Hybrid Vehicle Distribution Box

Hybrid Vehicle Distribution Box with an integrated insulation monitoring device (IR155-3204) for unearthed DC drive systems (IT systems) in electric vehicles
Hybrid Vehicle Distribution Box

Product description
The Hybrid Vehicle Distribution Box is optimised for use in hybrid or fully electric vehicles and monitors the HV insulation resistance between active HV conductors of an electrical drive system, with a voltage range, $U_n$, of DC 0 V to 750 V, and the reference earth (i.e. car chassis ground or Kl. 31).

It consists mainly of an ISOMETER® IR155-3204 Insulation Monitoring Device (IMD) and space to accommodate a maximum of six Siemens series 3NE8720-1 fuses.

Device features
- Insulation monitoring of AC and DC insulation faults for unearthed systems (IT systems) from DC 0…750 V peak
- Undervoltage detection for voltages < 100 V
- Suitable for 12 V and 24 V systems
- Automatic ISOMETER® self test
- Continuous measurement of the insulation resistance from 0 Ω…10 MΩ
  - Response time, $t_{an}$, for the system start initial measurement (Speed Start Measuring – SST): < 2 s after the supply voltage has been switched on
  - Response time, $t_{an}$, for insulation resistance measurement using Direct Current Pulse (DCP) method: < 20 s
- DCP ensures the automatic adaptation to the existing system leakage capacitance ($\leq 1 \mu F$)
- Detection of earth faults and interruption of the earth connection
- Short-circuit proof outputs for:
  - Fault detection (high-side driver output)
  - Measured value (with a PWM working range of 5…95 %) and status ($f = 10…50 \text{ Hz}$) at high-side driver (MHS output)
- Protective coating (SL 1301ECO-FLZ) on the insulation monitoring device

Approvals

CE 10R - 03 6056

In compliance with the UL standard 248-13, the SIEMENS fuses were tested with DC 700 V. For normal operation, the voltage is irrelevant. When a trip occurs, the fuse must be able to safely switch off the residual current under system voltage conditions. In this application, the conditions for the fuses are more favorable than in the UL standard, so that safe operation and safe tripping is guaranteed even at a higher system voltage of DC 750 V. Refer to the technical data for more information.

Functional description
Once power is switched on, the Hybrid Vehicle Distribution Box is initialised and the SST measurement begins. The first estimated insulation resistance measurement by the ISOMETER® IR155-3204 is available within two seconds after power on. The Direct Current Pulse (DCP) measurement (i.e. a continuous measurement method), which automatically adapts to the existing system leakage capacity of $\leq 1 \mu F$, starts subsequently.

To obtain these measurements, the ISOMETER® IR155-3204 generates a pulsed measuring voltage that is superimposed onto the IT system by terminals HV+/HV- and E/KE.

The measured insulation condition is available as a Pulse Width Modulated (PWM) signal at the terminal MHS, which is located on an integrated and galvanically isolated interface (high-side driver).

Fault information in the connecting wires to E/KE or functional faults is automatically recognised and signalled through this interface, which consists of the status output OKHS. These fault messages indicate a HV system insulation fault, an ISOMETER® connection or device error.
Hybrid Vehicle Distribution Box

Connection – Internal

To AUX inverter 1  To AUX inverter 2  To AUX inverter 3

Souriau Type UTS6JC128S plug

A (time-delay fuse is recommended. The fuse rating depends on the inrush current of the IR155-3204)

Chassis ground

Souriau receptor

DC Link 0 V…750 V
Wiring diagram

- **Side view top**
- **Side view left**
- **Top view without cover**
- **Side view right**
- **Top view with cover**
- **Side view bottom**

**Earth point**
- Welded stud M8 x 20
- 1 x locknut
- 1 x Spring ring
- 2 x Washer

**Mounting rail**
- + Mounting hole M5

**Box cover**
- Thread bolt M5 x 16 (Torx)

**Tightening torques**
- **Box cover**: 3.5 Nm
- **Earth point**: 12 ± 2 Nm
- **Chassis mounting**: 12 ± 2 Nm
- **Dummy plug for cable glands**: 10 Nm
Technical Data

**Supervised IT system**
- Rated voltage range \((U_n)\):
  
  \[\text{AC 0 V ... 750 V peak}\]
  
  \[\text{0 V ... 660 V rms (10 Hz ... 1 kHz)}\]
  
  \[\text{DC 0 V ... 750 V}\]

- Protective separation (reinforced insulation) between \((\text{HV+} / \text{HV-}) - (\text{KL.31, KL.15, E, KE, MHS, OK})\)

- Voltage test: AC 3500 V/1 min
- Load dump protection: < 60 V
- Undervoltage detection: 100 V
- System leakage capacitance \(C_e\):
  
  \[\mu F\] > 1

- Reduced measuring range and increased measuring time at \(C_e\):
  
  \[(\text{E.g. max. range 1 MΩ @ 3 μF; } t_{an} = 68 s @ \text{changeover } R_f: 1 \text{ MΩ} > R_{an/2})\]

**Supply voltage (ISOMETER® IR155-3204)**
- Supply voltage \(U_s\):
  
  DC 10 ... 36 V
- Nominal supply voltage:
  
  DC 12 / 24 V
- Max operational current \(I_s\):
  
  150 mA
- Max current \(I_k\):
  
  2 A
- 6A/2 ms inrush current
- High-voltage range:
  
  DC 0 ... 750 V
- Power dissipation:
  
  \(P_s\) < 2 W

**Measuring circuit (ISOMETER® IR155-3204)**
- Measurement method:
  
  Bender DCP technology
- Measuring voltage \(U_m\):
  
  ± 40 V
- Measuring current \(I_m\) at \(R_f = 0\):
  
  ± 33 μA
- Factor averaging \(F_{ave}\):
  
  1 ... 10 (default: 10)

**Measuring ranges (ISOMETER® IR155-3204)**
- Insulation resistance range\(^1\) for \(1 \mu F\):
  
  0 Ω ... 10 MΩ
- Insulation resistance range\(^1\) for \(3 \mu F\):
  
  0 Ω ... 1 MΩ
- Insulation resistance range\(^1\) for \(5 \mu F\):
  
  0 Ω ... 750 kΩ
- Insulation resistance range\(^1\) for \(6 \mu F\):
  
  0 Ω ... 550 kΩ
- Impedance \(Z_i\) at 50 Hz:
  
  ≥ 1.2 MΩ
- Internal DC resistance \(R_i\):
  
  ≥ 1.2 MΩ

**Relative uncertainty SST (≤ 2 s)**
- Good: > 2 x \(R_{an}\)
- Bad: < 0.5 x \(R_{an}\)

**Response values (ISOMETER® IR155-3204)**
- Response uncertainty (according to IEC 61557-8):
  
  ± 15% (default: 10)
- Hysteresis:
  
  ± 25%
- Response time under normal operating conditions:
  
  \(t_{an}\) (DCP):
  
  ≤ 20 s (at \(F_{ave} = 10\))
  
  ≤ 68 s (at \(F_{ave} = 10\))
- Response time after power on:
  
  \(t_{tan}\) (DCP):
  
  ≤ 40 s (at \(F_{ave} = 10\))
- Switch-off time \(t_{ab}\) (DCP):
  
  ≤ 40 s (at \(F_{ave} = 10\))
- Self test time:
  
  every 5 minutes; has to be added to \(t_{an/ab}\)

**Timing**
- Load current \(I_a\):
  
  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 from 10 to 30 % \(V_{OUT}\):
  
  Max. 6 μV/μs
- slew rate off from 70 to 40 % \(V_{OUT}\):
  
  Max. 8 μV/μs
### Technical data (continued)

#### Measurement Output (ISOMETER® IR155-3204)

- **Measurement Output**:  
  - $H_S$ switches to $U_S$ - 2 V  
    - external pull-down resistor of $\leq 2.2 \text{k}\Omega$ required
  - **Status Output ($O_K$)**:  
    - $O_K$ switches to $U_S$ - 2 V  
      - external pull-down resistor of $\leq 2.2 \text{k}\Omega$ required
      - **High**: $R_T > \text{response value}$  
      - **Low**: Insulation resistance $\leq \text{response value detected or IMD error or ground error or undervoltage detected or IMD off}

#### Status Output (OK)

- OK $H_S$ switches to $U_S$ - 2 V  
  - external pull-down resistor of $\leq 2.2 \text{k}\Omega$ required

#### ESD protection (ISOMETER® IR155-3204)

- Contact discharge - directly to terminals  
  - $\leq 10 \text{kV}$
- Contact discharge - indirectly to environment  
  - $\leq 25 \text{kV}$
- Air discharge - handling of the PCB  
  - $\leq 6 \text{kV}$

#### Fuses

- **Type**: Siemens series 3NE8720-1 (x 6)
- **Rated voltage $U_n$**:  
  - AC 690 V
  - DC 700 V
- **Rated current $I_n$**: 80 A
- **Interrupting rating**:  
  - 200 kA (in accordance with IEC 60947-2; UL 248-13)
  - 50 kA (with DC in accordance with IEC 60947-2; UL 248-13)
- **Pre-arching value ($t _{\text{vs}} = 1 \text{ ms}$)**: 380 A\(t _{\text{s}}\)
- **Total operating energy at $U_n$**: 2700 A\(t _{\text{s}}\)
- **Temperature rise (midsection) at $I_n$**: 80 K
- **Power dissipation at $I_n$**: 18 W
- **Mounting position**: Vertical and horizontal
- **Varying load factor**: 0.9
- **Ambient temperature**: -40°C...+70°C
- **Operating class (IEC 60269)**: aR

#### Connectors (Electric Distribution Box)

- **Souriau plug**: UT56/128S (8-pole)
- **Cable diameter for Souriau plug**: 3 mm...9 mm
  - 5 mm...12 mm (standard)
- **Grounding point**: M8 x 20
- **Blind plug**: M25 x 1.5
- **Protection level**: IP69K
- **For further information, please refer to Chapter 1**

#### Environment (Hybrid Vehicle Distribution Box)

- **Range of application**: 3,000 m above sea level
- **Contact discharge - directly to terminals**:  
  - $\leq 10 \text{kV}$
- **Contact discharge - indirectly to environment**:  
  - $\leq 25 \text{kV}$

#### Other (Hybrid Vehicle Distribution Box)

- **Operating mode**: Continuous operation
- **Protection level**: IP69K
- **Temperature range**: -40...+70°C
- **Storage temperature**: max. 50°C
- **Box material**: Stainless steel
- **Weight**: 9 kg (with dummy stoppers and without fuses on delivery)

#### Mounting (Hybrid Vehicle Distribution Box)

See Chapter 4.2 Chassis mounting in the manual for detailed information.

If the device is mounted on a metal or conductive subsurface, this subsurface has to be grounded (i.e. grounding point to vehicle chassis).

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**Notes:**

1. Increased measurement deviations should be expected outside this measurement range.
2. This response time value is qualified technically. The response value for the measurement series was set to 100 kΩ.
3. When connecting to ESX-LT pin 26, then according to the Siemens EFLA standard system, a 1 kΩ pull-down resistor is already included.
4. The suitability of these fuses for this application has been verified by Siemens AG. This was demonstrated with a short-circuit shutdown at DC 750 V with a fuse in the both the positive and the negative path. Voltage breakdown occured at high shortcircuit currents. This applies to short-circuit currents, which lead to a maximum fuse melting time of 10 ms. At the minimum short-circuit current of 350 A, the fuse is – according to the time/current characteristic (graph) – significantly quicker than 10 ms, ensuring a safe shutdown.
5. Rated voltage according to UL
   - In compliance with the UL standard 248-13, the SIEMENS fuses were tested with DC 700 V and this value is printed on the fuse label. For normal operation, the voltage is irrelevant. When a trip occurs, the fuse must be able to safely switch off the residual current under system voltage conditions. In this application, the conditions for the fuses are more favorable than in the UL standard, so that safe operation and safe tripping is guaranteed even at a higher system voltage of 750 V DC.
6. Not within the scope of delivery from Bender.
7. Each plug has 2 seals to cover the specified cable range. The standard seal for cables with a diameter of 5...12 mm is preassembled. The second seal, for cables with a diameter of 3...9 mm, is supplied as a loose part together with the plug.
**Ordering information**

<table>
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<th>Response value</th>
<th>Nominal voltage</th>
<th>Supply voltage</th>
<th>Undervoltage detection</th>
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<th>Art. No</th>
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**Spare parts**

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<td>&lt;100 V</td>
<td>ISOMETER® IR155-3204</td>
<td>IR155-3204-400 kΩ-100 V + B 9106 8139 CV4</td>
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