750-4) | Ka |
| Air humidity (rH) | 0…100 % |
| Altitude | ≤ 3000 m |
| **Classification of climatic conditions acc. to IEC 60721** | |
| Transport (IEC 60721-3-2) | 2K11 |
| Long-time storage (IEC 60721-3-1) | 1K21 |
| **Classification of mechanical conditions acc. to IEC 60721** | |
| Transport (IEC 60721-3-2) | 2M4 |
| Long-time storage (IEC 60721-3-1) | 1M10 |

## Other

| | |
|---|---|
| Operating mode | Continuous operation |
| Flammability class as per | UL 94 V-0 |
| Deflection | max. 1 % of the length or width of the PCB |
| Coating | Protective paint (ELPEGUARD® SL 1307 FLZ) |
| Weight | 37 g ± 3 g |

## Standards and approvals

The ISOMETER® iso175 has been developed in accordance with the following standards and approvals:

- IEC 61010-1
- IEC 60664-1
- IEC 60068-2-6
- IEC 60068-2-14
- IEC 60068-2-27
- IEC 60068-2-64
- ISO 6469-3
- ISO 16750-2
- ISO 16750-3
- ISO 16750-4
- (UN)ECE R10 Rev.6
- SAE J1939-82
- Insulation measurement functions based on: IEC 61557-8

### Cybersecurity

An assessment in accordance with (UN)ECE R155, R156 and ISO/SAE 21434 has been carried out. Further information is documented in the separately available Cybersecurity Case and in the Cybersecurity Safety Manual. The documents are available for download:

https://www.bender.de/fileadmin/content/Products/m/e/iso175-Cybersecurity-Case.pdf

https://www.bender.de/fileadmin/content/Products/m/e/iso175-Cybersecurity-Safety-Manual.pdf

## Ordering information

### Standard variants

| Type | Connector type (connection) | Interfaces | Standard-configuration | Art. No. | Manual No. |
|---|---|---|---|---|---|
| iso175C-32-SS | TYCO[1] | HS-CAN SAE J1939 | Baud rate: 500 kBaud Response value: 100 kΩ (error) 500 kΩ (warning) | B91068201 | D00415 |
| iso175C-42-SS | Samtec/Molex[2] | | | B91068202 | |
| iso175C-32-SB | TYCO[1] | HS-CAN Bender-Standard | | B91068203 | |
| iso175C-42-SB | Samtec/Molex[2] | | | B91068204 | |

[1]  HV+ / HV- connections
- Connector: TE Connectivity / AMP
- Tyco-Micro Mate-N-Lok™, 1445022-2

LV connection
- Connector: TE Connectivity / AMP
- Tyco-Micro Mate-N-Lok™, 1445022-8

Crimp contacts, suitable for both connections
- Connector: TE Connectivity / AMP
- Tyco-Micro Mate-N-Lok™ gold, plating B (38 µm), 1-794606-1
- Crimping tool (Tyco): 91501-1 (AWG 20…24)

[2]  HV+ / HV- connections
- Connector: Molex Mini Fit Jr. Housing, 39-01-2025
- Crimp contact: Mini Fit Jr. Contact gold, 39-00-0089, AWG 16
- Crimping tool (Molex): 2002182200

LV connection
- Connector: Samtec Mini Mate Housing, IPD1-08-S-K
- Crimp contact: Samtec Mini Mate gold, CC79R2024-01-L, AWG 20…24
- Crimping tool: 20-30 AWG (Samtec): CAT-HT-179-2030-13

Cable recommendation for proper functioning of the offline self test: AlphaWire (Art. No. 5875)

ℹ️ *CAN configurations (e.g. baud rate and addressing) cannot be changed later. Retrospective modification of these parameters is only available starting with firmware version D720V1.01.*

**Customized variants\***

| Type | Connector type (connection) | Interfaces | Customer-configuration | Art. No. | Manual No. |
|---|---|---|---|---|---|
| iso175 customized | TYCO (side) or Samtec/Molex (top) | HS-CAN (SAE J1939 or Bender-Standard) | According to customer specifications | B91068200 | D00415 |

\*    For sales contact data and further information see "https://www.bender.de/loesungen/emobility/" .

**Accessories**

| Description | Suitable for type | Art. No. |
|---|---|---|
| IR155 / iso175 fastening kit | All | B91068500 |
| IR155 / iso175 connection kit (TYCO) | iso175X-32-XX | B91068501 |
| IR155 /iso175 connection kit (Samtec/Molex) | iso175X-42-XX | B91068502 |